TEXT VERSION

REPUBLIC OF PALAU

National Biodiversity Strategy and Action Plan

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(DATE)

Palau's National Biodiversity Strategy and Action Plan was prepared by the members of the Ad-Hoc Committee of the Palau National Environmental Protection Council, composed of twenty representatives of government, non-governmental organizations, and the private sector:

Belau National Museum
Bureau of Agriculture
Bureau of Marine Resources
Coral Reef Research Center
Ministry of Resources and Development
Office of Environmental Response and Coordination
Office of the Vice President
One-Eco Habitat
Palau Automated Land and Resource Information System
Palau Community Action Agency
Palau Conservation Society
Palau Environmental Quality Protection Board
Palau International Coral Reef Center
The Environment, Inc.
The Nature Conservancy
US Army Corps of Engineers
USDA Natural Resources Conservation Service

This National Biodiversity Strategy and Action Plan (NBSAP) was written to reflect the conclusions of the community consultations, consultant reports, and two national workshops. The main authors were Andrew Bauman, Ethan Daniels, Julian Dendy, David Hinchley, Tarita Holm, Ann Kitalong, Elizabeth Matthews, Joel Miles, and Alan Olsen.

Format and layout by Youlsau Bells

Funded by GEF/UNDP – Enabling activities: The United Nations Convention on Biological Diversity

Volume 1: National Biodiversity Strategy and Action Plan
Volume 2: Consultants' reports:
Legislative Review, Steven Daugherty
Institutional Framework, One-Eco Habitat

Community Consultations (Phases 1 and 2), Palau Conservation Society
Resource Use Study, The Environment, Inc.

ACKNOWLEDGMENTS

This NBSAP could not have been completed without the contributions of the people in the communities of all 16 states of Palau, who took time out from their busy lives to participate in the Community Consultations where they shared their knowledge and experience, described their concerns, and prioritized local needs and actions related to the biodiversity upon which their lives and livelihoods depend.

Additionally, the full and active participation of the participants in two national workshops was essential to the identification and prioritization of the 8 themes, and drafting of the actions under those themes.

The funding contribution of the Global Environment Facility through the United Nations Development Programme is gratefully acknowledged.

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FOREWORD

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EXECUTIVE SUMMARY

"The people of Palau have depended on their islands' biodiversity since their first arrival several millennia in the past…. The abundance of the natural resources of these islands have maintained the social and economic well-being of the Palauan people; using and protecting these resources are part of the Palauan way of life."

So begins the Palau National Biodiversity Strategy and Action Plan (NBSAP). The Palau NBSAP was developed over a 3-year period, from January 2002 through December 2004. It was developed through an extensive process of research and multi-sectoral consultative activities involving a broad range of government (State and National), NGO, and private sector and community stakeholders. This process included a series of community consultations in all 16 states, held in order to discover issues, themes, and local concerns regarding biodiversity in Palau. The state consultations were particularly important in identifying issues and actions that are important at the community level. Scientific reviews of available literature on the nation's biodiversity were also undertaken, along with studies of resource use and the availability of human, financial, and technical resources. Local capacity building was incorporated throughout the consultative process as a secondary objective of the project.

The overall NBSAP vision is:

"The people of Palau are living in harmony with their diverse natural and cultural heritage."

To enable us to attain this vision, eight strategic themes, with clearly stated and achievable actions, were developed at two national workshops attended by representatives of national government agencies, state governments, non-government organizations, and the private sector. The themes and associated actions are based on ten guiding principles developed for the successful long-term preservation, conservation, and sustainable utilization and management of Palau's biodiversity. The eight strategic themes are:

1. ***Protected/Managed Areas***
2. ***Species Protection***
3. ***Biosecurity – Invasive Species and Biosafety***
4. ***Sharing Benefits of Genetic Resources***
5. ***Sustainable Economic Development***
6. ***Prevent or Minimize Waste***
7. ***Agricultural Biodiversity***
8. ***Mainstreaming of Biodiversity Conservation***

The eight **themes** each have a **vision** and **goal**. The effective pursuit of these goals will steer our nation on a sustainable voyage toward the overall NBSAP Vision. Each goal will be achieved through the fulfillment of **objectives**, which have been identified as priority areas that must be addressed to enable the sustainable use and management of the Republic's biodiversity. It is

anticipated that the implementation framework for this NBSAP will be developed in cooperation with the 16 State governments, traditional leaders, and other relevant stakeholders.

The conservation and sustainable use of Palau's biodiversity will require a merging of tradition with new approaches, along with cooperation and collaboration on a local, national, regional, and global scale. Palau embarks on this journey of cooperation and collaboration with cautious optimism. This Strategy is a reflection of Palau's readiness to undertake that journey in order to protect the precious biodiversity that is so much a part of Palau's culture and life.

1. INTRODUCTION

1.1 Importance of Palau's Biodiversity Strategy

The people of Palau have depended on their islands' biodiversity since their first arrival several millennia in the past. Palauans have not only depended on these resources, however; they have managed them sustainably, so that future generations could continue to enjoy the benefits they have supplied for thousands of years. The abundance of the natural resources of these islands have maintained the social and economic well-being of the Palauan people; using and protecting these resources are part of the Palauan way of life.

Biodiversity enters all facets of Palauan life, from providing the natural resources needed for food and shelter to providing medicines, and all other aspects of "Klechibelau," or "Palauan-ness." Through the millennia, a partnership has formed between the people and natural environment of Palau, creating a trust that the people would use and manage the natural resources sustainably, and that these resources would continue to sustain Palau's human population.

This partnership is now threatened. As the society changes from a traditional subsistence-based economy to a westernized commercial economy, and from a village-based management system to one centered in the national government, the culture of care Palauans once had for their natural heritage is being eroded. Coupled with this loss of traditional knowledge and practices, increases in the country's population and in the number of visitors to the islands are placing increasing demands on a fragile environment with limited biological resources.

Exacerbating these social and economic changes are increasing threats to biodiversity from global environmental changes such as climate change, sea level rise, droughts, more frequent storms, and rapid spread of invasive species. These global impacts make the protection of our biological resources an issue which must involve not only the entire population of Palau, but one which requires the cooperation of all nations.

The conservation and sustainable use of Palau's biodiversity will require a merging of tradition with new approaches, along with cooperation and collaboration on a national, regional, and global scale. Palau embarks on this journey of cooperation and collaboration with cautious optimism. This Strategy is a reflection of Palau's readiness to undertake that journey in order to protect the precious biodiversity that is so much a part of Palau's culture and life.

1.2 Background to the Strategy

The term "biodiversity" is formed from the words Biological Diversity, and refers to the variety of all living things on earth. This variety includes different ecosystems, the different species of living things within those ecosystems, and the genetic diversity within and among species. Palau's biodiversity includes all the different living organisms that inhabit all the ecosystems within Palau, and the genetic diversity within those living organisms, and includes not only native species of living things, but also all those living things which have been brought to the islands and sea of Palau by human beings. The biodiversity of the Republic of Palau is the

nation's living wealth, and life as we know it in Palau is completely dependent on this biodiversity.

Species endemism is high in Palau, especially among the terrestrial biota. The high endemism within the Republic is a direct result of the isolation of the islands, both from one another and from the rest of the world. The conservation and preservation of endemic species is of particular importance in Palau. In addition, the conservation and sustainable management of all of Palau's biological resources is vital to the ongoing social, economic, and cultural development of the country.

The National Biodiversity Strategy and Action Plan (NBSAP) builds upon the Republic's first documented environmental strategy, the National Environmental Management Strategies (NEMS, 1993). It also supplements the National Master Development Plan (NMDP 1996) and other sustainable development strategies, as well as Palau's strategy to deal with climate change (Climate Change report, 2000). The themes and actions recommended in the NBSAP are essential for the sustainable economic development of the Republic of Palau.

1.3 Convention on Biological Diversity

The United Nations Convention on Biological Diversity (UNCBD) was adopted at the Earth Summit in Rio de Janeiro in 1992. The UNCBD opened for signature in 1992 and came into force in 1994. Palau signed the Convention in 1998.

The provisions of the UNCBD are set out in 42 Articles. Article 1 identifies the three objectives of the Convention:

- The conservation of biological diversity;
- The sustainable use of its components; and
- The fair and equitable sharing of benefits arising out of the utilization of genetic resources.

Article 6 of the Convention includes a requirement for each Contracting Party, "in accordance with its particular conditions and capabilities, to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity…." This National Biodiversity Strategy and Action Plan (NBSAP) represents Palau's initial step to meet this obligation.

1.4 Process of Strategy Development and Formulation

The Palau National Biodiversity Strategy and Action Plan was developed over a 3-year period, from January 2002 through December 2004. It was developed through an extensive process of research and multi-sectoral consultative activities involving a broad range of government (State and National), NGO, and private sector and community stakeholders. The project was funded under the Global Environment Facility's (GEF) Enabling Activities, administered by the United Nations Development Programme (UNDP).

Overseeing the NBSAP Project was the Palau National Environmental Protection Council (NEPC). The NEPC is a multi-agency, multi-sectoral body created by the President. The NEPC created an Ad-Hoc NBSAP Planning Committee to advise project management. Membership in the Planning Committee included key government agencies, non-governmental organizations, and the private sector.

The project was managed by the Office of Environmental Response and Coordination (OERC), within the Office of the President. The OERC hired and housed a full time Project Manager for the project. In addition, several national consultants were engaged to undertake specific components of the NBSAP project.

Throughout the consultative process an element of local capacity building was incorporated as a secondary objective of the project. It is anticipated that the implementation framework for this NBSAP will be developed in cooperation with the 16 State governments, traditional leaders, and other relevant stakeholders, and incorporated as part of the NBSAP.

2. VISION AND GUIDING PRINCIPLES

2.1 VISION

The people of Palau are living in harmony with their diverse natural and cultural heritage.

2.2 GUIDING PRINCIPLES FOR BIODIVERSITY MANAGEMENT IN PALAU

- **Sovereign Rights –** The people of Palau hold the sovereign rights over their biological diversity
- **Equitable Sharing of Benefits –** All use, conservation, and management of Palau's biodiversity should benefit the people of Palau in some way. These benefits should be shared equitably among all the people of Palau.
- **Good Governance and Leadership –** The National government, State governments, and traditional leaders of Palau will work together, in full partnership with local communities, to ensure the protection, conservation, and sustainable management of our biodiversity, through effective governance and leadership.
- **Traditional Community-based Approach –** The community is traditionally the basic management unit for biodiversity in Palau. Communities have both the right and the responsibility to manage and use their biological resources sustainably for their benefit and that of future generations.
- **Traditional Heritage –** We will build upon and utilize the deep and extensive traditional knowledge and experience of our ancestors to devise and implement strategies for the sustainable stewardship of our rich natural resources.
- **Ecological Integrity –** We will strive to maintain and improve the diversity and quality of our ecosystems, conserving our biodiversity while enhancing our ecosystems' capacity to adapt to change.
- **Stakeholder Participation –** The full participation and collaboration of all stakeholders is required for the effective coordination and implementation of the NBSAP, to ensure accountability and transparency.

- **On-site and Off-site Conservation –** Biodiversity is best conserved in those places where it naturally occurs (*in situ*). However, off-site (*ex-situ*) conservation may be needed to assist in the conservation and management of threatened species or forms.
- **Public Awareness and Capacity Building –** Public awareness and support, education, and the strengthening of local capacity are essential for the protection, conservation, and sustainable management of Palau's biodiversity.
- **Respect for Biodiversity –** We affirm our respect for the intrinsic value of biodiversity resources, in addition to their value to human society.

3. NATIONAL CIRCUMSTANCES

3.1 Geography and Geology

The Republic of Palau consists mainly of an archipelago in the western Pacific Ocean located at approximately 7 degrees North latitude and 134 degrees East longitude. Palau is the westernmost island cluster of the six major island groups that make up the Caroline Islands. The main Palau archipelago is located approximately 800 kilometers east of the Philippines and 800 kilometers north of the island of New Guinea. The western Caroline Islands are exposed peaks of undersea ridges stretching between Japan and New Guinea, and are not located on the Pacific Plate, as are the eastern Carolines. The Palau islands originated on the now dormant southern section of the volcanic Palau-Kyushu Ridge, which formed about 43 million years ago (MYA) in a complex series of rifting and boundary shifts of the Pacific Plate margin during the formation of the Philippine Basin (Kroenke, 1984).

The main Palau archipelago stretches approximately 200 kilometers in a predominantly north-south orientation from the atoll of Ngeruangel in the north to the island of Angaur in the south. In addition to the main archipelago, there are 5 small islands and one atoll (the so-called Southwest Islands) located some 300-500 kilometers to the southwest of the main archipelago and less than 200 kilometers north of the nearest islands of Indonesia. Palau consists of 586 islands, of which only twelve are continuously inhabited. Total land area is 535 km^2 and the lagoons around some of the islands encompass more than 1135 km^2.

The islands of Palau represent five geological island types, volcanic, high limestone, low limestone, atolls, and a combination of volcanic and limestone (US Army 1956). The largest islands, such as Babeldaob, were formed by Eocene volcanic activity and are composed of basalt and andesite. They tend to have a high profile, well-developed perennial stream systems, and a high diversity of terrestrial flora. Babeldaob, the largest island in Palau, has severely leached and highly acidic soils, unsuited for large-scale agriculture. The world-famous "Rock Islands" are of limestone formation. Kayangel atoll, at the northernmost tip of the archipelago, is a classic coral atoll. Peleliu and Angaur, located at the southern end of the main archipelago, are low platform and reef islands. The Southwest group of islands, 300 to 500 kilometers to the southwest of the main archipelago, is made up of reef flats that have been subjected to uplift, and one atoll (Helen Reef).

Babeldaob island is the largest in the Palau island chain, and the second largest island in Micronesia. Babeldaob constitutes seventy-five percent of Palau's total landmass. At its greatest width, Babeldaob reaches fifteen kilometers across (APCC, 2001). The highest point on

Babeldaob, Mt. Ngerchelchuus, also the highest point in Palau, is 275 meters above sea level. With the exception of Kayangel, Angaur, and the Southwest Islands, all of the Palau islands are located within one barrier reef. Palau's territorial seas extend 12 nautical miles, with a 200-nautical mile exclusive economic zone (EEZ) which encompasses an area of approximately 600,900 square kilometers (Sant and Hays, 1996).

3.2 Climate

The Republic of Palau is blessed with a humid maritime tropical climate. Palau's mean annual temperature is 28 C, and fluctuates on a daily basis no more than 5 to 6 degrees Annual temperatures also vary only slightly; rarely by more than 10 degrees throughout the year. Annual mean humidity level is 82 percent. Annual mean rainfall is about 3,800 mm, with only small seasonal variation (National Climatic Data Center, 1996).

Palau has two predominant seasons during the year, the northeast monsoon (drier) and the southwest monsoon (wetter). The southwest monsoon typically begins in May and peaks in September. The northeast monsoon prevails from December to April. February, March, and April are the driest months of the year, while June and July are typically the wettest months (NOAA, 1991). Although not located within the main tropical cyclone track, Palau has experienced destruction from typhoons and severe tropical storms. For instance, approximately four million dollars of damage was done to Palau's infrastructure by torrential rainfall and flooding when Typhoon Utor swept several hundred miles north of Palau in July, 2001.

3.3 Current and Tides

The Palauan archipelago lies in an area influenced by the North Equatorial Counter Current (NECC) and the Mindanao Eddy (Rapaport and Moshe, 1999). Both the NECC and the Mindanao Eddy affect Palau's overall biodiversity by carrying coral and fish larvae originating in the Philippines, New Guinea, and Indonesia to Palau (Meyers, 1999). Terrestrial flora and fauna have reached Palau via wind, rafts, or drifting with the NECC.

Lunar periodicity dramatically affects the behaviors of fishes and invertebrates throughout the archipelago. Palau experiences semidiurnal tides, or two high and two low tides daily. Spring tides can cause over two meters of exchange, while neap tides may cause as little as ½ meter of exchange. Over millions of years, tidal currents have also been one of the factors that have helped shape the physical structure of coral reefs around the archipelago.

3.4 ENSO Events

The El Niño-Southern Oscillation (ENSO) phenomenon is an ocean-atmosphere circulation that affects Palau significantly on a regular basis. During an El Niño year, Palau generally experiences drought conditions that last from weeks to months, and the country must ration fresh water use. Since little irrigation is done in Palau the agricultural sector absolutely depends on regular rainfall. Also, since the rocky limestone substrate of many islands has limited water storage capacity, plants – and the animals which depend on them – become stressed during drought.

During and after the 1997-98 El Niño/La Niña Palau not only experienced a severe drought, but also a significant rise in sea water temperature (Bruno et al., 2001). Over several weeks during August and September of 1998, sea surface temperatures exceeded 30 C (CRRF, unpublished data). The unusually warm water caused widespread coral bleaching. While there has been some recovery, the impact of this bleaching event is still in evidence to this day.

3.5 History

The date of first human arrival to the Palauan islands is not known, though pottery uncovered in Babeldaob has been carbon dated to about 4,000 years ago. The first foreign contact of significance occurred in 1783, with the shipwreck of the vessel Antelope under the command of English Captain Henry Wilson. Foreign governance of the Palau Islands officially began when Pope Leo XIII asserted Spain's rights over the Caroline Islands in 1885. In 1899, Spain sold the Caroline Islands to Germany after Spain's defeat in the Spanish American War. Under German administration, three major economic industries were developed: phosphate and bauxite mining in Angaur and Babeldaob, respectively; and copra production.

At the outbreak of World War I in 1914, the Japanese government assumed control over Palau. The League of Nations officially gave Japan control over Micronesia, including Palau, in 1920, as a League of Nations Mandate. In 1922, Koror Island in Palau became the administrative center for all Japanese possessions in the tropical Pacific. While the total population reached a high of approximately 40,000 people, the native Palauan population declined to fewer than 10 percent of the total. During the 1920's and 1930's, Japan further developed the phosphate mining industry, and expanded agriculture and fish exports. Many hundreds of Palauans were relocated from their original homelands. In the late 1930's, Japan began fortifying the islands in preparation for war.

The island of Peleliu was the scene of some of the heaviest fighting during World War II, with several thousand Japanese and American soldiers killed. The entire population of Palau suffered from lack of food and other resources during the last year of the War. The landscape was destroyed by intensive bombing in many places, especially on Peleliu, around Koror's harbors and on Babeldaob Island.

In 1947, following World War II, Palau became one of six island districts as part of the United Nations Trust Territory of the Pacific Islands under the administration of the United States. In a 1978 plebiscite, after thirty years as a United Nations Trust Territory, Palauans decided to become independent, rather than join the Federated States of Micronesia. After fifteen years of negotiations and several plebiscites, a Compact of Free Association with the United States was ratified by the Olbiil era Kelulau (Palau National Congress) in 1993. The Compact of Free Association, establishing Palau as an independent nation, entered into force on 1 October 1994. The Republic of Palau was admitted to the United Nations on 15 December 1994, and has since become a Party to a number of international conventions and agreements.

3.6 Population

Palau's current population is 19,129 with an annual growth rate of 2.3 percent (Office of Planning and Statistics 2000), largely due to immigration of foreign workers from Philippines,

Taiwan and other countries. Seventy percent of the population is Palauan and 30 percent are non-Palauans (Census 2000). The great majority (≈70%) of the population resides in Koror, the most urbanized area in the country. Much smaller numbers of people live in villages throughout the rest of the archipelago, although population shifts are expected to occur as development spreads to more remote areas in the next few years. The Southwest Islands host a resident population of only 60 people. The remainder of people originating from these islands now mostly reside in Koror.

3.6.1 Socio-Cultural Characteristics

Due to linguistic similarities, it is generally believed that the islands of Palau were first settled by people migrating from the islands of Southeast Asia and Indonesia around 2,500 BC (Barbour, 1996). There is also evidence of early migration of Melanesians, from New Guinea, and Polynesians to Palau (BNM, 2001). Radiocarbon dating of the oldest known village sites located in the Rock Islands and the terraces of Babeldaob date to about 2000 BP (before present) (Kirch 2000). Some recent paleoenvironmental evidence suggests that people may have been living on Babeldaob as early as 4,200 BP, however, there is no direct archeological evidence to support this claim (Kirch, 2000).

The Southwest Islands of Palau are inhabited by a minority population, who have a unique culture and speak a different language from that of the majority, ethnic Palauan, population. The languages and cultures of the people of Sonsorol and Hatohobei States are considered to be more closely related to those of the atoll-dwelling peoples of Yap and Chuuk States in the Federated States of Micronesia.

3.7 Tradition

At the time of the first foreign contact in 1783, Palau had a sophisticated and highly organized social system. The matrilineal civilization was based on clans and chiefdoms, and these traditions are still carried on in modern Palauan society. Originally, Palauan villages were situated away from the coast, with piers on waterways leading to the reef-protected tidal flats. Villages were organized by clanships through the female line and subdivided into two political moieties (complementary subdivisions) (BNM, 2001). Councils of chiefs from the ten ranking clans of the community governed the villages and often managed and controlled uses of local resources. Women had an important advisory role and were particularly influential in the control of land and money.

There were three major facets to traditional Palauan culture: prestige orientation; competition between individuals and clans; and reciprocity and the manipulation of gifts, money, goods, and services. Kinship was the major determinant of social behavior, and each individual in Palauan society, from the moment of birth, had a definite rank in the family, clan, and village. This rank was based on family background and clan ranking, but achievement through individual merit was possible and enthusiastically sought.

3.8 Social System

Present day society in Palau is a complex blend of old traditions and modern concepts. Palauan society has maintained many of its traditional values, but life has changed dramatically with the introduction of new technology and currency. Koror, the provisional capitol of Palau, has paved roads, modern stores, and most people live an urbanized lifestyle. Every residential and commercial structure in Koror State has access to electricity, piped water, and telecommunications, but not all are connected to sewer.

The central importance of land and money as the root of wealth and power within Palauan society has not diminished with the various foreign occupations of Palau. Land, for the most part, is considered to be owned by an entire clan and the national Constitution prohibits foreign ownership of land. The exchange of bead-like money and turtle shell trays is still actively used in inter-clan payments for important events such as birth, marriage, divorce, and death. Although Palauan money is used today for ceremonial purposes, land and other commodities are typically purchased using Palau's current means of economic exchange, the U.S. Dollar.

3.9 Transportation

Palau currently has 61 kilometers of roads, with 36 kilometers of paved road (CIP, 2002). With the completion of the 85-kilometer "Compact Road" around the island of Babeldaob in 2005, Palau's highway system will be more than doubled in length.

The major seaport, Malakal Harbor, is located on the island of Malakal in Koror State, the provisional national capitol. At present, the country has three airports, but only the Palau International Airport located in Airai State, is open for international flights. The Palau International Airport terminal building was recently expanded to accommodate additional flights.

Over the past two decades, the number of cars in Palau has increased at a rate of nearly 300 vehicles per year (MoA, 2000). Importation of car parts and accessories, appliances, and prepackaged goods has nearly tripled in the past decade. Currently, only car batteries are reclaimed by the Environmental Quality Protection Board (EQPB) and stored for periodic shipment out of Palau for recycling. Currently one beverage (aluminum) can recycling operation exists in Palau, collecting and baling cans for shipment to a recycling plant.

3.10 Energy Sector

Palau has one public utilities corporation, the Palau Public Utilities Corporation (PPUC), that is responsible for supply of electrical services to all the inhabited islands. Two diesel burning power plants supply this electricity to Koror and parts of Babeldaob Island. Generators are used to supply power to the more remote islands of Kayangel, Peleliu, and Angaur. The isolated Southwest Islands of Sonsorol, Pulo Ana, and Merir in Sonsorol State, and the island of Tobi in Hatohobei State, are served by household solar power units. The PPUC is exploring alternative energy options as a more cost-effective means to provide energy to the more isolated islands of Palau.

There are two major oil companies in Palau. Both Shell Oil and Mobil Micronesia store fuel near Malakal Harbor and provide bunkering services to various airlines and international fishing vessels. Additionally, three private companies provide Liquid Petroleum Gas (LPG), which is widely used for domestic and commercial cooking.

3.11 Freshwater Resources

The primary source of fresh water in Palau is from rainfall. Groundwater is found in Palau, though the groundwater lens is thought to be fairly thin and most water pumped from the ground is non-potable. The majority of freshwater in Palau's municipal water systems is surface water.

The Ngerikiil River watershed, located in southeastern Babeldaob, is the main source of water for Palau's population, supplying 4 million gallons of water each day to residents of Koror and Airai States. These watershed areas are highly valued due to the freshwater that is collected here. They are also ecologically valuable, supporting wetland vegetation, freshwater species of fishes and invertebrates, nesting birds, and crocodile breeding areas. Lake Ngardok in Melekeok State on the island of Babeldaob is the largest lake in Micronesia, with an area of approximately 0.18 square km. The longest river in Palau, the Ngerdorch River, drains from Lake Ngardok and flows 10 km to its mouth in Ngchesar State on the east coast of Babeldaob. The Ngermeskang River is the second longest river in Palau, and drains Ngermeduu, the largest watershed in Palau, on the west coast of Babeldaob.

3.12 Health

Palau has a comprehensive national health care system. Basic public health and medical care is available at the Palau National Hospital. The Bureau of Public Health also serves the outlying states with seven satellite medical facilities. Two additional private medical clinics also provide comprehensive health care. Palau also has a well-developed health care referral program to hospitals in the Philippines, Guam, and Hawai'i for advanced care not available in Palau.

3.13 Economy

As with many small island countries, Palau faces many economic constraints deriving from geographic isolation, a small domestic market, lack of adequate infrastructure, high vulnerability to external and natural stresses, and a narrow resource base in terms of its natural, financial, and human assets.

Due to its past status as a UN Trust Territory under United States administration, Palau's currency is based on the US Dollar. Palau's main income sources are from the Compact of Free Association (the Compact) payments, tourism, trade, fishing and agriculture, and services mainly derived from the public sector (BOH, 2000). The Compact payments, which are scheduled to end in 2009, constitute the largest income for the Republic.

3.13.1 Compact of Free Association

The Compact of Free Association (the Compact) is a 50-year political, strategic, and economic treaty between the Republic of Palau and the United States. Under the Compact, Palau conducts

its own domestic and foreign affairs as any sovereign nation, while the United States has control of defense and security matters, as well as exclusive strategic access to Palau's waterways. In return for this access, the United States agreed to pay the Republic approximately US$ 630 million during the first 15 years of the Compact (1994-2009). However, this sum is not completely monetary, but is a combination of economic and technical support. To date, over half of the Compact payments have already been paid to the Republic.

3.13.2 Import Dependency

Palau imports all its energy generating requirements. In 1999/2000, there was a sharp increase in imports, reaching nearly 110 percent of GDP. This sharp increase was primarily due to capital improvement goods such as metal products, machinery, and equipment (IMF, 2002). Imports of fuel, food, and beverages together accounted for 28 percent of total imports. This figure also increased to about 45 percent during 1999/2000. Imports were estimated to have declined by about 25 percent in 2000/2001, as imports of construction-related materials declined.

In comparison to imports, Palau's exports account for about 15 – 20 percent of GDP, consisting mostly of fish (sashimi-grade tuna).

3.14 Tourism

Currently the main industry in Palau is tourism. From 1992 to 1997, tourist arrivals doubled from nearly 30,000 to 60,000. However, due to several factors, including an economic downturn in Asia and coral bleaching, Palau's tourism numbers declined in 1998, and this fall-off in tourism continued through 2000. Recovery began in 2001, and tourist arrivals in 2004 were the highest ever. With the increasing numbers of visitors, however, potential over-dependence of the economy on tourism, and the potential negative impacts of increasing numbers of tourists on biodiversity, especially coral reefs, are cause for concern.

3.15 Good Governance

The Republic of Palau is governed by three branches: an executive branch; a legislative branch; and a judicial branch. In addition, the President is advised by a council of traditional chiefs. The Executive Branch consists of the President, Vice President, and eight appointed Ministers. The eight ministries are: Commerce and Trade; Community and Cultural Affairs; Education; Finance; Health; Justice; Resources and Development; and State. The legislative branch consists of a Senate with nine members and a House of Delegates with sixteen members, one representing each State. The council of traditional chiefs consists of the highest-ranking chiefs from each of the sixteen States.

The sixteen States are governed by elected chief executives, and Legislatures comprised of both elected and traditional representatives. Each village within Palau has a traditional council of leaders who are entrusted with the overall welfare of their communities. This unique combination of traditional and modern governance has enabled Palau to build upon centuries of knowledge and values while moving forward within a global society.

The Republic entered into a 50 year Compact of Free Association with the United States, with funding that will end on Oct 1, 2009. This Compact has provided financial and technical support to build Palau's infrastructure and expand and diversify its economic base. Financial and technical support from nations and regional and international organizations such as the Secretariat of Pacific Communities, the United States, Japan, Taiwan, China, the European Union, and many others continues to advance Palau's technical and human capacity.

Palau has taken a leading role in the international community to ensure that the concerns and needs of the Pacific Island Nations are addressed. The Republic's commitment to traditional values and sustainable principles has enabled successful implementation of sound domestic and foreign policies creating a stable, peaceful nation with a vibrant economy.

4. DESCRIPTION OF BIODIVERSITY IN PALAU

4.1 Terrestrial Biodiversity

4.1.1 Overview

Though the rich terrestrial biodiversity of Palau is yet to be fully documented, it is estimated to include more than 7,000 species: 130 fungi (McKenzie, 1990), a projected 5,000 insects (BNM, 2004), 92 snails (Smith, 1993, Thompson, 1997), 46 reptiles and amphibians (Crombie, 1999, Smith, 2001), 47 freshwater fish (Jenkins, 1999) and 141 birds (Engbring,1988). The native mammals are made up of two bat species, both of which are endemic sub-species. Over 1,200 species of plants are found in Palau, including approximately 200 endemic plants with at least 46 trees, 26 shrubs, 47 herbaceous small plants, 11 vines, 11 ferns, 23 orchids, and many other plants (BoA and Raulerson, 2004). Table 1 gives a summary of terrestrial biodiversity in Palau.

Table 1 Terrestrial Biodiversity in Palau

Species	**Approx. Total**	**Endemic**	**Introduced**	**Endangered**
Plants	1,200	163	Unknown	Unknown
Fungi (not including lichen-forming fungi)	130	Unknown	Unknown	Unknown
Mangrove species	18			Unknown
Insects	5,000	1,500	Unknown	Unknown
Birds	141	9-12	4	1
Freshwater fish	47	4	5	Unknown
Terrestrial snails	77	32	2	Unknown
Freshwater mollusk	15	Unknown	Unknown	Unknown
Amphibians & Reptiles	46	12	3-5	5
Frogs	2	1	1	Unknown
Lizards	30	9	2	Unknown
Snakes (including 2 sea snakes)	7	2		Unknown
Turtles (including 4 sea turtles)	6		*2?*	*4*
Crocodiles	1	1		1
Bats (endemic sub-species)	2	2		

4.1.2 Major Terrestrial Ecosystems

4.1.2.1 Forests

While all of Palau may have been covered by forest at one time, at present approximately 75 percent of Palau is covered in native forest (Cole, 1987). With probably more than 1200 species of plants, Palau's forests are the most species-diverse in Micronesia. A wide range of plant and animal species rely on these native forests for their survival. In addition to their direct biodiversity values the forests provide vital services that help to maintain the health and ecological integrity of all of the terrestrial and marine ecosystems (e.g. sediment trapping, climate stability, nurseries for reef fish, soil production and conservation, etc.).

Table 2 below shows the major forest types in Palau, based on vegetation maps derived from 1976 aerial photography.

Table 2 Major Forest Types in Palau

Forest Type	Hectares	percent of natural forest cover
Upland (volcanic) forest	21,891	70
Mangroves	4,708	15
Swamp forest	1,680	5
Limestone forest	1,232	4
Rock Island forest	1,116	4
Casuarina forest	451	1
Atoll, plantation, palm forest	182	<1
Total Forest Cover	***31,259***	***100***
Agroforest	1,109	-

Since 1976 there has been some additional clearing of forests, mainly in southern Babeldaob, but also some regeneration of forest in previously cleared savanna areas. For most of Babeldaob, rates of forest loss are unknown due to a lack of updated maps and records.

Babeldaob island is home to the greatest area of upland volcanic forest in Palau. These forests are the most extensive and species diverse in Micronesia and include many endemic species. Information gaps and further research requirements include basic survey and taxonomy of species present and intensive field surveys to determine forest subtypes, including the habitat of rare and uncommon species such as *Parkia parvifoliola*.

Forests found on the coral islands of Peleliu and Angaur are described as limestone forest, while the Rock Islands are home to a specific kind of limestone forest known as Rock Island forest. While many of the species found in the upland forests of Palau are also found in limestone forests, there is also a set of species shared with the limestone islands of the Marianas as well as a species set endemic to Palau. Being less accessible and quite diverse, the flora of the Rock Islands is less well known and in need of documentation. Palau's Rock Islands provide a diversity of conditions in a relatively small geographic area; studies of the distribution of species on these islands could contribute to our understanding of the requirements of different plant and animal species.

4.1.2.2 Grassland/Savanna

The 1976 vegetation map of Palau categorizes wild areas without a continuous tree canopy as savanna. This category includes areas of: predominantly bare soil, fern lands, grasslands, and savanna shrub lands. Much of this open land results from human activities such as land clearing, repeated burning, and mining. Some areas dominated by grass are lands that were formerly cultivated. Savanna shrub lands, however, support a variety of native and even some endemic plant species, including many important for traditional healing and ceremonies. Some of these species are found only in savannas. Another set of plant species have the potential to grow into large forest trees under favorable conditions, but are also adapted to savanna conditions and can mature, flower, and fruit as shrubs.

4.1.2.3 Fresh water streams and lakes

Approximately 47 species of freshwater fish inhabit the streams of Babeldaob, all of them spending part of their life cycle in saltwater habitats (Jenkins, 1999). Saltwater crocodiles also use the streams as corridors between nesting and feeding sites.

Lake Ngardok and Ngerkall Pond are the two main natural bodies of fresh water located on Babeldaob. These are important breeding grounds for many of Palau's birds and animals, including the endangered saltwater crocodile.

4.1.2.4 Freshwater Wetlands

Freshwater marshes occur slightly above sea level and are surrounded by mangroves, or are located in depressions in upland areas. The vegetation in these areas may include tall reeds, especially *Phragmites karka*, sedges, and other taller herbaceous growth. Where the water is somewhat brackish, the fern *Acrostichum aureum* may be present. There are also many freshwater marshes cultivated for taro and here the edible vine *Ipomoea aquatica* may be found.

Palau's swamp forests are the most diverse in Micronesia, but are also Palau's most limited forest type in terms of area, making up only two percent of the forest and one percent of Palau's land area (Cole, 1987). Swamp forests and marsh provide important ecological services. They provide critical habitat for at least five resident birds and several migratory species. They also provide an important buffer of freshwater for mangroves to rely on, especially during times of drought. Swamp forests are particularly vulnerable to siltation resulting from road building activity, and to clearing for taro patches.

4.1.2.5 Mangroves

One of the most significant ecosystems found in Palau are the mangrove forests. Mangroves are the transition zone between terrestrial and marine ecosystems, and it is difficult to know whether it is best to describe them as terrestrial or marine habitats. For the purposes of this report, mangroves are included in the terrestrial description, but it must be understood that many marine species depend on the mangroves, spending part of their life cycles there, moving in and out with the tides, etc. Mangroves cover over 48 km^2 of Palau, accounting for approximately 11 percent

of the vegetation (Crombie and Pregill, 1999). The most extensive areas of mangrove forests occur along the west coast of the big island, Babeldaob, covering approximately 80 percent of the shoreline. There are 18 mangrove trees and associated plant species found in the mangrove habitats of Palau, making them the most diverse in Micronesia (Metz, 2000). Seventeen of these species have traditional uses including medicines, building materials, and handicrafts (Duke, 1999). The most common species are in the genera: *Rhizophora, Avicennia, Bruguiera, Ceriops, Nypa,* and *Sonneratia*. Mangrove tree species that are locally common in limited areas in Palau and uncommon or absent elsewhere include: *Ceriops tagal* and *Avicennia alba,* and Palau is the only place in Micronesia where the "mangrove holly," *Acanthus ebracteatus* occurs. Palau's mangroves include many epiphytes and other associates not found in other parts of Micronesia.

Palau's mangroves are well developed along the west coast of Babeldaob, especially around Ngermeduu bay where the transition from mangrove to riverine and swamp forest from the bay up the Ngermeskang river is spectacular. Groves of *Avicennia* are especially well developed along the northeast coast of Babeldaob. Mangroves growing around marine lakes are well protected from wave action and high tidal variation, creating roots and branches covered in diverse epifauna, including invertebrates with a high potential for endemism.

Mangroves are ecologically important because they help stabilize coastal areas by trapping and holding sediments washed down from inland areas and local watersheds. Many species of reef fishes, including: *Carcharhinus melanopterus* (blacktip reef shark), *Apogon* spp. (cardinalfish), *Gerres* spp. (mojarras), *Parupeneus* spp. (goatfish), and *Siganus* sp. (rabbitfish), use mangroves for foraging and shelter at some point in their life histories. In addition, mangroves provide habitat for Micronesia's only resident population of saltwater crocodiles (*Crocodylus porosus*), as well as for numerous resident and migratory bird species. Invertebrates, such as the economically valuable mangrove crab, *Scylla serrata*, and mangrove clams, *Anodonita* spp., *Polymeseda* spp., and *Terebralia* spp., are caught or gleaned from this ecosystem for semi-subsistence uses.

4.1.3 Terrestrial Species

4.1.3.1 Birds

Birds can be found in all of Palau's habitats, from the upland forests of Babeldaob to the open ocean outside of its barrier reef. One bird species, the Island Swiftlet (*Aerodramus vanikorensis*), even inhabits Palau's many caves and uses a form of echolocation to navigate their inner chambers. Palau's rich avifauna ranges from Ngeruangel Atoll in the north, to Helen Reef of the Southwest Islands, with several interesting differences in distribution in between. Befitting their mobile nature, most of Palau's bird species utilize a suite of different habitat types, linking ecosystems together and performing seed dispersal and insect removal services, free of charge.

Palau has the most diverse avifauna in Micronesia, with 141 species recorded so far. Of these, 50 are considered to be residents of Palau, with 36 land or wetland species and 14 nesting shorebird species (Engbring, 1988). . Four of these species have been introduced, one of which, the Greater Sulphur-Crested Cockatoo (*Cacatua galerita*), is considered to be a pest. This leaves 91 species of vagrant birds, recorded as they were passing through on their migratory routes or perhaps blown off course by tropical winds. Due to Palau's location in between Australasia and

Eastern Asia, any of the species that migrates between these two regions can reasonably be expected to be sighted in Palau sooner or later.

Of Palau's 50 resident species of birds, 9 are classified as endemic to Palau. All of Palau's endemic bird species are forest dwellers. One species, the Palau Giant White Eye (*Megazosterops palauensis),* can only be found on the islands of Ngeruktabel and Peleliu. All of the other endemic species can be found from Babeldaob to Angaur, but the Palau Ground Dove (*Gallicolumba califrons*), is reported to be very rare outside of the Rock Islands.

Table 3 Endemic Birds of Palau

Common Name	**Scientific Name**	**Palauan Name**
Palau Greater White-eye	*Megazosterops palauensis*	Charmbedel
Palau Morningbird	*Pitohui tenebrosa*	Tutau
Palau Fantail	*Rhipidura lepida*	Melimdelebteb
Palau Flycatcher	*Myiagra erythril-ops*	Charmelachull
Palau Bush-Warbler	*Cettia annae*	Wuul
Palau Owl	*Pyrroglaux podargina*	Chesuch
Palau Fruit-Dove	*Ptilinopus pelewensis*	Biib
Palau Ground-Dove	*Gallicolumba canifrons*	Omekrengukl
Dusky White Eye	*Zosterops semperi*	Chetitalial

Palau's only globally recognized endangered bird species is the Micronesian Megapode (*Megapodius laperouse*), whose range is limited to Palau and several of the Mariana Islands. In the Marianas it is thought to have been extirpated from Guam and Rota, while small populations continue to exist on some of the northern islands. In Palau it ranges from Kayangel Atoll to Angaur, and is considered to be most abundant on the non-inhabited islands of Kayangel and the Rock Islands. It is considered to be rare to uncommon on Babeldaob, Peleliu, and Angaur. Historically Palauans collected megapode eggs for food, but it is thought that presently this happens at low enough levels to not threaten the local population. Feral dogs, cats, and rats are considered to be potential threats to megapodes, while monitor lizards are known to prey on them and their eggs. The brown tree snake is also known to have helped extinguish the megapode and other bird populations on Guam, and its introduction to Palau would be disastrous to megapodes, as well as most of the other bird species here

Many of Palau's resident bird species are considered to be uncommon to rare, especially the wetland species which depend heavily on Palau's limited freshwater wetlands and taro patches. These include the Gray Duck (*Anas superciliosa*), the Common Moorhen (*Gallinula chloropsis*), the Purple Swamphen (*Porphyrio porphyrio*), the Slaty-Legged Crake (*Rallina eurizonoides*) and the White-Browed Crake (*Porzana cinerea*). Most of Palau's resident shorebirds are common and widespread throughout the archipelago, but the Great Crested Tern (*Sterna bergii*) is only known to nest within Palau on Ngeruangel Atoll and Helen Reef. The White-Breasted Woodswallow (*Artamus leucorhynchus*) is considered to be possibly the rarest resident bird in Palau, and is thought to be restricted to Palau's savannas, although it has been reported that they also utilize several marine lakes. All of these birds have rather large distributions outside of Palau.

4.1.3.2 Insects and Related Arthropods

Insects and related arthropods (spiders, scorpions, mites, etc.) have colonized and adapted to every habitat type in Palau. They are abundant in Palau's forests, savannas, wetlands and agricultural fields. Aquatic insects swim in Palau's inland waters and specialized cavernicolous insects inhabit Palau's caves. Insect life flourishes in the mangrove forests, estuaries and shore strands. Even the coastal waters and open ocean surrounding Palau support marine insects that live their entire lives at sea.

Palau's diverse fauna of insects and their kin encompasses 31 major groups of arthropods with a richness estimated at 5,000 species or more (BNM, 2004). Over 1,200 of these species have been described and catalogued with new discoveries happening on a regular basis. Most recently, a new complex of 19 endemic species of weevils (*Lophothetes* spp.) was discovered on Babeldaob Island (Cowrie et al 1996). Although much of Palau's insect diversity is still undescribed, it is apparent that insect diversity in Palau is comparable to the diversity of its plant and marine life.

Over 300 of the 1,200 known species of Palauan insects are endemic species found only in Palau. Based on the observed rate of endemism (25 percent) of known species, Palau is estimated to have a total of 1,500 endemic insects and related arthropods. Unusual Palauan endemics include two species of cicadas, a firefly, a mantis, a bat fly, a horse fly, and a march fly. The horse fly, *Tabanus palauensis*, is the only native horse fly in Micronesia and the march fly, *Plecia palauensis*, is the only member of its Family (Bibionidae) to occur in Oceania. Palau is also home to an endemic pauropod, a rare and primitive type of arthropod that vaguely resembles a tiny centipede.

Palau has a number of other unusual arthropods that merit attention because they are considered rare worldwide. One of Palau's arthropods, a short-tailed whipscorpion, is so rare that only 200 species are known from the order (Schizomoda) worldwide. Among the Palauan rarities are a pygmy mole cricket, a gnat bug, the only kelp fly from Micronesia, and a diversity of specialized cave-dwelling arthropods including a tailless whipscorpion, a cave cricket, and a cave midge. Perhaps the most unusual of Palau's insects are the marine insects that inhabit the ocean surrounding Palau. The coastal waters and open ocean around Palau harbor two genera and numerous species of sea skaters, a type of marine insect found only in the Indian Ocean and western Pacific Ocean. The reef midge, *Pontomyia oceana*, is found only in the coral reefs off Palau and Queensland.

Although insect diversity is valuable *per se*, insects are also important to the preservation of all biodiversity through the roles these tiny animals, play in the web of life as pollinators, recyclers, food sources for other animals and cultural icons. It can be said that without insects, most of Palau's, and the world's, terrestrial biodiversity would become rare or extinct.

4.1.3.3 Herpetofauna (Reptiles and Amphibians)

Palau has 42 species of reptiles and two species of amphibians (Crombie, 1999, Smith, 2001). There are isolated, anecdotal reports of two additional introduced species of freshwater turtles

but no concrete evidence that either of these species has established a breeding population in Palau. Among the native Palauan reptiles are four species of sea turtles, seven snake species, 30 lizard species and one species of crocodile. One of the lizard species is known from skeletal remains only. The two Palauan amphibians are an introduced toad and an endemic frog. The 44 species of herpetofauna are distributed among fourteen taxonomic families. Two amphibian families, five lizard families, five snake families, one marine turtle family and one crocodile family are represented in Palau.

The Palauan frog, *Platymantis pelewensis*, is the only endemic amphibian in Palau. The other amphibian is the introduced cane toad, *Bufo marinus*. There are no salamanders in Palau. The Palauan blind snake and the Palau Bevelnosed Boa (2 endemic sub-species) are endemic to Palau, while the remaining native snakes are not endemic to Palau but enjoy a wider distribution in the Australasian and Oceanian regions. The most diverse group of Palauan reptiles is the lizard group (Sauria) with 30 species including at least 9 endemic species. Two more of the thirty lizard species are categorized as "Pacific insular endemics" that are found only in the islands of the Pacific Ocean. At least two lizards, the American anole and the monitor lizard, are considered recent introductions, and the monitor lizard is now considered a pest.

The Palauan frog is unusual in that very few endemic frogs are known from small island countries. Its closest relatives are found in New Guinea and the Philippines. Two of Palau's endemic lizards are seemingly rare; the Palauan pandanus skink is known only from leaf axils of pandanus trees, and one endemic gecko species is known from only two islets in the Ngerukeuid Reserve. One Pacific insular endemic lizard is found only in the Southwest islands in Palau, but also occurs in other islands across the Pacific.

4.1.3.4 Bats

Palau's two native species of mammals are both bats and both are sub-species endemic to Palau. The Palauan sub-species of the Mariana's fruit bat (*Pteropus mariannus pelewensis)* seems to be unique in that it does not form very large roosting colonies, as the other sub-species do. There are reports of a few roosts of several hundred individuals in the limestone islands south of Airai state as well as a few other sites in Babeldaob and in the Rock Islands. However, it seems that most of Palau's fruit bats roost solitarily or in small colonies of less than 30-50 bats. The fruit bats are thought to play a very important role in seed dispersal within Palau's forests, especially because they are known to fly rather long distances between their roosting and feeding sites. They are known to feed on fruits from at least 54 plant species, flowers from 28 species, and leaves from one species of plants (Wiles and Engbring, 1997). These bats are relished as a delicacy by many Pacific islanders, but despite heavy hunting and commercial export over the past forty years, their population still appears to be relatively stable.

The Palauan sub-species of the Sheath-tailed Bat (*Emballanura semicaudata palauensis*) roosts in caves throughout the Palau archipelago, and is an important insectivore. It is active mainly and night and appears to be abundant throughout Palau, although a formal census of its population has never been conducted.

4.2 Marine Biodiversity

4.2.1 Overview

The Republic of Palau is probably best known for its remarkably high marine biodiversity. This diversity is the result of a wide variety of marine habitats in a relatively small geographic area. Numerous marine ecosystems exist within Palau and include coral reefs (i.e. fringing reefs, patch reefs, barrier reefs), seagrass beds, and marine lakes. Consequently, the diversity of marine organisms and their assemblages in Palau are high: it has been estimated that well over 10,000 marine species live in Palauan waters. However, only two major groups of marine organisms can be considered well-studied in Palau, the scleractinian corals and reef fishes. This leaves virtually all other marine phyla in Palau as incomplete. Table 4 gives a summary of marine biodiversity in Palau.

Table 4 Marine Biodiversity in Palau

Species	Approx. Total	Endemic	Introduced	Endangered
Marine invertebrates	Unknown			
Scleractinia (Hard corals)	400			
Other Cnidarians	>200		2	
Sponges	>300			
Crustaceans	>249			
Ascidians	>100		18	
Molluscs	>2000			
Marine worms	>70			
Seagrass	10			
Marine fishes	>1,387	?		
Sharks	19			
Marine mammals	Unknown			
Whales	>11			
Dugong	1			*1*
Marine Reptiles	7			
Sea turtles	4			*4*
Sea Snakes	2			
Crocodiles	1			1
Marine algae	259			
Marine microorganisms	Unknown			
Deep sea organisms	Unknown			

4.2.2 Major Marine Ecosystems

4.2.2.1 Coral Reefs

Palau has numerous reef types, including barrier, fringing, patch, and atoll reefs. The most recent measurements by the Palau Automated Land Resource Information System (PALARIS) show that coral reefs cover an approximate area of 821.9 km^2, and enclose a lagoon area of 1136.5 km^2. Palau's main archipelago has an extensive barrier reef system totaling approximately 260 km in length. A well-developed barrier reef exists on the west coast of Palau, measuring approximately 170 km in length.

Palau also has three atolls. Two of them (Kayangel and Ngeruangel) are found in the northern part of the Republic, near the main Palauan archipelago, while the third (Helen Reef) is approximately 500 km southwest of the main islands. Kayangel and Helen Reef are considered classic atolls. Ngeruangel, on the other hand, is a structure that appears to be an atoll, but it is really the southern end of a much larger "sunken" atoll, Velasco Reef. Most of Velasco Reef is "sunken" in the sense that the shallow reef comes only to within about 10-20 m of the surface, and the Ngeruangel portion is the only exposed reef.

The Palauan coral reef ecosystems have the most diverse flora and fauna of Micronesia, and Palau has one of the highest densities of tropical marine habitats in a comparable geographic area found anywhere in the world. One reason for this high level of marine biodiversity is Palau's considerable amount of reef area for a relatively small geographic area. Another reason for the high diversity is Palau's low latitude and close geographic proximity to the area called "the Coral Triangle". This area contains the Philippines, Indonesia, Papua New Guinea and eastern Malaysia, and has the highest diversity of shallow-water marine species in the world. Palau's marine biodiversity consists mainly of subsets of species found within the Coral Triangle (Colin, 2004).

4.2.2.2 Seagrass Beds

Palau contains some of the most extensive seagrass beds in all of Micronesia. Ten species of seagrass occur in Palau (Table 5) (Tsuda *et al.* 1977; McMillan, 1980; Coles and Kuo, 1995) out of the approximately 60 species of seagrass that occur worldwide (Short *et al.* 2001). Seagrasses are valuable, but often-overlooked habitats, that provide important ecological components of coastal ecosystems worldwide (Green and Short, 2003). Seagrasses provide a number of ecological functions, and are especially important as nurseries for juvenile fish, and as food and shelter for juvenile fishes, invertebrates, sea turtles, and dugongs. In addition, seagrass beds assist in sediment accumulation and stabilization.

Table 5 Species of seagrasses recorded from Palau

Species	**Depth**
Enhalis acoroides	Shallow
Thalassia hemprichii	Shallow to moderate
Halophila minor	Moderate to Deep
H. ovalis	Moderate to deep
Halodule uninervis	Shallow
H. pinifolia	Shallow
Cymodocea serrulata	Shallow
C. rotundata	Shallow
Syringodium isoetifolium	Shallow
Thalassodendron ciliatum	Shallow to deep

Most of Palau's 10 species of seagrass are widely distributed throughout the main archipelago. *Thalassia hemprichii* and *Enhalus acroides* are the most abundant and dominant species of

seagrasses in Palau. They serve as the main food source for herbivorous fishes, sea turtles, and dugongs. The three species, *Halophila minor*, *Thalassodendron ciliatum (*found only in Kayangel Atoll*),* and *Thalassodendron ciliatum*, have extremely limited distribution in Palau (Ogden and Ogden, 1982). Seagrass beds are important habitat for fish (rabbitfish aggregations, juvenile wrasses and parrotfish, pipefish, and invertebrates (sea cucumbers, molluscs).

Further research is required to learn about the species distribution, community structure, effects of climate change, and reproduction of seagrasses in Palau. Most studies to date have been site-specific and several areas in Palau are lacking qualitative and quantitative data necessary to incorporate these ecosystems into marine and coastal management plans.

4.2.2.3 Marine Lakes

Some of the most unusual ecosystems found in Palau are the marine lakes. A marine lake can simply be described as a "large body of seawater entirely surrounded by land" (Dawson and Hamner, in press). For the purposes of this section, as many as 70 bodies of water in Palau have been identified as marine lakes. This number includes both completely enclosed marine lakes, as well as those that are partially open to seawater through channels or tunnels, a somewhat looser definition than the one above.

Each of these lakes is isolated and distinct from the next, some being connected to the lagoon with tunnels and narrow channels, while others are more isolated and completely enclosed by limestone islands and have little water exchange with the lagoon. All the marine lakes rise and fall to some extent with the tide, evidence of their connection with lagoon water. A basic distinction can be made between marine lakes in Palau: those that are stratified vertically (meromictic) and those that are mixed throughout the water column (holomictic). Meromictic lakes remain permanently stratified from top to bottom due to density differences and lack of mechanisms to overturn the water column (e.g. wind, currents) (Hamner and Hamner, 1998)

Most of the lakes have extensive invertebrate and algal communities along their edges. The mix of species in any given lake often produces unusual communities (Colin, 2004). There are a few lakes popularly known as the Jellyfish Lakes. Each of these lakes contains millions of jellyfish from two species of Scyphozoan: *Mastigias sp.* and *Aurelia aurita*. The *Mastigias sp.* contain zooxanthellae, which photosynthesize to produce food for the jellyfish.

There have been numerous studies conducted in marine lakes, particularly the jellyfish lakes (Hamner and Hamner, 1998; CRRF unpublished data). However, more extensive research within these lakes is necessary to learn more about what actually occurs in them. It is, however, certain that among the lakes the particular biological communities that occur in them vary greatly. The marine lakes provide a natural laboratory where many scientific questions of ecology, evolution, and oceanography can be addressed in a more controlled manner than in the open ocean.

4.2.2.4 Open Ocean (EEZ)

Very little data are available on the marine biodiversity in the open ocean area surrounding Palau, aside from fishery catch data. Palau's exclusive fishing zone is 24 nautical miles, with a 200 nautical mile extended fishing zone, which encloses an area of approximately 600,900 km^2.

Much work is needed in this area, and there is a critical need for regional cooperation on research and management of highly migratory fish species.

4.2.3 Marine Species

4.2.3.1 Hard Corals

Of all the marine invertebrates in Palau, the stony or hard corals (Scleractinia) are the best known, although there is no comprehensive species list for Palau to date. The actual number of stony corals in Palau is not presently known, but is estimated to be around 400 species. Maragos et al. (1994b) estimated Palau's coral diversity at 425 species belonging to 78 genera, while Randall (1995) reported a lower number of coral species for Palau at 385 species belonging to 66 genera. Maragos' estimation included observations and a species list, while Randall's estimation was based on collections and specimens. Randall noted that greater collecting efforts in Palau are expected to reveal more species since only a relatively small percentage of coral habitats were surveyed. Certainly the coral fauna of Palau is one of the most diverse in the world; however, there are no endemic corals reported from Palau. Documentation of Palau's coral diversity is still far from complete and further comprehensive surveys are required to get more accurate species numbers.

4.2.3.2 Other Marine Invertebrates

There are over a million described species of animals on earth and more than 95 percent of them are invertebrates. While taxonomic knowledge of Palau's marine species is reasonably good for some groups of organisms it is almost totally lacking for others (Colin, 2004). Taxonomy is a never-ending process and basic knowledge of species that occur in an area is an important step in understanding and conserving environments.

This section is intended to summarize the current knowledge of the major phyla of marine invertebrates in Palau and indicate areas where more consideration is required.

- **Phylum Porifera (Sponges)** It has been estimated that over 300 species of macrosponges are found in Palau, however many cryptic and burrowing species are still poorly known or described, which could push estimates closer to 500 species. There have also been many papers published regarding natural product chemistry of Palauan sponges; these have been summarized by Faulkner et al. 2004.

- **Phylum Cnidaria (includes Hydroids, Jellyfishes, Sea Anemones and Black Corals)** Excluding scleractinian corals, there are approximately 200 other species of Cnidarians known to occur in Palau, although many smaller species have yet to be reported or identified (CRRF unpublished data). Additional collection and taxonomic work is expected to increase the number of known Cnidarians found in Palau.

- **Marine worms** This is a group of organisms that needs significant attention in Palau. A total of 28 species of marine flatworms have been listed for Palau (Newman and Cannon, 1997). The only work on polychaetes in Palau listed approximately 41 species in 12 families (Takahashi, 1941).

●**Phylum Arthropoda (Crustaceans)** The crustaceans are one of the most diverse marine groups, however the diversity of Palauan crustaceans is still unclear. Presently there are approximately 234 species of crabs listed for Palau (Takeda, 1989). This number could easily increase with more thorough collecting efforts within Palau. In addition, Sadayoshi and Fujino (1968) recorded 15 species of pontonid shrimp species.

●**Phylum Mollusca (Molluscs)** There is no definitive list of the number of mollusc species occurring in Palau. However, it has been estimated that Palau has around 2,000 or more species of mollusks (Colin, pers. comm.). This estimate comes from comparisons between the Philippines and Guam where reasonably complete surveys have been completed. Presently, there are approximately 185 species of opisthobranchs (nudibranchs and sea slugs), 1 species of nautilus (*Nautilus belauensis*), approximately 206 gastropod species, 7 species of giant clams, and 24 species of the submarine cave bivalves.

●**Phylum Echinodermata (Echinoderms)** This phylum includes sea stars, sea urchins, brittlestars, crinoids, and sea cucumbers. The total number of species occurring in these groups is not known for Palau.

●**Phylum Chordata (Ascidians)** There are over 100 described species of ascidians in Palau. However, this number could easily double with the verification of more species (CRRF, unpublished data). Of the 100 species in Palau, 18 are either probable or possible introduced species.

4.2.3.3 Marine Fishes

Coral reefs are home to a greater diversity of fish species than any other habitat on earth, with some 6000 species, or more than a quarter of all fish species worldwide (Pyle, 1995; Myers, 1999). Within Micronesia, Palau has the highest number of reef fish species and nearly 95 percent of all the fish fauna found in Micronesian waters (Myers, 1999). The inshore reef fishes are perhaps the best-identified group of marine organisms within Palau. The number of reef fishes in Palau known to date is 1,387, though it is estimated that well over 1,500 species may occur within the Palau islands (Myers, 1999, Winterbottom, 2004). As collecting techniques improve, new records and species of fishes from Palau should be discovered (Winterbottom, 2000).

A recent reef fish inventory conducted by the Royal Ontario Museum targeting poorly known, smaller reef fishes (i.e. gobies of the genus *Trimma*) has collected approximately 25 new species and records (Winterbottom, pers. comm.). A species list from these surveys will be published in the near future, and will certainly increase the number of records and species for Palau.

Palau has relatively few marine endemic fishes, since most reef fishes have a planktonic larval stage, which can disperse widely through ocean currents. Many species that are presently known only from Palau will in all likelihood eventually be found elsewhere, since surrounding areas have not had similar collecting efforts (Colin, 2004).

While the inshore reef fishes of Palau are fairly well known, the deeper reef fishes are poorly known (Pyle, 2000). However, recent developments in diving technology have made deep reef habitats (50-150m) more accessible for collecting. Few deep fish inventories have been conducted in Palau. However, some preliminary deep reef collections by Richard Pyle in 1997 resulted in the collection of nearly 30 new species. While there is considerable species overlap for shallow water fish communities, there is little overlap in deep reef communities. The potential for new species discovery is thus very high.

In addition to marine fishes of Palau, there are approximately 19 species of sharks which occur within in Palauan waters. A majority of these shark species occur within or around the reefs of Palau (Lundgren, 2002).

4.2.3.4 Marine Algae

There have been several studies on marine algae in Palau, but more comprehensive surveys are still needed. Approximately 259 species of marine benthic algae from 118 genera have been recorded in Palau (Tsuda, 2002). These include 20 blue green algae (cyanobacterica), 94 species of green algae, 30 species of brown algae and 115 species of red algae.

4.2.3.5 Microorganisms

Marine microorganisms in Palau are so poorly known that no attempt has been made to cover this important group in this section on Marine Biodiversity.

4.2.3.6 Marine Reptiles (Herpetofauna)

Only a few species of marine reptiles are found in Palau. Crombie and Pregill (1999) listed the herpetofauna of Palau to include 7 marine species (48 total, Crombie, pers. comm.). These include sea snakes, the estuarine crocodile, and sea turtles.

Seasnakes

Of the approximate 50 species of sea snakes in the world, Palau has two, the banded sea krait (*Laticauda colubrina*) and the yellow-bellied sea snake (*Pelamis platurus*). The banded sea krait is common throughout the Palauan archipelago, found inside the reef in a variety of shallow and deep-water habitats. Sea kraits are not tied to the ocean as the true sea snakes: they must come ashore to lay eggs (Crombie and Pregill, 1999). The yellow-bellied sea snake is much less common, with only two records indicating it being found within Palau (Crombie *pers. comm.*, 2004). There have been no basic scientific surveys to estimate the population abundance or densities of either of these species within Palau.

Crocodiles

The saltwater crocodile (*Crocodylus porosus*) is native to Palau and is the only population that occurs within Micronesia. Two other species have been reported to be in Palau, *C. mindorensis* and *C. novaeguineae*, which were imported from the Philippines and New Guinea in the 1930s for a farming venture. The crocodile populations are distributed throughout the main archipelago of Palau and can be found in all regions, particularly where mangroves are a primary component of the habitat (Brazaitis *et al.* 2003). Crocodiles can also be found in open ocean, marine lakes, rivers, and freshwater lakes on Babeldaob, Koror, and Peleliu. The last official survey of the

crocodile population was completed in June 2003 and estimated the population to be around 500 to 750 non-hatchling individuals (Brazaitis *et al.* 2003), with approximately 50 individuals held in captivity.

Further investigations using DNA technology are needed to help assess if scalation anomalies, present in the Palauan population, are unique to the population. To date, there is no evidence to suggest that two species coexist in the wild in Palau even after the introductions in the 1930s. In addition, morphological data from Palauan animals, data from museum voucher specimens, and data from other wild populations should be used for comparative purposes to augment DNA findings (Brazaitis *et al.* 2003).

Sea turtles

Four species of sea turtles have been documented within the waters of Palau, although only two species maintain resident and nesting populations in Palau, the hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles. The leatherback (*Dermochelys coriacea*) and olive ridley turtles (*Lepidochelys olivacea*) are known to occur in Palau but are much less common. Sea turtles are highly valued within Palau and have been exploited for millennia for their meat, eggs, and shells (Johannes, 1981; McCoy, 1981). Traditional marine tenure laws and sustainable fishing practices allowed for limited harvesting of sea turtles for food and other uses over thousands of years (Johannes, 1981). However, over-harvesting and the loss of nesting sites due to coastal development are the greatest threats to the sustainability of turtle populations within Palau today.

While reviews of historical accounts, local observations, resource assessments, analysis of conservation measures, aerial surveys, resource-use interviews, and nesting beach monitoring have provided information on the abundance and distribution of Palauan sea turtles, currently there are no in-depth studies of population structure, genetics, or demographics, leaving many critical management gaps.

4.2.3.7 Mammals

Two orders of marine mammals exist in and around Palauan waters, the cetaceans (Whales and Dolphins) and the sirenia (Dugongs).

Whales

Presently, there is no definitive list of cetaceans in Palau. Due to the highly migratory nature of cetaceans it is difficult to reliably estimate populations or the number of these species within Palau. The only cetacean which is resident in the near shore waters of Palau is the Spinner dolphin (*Stenella longirostris*). Other cetaceans, based on sightings, possibly migrate through Palau. In the Micronesian region there is documented evidence of many species being regularly present.

Dugongs

The only dugong (*Dugong dugon*) population in Micronesia occurs in Palau, apart from occasional sightings around Yap and Guam (Nishiwaki *et al.* 1979). Palau's dugong population is considered the most isolated in the world (Marsh *et al.* 1992), and is therefore likely to be genetically distinct from other populations of the same species. Aerial surveys have been

conducted six times since 1977 in order to determine the health of the local population (Brownell et al. 1981; Rathburn et al. 1988; Marsh et al. 1995; Smith, 1998 unpublished data). The most recent survey conducted by The Nature Conservancy (TNC) in May 2003 counted a total of 27 individuals, twenty adults and seven calves. The survey noted approximately the same number of individuals as the previous survey, done in 1998.

These aerial surveys do not provide sufficient information on possible changes in population numbers over time. The fact that the number of animals counted per unit flight time has not changed appreciably over the past 25 years does not necessarily mean that dugong numbers are stable (Davis, 2003). Limitations of such a comparison must be stressed in light of the variable conditions for each survey. The overall picture is one of relative dugong distribution and numbers, rather than actual numbers.

The major threat to the survival of Palau's dugongs is poaching. Although the introduction of a new dugong protection law may deter many poachers from continuing to kill dugongs, increased surveillance and enforcement are needed at both national and state levels. In addition, further studies on the impacts of dredging and other coastal activities on the health of seagrass beds are necessary in order to minimize the threat to dugong populations.

4.2.4 Marine Endemics

Recorded endemism is low among Palauan marine organisms, at least in part because many taxa have not been sufficiently studied to establish true levels of endemism. In addition, surrounding islands (i.e. Philippines, Indonesia and Papua New Guinea) are simply too close for species to have developed without genetic connection with adjacent island populations. Most endemics that do occur in Palau are closely related to similar species elsewhere and differ mainly as a result of long-term isolation (Colin, 2004).

There area few examples of marine endemics in Palau. One example is the Palau nautilus (*Nautilus belauensis*), which is typically found 200-300 m deep along steep reef drop-offs. This species has been the subject of numerous biological studies and has been subjected to regular trapping to allow tourist divers the opportunity to examine and photograph these unusual creatures (Carlson, unpublished). This species differs from its close relatives in nearby areas by having minor differences in the shape of the male's shell and achieving a large size. These minor differences do not reduce the importance of a species with a limited geographic range, but point out that there is not an extensive group of unique marine life present in Palau (Colin, 2004).

5. THE IMPORTANCE OF PALAU'S BIODIVERSITY

5.1 The Importance of Palau's Terrestrial Biodiversity

Palauans have depended on terrestrial resources for food, medicine, shelter, crafts, and customary exchange since the first settlement millenia ago. Palauans cultivate over 100 varieties of taro, 17 varieties of sweet potatoes, and many varieties of cassava, as well as bananas and other fruits for food. Over 44 species of trees are used for timber and firewood, and over 82 plants have medicinal healing powers. The fruits and flowers of over 100 plants are food for bats and wildlife. Master builders were respected for their knowledge on the strengths and uses of

each tree species and the proper timing to cut wood when it was strong. Hunters were esteemed for their ability to provide delicacies such as fruit bat for customary exchange. The land is a source of the minerals such as phosphate for fertilizer, and bauxite, sand, limestone, and volcanic rock for building homes, meeting houses, roads, and piers.

Terrestrial resources are not as heavily exploited as they were in the past, although taro patches and small-scale family farms continue to provide vegetables and starches to people throughout Palau. Farmed crops (such as cassava, fruits, and vegetables), taro, and mangrove trees are the most widely used terrestrial resources in Palau. Other important resources that people use are forest trees, fruit and nut trees, medicinal plants from a variety of habitats, and plants that are used for weaving materials. Forest birds and bats are hunted for local commercial sale and subsistence uses.

Subsistence living, which requires the use of natural resources, has changed considerably over the years. Locally made items such as cooking utensils, gardening tools, fishing gear, containers (for syrup, water, etc.), baskets, mats, thatch roofs, handicrafts, arts, fish and wild rooster traps, canoes and rafts, housing, ropes and strings to tie building materials, small tools, and pottery, have all been replaced by imported utensils, tools, and building materials. Much of the detailed knowledge and skills used to make these essential items are no longer practiced and are being lost. In addition, the cultural associations and roles that were bound to the preparation and use of these essential items are disappearing.

5.1.1 Forests, savannas, and wetlands

5.1.1.1 Traditional and Indirect Values

Traditional values. Terrestrial habitats are vital components of the economy and culture of Palau. In addition to using terrestrial resources for food, tools, traditional clothing, and building materials, the people of Palau also use many trees and other plants for traditional medicines and other customary purposes (e.g., first childbirth ceremonies). For example, forests are used to produce items integral to Palau's culture, such as *omsangel* boxes used to store traditional money, building materials for traditional *bai* (men's meeting houses), and *kabekel* (war canoes). Palauan healers used over 82 species of plants for medicine. Some food plants, such as coconut, guava, mango, papaya, pineapple, banana, and taro, have been used for their medicinal properties in Palau. Other plants, such as *Phaleria insidia* (*delal a kar*), *Morinda citrifolia* (*ngel*), *Codiaeum variegatum* (*kesuk*) and *Macaranga carolinensis* (*bedel*) have multiple healing properties. Many of these plants are planted near homes, while others are collected from the savannas, wetland taro patches, and forests.

Forests provide food in times of emergency. In desperate times in the past (e.g., during World War II when Japanese and American forces fought on Palauan soil) the forests provided food security through the provision of emergency foods.

The main agroforestry systems in Palau are the traditional taro patch farming areas (*mesei*), coconut forest areas (although many of these are now in disuse), and family farms. The taro patch system enabled Palau's people and culture to flourish. Taro is an important item in customary food exchange. It is so important to Palauan culture that a Palauan proverb states: *A mesei a delal a telid* (the taro patch is the source of breath). Traditional taro production includes

growing fruit and medicinal plants in cultivated wetland areas. There is a wealth of traditional knowledge held by women who know the traditional taro farming techniques. Taro patches remain the most sustainable form of agriculture in Palau.

Indirect values. Indirectly, forests play an important role in the economy through the ecosystem services they provide, in particular for their role in beautifying the land and in maintaining healthy reefs and fisheries, as these provide the basis for the tourism sector on which much of Palau's economy depends. The forested character of the Rock Islands, in particular, plays a vital role in maintaining their beauty and value as a major tourist attraction. Wetlands that are used in traditional taro farming may help maintain water quality by controlling erosion, and help to maintain bird diversity.

5.1.1.2 Commercial Value

Forestry. Currently, there is very little commercial forestry in Palau. Timber harvested locally is normally used locally and is rarely bought and sold, apart from small volumes for local construction or crafts such as storyboards (Palauan legends carved on pieces of wood). It is likely that the amount of timber harvested locally is small enough that harvest is currently at a sustainable level but there is no monitoring and no records kept on harvest to verify this.

The majority of wooden products and timber are imported. Because imports of wooden products are high there is scope for some substitution from local sources. The volume of standing timber in Babeldaob (Palau's largest island) has been estimated to be 2.9 million cubic meters (104.1 million ft^3) of which an estimated 2.5 million cubic meters (88.7 million ft^3) are located in the upland forest type (Cole, 1988). However, this is a gross figure and the actual accessible volume would be much smaller due to the steep and difficult terrain, erodible soils, and small tree size or poor tree form in much of the natural forest. Babeldaob's soils are generally poor and highly erodible and as a result once native vegetation is removed, re-vegetation is very difficult.

The commercial forestry sector in Palau is thus underdeveloped, and it is unlikely that large-scale commercial timber production for export would be a sustainable venture, due to the relatively small volumes that would be available and the dangers of significant environmental damage from broad-scale logging in the upland forest types. There is, however, potential for small-scale timber production for local use and value-added products such as storyboards, wooden bowls and other utensils, furniture, and other non-forest timber products such as woven Pandanus mats and/or baskets. Some of these may have potential for export.

The Forestry Unit of the Bureau of Agriculture has for some years promoted development of small-scale plantations for wood production. Free seedlings have been supplied to landowners from the forestry nursery at Nekken, together with extension advice on how to grow and manage the plantations. The main species planted has been mahogany (*Swietenia* spp.) and there are a number of mature small plantations that have provided logs for several small saw milling operations over the last 10-15 years. There have been no recent updates of the figures for the area of plantation timber but the area is probably less than 100 ha in total.

More recently, the Ministry of Trade and Commerce and private entrepreneurs have been promoting an expansion of the plantation program, and the Ministry is funding the supply of

more free seedlings to landowners and state governments in an effort to stimulate the development of a timber industry for both local use and export. The main species being promoted are teak (*Tectona grandis*) and mahogany. To date, there is no information available on the potential performance of teak in local conditions, but mahogany is a proven performer in Palau (although good quality seed supplies have sometime been difficult to obtain).

Tourism. There have been a few attempts to make use of Palau's forests, savannas, or wetlands as tourist attractions. These include short forest walks to two waterfalls on Babeldaob Island, and more recently the development of a trail in Lake Ngardok Nature Reserve in Melekeok State as part of efforts to stimulate ecotourism benefits for local communities. The Bureau of Marine Resources supports local communities in Ngaremeduu Bay Conservation Area in attempts to develop kayaking tours amongst the mangroves of the conservation area. A major limiting factor to date with these efforts has been the poor road access to most of Babeldaob, but this will change with completion of the new "compact" road in the next 2-3 years.

Weaving. Pandanus (*ongor, such*) is harvested for weaving materials in several states around Palau. The leaves of this plant are collected, dried, cut into strips and woven into baskets and mats. In some states, women receive income from their sales of woven items comparable to or greater than the local income from fishing.

5.1.2 Terrestrial Species

Birds and bats have a long and colorful history in Palau, as reflected by their inclusion in many Palauan legends, stories, and character traits. Birds were valued for teaching lessons by example and certain birds were emulated to improve hunting and fighting techniques. Many of the shorebirds, especially the noddies, are highly esteemed for pointing out schooling fish to local fishermen. Many of the forest dwelling species were used traditionally as food sources, and several continue to be sought after (illegally) to this day, especially the Micronesian Pigeon, the Palau Fruit Dove, the Nicobar Pigeon, and the Micronesian Starling. Bird eggs, especially from the Micronesian Megapode and shorebird colonies, were also a traditional subsistence source of food. Fruit bats are hunted as well. Both fishing using shorebird sightings, and bird and fruit bat hunting were traditionally respected activities for men to engage in, as is the case today.

Birds are also important for the ecosystem services they provide. Several of Palau's frugivorous species are important in seed dispersal and the more numerous insectivores keep pest and nuisance insects from accumulating beyond tolerance. Most of Palau's resident bird species utilize numerous different habitat types and often move between them. As such they are important to the flow of energy and nutrients, maintaining a healthy balance. The shorebirds of Palau are a good example, as they leave early each morning to search the lagoon and open ocean waters for fish to eat, then return to roost and nest in the forests of the archipelago, bringing with them nutrients that help the forests grow. In the harsh growing conditions of the Rock Islands, birds provide one of very few nutrient sources.

Boasting the highest bird diversity in all of Micronesia, Palau has significant potential as a birdwatcher's destination, especially considering that it offers sightings of 9-12 bird species that cannot be seen anywhere else in the world as well as several other range-restricted species. The Rock Islands provide a unique bird watching experience, offering eye-level views of many of

Palau's endemic species and nesting shorebirds. Many of the other islands, including Babeldaob, are attractive destinations where bird watching can be undertaken with little effort and at no great cost to environmental health. As Palau seeks to expand its tourism industry and encourage high-level, low-impact ventures, bird watching offers exactly that.

5.2 The Importance of Palau's Marine Biodiversity

Today marine biodiversity is commercially important for Palau's largest sources of income: tourism andfisheries . Marine biodiversity also has very important cultural value. Traditionally, Palauans depended upon local resources as sources of food, food procurement (for example, bamboo fish traps and shell fish hooks), food processing (clay cooking pots and fuel), custom and status (dugong meat and bone that are symbolically important to high clans and traditional leaders, and women's money in the form of turtle shell trays), clothing, transport (canoe-building materials), and shelter (building and decoration materials). Today, many of the local resources are not used as extensively as they were in the past and many have been replaced by imported materials. However, the cultural value remains high for certain resources. For instance, turtle shell money (*toluk*) is a vital part of the traditional exchange system among clans. Certain foods are highly valued for the exchange system either because they can feed large groups of people (large fish, turtle, dugong) or because they are more difficult (or even illegal) to catch (turtle, dugong). Palauans still enjoy collecting and eating local foods, especially fresh marine fish and many types of invertebrates.

5.2.1 Reefs, seagrass beds, mangroves and marine lakes

5.2.1.1 Traditional and Indirect Values

Traditional value. Marine resources have been a vital source of protein to the people of Palau for centuries. Hundreds of fish and invertebrate species are still important food sources. These fish and invertebrate species support an extensive semi-subsistence economy throughout Palau. Many women collect marine invertebrates such as clams, sea cucumbers, and crabs from nearshore reef flats, seagrass beds, and mangrove areas. Men catch dozens of species of reef fish, as well as octopus, squid, mangrove crabs, and giant clams. They often have motorized boats and are able to fish both inside and outside Palau's extensive barrier reefs. Traditionally, the reef and lagoons served as learning grounds to pass traditional knowledge about the tides, moon phases, and the behavior of marine life from one generation to the next. Rights of passage for young men often depended upon their skill as fishermen. Men acquired status and power by their levels of skill and knowledge about fishing and navigation. At times traditional chiefs were selected because of their knowledge of fish. These men were responsible for wise management of the local resources, and had the authority to open and close fishing seasons and fishing grounds.

At one time, Palauan villages were established behind stands of mangroves to protect villagers from dangerous raids by canoes full of warriors from other villages. The mangroves were important sources of firewood and other woods that were used for building materials. Channels through the mangroves were maintained to keep transportation passages clear. Today, the mangroves are not used nearly as extensively as they were in the past, as other materials now substitute for the products taken from the mangroves. The mangroves are often cut and filled to create more land for building. Many of the mangrove channels have become overgrown and clogged. Mangroves remain important habitat for mangrove crabs, which are an important

commercial and subsistence catch. A few women maintain mangrove clam collection sites and sell the clams or bring them home for family consumption.

Indirect value. Residents and guests alike are attracted to the simple beauty and pure enjoyment that the reef and lagoon provide. Seagrass beds and mangroves are important nurseries for fish and invertebrates that later migrate to the reefs. Reefs and mangroves are also important barriers that protect the coastal areas from the full impact of storms. In addition, mangroves protect the reefs from excessive land-based sources of sediment.

5.2.1.2 Commercial Value

Tourism. Tourism is one of Palau's principal industries. In 2003, more than 67,000 people visited Palau and in the first nine months of 2004, more than 80,000 people arrived (PVA 2004). The major tourism markets are Taiwan (45 percent of visitors) and Japan (38 percent of visitors). The remaining visitors are from North America, Europe, Australia, New Zealand, and various Pacific island countries. Palau's reefs are major tourist attractions and Palau is home to several world renowned dive sites. A recent exit survey indicated that approximately 85 percent of Palau's Japanese, North American and European visitors scuba dive, while only 22 percent of those from Taiwan dive. However, overall about 55 percent of the total visitors dive while in Palau. The remaining 45 percent snorkel, visit the Rock Islands, see WW II relics, visit Babeldaob Island and/or engage in sportfishing activities, among other activities (Cesar et al, 2004). Jellyfish Lake, one of Palau's marine lakes, is a major tourist attraction and is included in almost every tour of the Rock Islands. Although definitive numbers are not collected, a recent survey counted a peak of 300 visitors to the lake in one day (Olkeriil, pers. com. 2004). A recent estimate of the total economic value per year from tourism in Palau is $27.5 million. Japanese tourists contributed over half of this amount ($14.6 million), while Taiwanese tourists contributed around 16 percent ($4.3 million), combined USA and Europe ($4.2 million), and other nations ($4.4 million) (Cesar et al. 2004).

Recreational sportfishing activities are a developing industry in Palau. Tourists can now charter boats in order to go catch-and-release fishing. In 2003, there were four fishing derbies (two for trolling and two for bottomfishing). Approximately 50 boats joined each of the trolling derbies and about 20 boats participated in the bottomfishing tournaments. Palauan residents comprise the majority of derby participants, but there is hope to increase the tourism value of these events. The fish landed in the derbies are often donated to Palau's hospital or schools.

Fisheries. Palau hosts both export and domestic fisheries. Export fisheries are composed of foreign longline and purse seine fleets catching tuna, billfish, and other species. In 2003, a total of 90 longliners from China, Japan and Taiwan and 31 Japanese purse seiners were licensed to fish in Palauan waters. In 2003, these boats landed approximately 1720 metric tonnes of tuna (bigeye and yellowfin), 55 metric tonnes of marlin (black, blue and striped), 12 metric tonnes of swordfish and 26 metric tonnes of other species (Sisior 2004). From 1993 to 1997, Palau's long line tuna industry had an average annual gross value of $28 million (Kitalong, 2003).

Values of domestic fisheries are complex and difficult to quantify in Palau. The domestic fisheries are composed of fishing and invertebrate collection for local markets and restaurants, for informal and village markets, for customary events (funerals, festivals, sporting events), for

family consumption, and for export to family members abroad. In addition, fish and invertebrates are often processed, cooked, and sold throughout the country as "bentos" (lunch-sized packages). Data is collected on the commercial sale of fish and some invertebrates in the larger local markets. In 2002, more than 450,000 pounds with a market sale of $637,000 for many species of reef fish and invertebrates were recorded through these receipts (see Table 6).

This, however, is a fraction of the total catch, as many of the smaller markets (where a wide variety of other species from sea cucumbers to sea turtles, as well as processed bentos, are sold) are not regularly monitored. Studies have documented the extent of some of these small-scale fishing activities. Women, in particular, are involved in many small-scale, semi-subsistence activities. Women sell many species of sea cucumbers, molluscs, crabs, urchins, and anemones in small local markets throughout Palau (Matthews and Oiterong 1991; Lambeth 1999). Women also cook a large amount of what they sell. Due to the variety of venues and the difficulty of gathering information, sales through smaller commercial markets, village stores, restaurants, informal markets and special order direct from the fisherman or woman are also not monitored.

Table 6. Domestic fish catch 2002 - from local market receipts (Bureau of Marine Resources)

Category	Weight (lb)	Value ($)
Assorted Reef Fish	253,173	315,655
Surgeon and Unicornfish	81,035	119,515
Parrotfish	26,061	34,969
Wrasses	23,877	36,007
Tuna and Mackerels	13,071	10,841
Mangrove crabs	12,162	50,769
Rabbitfish	11,839	17,098
Groupers	11,600	16,504
Snappers	9,683	9,755
Emperors	7,339	7,669
Jack, Scad, Trevally	2,552	2,736
Lobster	2,332	8,498
Rudderfish	2,217	2,346
Herring, Sardines, Sprats	969	979
Goatfish	945	1,052
Milkfish and Mullets	942	1,092
Billfish	797	723
Barracuda	578	638
Mojarras	227	195
Dolphinfish	144	115
Rays	75	56
Squirrelfish and Soldierfish	59	66
Sweetlips	5	4
Total	**461,687**	**$ 637,292**

Aquarium trade. Giant clams, hard and soft corals, other invertebrates (such as starfish), and finfish have been exported as marine ornamentals for the aquarium trade. The giant clams and corals were hatchery raised, and all other species were collected from the wild. Currently, only cultured giant clams and wild caught fish are sold into the aquarium trade.

Aquaculture. Aquaculture is being encouraged in Palau as a potentially important income-earning opportunity. Although Palau has a long history of aquaculture projects, few have been long standing or have generated significant income. The Palau Mariculture Demonstration Center (PMDC) has been raising giant clams since 1981 for reseeding programs throughout the country and the Pacific. The clams are also sold to the aquarium trade, and some of their shells are sold to tourists in a small shop at the Center. In addition, the Center rears groupers and humphead wrasse. These activities are currently only in the experimental stage and do not yet generate any income. The Palau Community College Cooperative Research and Extension program conducts small-scale aquaculture projects focusing on trials of raising hard corals and freshwater prawns. Proposed projects around the country include milkfish, grouper, pearl, and prawn farming.

Research. Palau is home to two marine science research institutions (Palau International Coral Reef Center and Coral Reef Research Foundation). Other institutions that conduct marine research or host visiting scientists are: Palau Conservation Society, The Nature Conservancy, Bureau of Marine Resources, Office of Environmental Response and Coordination, and Palau Community College Cooperative Research and Extension. In addition, scientists from around the world come to Palau to conduct research independently. In 2003, the Bureau of Marine Resources sold 14 research permits and 1 aquaculture collection permit ($4,350). Some states also charge for research permits for research conducted in their jurisdiction.

5.2.2 Marine Species

As noted earlier, many marine species are valued in Palau. Culturally, some of the larger species have particular value, especially sea turtles, dugong, sting rays, humphead parrot fish, and humphead wrasse. In addition, many species of schooling fish such as rabbitfish, unicorn fish, and surgeonfish have local importance.

6. THREATS TO BIODIVERSITY IN PALAU

6.1 Major Threats to Terrestrial Biodiversity

6.1.1 Forest Loss and Fragmentation

A lack of land-use planning, and the poorly planned, piecemeal development that results, are the major threats to forests in Palau. Threats relate to both direct loss of forests through clearing of forests for various types of development, and fragmentation of forests, opening them up to the threat of invasive species and increased fire risk.

The island of Babeldaob has the largest intact native upland forest in all of Micronesia and large-scale development of the island was limited in the past by poor road access. Until the early 1990s, most of the ten States in Babeldaob could only be reached by boat. However, within the past 10-15 years, all of them have become accessible by land. The new Compact Road, a 53-mile (85 kilometer) road that goes completely around the island, is already making access to previously remote areas much easier and quicker. Once the Compact Road's construction is complete (by 2005), expanded development is expected to follow as new areas open up and new opportunities for development arise. In addition to this, part of the population in Koror is

expected to move to Babeldaob because the Government Capital (currently in Koror) will be relocating to Melekeok State in Babeldaob upon completion of the road. This will inevitably cause an increase in the need for housing and building materials and will attract further development to Babeldaob.

While there is considerable community support for the Compact Road and the development opportunities expected to follow, there is also community recognition that there are negative impacts that will need to be managed. For example, recent consultations undertaken by Palau Conservation Society for this NBSAP project found concern in every State about the impacts of sedimentation of reefs and fisheries following road construction and other development activities (PCS, 2003). The Association of Governors has also recognized the need for land-use planning and in 2001 contracted a consultant to develop land-use master plans for each state in Palau. Unfortunately, completion of the first phase of developing these land-use master plans was delayed by over a year and the final product was simply a set of land-use constraint maps, rather than a comprehensive land-use plan as many people expected. Considerable community consultation will be required to develop land and resource use planning more fully.

Fragmentation of forest through road building is already having a negative impact. For example, the native invasive vine *Merremia peltata* has spread extensively because of the increased amount of land clearing and construction of new roads providing new opportunities for colonization. Expanded secondary road building, following completion of the Compact Road, can be expected to exacerbate this problem and the impact of other invasive species.

The majority of Palau's resident bird and bat species depend on forests, and all of Palau's endemic bird species are forest dwellers. The basic ecology and habitat size requirements for most of these species remains unknown. A few threatened Palauan resident species, such as the Micronesian Megapode and the Palau Ground Dove are known to live in reduced numbers in inhabited areas, whether because of altered habitat or predation by humans or feral animals.

6.1.2 Invasive Species

Invasive species are considered to be possibly the greatest threat to biodiversity in the Pacific Islands and in Palau they are another major threat to forest resources. Additionally, invasive species threaten Palau's economy, human health, agriculture, even the unique Palauan way of life. Invasive species cause harm by eating animals or their eggs (monkeys, for example, eat bird eggs and nestlings), by eating plants (parrots and cockatoos eat the hearts of two palm trees found only in Palau's rock islands, killing the trees), by growing over plants (several invasive vines), by increasing the likelihood of wildfires (several plants, most notably *Imperata cylindrica* and *Chromolaena odorata*) or by being more likely to survive fires (same, plus African Tulip), by carrying diseases (city pigeon, rats, mosquitoes), by causing diseases of humans, animals, and plants (micro-organisms), by making noise (coqui tree frog, cockatoo, and parrot), and in many other ways.

A National Invasive Species Committee of the Palau National Environmental Protection Council has been established to coordinate action on invasive species, and a national policy and strategy have been adopted by the NEPC. In addition to these overall efforts, the Bureau of Agriculture now has a full-time Invasive Weed Control Officer committed to working on invasive plants

issues in Palau. There is, however, a major lack of resources and staff to undertake extensive invasive control or prevention programs.

At present, more information is available on invasive weeds than on other invasive species in Palau, and efforts to combat invasive weeds are more advanced. A recent report on invasive weeds of environmental concern in Palau found:

- 4 species that are presently subjects of eradication programs;
- 53 species that are in Palau that are known to be invasive or potentially invasive;
- 95 species that are invasive or weedy elsewhere and are common, weedy or cultivated in Palau;
- 15 native species (or Micronesian introductions) that exhibit aggressive behavior; and
- 249 species that are invasive elsewhere in similar ecosystems but are not currently known in Palau (potentially invasive).

The four species of invasive plants currently being eradicated are: *Imperata cylindrica* (kasoring, blady grass, cogon grass), *Mikania micrantha* (teb el yas, mile-a-minute weed), *Schefflera actinophylla* (octopus tree), and *Spathodea campanulata* (orsachel kui, African tulip tree). All of these have potential to cause serious damage to forest and savanna environments and habitats in Palau, and ongoing control efforts will be needed to fully eliminate them and prevent re-introduction.

Of the other invasive plants already widespread in Palau, Space et al (2003) note that eradication or extensive control is out of the question for all of these species, but that control in sensitive, natural and protected areas such nature reserves and protected watersheds may be required. In addition, they stress the need to make every effort to keep out all the species listed as potentially invasive, to monitor for their occurrence and to eradicate them immediately if found. These are all well-documented problem species that have had a major impact on natural ecosystems elsewhere. The potential impact of these species, if they are introduced and become established, can be severe.

6.1.3 Uncontrolled Fires

Most of Babeldaob Island is believed to have been forested at one time, and fire is considered to be one of the main reasons why grasslands are now a more prominent vegetation type on the island. Although forests in Palau do not easily burn, and fires burning into forested areas burn out fairly quickly, adjoining grassland areas are burnt regularly. This means that forest species are unable to regenerate in the grasslands and the edges of the forests are gradually impacted by fires. Grasslands originating from abandoned agricultural land have thus failed to return to forest cover, and in many cases have been subject to loss of vegetation cover and subsequent soil erosion.

Currently there is very limited capacity for fire management in Palau, at both national and state level. The Fire and Rescue Division of the Bureau of Public Safety is mandated to suppress both urban and rural fires, but is understaffed and has very limited resources (both equipment and manpower). In general it is unable to respond to forest fires on most of Babeldaob. State

governments and other national agencies also have limited capacity, for example the Forestry Unit of the Bureau of Agriculture currently has almost no fire management or suppression capacity.

6.1.4 Mangrove Cutting and Filling

The clearing and filling of mangrove areas is another threat, with a number of areas on Babeldaob already affected, particularly in southern Babeldaob where development pressures have been greatest. Partly due to the complications regarding land tenure issues and disputes in upland areas, mangroves are sometimes leased out by the States for housing or other development simply because there are no land tenure complications as there are in upland areas. These pressures are likely to intensify and expand with the completion of the Compact Road in 2005.

6.1.5 Hunting

Hunting of birds and bats is common in Palau and is thought to have resulted in a decrease in the numbers of fruit bats, Nicobar Pigeon, Micronesian Pigeon, Micronesian Megapode (through poaching of eggs) and Palau's national bird, the Palau Fruit Dove. Hunters are supplying a local demand from both an informal market (for banned species) and to a lesser extent the local stores and restaurants. The demand comes in part from customary/traditional obligations, and also the desire to eat delicacies or 'exotic' species, especially among tourists. In general, hunters harvest these species to earn extra cash, but also at times for recreation and for social status. As Babeldaob is opened up for development, hunting access will become easier, with unknown effects on these species.

6.2 Major Threats to Marine Biodiversity

There are many threats that have the potential to affect the overall health of marine biodiversity and marine environment in Palau. However, the complexity of marine ecosystems makes monitoring their health an extremely difficult task. Most of our knowledge on marine organisms and ecosystems from Palau comes from investigations conducted at one or a few sites, over short periods of time. Unfortunately, the repetitive and detailed monitoring required to produce results that are robust and statistically testable are generally beyond the capability of developing countries such as Palau. For example, surveying a reef once will only provide a snapshot of the status of coral reefs, but a longer-term approach is required to understand the processes underlying the changes on coral reefs (Hughes and Connell, 1999)

Natural threats to marine biodiversity include storms, predator outbreaks (i.e, crown-of-thorns), and temperature fluctuations. Marine systems appear to be somewhat resilient to these threats, and generally recover over time. However, some of the most serious threats to marine biodiversity in Palau may be the anthropogenic stress from human activities. The range of activities which are cause for concern includes runoff and sedimentation from development projects, eutrophication from sewage and agriculture, physical impacts from maritime activities, dredging, destructive collecting and fishing practices, pollution, and the synergistic impacts of anthropogenic disturbance on top of natural disturbance (Richmond, 1993). However, the

question regarding the degree to which marine biodiversity is susceptible to human-induced stress remains somewhat unsettled and more work is needed before definitive conclusions can be drawn (Grigg and Dollar, 1990). In addition, there has been more emphasis on the immediate impacts of anthropogenic and natural perturbations, but not enough on the process of recovery (Hughes and Connell, 1999).

6.2.1 Storms

Palau is south of the normal typhoon belt of the western North Pacific; consequently typhoons rarely hit Palau. However, a few times per year tropical storms and typhoons pass north of Palau, usually several hundred kilometers away, bringing heavy rains and winds. Typically, if a large typhoon passes between Guam and Yap (i.e. 600-800 km from Palau) this generates relatively strong winds of 30-40 knots, torrential rains, and heavy swell (Colin, 2004). The heavy swell generated from these typhoons or tropical storms may have sufficient strength to damage reefs, kill corals and displace fish. However, these storms are not considered to have long-term effects on reef areas unless other chronic impacts prevent rapid regeneration. Palau has historically been hit by a typhoon every 15-25 years.

6.2.2 Crown of Thorns starfish

The crown-of-thorns starfish (*Acanthaster planci*), or COTS, has been the focus of much debate on the fate of marine ecosystems (mainly coral reefs). However, evidence that COTS outbreaks are caused by human activity is circumstantial at present (Sebens, 1994). While outbreaks may be considered natural, an increasing number and persistence of these events may be compounded with anthropogenic effects (Richmond, 1993). Crown-of-thorns starfish have been a problem in Palau since at least the late 1960's (Colin, 2004). They have been the subject of a number of surveys and control efforts starting in the 1970's (Chesher 1969, Tsuda 1971, Marsh and Bryan 1972, McHugh 1978, Hamner 1979, and Birk 1979a,b). During this time, *A. planci* feeding activities decimated extensive areas of Palau's reefs and in many of these areas it is still possible to see this damage (Colin, 2004). However during the 1980's no surveys were conducted to document *A. planci* abundances, so no information is available for this period of time.

Crown-of-thorns starfish remain a problem in Palau, with localized areas of damage occurring periodically in the same locations. Control efforts have been ongoing since the late 1990s by local tourist operators (Leidich, pers. comm.) in response to *A. planci* infestations decimating popular tourist reef areas. There still remains the potential for periodic infestations of COTS to return to "plague" proportions as coral populations rebound from the 1998 bleaching event.

The most recent study on crown-of-thorns starfish in Palau was by Idip (2004), who reported that *A. planci* have two yearly spawnings. He reported a correlation between spawning and water temperature, with spawning times limited to water temperatures above 28 C. Further research is required to assess damage that COTS cause to the reefs of Palau.

6.2.3 Coral Diseases

In the past few decades, increases in coral diseases worldwide have become one of the major threats challenging the resilience of coral reef communities (Harvell et al. 1999, Willis et al.

2004). Coral disease impacts have increased on reefs worldwide and are emerging as one of the major causes of coral reef deterioration in the Caribbean. In the Indo-Pacific, very little is known about the ecology and pathology of coral disease despite the region encompassing more than 80 percent of the reefs worldwide (Bryant et al. 1998).

The first ecological surveys of coral disease prevalence on Palau reefs were carried out in 2004. The purpose of the surveys was to identify and establish baseline information for coral disease at sites representative of the major habitat and community types in Palau. Results from these initial surveys indicate that the mean prevalence of coral disease was relatively low, affecting between 1 and 5 percent of colonies at six sites representative of protected, moderately exposed and exposed communities on Palauan reefs. A total of twelve diseases and syndromes were recorded from across thirteen reefs. Eight of these syndromes have been previously observed on Indo-Pacific reefs, in particular on the Great Barrier Reef (Willis et al. 2004). However, four syndromes have not been recorded previously.

Further research is required to come up with a more quantitative assessment of coral disease prevalence within Palau.

6.2.4 Climate Change

Changes in climate include increasing temperatures, changes in precipitation, sea-level rise, and increased frequency and intensity of some extreme climatic events leading to increased climate variability (IPCC, 2002). Climate change is having and will continue to have significant impact on marine biodiversity worldwide (Buddemeier, 1993; Brown, 1997; Hoegh-Guldberg, 1999; Wilkinson 1994, 1999, IPCC, 2002). Many of the impacts from climate change are already apparent (e.g. sea level rise and coral bleaching).

As a result of the 1997/1998 El Niño/La Niña, at least one third of Palau's corals died due to climate change related weather events with coral mortality as high as 90 percent in some areas (Bruno et al. 2001). Impacts were seen in other environments as well. The famous "Jellyfish Lake" experienced a complete mortality of the medusa stage of *Mastigias sp.* due to elevated water temperatures. A major concern is that these accelerating rates of global environmental change could exceed the adaptive capacity of coral reef species and other related marine animals, resulting in local and regional extinctions (Hughes et al. 2003). Presently, coral bleaching related to climate change is considered one of the greatest threats to the Republic of Palau's coral reef ecosystems.

Coastal erosion, which is already a problem on many coastlines for reasons other than accelerated sea-level rise, is likely to be exacerbated by sea-level rise and adversely affect coastal biodiversity. Sea level rise will potentially affect mangroves, seagrass beds, and coral reef ecosystems in addition to affecting turtle nesting beaches and low-lying seabird colonies (IPCC, 2002). Increased precipitation, pH, water temperature, wind, dissolved CO_2, and salinity, combined with anthropogenic pollution by nutrients and toxins, can all affect water quality in estuarine and marine waters. Elevated seawater temperature (SSTs) will also cause changes in marine biodiversity, such as coral bleaching (Glynn, 1993; Brown, 1997; Hoegh-Guldberg and Jones, 1999) and decreases in reef fish populations (IPCC, 2002). Means to address these global

threats need to be incorporated into practical planning and management guidelines for MPAs (Goreau et al., 2000; Salm and Coles, 2001; West, 2001).

Sea temperatures in many tropical regions, including the Republic of Palau, are increasing (~1-degree C per century) and have increased by almost 1 degree C over the past 100 years (Hoegh-Guldberg, 1999). Many corals have undergone major, although often partially reversible, bleaching episodes when sea surface temperatures haven risen by 1 degree C above the mean seasonal sea surface temperature in any one season (IPCC, 2002). Coral bleaching, the whitening of corals, is due to loss of symbiotic algae and/or their pigments due to thermal stress, pollution or disease.

Recently a group of international and local scientists developed the first hydrodynamic model for Palau. The model uses satellite data and oceanographic information (i.e. sea-surface temperature, water depth, and mixing arising from currents and tides) to help predict and map coral bleaching within the main archipelago.

In addition to coral bleaching, large-scale climate oscillations may influence the numbers and distribution of marine organisms, especially fish and other coral reef invertebrates, which Palau is heavily reliant upon for subsistence purposes. Variations in the biomass volume of marine organisms are dependent on water temperature and other climatic factors (IPCC, 2002).

6.2.5 Overfishing

Overfishing is a significant environmental, economic, and social problem facing virtually all marine ecosystems (Jackson et al. 2003). Few areas of the ocean remain unexploited and economics rather than technology now limit fishing efforts (Jennings et al., 2001). The increasing intensity of fishing throughout the world has had impacts on marine ecosystems beyond the impacts on target species, and these impacts are now the focus of many research and management programs (Botsford *et al.*, 1995; Dayton, 1998; Pauly *et al*., 1998). The overexploitation of a mixed fishery typically depletes stocks of large predators first (i.e. sharks and groupers), subsequently herbivorous fishes and planktivores become a more prevalent component of the catch (Bellwood et al. 2004).

Marine ecosystems are under continuously increasing pressure and the indirect effects of fishing can have more significant impacts on marine ecosystems' structure and dynamics than do removals of the fish themselves (Hughes, 1994; Botsford et al., 1995; Dayton, 1998). Dayton (1998) stated that: '…in most marine examples, the indirect effects of reductions of so many species are completely unknown because there are no baseline data for comparisons.' As a result trophic cascades from the removal of higher tropic levels, has shifted dominance and impacts of consumers to lower levels (Pauly et al., 1998; Steneck, 1998). Overfishing can create trophic cascades in marine communities that cause similar declines in species richness (Coleman and Williams, 2002) and these changes in trophic structure are easily observed in individual fisheries as reflected in global landing statistics (Jennings and Kaiser, 1998).

Presently, overfishing is not conclusively proven to be a major problem for Palau's inshore fisheries, but Palau lacks quantitative scientific studies on local fishery stocks. The only available data are composed of catches (including invertebrate species) sold to the local markets

and restaurants. Unfortunately this data is typically fragmented and inconsistent because it does not take into account local subsistence (e.g. customs and overseas exports to family). Many local fishermen, and officers of the Division of Fish and Wildlife Protection, report that certain species of fish are less common and smaller than they used to be, which could signify that overfishing is occurring. With the exception of some of the species caught by humans, such as the dugong, turtles, and some reef fishes, no species of marine life appear to be in immediate danger of extinction in Palau (Colin, 2004).

In contrast to Palau's inshore fisheries, offshore export fisheries pose a potential, but unknown, threat to Palau's marine environment because of enormous discrepancies in catch data. Palau's offshore fisheries are composed entirely of foreign longline and purse seine fleets, which target mainly tuna and billfish. Sisior (2004) reported a total of 90 longliners from China, Japan, and Taiwan, and 31 purse seiners from Japan were licensed to fish in Palauan waters in 2003. These boats landed an estimated 1720 metric tonnes of tuna (bigeye and yellowfin), 55 metric tonnes of marlin (black, blue and striped), 12 metric tonnes of swordfish and 26 metric tonnes of other miscellaneous species. Given the high level of uncertainty for catch data in Palau and the lack of any quantitative or qualitative studies, true levels of abundance of highly migratory fish species are unknown at present.

6.2.6 Sedimentation and Coastal Runoff (Development)

Sedimentation and subsequent nutrient input has been listed as a primary threat to coral reefs ecosystems (Birkeland, 1997) and their associated flora and fauna. The effects of run-off on coral reefs are well documented and the most studied impact on coral reefs (e.g. Brown and Howard 1985; Grigg and Dollar, 1990; Roger, 1990). Excessive sedimentation from anthropogenic or natural processes can adversely affect the structure and function of the coral reef ecosystems by altering both physical and biological processes (see review by Rogers, 1990). In the marine environment sedimentation can come from many sources, including land based activities, coastal and offshore construction, and dredging.

Sedimentation associated with runoff from coastal developments around Palau poses one of the most serious threats to water quality in the marine environment, particularly around the biggest island, Babeldaob. The rise in development activities on Babeldaob may result in tons of soil being transported each year into mangroves, seagrass beds, and coral reefs (Golbuu, 2003, Colin, 2004). A recent study conducted in Palau by the Palau International Coral Reef Center (PICRC) showed severe impacts of soil erosion on lagoon ecosystems. This study emphasized the importance of implementing sustainable land management practices in order to maintain ecosystem integrity (Golbuu, et al. 2004). Physical smothering may be the most obvious effect of sedimentation. In addition, a range of organic and inorganic chemicals used for fertilizer and pesticides in agriculture may contaminate runoff, and end up in marine ecosystems. Nutrient input from agriculture and sewage outfalls degrades reef systems by favoring the growth of algae and suspension-feeding animals rather than corals. It can also increase bioerosion rates by boring bivalves and sponges, and increase bacterial infections in corals (Birkeland, 1997).

Alteration of watersheds and associated changes in vegetative cover typically decrease the ability of the land to absorb rainfall, which flows through streams and rivers into nearshore areas. Runoff from developed watersheds carries higher sediment loads than undeveloped areas, a

result of erosion caused by improper development practices. Quantifying the effects of physical alteration of ecosystems affecting coastal and inshore areas is currently being done in Palau, mainly through research on sediment flow in particular watersheds. Victor et al. (2004) reported sediment yields of 10-19 times higher in one of Palau's river catchments, which has been cleared and farmed.

Coastal developments within Palau, especially road and other construction projects, present a wide range of challenges for coastal areas and inshore marine ecosystems. Road construction, dock improvements, land reclamation, and increasing population and intensity of land use have all contributed to increases in sedimentation. Marine habitat destruction of this nature creates the potential for species extinctions, especially where both endemism and human populations are high. During the community consultations conducted in connection with the development of this NBSAP, most communities on the island of Babeldaob identified sedimentation as one of their key concerns.

6.2.7 Invasive Species

Introduction of non-indigenous species is one of the most pervasive and irreversible impacts of human activities on natural ecosystems. In the marine environment, invasive species have been rated as one of the 4 greatest threats to the world's oceans. Marine ecosystems are particularly vulnerable to alien species invasions. Organisms can spread rapidly in marine environments and they are hard to detect. In addition, many control and eradication options used in terrestrial ecosystems cannot be used in marine environments.

Several marine invasive species have been identified in Palau (Colin, pers. comm.), however, at present it appears that none of these species are having a quantifiable effect on fisheries or the marine tourism industry. Despite this, marine invasive species do have the potential to become a serious problem within Palau. Introduced marine species have become a widespread occurrence with the advent of regular ocean transportation. Most marine invasive species in Palau come from a small group of marine invertebrates probably introduced as fouling on ship's hulls or from ballast water pumped out in harbors. Relatively little baseline information exists for the groups of marine invertebrates that are invasive species in Palau. The major groups of marine invasive species in Palau are the ascidians or tunicates (Phylum Chordata, Subphylum Urochordata), hydroids and other cnidarians (Phylum Cnidaria), molluscs (Phylum Mollusca), sponges (Phylum Porifera), bryozoans (Phylum Ectoprocta), and other small groups (Colin, *pers. comm.*).

Presently only one marine invasive species appears to have the potential for becoming a "pest" organism in Palau, and this is the hydroid *Eudendrium carneum*. This particular hydroid is a rapid growing species which has been found growing in at least three channels of Palau. *E. carneum* prefers rocky bottom substrates with particularly high currents, and often forms a tangle of branches that tends to accumulate sediment, making it a fairly unattractive "weed". As with any marine invasive species, *E. carneum* has the potential to spread throughout the marine environments (e.g. rocky bottoms) of Palau. *E. carneum* could potentially interfere with the feeding of bottom grazers, such as parrotfishes and surgeonfishes, which scrape algae from rock surfaces. In addition the masses of E. *carneum* tend to make rocky surfaces on the reef less visible and the reef look "dirty". At present, the current knowledge on the status and distribution

of *Eudendrium carneum* in Palau is very limited. It would be useful to survey the extent of its distribution at regular intervals.

There is always the potential for more introductions of marine organisms from fouling communities. For this reason, instruments and strategies to deal with marine invasive species should focus on the prevention of introduction and the early detection of introduced species.

6.2.8 Ship groundings and anchor damage

Palau has had numerous ship groundings in the last decade, all of which have contributed to coral reef damage. Many of these ship groundings have occurred on the western barrier reefs and southern lagoon, which are in close proximity to the main shipping channels. Ship groundings in Palau generally have only localized effects, but these groundings can be quite detrimental to the area they impact. When large vessels run aground and contact the reef, they can crush and break the substrate, killing corals and other sessile organisms eliminating topographic complexity (Precht et al. 2001). An additional impact of ship groundings is contamination by TBT anti-foulant on coral reefs which kills algae and invertebrates. The magnitude of the damage from groundings varies, depending on factors such as the size and speed of the vessel, the length of time the vessel remains grounded, and the procedures used to salvage or dislodge the ships. In a majority of ship groundings in Palau no restoration has been undertaken to re-claim these damaged reefs.

Fortunately, no major groundings in Palau have resulted in oil spills since the fighting during World War II. However, a recent oil spill in Yap, a neighboring island of Palau, gives a warning of what might potentially happen in Palau someday if better navigational markers aren't put in place. Aerial photos taken during that period show many Japanese ships with large amounts of oil in the lagoons of Palau (Colin, 2004)

6.2.9 Unsustainable tourism practices

Tourism is a major source of economic welfare and livelihood to many coastal communities. Currently tourism is the main industry and one of the most important sources of revenue in Palau. A recent estimate of the total economic value per year from tourism in Palau is $27.5 million. (Cesar et al. 2004). Unfortunately, the negative side effects of tourism may outweigh the benefits if it is not developed in a sustainable and responsible manner. Recreational uses of coral reefs in Palau include SCUBA diving, snorkeling, boating and yachting, fishing, and kayaking. Depending on the location of the reef, these uses are frequently enormous.

In 2004, The Coral Reef Alliance conducted a two-day workshop with tour operators and resource managers in Palau. The group ranked uneducated divers, lack of tourism enforcement, site crowding, and anchor damage as the top four unsustainable tourism practices in Palau. To mitigate such impacts of tourism often involves raising awareness and educating for behavior change. A zoning plan was proposed by workshop participants to minimize tourist impacts on sensitive sites. While the impacts of individual tourists are not huge, the growing numbers of tourists and greater accessibility to sensitive sites have resulted in larger negative impacts of tourism.

7. INFORMATION GAPS

7.1 Terrestrial Information Gaps

Conservation efforts in Palau are hindered by the fact that few studies have been done on Palau's terrestrial ecology and as a result there is little known about its terrestrial biodiversity in general (e.g. species populations and distribution, rare and endemic species, habitat requirements for birds and other fauna). This limits the ability to plan developments to minimize impacts on forest ecosystems or to plan a comprehensive terrestrial protected areas network that conserves representative samples of all ecosystems and habitats in Palau. Priorities for research are outlined below.

7.1.1 Surveys of endemic, rare, and endangered species

Rare and endemic species are the gemstones of biodiversity, deriving added value from their uniqueness and scarcity. This is especially true of small island diversity where typically small populations and limited habitat expose rare and endemic life forms to greater risk of extinction. For example, the risk of extinction for *Atherigona tobi*, an endemic fly from one of Palau's smaller islands, is likely greater than the risk for a related fly species, *A. theta*, that inhabits Australia. Populations of the continental endemic can withstand environmental stressors because the species is widespread and has a large choice of suitable habitat locations for refuge. A loss of 10 acres of habitat on the continent of Australia may have little impact on *A. theta* where an equivalent loss on the small Palauan island could mean the destruction of the only habitat available for *A. tobi*.

Further research requirements in forests include basic survey and taxonomy of plant and animal species present and field intensive surveys to determine forest subtypes, including the habitat of rare and uncommon species such as *Parkia parvifoliola*.

7.1.2 Habitat Studies

There is a need for increased understanding of the habitat needs of native species, particularly endemics (minimum viable areas, area needed for breeding populations etc.).

Of Palau's known assemblage of diverse native and endemic terrestrial species, little to nothing is known of their habitat requirements. Research into the life histories, ecology and biogeography of some of Palau's important pollinators and seed dispersers, such as some of the native birds and the fruit bat, would go a long way towards the knowledge which would allow for the management of healthy native forests in Palau.

In addition there is a need for research into forest revegetation on grassland areas and other barren areas in Babeldaob that continue eroding with every heavy rain. During the Japanese administration of Palau bauxite was mined in various parts of Palau, mainly in Ngardmau State in Babeldaob. The Japanese mined these areas from the late 1930s to mid 1940s, and to date little to no vegetation has been able to colonize these areas and effective reforestation methods have not yet been developed. The Forestry Unit initiated a study on native tree propagation, however due to limited staff , the study has been put on hold.

Another area of concern is the cataloguing of the insect species that pollinate endemic plants and that provide food for birds and other insectivores. Plant/pollinator relationships for most of

Palau's forest plants are largely unknown, yet the loss of a single pollinator species can have a profound impact on the diversity of a forest habitat. Similarly, the predator/prey relationships of Palau's insectivores are unknown. The dietary needs of insectivorous birds can be complex. Different birds exploit different assemblages of insect species and a single bird species may vary its diet depending on the bird's age, molting, reproductive status or on seasonal fluctuations in insect populations. A thorough understanding of the relationships between plants and their pollinators or between insectivores and their insect prey species enhances the effectiveness of programs for managing and preserving habitats of endangered or endemic plants and animals

7.1.3 Ecosystem processes and interactions

There is a great scarcity of data that can be used to inform basic resource-use decisions on Babeldaob. Overarching questions that need to be addressed include: What are the forms, magnitudes, dynamics, and spatial scales of linkages between terrestrial, coastal, and reef systems? How do these linkages influence key ecosystem properties that equate to valued services that must be maintained (eg. terrestrial and aquatic productivity, structure and maintenance of food webs, soil generation and retention, nutrient cycling, terrestrial and coastal hydrology/hydrography)?

Another broad area of research needed is to examine current resource use practices more closely to identify best practices and, in consideration of emerging scientific information, make recommendations to land-owners, resource users, and managers. For example, what are the impacts of different management interventions, and what aspects of traditional and local resource management approaches can be used in the modern Palauan context?

7.1.4 Socio-economic issues

In addition to these biological questions a range of social and economic questions must be explored. Important social science questions are: What are the factors influencing land-use and management decisions in Palau? What are the best ways to engage in the decision-making process to ensure conservation and sustainable development issues are properly considered? Are there tenure and conflict issues on Babeldaob and how do they affect resource-use decision making? How will the compact road affect the island's demographics and socioeconomic patterns? What are the impacts of the increasing foreign workforce on resource use patterns, resource management, and Palauan social structures in Babeldaob villages?

7.2 Marine Information Gaps

Due to Palau's remarkably high marine biodiversity (≈10,000 species) and wide variety of marine habitats there remain substantial gaps in our knowledge of Palau's marine environment (e.g. actual number of species including rare and endemic species, community structure within marine habitats). This in turn limits our ability to effectively manage and minimize impacts on Palau's marine ecosystems or to plan a comprehensive marine protected areas network that conserves representative samples of all ecosystems and habitats in Palau. Key research priorities are listed below.

7.2.1 Coral Reef Connectivity

Connectivity can be defined as the flux (movement) of items between locations. It exists for nutrients, sediments, and pollutants, but in the context of coral reef management, connectivity in the form of effective transfer of individuals (usually pelagic larvae) between local populations is the most important, and also the most difficult to measure. Presently, Palau lacks quantitative data on demographic connectivity, yet these data are essential to improve our ability to design and implement networks of Marine Protected Areas (MPAs) and other spatially explicit management systems. The design of MPAs containing coral reefs and their implementation uses educated guesses to decide appropriate spatial scales and patterns of placement, however there is little information to determine whether these guesses are even approximately correct. As levels of direct exploitation on Palau's coral reefs increase, and as other pressures on the coastal environments intensify, it is extremely important that the establishment of spatially explicit management be carried out at correct spatial scales that are compatible with known patterns of "connectivity" of target populations.

7.2.2 Increased Taxonomic Inventories

Knowledge of species that occur in an area is an important first step towards any analysis of conservation needs and priorities (Colin, 2004). While taxonomic knowledge of Palau's marine species is reasonably good for some groups of organisms it is almost totally lacking for others (Colin, 2004). Taxonomy is a never-ending process and basic knowledge of species that occur in an area is an important step in understanding and conserving environments. Without such basic understanding, conservation efforts focused on management of ecosystems will be much less effective. More effective taxonomic inventories are needed to determine what species are present, how they are distributed, their community structures, and in what abundance they inhabit the Palauan waters. This will help provide essential information to guide management policies that currently focus of the marine protected areas and its regulations.

7.2.3 Standardized Coral Reef Monitoring

Coral reefs are subject to a high rate of recurrent biological, physical and sometimes anthropogenic disturbances. Baseline data is essential for determining the overall health and/or impacts that these disturbances have on an area. However, the repetitive and detailed monitoring required to produce results that are robust and statistically testable are generally beyond the capability of developing countries such as Palau. Palau needs a more standardized system for the collection of baseline data to survey and monitor target areas within the marine environment. Furthermore, the analysis of this information must be standardized in such a way that it will be in a format useable by all related or involved organizations, programs, projects or agencies. In addition, the proper gathering and management of this information is crucial to ensuring it is useable, beneficial and valuable to management entities, environmental agencies, research organizations, and other stakeholders.

7.2.4 Habitat mapping

Habitat mapping is a multidisciplinary task that combines physical, biological, oceanographic, and chemical components of the seafloor (e.g. coral reefs, seagrass beds, mangroves). Data on substrate type, topography and biological species are necessary to create an accurate picture of a

habitat. The mapping process will enhance the information gathering capacity of Palau regarding coral reefs and will provide critical information for establishing effective management, designing research activities, conducting damage assessments, tracking trends and patterns, evaluating the results of management efforts and building local capacity.

In addition to the above, there are numerous other gaps in information on marine biodiversity in Palau. A partial listing is provided below:

- Quantitative assessment of coral disease prevalence
- Enhanced reef, seagrass, and mangrove mapping and bathymetry
- Qualitative reef fish assessments
- Sedimentation and runoff rates
- Marine lakes
- Deep sea communities
- Detailed inshore current profiles
- Crown of thorns reproductive schedule
- Outer reef, coral reproduction studies

8. STRATEGY AND ACTION PLAN

A series of multi-sectoral discussions and meetings, and community consultations in all 16 states, were held in order to discover issues, themes, and local concerns regarding biodiversity in Palau. The state consultations were particularly important in identifying issues and actions that are important at the community level. A set of eight strategic themes, with objectives and actions were developed at two national workshops attended by representatives of national government, state government, non-government organizations, and the private sector. The themes, objectives and actions are based on the guiding principles developed for the successful long-term preservation, conservation, and sustainable utilization and management of Palau's biodiversity. The eight strategic themes are:

1. ***Protected/Managed Areas***
2. ***Species Protection***
3. ***Biosecurity – Invasive Species and Biosafety***
4. ***Sharing Benefits of Genetic Resources***
5. ***Sustainable Economic Development***
6. ***Prevent or Minimize Waste***
7. ***Agricultural Biodiversity***
8. ***Mainstreaming of Biodiversity Conservation***

The above **themes** each have a **vision** and **goal**. We believe that the effective pursuit of these goals will steer our nation on a sustainable voyage toward the overall NBSAP Vision. Each goal will be achieved through the fulfillment of **objectives**, which have been identified as priority areas that must be addressed to enable the sustainable use and management of the Republic's biodiversity.

Each objective will be reached through a list of required **actions** necessary for the accomplishment of the objective, and thereby further contributing to the achievement of the strategic goal for each theme. The actions have been carefully developed to be realistically achievable within a relative short time frame and within the current human resource capacities and financial constraints of the Republic. It is, however, clearly acknowledged that considerable time and effort from all sectors of the Republic will be required to achieve the Vision of this NBSAP. Financial and technical assistance from outside the Republic is also acknowledged and will be required to achieve the vision and goals of the NBSAP.

9. IMPLEMENTATION AND MONITORING

9.1 Overview

The legislative and institutional framework of the Republic of Palau includes both National and State constitutions. The national constitution of the Republic of Palau is the basis for all legal authority and decision making for the nation. Under Article I, Section 2 of the Constitution of the Republic of Palau, each state "has exclusive ownership of all living and nonliving resources, except highly migratory fish, from the land to twelve nautical miles seaward of the baseline." Ownership and management of terrestrial resources is more complex; land is owned by individuals and clans as well as by States and the National government. Much state and national land is managed by state and national Public Land Authorities.

Management of natural resources has traditionally been the responsibility of local communities, although, in many cases, the capacity to do this has eroded over the years. It is essential that a partnership among traditional leadership, national and state governments, non-governmental organizations, and the private sector of Palau be engaged to implement the National Biodiversity Strategy and Action Plan.

The planning and development of national, state, and community implementation programs and projects will be based on the results of the NBSAP national and community consultations. This process will require additional multi-sectoral consultations to define and prioritize the specific programs and steps towards successful implementation. The programs and projects developed will directly address the issues highlighted in the strategic themes outlined in this report. Close collaboration with traditional leaders – both men and women – and with local communities and non-governmental organizations and the private sector will be essential for successful implementation of the NBSAP.

The National Government will take the lead in implementation and monitoring of the NBSAP, in full partnership with the State governments, national and state Public Land Authorities, traditional leaders, and local communities. The lead national government implementing and monitoring agency will be the Ministry of Resources and Development. As outlined in Theme 8, Mainstreaming, however, successful implementation of the NBSAP will involve all government agencies and other stakeholders. It will therefore be essential to ensure coordination of projects and collaboration among implementers.

Both National and State government agencies have the responsibility to provide the necessary technical skills and human resources required to enable the successful implementation of individual programs and projects. Currently technical and financial capacity to implement some of the actions outlined in this Strategy and Action Plan is insufficient in many government agencies. Therefore, capacity building and institutional strengthening programs are an integral component and will be incorporated into each program and project.

The National government will be required to evaluate each project for compliance with National legislation and international conventions, provide capacity building and institutional strengthening, and be accountable to financial sources. State governments will be required to evaluate for compliance with State laws and policies, be financially accountable to the National

government and donor agencies for each project, and provide capacity building and institutional strengthening. Local communities and organizations that are the implementers of the NBSAP will be required to monitor and evaluate, and provide information pertaining to progress of each project, as well as to document and monitor the status of the biodiversity health and threats within individual projects, provide capacity building opportunities, and provide financial accountability to their respective government and donor funding agencies.

The National Environmental Protection Council (NEPC) and the Ministry of Resources and Development (lead agency), through the NBSAP Panel and the NBSAP Coordinator, will provide continued national government guidance, support, and assistance to stakeholders in the development of programs and projects for implementation and monitoring of the NBSAP.

9.2 Priority Issues and Actions from Community Consultations

Meetings were held with community groups from all of Palau's 16 states over several months in 2003 and 2004. These meetings were facilitated by staff of the Palau Conservation Society (PCS) and the Office of Environmental Response and Coordination (OERC). The meetings were held in community centers and meeting areas in each state to encourage wide participation among local residents. The goals of the meetings were to identify and prioritize issues and local actions that could be implemented by states and communities regarding protection and maintenance of local biodiversity. The summarized results of these meetings are included in the Appendix (Priority Issues and Actions from Community Consultations in all States). This Appendix shows the priority issues at the local community level in each state, with prioritized ideas for local actions to address those issues. The issues and actions identified by the local communities, and the actions that appear as part of this NBSAP are complementary. The NBSAP actions in Chapter 8 are national level actions identified during two national planning workshops, while the actions listed in the Appendix are more specific to local community needs. While the community actions are quite specific to the local situations, a number of them addressed the need for wider national government assistance.

9.3 Management Structure for Implementing the NBSAP.

9.3.1 Current Situation

The National Environmental Protection Council (NEPC) is the Steering Committee for development of the NBSAP. The NEPC is a multi-sectoral group that includes representatives from national government and non-government organizations. The NEPC created an Ad Hoc Planning Committee to oversee development of the NBSAP. The Project Manager (NBSAP Coordinator) for development of the NBSAP is located in the Office of Environmental Response and Coordination.

9.3.2 Recommended Management Structure for Implementation

Based on the current management structure of the Republic, it is recommended that the Ministry of Resources and Development be the lead National government implementing and monitoring agency for the NBSAP. However, successful implementation of the NBSAP will involve all National government agencies, in partnership with State governments, local communities, non-government organizations, and the private sector. Therefore, coordination of the implementation efforts will be essential. To ensure coordination of implementation efforts, the National

Environmental Protection Council (NEPC) will guide and coordinate the implementation of the NBSAP. The NEPC will create an NBSAP Panel to coordinate and monitor implementation of the NBSAP. This panel should be similar in structure and membership to the current NBSAP Ad Hoc Planning Committee.

To carry out the directives of the NEPC and the NBSAP Panel, a National NBSAP Implementation Coordinator position will be created in the appropriate National government agency, as determined by the President upon the recommendation of the NEPC. This individual will coordinate the implementation of the NBSAP, working closely with National government agencies, State governments, traditional leaders and their communities, non-governmental agencies, and the private sector. This individual will also coordinate cooperation with international bodies and organizations, and represent the Republic at international meetings.

The role of the NBSAP Coordinator, guided by the NBSAP Panel, therefore is to:

- Identify lead agencies and ensure collaboration among all agencies (National and State) on the implementation of specific actions identified in the NBSAP;
- Monitor and recommend appropriate actions regarding the implementation of the NBSAP;
- Discuss biodiversity issues and be the nation's mediator and representative to regional and international biodiversity related conferences and meetings;
- Facilitate and assist with the dissemination of biodiversity related materials to all stakeholders;
- Coordinate and facilitate interstate collaboration for all biodiversity programs and projects;
- Maintain and update a list of all biodiversity related projects undertaken within the Republic;
- Facilitate and assist expert groups to undertake biodiversity related projects when required;
- Initiate monitoring programs to assess the effectiveness of the NBSAP in managing and sustaining Palau's biodiversity; and
- Coordinate activities carried out under the UNCBD with national activities under the UNFCCC, UNCCD, and related international agreements.

9.3.3 Implementation Priorities

Implementation priorities should be based on the eight Themes identified in the NBSAP itself, the priority issues and actions from community consultations, and on emerging priorities identified during the implementation and monitoring process.

9.4 Local Expert Panels

Implementation of the NBSAP requires the collection and analysis of scientific, economic, and socio-economic data. To obtain this information and to provide useful recommendations on appropriate actions to be taken, relevant expert panels will be required. It is recommended that local expert panels be formed to undertake such tasks wherever feasible. Panel members should include representatives from National and State governments, communities, NGO's, institutions of higher learning (Palau Community College), private consultants, and the private sector.

Membership in such panels should be based on recommendations of the NBSAP Panel and other relevant agencies. It is acknowledged that specific scientific skills required to develop the Republic's biodiversity program may not always be available within the Republic and that technical assistance from outside Palau will in such cases be required.

9.5 Regional and International Linkages

To advance the development of the Republic's biodiversity program, especially the programs associated with the implementation of the NBSAP, strong associations and links need to be made and maintained with relevant regional and international organizations and private companies to provide needed skills and expertise when required. It is expected that these organizations will work closely with the local expert panels and include local capacity building program components in all activities. Therefore, the Republic needs to identify all regional and international agencies and organizations which can assist these programs, and utilize these external resources when necessary.

9.6 National Biodiversity Database and Clearinghouse

To ensure the continual access of government agencies, statutory bodies, non-governmental organizations, local communities, and the private sector to the best available information on the sustainable management of Palau's biodiversity, a formal clearinghouse mechanism needs to be established. This mechanism should be developed in the form of a national biodiversity database to store the information, and to facilitate access to and dissemination of this information to decision-makers, national government agencies, state governments, traditional leaders, local communities, non-government organizations, and the general public.

To function effectively, it is recommended that all relevant information pertaining to the Republic's biodiversity should be deposited at a national biodiversity clearinghouse. This should include both digital and printed copies of all published documents and reports, including all gray literature. All government agencies will be required to deposit relevant documents at the clearinghouse. Non-government organizations and other institutions will be encouraged to do so as well. The successful development of this database and clearinghouse will require full cooperation and support of all National and State government agencies, NGO's, and the private sector.

9.7 Monitoring

The assessment and continued monitoring of all NBSAP actions undertaken in the future are integral components of the Republic's biodiversity program. Careful evaluation and monitoring of such action programs need to be undertaken to ensure that projects are indeed producing useful results and therefore meeting the goals and objectives of the NBSAP. Long-term monitoring programs to track changes in the status of biological resources will serve as indicators of the effectiveness of implementation. In addition, monitoring of socio-economic indicators will help track the impact and effectiveness of programs. Threat-based monitoring programs will be implemented to track changes in intensity and severity of threats to biodiversity and will provide additional information to support biological monitoring data (e.g., aerial photography and vegetation mapping). The monitoring program should utilize information from

the National Biodiversity Database, with additional information collected from specific field surveys and evaluations when required. The National Biodiversity Database will also house the monitoring data collected in order to facilitate long-term monitoring of changes to biodiversity in Palau.

Monitoring of program outcomes, effectiveness, and progress will be incorporated into each implementation project and program to provide a mechanism to evaluate all biodiversity projects undertaken within the Republic. An achievable and measurable monitoring plan will be required as part of all proposals developed under the biodiversity implementation program. A working partnership between the National government, State governments, non-government organizations, and local communities is required to allow the successful evaluation of these programs, with each entity having specifically defined roles, objectives, and requirements. It will be necessary to increase the capacity to monitor projects and outcomes, especially at state and local levels.

9.8 Reporting

The national government is responsible for the reporting and dissemination to all stakeholders of information pertaining to all NBSAP programs. This will be the responsibility of the National NBSAP Coordinator, with the guidance of the NBSAP Panel. A mechanism to effectively distribute updates and progress reports on all biodiversity related programs and activities will be established and coordinated by the National government. This mechanism must include participation and assistance from all relevant agencies and organizations.

10. APPENDIX: Priority Issues and Actions from Community Consultations in all States

10.1 Aimeliik

10.1.1 Priority Issues

Crop diseases and invasive plants and animals
Dangerous animals and pests
Decline of fish and invertebrates (including sea mammals)
Fire; burning of savannas and forests
Pollution (household and commercial chemicals, vehicles, motors, etc.)

10.1.2 Priority Actions

Bring experts in to assist with crops diseases
Designate boat route
Develop and establish public awareness campaign on fires, wild animals, etc.
Restrict/limit the use of pesticides, herbicides, and all imported toxic chemicals
Strengthen enforcement of EQPB regulations on disposal of batteries, waste oil and chemicals

10.2 Airai

10.2.1 Priority Issues

Destructive fishing methods
Erosion, sedimentation and silt, along with household and commercial chemicals
Filling of mangrove and mangrove growth
Impacts of development (businesses and housing), especially on water sources, mangroves, plants and animals
Loss of traditional knowledge, practices, and ethics
Solid waste dumping area

10.2.2 Priority Actions

Request National and State governments to speed up the clean-up of existing dump site for health purposes (urgent)
Request National Government to assist the State to develop Airai land use plan including a sewer system
The State clarify existing marine laws, develop needed laws, and hire marine law officers
The State, with hamlet representatives, conduct a study on erosion, sedimentation and impacts of burning, and request assistance from National Government
Traditional leaders (men and women) and hamlet representatives spearhead a project to clean and maintain Airai mangroves
Traditional leaders (men and women) develop an educational program to revive traditional knowledge, practices, skills, and ethics

10.3 Angaur

10.3.1 Priority Issues

Dangerous animals; pests
Diseased crops; invasive species
Increase of non-resident users
Loss of traditional knowledge, practices, and ethics
Poaching (foreign fishing)

10.3.2 Priority Actions

Create and enforce legislation to prohibit foreign fishing and split fines between National and state government
Hold a community meeting to discuss how to restore traditional knowledge, practices, and ethics
Request assistance from Bureau of Agriculture to cure diseased crops and resolve invasive plant problems
Request USA and Germany to provide assistance in eradicating the monkeys and the shrews that were introduced by their citizens
Seek funding to reinstate bounty on monkeys and shrews

10.4 Hatohobei

10.4.1 Priority Issues

Loss of traditional knowledge, practices and ethics (cultural and social)
No development due to lack of adequate and regular transportation
Pests; crop diseases
Poaching (foreign fishing)
Shoreline erosion
Shortage of freshwater sources

10.4.2 Priority Actions

Develop and implement cultural and social program and activities to revive traditional knowledge, practices and ethics
Identify/eradicate/control pests and prevent new pests from entering the islands
Improve existing transportation to be more regular and adequate
Increase the number of patrols to the Southwest islands
Provide more water tanks or other freshwater sources
Request feasibility study to find out causes of shoreline erosion and to suggest solutions

10.5 Kayangel

10.5.1 Priority Issues

Decline and overharvest of invertebrates
Decline of fish
Increased impacts of speed boats
Solid wastes

10.5.2 Priority Actions

Create conservation areas
Designate boat routes to reduce boat impacts on shallow area where fish and invertebrates live
Increase marine law enforcement to combat illegal dumping
Regulate type of boat engine to be used (4 stroke)
Strengthen enforcement regarding non-resident and non-users

10.6 Koror

10.6.1 Priority Issues

Decline of fish
Erosion; sedimentation
Loss of traditional knowledge, practices and ethics
Sewer discharge and hook-up

Waste dumping area

10.6.2 Priority Actions

Close, clean and remediate dump area at M-Dock
Develop maintenance plan for catchment basins and seek funding to construct and implement catchment basins
Seek funding to conduct a study of use of traditional knowledge and customary laws to control and manage natural resources
Seek funding to conduct a study through PICRC to determine the cause of declines of fish
Seek funding to construct emergency sewage discharge basin for all 42 pump stations

10.7 Melekeok

10.7.1 Priority Issues

Decline of fish and ocean mammals
Dredging
Erosion, sedimentation and filling of mangroves
Loss of traditional knowledge, practices and ethics
Shallowing of nearshore areas

10.7.2 Priority Actions

EQPB monitor and check areas affected by erosion and sedimentation once a month and report to the State
Equal enforcement of environmental regulations for all projects at all levels
National and State Governments conduct feasibility study on sand removal to find out if it relieves pressures on the seagrass areas and make seagrass areas once again habitable [find ways to lessen impacts of sediment on seagrass beds]
State conduct survey and collect data to find causes of declines of fish and ocean mammals
State Government inform National Government about issues detrimental to the State
Traditional leaders (men and women) educate the community members on traditional knowledge practices, and ethics

10.8 Ngaraard

10.8.1 Priority Issues

Crop diseases
Dangerous animals; pests
Destructive fishing methods
Development
Loss of traditional conservation knowledge, practices and ethics
Polluted air, ocean, freshwater, and soil

10.8.2 Priority Actions

Develop educational program to revive traditional conservation knowledge, practices and ethics
Develop good water system and improve potable water
Establish eradication program for crocodile, rats, monitor lizard, and wild cats and dogs
Establish speed boat route
Find cure for crop diseases and establish eradication program
Find good development system and follow it

10.9 Ngarchelong

10.9.1 Priority Issues

Declines of fish
Dredging; siltation
Erosion; sedimentation
Increased boat use
Waste dumping areas

10.9.2 Priority Actions

Clean up the existing dump site and develop a management plan for the site
Develop fisheries management plan
Enforce environmental regulations and give fines to impacted states
Identify and designate boat routes
Improve drainage systems to include sediment filters and catchments
Install and maintain sedimentation curtains

10.10 Ngardmau

10.10.1 Priority Issues

Burning; fire
Dangerous animals; pests
Erosion; sedimentation
Poor soil

10.10.2 Priority Actions

Develop and implement reforestation and revegetation program at bauxite mines and all bare areas
Establish an eradication and control program for dangerous animals especially wild pigs and rats
Establish and implement “real education” regarding burning and fire, a main cause of erosion and sedimentation
Improve coordination between CIP/EQPB and contractors (state)
Purchase and distribute wild and dangerous animal traps to states

10.11 Ngaremlengui

10.11.1 Priority Issues

Dangerous animals (especially wild pigs, dogs and cats)
Declines of fish, invertebrates and other ocean animals (due to overfishing and overharvesting)
Diseased crops and invasive species
Erosion; sedimentation
Loss of traditional knowledge, practices and ethics

10.11.2 Priority Actions

Conduct research to find out the cause(s) of fish depletion
National Government create traditional education program at state level
National Government hire and deputize state officers to kill pigs, wild dogs, wild cats and other pests
OEK establish legislation to have fines from National Government's negative environmental impacts go directly to the states that suffered the impact

10.12 Ngatpang

10.12.1 Priority Issues

Declines of fish; increased boat use
Declines of invertebrates
Erosion and sedimentation
Filling and killing mangrove
Loss of traditional knowledge, practices, and ethics

10.12.2 Priority Actions

Aquaculture implementation
Conduct research on fish
Establish awareness program and conduct public hearings about overharvest of invertebrates and ways to revitalize traditional knowledge
Establish fishing conservation area
Study life cycle of sea cucumber

10.13 Ngchesar

10.13.1 Priority Issues

Declines of fish (due to overfishing)
Erosion; sedimentation
Invasive plants and animals
Poor development and habitat destruction

10.13.2 Priority Actions

Develop improvement and management plan for development that includes emergency response measures
Empower states to impose fines for negative environmental impacts
Establish eradication program of invasive species and establish control program for crocodiles
Establish guidelines/rules and enforce existing regulations for development projects.
Provide manpower and capacity building to the State to enforce and manage declines of fish and invertebrates

10.14 Ngiwal

10.14.1 Priority Issues

Declines of fish
Declines of invertebrates
Environment is not good
Filling of mangroves
Loss of traditional knowledge, practices and ethics
Poor development; habitat destruction

10.14.2 Priority Actions

Develop aquaculture programs
Develop coastal management plan to be implemented and enforced by all stakeholders
Re-enforce traditional conservation practices
Review and implement Ngiwal master plan
Revitalize cultural programs and practices
The community will conduct a survey to identify areas suitable for different types of restoration activities. The State will develop a mangrove restoration program before requesting assistance from the National Government.

10.15 Peleliu

10.15.1 Priority Issues

Declines of fish
Erosion and sedimentation
Loss of traditional knowledge, practices and ethics
Poor compliance with regulations
Poor soil

10.15.2 Priority Actions

Develop and implement awareness program through media and public meetings
Request National Government to assist State to develop aquaculture farm
Request National Government to assist the State to improve drainage and discharge system.

Request National Government to provide technical assistance on agricultural development on sandy and porous soils
Traditional leaders (men and women) will work with community to restore and revive traditional knowledge, practices and ethics

10.16 Sonsorol

10.16.1 Priority Issues

Crops diseases and pests
Limited and scarce freshwater sources
Loss of traditional knowledge, practices and ethics
No development due to lack of regular transportation

10.16.2 Priority Actions

Establish quarantine policies and procedures regarding transportation of crops and animals between the ports of Koror and the Southwest islands
Request National Government to conduct research on Sonsorol water sources that looks at capacity of water table, water quality, sustainability, etc.
Request National Government to work with the State to establish regular transportation to support needs of the State
Seek funding to hire an expert to assist the State in economic development planning
Seek funding to support programs that will preserve and facilitate the transfer of traditional knowledge, practices, ethics and folklore from elders to the youth

10.17 Summary of Priority Issues

Issue	*No. of states*	*States*
Loss of traditional conservation knowledge, practices and ethics	11	Airai, Angaur, Hatohobei, Koror, Melekeok, Ngaraard, Ngaremlengui, Ngatpang, Ngiwal, Peleliu, Sonsorol
Declines of fish	10	Aimeliik, Kayangel, Koror, Melekeok, Ngarchelong, Ngaremlengui, Ngatpang, Ngchesar, Ngiwal, Peleliu
Erosion and sedimentation	9	Koror, Melekeok, Ngarchelong, Ngardmau, Ngaremlengui, Ngatpang, Ngchesar, Ngiwal, Peleliu
Crop diseases	6	Aimeliik, Angaur, Hatohobei, Ngaraard, Ngaremlengui, Sonsorol
Dangerous animals; pests	5	Aimeliik, Angaur, Ngaraard, Ngardmau, Ngaremlengui
Invasive plants and animals	4	Aimeliik, Angaur, Ngaremlengui, Ngchesar
Polluted air, water (saltwater and freshwater) and soil; poor environment	4	Aimeliik, Kayangel, Ngaraard, Ngiwal
Waste dumping area and garbage	4	Airai, Kayangel, Koror, Ngarchelong
Poor development; impacts of development	4	Airai, Ngaraard, Ngchesar, Ngiwal
Filling of mangroves, dead mangroves and overgrowth of mangroves	4	Airai, Melekeok, Ngatpang, Ngiwal
Increased boat use	3	Kayangel, Ngarchelong, Ngatpang
Poor or reckless development	4	Airai, Ngaraard, Ngchesar, Ngiwal
Declines of invertebrates	3	Kayangel, Ngatpang, Ngiwal
Shortage of freshwater	2	Hatohobei, Sonsorol
Poaching; foreign fishing	2	Angaur, Hatohobei
No development due to lack of regular transportation	2	Hatohobei, Sonsorol
Dredging; siltation	2	Melekeok, Ngarchelong
Burning; fire	2	Aimeliik, Ngardmau
Filling of mangroves	4	Airai, Melekeok, Ngatpang, Ngiwal
Declines of invertebrates	3	Kayangel, Ngatpang, Ngiwal
Destructive fishing methods	2	Airai, Ngaraard
Coral bleaching and death	1	Ngiwal
Shoreline erosion	1	Hatohobei
Shallowing of nearshore areas	1	Melekeok
Sewer discharge and hook-up	1	Koror
Increased non-resident users	1	Angaur
Poor soil	1	Peleliu
Poor compliance with regulations	1	Peleliu

11. GLOSSARY

For the purposes of the Convention on Biological Diversity and this NBSAP:

"**Biological diversity**" means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

"**Biological resources**" includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

"**Biotechnology**" means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

"**Country of origin of genetic resources**" means the country which possesses those genetic resources in *in-situ* conditions.

"**Country providing genetic resources**" means the country supplying genetic resources collected from *in-situ* sources, including populations of both wild and domesticated species, or taken from *ex-situ* sources, which may or may not have originated in that country.

"**Domesticated or cultivated species**" means species in which the evolutionary process has been influenced by humans to meet their needs.

"**Ecosystem**" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

"***Ex-situ* conservation**" means the conservation of components of biological diversity outside their natural habitats.

"**Genetic material**" means any material of plant, animal, microbial or other origin containing functional units of heredity.

"**Genetic resources**" means genetic material of actual or potential value.

"**Habitat**" means the place or type of site where an organism or population naturally occurs.

"***In-situ* conditions**" means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"***In-situ* conservation**" means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"**Protected area**" means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

"**Sustainable use**" means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

"**Technology**" includes biotechnology.

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Theme 1. – Protected/Managed Areas					
Vision: Sufficient areas of all ecosystems and habitats in Palau are included in a well planned and managed system of protected areas that will play a central role in ensuring the long term survival of the full range of biodiversity in Palau while helping to meet the needs of current and future generations.					
Goal: To establish within ten years a network of adequately funded and effectively managed protected areas that includes representative areas of all ecosystems and habitats in Palau.					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *To develop an effective management framework for the designation and long term sustainable management of protected areas, including sustainable funding mechanisms*	**1.1** Develop and implement national coordination mechanisms, criteria and regulations under the Protected Areas Network Act (PAN).	Finance, Technical Assistance	MRD	Immediate, On-going	Criteria and regulations in place.
	1.2 Seek international and national funding to support the development and implementation of the PAN and individual sites.	Human resources	MRD	Immediate, On-going	Funding secured
	1.3 Develop sustainable funding mechanisms to support protected area management.	Human resources	MRD	Immediate, On-going	Funding mechanisms in place
	1.4 Develop education and awareness programs for protected/managed areas, merging traditional and modern concepts.	Finance, Human resources	MRD States	Immediate, On-going	Programs in place
Objective 2: *To identify through scientific and traditional knowledge all areas that should be protected and managed to satisfy biodiversity conservation and resource management objectives*	**2.1** Conduct scientific studies to identify and map ecosystems and habitats and areas important for protecting rare, endangered, or endemic species, or for maintaining ecosystem process.	Finance, Human resources	MRD	Medium	Reports of studies and maps
	2.2 Identify conservation requirements for each ecosystem or habitat type.	Finance, Human resource	MRD	Medium	Requirements identified
	2.3 Undertake a review of existing protected areas to identify gaps and priorities for future protected areas.	Finance, Human resources	MRD	Medium	Future protected areas proposed

	2.4 Undertake consultations with all relevant stakeholders to identify priority areas for inclusion in the network.	Finance, Human resources	MRD, OERC	Medium	Records of consultations
Objective 3: *To ensure all protected areas have adequate and appropriate legislative and/or traditional support*	**3.1** Support states in designating protected areas through legislative or traditional means as appropriate, and in nominating them for inclusion in the Protected Areas Network.	Finance, Technical assistance	MRD, States	Medium to Long-term	Number of protected areas designated and total area
Objective 4: *To develop and implement appropriate management strategies for each of the identified areas*	**4.1** Develop site-specific management plans.	Technical assistance, Human resources	MRD, States	Long-term	Management plans in place
	4.2 Build management capacity at national, state and community levels.	Finance, Technical assistance	MRD, States	Long-term	Management activities successfully implemented at all levels
	4.3 Undertake research to identify and understand biological processes necessary to maintain the viability of habitats and communities.	Finance, Technical assistance	MRD	Medium to Long-term	Reports of studies with management recommendations
	4.4 Provide support to develop opportunities for sustainable development in and around protected/managed areas	Finance, Technical assistance	MRD, States	Long-term	Number of sustainable development projects in place. Analysis of benefits
Objective 5: Develop and implement appropriate monitoring and evaluation processes for protected areas.	**5.1** Develop appropriate monitoring and evaluation plan	Technical assistance	MRD	Short-term	Monitoring and evaluation plan being used with regular report of results
	5.2 Build capacity at national, state and community levels to monitor and evaluate protected areas	Finance, Technical assistance	MRD, States	Medium to Long-term	Monitoring activities successfully implemented at all levels

Theme 2. –Species Protection					
Vision: Palau's biodiversity, especially all native and endemic species, is conserved through maintenance and restoration of healthy populations and ecosystems within the Republic of Palau.					
Goal: To maintain functional populations of native, endemic (especially threatened and endangered species) and their habitats.					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *To develop a comprehensive inventory of species to identify and prioritize their importance and status.*	**1.1** Conduct national taxonomic needs assessment (DIVERSITAS Systematics Agenda 2000 Guidance)	Finance, Technical assistance	MRD (PICRC, BNM, OERC)	Long-term, On-going	National comprehensive needs assessment report.
	1.2 Conduct national surveys to inventory biodiversity in order to identify species that require specific management strategies from the national needs assessment.	Finance, Human resources, Technical assistance	MRD (TNC, PAN, MRD, OERC, PICRC)	Long-term, On-going	National comprehensive species lists.
Objective 2: *To develop appropriate and specific management strategies to conserve biodiversity, particularly, high priority species.*	**2.1** Develop management/recovery and monitoring plans for high priority species, including threatened and endangered species	Finance, Human resources, Technical assistance	MRD	Medium	Management and monitoring plans developed
	2.2 Implement species protection especially by designation of management areas, which protect important habitat for target species.	Finance, Human resource	MRD	Medium	Areas designated and management plans in place
	2.3 Incorporate traditional management practices into species protection strategies.	Finance, Human resources	MRD	Medium	Strategies developed
	2.4 Enact effective endangered and threatened species regulations	Finance, Human resources	MRD	Immediate to Short-term	Criteria and regulations in place
	2.5 Identify lead agencies and build capacity to implement and enforce the Endangered Species Regulations.	Human resources	MRD, MOJ	Short-term	Agencies identified, regulations implemented and enforced successfully at all levels

	2.6 Support implementation of relevant international instruments and conventions.	Finance, Human resources	OERC	On-going	International conventions implemented
	2.7 Seek opportunities for international cooperation for species with regional range.		MRD	Medium	Successful international cooperation
	2.8 Seek and develop funding options for species-specific conservation programs	Finance, Human resources	MRD	Medium	Funding mechanisms in place

Theme 3: Biosecurity/Invasive Species & Biosafety					
Vision: Palau is free of damaging invasive species or Living Modified Organisms.					
Goal: To protect Palau's biological diversity from negative impacts of invasive species and Living Modified Organisms (LMOs) through prevention, mitigation, and management.					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *Provide a framework and capacity for ongoing prevention and management of invasive species*	**1.1** Assign clear responsibilities to governmental bodies and agencies for prevention, detection, rapid response, eradication, and long-term management of invasive species	Human resources	NEPC MRD	Immediate to Short-term	Clear assignments made
	1.2 Review and update national and state legislation and regulations related to invasive species	Human resources	MRD	Short to Medium-term	Report of review, Updated legislation and regulations
	1.3 Assist state governments, communities, NGOs, and private citizens to identify their own responsibilities for invasive species prevention and management	Finance, Human resources, Educational materials	MRD	Medium-term	Records of activities, Review of changes
	1.4 Build national capacity for research, education, and enforcement with regard to invasive species	Finance, Technical assistance	MRD	Medium to Long-term	Records of activities, Improved research, education, and enforcement
	1.5 Develop and implement strategic plans for management of invasive species	Human resources	NISC MRD	Short to Medium-term	Plans in place, Records of implementation
Objective 2: *Prevent the development of new problems with invasive species*	**2.1** Prevent the introduction of new species with the potential to become invasive	Laws and regulations, Finance, Human resources	MRD	Immediate, Ongoing	No new harmful introductions
	2.2 Ensure early detection of, and rapid action against, new introductions of potentially invasive species	Finance, Human resources	MRD	Immediate, ongoing	New introductions responded to
	2.3 Prevent or reduce the spread of invasive species within Palau, especially from one island to	Finance, Human resources	MRD, States	Short-term, Ongoing	New national and state laws &

	another				regulations, Enforcement
Objective 3: *Reduce the impact of existing invasive species in Palau*	**3.1** Identify, assess, and prioritize established invasive species for appropriate management action, including control and/or eradication	Finance, Human resources	MRD NISC	Short-term, Ongoing	Prioritized lists
	3.2 Reduce negative impacts of established invasive species through integrated, cost-effective, and sustainable management	Finance, Human resources	NISC MRD	Immediate, Ongoing	Reports of successful management efforts
Objective 4: *Prevent the development of new problems with Living Modified Organisms (LMOs)*	**4.1** Develop and implement a comprehensive legislative framework for Biosafety, in accordance with international conventions	Finance, Human resources, Technical assistance	MRD, MOJ	Short-term, Ongoing	Legislation enacted and implemented
	4.2 Build national capacity for research, education, and enforcement with regard to LMOs	Finance, Human resources, Technical assistance	MRD	Medium- to Long-term	Evidence of improved management
Objective 5: *All sectors of Palauan society will support the appropriate management of invasive species and LMOs*	**5.1** Develop and implement both general and species-specific education and awareness programs for both invasive species and LMOs.	Finance, Human resources, Technical assistance	MRD	Short-term, Ongoing	Records of programs, educational materials, evidence of public support

Theme 4: Sharing Benefits of Genetic Resources					
Vision: Traditional resource owners and communities are fully involved and are primary beneficiaries from conservation and resource management of Palau's biodiversity. The rights of traditional ecological knowledge holders are fully protected.					
Goal: Within five years resource owners and communities are implementing sustainable resource management and conservation practices and sharing the benefits, with full legal protection.					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *Create a multi-stakeholder committee to develop and lobby for adoption of legislation protecting Palau's genetic resources*	**1.1** Source funding for collaboration between regional and international consultant to work with the existing legal services to research and draft legislation for protecting and maximizing equitable benefit sharing of genetic resources.	Finance, Human resources, Technical assistance	MOJ, MRD	Medium-term	Adopted Legislation
	1.2 Review and improve the existing permitting for use of Palau's genetic resources to ensure the rights of Palauans are met.	Human resources	MRD, MOJ	Short-term	New permit process implemented
Objective 2: *Develop and implement a public awareness/education program*	**2.1** Conduct multi-stakeholder workshops	Finance, Human resources	MRD, PCS	Short-term, Ongoing	Higher awareness after program
	2.2 Develop and distribute literature on genetic resources benefit sharing	Finance, Human resources, Technical assistance	MRD, PCS	Short-term, Ongoing	Literature, and records of distribution
Objective 3: *Develop and implement an effective enforcement and management program*	**3.1** Develop an authority that consists of members well versed in genetic resource management issues to issue permits and ensure that the conditions of the permit are met.	Finance, Human resources	MRD/ PICRC	Medium-term	Authority developed, Permitting process in place
	3.2 Disseminate information about the research projects and their findings to the public	Human resources	MRD, OERC	Medium-term, Ongoing	Information disseminated

	3.3 Monitor the progress of all permitted research projects to ensure that all conditions of the permit are satisfactorily met.	Finance, Human resources	MRD	Ongoing	Monitoring reports on file
Objective 4: *To promote community participation in biodiversity conservation*	**4.1** Develop community contacts to establish and improve communication, to exchange information, and promote management and conservation.	Human resources	PCS TNC MRD	Ongoing	Contacts developed
	4.2 Work with traditional men's and women's groups to promote biodiversity conservation.	Human resources, Finance	PCS MRD	Ongoing	Records of meetings
	4.3 Support existing environmental groups in the schools at all levels.	Human resources, Finance	MOE	Ongoing	Records of activities
Objective 5*: To increase awareness & promote the use of traditional management practices together with science & technology.*	**5.1** Encourage Palauans to pursue degrees in science & take pride in Palau's unique biodiversity.	Human resources, Technical assistance, Finance	MOE	Ongoing	More Palauaans earn science degrees
	5.2 Document & publicize traditional knowledge on resource use & management practices.	Human resources, Finance	PCS MRD MCCA	Medium-term, Ongoing	Publications
	5.3 Strengthen coordination & cooperation between traditional, State & National leaders to ensure integration of traditional & modern resource management practices are implemented & maintained through legislation.	Human resources, Finance	Cabinet, States	Medium-term, Ongoing	Legislation, Records of meetings
Objective 6: *To promote community capacity to launch & successfully manage small businesses that enhance & benefit from biodiversity.*	**6.1** Conduct training for Chamber of Commerce on the benefits of promoting conservation and resource management of biodiversity	Human resources, Technical assistance, Finance	MRD MCT	Medium-term, Ongoing	Training materials developed, training conducted
	6.2 Share expertise between businesses & give incentives for 1st time business owners for implementing sustainable practices	Human resources, Finance	MCT MRD	Medium-term, Ongoing	Expertise shared, incentives implemented

	6.3 Develop and implement special loan programs for small businesses doing environmentally sustainable development (i.e. ecotourism)	Human resources, Finance	PNDB	Medium-term, Ongoing	Loan programs implemented

Theme 5. – Sustainable Economic Development

Vision: Sustainable economic development is mainstreamed into all sectors and at all levels thereby ensuring that economic development supports the preservation and protection of biodiversity. .

Goal: To provide an enabling framework within each State to facilitate long-term sustainable development and ensure that each each State is engaging and deriving the maximum benefits from sustainable economic development each community receives the benefits derived from the sustainable use of their respective resources.

Objective	Action	Resources Needed	Lead Agency	Timeline	Indicator
Objective 1: *National Tourism Unit established and actively promoting and educating the communities on the value and benefits of eco-tourism in Palau*	1.1 Conduct a national program to define and promote support for community based eco-tourism ventures.	Finance, Human resources	NTU	3 years	Within ten years, community led eco-tourism will represent 30% of Palau's tourism product.
	1.2 Identify and expand the promotion of Palau's eco-tourism product in local and foreign markets.	Finance, Human resources	PVA	Ongoing	Increased local and international awareness of Palau's eco-tourism product.
	1.3 Train interested local communities and groups in eco-tourism related activities.	Finance, Human resources, Technical assistance	NTU, PVA	Short-term, Ongoing	Increased capacity within local communities and groups to participate and manage eco-tourism related activities.
Objective 2: *Increased economic incentives and capacity for community led sustainable eco-tourism development.*	2.1 Provide government incentive packages for community based small business assistance programs focusing eco-tourism activities and facilities.	Finance, Human resources	NTU, PVA	Medium-term	Increased participation and product diversification of community based

					eco-tourism activities and facilities.
	2.2 Increase public awareness on existing assistance programs geared at sustainable small business start-ups and expansion opportunities.	Finance, Human resources	NTU, MoF, PCC, PCAA	On-going	
	2.3 Increase capacity building training programs to Palauan entrepreneurs and small business management for interested individuals and start-up companies entering into small-scale community-based enterprises.	Finance, Human resource, Technical assistance	NTU, MoF, PCC	On-going	Increased number of entrepreneurs and small businesses operating sustainably within Palau's communities.
Objective 3: *Reduce dependency on importation of foodstuffs.*	3.1 Establish nationwide educational program in schools and community groups on the economic and health value of locally produced foods.	Finance, Human resources	MoE, PCAA, MRD	Short-term, Ongoing	Greater awareness and increased production of locally produced foods.
	3.2 Review and update or lobby for the adoption of legislation regarding the imposition of additional taxes on imported non-essential food products.	Human resources	MoH, EQPB, NEPC, OEK	Short-term	Tax for non-essential imported food products adopted and enforced.
	3.3 Introduce incentive measures for the promotion of agricultural co-ops through assistance in the development, packaging, and marketing of locally grown and harvested foods.	Finance, Human resources, Technical assistance	MoF, MRD, MCT, PCAA	Short-term, Ongoing	Number of successfully functioning agricultural co-ops increased.
	3.4 Develop and introduce national legislation to establish health and sanitary inspection guidelines for locally produced and packaged foods.	Human resources, Finance, Technical assistance	MRD, MoH, MoF, OEK	Medium-term	National guidelines for the inspection of locally produced foods adopted and enforced.
	3.5 Increase State government and community awareness of sustainable economic opportunities for local production of foodstuffs.	Human resources	MoF, MCT	Ongoing	Enhanced State and community awareness regarding economic

					incentives and participation in agricultural development.

Theme 6: Prevent or Minimize Waste					
Vision: All wastes are reduced, reused, or recycled to minimize degradation and/or loss of habitats.					
Goal: By the year 2012, 65% of all wastes in Palau are reduced, reused, or recycled.					
Objective	**Action**	**Resources**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *Integrate solid waste management programs at State and National levels.*	**1.1** Government and private stakeholders review and adopt an Integrated Solid Waste Management Program (ISWMP) based on the 1999 Golder Associates draft submitted to Republic of Palau Bureau of Public Works	Human resources Technical Assistance	MRD-BPW EQPB	Immediate	Finalization of ISWMP
	1.2 Promulgate legislation to implement ISWMP.	Human resources Technical assistance	President's Office OEK	Immediate	Waste Management Law creates administrative and regulatory framework for ISWMP.
Objective 2: *Establish Waste Management Agency*.	**2.1** Create a separate agency with dedicated funding to implement and administer ISWMP.	Human resources Finance	MRD	Immediate	Waste Management Agency created and funded.
	2.2 Develop training programs for Agency staff, and private sector counterparts, in modern waste management.	Technical assistance Finance	MRD EQPB PCC	Short-term	Agency staff and counterparts have developed required expertise.
Objective 3: *Increase public understanding of waste management issues.*	**3.1** Develop a Republic-wide public education program at the national level with State and NGO participation.	Technical assistance Finance	EQPB MRD PCC	Short-term, Ongoing	Public participation in collection, recycling/reuse programs.

Theme 7. – Agricultural Biodiversity (Agrobiodiversity)					
Vision: The conservation and sustainable use of Palau's agricultural biodiversity contributes to national development and to the preservation of traditional knowledge and practices.					
Goal: To effectively conserve and use Palau's agrobiodiversity for the benefit of present and future generations..					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *Develop a comprehensive inventory of Palau's agrobiodiversity to identify and prioritize species and varietal importance and status.*	**1.1** Collect baseline data on the existing agrobiodiversity, and assess the data to identify species and/or varieties/breeds that require specific management strategies, incorporating traditional and modern scientific knowledge	Finance, Human resources, Technical assistance	MRD	Short-term, Ongoing	Responsibilities Assigned
	1.2 Inventory and map the location of important agricultural species, varieties, and breeds	Finance, Human resources	MRD	Short-term, Ongoing	Inventories and maps
Objective 2: S*ustainably manage and conserve Palau's agrobiodiversity.*	**2.1** Establish a national Agrobiodiversity Center to maintain germplasm collections	Finance, Human resources, Technical assistance	MRD, PCC	Medium-term	Center established
	2.2 Contribute agricultural germplasm to regional and international germplasm collections, to further cooperation, and as a backup to the national collections	Finance, Human resources, Technical assistance	MRD, PCC	Short-term, Ongoing	Records of contributions
	2.3 Incorporate traditional management practices into agrobiodiversity conservation strategies.	Finance, Human resources	MRD		
	2.3 Ensure that appropriate biosafety protocols are in place to protect traditional species and varieties from genetic contamination	Finance, Human resources, Technical assistance	MRD, PCC	Short-term, Ongoing	Protocols in place and adhered to
Objective 3: *Farmers and others will grow and utilize local and traditional species, varieties, and breeds.*	**3.1** Propagate and distribute traditional agricultural species, varieties, and breeds.	Finance, Human resources	MRD, PCC	Short-term, Ongoing	Records of distributions
	3.2 Strengthen educational curriculum for agriculture, including information on	Finance, Human	MOE, MRD,	Short-term, Ongoing	New curriculum materials

	agrobiodiversity conservation and traditional management strategies and practices	resources, Technical assistance	PCC		developed and utilized
	3.3 Conduct public awareness activities to increase public utilization of traditional varieties and breeds	Finance, Human resources, Technical assistance	MRD, PCC, MOE	Short-term, Ongoing	Educational materials, records of activities

Theme 8. Mainstreaming Conservation					
Vision: Individuals are aware and take responsibility for their effect on Palau's biodiversity in a way that they participate actively in its protection. All stakeholders are well informed and empowered and are working together to ensure the conservation and sustainable use of Palau's biodiversity.					
Goal: Biodiversity conservation and sustainable resource use is integrated into all aspects of government and community planning, development and operations.					
Objective	**Action**	**Resources Needed**	**Lead Agency**	**Timeline**	**Indicator**
Objective 1: *To increase public awareness of and support for biodiversity conservation through understanding of importance of biodiversity.*	**1.1** Identify key individuals from all relevant agencies and organizations to coordinate and implement a strategic public awareness program	Human resources	MRD, OERC	Short-term Ongoing	Public awareness team identified and organized, 90% of the resident population has a clear understanding of the importance of biodiversity.
	1.2 Identify funding mechanisms at the local, regional, and international levels	Human resources	MRD, OERC	Short-term, Ongoing	Funding identified and accessed
	1.3 Conduct public awareness activities	Finance, Human resources, Technical assistance	MRD, OERC	Short-term, Ongoing	Records of activities
Objective 2: *To successfully integrate biodiversity into curriculum at all levels through the Ministry of Education*	**2.1** Review current curriculum and identify opportunities to integrate topics related to biodiversity at all levels.	Finance, Human resources	MOE, MRD	Medium-term	Curriculum review and opportunities identified
	2.2 Design and implement educational tools to supplement curriculum and lesson plans	Finance, Human resources, Technical assistance	MOE, MRD	Ongoing	Educational tools used in the classrooms
	2.3 Link curriculum integration with public awareness activities	Human resources	MOE, PCS, PCC	Ongoing	Curriculum linked to the public awareness activities

Objective 3: *To strengthen conservation capacity of residents and all communities in Palau*	**3.1** Conduct community capacity building activities based on the priorities identified in the NBSAP themes and emerging community priorities.	Finance, Human resources	MRD	Ongoing	Specific indicators to be developed for each program
	3.2 Fund scholarships for Palauans in advanced degrees in policy, resource management, and local/cultural resource issues.	Finance	PNSB	Short-term, Ongoing	Increase in the number of Palauans with degrees in listed areas
	3.3 Develop incentives for Palauans with biodiversity-related expertise to work in Palau	Human resources, Finance	MCT	Ongoing	Increase in the number of Palauans working in relevant fields
	3.4 Utilize applied learning, continuing education, and related educational opportunities for Palauans in relevant fields	Human resources, Finance	MCT	Ongoing	Increase in the number of learning activities
Objective 4: *To strengthen conservation capacity of government and non-government organizations in Palau*	**4.1** Create and fill a position at the appropriate level in the appropriate government agency to coordinate and monitor implementation of the NBSAP.				
	4.2 Increase interagency/interpersonal communication and cooperation	Human resources	Cabinet NEPC	Ongoing	Number of collaborative programs, Decrease in the duplication of effort
	4.3 Seek new funding sources for programs and projects that aim to protect biodiversity	Human resources	OEK MOS MOF OERC	Ongoing	New funding sources
	4.4 Conduct institutional capacity building based on the identified needs, as well as strengths, gaps, and available expertise.	Human resources, Finance, Technical assistance	MRD	Ongoing	Records of activities, improved performance
	4.5 Actively and effectively participate in regional and international conventions and organizations to influence decisions relevent to Palau	Human resources, Finance	MRD NEPC	Ongoing	Improved performance

Objective 5: To Strengthen local capacity to participate effectively in regional and international conventions and organizations that relate to biodiversity conservation.	**5.1** Develop and continuously update a data-base of Palauan nationals and long-term residents who have the potential and are able to represent Palau strategically and effectively at regional and international meetings related to biodiversity conservation.	Human resources	NEPC	Short-term Ongoing	Data-base established and in use.
	5.2 Develop and implement policies that ensure that priority is given to appropriately qualified Palauan nationals and long-term residents for participation in regional and international conventions and organizations related to biodiversity conservation.	Human resources	NEPC MOS MRD OERC	Short-term	Policies developed and implemented
	5.3 Conduct capacity building activities targeting Government agencies and non-governmental organizations (NGOs) for effective and strategic participation in regional and international conventions and organizations related to biodiversity conservation.	Human resources, Technical assistance, Finance	OERC MOS MRD NEPC	Short-term Ongoing	Activities conducted. Measurable increase in capacity within government agencies and representatives.
	5.4 Conduct preparatory meetings of government and NGO representatives to formulate national positions on issues to be addressed at major international meetings and for a related to biodiversity conservation.	Human resources	OERC MRD NEPC	Short-term Ongoing	National positions formulated, adopted, and addressed
	5.5 Establish or designate a national body made up of government and civil society representatives to collaboratively decide on participants to regional and international meetings, workshops, and other activities related to biodiversity conservation.	Human resources	NEPC	Short-term Ongoing	National body established or designated and active

Objective 6: To integrate biodiversity conservation strategies and policies into all government planning and operations, based on the priorities identified in the NBSAP themes and on emerging priorities, and targeting agencies and departments which have biodiversity/environment as part of their portfolios. Priority areas should include at a minimum prevention of invasive species, energy conservation, and waste management.	**6.1** Conduct reviews of current and existing government strategies and policies and identify opportunities where biodiversity conservation can be integrated.	Human resources, Finance	NEPC Cabinet OERC	Short-term ongoing	Review conducted. Biodiversity conservation integrated into current and existing strategies and policies.
	6.2 Develop and implement government strategies and policies, including incentives where appropriate, to integrate biodiversity conservation into all government programs and activities, based on the priorities identified in the NBSAP themes and on emerging priorities.	Human resources, Finance, Technical assistance	Cabinet NEPC OERC	Medium-term Ongoing	Strategies developed and implemented. No invasives are introduced by government. related activities
	6.3 Conduct educational activities for government employees to build awareness of and compliance with strategies and policies for conservation of biological diversity.	Human resources, Finance	NEPC OERC Cabinet	Medium-term Ongoing	Educational materials, Records of activities, Improved compliance
	6.4 Develop and implement communications strategies for ensuring that results from key research activities conducted in Palau and relating to Palau's biodiversity are effectively communicated to and used by key decision makers at the community, state and national levels.	Human resources, Finance	NEPC PCS PICRC TNC OERC	Short-term Ongoing	Strategy developed and implemented. Decision makers utilizing information from relevant research when making key decisions
Objective 7: To develop and implement effective long-term sustainable finance mechanisms for biodiversity conservation planning and programming.	**7.1** Identify and utilize opportunities for developing, implementing, and utilizing effective long-term sustainable finance strategies and mechanisms for biodiversity conservation activities and programs.	Human resources, Technical assistance	NEPC TNC OERC	Long-term	Technical assistance accessed. Strategies developed. Mechanisms in place and being used.

	7.2 Assess the feasibility of establishing and effectively utilizing a Palau Conservation Trust Fund.	Human resources, Technical assistance	NEPC TNC MOF MOS MRD	Short-term	Feasibility assessment conducted and recommendations made to NEPC.
	7.3 If feasible, establish a Palau Conservation Trust Fund.	Human resources, Finance	NEPC MOF	Long-term	Trust Fund established, managed and utilized.
Objective 8: *Survey existing statutory and regulatory coverage to determine where improvements are needed.*	**8.1** Identify the agencies involved with enforcement and compile the statutes and regulations involved.	Human resources	NEPC EQPB	Short-term	Clear assignments made
	8.2 Review data collected to determine where statutory or regulatory coverage should be expanded	Human resources	NEPC OERC	Medium-term	Report produced detailing requirements
	8.3 Assign responsibility with deadlines to agency heads to develop suggested statutory and regulatory changes and capacity requirements	Human resources,	OERC	Medium-term	Record of assignments given to NEPC
	8.4 Evaluate submissions and determine project scope and whether outside consultant needed for systems development	Human resources	OERC NEPC	Medium to Long-term	Decision made on how to proceed with making changes
Objective 9: *Define agency responsibilities and capacity requirements in cooperative plan to implement protection system*	**9.1** Determine where agencies must interact and required capacity to do this.	Laws and regulations, Finance, Human resources	OERC Involved Agencies	Medium to Long -term	Report on areas of interaction and capacity needs
	9.2 Determine need for State and Traditional Leader input	Human Resources	OERC NEPC States	Medium-term	Decision and method
	9.3 Develop SOP for Agency cooperation	Human resources	OERC Involved Agencies	Long-term	Document produced
Objective 10. *Implement required changes*	**10.1** Integrate results of Objective 2 & 3 process for final changes needed	Human resources		Long-term	List of requirements
	10.2 Develop and submit legislative and regulatory requirements	Human resources		Long-term	Framework in place

Objective 11*: Ensure state and community issues and needs related to protection and health of local biodiversity are acknowledged and addressed*	**11.1** Utilize and respond to list of priority issues and actions identified during the community consultations (see Appendix).	Human resources, Finance	MRD, OERC, States	Ongoing	State priority issues and actions addressed