soe

State
Of the
Environment
Report

Republic of Palau

Republic of Palau

***S**tate*
***O**f the*
***E**nvironment Report*
1994

USP Library Cataloguing-in-Publication data:

Otobed, Demei O. and Maiava, Iosefa A.
Republic of Palau : state of the environment report.
—[Apia, Western Samoa : SPREP, 1994].

xviii, 82p. : 29cm

"Produced with financial assistance from the
United Nations Development Programme (UNDP)"

ISBN 982-04-0097-X

1. Environmental policy—Palau 2. Environmental protection—Palau 3. Palau—Environmental conditions I. Otobed, Demei O. II. Maiava, Iosefa A. III. South Pacific Regional Environment Programme IV. Title

HC79.E5P2R46 333.71509966

Prepared for publication by the South Pacific
Regional Environment Programme,
Apia, Western Samoa

Coordinating editor
Suzanne Grano

Editor
Barbara Henson

Design and production
Peter Evans

Artwork for symbols
Catherine Appleton

Dugong drawings reproduced courtesy of
Division of Marine Resources

Photography
Demei Otobed and
Environmental Quality Protection Board

Cover design by Peter Evans based on
an original design by Catherine Appleton

Maps supplied by MAPgraphics, Brisbane, Australia

Typeset in New Baskerville and Gill Sans
Printed on 110 gsm Tudor R. P. (100% recycled)
by ABC Printing, Brisbane, Australia

Produced with financial assistance from the United Nations Development Programme (UNDP)

Cover photograph: Ngeremeduu Bay, one of the largest coastal bay ecosystems in Micronesia. (photo reproduced courtesy of Environmental Quality Protection Board)

Republic of Palau

State Of the Environment Report 1994

by Demei O. Otobed and Iosefa A. Maiava

Produced with financial assistance from the United Nations Development Programme (UNDP)


Palau
180°
134° 30'E
Northern Marianas
Hawaii
Guam
Federated States of Micronesia
Marshall Islands
PACIFIC OCEAN
Palau
Kiribati
Nauru
Papua New Guinea
Solomon Islands
Tuvalu
Tokelau
Western Samoa
American Samoa
French Polynesia
Wallis and Futuna
Vanuatu
Fiji
Tonga
Niue
Cook Islands
New Caledonia
Pitcairn
Australia
New Zealand
Scale 1:140,000,000
0 1000 2000 km
0 1000 miles
134° E
Ngaruangel
Kayangel
8° N
PACIFIC
OCEAN
Ngarechur
Ngarkeklau
Ollei
Badrulechau
Ngarchelong
Scale 1:700,000
0 10 20 30 km
0 10 20 miles
∴ Archaeological site
Elab
Ngardmau
Mt Ngulitl
Ngkeklau
Ngaraard
Mt Ngerechelechuus
Ngiwal
Ngaremlengui
Ngardok Lake
7° 30'N
BABELDAOB
Melekeok
Ngatpang
Aimeliik
Ngchesar
Airai
Oikull
Meiuns
Malakal
KOROR
Koror
ROCK ISLANDS
Ulong
Ngebedangel
Ngeruktabel
Ngerukewid Islands Wildlife Preserve
Mecherechar
Ngemelis
Ngerechong
7° N
Ngardclolk
Peleliu
Angaur
134° E
134° 30'E
Babeldaob
PACIFIC OCEAN
Sonsorol
Pulo Anna
SOUTHWEST ISLANDS
Merir
Hatohobei
Helen
0 100 200 km
0 100 miles

Foreword

This document represents a concise report on the State of the Environment for the Republic of Palau. It was prepared as a component of the National Environmental Management Strategies (NEMS) Project. The NEMS Project was instigated to address sustainable environmental development and planning issues in a number of Pacific Island countries, namely Kiribati, Nauru, Niue, Palau, Tokelau, Tuvalu and Western Samoa. It was funded by the United Nations Development Programme (UNDP) and implemented through the South Pacific Regional Environment Programme (SPREP) as part of a broader assistance project called Pacific Multi Island (PMI): Planning and Implementation of Pacific Regional Environment Programme, which concentrates on regional and in-country institutional strengthening and training of environmental managers.

The State of the Environment Report for the Republic of Palau is a comprehensive reference document on the current status of Palau's environment which should act as a benchmark against which changes to the environment can be gauged. The Report summarizes the current state of knowledge about the environment of Palau in areas such as the terrestrial environment, marine resources, cultural and archaeological resources, and socio-economic environment, and outlines environmental challenges facing Palau. The State of the Environment Report also provides an important vehicle for raising the awareness of the community to the importance of environmental issues and how these should be integrated into future decision-making processes.

We also wish to acknowledge that the Report draws a substantial amount of in-depth information from the Comprehensive Conservation Strategy (CCS) for the Republic of Palau, authored by Demei Otobed, Jodi Cassell and Haruo Adelbai.

SPREP looks forward to working with the Republic of Palau and with other regional and international organizations in tackling the environmental issues identified in this State of the Environment Report.

Vili A Fuavao
Director
South Pacific Regional Environment Programme

Contents

Notes All currency amounts in this report are in United States dollars ($US).
A financial year spans the period October 1 to September 30.

Acronyms

BMDC	Belau Mariculture Demonstration Center
BNRD	Bureau of Natural Resources and Development
CCS	Comprehensive Conservation Strategy
CEDAM	Conservation Education Diving Archeological Museum
DCE	Division of Conservation and Entomology
DMR	Division of Marine Resources
DOI	Department of the Interior (US)
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EQPB	Environmental Quality Protection Board
FAD	Fish Aggregation Device
MOC	Micronesian Occupational Center, or Palau Community College (PCC)
NEMS	National Environmental Management Strategy
NGO	non-government organization
NPO	National Planning Office
OEK	Olbiil Era Kelulau (national congress)
PATA	Pacific Asia Travel Association
PCAA	Palau Community Action Agency
PFA	Palau Fishing Authority
PITI	Palau International Traders, Inc.
PMA	Palau Maritime Authority
PMCI	Palau Modekngei Co-operative, Inc.
PNC	Palau National Code
PNMDP	Palau National Master Development Plan
PRI	Palau Resource Institute
PVA	Palau Visitors Authority
SPC	South Pacific Commission
SPREP	South Pacific Regional Environment Programme
TNC	The Nature Conservancy
UNDP	United Nations Development Programme

Glossary

Palauan words

bai	Traditional men's house.
chutem buai	Public domain lands.
chetemel a kebliil	Clan lands.
kerreomel	Persons assigned to gathering food for custom feasts.
klobak	Traditional male chiefs.
klobak-l-dil	Traditional female chiefs.
subed	Announcements by chiefs concerning seasonal or species hunting closures.

General

agroforestry	The combination of agriculture and forestry into a sustainable system.
alluvium	A deposit of sand, mud etc. formed by flowing water.
aquaculture	The farming of marine or freshwater plants and animals.
Compact	Compact of Free Association between the Government of the Republic of Palau and the United States of America.
conservation	Managing the way people use natural resources so that they give the greatest sustainable benefit today, while keeping their full potential to meet the needs and aspirations of future generations.
cost–benefit analysis	Comparison between benefits derived from a project and its cost.
degradation	The result of poor resource use which pollutes, damages or reduces the quality of resources available to future generations.
ecology	Branch of biology which deals with the relation of plants and animals to their environment.
economic growth	The increase in the value of goods and services produced in a country, usually measured over a year.
ecosystem	A community of plants and animals and the environment they inhabit.
effluent	A liquid flow.
endangered species	Species that are in danger of disappearing.
endemic	An animal or plant which is found only in one region or country and is not present naturally in any other part of the world.

environment	All the living and non-living things in a particular place or on the earth generally, and the way they interact or work together.
erosion	The wearing away of the earth's surface (for example, soil) by the action of water, wind etc.
eutrophication	The process in which high levels of nutrients encourage the growth of small plants called algae which use up so much oxygen that nothing else grows.
extension	Providing specialized knowledge to community groups, for example, agricultural expertise to farmers.
fauna	Animals.
feldspar	Type of mineral made up of aluminum silicates with sodium, potassium or calcium found in igneous rocks. Feldspars in Palau contain magnesium.
flora	Plants.
geology	The science of the earth, including the composition, structure and origin of its rocks.
Ghyben-Herzberg lens	The lens-shaped fresh-water-saturated zone formed as fresh water percolates down through island soils. This fresh-water zone is confined in a general lens shape by the surrounding denser seawater.
ground water	Water found in soil or in the pores and crevices in rock.
habitat	The natural home of a plant or animal species.
heritage	A nation's archaeological resources, historic buildings, special places, especially when regarded as worthy of preservation.
indigenous	Belonging to a particular area.
infrastructure	The basic structural foundations of a society or enterprise. Also refers to basic facilities such as roads, airports, electricity and communication systems.
introduced species	A species which does not naturally occur in a particular area but rather has been brought in from outside.
invertebrate	Animal with no backbone or spinal column.
leachate	Water which has seeped through the earth, a rubbish tip, mine waste etc. and hence carries impurities.
nonpoint source pollution	Pollution which is diffused within an environment, for example, topsoil erosion, pesticides or fertilizer runoff.
nutrient	A substance providing essential nourishment for the maintenance of life.
oligotrophic water	Water which is low in plant nutrient minerals and organisms and so is not highly productive in plant life.
organic	Relating to plants, animals or other living matter.
pelagic fish	Fish that live in the open ocean rather than close to shore.
permeable	Able to be penetrated, for example, by water.
pesticide	Chemical that kills unwanted organisms.
reticulation	A system of pipes carrying water.
sediment, sedimentation	Matter which settles to the bottom of a liquid.
sewage	Waste matter, especially from toilets, conveyed in sewers.
sewerage	System of pipes to carry toilet waste.
species	A scientific name given to each different type of animal or plant.
strategy	A plan to help achieve certain goals.

subsistence	Producing mostly for own consumption, for example, farming which directly supports households without producing a significant surplus for trade or sale.
sustainable	Using a resource in such a way that its supply and quality are maintained indefinitely into the future.
terrestrial	Relating to the earth.
toxic	Poisonous.
vascular plant	A plant with conducting tissue.
vegetation community	A commonly occurring grouping of plants and trees.
vertebrate	Animal with a backbone or spinal column, including mammals, birds, fishes and amphibians.
water catchment	The area from which a river or lake collects water.
wetland	Swamp or other damp area of land.

Executive summary

Background

This State of the Environment (SOE) Report is part of the process of assessing the environmental issues confronting Palau, and will contribute to the development of a National Environmental Management Strategy (NEMS) for the Republic. It was commissioned by the South Pacific Regional Environment Programme for the Government of the Republic of Palau.

The report was prepared in October 1993 using information drawn from a range of publications made available in Palau, particularly the Comprehensive Conservation Strategy (CCS) for Palau (Cassell, Otobed & Adelbai 1992). This report is essentially an adaptation of the CCS document, from which virtually all the information on the physical environment has been taken. Some information is taken from work done since the preparation of the CCS as well as through direct observations and interviews with technical people in the country.

The report is divided into five parts.

(1) natural environment
(2) human environment
(3) economic and built environment
(4) management of the environment
(5) priority programs

Natural environment

This section provides a description of the climate and the geological landmarks of Palau. The islands of Palau are diverse in geological origin and formation, with four types of islands existing in the archipelago: volcanic, reef and atoll, low platform, and high limestone.

The terrestrial resources of Palau are also described. They are limited by the size and isolation of the island archipelago, although the island group does support a high diversity of terrestrial resources in comparison with many other Pacific nations. The overall isolation of the archipelago has given rise to a significant number of endemic species.

The range of geological formations has contributed to the non-living terrestrial resources of these islands. Palau has a wide range of soil types, water resources, and minerals although, again, resource quantities are limited by the size of the archipelago.

Terrestrial environment

With regard to the terrestrial fauna of Palau, its limitation is noted in comparison to that of surrounding land masses such as the Philippines, New Guinea, and Asia, although it is the richest terrestrial fauna found in Micronesia.

The main issues and concerns raised over terrestrial resources relate not so much to the direct exploitation of resources but rather the direct and indirect destruction of terrestrial habitats for development or other purposes. Habitat conversion or destruction for purposes of resort development, road building, or other purposes (for example, agriculture) is increasingly taking place or being planned for areas of Koror and Babeldaob. Proposed large-scale developments catering to tourists and the expected increase in Palau's population may substantially increase the burden on water resources in Palau in the future. Pollution from solid waste disposal and direct waste dumping associated with new forms of development also has the potential to adversely affect the terrestrial habitat.

The ecological and economic value of terrestrial resources including plants (vegetation), birds, insects, and animals is described in some detail, as are the threats to their existence.

Marine environment

Palau is endowed with a high level of diversity and abundance of marine resources which historically have provided one of the most important food sources for its population. Commercial development of marine resources is also currently being pursued as a means of achieving sustainable economic development for Palau.

The richness of marine habitats in Palau has undoubtedly served to enhance the diversity of its marine resources. Being a high island, Palau has perennial streams, rivers, and well developed mangrove forests which provide a sustained flow of nutrients to the ocean. Mangrove and seagrass habitats are required by the young of a large variety of marine fishes, some of which migrate to coral reefs as adults.

Palau also has several coastal bays which provide sheltered, nutrient-rich estuarine habitat for juvenile and other marine resources. Also surrounding the majority of the islands of the Palau archipelago is an extensive barrier reef system that provides productive fishing grounds.

The report notes the present destruction of, and potential threat to, the country's marine habitats. This is of concern considering that the majority of the perceived opportunities for increasing economic self-sufficiency in Palau focus on utilization of resources which are directly or indirectly dependent upon coastal marine habitat.

As a relatively small island nation, Palau has a very limited amount of such habitat. It is therefore important that impacts to coastal marine habitat be quantified and monitored, and that some level of long-range planning be implemented to ensure that a designated adequate amount of such habitat is preserved.

The status of different marine resources is also discussed, as are the issues relating to their future.

Human environment

Population

Since most of the environmental problems described in the report are caused by humans putting too much stress on the natural resource base, this section starts with a discussion of the population issues. It concludes that Palau's population density is relatively low, but notes with concern the population forecasts which predict an increase to 28,045 by the year 2005 — an increase of almost 85 per cent from the 1990 figure.

More significantly, the population in Koror State will virtually double, from 10,501 (1990) to 20,794 (2005), giving it the very high population density of 2,772 people per square mile. Such high population density will inevitably translate into a substantial increase in the burden on water supplies, the sewerage system, and the energy generation system of the state. This is of concern since the current infrastructure in Koror is ill-equipped to deal with even the present level of use, and environmental degradation around Koror is an increasing problem.

Education and information

The report argues that education is the key to preventing further environmental degradation in Palau. It points out that human actions, mostly carried out in ignorance or without a full appreciation of the implications, are the principal cause of almost all the environmental problems discussed in the report. It also notes an overall lack of awareness of ecological processes and of the issues of sustainable development in Palau, and sees the need to address this through environmental education at community, school, and government levels.

A related issue is that of information on the country's natural systems. Although Palau's natural environment has been well studied and documented compared to many other Pacific Island countries, there remain significant gaps in knowledge and information.

Cultural, historical and archaeological resources

An important aspect of the human environment in Palau is contained in its culture as well as its historical and archaeological resources. Palau's culture contains many elements which could be harnessed for resource and environmental management. Kinship ties, subsistence lifestyle, traditional land and sea tenure and conservation practices, communication and interactive forms of play (legends, songs, chants, and dances) are some of the cultural resources of Palau which could be harnessed in

support of conservation and sustainable development.

Significant historical and archaeological resources also exist in Palau, and apart from their great cultural value, they represent important opportunities for the tourist industry and the economy.

Economic and built environment

Economic framework

The Palauan economy is described as a mixture of subsistence and cash types. The report notes that Palau has the potential to sustain a cash economy without too much support from international aid, although there is much to be done before this could be realized. After years of being dependent on the United States government for revenue, the leaders of Palau will find it a big challenge to develop in a way which is both economically and ecologically sustainable.

Economic development prospects in Palau are largely based on the exploitation or passive utilization of natural resources. The three major areas thought to have potential for sustainable economic development are tourism, fisheries, and agriculture.

Efforts are near completion under the Palau National Master Development Plan (PNMDP) to establish the economic development policy framework for an independent Palau. The key economic and social objectives of the government are described, and issues relating to different economic sector objectives are discussed throughout the report.

The key issue raised here is the need to ensure the integration of economic and environmental planning. While present government policies as well as the scope of work for the Palau National Master Development Plan (PNMDP) identify the need to promote economic development in an environmentally sustainable manner, there is at present little coordination between economic development and environmental protection activities. This is understandable given the scattered nature of the environmental protection program inherited by Palau, and the high level of uncertainty regarding mandates and direction associated with contemporary changes in the country's political status and development.

In this regard, the government's commitment to prepare a National Environmental Management Strategy and the emphasis given to sustainable development and environmental planning in the PNMDP's scope of work represent an invaluable opportunity to put in place institutional arrangements for the effective integration of environmental protection with the economic development program.

Infrastructure and industry development

This section of the report looks at the likely development sectors and comments on possible environmental issues that may have to be considered in the planning and implementation of associated projects/programs. The key sectors discussed include tourism, fisheries, agriculture, and social services (water and sanitation).

Pollution

Although pollution is not yet a critical issue in Palau, the changes being experienced including rapid growth in tourism and overall population, the increased availability of imported consumer products, and an increase in the number of industrial-type activities, means that the potential exists for serious problems to develop in the future. Already, the issue of pollution is a growing concern in Palau, particularly with regard to improperly treated sewage, pesticides, and dumping in marine waters. Pollution issues are also discussed throughout the report under different sectors.

Management of the environment

Legislation and policies

The key issue with regard to environmental management is the regulatory framework. Despite the existence of many laws for the protection and conservation of the environment, there is concern that their enforcement is weak. Examples are given of the many protection laws which are being broken at present. The causes of the problem seem to relate to the need for an effective national enforcement program, and the need for strong coordination amongst the resource management and development agencies.

The difficulties in environmental management are compounded by the absence of an overall land

use plan for the country. There currently is no plan for Palau which details suitable levels and locations for development through reference to the overall carrying capacity and current state of the environment. The report notes, however, that land use planning will be a major focus of the Palau National Master Development Plan (PNMDP), and that an opportunity now exists for collaboration between the NEMS and the PNMDP to establish a planning framework that will facilitate environmental protection and sustainable development of the country's resources.

Government administration

The organization of government is a significant element in the management and protection of the environment. The report summarizes this role and goes on to describe each of the major resource management and development entities or agencies in Palau.

The purpose of this is to outline the current structure of government in Palau, identify which groups have responsibility for different sectors, and describe the coordination arrangements between them. The hope is that this will facilitate the creation of more effective systems of coordination and management. The entities included in the discussion are the national government, state governments, traditional leadership, and the various government ministries, bureaus, divisions, departments and statutory bodies.

Although several new private/nonprofit groups have recently established a presence in Palau, such groups are currently not well represented within the country. There is potential, however, for non-government bodies to be part of overall environmental management in Palau, although this will need to be promoted in a more deliberate fashion than in the past.

Priority programs

In each section of the report, the environmental issues are discussed in the context of possible actions that can be taken to address them. Though the list may appear long, the NEMS will provide the process which will assess and establish priorities for these and other projects.

This section of the report serves to identify the major requirements based on the discussion of the major concerns in the whole report. Some effort is made to suggest the priority strategies and programs to address the major requirements, though the list is intended mainly to provide some guidance and reference points. The priority requirements are grouped under the following broad headings.

- Enforcement of existing laws and regulations
- Control over large-scale development
- Natural and historical or archaeological resources
- Environmental awareness and education
- Knowledge of natural systems
- National and state coordination
- Managing population growth and its impacts (Koror State)
- Pollution
- The need for economic development in Palau

Chapter 1

Introduction

1.1 General

The Republic of Palau, an archipelago of over 300 high and low islands, is the most western of the Caroline Islands group of the southwest Pacific. It is situated at a latitude of 7° 20'N and a longitude of 134° 28'E. The total land area is 188 square miles (Canfield 1981). A well developed barrier reef system, approximately 70 miles in length and up to 20 miles wide, surrounds the majority of the islands, forming a productive lagoon. The lagoon area is approximately 560 square miles (Division of Marine Resources 1990).

In addition to the land and lagoon area, the Republic has also declared jurisdiction over a territorial sea (traditional baseline/0–3 nautical miles offshore), an Exclusive Fishery Zone (3–12 nautical miles offshore), and an Exclusive Economic Zone (12–200 nautical miles offshore) (Republic of Palau 1986).

The government of Palau has not yet adopted a comprehensive policy on the environment and conservation, although a number of statutes and regulations exist for the purpose of protecting the environment and promoting conservation and sustainable development. Under the *Environmental Quality Protection Act* (24th Article of Palau National Code:102), reference is made to the policy of creating and maintaining "conditions under which humankind and nature can coexist in productive harmony, and fulfill the social, economic and other requirements of the present and future generations of the Republic".

As well, there are specific references in the Palau National Code (PNC) to conservation requirements, resource development and management, and general environment quality control measures including Environmental Impact Statements and the monitoring and enforcement of pollution regulations.

Judging by the scope of work for the Palau National Master Development Plan which is expected to be completed by the end of 1994, it is apparent that the government has committed itself to an economic development model that is economically and ecologically sustainable. This State of the Environment (SOE) Report is part of the process of assessing the environmental issues confronting Palau, and will contribute to the development of a National Environmental Management Strategy (NEMS) for the Republic. The NEMS will integrate with the Comprehensive Conservation Strategy (CCS) for the Republic of Palau (Cassell, Otobed & Adelbai 1992) and the Economic Framework Program of the Palau National Master Development Plan (Government of Palau 1994) to promote sustainable development in the Republic.

This State of the Environment (SOE) Report is only one of a number of sources of information which will assist the people of Palau prepare their NEMS. Much has been written in the past and these documents are referred to in the reference list of the Comprehensive Conservation Strategy document, an updated copy of which is included in this report.

1.2 Scope of report

In order to keep this report concise, readable and practical, it will not exhaustively describe every social, economic and environmental issue in Palau but is rather intended to assist and prompt discussion of key environmental issues. It therefore attempts to go beyond merely describing the state of the environment to discussion and analysis of the major issues in the key sectors. There is also an

emphasis on highlighting courses of action which could potentially be adopted in a national strategy. Readers are directed to other references (where these exist) for a more detailed discussion of the sector of interest.

The purpose of this approach is to focus discussion on a set of environmental management and protection projects which can be placed in priority order for action by the NEMS. A strategy based on priority projects can then be used by the government in discussions with development partners and during its own budget-building process.

1.3 Major issues

It is important that a discussion of the environment is not exclusively negative and that the environmental issues confronting Palau are put into perspective. In general, the environmental problems which Palau must deal with in the short term can be solved. In fact, the environmental condition of all the Palauan islands could be considered good, especially when compared to other island archipelagos of the Pacific. Palau's marine environment remains one of the world's most pristine ecosystems.

The major concerns for Palau relate to the pressure being put on natural resources and the infrastructure by population growth, mainly around Koror, and by new infrastructural and industrial development. This pressure is the principal cause of depletion of some natural stocks, damage to natural habitats (particularly the marine ones), decline in the quality and adequacy of water and sanitation services, and difficulties in controlling and managing solid and chemical wastes.

To prevent and overcome environmental problems, Palau will need a range of well directed physical and institutional resources, plus the will and commitment to use them. The most important factor is seen as the regulatory functions of government, at both national and state levels.

In general, an enabling legal framework already exists for Palau, as well as a wide range of policies and actions that the government could adopt for protection of the environment. However, there is probably a need for greater clarification of the mandates of resource management agencies in order to facilitate policy making and program implementation.

On the other hand, there are important

Wetland screw pine, pandanus kanechirae. *(photo: Demei Otobed)*

policies and regulations which, although valid under existing laws, have not been enacted. There may also be a need to strengthen the policy framework with regards to population issues, pollution/waste management, and education/awareness. It is expected that these will be addressed through the National Environmental Management Strategy (NEMS) and the Palau National Master Development Plan processes.

The most important factors with regard to resource/environment management in Palau are:

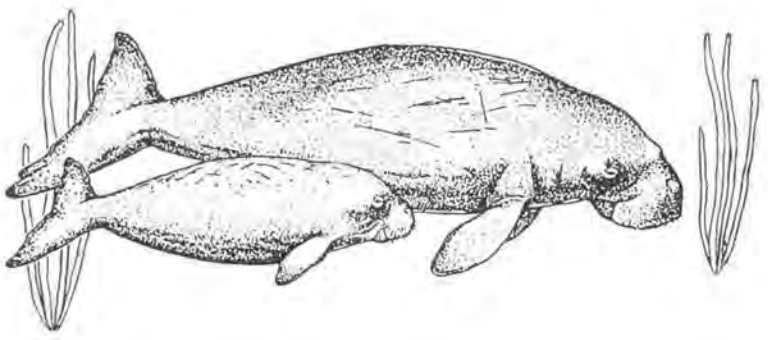
(1) the need for coordination between the responsible agencies; and
(2) the need to strengthen enforcement capacity.

This is borne out clearly in the priorities of the government sectors spelt out in Part 4 of this report.

The other important factor is knowledge. Environmental education, not just in schools but throughout the entire society, is a fundamental requirement. If people can learn about the impact of their actions and are given the opportunity and support to change the way they do things, many important environmental concerns can be addressed.

1.4 Sources and methodology

This report was commissioned by the South Pacific Regional Environment Programme for the Government of the Republic of Palau. It was prepared in October 1993 from information drawn from a range of publications made available in Palau, most particularly the Comprehensive Conservation Strategy for the Republic of Palau (Cassell, Otobed & Adelbai 1992). A greater part of the information in this report has come from that document, supplemented by the findings of work done after the Comprehensive Conservation Strategy was completed, and by direct observations and interviews with technical people in Palau.



PART I
Natural environment

Chapter 2

Physical characteristics

2.1 Climate

With its location some 500 miles north of the equator, the climate of Palau is described as maritime tropical rainy. There is little seasonal variation in temperature, and the mean daily temperature for all months is 81°F. The average relative humidity in Palau is 82 per cent, and rainfall averages 150 inches, with the maximum rainfall occurring in July. The prevailing surface winds in Palau vary seasonally: from November through May, trade winds from the northeast and east dominate, and from June to September, southwest winds are predominant. Palau is outside the main paths of severe tropical disturbances and typhoons (US Department of Defense 1956) although some typhoons have struck in the recent past (for example, Typhoon Mike in November 1990). These storms occur mainly during the autumn and winter months, and may cause a great deal of damage to structures and vegetation.

2.2 Geology and landmarks

The islands of Palau are diverse in geological origin and formation. Broadly classified, four types of islands exist in this archipelago: volcanic; reef and atoll; low platform; and high limestone. Several islands, such as Koror, Peleliu, Angaur and some of the Southwest Islands, are combinations of these four basic types. The four volcanic islands of Babeldaob, Meiuns, Malakal and the western part of Koror comprise the greater part of the land area of the archipelago.

Babeldaob, with an area of 128.5 square miles, is the largest island. It is also the location of Mt Ngerechelechuus which at 700 feet above sea level is the highest point in the archipelago. As well, Babeldaob contains the only perennial streams and rivers in Palau. The Ngeremeskag River is the largest of these rivers at 9.8 miles long. Several relatively large waterfalls are found on these river systems. Other significant features and landmarks

A typical isle in the Rock Islands group. (photo: Demei Otobed)

of Babeldaob include Ngardok Lake, a fresh-water lake with an area of 12.5 acres, and Ngeremeduu Bay, one of the largest coastal estuaries found in Micronesia.

Seven reef islands of Palau are located north and northeast of Peleliu. These islands are the three Ngemelis islands, and Ngerkersiul, Ngeruchubtang, Ngareklim and Ngerechong islands. Two atolls, Kayangel and Ngaruangel, exist just north of the northernmost point of Palau's barrier reef. The Southwest Islands, 300 miles to the south of the main island group, are a combination of low platform islands and atolls. Peleliu and Angaur are, for the most part, classified as low platform islands, although they also contain high limestone ridges and beach deposits from the reef (US Department of Defense 1956).

Over 300 high limestone islands exist in the central and southern regions of the archipelago. The majority of these islands are the steep, coralline, limestone Rock Islands, whose beauty and uniqueness have attracted much attention to Palau. The Rock Islands are frequently eroded and undercut at sea level, with overhangs of 6–20 feet (Birkeland & Manner 1989). Parts of Peleliu, Angaur, and Koror are also classified as high limestone islands.

The origin of the volcanic islands of the archipelago is quite distinct from that of the other island classes in Palau. It is estimated that the volcanic islands formed during the Miocene and Pleistocene. These islands are the result of tectonic activity along the Palau Ridge and the accumulation of volcanic materials along this crest.

The reef and atoll islands, platform islands, and high limestone islands were formed during more recent times in the shallow waters surrounding Palau's volcanic islands. The remains of calcium-secreting animals and plants form the basis of these islands. Uplift of the reef structures or subsidence of the surrounding waters during geological history caused exposure of the reef systems and, in the case of these types of islands, created areas appropriate for colonization by plants and animals. The Rock Islands between Koror and Peleliu are the most spectacular example of this type of island development from reef systems.

Chapter 3

Terrestrial environment

3.1 General

The terrestrial resources of the Republic of Palau are limited by the size and isolation of the island archipelago. The entire land area covered by the Republic is only 188 square miles. Palau is also an average of 500 miles from the nearest neighboring islands of Guam, the Philippines, and Papua New Guinea, allowing for only limited migration of terrestrial species to Palau (Canfield 1981).

On the other hand, Palau does support a high diversity of terrestrial resources in comparison to many other Pacific Island nations. Its proximity to Asia and the presence of both volcanic and limestone geological formations which generally sustain different terrestrial habitats, are the main factors which have contributed to the diversity of Palau's terrestrial resources.

The overall isolation of the archipelago has also given rise to a significant number of endemic species. Thus, approximately 1,258 taxa (species and varieties) of plants are found in Palau, and 839 of these taxa are native. By comparison, in Pohnpei, some 1200 miles east of Palau, only 563 species of plant are found. Approximately 65 plant species and ten plant varieties are endemic to Palau (Canfield 1981). Palau may also have up to 5,000 species of insect (Glassman 1952). Some 141 species of birds from 41 families have been seen in the country. Fifty bird species are resident in Palau, and eight species are endemic (Engbring 1988). Palau has only three species of native terrestrial mammal: one species, the Palau fruit bat, is endemic to Palau (Owen 1977).

The range of geological formations has also contributed to the non-living terrestrial resources of these islands. Palau has a wide range of soil types, water resources, and minerals although, again, resource quantities are limited by the size of the archipelago.

3.2 Soils

3.2.1 Classification and distribution

There are 18 different types of soil in Palau, and they vary widely in their textures, natural drainage, depth, fertility, and other characteristics (Smith 1983). A detailed description of the characteristics of each of the 18 soil types is beyond the scope of this report. Instead, the soils will be discussed in the context of the following six broader categories: latosols, lithosols, bog/half-bog/swamp, alluvial, regosols, and unclassified. The study by the US Soil Conservation Service (Smith 1983) provides further detail, including maps, on the soils of Palau.

Latosols

Latosols comprise the majority of the soils, encompassing 112.49 square miles of land, principally on Babeldaob. This soil type is often devoid of feldspars or other minerals that, with weathering, release nutrients for plants.

Lithosols

Lithosols are present on some areas of the volcanic islands, but are mainly seen on limestone formations of the reef and atoll, platform, and high limestone islands. About 34.71 square miles of land is classified as having this soil type, which is alkaline or neutral, highly permeable, and rich in calcium carbonate.

Bogs, half-bogs and swamplands

The bottom land soils of bogs, half-bogs, and swamplands form the third largest soil type in Palau, encompassing 17.47 square miles of land.

Cassava garden. Even on soils conventionally regarded as infertile, traditional cropping systems of rotating patches of forest, grass and cultivated crops enable sustainable use of these areas for sweet potatoes, cassava and other crops. (photo: Demei Otobed)

The majority of these lands are mangrove wetlands (14.60 square miles), which are poorly drained areas of silts and clays with a high amount of decaying organic matter and dense mangrove forests.

Alluvial soils

Alluvial soils exist on 4.35 square miles of land, and are confined mainly to flood plain areas in Babeldaob. These soils result from erosion of latosols, are generally acidic, and may be poorly to well drained.

Regosols

Regosols exist on 2.7 square miles of land. They are limited to shioya sand, a coralline beach sand soil which is darkened by accumulation of organic matter in the upper foot. Regosols are found mainly along the coasts of Babeldaob, Angaur, Peleliu, and other reef and atoll islands. Shioya sands are highly permeable and are generally infertile.

Unclassified soils

Unclassified soils are of the Tabecheding Association. These soils, which exist on 3.58 square miles of the land of Palau, are comprised mainly of bedded clay, and are relatively impervious and highly acidic. They occur mainly on the uplands of Babeldaob (US Department of Defense 1956).

3.2.2 Suitability for agriculture

Agricultural production for subsistence or commercial purposes is presently not as extensive as in the past. The terraced hillsides on Babeldaob and Koror probably indicate that lower-quality hillside land was once part of a much more intensive agricultural system (Snyder 1985). It is also known that three pineapple canneries were in operation on plantations in Babeldaob during the Japanese administration (which began in 1914 and continued until the end of World War II).

The various soil types do currently support some level of subsistence and commercial agriculture in Palau. Alluvial soils, specifically the poorly drained alluvium and regosols, represent some of the more fertile lands for agriculture. Bog and half-bog, muck and peat areas are also highly fertile natural areas and are used for taro production.

Although latosols are classified as highly infertile, native cropping systems of rotating patches of forest, grass, and cultivated crops have resulted in sustainable use of these areas for sweet potatoes, upland taro, sugarcane, pineapple, banana, cassava, and papaya. Shioya sand soils, although unsuitable for many types of agriculture, constitute the major areas where the coconut palm is native and where plantation stands occur.

Finally, soils of the Tabecheding Association are also suitable for some types of agriculture. Lithosols, in general, are infertile and unsuitable for agriculture, supporting mainly scrub vegetation and forest (US Department of Defense 1956).

Stockpile of dredged coral materials for road capping at Urung Dock, Ngaraard State. A comprehensive study to assess the overall impact of the current level of dredging in Palau would be valuable. (photo: Demei Otobed)

3.3 Earth and mineral resources

3.3.1 General

Mineral resources have also been exploited from the soils of Palau. Most importantly, lithosols in Angaur and Peleliu were found to contain substantial reserves of phosphate, which were mined during the German and Japanese administrations (1899–1945). One source has indicated that bauxite might still occur in commercial deposits on Babeldaob. Commercial deposits of clay also probably exist on Babeldaob (US Department of Defense 1956). Other resources such as gold, copper, iron, antimony, zinc sulfide, and lignite have never been found in large enough quantities to merit exploitation.

Presently, only gravel, soils, sand and corals are mined or dredged in Palau. Dredging operations are fairly numerous. These operations are in effect mainly to supply materials for road building and fishing port construction, infrastructure which is the basis of a current emphasis on economic development through tourism and fisheries. However, no comprehensive study has been done to assess the overall impacts of the current level of dredging in Palau. The impacts of specific projects are reviewed on a one-to-one basis through the Environmental Quality Protection Board (EQPB) permitting process.

3.3.2 Implications for resource use

These resources are abundant, and it is obvious that all use should not be prohibited. It must be recognized, however, that mining and dredging have a great impact on resources which constitute the very foundation for economic development in Palau. It makes no sense to develop infrastructure for economic development if the basis for economic development is destroyed in the process. In this sense, it is imperative that levels of dredging and mining be balanced with a recognition and protection of the requirements of marine and terrestrial organisms which are so vital to the sustainable economic development of Palau.

As pressures for economic development continue to grow in Palau, it is logical to assume that there will be a need for increased levels of mining and dredging for building materials, and that the impacts of these activities will increase as well. A recent proposal for a large-scale resort development, the Ngesaol Project, calls for the use of substantial amounts of material from existing quarry sites and extensive on-site dredging activities to provide materials for landfill, causeway improvements, and general resort construction (Brewer 1991). Several other such large-scale projects which may require considerable amounts of construction materials have also recently been proposed for Palau (EQPB 1994).

3.4 Fresh-water resources

The Republic of Palau has limited fresh-water resources, as is true of most small Pacific Island nations. The range of geological formations and

soils in Palau have, however, allowed for the development of several distinct sources of water.

3.4.1 Streams

The only sustained streamflow in Palau is found on the large volcanic island of Babeldaob. Perennial streams are fed by slow seepage from the mantle to valleys, which is, in turn, fed by the weathered igneous rocks in the upper soil layer which have some capacity to hold water. With an average annual rainfall of 150 inches, the streams on Babeldaob discharge an average of 500,000,000 gallons of water daily.

3.4.2 Lakes and ponds

Other surface water resources exist in the form of a fresh-water lake and pond on Babeldaob. Ngardok Lake, with a surface area of 16 acres and a storage capacity of 80 acre feet, is situated in Melekeok State. Recent studies (US Soil Conservation Service 1991) have looked at increased utilization of water resources from this spring and the lake which is fed by surface runoff. The current water capacity of Ngardok Lake is 15,000,000 gallons. The fresh-water pond, one mile northwest of Ngarkeklau, has a capacity of approximately 500,000 gallons.

3.4.3 Seepage springs

Small seepage springs are fairly common on Babeldaob, particularly a few miles above the mouths of rivers where there is a vegetation transition from grass or brush to forest. However, large water supplies are not obtainable from these sources, and supply and quality from such sources often varies with the amount of precipitation. On upper slopes, where dense and impervious bedrock exists close to the surface, wells are generally only successful at the irregularly occurring joint and shatter zones (US Department of Defense 1956).

3.4.4 Fresh-water lenses

The permeable nature of soils on low coral islands and atolls of Palau has allowed the development of water resources in the form of a Ghyben-Herzberg lens of fresh water existing beneath these islands. In particular, due to the existence of permeable and porous coralline rubble soils on Angaur and Peleliu, substantial fresh-water lenses have formed a few feet above sea level beneath these islands. It is estimated these underground water reserves of Angaur and Peleliu could each yield up to 1,000,000 gallons of water per day. In 1945, when Peleliu served as a fleet base for US armed forces, 42 wells were established to provide the 15,000 troops with water (US Department of Defense 1956).

Kayangel Atoll is the only atoll in Palau large enough to support development of a potable lens of fresh water. However, the supply available from the Kayangel lens is small, and is somewhat brackish due to salt-water intrusion. As well, areas of Koror which are limestone in origin are underlaid by a lens of fresh water (US Department of Defense 1956).

3.4.5 Other fresh-water resources

Finally, the high limestone or Rock Islands contain very minimal, if any, fresh-water reserves. The

Savanna with its typical vegetation. Grassland/savanna accounts for 16 per cent of the total land in Palau. (photo: Demei Otobed)

extremely permeable nature of soils in these islands permits rapid percolation of rainwater to sea level. Therefore, while there may be a small lens of fresh water under some of the larger islands, it is very likely to be brackish due to intrusion of seawater, and too deep for exploitation (US Department of Defense 1956).

3.5 Habitat/vegetation

3.5.1 Overview

Approximately 1,258 taxa (species and varieties) of plants are found in Palau; 839 of these taxa are native representing over 400 genera (Canfield 1981). Palau is also said to have 65 endemic species and ten endemic varieties of plants. Thus, by current data, 9 per cent of the taxa native to Palau are endemic (Canfield 1981). The use and status of these vegetation species play a major role in determining the integrity of terrestrial habitat systems.

Obviously, diversity of plant species is not the only factor which determines terrestrial habitat type or status. Soil, water, and fauna are important components of terrestrial habitat, and use of these resources can also have an impact on the status of habitat, as is discussed in other sections of this report. However, in that classification and status of terrestrial habitat is mainly determined by the existence and health of dominant vegetation communities, discussion of terrestrial habitat is included with this section on the vegetation of Palau.

Table 3.1, from the survey by Cole et al. (1987), details the land area of specific vegetation types or habitat in Palau. This data was generated through aerial photographic interpretation. Funding for ground verification of this survey has not been available, although this represents an important area for future study in Palau.

3.5.2 Indigenous forest

As can be seen from the table, 75 per cent of the lands of the Republic of Palau are covered with native forest. Of this 54,095 acres, or 53 per cent of the total area of land, is upland forest, which is found mostly (that is, 99 per cent) on Babeldaob. Swamp forests are dispersed throughout Palau, with the largest areas (3,996 acres or 96 per cent of the overall total area comprised by these forests) existing on Babeldaob. Mangrove forests currently comprise the third largest land class of Palau, at 11,634 acres or 11 per cent of the total land area. There are limited areas of plantation forest on Babeldaob and the other high islands covering some 64 acres, or 6 per cent of total land area. Limestone and Rock Island forest, covering 5,803 acres, generally occur on areas of extremely poor soil conditions comprised mainly of rough eroded raised coral rock. Small areas of atoll and casuarina forests exist also on the low coral islands and the Rock Islands. There are 383 acres of atoll forest and 1,115 acres of casuarina forest, representing 0.4 per cent and 1.1 per cent of the total land area respectively.

3.5.3 Secondary vegetation

Secondary vegetation exists where areas of native forest have been cleared for cultivation or other purposes. This vegetation class currently exists on 1,797 acres, or 1.8 per cent of the total land area. The majority of the areas of secondary vegetation exist on the volcanic islands of Babeldaob, Koror, Malakal, and Meiuns, although secondary vegetation also occurs on some limestone and Rock Islands. Many of these areas are lower slope regions which have been cleared and used to cultivate coconut, true taro, cassava, and pineapple. When such traditional gardens are abandoned, ecological succession allows the vegetation to progress from grassland to scrubland to dense secondary forest.

Secondary vegetation is characterized by fast-growing small trees, shrubs, and vines. Some plant species commonly found in secondary vegetation of Palau include: *Alphitonia carolinensis*, *Macaranga carolinensis*, *Rhus taitensis*, *Commersonia bartramia*, *Ixora casei*, *Hibiscus tiliaceus*, and *Merremia peltata*.

3.5.4 Agroforest

Agroforestry has traditionally been practiced in the Republic of Palau. In these systems, crops such as pineapples (*Ananas comosus*), bananas (*Musa sapientium*), taro (*Colocasia esculenta*), cassava (*Manihot esculenta*) and papaya (*Carica papaya*) are grown among coconut trees (*Cocos nucifera*), breadfruit (*Artocarpus* spp.), mango (*Mangifera indica*), betelnut (*Areca catechu*), and leguminous trees. Agroforestry represents a sustainable system of food production and a wise use of limited land resources in Palau. Currently, 2,741 acres (2.5 per cent of the total land area) is used for agroforestry. Although

Table 3.1 Area of Republic of Palau by island group, land class, and type (acres)

Land class and type	Babeldaob	Other high islands	Coral islands	Rock Islands	Total
Forest					
Upland	53,598	497	0	0	54,095
Swamp	3,996	37	116	2.5	4,151.5
Mangrove	9,946	507	1,075	106	11,634
Plantation	59	5	0	0	64
Rock Island	257	519	0	1,982	2,758
Limestone	0	0	2,904	141	3,045
Casuarina	0	0	1,115	0	1,115
Atoll	0	0	240	143	383
Palm	0	<2.5	0	0	2.5
Total	67,856	1,567.5	5,450	2,374.5	77,248
Secondary vegetation	1,273	195	324	5	1,797
Agroforest					
Agroforest	20	0	5	15	40
Agroforest (w/coconut)	428	15	247	0	690
Coconut plant	1,836	0	0	175	2,011
Total	2,284	15	252	190	2,741
Nonforest					
Marsh, fresh	1,107	<2.5	67	0	1,176.5
Marsh, cultiv.	264	5	62	0	331
Marsh, saline	0	0	62	<2.5	64.5
Grassland	16,625	131	2.5	2.5	16,761
Strand	0	0	25	2.5	27.5
Cropland	346	146	10	0	502
Cropland/Secondary vegetation	0	69	0	0	69
Urban	348	549	82	2.5	981.5
Urban/Cropland	262	173	0	0	435
Urban/Agroforest	0	0	151	0	151
Urban/Secondary vegetation	0	7	0	0	7
Barren	368	12	64	0	444
Water	37	22	42	17	118
Total	19,357	1,116.5	567.5	27	21,068
Total area	90,770	2,894	6,593.5	2,596.5	102,854

Source: After Cole et al. 1987

this traditional practice has somewhat waned in use, efforts are underway through the Division of Agriculture and Mineral Resources to promote such agricultural methods.

3.5.5 Nonforest lands

Nonforest areas comprise the second largest land class in Palau, existing on 21 per cent of the total land area of these islands. By far, the largest areas of nonforest vegetation are encompassed by the vast areas of grasslands on Babeldaob. Nonforest lands in Palau have either never supported forests or, although previously forested, are now developed for other nonforest use. These nonforest lands contain a variety of land types including marsh (1,177 acres of fresh-water and 65 acres of saline types), grassland/savanna (16,761 acres or 16 per cent of total land), cropland (1,006 acres or 1 per cent of total land), and strand vegetation (27 acres). Urban vegetation types are comprised mainly of ornamental species, croplands, agroforest, or secondary vegetation surrounding houses or other buildings.

3.6 Terrestrial fauna

The terrestrial fauna of Palau is limited in comparison to that of surrounding land masses such as the Philippines, Papua New Guinea, and Asia, although it is the richest terrestrial fauna found in Micronesia.

3.6.1 Insects

With up to 5,000 species of insect, Palau has the most diverse insect fauna of Micronesia. Endemism for insect species in Palau is high, although Pohnpei, with approximately 2,000 endemic species, is considered the center of endemism for Micronesia. Gressitt (1954) notes that insects of the groups Mantidae, Phyllinae, Rutelinae, Dynastinae, Glaucytini, Mutillidae, Scoliidae, and Crabronidae are, for the most part, only found in Palau in Micronesia. Papilionidae are only found in Palau and Yap. Non-insect terrestrial invertebrates including terrestrial arthropods, mollusks, and annelids are also found.

3.6.2 Reptiles and amphibians

Limited species of reptiles and amphibians are found in Palau although, once again, greater species diversity is found there than elsewhere in Micronesia. Only two species of amphibians are found in Palau. The giant toad, *Bufo marinus*, is introduced, and thrives throughout Micronesia. This pest is an indiscriminate scavenger which may contaminate water supplies and poison other more desirable animals which prey on it (Gressitt 1954). The second amphibian found in Palau is the endemic Palau frog, *Platymantis pelewensis*, which is the only native amphibian species in Micronesia.

A greater variety of reptiles, including six native species of snakes, are found in Palau. Terrestrial native snake species include two species of *Typhlops* (one endemic): *Candoia carinata* and *Dendrolaphis lineolatus*. The brown tree snake, *Boiga irregularis*, which has decimated the endemic land avifauna of Guam since its introduction there has fortunately not been found in Palau.

Palau also hosts a variety of lizard and skink species. The pandanus skink, *Aulacoplax leptosoma*, is endemic to Palau, and the green skink, *Lamprolepis smaragdina*, is also a common native species. *Emoia werneri*, *Emoia cyanurus*, *Mabuya multicarinata*, *Lygosoma noctua*, *Eugongylus mentovarius*, *Gehyra brevipalmata*, *Lepidodactylus lugubris*, *Peropus mutilatus*, *Gekko vittatus*, *Hemiphyllodactylus typus*, and *Hemidactylus frenatus* are found in Palau, and are important insect feeders.

Introductions of species such as the American chameleon, *Anolis carolinensis*, and the Indian monitor lizard, *Varanus indicus*, have also occurred. The monitor lizard was introduced to provide rat control, but this lizard has unfortunately been found to prey also on chickens and wild birds and their eggs (Owen 1977).

Sea or estuarine reptiles are discussed in Chapter 4 (Marine environment). It should be mentioned that five of the seven known species of sea turtle have been recorded in the waters of Palau, although the hawksbill, *Eretmochelys imbricata*, and the green turtle, *Chelonia mydas*, are by far the most common species. The banded sea snake, *Laticauda colubrina*, the dog-faced water snake, *Cerberus rhynchops*, and the estuarine crocodile, *Crocodylus porosus*, are also native to Palau (Owen 1977).

3.6.3 Avifauna

Palau also hosts the richest avifauna of Micronesia. Some 141 bird species of 41 families have been recorded in Palau. Fifty of these species are actually

Figure 3.1 Educational poster: Birds of Palau

Some 141 bird species of 41 families have been recorded in Palau, representing the richest avifauna of Micronesia. (artwork by Takesi Suzuki, reproduced courtesy of Division of Conservation and Entomology)

residents of Palau. The remaining 91 avian species are migratory or vagrant species from the nearby islands of the Philippines, Papua New Guinea, or Indonesia. It is speculated that many birds reach Palau on their migration to Indonesia and Australia. Of the 50 resident species, eight are endemic and five were introduced. The two introduced species which have caused some concern are the greater sulphur-crested cockatoo, *Cacatua galerita*, and the eclectus parrot, *Eclectus roratus*. These species are thought to feed on the heart of two species of endemic palm trees and thus may be responsible for the destruction of large stands of these trees (Engbring 1988).

The 45 native resident or endemic bird species of Palau are listed in Table 3.2. This list was adapted from *Field Guide to the Birds of Palau* (Engbring 1988). For further information on migratory species recorded in Palau, the reader is referred to this book.

3.6.4 Terrestrial mammals

The native terrestrial mammals of Palau are limited to two species of bat and one species of rat. The bat species, *Emballonura palauenses*, a small insectivorous bat, and *Pteropus pelewensis*, the Palau fruit bat, are endemic to Palau (Owen 1977). The Polynesian rat, *Rattus exulans*, is also native to Palau.

Terrestrial mammalian species which have been introduced to Palau are more varied. Species of rodent, domestic animals such as dogs, cats, cattle, goats, pigs, and rabbits, and one species of monkey have all been introduced and have some presence in Palau. The house mouse (*Mus musculus*), roof rat, (*Rattus*), Norwegian rat (*Rattus norvegicus*), Himalayan rat (*Rattus nitidus*), and the Asiatic musk shrew (*Suncus murinus*) are found to some degree throughout Palau, and are considered general or agricultural pests. The crab-eating macaque (*Maacca fascicularis*), introduced to Angaur in the early 1900s, has been confined to Angaur where it causes some agricultural damage. Although feral pigs and goats are found on Babeldaob, damage to vegetation caused by these animals is minimal in comparison to the situation on islands such as Hawaii.

Pigs and goats are the domestic livestock most commonly found in Palau. There is little cattle ranching, apart from that occurring at the Nekken Forestry Demonstration Center on Babeldaob.

3.7 Terrestrial resources: significant issues

3.7.1 Overview

In general, direct exploitation of resources is not the major issue. In fact, the most critical threats to terrestrial resources are occurring because of direct and indirect destruction of terrestrial habitats for development or other purposes. Currently, habitat conversion or destruction for reasons of

Road to Melekeok and Ngchesar States. Road building and burning not only destroy upland forest and other habitats, but can cause the degradation of soils through erosion. (photo: Demei Otobed)

Table 3.2 Native resident or endemic bird species of Palau

Species	Common name/Palauan name	Status
Puffinus lherminieri	Audubon shearwater, Ochaieu	Resident
Phaethon lepturus	White-tailed tropicbird, Dudek	Resident
Sula leucogaster	Brown booby, Kuel	Resident
Sula	Red-footed booby, Kuel	Resident
Phalacrocorax melanoleucos	Little pied cormorant, Deroech	Resident
Fregata minor	Great frigatebird, Kedam	Resident
Fregata ariel	Lesser frigatebird, Kedam	Resident
Ixobrychus sinensis	Yellow bittern, Cheloteachel	Resident
Egretta sacra	Pacific reef heron, Sechou	Resident
Nycticorax caledonicus	Rufous night-heron, Melabaob	Resident
Anas superciliosa	Gray duck, Debar	Resident
Megapodius laperouse	Micronesian megapode, Bekai	Resident
Rallus philippensis	Banded rail, Terriid	Resident
Rallina eurizonoides	Slaty-legged crake, Ulerratel	Resident
Poliolimnas cinereus	White-browed rail, Sngorech	Resident
Porphyrio porphyrio	Purple swamphen, Uek	Resident
Gallinula chloropus	Common moorhen, Uek	Resident
Sterna bergii	Great crested tern, Roall	Resident
Sterna sumatrana	Black-naped tern, Kerkirs	Resident
Sterna anaethetus	Bridled tern, Bedebedechakl	Resident
Sterna fuscata	Sooty tern	Resident
Anous stolidus	Brown noddy, Mechadelbedaoch	Resident
Anous minutus	Black noddy, Bedaoch	Resident
Gygis alba	White tern, Sechosech	Resident
Caloenas nicobarica	Nicobar pigeon, Laib	Resident
Gallicolumba canifrons	Palau ground-dove, Omekrengukl	Endemic
Ptilinopus pelewensis	Palau fruit-dove, Biib	Endemic
Ducula oceanica	Micronesian pigeon, Belochel	Resident
Pyrroglaux podargina	Palau owl, Chesuch	Endemic
Caprimulgus indicus	Jungle nightjar, Chebacheb	Resident
Aerodramus vanikorensis	Vanikoro swiftlet, Chesisekiaid	Resident
Halcyon cinnamomina	Micronesian kingfisher, Cherosech	Resident
Halcyon chloris	Collared kingfisher, Tengadidik	Resident
Coracina tenuirostris	Cicadabird, Kiuidukall	Resident
Cettia annae	Palau bush-warbler, Wuul	Endemic
Myiagra erythrops	Palau flycatcher, Esisebasech	Endemic
Rhipidura lepida	Palau fantail, Melimdelebteb	Endemic
Colluricincla tenebrosa	Palau morningbird, Tutau	Endemic
Artamus leucorhynchus	White-breasted wood-swallow	Resident
Aplonis opaca	Micronesian starling, Kiuid	Resident
Myzomela cardinalis	Cardinal honeyeater, Chesisebangiau	Resident
Zosterops conspicillatus	Bridled white-eye, Charmbedel	Resident
Zosterops cinereus	Dusky white-eye, Chetitalial	Resident
Megazosterops palauensis	Palau greater white-eye, Charmbedel	Endemic
Erythrura trichroa	Blue-faced parrotfinch	Resident

Source: Engbring 1988

resort development, road building and other purposes such as agriculture is increasingly taking place or being planned for areas of Koror and Babeldaob. Although no assessment of the total area of upland forest destruction is available, the information on current EQPB-permitted earth-moving and dredging projects (EQPB 1994) indicates that approximately 30 miles of new roads have been built or are planned for areas of Babeldaob.

As well, although little is known about the quantity of terrestrial habitat or vegetation which has been destroyed by burning, it is understood that the origins of some areas of savanna may be traced to burning activity rather than natural origins (Canfield 1981). Road building and burning for agricultural and other purposes directly destroy upland forest and other habitats, and cause the degradation of soils through erosion. In addition, sedimentation resulting from erosion can smother mangrove forest habitat and have an adverse impact on the very basis of marine life in Palau, the reef systems.

3.7.2 Large-scale development

Fortunately, in the past, damage to the mangrove forests and other important habitats appears to have been minimal. According to Environmental Quality Protection Board records (EQPB 1994), the only significant destruction of mangroves during the past ten years has been the loss of 35 acres in Ngatpang State due to causeway construction. It is known that some filling of mangrove forests was done during the Japanese administration (approximately 1914–1945), but no records are available on these activities.

However, many areas in Babeldaob are now designated for possible large-scale developments. Unfortunately, the oceanfront location of many of the mangrove forests makes them prime targets for destruction for the purposes of resort development. With the increasing focus in Palau toward economic development through tourism, this is likely to become a more significant issue in the future. In fact, a recent proposal for a large-scale resort development in the village of Ngesaol in Koror called for the filling of approximately 40 acres of mangrove forest (Brewer 1991). The proposal for this project is currently under review by the US Army Corps of Engineers.

3.7.3 Demand for water resources

It is also clear that proposed large-scale developments catering to both tourists and the expected increase in Palau's population may substantially increase the burden on water resources in Palau in the future. This will be a major issue for Koror State in particular although it is of some national significance as well. Increases in demand for water supply may have several effects in Palau.

First, new sources of fresh water may have to be tapped. For instance, the Melekeok Watershed Management Plan indicates that "increasing the storage capacity" of Ngardok Lake by building a small dam might be one way to generate additional

Sedimentation in offshore waters of Ngarchelong has smothered and destroyed mangroves. (photo reproduced courtesy of Environmental Quality Protection Board)

water supplies for increased development in Melekeok (US Soil Conservation Service 1991). However, such a development would most likely have an effect on the ecology of Ngardok Lake, and an impact on some of the best remaining habitat of the estuarine crocodile, an endangered species which inhabits the lake.

An increased demand for fresh-water resources can also result in depletion of the supply available for uses such as subsistence agriculture. This impact, in fact, may already be occurring in Koror State. Some people believe that the Palau Pacific Resort, a large-scale tourist resort in Meiuns, is depleting a substantial amount of ground water from this area. This information was reported by villagers from Meiuns who noticed that, following the developing of this resort, their taro patches appeared to hold insufficient water. Although this impact is only conjectural at present, it certainly merits further study (Cassell, Otobed & Adelbai 1992).

3.7.4 Pollution

Aside from creating problems for subsistence agriculture, extreme depletion of water from the fresh-water lenses may allow for salt-water intrusion into these reserves, rendering the fresh-water resource brackish and useless. Water resources in Palau are also being affected by pollution, although the extent of this impact is uncertain. Of grave concern is the increasing use of pesticides by foreign farm helpers and the threat it poses for local water supplies, particularly when gardens are located close to rivers.

Ground-water contamination may also result from improper disposal of solid wastes, poorly designed landfills, and defects in public sewer systems or septic tanks. Each of these pollution sources represents an issue of some significance in Palau at present (EQPB 1994). It also seems obvious, given the projected increases in tourism and the Palauan population, that pollution problems from waste disposal will continue to be a significant issue in the future.

Pollution from solid waste disposal and direct dumping of waste also has potential to adversely affect terrestrial habitat. This issue is particularly relevant in mangrove habitat, which interfaces land and sea. In Palau, such pollution is a significant issue in at least one location, Koror State, where the landfill site is currently located adjacent to an area of mangrove forest. Seepage of oil and metals into mangroves from this landfill site is causing some contamination of surrounding marine areas (EQPB 1991).

3.7.5 Use of vegetation

Utilization of terrestrial vegetation has also affected habitat in Palau. For example, the logging operation which was in operation in Aimeliik included no provision for replanting of trees for timber. Thus, it is likely that this logging operation, in addition to having an impact on primary upland forests, has also rendered a large area in Aimeliik vulnerable to erosion and soil degradation, which may inhibit the existence of such forests on these lands in the future. Fortunately, logging activities are relatively minimal in Palau, and with educational and enforcement activities such poor resource management practices could be curbed in future.

3.7.6 Introduced species

Aside from general threats created by increased human presence and development, terrestrial habitat and plant species may be threatened by the introduction of exotic plants and animals. There are 428 known alien plant taxa in Palau. Exotic weeds such as *Lantana camara* and *Chromolaena odorata* are the focus of current biological control efforts. One species, *Merremia peltata*, which tends to spread rapidly in disturbed areas, has displaced or injured native flora in some areas, and various control measures are being pursued (Cassell, Otobed & Adelbai 1992).

Some exotic plant species which were intentionally introduced for human or livestock food production have created problems by 'escaping' from controlled situations and outcompeting native flora (Cassell, Otobed & Adelbai 1992). One such problematic exotic species is *Setaria*, which was introduced to provide food for livestock at the Nekken Experimental Forestry Station. Introduced mammals and insects have not caused major problems for native or endemic flora, although the introduced coconut beetle (*Oryctes rhinoceros*) did much damage to exotic coconut palm (*Cocos nucifera L.*) plantations before it was eventually controlled in the late 1980s. Two introduced bird species, the greater sulphur-crested cockatoo (*Cacatua galerita*) and the eclectus parrot (*Eclectus roratus*), which eat the terminal buds of several

Native palm, Pinanga insignis, *in forest. Vegetation serves to hold soils and prevent erosion, allowing for the maintenance of water quality in Palau's lagoon. (photo: Demei Otobed)*

native and endemic palm species growing on the Rock Islands, have been the cause of the demise of these palm species in Rock Island forest vegetation (Canfield 1981).

3.7.7 Value of endemic species

Palau's endemic plants represent unique species not found elsewhere. Endemic plant species, having evolved in the distinctive environment of Palau, are obviously ecologically important species for the maintenance of ecosystem functioning. Endemic species also often have traditional uses, and thus are important to the maintenance of cultural heritage in Pacific Island societies as well. As development activities (specifically, construction of roads and large tourism developments) continue to grow in Palau, it is imperative that the status of native and endemic plant species be accurately recorded to allow for protection where necessary.

3.7.8 Value of terrestrial habitat

Support for species

Many of the plants in Palau support traditional and contemporary uses; plants and terrestrial habitats also perform various support functions. Terrestrial habitat and plant communities provide shelter and food for animal species which are harvested by humans. Upland forest vegetation supports the Micronesian pigeon and the Palau fruit bat which are harvested for subsistence and commercial purposes.

Soil protection

Vegetation also serves to hold soils and prevent erosion, allowing for the maintenance of water quality in Palau's lagoon. This is indicative of the manner in which terrestrial systems such as upland forests are intricately connected with the health of marine systems. Secondary vegetation is of particular importance in preventing erosion of burned or otherwise disturbed areas. The presence of secondary vegetation also allows for accumulation of humus and nutrients in these disturbed soils so that, through succession, forests can be regenerated.

Role of mangroves

Mangrove forests, in particular, perform several support functions, and are a vital link between land and sea. They provide vital fish spawning and nursery grounds as well as habitat and foraging grounds for various marine invertebrates, birds and fruit bats; they provide a settling and filtering ground for waters entering the lagoon; and they export a high and sustained amount of organic

matter into the otherwise oligotrophic waters of Palau's lagoon (Hamilton & Snedaker 1984).

Value for tourism

Finally, terrestrial vegetation and habitat may have a value for tourism which to date has been largely overshadowed by the spectacular marine environment in Palau. With the new emphasis on ecotourism, tourism in all habitats has significantly expanded. It is very likely that, if desired, hiking and other opportunities to view terrestrial habitats in Babeldaob and elsewhere could be successfully marketed to draw tourism.

Other uses

Bird species figure significantly among the terrestrial animals which have historically been directly utilized by humans in Palau. Foods from certain birds, such as the eggs of the Micronesian megapode, were reserved for chiefs and their particular clan. Other bird species (such as pigeons and doves) and their eggs have historically been hunted for subsistence food (Engbring 1988). Currently, pigeon and dove species are illegally hunted for subsistence and commercial purposes, although the level of exploitation is not known.

Many bird species also have cultural significance, and birds are an important element in many Palauan legends. Bird species may also represent an economic resource with respect to the development of a diversified tourism industry. Bird-watching is increasingly an important part of nature based tourism, for which Palau has great potential. The popularity of recent publications such as John Engbring's *Field Guide to the Birds of Palau* (1988) is one indication of the growing interest in such environmentally based activities.

Fruit bats are the only other purely terrestrial native animal species which is directly exploited by humans in Palau. Hunting of fruit bats for subsistence historically has not been prevalent in Palau. However, a commercial export trade of these species to Guam has occurred in recent times.

Some domestic livestock husbandry does occur, mainly in the form of pigs and goats species raised for subsistence purposes. Commercial poultry production is increasing, and limited cattle ranching occurs at the Nekken Forestry Demonstration Station.

3.7.9 Ecological significance

Aside from species which are directly utilized by humans, the great ecological significance of certain terrestrial animal species should also be mentioned. For instance, the diverse flora of Palau could not have evolved without the presence of a diverse insect population. Avian and reptilian species are also important ecologically in that many of these species serve as necessary controls on insect populations (Gressitt 1954; Owen 1977).

Interrelatedness of species

Given the fact that the diversity of terrestrial vertebrate fauna in Palau is extremely low, the role of each of the existing species in supporting or controlling other organisms is vital. In such a small system, conservation of vertebrate populations is

Micronesian megapode bird nest. Increased use of Rock Island beaches for tourism and recreation has resulted in disturbance of megapode nesting sites.
(photo Demei Otobed)

especially important because extinction of one species may have a great impact on other ecosystem components (Gressitt 1954).

The status of terrestrial animal species is strongly determined by the availability of adequate habitat. In this regard, animal species are, by definition, affected by anything which affects the terrestrial habitat. It should be noted that the small size of Palau, which limits its terrestrial habitat from the outset, requires that extra caution be taken when assessing development impacts on the environment. Seemingly reasonable activities may have a relatively bigger impact in Palau than in areas with a larger land base, and this impact is directly channeled to animal species and others (including humans) dependent on terrestrial habitat.

Impacts on bird populations

Loss of terrestrial habitat is now a major issue with respect to bird populations in Palau. The impact of development on upland forests limits the habitat of forest birds. Increased use of Rock Island beaches for tourism and recreation has resulted in disturbance of Micronesian megapode nesting sites. Fires also destroy habitat of avian species. Loss of avian wetland habitat due to development or decline in traditional wetland taro cultivation will also undoubtedly be a major issue in the future, given the increasing pressures for development (Engbring 1988).

Illegal hunting may also be causing the decline of some avian species in Palau. For instance, there is concern over the illegal hunting of the Micronesian pigeon. A constitutional provision which designates shotguns as illegal by law has had some effect in curbing the harvest of birds. Apparently, however, pigeons are being shot and can be found fairly regularly in markets in Koror. Pigeon is also advertised and available at many local restaurants. However, the overall level of harvest of pigeon for subsistence and commercial purposes has not been quantified. Data on harvest of Micronesian megapode eggs and other birds species was also unavailable despite the fact that they are being collected and eaten.

Fortunately, the indications are that most resident bird species of Palau have healthy populations. No native species have become extinct, although the Micronesian megapode is on the US Endangered Species List, and several species have become rare. The Rock Islands south of Koror, most of which are steep and inaccessible, have provided a refuge of relatively undisturbed habitat for the native forest birds of Palau. Some demographic changes, such as declines in the human populations of the Southwest Islands, may actually result in increased habitat for seabirds (Engbring 1988).

Bat population issues

A recent survey of fruit bat populations in Palau indicates that these populations are still at healthy levels (Cassell, Otobed & Adelbai 1992), although there is some concern over the increasing export of fruit bats to Guam. Fruit bat populations may also be affected as a result of the loss of native upland forest habitat.

Chapter 4

Marine environment

4.1 General

The Republic of Palau is endowed with a high level of diversity and abundance of marine resources which historically have provided one of the most important food sources for the population. Commercial development of marine resources is also currently being pursued as one avenue towards achieving sustainable economic development for the country. Although figures for all marine resources are not available, it is estimated that Palau has 1,357 inshore fish species. By comparison, the eastern Caroline Islands are estimated to have 1,149 species, and the Marshall Islands 827 species. Palau also has five endemic species of marine fish (Myers 1989).

The richness of marine habitats of Palau has undoubtedly served to enhance the diversity of its marine resources. Being a high island, Babeldaob has perennial streams, rivers, and well developed mangrove forests which provide a sustained flow of nutrients to the ocean. Mangrove and seagrass habitats are required by the young of a large variety of marine fishes, some of which migrate to coral reefs as adults (Myers 1989). Palau also has several coastal bays which provide sheltered, nutrient-rich estuarine habitats for juvenile and other marine species.

Surrounding the majority of the islands of the Palau archipelago is an extensive barrier reef system enclosing a lagoon with an area of approximately 560 square miles (1,455 square kilometres). Historically, lagoonal waters have been the main fishing grounds in Palau (Johannes 1981), but reef channels, reef flats, and reef slopes also provide productive fishing grounds.

Extensive reef systems are also present at Peleliu, Angaur, and the Southwest Islands. Although not of much value for fisheries resources to date, the isolated marine lakes inside the Rock Islands have evolved into marine systems unique to Palau. Kayangel and Ngaruangel, to the north of the barrier reef, are atolls with their own lagoon and reef systems. In addition to these reef and lagoon resources, Palau has claimed a 200-mile Exclusive Economic Zone (EEZ), which is rich in migratory and oceanic fishery resources.

But, as with other resources previously discussed, the seeming abundance of the marine resources of the country is tempered by the small base size of this island nation. Economic development strategies for utilization of marine resources must therefore focus on management for controlled and sustainable harvest.

4.2 Marine habitat

4.2.1 Range and distribution

Estimates of the area of marine habitats in Palau are provided in Table 4.1. Figures are not included for habitat areas beyond the barrier reef, although it should be recognized that the actual marine habitat of Palau extends to the 200-mile EEZ.

Mangrove forests interface land and sea and are included in this chapter as well because of their vital importance for maintaining marine resources. Table 4.1 does not detail areas of coastal bay or sandy beach habitat, although Palau does include several fairly large estuarine bays. Ngeremeduu Bay on the west side of Babeldaob represents one of the largest coastal bay ecosystems in Micronesia.

Sandy beach habitat also interfaces the land and sea in Palau, but will be considered as marine habitat for the purposes of this report. Numerous isolated sandy beaches exist in the Rock Islands. A significant amount of sandy beach habitat also

Table 4.1 Estimated area of fishing habitats by state (sq km)

State	Mangrove	Inner reef	Outer reef	Lagoon	Total area
Angaur	0.0	2.6	-0-	-0-	2.6
Peleliu	4.9	35.5	-0-	-0-	40.4
Koror	1.6	19.2	100.0	500.0	620.8
Airai	7.9	22.7	4.0	30.0	64.6
Aimeliik	2.8	8.2	27.0	55.0	93.0
Ngatpang	6.3	2.7	7.1	15.0	31.1
Ngaremlengui	4.0	7.5	12.3	15.0	38.8
Ngardmau	7.2	13.8	11.0	22.5	54.5
Ngaraard	3.4	23.2	17.3	23.8	67.7
Ngarchelong	12.1	23.0	81.3	325.0	431.4
Ngiwal	1.3	5.8	-0-	12.1	19.2
Melekeok	1.7	8.4	-0-	-0-	10.1
Ngchesar	1.8	6.9	4.7	23.0	36.4
Kayangel	-0-	7.1	-0-	12.1	19.2
	45.0	186.6	264.7	1,033.5	1,529.8

Source: Division of Marine Resources 1990

occurs along the northeast side of Babeldaob Island including Ngiwal, Ngaraard, Melekeok and Ngarchelong States, as well as Kayangel, Peleliu and Angaur and the Southwest Islands.

The varied marine environments of Palau obviously provide habitat for a wide range of marine species. In particular, the lagoon and reef flats, channels and reef slopes support some of the richest areas of marine fauna found worldwide. Coral reef habitat is also now the major drawcard for a booming tourist industry in Palau. Sandy beach areas have always provided important nesting grounds for sea turtles, and these areas are also being increasingly utilized by tourists.

4.2.2 *Functions of mangroves*

As with any marine area, the integrity of the overall marine system in Palau is highly dependent on coastal ecosystems such as mangrove wetlands and shallow water reef and lagoon areas. Mangrove forests perform several functions vital to maintenance of healthy inshore marine resources.

First, they provide spawning and nursery grounds for many species of marine fish, already described above. It is known that snappers, milkfish, and grouper species at least utilize mangroves to some degree in larval, juvenile, or adult stages (Hamilton & Snedaker 1984).

Mangrove systems are also extremely productive, and export a high and sustained amount of

A mangrove tree, Rhizaphora apiculata. *(photo: Demei Otobed)*

Mangrove channel. Mangrove forests provide spawning and nursery grounds for many species of marine fish, as well as providing a settling and filtering ground for waters entering Palau's lagoon. (photo: Demei Otobed)

organic matter into the otherwise oligotrophic waters of Palau's lagoon. Decomposing mangrove litter is a food source for primary consumers such as mollusks, crabs, and polychaete worms which are, in turn, eaten by small or juvenile fish. Small and young fish serve as a food source for larger inshore species which migrate to feed in shallow water areas. Thus, it may be seen that mangroves are a vital link in tropical marine food webs (Hamilton & Snedaker 1984), so the destruction of mangroves can have devastating effects on inshore and offshore fisheries.

Mangrove forests also serve to provide a settling and filtering ground for waters entering the lagoon of Palau. In this way mangroves prevent the intrusion of excess sediment into coastal waters, which could damage fish, invertebrate and, in particular, coral populations. The contribution of mangroves to overall lagoonal water quality is also important in sustaining healthy stocks of marine resources (Hamilton & Snedaker 1984).

Finally, mangroves, estuarine bays, and shallow-water lagoon and reef areas provide habitat and/or feeding grounds for species of fish and invertebrates. In Palau, mangrove forests are the habitat of mangrove crabs and clams, which are important subsistence and commercial marine resources. Sea cucumber, giant clam, and trochus inhabit the shallow lagoon and inner reef flats, and are the target of subsistence and commercial reef gleaning. Eelgrass and seagrass beds in shallow aquatic habitat provide the primary food source for rabbitfish and dugong in Palau.

4.3 Marine habitat: significant issues

4.3.1 General

The importance for Palau of maintaining healthy and functioning areas of marine habitat, particularly coastal marine habitat, cannot be overemphasized. The majority of the perceived opportunities for increasing economic self-sufficiency in Palau focus on utilization of resources which are directly or indirectly dependent upon coastal marine habitat. As a relatively small island nation, Palau has a very limited amount of such habitat. It is therefore important that impacts on coastal marine habitat be quantified and monitored, and that some level of long-range planning be implemented to ensure that an adequate amount of such habitat is designated and preserved.

4.3.2 Development and population pressures

In the future, marine habitat in Palau is likely to suffer heavy and increasing pressure due to development initiatives and population growth. Already, development efforts are having both direct and indirect impacts on the marine environment. Direct impacts are being created, for the most part,

Damaged mangrove forest in Ngatpang. (photo reproduced courtesy of Environmental Quality Protection Board)

by dredge-and-fill activities in Palauan waters for purposes of marina/dock development, and for obtaining materials for road building. EQPB records show that, through the permitting process, more than 371,850 square feet of shallow reef flat habitat have been destroyed by dredging or filling (EQPB 1994).

Dredge-and-fill activities hence reduce shallow aquatic habitat which is utilized by invertebrate and vertebrate species. Species which graze on seagrasses such as rabbitfish and dugong are particularly vulnerable to such habitat destruction. In addition, dredge-and-fill activities may cause increased sedimentation in nearby marine communities, which has an impact on fish and invertebrates. Although permit records do exist which allow dredge-and-fill activities in Palau to be quantified, it is difficult to quantify the overall indirect impacts of dredge and fill on marine ecosystems.

Other direct impacts on marine habitat are created by the increased use of marine areas for tourism based activities. It is known, for example, that constant anchoring at various dive sites in Palau causes damage to coral reef communities. It is also obvious that increased tourist presence and recreational use of the Rock Islands is disturbing sea turtle nesting sites.

Direct destruction of mangrove habitat has also occurred, although not to the same extent as in many other Pacific islands. A recent development to build a causeway in Ngatpang destroyed 35 acres of mangrove habitat. This development decimated crab and clam resources in this mangrove area, and will most likely reduce the inshore fisheries of Ngatpang.

Although impacts remain unquantified, it is clear that the sediment load to Palau's major rivers has increased due to road development and forest burning. The resulting increased flow of sediments to coastal waters is potentially toxic to corals and other marine organisms, decreases water quality, and may cause eutrophication of shallow water areas (Carpenter & Maragos 1989). Further, direct observation indicates that sedimentation and runoff from improperly engineered roads is smothering and destroying areas of mangrove forest in Ngatpang State at least.

Pollution impacts

Pollution has a direct impact on the marine environment, particularly in Koror State where development and population are heaviest, and also increasing. Recent tests of marine water at a location in Koror State showed contamination with fecal coliform and other types of bacteria. Investigation of this contamination by EQPB resulted in a listing of several potential causes, the most likely one being a public sewer system which is rapidly approaching capacity (EQPB 1991).

Pollution resulting from increased shipping traffic and from foreign fishing vessels dumping waste into the harbor is also a concern in Palau. Tests of the water quality of Malakal Bay, the major shipping port of Palau, showed high levels of chlorophyll in this area, indicating a high potential for

Ngeremeduu Bay, one of the largest coastal bay ecosystems in Micronesia. (photo reproduced courtesy of Environmental Quality Protection Board)

eutrophication in the future (Marine Biotechnology Institute 1990).

Pollution from solid waste disposal is also an issue of concern. Although not adequately studied, pollution created by leaching from the Koror State landfill is thought to be having an impact on water quality near Koror (EQPB 1991).

Large-scale projects

Pressure for development which has a negative impact on marine habitat continues to grow in Palau. Currently, several large and highly publicized projects are going through the permit application process. Among the recently proposed projects are a new international airport in central Babeldaob, a multi-million dollar resort for the Ngesaol area, golf courses in Airai and Melekeok States, and further state road development (EQPB 1994). Although each of these projects has the potential to directly and indirectly affect marine habitat in Palau, impacts from the airport and large resort development would probably be greatest.

The proposed airport would be located within the watershed of the Ngeremeduu Bay, which is the largest estuarine area in Palau. Erosion and sedimentation created by development of a large airport in this region could lower productivity of this important coastal bay habitat (Birkeland et al. 1989).

The resort development proposed for Ngesaol calls for the destruction and filling of 42.1 acres of mangrove habitat, 24.3 acres of open water, and 97.3 acres of shallow aquatic habitat (Brewer 1991). Such a development would not only reduce the quality and quantity of marine habitat in Palau, it could also indirectly lower fisheries productivity through increased sedimentation to surrounding areas and food web interactions.

Thus, although a substantial amount of quantitative data is not available on the status of marine habitat, it is easy to see that the levels of various types of development which may affect this habitat are increasing in Palau.

4.3.3 Need for environmental planning

A more detailed assessment of the state of the marine and terrestrial environment in Palau is also available through the Rapid Ecological Assessment carried out by The Nature Conservancy (TNC) with

funds from the US Department of the Interior (Cook & Maragos 1991). The information contained in the Comprehensive Conservation Strategy document (Cassell, Otobed & Adelbai 1992) and this SOE Report, together with the information gained through the Rapid Ecological Assessment, should be used as a basis for future planning for sustainable economic development in Palau. Environmental planning is badly needed to curb the current thrust for rapid and careless development, and to set a framework for wiser and more informed decision making.

Given the relatively small amount of overall habitat in Palau and the fact that most of the perceived opportunities for economic development are based on the marine environment, it is all the more imperative that any development causing loss or degradation of marine habitat be carefully weighed for its costs and benefits. This planning should also consider the fact that marine and terrestrial systems are integrally linked, as has been mentioned above.

4.4 Inshore finfish

4.4.1 General

A high diversity of inshore finfish species is present in Palau. Many species are present in shallow-water reefs. The locations of spawning aggregation sites for several inshore species are also known by local fishermen, but are not documented. Inshore finfish species groups which are harvested in Palau include snappers (Lutjaniedae), emperors (Lethrinidae), groupers (Serranidae), parrotfish (Scaridae), wrasses (Labridae), rabbitfish (Siganidae), surgeon fish (Acanathruidae), trevallies (Carangidae), and herrings (Clupeidae).

The most recent available data indicates that at least 250 metric tons of reef fish, mangrove crab and lobster were landed or exported from Palau in 1990. This reflects an increasing demand for fish at local restaurants and hotels associated with the growing tourist trade; population growth; and increase in export, mainly to Guam and Southeast Asia. The increase in demand is putting pressure on resources and the environment, which must now be managed properly if resources are to remain at sustainable levels.

4.4.2 Data issues

Catch-level data is incomplete or inadequate for most species, thus stock status for the majority of species remains unknown. It is important, therefore, to gather more information on inshore fisheries stock for management purposes. However, it is apparent that there is a decline in some of the major species, which has caused concern. Declines in species of grouper, rabbitfish, parrotfish, and wrasse have been most noticeable.

4.4.3 Destructive fishing practices

Destructive fishing practices are another concern. Although traditional fishing methods as described by Johannes (1981) are used in some villages, fishing methods are now predominantly modern: trolling, spear gun, hand-held spear, hand line, drop line, gill net, set net ('kesokes'), portable fish traps, cast nets, and spear gun with scuba. Methods which are currently illegal in the Republic of Palau, such as dynamiting and use of industrial bleach (Palau National Code, Section 1302) are known to be used for harvest of inshore species.

4.5 Offshore finfish

4.5.1 General

Tuna are the primary pelagic finfish species group targeted for harvest from the Exclusive Economic Zone of the Republic of Palau. Species of tuna harvested in the waters of Palau include albacore (*Thunnus alalunga*), bigeye (*T. obesus*), yellowfin (*T. albacares*), skipjack (*Katsuwonus pelamis*), and northern bluefin (*T. macoyii*). Other pelagic finfish taken in considerable quantities in Palau include blue marlin (*Makaira nigricans*), sail fish (*Istiophorus platypterus*), striped marlin, black marlin, swordfish, shark, spearfish, and dolphin fish (*Coryphaena hippurus*).

Historically, harvest of offshore fisheries stocks has not played a major role in the fisheries of Palau. Shark fishing was practiced in the past in Palau, but harvest of other pelagic species was mostly incidental to fishing for inshore stocks (Johannes 1981).

4.5.2 Offshore fishing industry

Tuna are currently the primary target of a growing offshore fishing industry in Palau. Presently, only foreign or domestic joint venture companies are

involved in exploiting this resource. During 1990 five foreign fishing agreements were in effect, which allowed some 487 vessels to participate in offshore fishing in Palau.

Direct economic benefits to Palau are mainly in the form of license fees, although Palau obviously has opportunities to expand its involvement in the industry. Presently, approximately 830.6 metric tons or 44 per cent of the catch from Palau's EEZ is air-freighted fresh to Japan and sold on the sashimi market. The remainder of the catch is frozen and shipped to Taiwan for canning. No value-added processing occurs in Palau.

4.5.3 Potential for tourism

The fact that the presence of offshore species may represent an additional attraction to the tourist industry in Palau has also come to the attention of marine management and other individuals. Discussions have taken place regarding the development of a tourist sportfishing industry centered on billfish, although to date no development has occurred.

4.5.4 Data issues

Data collection on landings of offshore species from Palau's waters has been extremely limited. At most, landings data is available for the past four years only, and only for some companies. Due to the incomplete and limited nature of available data, it is currently impossible to assess the status of Palau's offshore fishery resources. However, Division of Marine Resources staff, with assistance from the South Pacific Commission (SPC), have recently begun a program to monitor tuna caught from foreign vessels. It is imperative that such monitoring programs continue, and that data from such programs is utilized to implement strategies to prevent overharvest and to ensure management for sustainable utilization of offshore resources.

4.6 Deep-water finfish

4.6.1 General

Deep-water finfish resources in Palau are primarily from the species groups of snapper (Lutjanidae), emperors (Lethrinidae), and groupers (Serranidae). The dominant deep-water finfish species found in the waters of Palau are *Pristipomoides flavipinnis*, *P. auricilla*, *P. zonatus*, *Aphareus furcatus*, *A. rutilans*, *Gnathodentex mossambicus*, *Etelis carbunculus*, *E. coruscans*, *Lethrinus miniatus*, *L. variegatus*, and *Ephinephelus* spp.

4.6.2 Potential value

As said before, a focus on deep-water fisheries resources historically has not been evident in Palau. However, it has been recognized recently that this resource may have potential value for development. Deep-water resources may also represent a mechanism to remove some pressure from more heavily exploited inshore stocks. At present, it appears that increased harvests of these resources could be readily absorbed by the domestic and export market.

4.7 Invertebrates

4.7.1 General

Diversity of invertebrate marine fauna is very high in Palau. Invertebrates which have been harvested for subsistence or other purposes in Palau include representatives from the Phyla *Crustacea*, *Echinodermata*, *Mollusca*, and *Porifera*.

Species listed as being important or potentially important marine resources in Palau include mangrove crab (*Scylla serrata*), coconut crab (*Birgus latro*), land crab (*Cardisoma hirtipes* and *C. carnifex*), rock lobster (*Panulirus penicillatus*, *P. versicolor*, and *P. longpipes femoristriga*), slipper lobster (*Scylarides neocaledonicus*), deep-water shrimps (*Heterocarpus ensifer* and *H. laevigatus*), deep-water crabs (*Geryon granulatus*), mangrove clams (*Anodonita alba*, *A. edulenta*, *Polymesoda luhuana*, and *Terebralia semestriata*), blacklip pearl shell (*Pinctada margaritifera*), native oyster (*Crassostrea echinata* and *C. glomerata*), eight sea cucumber species (white teatfish, *Holothuria (Microthele) nobilis*, black teatfish, *H. (Microthele) fuscogilva*, blackfish, *Actinoptyga* sp., surf redfish, *A. mauritiana*, prickly redfish, *Thelenota ananas*, sandfish, *Holothuria scraba*, eremrum, *Actinopyga echinites*, and ngims, *Stichopus variegatus*) and bath sponge, *Spongia officinalis*.

All seven species of giant clam and a species of trochus are also present in the waters of Palau. These species, however, have been significantly depleted, and no legal harvest of wild stocks is allowed. Replenishment of stocks is currently being attempted through aquaculture.

4.7.2 Population levels

With the limited amount of data, it is impossible to determine the status of most species of invertebrates harvested from Palau's waters. Studies indicate, however, that at least two of the more highly demanded species, the mangrove crab and the coconut crab, may be declining due to increasing exploitation. Lobster populations may be more self-sustaining as rough weather limits harvest for at least six months of the year. The heavily exploited populations may also become wary of fishermen and lights at night. And since lobster larvae can be recruited to a given area from outside populations, restocking an area may occur naturally.

Sedentary invertebrate species such as the sea cucumbers and clams are particularly vulnerable to overexploitation depending on the level of effort in the fishery at a given time. Similarly, species harvested during migrations, such as the land crab, are susceptible to overharvest. Again, however, stock status data for Palau is lacking for these species.

Little information exists on the level of harvest of invertebrates for the tourist shell trade, although some concern does exist on this issue.

4.8 Aquaculture issues

Seven species of giant clam, *Tridacna gigas*, *T. derasa*, *T. squamosa*, *T. maxima*, *T. crocea*, *Hippopus*, and *H. porcellanus*, and several species of trochus exist in the wild in Palau. Only one trochus species, *Trochus niloticus*, is harvested in Palau. It is well documented that populations of wild giant clams and trochus throughout Palau have declined noticeably. Typhoon Mike in November, 1990 is also thought to have had an impact on trochus stocks.

A moratorium on trochus harvest is therefore in effect, and only giant clams raised through aquaculture may be legally exported from Palau. Intensive aquaculture development efforts are underway for both giant clams and trochus as a means to maintain harvestable levels of these resources. Efforts are also underway to assess and monitor existing trochus stocks through the Division of Marine Resources (DMR). The Division of Marine Resources and the Belau Mariculture Demonstration Center (BMDC) are also working together to develop a reef re-seeding program for trochus, although seed production has not been as successful as hoped.

BMDC has developed a highly successful program in giant clam aquaculture. Between 1986 and 1990, giant clam seed production increased almost tenfold, from 116,503 to 1,353,296 per year. BMDC is also working with the fourteen coastal states of Palau to develop state demonstration farms and sanctuaries. In spite of this aquaculture success, intensive commercial and subsistence harvest and illegal poaching by foreign vessels has continued to cause declines in populations of wild giant clams. Recent surveys have led some authors to recommend a ban on giant clam fishing, at least in some popular fishing areas.

4.9 Seaweeds and aquarium fish: significant issues

Seaweeds and aquarium fish historically have not been harvested in Palau. These two resources are briefly considered here, however, because both have recently become targets for harvest. Increasingly, seaweeds are being harvested for subsistence by the growing Filipino populations in Palau, although no quantification of this subsistence use exists.

Discussion of pursuing seaweed farming for export has also occurred, and several sources indicate that aquarium fish are being exported from several operations in Palau. The only regulation of these operations is through fishing licenses (required in some states), although the Environmental Quality Protection Board (EQPB) is also attempting to track some of these operations.

Concern exists over harvest of seaweeds and aquarium fish for two major reasons. First, there is concern over the impact that such harvest may have on other species. For instance, the harvest of seaweeds may adversely affect herbivorous fish species, and harvest of aquarium fish may have food chain impacts. Second, as these resources have not been previously harvested, no regulatory framework exists to control harvest so that impacts can be adequately studied.

Although these uses may represent sustainable fisheries development opportunities, they also represent a current resource management issue in that their impact has been so little studied. The need to track, study, monitor and, if necessary, regulate such new uses of marine resources should be

Dugong. It is estimated that there are now fewer than 200 dugong in Palauan waters. (photo: Demei Otobed, photographic collection, Division of Conservation and Entomology)

recognized in any fisheries management plan for Palau.

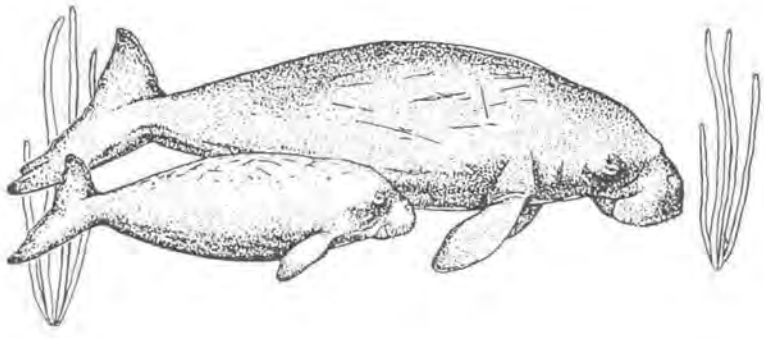
4.10 Other marine resource issues

Several resources existing in Palau's marine ecosystems do not readily fit into any of the above categories. These resources, which have been traditionally harvested or are thought to have potential for harvest, include hawksbill sea turtle (*Eretmochelys imbricata*), green sea turtle (*Chelonia mydas*), Olive Ridley sea turtle (*Lepidochelys olivacea*), leatherback sea turtle (*Dermochelys coriacea*), estuarine crocodile (*Crocodylus porosus*), dugong (*Dugong dugon*), and seaweeds.

Concern exists over perceived declines in adult green and hawksbill sea turtles although actual populations and causes of these declines remain undocumented. Surveys of the Palau dugong population in 1977, 1978, 1983, and 1991 indicated that the dugong population in Palau is extremely small, isolated, and vulnerable to overexploitation due to poaching (Marsh et al. 1991). During the 1991 survey, 26 dugong were sighted, which included only four cow-calf pairs, and it was estimated that there are now fewer than 200 dugong in Palauan waters. The small size and isolation of dugong populations in Palau highlight the need for continued efforts to curtail illegal poaching and otherwise protect these populations.

Crocodile farming. Because of the severe decline in crocodile numbers, farming and/or maintenance systems are necessary to preserve species stocks. (photo: Demei Otobed)

The numbers of crocodiles in Palau have also declined significantly, and it is thought that no more than 150 remain. Until education and enforcement efforts can more adequately address the problem of wholesale slaughter of this species, farming and/or maintenance systems are necessary to preserve species stocks.



PART 2
Human environment

Chapter 5

Population

5.1 Overview

Most of the environmental problems described in this report are caused by humans putting too much stress on our natural resource base. The number of people and their material expectations are both increasing rapidly, which is causing environmental degradation, especially in a situation of limited resource base such as exists in Palau.

It is true that in the past the islands of the Republic of Palau supported a much larger population than currently exists. At the time of its discovery by Western civilization in 1783, Palau was estimated to have a population of 40,000–50,000. This population, said to have originated from Indonesia in 2,500 BC, existed in a complex and highly organized village-based social system. With the introduction of European contagious diseases, however, many villages were devastated by high death tolls. Population in Palau declined rapidly until 1901 when it reached a low of 3,700 people (Office of Planning and Statistics 1987).

The most recent available census figures are listed in Table 5.1.

5.2 Current issues

5.2.1 Recent trends

Data from the most recent census (Table 5.1) places the population of Palau at 15,122 people (which would be considered a relatively low density). These 1990 figures represent an increase of 34.8 per cent from the 1986 census count recorded in Office of Planning and Statistics (1987) data. Overall, however, the annual population growth rate has been low during the past several decades. Between 1973 and 1986, for example, an annual population growth rate of only 0.7 per cent was recorded (Office of Planning and Statistics 1987). Limited population growth rates result mainly from continued emigration of native Palauans to the United States, Guam, Saipan, and other areas for employment and education.

On the other hand, higher levels of immigration from other countries during the past five years has served to partly offset this exodus by the native Palauan population. Although figures were not available from 1990 census data, other sources indicate that higher levels of foreigners are relocating to and working in Palau.

5.2.2 Patterns of change

Distinct patterns of change in population distribution in the Republic may also be observed from the 1990 census data (Table 5.1). Since 1980 the populations of Koror and two southern states in Babeldaob, Aimeliik and Airai, have increased by 41.4 per cent, 60.8 per cent and 90.4 per cent respectively. At the same time, the populations of the other 13 states of Palau, already significantly lower, have witnessed population declines during this period.

This migration pattern from villages to areas in or near Koror is caused, for the most part, by the fact that most government or other job opportunities exist in the urban center of Koror. Increasingly, the educated youth of Palau cannot find satisfactory work or are not content to remain in their home states and villages — hence the migration to Koror, the southern states of Babeldaob, or other countries.

5.2.3 Implications of future growth

Although the problems of high population density presently experienced in many Pacific Island

Table 5.1 Republic of Palau: 1990 census data

State	Population		Change in population	
	1980	1990	Number	Per cent
Aimeliik	273	439	166	60.8
Airai	648	1,234	586	90.4
Angaur	243	206	– 37	– 15.2
Hatohobei	74	22	– 52	– 70.3
Kayangel	140	137	– 3	– 2.1
Koror	7,425	10,501	3,076	41.4
Melekeok	261	244	– 17	– 6.5
Ngaraard	437	310	– 127	– 29.1
Ngarchelong	372	354	– 18	– 4.8
Ngardmau	140	149	9	6.4
Ngatpang	166	62	– 104	– 62.7
Ngchesar	364	287	– 77	– 21.2
Ngaremlengui	358	281	– 77	– 21.5
Ngiwal	247	234	– 13	– 5.3
Peleliu	609	601	– 8	– 1.3
Sonsorol	79	61	– 18	– 22.8
Total for Palau	11,836	15,122	3,286	27.8

Source: US Bureau of the Census 1990 (Government of Palau 1994)

nations, particularly the atolls, are not felt to the same extent in Palau, recent trends indicate that the situation may be changing rapidly. According to population forecasts prepared for the Palau National Master Development Planning exercise, the country's population will increase to 20,028 in two years, and will have reached 28,045 by the year 2005, an increase of almost 85 per cent from the 1990 level (PNMDP 1994).

In particular, it is worth noting that the population in Koror State will virtually double from 10,501 (1990) to 20,794 (2005), giving it a very high population density of 2,772 people per square mile. This translates into a substantial increase in the burden on water supplies, the sewerage system, and energy generation system of the state. The current infrastructure in Koror is ill-equipped to deal with even the present level of use, and environmental degradation around Koror is an escalating problem. Without proper planning and management, this trend will continue, with inevitable impacts on other areas of Palau.

Palau is a rapidly developing country, with impetus for change coming not from one source but from all over the Pacific including Asia. As a result of modernization, Palauans are adopting new lifestyles that require more and more resources. The subsistence lifestyle which made it possible for the environment to sustain larger populations in the past is still present in many parts of Palau, but more and more people, especially in the urban areas, are finding such life inadequate. They require more of the modern services and other conveniences, and for this they need money — hence the push for more efficient exploitation of natural resources. Pressure to exploit natural resources will also come from foreign investors with associated potential for environmental degradation.

As well, the increase in immigration of foreigners to Koror and other areas of Palau represents additional stress on the natural resource base, especially with the intense and damaging methods of resource exploitation being introduced into the country through such groups. If present forecasts are correct, the resident alien population of Palau will be 10,804, or about 52 per cent of total population, by 2005, representing a fivefold increase from the 2146 recorded for 1990 (PNMDP 1994).

Although problems created by these demographic trends represent certain threats to sustainable development in Palau, they are not insurmountable. However, proper planning and forethought is needed if Palauan leaders are to succeed in curtailing potential future problems.

Chapter 6

Education and information

6.1 Environmental education

Education is the key to preventing further environmental degradation in Palau. Human actions, mostly carried out in ignorance or without a full appreciation of the implications, are the principal cause of almost all the environmental problems discussed in this report.

An overall lack of awareness of ecological processes and of the issues of sustainable development is a problem at all levels in Palau. Consequently, unsustainable development is often accepted and pursued with little thought or question.

At present, a National Task Force on Education is preparing an Education Master Plan for Palau. The task is expected to be completed by September 1994, so an opportunity exists for addressing the gaps in environmental education.

With increasing pressure on Palau's leadership to develop the country's natural resources, there is an urgent need for effective educative programs to discourage unsustainable resource-use practices. The communities should be relied upon to influence the leaders but greater public responsibility needs to be encouraged through more effective public awareness programs. In this regard, the interest shown by Palauan officials and private citizens in establishing an environmental non-government organization is worthy of note.

If a public education program is successfully pursued, it will empower local people to assume some sense of stewardship and willingness to report permit violations. By increasing their overall awareness both of the environment and of government efforts to protect the environment, it is also hoped that local people will assume more responsibility and accountability for their own actions.

Traditional Palauan culture included many forms of sustainable resource-use practices and while much has been forgotten, a great deal of traditional knowledge is still present in Palau today. The knowledge and revival of such traditional practices could be critical to the efforts to promote sustainable development of resources.

6.2 Information on natural systems

Although Palau's natural environment has been well studied and documented compared to many other Pacific Island countries, there remain significant gaps in knowledge and information. With current efforts to assess resources, there will be some improvement in overall knowledge about the resources base. However, some serious deficiencies will remain with regard to the detailed information necessary for effective resource monitoring and management programs.

There is therefore a need to support the excellent baseline studies program which has been initiated by the Bureau of Natural Resources and Development in cooperation with The Nature Conservancy. Scientific research, specifically on endangered species and endemic plant status, should also be given continued encouragement.

Cultural, historical and archaeological resources

7.1 Cultural resources

An important aspect of the human environment in Palau is contained in the culture, as well as in historical and archaeological resources. Palau's culture contains many elements which could be harnessed for resource and environmental management, while the country's historical and archaeological resources are valuable assets for its tourism industry.

7.1.1 Kinship

One of the fundamentals of Palauan life is kinship, and kinship ties have traditionally been a powerful determinant of behavior. The strong extended family ties in Palau have historically served to support laws or decrees imposed by the traditional chief systems in Palau and, as is the case in other Pacific Island communities, many such laws pertained to the sustainable use of the limited resource base of island ecologies (see Section 7.1.3).

7.1.2 Subsistence lifestyle

Subsistence farming and fishing have long been an important aspect of life in Palau. Virtually total dependence on subsistence production from a limited resource base has led to the evolution of traditional systems of tenure to control use of land and marine resources. The cooperative nature of subsistence living helps to maintain family tradition and structure (Birkeland et al. 1989), including those pertaining to resource conservation.

7.1.3 Traditional conservation practices

Palauans have long depended on the land and sea to provide their means of existence. As such, areas

Betelnut palms line the main road in Ngkeklau Hamlet, Ngaraard State. (photo: Demei Otobed)

Traditional women's money, 'toluk', made from the shell of hawksbill turtle. (photo: Demei Otobed)

of land and sea have historically been strictly guarded by village-based land and marine tenure systems. Through these systems, defined areas of land and sea were under the direct ownership of clans, villages, or village clusters. Chiefs — most often specially designated chiefs with an understanding of natural resource needs and cycles — had the power to control access to and use of these areas for hunting.

Land tenure systems in Palau have been extensively documented by Kaneshiro (1958) and McCutcheon (1985). These authors note that, prior to European contact in 1783, individual ownership of land was not seen in Palau. Traditionally, all lands in Palau were considered either public domain ('chutem buai') or clan lands ('chetemel a kebliil').

Public domain lands were owned and controlled by individual villages or village clusters. The public domain lands of a given village could be used by villagers to obtain wild pigeon, timber, or wild yams. Where deemed necessary, the village council of chiefs had the power to make announcements ('subed') to close seasons for hunting on these village lands. In all cases, outsiders or non-village members were required to ask permission of the council of chiefs to use public domain lands (Kaneshiro 1958).

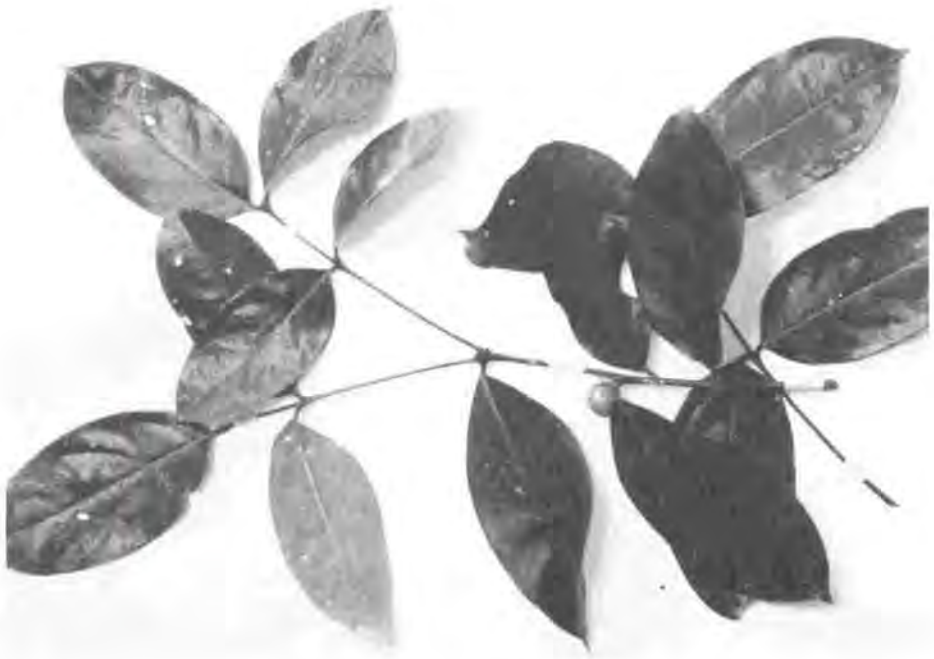
Marine tenure systems in Palau, as first detailed by Johannes (1981), were administered in a similar fashion to land tenure. Reef and lagoon tenure denoted ownership of a specific marine area by village clusters. These village clusters had the right to restrict access to their fishing grounds. Normally, only villagers could fish in these designated areas although Johannes documents cases where outsiders were granted permission by the controlling council of chiefs to fish in village reef areas as a favor or in exchange for a certain amount of their catch. Conservation decrees by chiefs, such as restrictions on the harvest of massing spawning fish in a given village tenure area, were also documented by Johannes.

Other traditional conservation methods in Palau have been discussed by various authors. The fact that each village in Palau holds different bird and fish species as taboo may be considered as a form of conservation measure. In various areas in Palau, it has also been documented that certain easily harvested marine species are reserved for harvest during the rough weather months. This is true of milkfish in Peleliu and of sea cucumber and giant clams in Ngaremlengui (Johannes 1981).

Finally, it is worth mentioning that at traditional Palauan custom feasts, various individuals assigned to gather food such as fish and coconut were called 'Kerreomel'. Literally translated, 'Kerreomel' means to conserve. This is indicative of the degree to which conservation was integrated into the traditional way of life in Palau. Although the person designated as 'Kerreomel' would harvest large quantities of resources for the custom feast, the very name indicates that they were also expected to practice conservation with respect to how, where and how much of the resources were harvested (Cassell, Otobed & Adelbai 1992).

7.1.4 Communication: legends, songs, chants, and dances

The Palauan language, legends, songs, chants and dances continue to be a powerful force for communicating and transmitting important information about histories of persons, places or events. They are perhaps even more potent as a medium for the transfer of messages about what is important today, and therefore represent a potentially



Shrub, Phaleria nisidai, *used in traditional medicine. (photo: Demei Otobed)*

powerful avenue for environmental education and management.

7.1.5 Cultural resources: significant issues

Although it is impossible to assign a conventional economic value to cultural resources, it is well accepted that cultural traditions and values are of major importance to any society. Aspects of Palau's culture are, for example, important in reinforcing ideas about appropriate lifestyle and use of resources. Many of the chants and stories of Palau convey ideas about the conservation of resources. Also, subsistence agricultural and fishing methods produced a traditional diet much more suited to nutritional needs and climatic conditions than the current diet of imported processed foods.

Source of identity

Most importantly, perhaps, cultural heritage in Palau provides a sense of identity, as is true anywhere. Many sociological studies have detailed the impacts which loss of cultural phenomena and resulting loss of identity can have on a society. Although cultural change and evolution is an inevitable process, it would appear that more adequate recognition and awareness of cultural values is necessary to mitigate the social disruption created by change.

Pressures on traditional culture

It has been noted, that some important cultural practices such as the growing of taro are on the decline in Palau due to the demands of employment or other aspects of modern life. Increasingly, too, complaints about the time and monetary demands created by custom ceremonies are heard from younger generations in Palau (Smith 1977). Although participation in kinship-based custom events is still relatively strong, it is possible that it could decline in the future. Loss of traditional knowledge contained in oral histories, legends, and chants, and often not recorded in writing, has occurred as older generations — the last carriers of much of this knowledge — have passed away.

Significant change has also occurred to traditional land tenure systems in Palau. During the German administration in the first decade and a half of the 20th century, the precedent was set for considering public domain village lands as 'unowned' land and hence available for government use. With the transfer of power to Japan in 1914, these 'unowned' lands were targeted for government development projects such as coconut palm plantations (McCutcheon 1985). During the US administration after World War II, some of these lands have come under individual ownership through homesteading and other provisions.

The US Trust Territory administration established a policy whereby these public lands would

eventually be returned to village-states (McCutcheon 1985). In fact, the return of lands to villages has largely not occurred, and some of these lands are now being designated for development before any actual investigation of their original ownership is made.

The lands of Ngesaol, in Koror State, now designated for resort development in their current 'public' land status, illustrate this phenomenon. While the resort development proposal for the Ngesaol lands (Brewer 1991) refers to these lands as public, the Ngesaol lands have historically belonged to the nearby village of Ngermid, as is detailed by Rehuher et al. (1990). Residents of Ngermid have recently submitted a petition against the proposed resort as well as a claim for their lands.

Clan land tenure, too, has undergone change during Palau's recent history. Individual ownership of traditional clan lands has become increasingly prevalent, and inter-clan disputes over the right to clan lands are more common.

Integrating traditional and modern

Some aspects of marine tenure and traditional conservation measures do remain valid in Palau today. Decrees by chiefs continue to be issued for both marine and terrestrial areas to prevent harvest from certain areas or harvest of certain species. As with many other institutions in Palau, this system has been somewhat modernized. For instance, announcements for season or species closures may be made over radio or in newspapers.

Unfortunately, respect for and adherence to the provisions of such decrees seems to be waning for reasons such as general social change, or impingement by Western governing entities. This has led some chiefs to acknowledge the need for assistance with enforcement of traditional laws, which actually may represent an excellent opportunity for cooperation between the Western and traditional governing systems (Nichols 1991).

Potential revival

On a more positive note, some sources also point to indications that Palau, as is true of indigenous populations worldwide, is experiencing some revival of traditional culture. Younger generations in Palau are more interested in learning about dance and other aspects of their cultural heritage (Cassell, Otobed & Adelbai 1992). Such interest in cultural identity, if sufficiently stimulated, will probably provide the most important impetus for preservation of valuable aspects of Palau's cultural heritage.

7.2 Historical and archaeological resources

Historical and archaeological resources may be classified into four time periods in Palau: "Time of the Gods"; pre-contact (prior to 1783); contact (1783–1888); and modern (1888–present).

7.2.1 "Time of the Gods"

There are historical and archaeological sites in Palau whose origins are unknown, although some are referred to in legends. The Stone Faces of Melekeok State, the ancient stone monoliths (Badrulechau) of Ngarchelong State, and the Medechii Belau of Airai State are examples of such sites.

7.2.2 Pre-contact period

Numerous pre-contact historical or archaeological sites exist in Palau, and may be divided into four basic types: ancient Rock Island village sites, caves, traditional village sites, and physical remains of traditional culture. Snyder (1985) provides a fairly comprehensive treatment of such sites. Ancient abandoned village sites have been found at several locations in the Rock Islands of Palau, identified mainly by the presence of ceramic pottery shards, shell middens, platforms, and burial sites. Some of these villages have been dated back to AD 1300, and it is known that most had been abandoned by 1783. Little else, including the reasons for abandonment, is known of these sites (Snyder 1985).

Shell middens (Uchularois Cave, Ngemelis Island) and pictographs (Oibadelmerach Island) have also been found in some Rock Island caves (Snyder 1985). There is some speculation that these sites could represent the 'first shelters' of early inhabitants of Palau. On the other hand, Kramer (1926) has documented stories which "imply that the (Rock Island) caves were inhabited, but only by mystical beings". Other historical/archaeological cave sites include the caves on Omisech and others of the Rock Islands where Yapese stone money was quarried (Belau National Museum 1975).

Remnants of more recent traditional village sites are found throughout Palau. These village sites are identified by stone pathways, old platform

roads, platforms for traditional chiefs houses, and traditional 'bai' (men's house) foundations. The most striking remaining traditional village sites are found in Ngatpang, Ngaraard, and Ngardmau States.

Traditional men's house, or 'bai'. (photo: Demei Otobed, photographic collection, Division of Conservation and Entomology)

Other remnants, classified as physical remains of traditional culture for the purposes of this report, are relatively few. One such site, the last remaining 'bai' in Palau, is found in Airai State and is thought to be eighty years old. All other 'bais' were destroyed during World War II. A traditional Palauan war canoe and canoe house also exists in Ngiwal State. Canoes were largely destroyed during the Japanese administration, in an effort to prevent Palauans from leaving their work on Japanese plantations.

7.2.3 Contact period

Little information could be found on historical sites related to the contact period of history in Palau. One site, Englishmen's Beach (Ulong Island) was so named because Captain Henry Wilson and his crew (the first Europeans to reach Palau) lived in this area while rebuilding their boat, "The Antelope", which was wrecked off Ulong Island (Belau National Museum 1982).

7.2.4 Modern period

Most of the modern historical sites in Palau are remnants of the intense battles which occurred between American and Japanese troops in Palau during World War II. Numerous guns, tanks, and fighter planes used in this conflict can be found throughout Palau. The most numerous remains are found on Peleliu Island, which was the main

Old stone path. Remnants of traditional village sites are found throughout Palau, the most striking in Ngatpang, Ngaraard, and Ngardmau States. (photo: Demei Otobed)

center of Japanese defense during that war. A detailed description of these wartime historical sites is provided by a recent joint study by the government of Palau and the US National Park Service to investigate the potential for establishing a historical park on Peleliu (Government of Palau/US National Park Service 1988).

7.2.5 Present value of sites

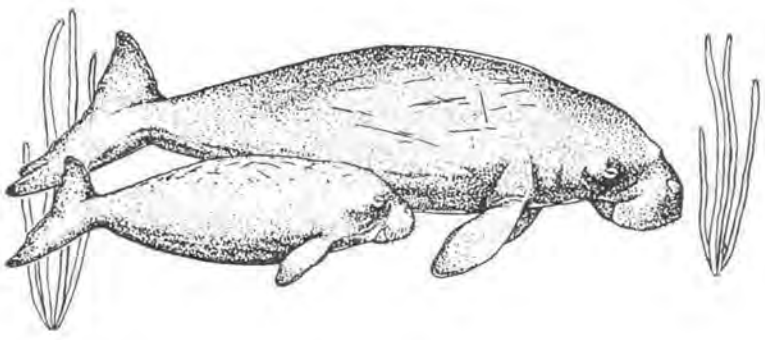
Although it is difficult to assign monetary values to historical and archaeological sites, there is no doubt that they represent valuable assets for the country. To begin with, they provide a physical link to the past and to the history of a given area or people. As such, exploration of sites such as the early Rock Island settlements (Snyder 1985) can provide information on aspects of history for which no written record exists. As well, the value of historical sites in providing a sense of national and cultural identity to a population is almost immeasurable.

In recent times there has been increasing recognition of the value of historical and archaeological sites to the growing tourism industry in Palau. Although the marine environment will most likely remain the primary attraction for tourism in Palau, historical and archaeological sites will add another important dimension to the tourist experience. Palau Visitors Authority (PVA) tourist brochures currently detail some of these sites, and an additional brochure on this subject is planned.

7.2.6 Threats to sites

However, the integrity of historical and archaeological sites in Palau is threatened by many aspects of modern life. Most notably, Snyder (1985) indicates that the archaeological record in traditional village sites near areas of rapid development, particularly in Koror, is being destroyed or otherwise adversely affected. Direct impacts to historical and archaeological sites created by increased tourism presence in Palau, although relatively undocumented, are a cause for concern. Effects on Rock Island village sites associated with increased use of these islands for recreation and tourism activities have been noted as a potential problem.

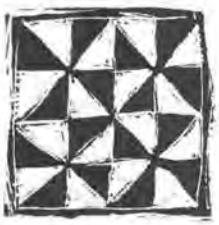
It has also been noted that, as access to and promotion of other historical and archaeological sites on Babeldaob and elsewhere increases, some consideration will have to be given to protecting these sites from degradation which may follow increased human presence and activities. Snyder (1985) strongly recommends that increased study of all historical and archaeological sites be pursued and sites adequately documented so that some restriction of access can be implemented at sensitive sites.



PART 3
Economic and built environment

Chapter 8

Economic framework



8.1 Economic structure and development potential

8.1.1 General

The Palauan economy is a mixture of subsistence and cash types. Approximately 33 per cent of Palau's population currently lives in villages, and is heavily dependent upon subsistence production of food (Cassell, Otobed & Adelbai 1992). Those Palauans employed by the government, private, or other sectors also partly rely on subsistence activities, although little is known about the extent of such reliance. On the other hand, the cash economy is becoming increasingly predominant, especially in the Koror area. The breakdown of sources of government revenue for 1990 is provided in Table 8.1 to give some indication of the economic and revenue base.

Table 8.1 Republic of Palau: revenue and expenditure, 1990 ($US)

Annual revenue	
DOI funds	14,321,000
Federal grant funds	4,965,000
Capital improvement funds	6,064,000
Other (local revenue, taxes, reimbursements)	10,200,000
Total revenue	35,550,000
Annual expenditure	27,499,000

Source: US Department of State 1990

8.1.2 United States funding

A grant of $14.321 million appropriated by the US Congress to the US Secretary of the Interior was the largest source of annual revenue in 1990, representing 40 per cent of the total revenue for the country (Table 8.1). Federal grant funds (matching or outright) were received from US agencies such as the US Environmental Protection Agency (which funds an analogous Palauan agency, the Environmental Quality Protection Board, through Section 9 'State' funds); the US Forest Service; and the US Soil Conservation Service. Capital improvement funds were allocated for specific projects such as road and Koror–Babeldaob bridge repairs and the new national hospital. Again, these funds were provided by the United States (US Department of State 1990).

8.1.3 Local revenues

Locally generated revenue accounted for only $10,200,000, or 28.7 per cent of total revenue for 1990, and although this figure represents a substantial increase from the $3 million (approximately) generated locally in 1973, it is still alarmingly low when compared with the $24.563 million import bill for the same period. Local revenues are particularly critical if Palau is to increase its economic self-sufficiency. (For the purposes of this report, local revenue is taken to include revenues generated by local business, export, tax revenues, and reimbursements for services provided such as utilities, ship charter, and the sale of licenses and permits.)

8.1.4 International and regional support

Palau also receives a substantial amount of support, mainly in the form of technical assistance, from various international and regional organizations. Nonprofit public interest organizations have also developed a stronger presence in the Republic, as well as in other areas of the Pacific, over the past several years. Most notably, The Nature Conservancy, a US-based nonprofit group, has provided support

and assistance for environmental management efforts.

Finally, wealthier Pacific countries such as Japan, Australia, and New Zealand have provided financial and technical assistance to Palau. Japan has provided grants to assist with fisheries development, for improvement of the Airai–Koror water supply system, and for scholarships for Palauan students to pursue study in Japan.

8.1.5 Present challenges

Palau has the potential to sustain a cash economy without too much support from international aid although there is much to be done before this could be realized. After years of being dependent on US government revenue, the challenge to Palauan leadership is to develop resources in an economically and ecologically sustainable way.

Economic development prospects in the Republic of Palau are largely based on exploitation or passive utilization of natural resources. The three major areas thought to have potential for sustainable economic development are tourism, fisheries, and agriculture.

It is worth noting that proposals for other types of development and investment have occurred in Palau. For instance, a proposal to establish eight garment factories was approved recently by the Foreign Investment Board. However, because this and several other similar development proposals have not yet gone through any of the required environmental permitting procedures conducted by EQPB, the viability of these proposals remains questionable (Cassell, Otobed & Adelbai 1992). This report will not attempt to evaluate any of these proposed developments. Instead, it will address development sectors which have proven to have some prospect for sustainable development in Palau.

8.2 Economic development framework

8.2.1 Palau National Master Development Plan

With the transition from its Trust Territory status to Compact status, the government of Palau is now in the process of developing a framework for new economic policies — to be known as the Palau National Master Development Plan (PNMDP). According to the scope of work for the PNMDP, the key economic and social objectives of the government are:

- sustained long-term and equitable economic growth;
- development of appropriate private sector policies;
- environmental enhancement;
- cultural and social improvements;
- establishment of sound administrative and management policies and strategies within the public sector for the management of the country's financial, economic and social affairs; and
- meshing of national with states interests.

In order to support the attainment of these objectives, the PNMDP will emphasize:

- strategic sector planning (particularly for tourism, agriculture, fisheries, industry, labor, environment, infrastructure, human resources, and the cultural and social sectors);
- investment for development;
- land use planning; and
- public administration for development.

Many of the issues related to economic development are dealt with under the relevant sector discussion, so the issues covered under this section will be confined to matters of principle and macroeconomic planning.

8.2.2 Integration of economic and environmental goals

The key issue is the need to ensure the integration of economic and environmental planning. While the present policies and the scope for work for the Palau National Master Development Plan (PNMDP) identify the need to promote economic development in an environmentally sustainable manner, environmental protection and development activities are currently not well integrated.

This is understandable given the scattered nature of the environmental protection program inherited by Palau, and the high level of uncertainty regarding mandates and direction associated with recent changes in the country's political status and development. In this regard, the government's commitment to prepare a National Environmental Management Strategy, and the emphasis given to sustainable development and environmental

planning in the PNMDP's scope of work, represent a valuable opportunity to put in place institutional arrangements for the effective integration of environmental protection and the economic development program.

Infrastructure and industry development

9.1 General

As discussed above, the Palau National Master Development Plan is expected to put in place an economic development program aimed at long-term and sustainable growth, and an improved distribution of income. This will be achieved through the development and improvement of infrastructure (roads, airports, sea ports) as well as the expansion of industries (tourism and small-scale manufacturing) and the use of natural resources (agriculture, fisheries, tourism etc.). This section looks at the sectors in which development is most likely to take place, and comments on possible environmental issues that may have to be considered in the planning and implementation of projects and programs associated with them.

9.2 Tourism

9.2.1 Strong growth

Over the past decade, tourist visits to Palau have increased by about 500 per cent, from 4,516 in 1981 to 23,000 in 1991 (PATA 1993). It is also estimated that during 1989 a total of $7.9 million in local revenue was generated by tourist expenditures in Palau. This estimate for 1989 tourist revenues represents a substantial increase from the $2 million in tourist revenues generated in 1982 (Government of Palau/US National Park Service 1988). Growth in private business activity associated with tourism, such as land, air, and surface transportation, construction, retailing, hotels, nightclubs, and a wide range of services, has also been seen (US Department of State 1990).

The prospects for continued economic growth through tourism seem favorable for the Republic of Palau. The Palau Visitors Authority (PVA) is actively involved in promoting and encouraging tourism. In 1989, the Conservation Education Diving Archeological Museum (CEDAM) in the United States designated the reefs and underwater scenery of Palau to be the best of seven sites designated as the Seven Underwater Wonders of the World, as has the Smithsonian Institute. With this designation, promotion and marketing of Palau as a destination for international tourism has increased. With its spectacular land and ocean environment, Palau has enormous potential to cater to the rapidly expanding tourist numbers interested in nature-based tourism.

9.2.2 Potential impacts

Unfortunately, as Palau's popularity for tourism has increased, the potential for social and environmental problems related to this industry has increased as well. Recent proposals for tourism oriented development — for example, for a second and larger airport on northern Babeldaob, and a large-scale resort in Koror — are examples of development planning where economic advantage, rather than preservation of the natural environment, may have been the deciding factor. The above developments, as well as several other proposed developments, if built as planned, would cause a significant amount of environmental damage, which would then reduce the attraction of Palau as a tourist destination.

Unplanned tourism may also create significant social impacts. Large resorts or other such large-scale developments inevitably alienate some Palauans from their land, their subsistence agricultural plots, and even from supplies of water and other basic services. The environmental effects of such developments also have a great potential for

Rock Island beaches. Careful planning for tourism is needed if the beauty of Palau's natural environment is to be preserved. (photo: Demei Otobed)

adverse impact on subsistence harvest from the ocean. In that subsistence harvest of agriculture and fisheries remains an important aspect of Palauan culture, tourism development should be required to take steps to minimize any adverse effects to subsistence production.

9.2.3 Need for balance

This is certainly not to say that all types of development related to tourism are necessarily harmful. Tourism can do much to increase the economic self-sufficiency of the country. In addition, tourism can be used to introduce people to, and educate them concerning, the unique marine and terrestrial ecosystems of the Palau archipelago.

However, it is crucial that developments be closely scrutinized for their sustainability. The costs and benefits of developments must be accurately weighed, and the balance sheet of projected economic returns specifically evaluated. Enclave tourist resorts where the tourist eats, shops, and relaxes on site will obviously not represent much of a boon to local businesses. However, with proper forethought and planning, Palau could develop a tourist industry which is dependent on, but also works to sustain, the beauty of the natural environment and the cultural heritage and quality of life of the people of Palau.

9.2.4 Commitment to planning

It is fortunate, therefore, that the government has now taken steps to ensure proper planning of the tourism industry. A report commissioned by the government has emphasized the need to develop the industry in a sustainable and equitable manner (PATA 1993). The Palau Visitors Association (PVA) and the Office of the President have fully endorsed the report's recommendations including the call for a tourism vision for Palau and the strategies for attaining it. Palau's tourism vision is thus described:

> Tourism will be developed to be a key economic sector for Palau provided that development ensures the well-being of the people, the maintenance of our way of life, the protection of the environment, equitable distribution of the benefits among the Palauan people . . . [The] nature, size, quality and rate of the acceptance of development will depend on the capacity of Palau to absorb growth and the acceptance/tolerance of the Palauan people of that growth (PATA 1993).

The President, in accepting the PATA report, said that while tourism had the biggest potential for Palau's revenue base, he did not believe in investing all efforts in only one direction. Reference was made to the Palau National Master Development Plan and the need to incorporate other potential industries for diversification of the revenue base (PVA 1993).

9.3 Fisheries

Two types of revenue are currently collected from commercial harvest of marine resources in Palau: (1) through local landings and export of inshore

reef fish, mangrove crabs, lobster, and other fisheries; and

(2) mainly license fees for foreign boats operating in the Exclusive Economic Zone of Palau (US Department of State 1990).

9.3.1 Inshore fisheries

According to Division of Marine Resources records, at least 250 metric tons of reef fish, mangrove crab, and lobster were landed locally or exported from Palau in 1990 (Division of Marine Resources 1990). However, much remains unknown about changes in the level of commercial harvest of marine resources, and about the ability of stocks to sustain current or higher levels of harvest. The Division of Marine Resources, the government agency charged with the development and management of inshore marine resources, has recently initiated a program to collect data on landings from the five major fish markets in Palau and on export from manifest forms from Continental Airlines (the only airline servicing Palau). This project will provide more accurate economic data, as well as stock assessment data, which will be vital to designation of management practices for sustained utilization of the resource.

Potential concerns

Several potential concerns can be deduced from initial Division of Marine Resources data, and from the observations of local commercial or recreational fishermen.

First, the demand for inshore marine resources has definitely increased over the past decade. Restaurants in Koror catering to the rapidly expanding tourist industry, for instance, bought 38,050.5 pounds of reef fish, tuna, mangrove crab and lobster during the first nine months of 1990 (Division of Marine Resources 1990). With this increase in demand has come increase in prices. Secondly, several sources have also concluded, based on personal observation, that inshore marine resources are less abundant.

Finally, initial air cargo export data compiled by the Division of Marine Resources has provided proof that endangered marine organisms such as giant clams and turtles are being exported illegally. Given the pressure expected on inshore marine resources in Palau over the next decade, there is an urgent need to address the above concerns in a management plan for sustainable management and utilization of such resources.

9.3.2 Offshore fisheries

Foreign fishing agreements to allow for tuna fishing within Palau's 200-mile EEZ are negotiated by the Palau Maritime Authority. During 1990, five foreign fishing agreements were in effect, allowing 487 vessels to fish in Palau's waters. License fees from these agreements generated $659,000 in local revenues in 1990 (US Department of State 1990).

Statistics compiled from the landings of 450 long-line and purse seine vessels indicate that 4,971.52 metric tons of tuna, billfish, and shark were landed by these vessels in 1990 (Division of Marine Resources 1990). Because statistics were not available for harvest during all months of 1990, the above figure is probably an underestimate of the total harvest from offshore fisheries during that year.

Presently, a high proportion of the tuna landed from Palau's EEZ is exported to the sashimi market in Japan. For two foreign fishing companies, PITI and PMCI, the total metric tons of tuna exported from Palau to the Japan sashimi market (1,043 metric tons) was 14 times greater than that of all other marine resource exports (106 metric tons). The remainder of the landings of these foreign fishing vessels is sent to Taiwan for processing or sold locally (Division of Marine Resources 1990). Currently, there is no onshore value-added processing for offshore fisheries in Palau (Nichols 1991).

Potential concerns

Not much stock assessment has been done for offshore marine resources in Palau. Recently, the Division of Marine Resources, with support from the South Pacific Commission, has begun a tuna monitoring study which should provide some baseline information on the status of tuna stocks. There is presently concern in Palau over the sustainability of the current level of harvest, and about the impacts of some activities (such as waste disposal) associated with this fishery.

Further, there is growing concern over the level of economic return or benefits to Palau from this industry. In fact, the foreign fisheries agreement with the Fisheries Association of Japan was recently not renewed due to a lack of agreement over appropriate license fees and permit conditions.

For offshore fisheries development to be

sustainable and acceptable in the long term, the goal of increasing local involvement and increasing local revenue, along with the collection of species assessment data, must be integrated with a management framework for the industry.

9.3.3 Other fisheries development

Fisheries development programs remain a strong aspect of fisheries management in Palau. The Belau Mariculture Demonstration Center (BMDC), which is under the Bureau of Natural Resources and Development, is a focal point for sea farming technology and training in the Pacific. Major programs of BMDC have focused on the production of cultured giant clams, and the development of small giant clam demonstration farms and sanctuaries in each of the 14 coastal states of Palau. Export of cultured giant clams takes place under permit from BMDC, and revenues from this activity totalled $122,097 for 1990.

The recently initiated trochus hatchery project of BMDC is also of importance to inshore commercial fisheries development in Palau, as trochus once represented a lucrative export commodity for Palauan rural communities. During the 1980s, 100–300 tons of trochus were exported annually. Due to rapid declines in trochus populations, however, a three-year (1990–1992) moratorium is now in force (Division of Marine Resources 1990). Assessment of trochus stocks, along with the hatchery program, is now being pursued to develop a management regime for sustainable utilization of this resource.

Fisheries development work through the Division of Marine Resources has focused on information dissemination, technical training of staff, research on harvest of additional species, and development of additional fisheries infrastructure. Two major fisheries development projects of the Division of Marine Resources have been the deployment of Fish Aggregation Devices (FAD) and the Palau Fishing Community Development Project.

Through the FAD program, 11 FADs (essentially, anchored Coast Guard mooring buoys) were to be deployed on offshore sea mounts to attract deep-water snappers and groupers. The aim of this project is to reduce dependence on inshore reef fish, and to provide locations for offshore sportfishing by locals and tourists. The FAD program is currently in the initial stages of development. However, if successful, the FADs could form the basis of a new and potentially lucrative tourism sector based on offshore sportfishing.

The Palau Fishing Community Development Project has been facilitated through funding from the grant aid program of the Japanese government. Through this project, rural fishing ports and facilities have been developed in Angaur and Ngarchelong, and similar developments are proposed for Ngatpang and Melekeok. The Palau Fishing Authority (PFA) is also working to establish fisheries co-operatives to assist with handling and marketing of marine resources in these rural areas (Division of Marine Resources 1990).

9.4 Agriculture

9.4.1 General

Agricultural production in Palau is limited by the relatively small land base, low soil fertility, and limited water availability. Commercial agricultural production reached a peak during the Japanese administration when three pineapple canneries were in operation and copra production was also high (Cassell, Otobed & Adelbai 1992). Most of this production was discontinued because of World War II. At present, agricultural production is only for the domestic market which in 1990 generated revenues of $440,675 from the sale of vegetables, fruits, staple crops, local eggs, local meat, processed food, betelnut, and betel pepper leaves (US Department of State 1990).

Although the amount of domestically produced agricultural products is small in comparison to the quantities which are imported from outside, domestic production remains an important sector for local sale or subsistence consumption. Programs of the Division of Agriculture and Mineral Resources have been aimed at increasing domestic production through agroforestry, the introduction of new species, and the dissemination of knowledge on agricultural techniques such as rotating crops with legumes.

9.4.2 Current problems

Major problems associated with current agricultural practices are burning of forests for planting and heavy use of pesticides. As discussed above, burning removes plant cover, exposes or removes topsoils, and causes erosion and sedimentation/siltation in rivers and lagoons. There is also growing concern

over the quantities and types of pesticides applied to farms, and the potential thereby for contamination of river water from these sources. Obviously, the issue of training and monitoring for burning and pesticide use must be addressed in a program for sustainable agriculture in Palau.

Another problem is the introduction of animal or plant species or diseases which may threaten existing species. Examples of these discussed above include *setaria* (introduced to provide food for livestock), coconut beetle (*Oryctes rhinoceros*), and two introduced bird species, the greater sulphur-crested cockatoo (*Cacatua galerita*) and the eclectus parrot (*Eclectus roratus*), which eat the terminal buds of several native and endemic palm species growing on the Rock Islands. The damage caused by the brown snake in Guam and the taro blight in Western Samoa serves as a constant reminder of the need for effective quarantine laws and enforcement capacity.

A Taiwanese pesticide. The increasing use of pesticides poses a threat to local water supplies, and labelling in Taiwanese makes their contents unidentifiable in Palau. (photo reproduced courtesy of Environmental Quality Protection Board)

9.5 Water and sanitation

9.5.1 Present concerns

With the expected increase in the number of tourists and residents, water supply and sanitation are likely to become critical issues, particularly for Koror State and Babeldaob. There are already concerns about the level and quality of water supplies and the ecological effects of tapping more water sources, as well as concern over pollution resulting from improper or inadequate disposal systems of solid wastes, poorly designed landfills, and defects in public sewer systems or septic tanks.

Of great importance also is the increasing burden which tourism and population growth is placing on the sewer and solid waste disposal systems in Koror State. The Koror State sewerage system is rapidly approaching maximum capacity, and improvements to this system will have to be considered in the near future. Already, there is concern about the level of nutrients flowing into lagoons and ground water resources, and the resulting damage to the marine environment and water supplies.

9.5.2 Future needs

A number of issues related to water and sanitation need to be considered in the development of the National Environmental Management Strategy (NEMS) and future land use plans. With water supply and sewerage systems in Koror State nearing capacity, there is a need for a water monitoring program combined with a study of the lagoon flushing regime. This will provide the basis for improving current systems and/or establishing alternatives.

9.5.3 Developing appropriate systems

With growing populations in Koror and Babeldaob, it will remain necessary to have a reticulated sewage treatment and effluent disposal scheme. But for rural areas and the outer islands, particularly atolls, alternatives may need to be investigated. Composting toilets (which require no water for flushing and produce quality agricultural fertilizer as a byproduct) are one possibility. Such systems are being used in other places throughout the world, and an experimental system has been successfully established in the State of Yap in the Federated States of Micronesia.

Chapter 10

Pollution

10.1 General

Pollution is not yet a critical issue in Palau. In fact, in many respects, Palau has one of the most pristine environments in the Pacific region. However, the changes being experienced — from rapid growth in both tourism and the general population, to increased availability of imported consumer products, to an increase in the number of industrial-type activities — mean that the potential exists for serious problems to develop in the future. Already, the issue of pollution is a growing concern in Palau, particularly with regard to improperly treated sewage; pesticides; and waste disposal into marine waters. Some of these issues have been discussed under the relevant sector.

10.2 Solid waste

The problem of solid waste is not yet apparent in Palau but will become more of an issue with the changes currently being experienced. In addition to the overall growth in solid waste due to population increase, an issue characteristically associated with the tourism industry is high use of disposable items. Pollution from solid waste disposal and direct waste dumping also have the potential for adverse impacts on terrestrial habitat. This issue is particularly relevant in mangrove habitats, which interface land and sea.

In Palau, such pollution is currently an issue in at least one location, Koror State, where the landfill site is located adjacent to an area of mangrove

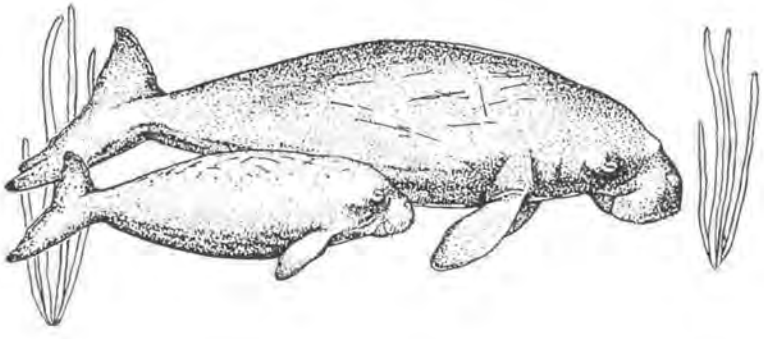
Solid waste dumped in mangrove area. Leachates from landfills and direct waste dumping are likely to contaminate surface water, ground water, and marine habitat. (photo reproduced courtesy of Environmental Quality Protection Board)

forest. Seepage of oil and metals into mangroves from this landfill site is creating some contamination to the surrounding marine areas (EQPB 1991).

The unsafe disposal of solid waste has the following major environmental impacts, some of which have already been noted above:

(1) the creation of leachates, and consequent contamination of surface water, ground water, and marine habitat;
(2) the blockage of drainage, including flooding;
(3) the proliferation of pests;
(4) air pollution caused by garbage burning and gaseous contamination;
(5) ill-effects to health caused by any of the above; and
(6) effects on land values.

Palau is in an excellent position to establish policies, administrative arrangements, and adequate resources to prevent pollution problems from getting out of control. In this regard, current work by the US Environmental Protection Agency in studying waste and sewerage requirements in Palau could provide a good basis for developing an effective pollution control and waste management strategy.



PART 4
Management of the environment

Chapter 11

Legislation and policies

11.1 General

Currently, there are many laws in place for protection and conservation of the environment. The Palau National Code, which is a compilation of statutes governing the Republic, is relatively comprehensive in its treatment of the environment. Furthermore, the statutes empower the relevant government ministries and bureaus to draft and submit specific pieces of legislation for the effective execution of their mandates. In this respect, the Bureau of Natural Resources and Development (BNRD) and the Environmental Quality Protection Board (EQPB) have drafted new or amended existing legislation, and are continuing to do so, in quest of a stronger legal framework for their environmental protection programs.

11.2 Enforcement issues

Much opinion in Palau supports the idea that adequate legal safeguards do exist for the purpose of protecting the environment and sustainable development of resources. There is some concern, however, that enforcement of existing laws and regulations is weak.

For instance, the poaching of endangered and protected species such as dugong and pigeon occurs in Palau, as do illegal methods of harvest like dynamiting and poisoning. Air cargo records show that the illegal export of wild giant clam and crocodile also occurs. Road building and other construction has occurred without permit, and for projects with permits, there has been a lack of enforcement of permit conditions. EQPB representatives admit that there is some weakness in enforcement and would like to have more staff and training opportunities.

11.3 Resource issues

With regard to resource conservation, efforts to build a national enforcement program have been constrained by lack of resources. State enforcement programs have been even more limited, and those which do exist have not been effectively carried out because strong kinship and communal ties within states tend to undermine the willingness of officers to report violations. The lack of funding and trained personnel is another important constraint. In the case of Koror, the effectiveness of the state conservation enforcement programs appears to have been severely limited by the large area and population.

11.4 Permit process

Part of the problem is the inadequacy of the current informal consultation mechanism between EQPB and the other resource management agencies over the former's permit review process; the result is that permits are sometimes issued without proper assessment. There is, however, general recognition of the need for better collaboration between EQPB and the different resource management agencies.

This could perhaps be achieved by formalizing or mandating consultation over EQPB's permitting review process. There is reference in the Palau National Code (24 PNC 142–3) to the need for all national and state government agencies to work together, and for comments by the interested public and relevant government agencies to be made known before any Environment Impact Statement is finalized. Thus, it would be possible to mandate that comments on development proposals are received from all relevant resource management

agencies and considered before a permit can be issued.

With regard to foreign investment permitting procedures, there is no requirement for consultation with any of the resource management agencies before a permit is issued. This has given rise to a situation whereby permits for investment are sometimes approved before any required environmental permitting occurs. In the past this has created ill feeling between foreign investors and the government, as some projects approved through the foreign investment process have later been rejected through the environmental permitting process. There is a need, therefore, for foreign investment permits to be considered in conjunction with any required environmental permitting, and for such investment permits to be denied until environmental permitting occurs.

11.5 Need for land use planning

The difficulties in environmental management are compounded by the absence of an overall land use plan for the country. There currently is no plan for Palau which, through reference to the overall carrying capacity and current state of the environment, details suitable levels and locations for development. Without proper land use planning, it has been very difficult to plan for and control the environmental impact of large-scale infrastructure and other physical development projects.

This is of concern given the significant amount of large-scale development which has occurred or has been proposed for Palau. Even small-scale developments such as trails, bridges, camping, and picnicking facilities are likely to have significant adverse effects on the environment if they are not considered and developed within a proper land use planning framework. Some concern already exists over increasing promotion of sites by the Palau Visitors Authority, and of the impacts which could result from such promotion.

Land use planning will be a major focus of the Palau National Master Development Plan (PNMDP), so an opportunity now exists for collaboration between the NEMS and PNMDP processes to establish a planning framework that will facilitate environmental protection and sustainable development of the country's resources.

11.6 Procedural issues

The other problem related to the permitting process seems to be the procedure for carrying out Environment Impact Assessment (EIA). Impact assessment for large-scale developments can be biased if the developers' choice of consultants is accepted. The judicious use of appropriate tendering procedures for EIA tasks could perhaps ensure that consultants will not simply endorse the views of the developers concerned.

It has also been suggested that the procedure for appointing EQPB board members leaves the Board vulnerable to political influence. The Board, including the Chairman's position, is certainly constituted through political appointment. However, according to the EQPB executive, the present status of the Board, being directly under the President rather than a minister, does reduce the likelihood of political interference, as well as giving it more autonomy and power.

Chapter 12

Government administration

12.1 General

The organization of government is a significant element in the management and protection of the environment since government has a central role to perform in this area. In Palau, this role can be summarized as follows:

(1) establishment of environmental policy and coordination of environmental programs;
(2) law enactment and enforcement;
(3) provision of technical skills and standards;
(4) resource allocation between different functions; and
(5) provision of public education and information.

Responsibility for environmental management in Palau, as in all countries, is spread across a wide spectrum of government agencies. One of the biggest challenges, therefore, is to coordinate these responsibilities so that environmental management is effective, resources are spent effectively, and agreed priorities and duplication of effort is minimized. The principal purpose of the NEMS process is to enable the government of Palau to establish its environmental priorities, and to provide a basis for the allocation of resources and responsibility across the government sectors.

The purpose of this section is to outline the current structure of government in Palau, identify which groups have responsibility for different sectors, and describe the coordination arrangements between them.

12.2 National government: overview

The national government of the Republic of Palau is organized, similarly to the US system, into executive, administrative, and legislative branches. The President of the Republic and the Vice President preside over the executive branch of the national government. A council of traditional chiefs, with representatives from each state, also exists to advise the President on matters concerning traditional laws and customs.

The national executive branch of the Republic of Palau was recently reorganized under Executive Order #89, issued in 1990 by the President. Eight ministries comprise the Presidential Cabinet of the executive branch. Each of these ministries, in turn, is composed of bureaus and divisions.

The Olbiil Era Kelulau (OEK) is the national legislative body of the Republic of Palau, and is composed of two equal houses, the Senate and the House of Delegates. The membership of the OEK includes 14 senators and 16 delegates, and the apportionment of the Senate is determined every eight years. Currently, nine senators are from Koror, four are from northern Palau, and one represents the Southwest Islands. Delegates are elected from each state in Palau.

The Republic of Palau judiciary includes the Supreme Court, the National Court, Court of Common Pleas, and Land Claims Hearing Office, and functions to administer the statutory and other laws of the Republic. The statutory laws are codified in the Palau National Code, which was for the most part carried over from the Trust Territory Code. Customary traditional and indigenous laws of Palau, some of which have been recorded, are given the full force of law as long as they are not in conflict with statutory or other written laws.

12.3 State governments

12.3.1 Structure

States in Palau have a potentially large role to play in the management and development of resources

in that, under a Constitutional provision, they have exclusive ownership of their land and sea resources out to 12 nautical miles. Today, sixteen states exist in Palau, having evolved from the municipality systems under the US Trust Territory administration but originally being loosely tied village clusters. Each state has its own Constitution, an elected Executive Officer (Governor), and an elected legislative body. The traditional governing chief system also plays a strong role in the governing of state affairs, as will be discussed below. Only the Koror State is covered here in some detail.

12.3.2 Resource/environment role

As the exclusive owners of all living and non-living resources, except highly migratory fish, from the land to 12 nautical miles (Article I, Section 2, Republic of Palau Constitution), states are responsible for the management and development of all resources within these boundaries.

State resource/environment management tasks

(1) Establish laws and a permitting system regulating some of the marine and terrestrial resources.
(2) Prohibit illegal harvest or illegal methods of harvest for marine or terrestrial resources through the state conservation enforcement program.
(3) Establish zoning and other regulations to limit and control development on state lands.
(4) Promote sustainable development of resources to maximize economic benefit to the state and its population.

Koror State government concerns

(1) Declines in resource abundance created by direct overharvest of marine and terrestrial resources.
(2) Significant increases in population and tourism in Koror. Increased pressure for development of roads, housing, and resorts are likely to destroy or have an adverse impact on resource habitat. Increased sewage outflow, sedimentation, and other impacts will also follow increased development and human presence.
(3) Impacts to water and other resources created by changing land use patterns and changing technologies such as increasing pesticide use.
(4) Illegal harvest of resources, or poaching during off-seasons or from preserve areas.
(5) Lack of knowledge on resource levels and on quantities which may be sustainably harvested.
(6) Overall lack of public knowledge on conservation and the need for wise use of resources.
(7) Ocean dumping or other activities causing pollution of marine or fresh-water areas.

Koror State priorities

(1) *Input into the Palau National Master Plan for economic development.* State representatives indicated they would like to be actively involved in the Master Planning process.
(2) *Drafting conservation legislation.* Laws are needed to address new uses of resources, such as collection of aquarium fish. Koror State hopes to address some of these issues in the future.
(3) *Solid waste disposal programs.* Program development will be pursued on issues such as recycling. Legislation to put fees on bottles may be one mechanism used to promote recycling.
(4) *Sewerage system study/improvements.* The sewage treatment plant in Koror is rapidly approaching capacity. A study is needed on how best to address this issue: either increasing the capacity of this system or designing a new system. Although this is a priority concern, no planning to address it has yet taken place.
(5) *Enforcement of conservation laws.* More conservation officers are needed to patrol the Koror State area efficiently.
(6) *Review of land use planning.* Work is needed to review the current state of land use and land use planning in Koror. It is not currently known how this issue will be addressed, although it will be one of the major foci of the Palau National Master Development Plan.

12.4 Traditional leadership

12.4.1 Overall description

Despite the high level of development of Western government infrastructure in Palau, traditional

leadership retains a presence in Palauan society and government. The traditional form of government in Palau was through village based chief councils. Each village had a council of ten ruling chiefs ('klobak') and a parallel advisory council of ten female chiefs ('klobak-l-dil') (/Government of Palau/US National Park Service 1988).

This village-based governing system still exists in Palau today. However, with the grouping of villages into municipalities and then states, 'state' chief councils were also formed to sit above the village councils. State councils are now formed from the ten highest chiefs from the highest ranking village clans. In addition, as mentioned above, a national council of traditional chiefs now exists, which is formed from the highest ranking chiefs from each state.

Throughout history, Palau has also been typically divided into two: Babeldaob to the north and Youldaob to the south. Thus, 'high chief' positions have also existed for north and south Palau, with the highest ranking chiefs from Koror and Melekeok typically representing the south and north respectively (Force & Force 1972).

Titles and positions in the traditional chief system were, and still are, passed mainly through matrilineal kinship ties in Palau. Chiefly duties are assigned according to rank in this system, and traditional laws, as designated by the chiefs, have historically been enforced by a fining system. In this system, if an individual was known to have broken a law, the chiefs had the full authority to impose a fine, possibly of Palauan money, on the person or his clan. Because of the strong clan allegiances (Smith 1977), the mere thought of being fined and embarrassing one's clan was enough to discourage many potential 'crimes'.

Traditional leadership rights are currently protected by a provision of the Palau National Constitution which basically forbids the government from taking any action to prohibit or revoke the role or function of a traditional leader as recognized by custom and tradition, as long as it is not inconsistent with the Constitution (Government of Palau/US National Park Service 1988).

12.4.2 Present challenges

Thus, at least in theory, the traditional chief system retains a strong role in government affairs in Palau. In a recent study of the role of traditional authority in managing marine resources, however, Johannes (1991) found that respect for and compliance with traditional laws, at least for marine resources, is waning.

One reason for this decline in traditional power may be the fact that poachers and other 'lawbreakers' may now be punished through Western government entities, which are often more lenient than traditional punishment. For example, one source cited a case where an individual was recently caught fishing in a designated grouper preserve area. Punishment was pursued through the Western legal system, and the individual was acquitted because the sanctuary was unmarked. Under the traditional system, however, punishment through fining would have occurred without much question.

Problems with enforcement of traditional law are also created by social change resulting in a weakening of kinship ties and respect for traditional systems. This is increasingly evident in Koror State, which is home to an increasing number of individuals, including foreigners, with no direct clan ties in this state (Johannes 1981).

Thus, although the traditional governing structure is strong in Palau, the role of this system within the Western government system remains largely undefined. In some respects, the traditional chief system still does and should continue to have a role in the management of Palau's resources. Work is needed, however, to further define and support this evolving role, and to set a path for coordination and cooperation between traditional and Western systems of governance.

12.5 Government ministries, bureaus, divisions, departments and statutory bodies

12.5.1 Key agencies

While agencies from other ministries may provide assistance with some aspects of natural resource management and development, the major responsibility for such activity rests with agencies, divisions and departments of the Ministry of Resources and Development. Within the Ministry, the Bureau of Natural Resources and Development (BNRD) is the main body charged with the development and management of resources.

The Bureau is further divided into the Division of Conservation and Entomology, the Division of

Division of Conservation and Entomology Office. (photo: Demei Otobed, photographic collection, Division of Conservation and Entomology)

Marine Resources, the Division of Agriculture and Mineral Resources, and the Department of Forestry. All of them are active in developing programs to manage and/or develop the natural resources of Palau.

A major stumbling block to sustainable utilization of resources, however, has been that government appropriations to the Bureau have been extremely limited. For the fiscal year 1991, only $470,000 or 1.6 per cent of total expenditure for the period was appropriated for the Bureau (US Department of the Interior 1991). Indeed, government funding of the Bureau generally only accounts for the salaries of workers and some operating costs. For development and management programs, funds have to be sought from elsewhere.

12.5.2 Trends in government spending

Because budget records from previous years were unavailable, it was difficult to delineate any trends in government spending for natural resource management and development. However, for some agencies such as the Division of Conservation and Entomology, expenditure records are not necessary to demonstrate changes in government support. During the mid-1970s, the Division of Conservation and Entomology housed four national conservation officers. This conservation enforcement program has since disappeared because funds are not available from the national government. The Division is currently working to secure government and outside funding to reinstate a conservation enforcement program, and has had some success although much more assistance is required.

A separate agency, the Environmental Quality Protection Board (EQPB), is responsible for protection of the human environment of Palau — that is, soil, air and water. In that the quality of the human environment also has an obvious association with the natural resources of a given area, the work of this agency overlaps significantly with those of natural resource management agencies. The funding for positions and programs of EQPB, however, has been somewhat separate from government appropriations in Palau, as EQPB is funded totally through the US Environmental Protection Agency in much the same manner as are states of the United States.

In a similar fashion, the Department of Forestry of the Republic of Palau can and has received funding from the US Forest Service through the Pacific Region Office based in Hawaii (US Department of State 1990). This will, of course, change with the passage of the Compact of Free Association, and the

A portion of the road site between Ngkeklau Hamlet, Ngaraard State and Ongiie, Ngiwal State goes through a mangrove area. Land use planning is vital to ensure environmental protection and sustainable development of the country's resources. (photo: Demei Otobed)

government of Palau will be expected to assume an increasing share of financial responsibility. It is not certain, therefore, how the level of funding for environmental management and sustainable resource development will change, if at all, in the future.

12.6 Specific government agencies

Ministry of Commerce and Trade

The Ministry of Commerce and Trade promotes and regulates economic and commercial development proposals and projects.

Resource/environment management tasks

(1) Development of sustainable trade and exchange of natural resources of Palau.

(2) Prohibition of unregulated and illegal fishing in Palau's EEZ.

(3) Marketing and promotion of economically sustainable development projects which benefit the local economy and enhance the quality of life of the people.

Future priorities

(1) *Enforcement of endangered species import/export prohibitions.* With assistance from the US Fish and Wildlife Service (money and training), the Ministry would like to develop an enforcement program with at least one agent responsible for enforcement.

(2) *Reconcile export and import laws with US laws.* Exports of endangered species are not being policed because Palauan law is in many cases unclear on the legality of export.

(3) *Coordination.* Continued efforts for coordination need to occur so that natural resource management efforts are efficient and are not duplicated.

(4) *Economic development.* Continued efforts to promote small projects which will assist the local economy and labor needs as much as possible.

Palau Maritime Authority (PMA)

The main task of the Palau Maritime Authority is to develop and manage offshore fisheries in the Extended Fishery Zone and the Exclusive Economic Zone (3–200 nautical miles offshore).

Resource/environment management tasks

(1) Development of sustainable fisheries for offshore migratory and non-migratory species such as tuna, billfish, and shark, and limiting the number of boats admitted to fisheries if necessary to attain a sustainable level of harvest.

(2) Setting standards and requirements for foreign vessels wishing to harvest resources from the EEZ of Palau, through licensing and negotiations.

(3) Monitoring the status of offshore stocks and setting limits on harvest where necessary.

Major concerns

- Possible overharvest and poaching of offshore stocks.
- Pollution from disposal of wastes from foreign fishing vessels.
- Nonpoint source pollution from terrestrial

or other sources which has an adverse impact on the offshore fisheries.
- Decline in population of inshore species which provide food for offshore stocks.
- Lack of onshore infrastructure development to maximize economic benefits to Palau from this industry.

Future priorities

(1) *Increased capability and efficiency of surveillance/enforcement programs.* Financial assistance and training from the US Department of the Interior, the US Coast Guard or the US Navy are needed to implement and improve the current patrolling program for the EEZ of the Republic of Palau. Law enforcement is currently inadequate.

(2) *Management for sustainable utilization of offshore marine resources of Palau.* Efforts will continue to assess the status of offshore marine resources and develop effective management strategies to promote sustained economic use of the resources. Stock assessment for various marine resources is badly needed. Efforts to secure outside technical assistance to improve management capacity are a priority.

(3) *Coordination.* Coordination of funding and expertise between agencies needs to continue:
   (a) for studies — work to set up cooperative studies where PMA administers permits and the Division of Marine Resources performs data analysis will continue;
   (b) for enforcement — PMA, the Ministry of Commerce and Trade, and the Attorney General's Office all have some responsibility for surveillance of the EEZ of Palau. Attempts to coordinate the implementation of the surveillance and enforcement program will continue.

Environmental Quality Protection Board (EQPB)

The major objective of the Environmental Quality Protection Board is to ensure that the quality of the human environment of the Republic of Palau — the air, soil, and water — is protected. EQPB reports directly to the President.

Resource/environment management tasks

(1) Maintaining for all Palauans and for future generations a safe, healthy, productive, and aesthetically pleasing environment.

(2) Preserving the ecological functioning of natural air, water, and soil systems which influence the quality of the human environment.

(3) Allowing for the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

(4) Advising and educating groups or individuals on the status of Palau's natural environment and threats to environmental quality.

Major concerns

(1) Road building, resort, or other development projects or use of resources which directly or indirectly have an impact on soil, air, or water quality through dredging, earthmoving, and/or filling of mangroves or other aquatic habitat.

(2) Issues related to population growth in Koror and other areas, and increased numbers of tourists traveling to Palau. These include:
   — water quality problems related to increasing levels of sewage outflow and lack of adequate or proper facilities to deal with the sewage increases; and
   — increased levels of solid waste taken to landfills, particularly in Koror, partly through increased use of non-biodegradable products, particularly by the tourist industry.

(3) Contamination of fresh and marine water created by terrestrial or marine waste dumping and use of pesticides.

(4) Lack of knowledge by the general public, business people, and government representatives on the potential impacts of development and/or day-to-day activities on environmental quality.

Future priorities

(1) *Public education program.* A public environmental education program existed previously through EQPB, but has not been in effect since the staff member responsible left the agency last year. This program included speaking at schools; radio programs

on issues such as water quality and recycling; and implementation of an aluminum can recycling program. The reinstatement of this program through hiring an individual for this position is a high priority.

(2) *Coastal zone management planning.* EQPB is working in cooperation with the Division of Marine Resources to solicit funding and support to begin coastal zone management planning in Palau.

(3) *Solid waste management.* Development of expanded recycling through the private business community of Palau and management of hazardous waste will be major issues for EQPB in the future.

(4) *Palau National Master Development Plan input.* EQPB will continue its efforts to be a part of the National Master Development Planning process and to ensure that environmental quality standards are taken into account.

(5) *Coordination.* Improved coordination and cooperation between various resource management agencies for permit review and other programs continues to be a high priority.

Ministry of Community and Cultural Affairs

The main objective of the Ministry of Community and Cultural Affairs is to develop and promote cultural and historical resources.

Resource/environment management tasks

Through the Bureau of Arts and Culture, Division of Cultural Affairs:

(1) Development of ongoing programs to research, identify, and manage tangible and non-tangible aspects of Palau's cultural, historical, and archaeological resources. This includes grant-writing to secure funding and technical assistance from public and private sources.

(2) Establish and maintain a register of tangible cultural resources and living natural treasures in Palau.

(3) Acquire historical sites or tangible cultural properties and develop a program to allow for admission to and viewing of sites.

(4) Prepare, review, and revise a national historical and cultural preservation plan.

(5) Coordinate and provide assistance to states and other public and private agencies involved in historical and cultural preservation.

(6) Stimulate public interest in historical and cultural preservation.

(7) Develop a written history of Palau and index traditional laws and their underlying principles.

Through the Bureau of Community Services, Division of Parks and Recreation, and Division of Youth Affairs:

(1) Organize and coordinate community fairs and other national festivals.

(2) Identify and designate, in consultation with states, locations for national parks.

(3) Develop and maintain public parks and facilities (US Department of State 1990).

Major priorities

(1) *Expansion of preservation programs through the Division of Cultural Affairs.* The programs of the Division of Cultural Affairs are currently narrow in their focus and definition of cultural resources. As the trees, plants, fish, and other aspects of the natural environment all constitute important aspects of Palau's cultural heritage, they should be considered in a program for cultural preservation.

(2) *Increased involvement of the Division of Parks and Recreation and the Division of Youth Affairs with the development and management of nature parks in Palau.* Too much emphasis is being placed on parks for recreation, and the concept of nature parks is not well understood. Other than through park maintenance and sports park development efforts, the Division of Parks and Recreation and the Division of Youth Affairs are largely not fulfilling their duty to plan, develop, and manage parks in Palau. More planning and development of parks needs to occur through these agencies.

(3) *Coordination.* With the overall limited funding and manpower in Palau, there is a need for continued effort for coordination between agencies with overlapping jurisdiction.

(4) *Designation of resource preservation areas through the Palau National Master Development Plan (PNMDP).* Some attempt has been made to include in the PNMDP process a provision for consultation with governors regarding the setting aside of state lands for preservation.

Bureau of Natural Resources and Development (BNRD)

The key objective of the Bureau of Natural Resources and Development is to protect and exploit the resources of Palau.

Resource/environmental management tasks

(1) Develop practices for sustainable utilization of the natural resources of Palau which provide maximum benefit to the citizens of the country.
(2) Control exploitation of, or impacts on, Palau's resource base which cause degradation, destruction, or extinction of natural resources.
(3) Coordinate relations with various Palauan government agencies, US government agencies, international assistance, and nonprofit sector groups.

Major concerns

(1) Lack of proper management for sustained utilization of natural resources which may result in:
   — overharvest of marine or terrestrial resources, leading to depletion of stocks;
   — lack of follow-up practices such as replanting of trees after harvest, leading to lower potential for harvest in the future.
(2) Growth of development and other activities with a direct and indirect impact on resources and habitats in Palau.
(3) Poaching and illegal harvest of resources by Palauans and foreigners.
(4) Lack of education and knowledge on resource conservation and development issues.

Areas of current focus

(1) *Program development.* The Bureau is working to develop programs in its various divisions, but because some division activities and responsibilities are relatively new, establishment of rules and regulations for resource management is a top priority.
(2) *Cooperation with US federal agencies.* Aspects of Palauan law and resource management are in conflict with major US laws such as the *Endangered Species Act 1975*, and international conventions such as the *Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973* (CITES). The Bureau is cooperating with the US Fish and Wildlife Service to minimize conflicts and inconsistencies.
(3) *Conservation education program.* With funding from the US Department of the Interior, the US Forest Service, and the US Soil Conservation Service, the Bureau was able to hire an individual to design and implement a public education program to improve awareness on conservation issues. However, this has been discontinued due to lack of funding, so there is a need for resources to continue and maintain such a program.
(4) *Provision of assistance to nonprofit groups in Palau.* The Bureau serves as the major contact point for The Nature Conservancy in Palau. Bureau staff are assisting The Nature Conservancy (TNC) with planning and implementation of programs such as baseline surveys of Palau's resources, and bioreserve development.

A priority for the Bureau is to improve the capacity to enforce modern and traditional conservation laws, and there has been some success in hiring conservation enforcement officers for work under the supervision of the Chief Conservationist/Entomologist. The aim eventually is to hire conservation officers to patrol each state in the Republic. Research is also being carried out to evaluate the potential for some level of enforcement through the traditional governing entities in Palau.

Division of Marine Resources, Bureau of Natural Resources and Development

The main objective of the Division of Marine Resources (DMR) is to manage and develop the inshore marine resources.

Specific responsibilities

(1) Fishery resource management:
   — to assess and evaluate the commercial potential of reef, pelagic and deep-water fishes, baitfish, mollusks, turtles, and crustaceans from catch records, census and quantitative field measurements;
   — to develop and recommend regulations for the scientific management of these resources on a sustained yield basis;

— to recommend establishment, by legislation, of regulatory measures such as size limits, fishing seasons, and sanctuary areas where appropriate; and
— to advise and inform the general public and state governments of any measures and other important matters concerning marine conservation in the Republic.

(2) Fishery resources development:
— to continue efforts to develop offshore and inshore fisheries by providing modern fishing techniques and gear, and established fishing businesses for Palauan fishermen;
— to conduct a pilot program to promote and develop commercialization of fisheries and fishery products; and
— to provide technical assistance and advisory services to local fishing co-operatives in the purchasing, handling, marketing, and processing of fish and other marine products.

(3) Marine and aquaculture research:
— to maintain and operate the Belau Mariculture Demonstration Center (BMDC) as a site for research, education, and experimentation on Palau's living marine resources;
— to conduct hatchery rearing and mass production of commercially important marine species for the dual purposes of conservation and economic development, and to produce giant clams, trochus, and turtles for either farming or release in Palau's natural environment;
— to serve as a center for education and training of Palauan students in principles of marine biology, conservation, and mariculture. This includes the conduct of intensive summer education programs for Palauan students and the provision of educational tours of the facility for school classes of all grade levels; and
— to stimulate economic development by attracting private investment in commercially profitable mariculture enterprises.

Issues of concern

(1) Increased demand for marine resources locally (due mainly to tourism) and for export which may cause:
— over-harvest of some species; and
— decreased subsistence harvest potential for local populations.

(2) Illegal poaching and export of endangered marine species.

(3) Illegal poaching of marine resources at designated preserve areas such as Ngerukewid Islands Wildlife Preserve and Ngerumekaol Spawning Area.

(4) Increased levels of large-scale land developments which directly impact mangrove forest and shallow-water aquatic habitat, or which create indirect impacts such as sedimentation to reefs.

(5) Increased levels of marine pollution created by improperly treated sewage outfall, ocean dumping, or other activities which directly and indirectly affect marine species.

(6) General lack of public knowledge on marine resource conservation issues.

(7) Lack of local infrastructure, or adequate marketing and handling to allow for the most efficient and economically beneficial utilization of inshore marine resources.

(8) Lack of knowledge on techniques or viability of harvest for new species which could diversify industry focus.

Major priorities

(1) *Five-year fisheries plan development.* A Palau marine resources profile has been recently completed (Nichols 1991). This information, combined with information on various species status, recommendations on legal aspects of management, and recommendations on traditional management, will be used to develop a long-term plan for fisheries development and management in Palau based on national institutions.

(2) *Subsistence studies.* Efforts will continue to study and determine the impacts and extent of subsistence fisheries in Palau.

(3) *Tuna monitoring program.* With technical and financial assistance through the South Pacific Commission, a tuna monitoring program has recently been established. One DMR staff member is assigned to this project.

(4) *Program funding.* Continued grant-writing efforts will be made to augment national government funding with funding from international sources.

Division of Agriculture and Mineral Resources, Bureau of Natural Resources and Development

The main objective of the Division of Agriculture and Mineral Resources is to promote proper management of terrestrial resources.

Resource/environmental management tasks

(1) Promotion of proper, sustainable agricultural methods through extension education on agroforestry methods, pesticide use, and soil enhancement through composting.
(2) Promotion of domestic livestock production through educational and other assistance programs.
(3) Provision of assistance to states on soil, water quality, and watershed management issues and planning.
(4) Screening, controlling, and providing a testing and quarantine station for exotic plants and animals brought to Palau.
(5) Assistance to local farmers by providing seedlings, fertilizer, pesticides, and other materials through a supply shop at the Division Office.
(6) Control/regulation of mining activities is a new function of the Division of Agriculture and Mineral Resources under RPPL No. 3–39, which was passed in 1990. Since no true mineral mining currently occurs in Palau, it is assumed that policies on mining may not yet have been developed by the Division.

Future priorities include an increased focus on conservation education.

Department of Forestry, Division of Agriculture and Mineral Resources, Bureau of Natural Resources and Development

The main objective of the Department of Forestry is to provide technical assistance and advice on utilization and management of timber resources in Palau.

Resource/environmental management tasks

(1) Promote sustainable utilization of forestry resources.
(2) Provide information and materials to encourage and support forestry efforts in Palau.
(3) Improve public awareness of practices which are damaging to forestry resources or to the habitat which supports these resources.

Major concerns

(1) State ownership of terrestrial resources prohibits the Department of Forestry from enforcing regulations against states for use of resources (Republic of Palau 1986). However, increasingly, states are allowing large-scale development with impacts on forestry resources. The Department of Forestry may advise them against a type of development, but cannot prohibit it.
(2) Replanting was not required under one major logging contract with a Taiwanese company in Aimeliik State. There is a concern that these types of arrangements will continue to occur.
(3) Carelessly planned road and other development is occurring which degrades soil conditions and allows for active erosion. Forestry staff are often not consulted until much later when tree planting becomes necessary to combat erosion.
(4) Setting of fires on Babeldaob which actively destroys forest lands and degrades soils.
(5) General lack of public knowledge on methods for sustainable utilization of forestry resources or other aspects of forestry conservation.

Future priorities

(1) *Forestry management.* Work is currently being undertaken, in cooperation with the US Forest Service, to begin development of a Forestry Management Plan for Palau. This plan will set goals and policies to be followed by states in the use and management of forests.
(2) *Fire control.* Draft legislation has been developed which gives authority for control and enforcement of fire control regulations to the Director of the Bureau of Natural Resources and Development. If this bill becomes law, the Department of Forestry would take a more active role in enforcing restrictions on burning.
(3) *Program funding.* Continued grant-writing efforts will be made to augment national government funding with direct funding from international sources.

Division of Conservation and Entomology, Bureau of Natural Resources and Development

The main function of the Division of Conservation and Entomology is to develop and implement national policies and programs for the conservation of the resources of Palau.

Resource/environment management tasks

(1) Plan, develop, and implement strategies for sustained use and protection of the natural, cultural, and historical resources of Palau.
(2) Promote, develop, and implement conservation and entomology education for the general public, and for private and government sector representatives.
(3) Promote and maintain contacts with US and international conservation organizations.
(4) Plan and implement strategies for control of existing insect pests and weeds and for protection against introduction of new ones.

Major concerns

(1) Loss of terrestrial or aquatic habitat due to development, fire, or other destructive activities.
(2) Poaching and illegal harvest of species from preserve areas during the offseason or by foreign fishing vessels.
(3) Decline in resource abundance due to overharvest of marine and terrestrial resources.
(4) Lack of knowledge on resource levels and on quantities which may be sustainably harvested.
(5) Overall lack of public knowledge on conservation and the need for wise use of resources.
(6) Trade in endangered species.
(7) Pollution of ocean or fresh-water habitat areas created by ocean dumping, improperly treated sewage outflow, or pesticide residues.
(8) Indirect impacts of construction or burning activities such as increased flow of sedimentation to reef systems.
(9) Introduction of insect, plant, or animal pests to Palau.

Main priorities

(1) Implementation of a national conservation enforcement program. Secure funding to hire more national conservation enforcement officers is being pursued through the national government and other sources. The Division would like to eventually hire an officer to patrol each state in Palau, help educate local people, and enforce various aspects of Palau's conservation laws.
(2) *Selection of sites and development of management programs for the natural heritage reserves system.* The Division will work with states to select sites and establish management programs for this system. Establishment of sites could also fit well into the effort to develop a National Master Development Plan for economic development for the Republic.
(3) *Conservation education program.* Funds are needed to continue the program to develop a formal community and school-based conservation education program through the Division of Conservation and Entomology. A start has been made but work had to be discontinued due to lack of funds.
(4) *Collection of traditional knowledge.* Collection of information and photographs on traditional ethnobotany is currently being pursued for publishing by the Chief Conservationist/Entomologist.

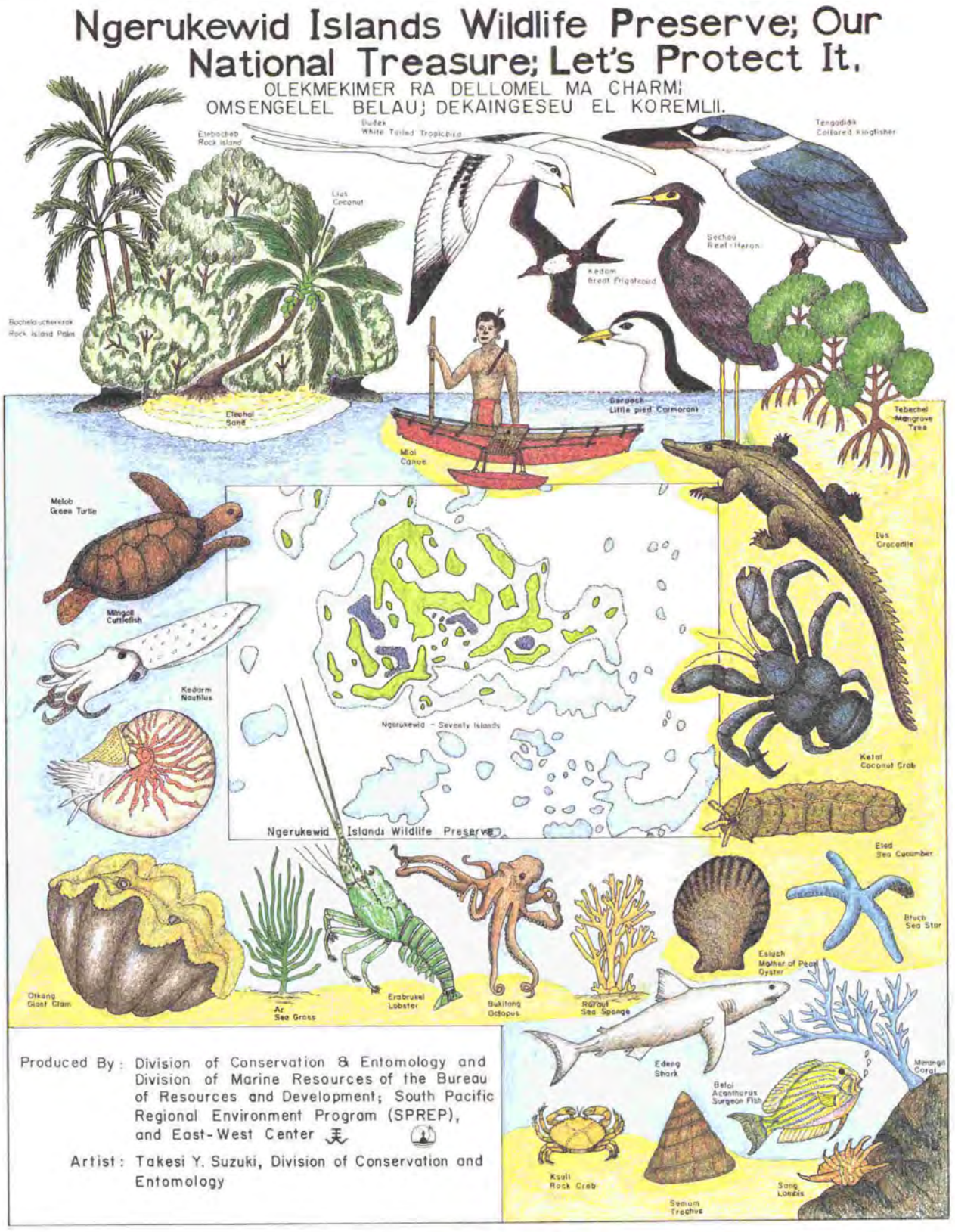
Palau Visitors Authority (PVA)

The key mandate of the Palau Visitors Authority is the promotion and marketing of tourism.

Resource/environmental management tasks

(1) Marketing of the cultural, historical, and natural resources of the Republic to increase tourism to Palau.
(2) Provide easy access to information on tourist attractions (cultural, historical, and natural resources) and amenities for tourists on-island.
(3) Provide training and information to improve tourism services such as tour guide operations.
(4) Assist where possible with various interest groups and agencies involved in beautification efforts or preservation of resources in Palau (while this is not a mandated policy, PVA has pursued work in this area).

Figure 12.1 Educational poster



Ngerukewid Islands Wildlife Preserve in the Rock Islands is the only designated resource reserve which currently exists in Palau. (artwork by Takesi Suzuki, reproduced courtesy of Division of Conservation and Entomology)

Particular concerns

(1) Littering and other solid waste disposal issues which may have an impact on a tourist's impression of Palau.
(2) Pollution, physical destruction, or other impacts to the marine environment, on which Palau's tourism industry is almost totally based.
(3) Destruction or adverse impacts to cultural, historical, or natural resources created by increased tourist presence in Palau.
(4) Impacts to Palau's cultural, historical, or natural resource base created by development of tourism infrastructure in Palau.

Major priorities

(1) *Tour guide licensing.* PVA has a tour guide licensing program which includes aspects of conservation education.
(2) *Marine buoy system.* PVA is currently working with the Division of Marine Resources and The Nature Conservancy to fund a study for the establishment of dive buoys at popular area dive sites where significant anchor damage is now occurring.
(3) *Increasing tourist access to attractions.* PVA is currently planning developments to improve visitor access to popular tourist sites such as the Ngardmau Waterfall and Jellyfish Lake. These access improvements will be in the form of footbridges on the path to the Ngardmau Waterfall and handrails on the path to Jellyfish Lake.

National Planning Office (NPO)

The Office's main role is to coordinate and assist planning and development strategies at various government levels in the Republic. Some issues in particular have an impact on economic development and need addressing in the planning process.

Key issues

(1) Required environmental assessment and permitting of infrastructure development projects (EQPB — Earthmoving; Cultural Affairs — Historic Preservation Waiver; US Army Corps of Engineers — Dredging Permit).
(2) Zoning or other permitting issues which may affect potential for development or types of allowable development.
(3) Environmental impacts created by development or utilization of resources which may affect potential for economic development in Palau.

Areas of current focus

(1) *Infrastructure planning and development.* Efforts through this office focus mainly on the primary duty of planning and developing infrastructure in Palau.
(2) *Development of the Palau National Master Development Plan.* A current major project of the National Planning Office is to develop a National Master Development Plan for economic development in Palau. This project was mandated by a US Secretary of the Interior Executive Order, and is funded through the Department of the Interior and the United Nations Development Programme (UNDP). Plan development will attempt to provide a process whereby informed decisions may be made on how to best achieve Palau's economic development needs through tourism, fisheries development, aquatic resorts, and road development. The Palau National Master Development Plan is expected to address carefully the question of economically and environmentally sustainable development. This means that economic planning could in the future be carried out within a framework of sound environmental management.

Palau Fishing Authority (PFA)

The Palau Fishing Authority was established to provide support and assistance for the development of local fisheries in Palau.

Resource/environment management tasks

(1) Assist and promote sustained utilization of inshore marine resources to provide a basis for local economic enterprise in Palau.
(2) Assist with provision of marketing, infrastructure, facilities, and programs to promote efficiency and secure maximum economic benefit from the utilization of inshore marine resources.

Major concerns

(1) Depletion of inshore marine resources due to direct overharvest.
(2) The need for management of the harvest of marine species given the increased demand for local consumption and export.
(3) Illegal poaching and export of endangered marine species.
(4) Illegal poaching of marine resources at designated preserve areas such as Ngerukewid Islands Wildlife Preserve and Ngerumekaol Spawning Area.
(5) Increased levels of large-scale land developments which directly impact mangrove forest and shallow-water aquatic habitat, or which create indirect impacts such as sedimentation to reefs.
(6) Increased levels of marine pollution created by improperly treated sewage outfall, ocean dumping, or other activities which directly and indirectly affect marine species.
(7) General lack of public knowledge on marine resource conservation issues.
(8) Lack of local infrastructure or adequate marketing and handling to allow for the most efficient and economically beneficial utilization of inshore marine resources.
(9) Lack of knowledge on techniques, or viability, of harvest for new species which could diversify industry focus.

Ministry of Education

Apart from its usual mandate in general public education, the Ministry of Education has a role in resource/environmental management.

Relevant tasks

(1) Develop curricula and educational programs with a focus on the natural environment, culture, history, and resources of Palau.
(2) Encourage development of and participation in teacher training programs on natural resource, cultural and historical, and other issues.

Particular concerns

(1) Changing family and social structures which limit transfer of traditional knowledge and values between generations.
(2) Overall lack of knowledge and interest in natural sciences and environmental issues.
(3) Limited teacher resources for instruction in science and mathematics.
(4) Increased pressure for the development of Palau's natural, cultural, and historical resources which, to allow for public involvement in decision making, requires that the general public have an expanded knowledge of and interest in conservation issues.

Future priorities

(1) *Implementation of the five-year Master Plan.* The Task Force has been organized and submitted for approval, and work will continue on designing curricula and other strategies for plan implementation.
(2) *Cultural heritage awareness program.* A program used to exist where high school students worked to document stories, take pictures of landmarks, etc. This program was halted due to a lack of funding, but may be reinstated.
(3) *Continued support for development of educational materials specific to Palau.*
(4) *Continued work to secure additional funds to increase programs and field trip opportunities for students.*

Bureau of Community Services, Palau National Youth Congress and Palau Boy Scouts

The main objective of the Bureau of Community Services is the development of programs and activities to enhance social skills, knowledge, and awareness of youth of all ages in Palau.

Main responsibilities

(1) The encouragement of active youth participation in community based programs to enhance social skills, knowledge, and awareness.
(2) The encouragement of active youth participation in programs and activities which are of benefit to the environment and the community.

Relevant issues

(1) Changing family and social structures which limit transfer of traditional knowledge and values between generations.

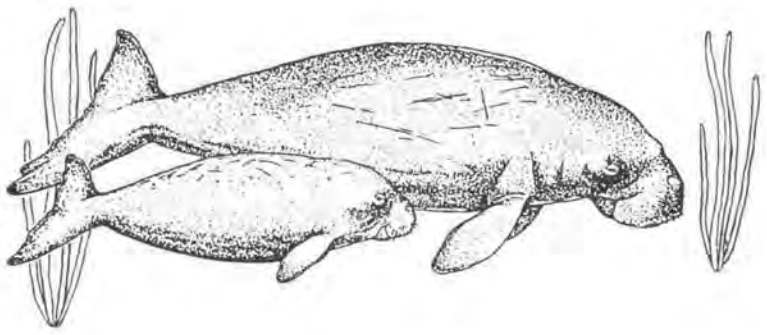
(2) Overall lack of knowledge and interest in natural sciences and environmental issues.
(3) Increased pressure for the development of Palau's natural, cultural, and historical resources which, to allow for public involvement in decision making, requires that the general public have an expanded knowledge of and interest in conservation issues.

Important programs of the Bureau include beautification programs. The Palau National Youth Congress and the Palau Boy Scouts have been involved to some degree in beautification programs for Palau. The Boy Scouts were involved in placing signs on various Rock Islands to instill awareness of the need to remove trash after use of islands. The Boy Scouts and the Youth Congress have participated in community cleanup days in Koror, and the Youth Congress has been involved in tree planting and dock cleaning efforts.

A future priority is a youth congress to work on conservation issues. The Palau National Youth Congress has only been in existence for two years and has not yet had an opportunity to address conservation issues. Work may proceed on this issue in the future.

12.7 Non-government organizations

Although several new private/nonprofit groups have recently established a presence in Palau and it is hoped that group numbers will continue to grow, this sector is currently not well represented in the country. The Belau National Museum was chartered as a nonprofit corporation in 1973, and plays an important role in implementing and developing programs for cultural preservation in Palau. Representing the non-government organization (NGO) sector in Palau is the Palau Resource Institute (PRI) which was founded in 1990. A major goal of PRI is to assist developers, government agencies, or private groups with planning and implementing strategies for sustainable development in the Republic of Palau. The Nature Conservancy has also recently established a strong presence in Palau.



PART 5
Priority programs

In each section in this report, environmental issues have been discussed in the context of possible actions that can be taken to address them. Though the list may appear long, the National Environmental Management Strategy (NEMS) will provide the process which will assess and establish priorities for these and other projects. This section of the State of the Environment Report will identify the major requirements based on the identification and discussion of the major concerns in the report. Some effort is made to identify the strategies and programs necessary to address the major requirements. However, the list is intended mainly to provide some guidance and reference points.

Chapter 13

Priority issues and programs

13.1 Enforcement of existing laws and regulations

13.1.1 General

A relatively well developed legal framework for environmental and resource management already exists in the Republic of Palau. Although there is a need to introduce new regulations and clarify existing ones, the major problem at present appears to be the *enforcement* of existing laws and regulations. This is true not only of specific resource conservation laws, but also of laws aimed at overall environmental protection. There is a need to consider a different strategy for each of these two types of law.

13.1.2 Resource conservation laws

As noted in this report, illegal harvest and poaching of endangered or protected species such as dugong and pigeon do occur in Palau. The use of illegal methods of harvest such as dynamite or poison also occurs, as does the illegal export of wild giant clam and crocodile.

There is currently no program to enforce resource-specific conservation laws at the national level in Palau, and state enforcement programs have been limited and largely ineffective. In the case of Koror, the problem is compounded by the large area and population.

The following programs might be considered for improving the enforcement capacity of resource management agencies.

- Development of a national conservation law enforcement program through the Division of Conservation and Entomology.
- Development of an import/export enforcement program through the Ministry of Commerce and Trade.

13.1.3 Environmental protection laws

There is clearly a lack of overall enforcement with respect to the environmental protection laws and regulations under the Environmental Quality Protection Board (EQPB) of the Republic of Palau. As discussed in this report, illegal and unpermitted road building and other construction has occurred in Palau, and for permitted projects there has been a lack of enforcement of permit conditions. The following programs might be considered for improving the enforcement capacity of EQPB.

- *Improved coordination between EQPB and other resource management agencies during the permitting process.* It has been noted that the level of consultation between EQPB and other resource management agencies during the initial stages of the permit review process is insufficient, making it difficult for other agencies to assist EQPB in enforcing permit conditions. It is recommended that, in the interests of providing a stronger consolidated effort for enforcing permit conditions and for providing increased use of available knowledge and manpower, some consideration be given to the idea of mandating such consultation.
- *Environmental education for and involvement of the public in the permit review process.* For all developments with a major impact on the environment and resources of the Republic of Palau, increased attention needs to be given to education of the general public regarding the proposed development criteria and potential adverse impacts of development. This education will empower local people to assume some sense of stewardship and responsibility over their actions and role in monitoring the

environment and permit violations. It is also hoped that the general public could assume more responsibility in reporting unpermitted development to EQPB staff.

- *Specific coordination with Division of Conservation and Entomology (DCE) staff involved in a national conservation enforcement program.* There is probably a need to mandate coordination between the Division of Conservation and Entomology (DCE) enforcement officers and EQPB staff. National enforcement officers under DCE could receive briefings on major development activities in their patrol areas while EQPB staff could be instructed on resource conservation laws and regulations.

13.2 Control over large-scale development

13.2.1 General

As noted in the report, a significant number of large-scale development programs/projects have occurred or have been proposed for Palau; these have resulted or may result in:

- direct or indirect destruction of marine and terrestrial habitat;
- decrease in the availability of terrestrial and marine resources for subsistence farming and fishing;
- depletion of fresh-water resources;
- increased burden on public sewer and water treatment systems (which are already largely operating at capacity);
- importation of foreign workers.

Given the concerns over the need to improve the planning and regulation of such development activities, the following strategies and programs might be considered for action under the National Environmental Management Strategy:

(1) a general strategy for the regulation of all large-scale projects;
(2) a strategy specific to EQPB; and
(3) a strategy aimed at controlling the environmental impacts of foreign investment programs which, in the final analysis, are the major ones.

13.2.2 Establishment of a planning framework

A planning framework is needed to define limits in size, location, and overall amount of large-scale development programs/projects. Currently, permits are evaluated on an individual basis, and there is no plan for Palau which, by reference to the overall carrying capacity and current state of the environment, details suitable levels and locations for development. Some of these issues may be dealt with in the Palau National Master Development Plan. The following programs should be considered for action by both the Palau National Master Development Plan and the NEMS, or by any planning exercise.

- Documentation of current subsistence use and establishment of a mechanism to preserve areas for subsistence farming and fishing.
- Documentation of natural resource habitat needs and establishment of core preserve areas.
- Designation of areas which have suffered degradation in the past which are suitable for development.
- Establishment of carrying capacity of water and other resources, and resultant limits to allowable development.
- Establishment of a standard process to evaluate developments for their direct and indirect impacts on natural and social systems as a result of use or destruction of resources, the need for foreign workers, etc.
- Review of the capacity of current sewage and solid waste disposal systems, and development of policies which address the need to improve them.

13.2.3 EQPB regulation of large-scale development

As noted above, there are concerns about the extent to which EQPB has not been able to regulate or control the environmental impacts of certain large development projects in Palau. For one thing, the current informal consultation with other resource management agencies seems inadequate for the preparation and enforcement of EIAs. Further, where EIAs have been carried out, there are also concerns about using consultants of the

developers' choice. The following programs might be considered for improving the capacity of EQPB.

- *Formal review of EQPB activities.* This should include recommendations for revision or amendments to the *Environmental Quality Protection Act* — 24 PNC — to address current problems.
- *Establishment of a formalized review process for EQPB permitting.* A formalized review process should be mandated by law to ensure that comments on development proposals are received from all relevant resource management agencies for incorporation into the final decision.

13.2.4 Foreign investment permitting procedures

The current foreign investment permitting procedures do not require consultation of any resource management agencies for permit approval. Consequently, permits for investment are approved before any required environmental permitting occurs. It is recommended that the review and approval of foreign investment permits through the Foreign Investment Board should be considered in conjunction with any required environmental permitting, and should not be approved before environmental permitting occurs.

13.3 Natural and historical or archaeological resources

13.3.1 General

Terrestrial and marine habitat is being increasingly destroyed and affected due to large and small-scale development projects, fire, and the growing tourist presence in Palau. This destruction and degradation has direct and indirect impacts on many marine and terrestrial resources. Destruction and degradation of historical/archaeological resources has also occurred, largely as a result of development and tourism activities. The problem could be addressed by regulating development activities, by controlling fire, and through a reserve area system.

13.3.2 Regulation of small-scale development

Issues related to the regulation of large-scale development activities are discussed above. In some ways, the environmental impacts of large-scale projects are easy to manage as long as there is real commitment to conduct proper EIAs and enforce them.

Small-scale development activities may be harder to regulate because, individually, they may not have a significant impact. On the other hand, their cumulative effects can be more damaging than the large-scale projects. It is therefore equally important to regulate the smaller, incremental development activities.

In Palau, small-scale activities such as the development of trails, bridges, camping, and picnicking facilities are becoming an issue in that they increase tourist traffic and hence increase the potential for incidental or severe impacts to a given resource or habitat. These smaller activities could be regulated through land use plans which detail what can and cannot take place in certain areas. An important program would be as follows.

- *The preparation of comprehensive and environmentally sensitive land use plans for each of the states, or at least for the high pressure areas such as Koror.* On the basis of such land use plans, each agency could develop its own sector plans. There is some concern over the increasing promotion of sites by the Palau Visitors Authority, and of the potentially increased impact on those sites resulting from that promotion. It would be useful if the Palau Visitors Authority used an overall planning framework in developing access to and activities on some of these sites.

13.3.3 Controlling fire

As noted in this report, burning of forests not only destroys terrestrial habitat; it is one of the major causes of soil degradation, erosion, sedimentation, and siltation. The following programs are recommended for consideration under the NEMS.

- *Palau Wildland Fire and Forest Management Bill.* As there is currently no law prohibiting forest fires, this bill represents a valuable tool for management of terrestrial habitat systems in Palau. It should be given full support by the Olbiil Era Kelulau and various government agencies and, if passed, should be enforced through the national conservation enforcement program of the Division of Conservation and Entomology.

- *Educational program.* Educational efforts on the impacts of uncontrolled burning of forests should continue through the Department of Forestry.

13.3.4 Reserves system designation

Ngerukewid Islands Wildlife Preserve in the Rock Islands is the only designated resource reserve which currently exists in Palau. However, it is not well managed and enforced, and does not integrate natural and historical/archaeological preservation. It is therefore recommended that additional reserves be established that are well enforced, managed, and integrated. Specific programs to support such recommendations could include the following.

- *Assist states to designate reserve sites under the* Natural Heritage Reserves System Act 1991. This recently became law, and efforts should be made to require and assist state designation of National Heritage Reserve sites for inclusion in the Palau National Master Development Plan. States should be encouraged to consider sites for purposes of both natural and historical/archaeological resource preservation.
- *Continue work to support the concept of bioreserve planning for specific sensitive areas with The Nature Conservancy (TNC).* Unique sensitive natural areas of Palau such as the Rock Islands and Ngeremeduu Bay require special recognition and consideration. Both the Rock Islands and the Ngeremeduu Bay watershed also contain significant historical/archaeological sites.
- *Development of a management and enforcement framework for the existing reserve and planned future reserves.* Issues and recommendations for an improved enforcement program are detailed above. The need for active management of reserve systems also needs to be recognized. Active management of reserve systems should be implemented through the following.
  - — Development of one or several staff positions in the Division of Conservation and Entomology to develop and implement management plans for reserve areas.
  - — Development of policies and programs to encourage involvement of the Division of Parks and Recreation, and the Division of Youth Affairs in the management of reserve areas for human use.
  - — Securing local involvement in the planning and management of reserve areas. Agencies such as the Palau Community Action Agency (PCAA) could be utilized to encourage and facilitate local involvement.

13.4 Environmental awareness and education

An environmental educational program could be pursued through the following programs.

- Development and use of school education materials relevant to Palau and the region.
- Teacher training programs to ensure the effective use of materials.
- Development of special-purpose education materials for communities, government officials, and politicians.
- Establishment of and support for conservation/environment education staff positions.
- Utilization of traditional and local knowledge in educational programs.
- Utilization of existing entities such as the Micronesian Occupational Center (MOC).
- Funding of scholarships to encourage scientific and technical university training for Palauan students.
- Seminars and workshops for communities, as well as for political and government agency representatives.

13.5 Knowledge of natural systems

Another concern highlighted in this report is the overall lack of knowledge regarding resources and their status. Serious deficiencies exist in knowledge which is integral to resource management in Palau. These deficiencies could be addressed through the following programs.

- *Baseline studies.* An excellent program of baseline studies has been initiated by the Bureau of Natural Resources and Development in cooperation with The Nature Conservancy. Scientific research,

specifically on endangered species and endemic plant status, should also be continued and funded.

- *Marine resources stock assessment.* Given that development of marine fisheries represents such an important sector for economic development in Palau, it is imperative that the recently initiated stock assessment data collection programs of the Bureau of Natural Resources and Development be continued.
- *Terrestrial resources status assessment.* Terrestrial development is increasing in Palau, and there is a need to try to quantify the effects of changing land use patterns on soil, habitat and species. A Rapid Ecological Assessment for Palau carried out through The Nature Conservancy in 1992 provides valuable information in this respect (Maragos et al. 1994). Efforts should be made to integrate information from this assessment into the Palau National Master Development Plan.

13.6 National and state coordination

While the states in Palau are given exclusive ownership of their land and sea resources to 12 nautical miles offshore, most of them lack funding and expertise for effective resource management. It is essential that the national government, given its greater resources, should coordinate with the states over resource management. The lack, to date, of such coordination represents one of the most critical constraints in enforcing any of the resource/environment laws or regulations. The following programs might be considered for addressing this problem.

- *Promulgation of national regulations and policies to assist and guide states in resource management.* National policies or acts to establish a framework for resource management decisions are needed in Palau. Work is occurring in some sectors, such as the work to develop a fisheries management plan by the Division of Marine Resources. Similar work should be pursued for terrestrial resources. National standards should be applied where no state regulations exist. However, if states wish to develop their own management plan, this should be supported, subject to review and approval by national agencies.
- *Enforcement support for traditional management systems.* Traditional government systems remain prominent in Palau, particularly at the state level. As discussed earlier, traditional laws to manage resources have had a strong place in Palau's past. Although there has been an erosion of traditional laws and authority, chief councils still possess a great amount of knowledge related to resource management. This should be harnessed and integrated into the modern systems of education and resource management. This report recommends that some consideration be given to the idea of enforcing traditional laws through the recommended national conservation enforcement program. The issue of allowing punishment through the traditional fining system should also be considered.

13.7 Managing population growth and its impacts (Koror State)

Rapid population growth and growing numbers of tourists visiting Koror State have led to increased burdens on various aspects of the infrastructure of this state. Of major concern is the increasing burden which this growth is placing on the sewage and solid waste disposal systems. The Koror State sewerage system is rapidly approaching maximum capacity, and improvements to this system will have to be considered in the near future. Recommendations for dealing with these issues are presented below.

- *Development of a population management plan.* Such a plan would incorporate family planning, labor requirements, an assessment of the carrying capacity of Koror State, and the decentralization of services and economic opportunities.
- *Tourist revenue designation.* A certain percentage of the revenue generated by tourism in Palau should be designated for the planning and development of infrastructure needs such as water, sewerage, and power, as well as for planning of landfill and recycling programs.
- *Encourage resort self-sufficiency.* In the permitting process, large-scale resorts which

are likely to put much pressure on existing infrastructure should be required to fund development of increased capacity in public sewerage and water; otherwise, they should be required to be self-sufficient with respect to such services.

- *Recycling initiatives.* Initiatives should be developed, such as a 'Bottle Bill' to encourage recycling. Restrictions on the use of plastics and styrofoam should also be considered.

13.8 Pollution

The issue of pollution from terrestrial and marine point and nonpoint sources is a growing concern in Palau. Concern is particularly strong over pollution from improperly treated sewage; pesticides; and dumping in marine waters. Possible programs for addressing this issue are the following.

- *Enforcement of existing laws and regulations.* Recommendations for improving enforcement of existing conservation laws were provided earlier in this section. Improved enforcement is particularly needed to curb the growing importation and use of nondegradable materials, pesticides and other chemicals.
- *Public awareness/education.* Increased educational efforts are needed to improve awareness of the detrimental impacts of pesticide use and improper waste disposal.
- *Ratification of the SPREP Convention.* Palau signed the *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region*, the SPREP Convention, in 1986. This convention and its associated protocols establish a framework for control of land, sea, and air pollution in an overall effort to protect marine environments. Palau is currently working on amending its legal framework to enable ratification of this convention. Work should continue on this issue.

13.9 The need for economic development in Palau

The need for environment protection notwithstanding, Palau will need to emphasize resource development and infrastructure improvement if it is to attain some measure of economic self-reliance. In order to minimize damage to the environment and maximize sustainability, Palau will need to put in place a management framework that could effectively integrate economic and environment planning and program development. The legal and policy aspects of such a framework are largely in place. As already mentioned, it is the areas of planning, coordination and enforcement that require attention. In establishing a program for development based on sustainable utilization of resources, it is recommended that Palau undertake the following:

- *Development of a system or framework to evaluate the costs, benefits, and sustainability of development proposals.* Through the Palau National Master Development Plan or some other land use planning initiative, a standard mechanism should be established for proper evaluation of developments for their sustainability, costs, and benefits. Palau may want to consider the establishment of a commission to permit or disapprove developments based on these criteria.
- *Encourage small-scale community-based tourism efforts.*
- *Encourage value-added processing in both the inshore and offshore fisheries to maximize returns from these industries.*
- *Encourage diversification of the tourism industry, such as through sportfishing.*

References and other source materials

Belau National Museum. 1975. Palau Historic Sites. Unpublished list. Belau National Museum, Koror, Republic of Palau.

Belau National Museum. 1982. Republic of Palau: Beluu era Belau. Belau National Museum, Koror, Republic of Palau.

Birkeland, C. & Manner, H. (eds). 1989. Resource Survey of Ngerukewid Islands Wildlife Preserve, Republic of Palau. A report to the Government of Palau, the South Pacific Regional Environment Programme, World Wildlife Fund, and the International Union for the Conservation of Nature and Natural Resources.

Birkeland, C., Richmond, R.H., Matson, E.A., Holthus, P. & Convard, N.S. 1989. Visual Surveys of the Coastal Marine Communities of Babelthaup and Koror (Belau): Some Implications for Potential Effects of Proposed Coastal Zone Developments. A cooperative study by the Environment and Policy Institute, East–West Center/South Pacific Regional Environment Programme/University of Guam Marine Laboratory/Environmental Quality Protection Board, Government of Palau.

Brewer, W.A. 1991. Environmental assessment for Ocean Development Company, Inc., Palau Resort Development, Ngesaol, Koror State, Republic of Palau. Brewer/Bandman Associates, Honolulu, Hawaii.

Canfield, J.E. 1981. Palau: Diversity and status of the native vegetation of a unique Pacific island ecosystem. Newsletter of the Hawaiian Botanical Society, vol. 20, pp. 14–21.

Carpenter, R.A. & Maragos, J.E. 1989. How to Assess Environmental Impacts on Tropical Islands and Coastal Areas. Environment and Policy Institute, East–West Center, Honolulu, Hawaii.

Cassell, J., Otobed, D. & Adelbai, H. 1992. Comprehensive Conservation Strategy 1992 for the Republic of Palau: A Review of the Palau Conservation Program and Recommendations for Additional Program Policies. Koror, Republic of Palau.

Cole, T.G., Falanruw, M.C., MacLean, C.D., Whitesell, C.D. & Ambacher, A.M. 1987. Vegetation Survey of the Republic of Palau. Resource Bulletin PSW–22. Pacific Southwest Forest and Range Experiment Station, US Forest Service, US Department of Agriculture, University of California Press, Berkeley, California, USA.

Cook, C. & Maragos, J.E. 1991. The Palau Islands Bioreserve. Draft. The Nature Conservancy, Koror, Republic of Palau.

Division of Marine Resources. 1990. 1990 Annual Report. Bureau of Natural Resources and Development, Koror, Republic of Palau.

Engbring J. 1988. Field Guide to the Birds of Palau. Division of Conservation and Entomology, Koror, Republic of Palau.

EQPB. 1991. Environmental Quality Report. Environmental Quality Protection Board, Koror, Republic of Palau, August 2.

EQPB. 1994. Fiscal Year 1994 Semi-Annual Report (October 1, 1993 to March 31, 1994). Environmental Quality Protection Board, Koror, Republic of Palau.

Force, R.W. & Force, M. 1972. Just One House: A Description and Analysis of Kinship in the Palau Islands. Bernice P. Bishop Museum, bulletin 235, Honolulu, Hawaii.

Fosberg, F.R., Otobed, D., Sachet, M.H., Oliver, R.L., Powell, D.L. & Canfield, J.E. 1980.

Vascular Plants of Palau with Vernacular Names. Department of Botany, Smithsonian Institution, Washington, DC.

Glassman, S.F. 1952. The Flora of Ponape. Bernice P. Bishop Museum, bulletin 209, Honolulu, Hawaii.

Government of Palau. 1994. Economic Development Plan, Fiscal Years 1995–1999. Koror, Republic of Palau.

Government of Palau/US National Park Service. 1988. Bliliou (Peleliu) Historical l Park Study, Preliminary Review Draft. Government of Palau/US National Park Service, Koror, Republic of Palau.

Gressitt, J.L. 1954. Introduction. In Insects of Micronesia, vol. 1. Bernice P. Bishop Museum, Honolulu, Hawaii.

Hamilton, L.S. & Snedaker, S.C. (eds). 1984. Handbook for Mangrove Area Management. By a writing team of the Environment and Policy Institute, East–West Center/International Union for the Conservation of Nature and Natural Resources/United Nations Educational, Scientific, and Cultural Organization.

Johannes, R. 1981. Words of the Lagoon; Fishing and Marine Lore in the Palau District of Micronesia. University of California Press, Berkeley, California, USA.

Johannes, R. 1991. Some suggested management initiatives in Palau nearshore fisheries, and the relevance of traditional management. South Pacific Commission Inshore Fisheries Research Project Country Assignment Report. Unpublished report to the Government of the Republic of Palau. South Pacific Commission, Noumea, New Caledonia.

Kaneshiro. 1958. Land tenure in Palau. In Land Tenure Patterns in the TTPI. Office of the High Commissioner, Trust Territory of the Pacific Islands, Guam.

Kramer, A. 1926. Palau. English translation. Belau National Museum, Koror, Republic of Palau.

McCutcheon, M. 1985. Landlessness in Palau. In Modernization and the Emergence of a Landless Peasantry: Essays on the Integration of Peripheries to Socioeconomic Centers. Studies in Third World Societies, publication 33. Department of Anthropology, College of William and Mary, Williamsburg, Virginia, USA.

McHenry, D.F. 1975. Micronesia: Trust Betrayed. Carnegie Endowment for International Peace, Washington, DC.

MacLean, C.D., Whitesell, C.D., Cole, T.G. & McDuffie, K.E. 1988. Timber Resources of Babelthaup, Republic of Palau. Resource Bulletin PSW–23. Pacific Southwest Forest and Range Experiment Station, US Forest Service, US Department of Agriculture, University of California Press, Berkeley, California, USA.

Maragos et al. 1994. Palau Rapid Ecological Assessment, Part 2: Marine and Coastal Areas of the Main Palau Islands. The Nature Conservancy, Koror, Republic of Palau.

Marine Biotechnology Institute Co. Ltd. 1990. '90 Sohgen Maru Expedition in Palau. Tokyo, Japan.

Marsh, H. et al. 1991. An Assessment of the Status of the Dugong in Palau: A Preliminary Report to the Palauan Government. IUCN Sirenia Specialist Group.

Myers, R. 1989. Micronesian Reef Fishes. Coral Graphics, Agana, Guam.

Nichols, P.V. 1991. Republic of Palau marine resources profiles. Draft report. Fisheries Development Section, Forum Fisheries Agency, Honiara, Solomon Islands.

Office of Planning and Statistics. 1987. 1986 Census of Population and Housing of the Republic of Palau. Koror, Republic of Palau.

Otobed, D.O. 1974. Development plan for entomology service: 1975–1980. Unpublished manuscript. Office of the Chief Conservationist/Entomologist, Trust Territory of the Pacific Islands, Koror, Republic of Palau.

Owen, R. 1977. Terrestrial vertebrate fauna of the Palau Islands. Unpublished Manuscript. Office of the Chief Conservationist/ Entomologist, Trust Territory of the Pacific Islands, Koror, Republic of Palau.

PATA. 1993. Palau — Belau: Your Future in Tourism. PATA Task Force Study, Pacific Asia Travel Association, Sydney, Australia, March.

Peacock, K. M. 1990. The maze of schools: Education in Micronesia, 1951–1964: The Gibson years. PhD dissertation, University of

Hawaii. University Microfilms International, Ann Arbor, Michigan, USA.

PNMDP. 1994. Informal sector reports. Palau National Master Development Plan Office, Koror, Republic of Palau.

Preston, G.L. 1990. Inshore fishery resource management in Palau. South Pacific Commission Inshore Fisheries Research Project Country Assignment Report. Unpublished report to the Government of the Republic of Palau. South Pacific Commission, Noumea, New Caledonia.

PVA. 1993. Palau: Your future in tourism: A summary of the presentation by Ian Kennedy of the Pacific Asia Travel Association, Pacific Division and the remarks by the President of the Republic of Palau, July 5. Pacific Visitors Authority, Koror, Republic of Palau.

Rehuher, F., Tellei, J., Gordon, M., Koshiba, E. & Souder, L. 1990. Ngesaol Socio-cultural Impact Study. Western Pacific Women's Research Institute, University of Guam, Mangilao, Guam.

Republic of Palau. 1986. Republic of Palau National Code. Koror, Republic of Palau.

Smith, C.W. 1983. Soil Survey of the Islands of Palau, Republic of Palau. US Soil Conservation Service, US Department of Agriculture, Washington, DC.

Smith, D.R. 1977. The ties that bind: Exchange and transactions in kinsmen in Palau. PhD dissertation. Bryn Mawr College, Pennsylvania, USA.

Snyder, D. 1985. An Archaeological Survey of Koror State, Republic of Palau. Center for Archaeological Investigations, Southern Illinois University, Carbondale, Illinois, USA.

Thomas, P.E.J., Holthus, P.F. & Idechong, N. 1989. Ngerukewid Islands Wildlife Preserve and Management Plan. South Pacific Commission, Noumea, New Caledonia.

US Bureau of the Census. 1990. 1990 Census Data for Palau. Cited in Government of Palau, Economic Development Plan, Fiscal Years 1995–1999, Koror, Republic of Palau, 1994.

US Department of Defense. 1956. Military Geology of Palau Islands, Caroline Islands. US Army Strategic Study.

US Department of the Interior. 1991. 1991 Republic of Palau Budget. Executive Order, US Secretary of the Interior, Department of the Interior, Washington, DC.

US Department of State. 1990. 1990 Trust Territory of the Pacific Islands. 43rd Annual Report. Washington, DC.

US Soil Conservation Service. 1991. A Conservation Study and Plan for Melekeok State, Republic of Belau. US Department of Agriculture, Agana, Guam.

Van Bohemen, G. 1990. Report on the Implementation in Palau and Tuvalu of: The Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and The Convention on the Conservation of Nature in the South Pacific. South Pacific Regional Environment Programme, Noumea, New Caledonia.

soe

State Of the Environment Report

South Pacific Regional Environment Programme