Northern Marianas Coastal Zone Management Program

MANAGAHA ISLAND

MARINE PARK

MANAGEMENT PLAN

June 1985

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Southern Mariana Islands Coastal Zone Management Program

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Managaha Island Marine Park

Management Plan

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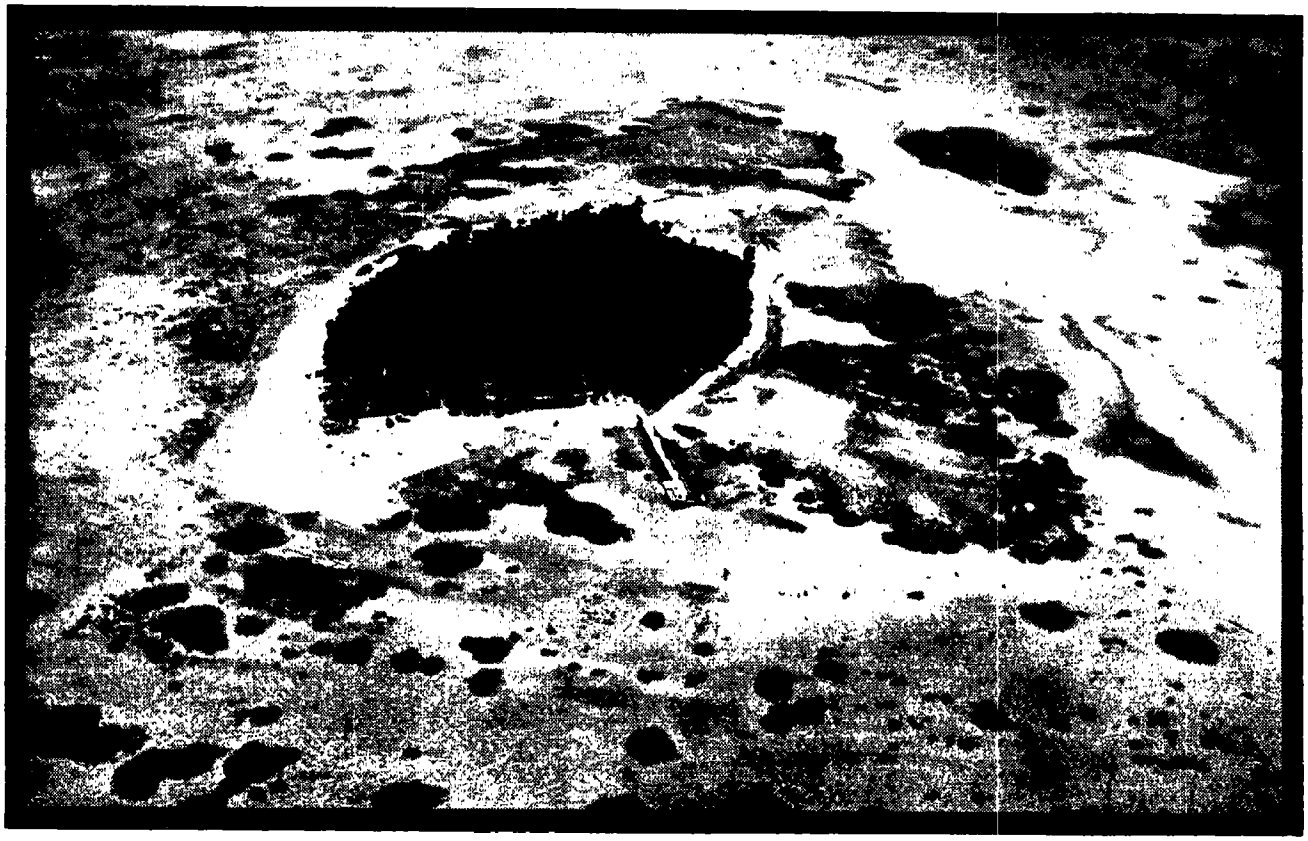

Prepared for

Coastal Resources Management Office
CNMI

Prepared by

Pacific Basin Environmental Consultants Inc.

June 1985

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I. INTRODUCTION

A. General Concept

Marine parks were conceived in the early 1900's as a means to protect unique marine habitats, particularly coral reefs. The idea of national parks to protect resources in the sea has developed slowly. However, with the increasing popularity of swimming, diving, fishing and coral and shell collecting there is an urgency and necessity to protect marine life, particularly unique and pristine areas near to large population bases. Like their counterparts on land, marine parks are usually a great tourist attraction. In this light, there must be a careful balance between areas reserved for tourists and areas established as sanctuaries where scientific studies can be carried out.

Just like there are areas of great beauty on land, the sea also contains areas of unusual beauty. Quite possibly these areas are even more unique and important to mankind. Even the idea of preserving unique terrestrial sites has been slow to develop. Yellowstone, the world's first national park, in the modern sense, was not established until 1872. It was not until 1935 that a marine site was included within the Jurisidiction of the U.S. National Park Service. This was the Fort Jefferson National Monument at Dry Tortugas, 65 miles (offshore) west of Key West, Florida. The park was established for the marine fortification, not as a marine park. However, since only 87 of the monuments 47,125 acres (2.2 percent) is on fastland, and since excellent coral reef exist in the area, most of the monument can be viewed as the world's first marine park. These reefs were not protected initially nor was the diverse marine life living within it. Over time greater protection has been given to the marine environment in this area.

It is not difficult to understand why marine parks have developed so slowly. Only in the last few decades through the use of snorkeling and SCUBA gear has man enjoyed the sea for recreation on a large scale. Man has always been closer to the ocean than the stars, but paradoxically, mans' understanding of space is more advanced than understanding of the ocean. This is obvious by mans' ventures into space which far exceed his exploration of the seas in imagination, technology and expenditure of funds. It was not until the 1940's when Jacques Cousteau developed SCUBA that man was able to spend any length of time observing the underwater environment.

Because of a general lack of information regarding the oceans there is a feeling that the resources of the oceans are so immense as to be virtually inexhaustable. This is not true and scientists know that mans' unregulated harvesting in the seas has depleted certain food sources and has endangered stocks of other fish and sea food sources. Another unfortunate general attitude is to regard the oceans as a convenient dumping place for our waste. The saying goes "Dilution is the solution to pollution," though not a particularly popular phrase today. This attitude has been common along the coastline environment. Inland, where the problem is more acute from dumping waste into small rivers and lakes, the results have been devastating. The most toxic of these wastes come from large manufacturing plants that use water for cooling machinery or industrial wastes dumped directly to the water source. These wastes can be chemicals that completely alter the water chemistry or other wastes, like plastic and metal beverage containers that resist deterioration for extended periods of time and accumulate on beaches and coral reefs. Although it is not seen by most people, a

beverage container or plastic bottle is as offensive, if not more so, in the undersea environment than it is on land.

Gradually, public indignation regarding pollution (terrestrial or marine) is increasing. A healthy feeling for preservation and conservation is replacing this wanton exploitation of our environment. One significant manifestation of this movement is the marine park. Through the establishment of marine parks, unique undersea areas, selected coral reefs and other important resources can be protected for the enjoyment of all.

The concept of marine parks is for the protection, conservation and future preservation of unique and/or pristine marine environments. Protection in this manner has been enthusiastically received by many nations in recent years, including underdeveloped countries.

In 1962 Seattle hosted the First World Conference on National Parks where numerous countries met to create marine parks or reserves. The key recommendation of this conference stated:

> "Whereas it is recognized that the oceans and their teaming life are subject to the dangers of human interference and destruction of the land, that the sea and land are ecologically interdependent and indivisible, that population pressures will cause man to turn increasingly to the sea, and especially to the underwater scene, for recreation and spiritual refreshment and that the preservation of the unspoiled marine habitat is urgently needed for ethical and esthetic reasons, for the protection of rare species, for the replenishment of stock and valuable food species and for the provision of undisturbed areas for scientific research."

Since this conference, numerous marine parks have been established worldwide, particularly in the tropics but not exclusively so.

What is a marine park and does it have to be mostly ocean to qualify for such status? A marine park is any park that includes part of the sea, regardless of land area. To some, the word "park" conveys

the principle objectives of recreation. To others, it means primarily a reserve. However, the two need not be incompatible. Visitors at a park can enjoy wild flowers without picking them or watch birds instead of shooting them. Similarly, coral reefs can be merely observed or photographed and fishes watched and not speared. Large marine parks can be divided into zones. Recreation can take place in some areas and complete protection or conservation with minimal disturbance in other areas depending on the particular park.

B. Purpose and Need

The proposed Managaha Island Marine Park represents a great opportunity for the development, protection and conservation of a truly unique site. Situated in the Saipan Lagoon near the barrier reef in relatively shallow water are coral reefs with a diversity of marine life. Numerous Japanese tourists visit Managaha Island daily and the use of this island by local residents is popular. The island itself has both historical and cultural value including gun placements and bunkers from World War II and an ancient Carolinian burial site. In the waters surrounding Managaha Island can be found numerous war related artifacts, wrecked ships and airplanes, barges and an assortment of war related debris. The coral reef surrounding Managaha Island has been used traditionally for subsistence fishing and gathering. SCUBA and skin diving groups frequent the waters around Managaha Island as do other water enthusiasts like windsurfers, sailors and waterskiers.

Because of the intensive pressure placed on the natural, cultural and historical resources on and surrounding Managaha Island, protection at some level should be initiated. The inclusion and prompt

development of the area as a Marine Park will help provide the protection these resources deserve.

C. Goals and Objectives

The primary objective of this management plan is to designate a uniquely beautiful site presently utilized by the majority of tourists and residents who visit or live on Saipan. The goal is to protect unique resources found within the park and preserve them for future generations. Because of the increasing use of Managaha Island catering to tourists and the general public, and the threat of coral reef predators, time is of essence in protecting this resource.

Development of this marine park will represent the first designation of this concept in the Western Pacific. It is anticipated that this park will set a precedent for similar parks in this Region of the Pacific.

II. SITE

A. Saipan General Environment

1. Geography

The Mariana Islands constitutes a chain of 17 islands which extend approximately 440 miles along a north-south axis. Total land area of the Marianas chain is approximately 400 square miles. Saipan (13 miles long and 3.5 miles wide), the second largest of the chain, occupied approximately 47 square miles (21,811 acres) (Figure 1).

Saipan (Figure 2) is located in the Western Pacific Ocean at about 15°12' North Latitude and 145°37' East Longitude. The nearest islands are Tinian and Aguijan, which are three and 20 miles respectively to the south-southwest. Guam (three times larger than Saipan) lies about 120 miles south-southeast of Saipan.

2. Geology

The Mariana Islands are peaks of a submerged volcanic mountain range, uplifted by tectonic forces resulting from the subsidence of the Pacific Basin. The slight curvature of the island arc, as well as the geomorphology of the islands indicates that, geologically, the Mariana Islands are young, probably dating from the Eocene Period (approximately 40 million years ago).

Geologically, the islands fall into two archs, a younger one of small purely volcanic islands extending from Anatahan to the north and an older, more complex group consisting of Saipan and the islands to the south. The northern islands retain their initial volcanic form. Saipan and the southern islands are volcanic at their base and coral-capped, evidence of more prolonged evolution.

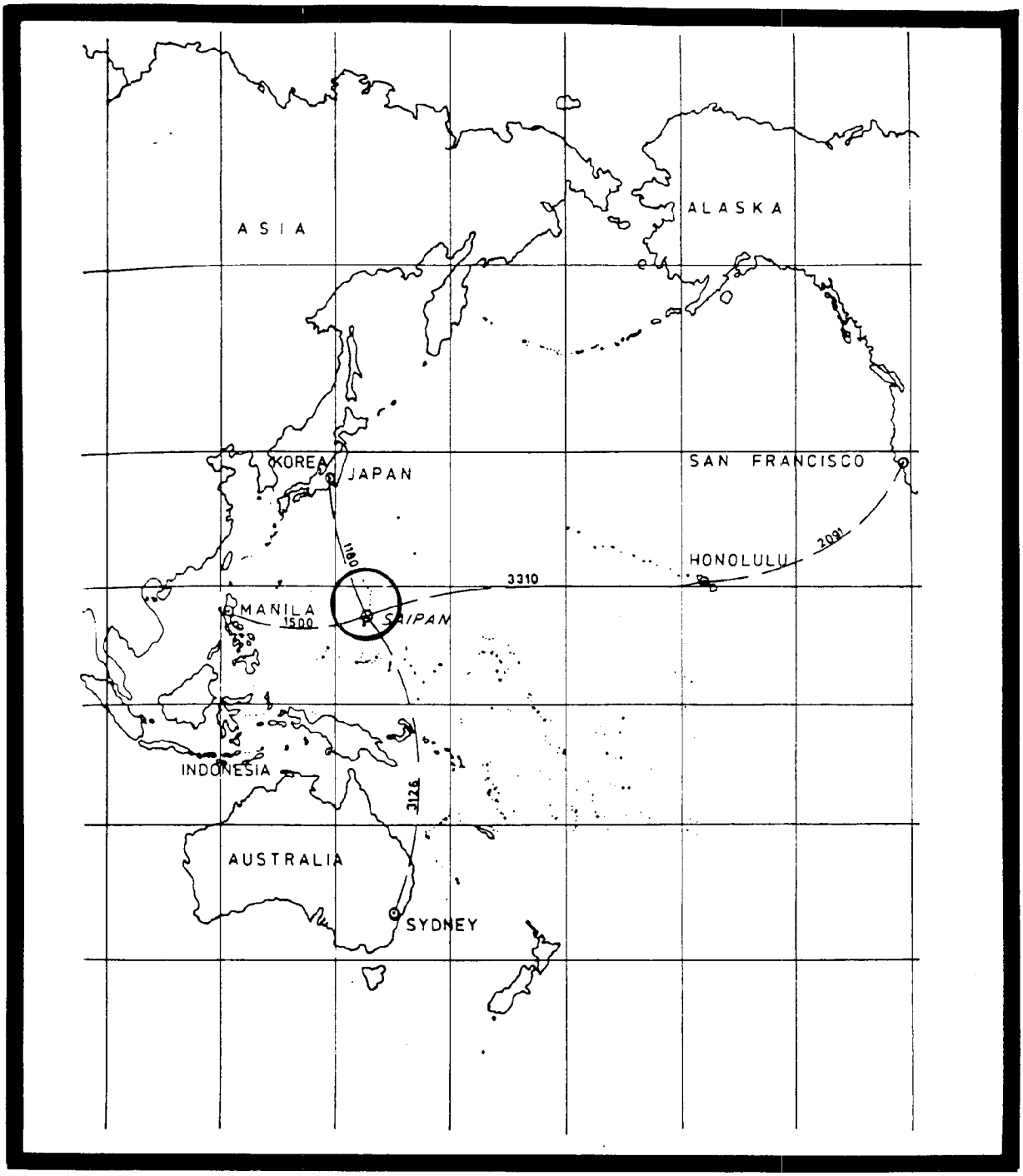


Figure 1. General Location Map of Saipan.

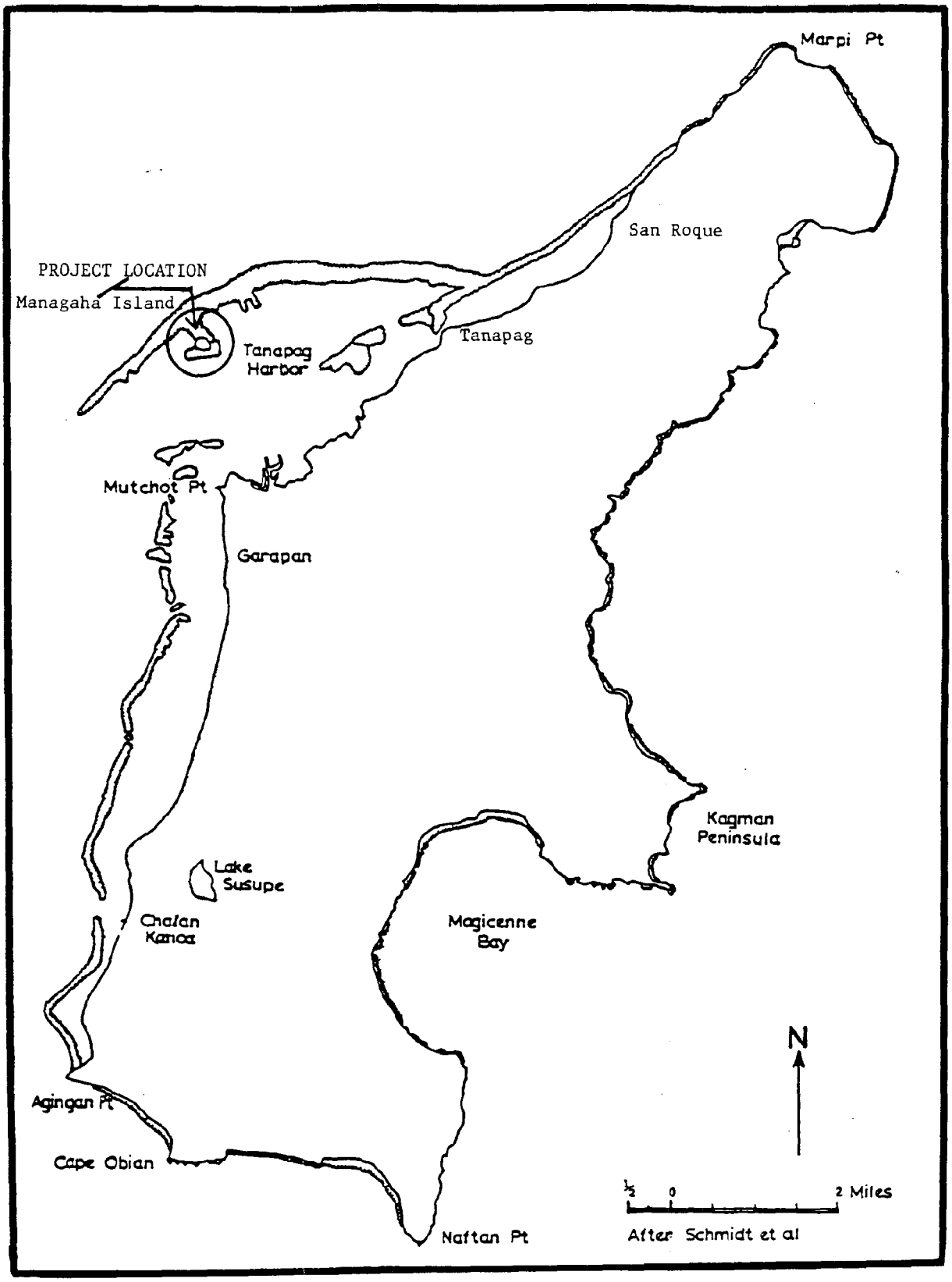


Figure 2. Map of Saipan Showing Project Area Location.

Barrier reefs tend to develop on the more gentle western slopes, while fringing reefs closely hug the eastern shores. The eastern coastlines are generally rocky and cliff-bound and are characterized by wave-cut notches, sea caves, abrasion benches and detached segments of the former shore.

3. Topography

Despite Saipan's relatively small size, it is considered to be more complex geomorphically than neighboring islands. The dominant topographic feature is the axial upland (hills) extending through three-forths of Saipan. It consists of northern and southern terraced limestone uplands with a maximum elevation of 1,555 feet at Mount Tagpochau.

4. Soils

Three major soil groups exist on Saipan: soils on limestone, soils on volcanic rocks and soils on elevated beach deposits. Limestone underlies approximately 83 percent of the island. Volcanic rocks and elevated beach deposits represent approximately ten and seven percent respectively.

Eighty percent of the island is covered by soils generally less than 30 inches deep. It is felt that the shallow soils result from continuous natural erosion that appears to be occurring at about the same rate the soils are being formed.

5. Climate

The climate of the Marianas is tropical marine, reflecting the nearness to the equator and the influence of warm surrounding waters. Wind and rainfall are the most variable elements.

Humidity, temperature and barometric pressure remain fairly constant throughout the year except when large tropical storms approach.

Climatically, the year falls into two seasons, with very little temperature variation but pronounced rainfall differences. Average temperature for Saipan is 81.5° F. Extreme minimum and maximum temperatures of 68°F and 89°F have been recorded.

The period of heaviest rainfall occurs from July through October. The ratio between the dryest and wettest months of the year is approximately one to five. Annual rainfall extremes recorded range from 59.8 inches to 115.1 inches over a 19 year period, averaging approximately 83 inches annually. Relative humidity averages 83 percent.

The outstanding characteristic of the wind regime on Saipan are the tradewinds with an average annual velocity of 10.5 miles per hour (mph). Tradewinds are pronounced and persistent during the period from January through May, when the winds blow from the northeast and east-northeast more than 90 percent of the time. Wind direction is far more variable during the period from July through October with dead calms during the months of July and August.

Two principal kinds of storms contribute markedly to the climatic character of Saipan: small scale storms, consisting of thunderstorms and squalls and large systems of tropical disturbances, storms and typhoons. The small-scale disturbances may dominate an area of only a few square miles. Tropical storms are closed pressure systems about which the air moves counterclockwise

(in the northern hemisphere) with wind speeds of 33 to 65 knots (38 to 74.9 mph). Typhoons are similar to tropical storms but are accompanied by winds in excess of 65 knots. These larger cyclonic typhoon storm systems may dominate an area as large as 300,000 square miles and may persist for a week or more. Major tropical cyclonic disturbances of these kinds occur in the Saipan area. Although they have occurred in all months of the year, they are far more frequent during the rainy season (July - October).

6. Groundwater Resources

The limestone terrain covering 90 percent of Saipan is open to vertical infiltration of rain water to aquifers which slowly drain to the sea. Overland drainage in these areas (rivers and streams) is nonexistant.

The fresh groundwater of Saipan commonly has been classified as either basal, which occurs in the form of a thin lens of fresh water floating on sea water in buoyant equilibrium near sea level, or high level, which saturates aquifers having relatively impermeable bottoms lying above sea level. A third type called parabasal is transitional between the first two and may occur, although it has not yet been discovered. This water is hydraulically continuous with basal water but rests on an impermeable bottom that rises above sea level.

7. Flora

The vegetation on Saipan has been so disturbed by human occupation, particularly through the domination of four successive foreign cultures and destruction during World War II, that the floristic pattern is neither simple nor stable. It is, however, in a

state of rapid change. In all probability, the greater part of the island was originally forested, mostly with the typical mixed forest found on limestone in the Marianas. Some of the mixed forest can still be found near the top of Mount Tagpochau, on and around the base of Laderan Banedero and on cliffs along Kagman.

Relatively few plant species are unique to the Mariana Islands including Saipan. The basic flora of Saipan was probably originally introduced by overwater means or possibly by airborne transport during major tropical cyclonic disturbances (typhoons) that periodically ravage the Caroline and Mariana Islands. Hitchhikers on birds, bats, insects, or 'drifters' associated with floating logs or debris are also likely modes of introduction.

Introductions by aboriginal man were also significant. Present vegetation includes at least 30 species of crop plants that are in all probability of pre-European aboriginal introduction. Among the latter are the familiar bamboo (Bambusa vulgaris), banana (Musa sapientum), breadfruit (Artocarpus communis), mango (Mangifera indica) and sugarcane (Saccharum officinarum).

During Japanese tenure in the Mariana Islands, most level land on Saipan was seeded for sugarcane. Sugarcane growing was not resumed after the war, and the cane fields have been gradually invaded by different woodly plants forming uneven mixed thickets with the cane persisting in a few place. There is no record of what original vegetation existed before the war, although some of it must have been primary or secondary mixed forest. Since the island at one time supported a large Chamorro population, most of the forest on level land was secondary growth on abandoned fields

and dwelling sites. Such growth was probably dominated by Hibiscus and Melochia, with blankets of Operculina ventricosa.

Much of the land previously in sugarcane has become infested with pure stands of tangantangan (Leucaena leucocephala). This species was introduced after the war to help revegetation. It grows quickly and is very difficult to eliminate.

Many areas of level, sloping ground have been covered, either since the war or during Japanese times, by pure or mixed stands of Formosan Koa (Acacia confusa), and other areas by Ironwood (Casuarina equisetifolia). The first was said to have been planted by the Japanese for charcoal. Both of these species are similar to tangantangan in that they tend to exclude undergrowth.

8. Fauna

Terrestrial fauna is rather limited in the Mariana Islands. The only native mammals are two species of bats. One of these, the 'fanihi' or fruit bat (Pteropus mariannus), has historically been and is still a popular local delicacy. The fruit bat nests in trees during the day and, at dusk, flies over well-established routes to feed on papaya, guava, soursop and sweetsop. Unrestricted hunting and reduction of its habitat have nearly eliminated the fruit bat on Saipan until recently. Federal laws protect the fruitbat as an endangered species. The second bat, Emballonura semi-caudata, is an uncommon, small, insectivorous cave-dwelling bat found throughout the Marianas.

The Marianas Deer (or Sambar Deer), Cervus unicolor mariannus, is an introduced species originally brought to Saipan and Rota from the Philippines between 1771 and 1774. Heavy

hunting pressure has brought it near to extinction on Saipan, However, it is likely that small populations still exist in the more remote, isolated areas of the island.

Rats and mice were inadvertently introduced by early ship visits. The common Norway rat (Rattus norvegicus) and mouse (Mus musculus) have long been pests to all the Mariana Islands. Two other rats may also be present on Saipan: the roof rat (Rattus rattus) and the Polynesian rat (Rattus exulans). The Oriental musk shrew (Suncus murinus), accidentally introduced to Guam in the early 1950's, has since spread to Saipan (Owen, 1974).

Several (wild) dogs and cats are also found on most of the islands, the latter often constituting a problem by preying on chickens and other small farm animals.

The monitor lizard (Varanus indicus) is the largest terrestrial reptile in the Mariana Islands, occasionally reaching lengths of up to six feet. The blue-tailed skink (Emoia cyanura), the golden-brown skink (Emoia sp.), New World chameleons and several species of geckos constitute the remainder of the known lizard fauna.

Typhlops braminus is the only terrestrial snake in the Marianas. It is a small, blind, nonpoisonous, burrowing snake that resembles an earthworm. The West Indian or marine toad (Bufo marinus) was introduced by the Japanese to control slugs and insects and is found in large numbers throughout the Marianas.

Today, 191 kinds of birds, belonging to 41 families and 103 genera, are known to exist in Micronesia. The avian fauna of the Mariana Islands is influenced by the Japanese-Marianas flyway. From breeding grounds in Asia, the Aleutians and Alaska, certain

migratory birds (especially waterfowl) follow the Asiatic coast or adjacent island chains to the Japanese archipelago. From Japan, some birds fly through the Bonin and Volcano Islands to the Marianas and other islands to the southeast.

The Golden Honeyeater (Cleptornis marchei) is a species endemic to the islands of Saipan and Agiguan. The Marianas Mallard (Anas oustaleti) and Rock Pigeon (Columba livia) are endemic to the islands of Saipan and Tinian.

The Marianas Mallard is one of the very rare birds of the world with a range that once extended only from Guam to Saipan. This nondescript patterned duck is, and probably always has been, rare in the Mariana Islands since it is restricted to freshwater marshes and swamps, neither of which are extensive habitats here. The last stronghold for this bird is believed to be Lake Susupe on Saipan and Lake Hagoi on Tinian. On July 10, 1977, the Department of the Interior, U.S. Fish and Wildlife Service, officially declared the Marianas Mallard to be an endangered species under the U.S. Endangered Species Act. Continued hunting pressure and destruction of marshland habitat by draining or filling could easily force the duck into extinction. The last confirmed sightings of a Marianas Mallard on Saipan occured in February and March 1979 (Tenorio, 1979).

The Nightingale Reed-warbler (Acrocephalus luscinia) is listed as endangered throughout its range, which includes the southern Mariana Islands. It no longer exists on Guam. This species is restricted to cane thickets and adjacent areas in and near fresh and brackish water marshes. The Lake Susupe area provides suitable

habitat for this species, and it still exists in significant numbers here as well as in numerous other forested areas on Saipan.

B. Location of Park

Preliminary work for the development of conservation areas and underwater parks for Saipan was conducted in 1982 by personnel from the Coastal Resources Management Office (CRMO) and the Department of Natural Resources (DNR), Division of Fish and Wildlife. Several sites were surveyed. Considerable effort was given to choosing locations that were accessible, close to shore, on public lands, easily developed and in relatively safe proximity in regards to wave action, currents and water depth. High priority for siting underwater parks was finding a location with a well developed reef, good live coral coverage, abundant fish and associated marine life.

Saipan has a rather extensive lagoon and barrier reef along the entire length of the west side of the island. Although there are several potential sites for an underwater park, one stands out in terms of coral reef development, abundance of marine life, moderate water depth, access and existing tourist use. The recommended site includes Managaha Island and the underwater area surrounding the Island including numerous patch reefs and a section of the barrier reef. Resources include a few WWII historic properties including several airplanes, small shipwrecks, bunkers, guns and an ancient Carolinian burial site. The majority of the park (all major features) can be seen in Figure 3. Actual park boundaries and use zones are dipicted in Figure 5.

Within the park boundaries, it is proposed that an underwater trail be developed. This trail would be located in the diverse shallow patch

FIGURE 3 . AERIAL PHOTOGRAPH OF MANAGAHA ISLAND WITH INNER (I) AND OUTER (II) UNDERWATER TRAIL AREAS MARKED.

reefs just offshore of the beach along the northwest corner of Managaha Island (Figure 4). This trail would be marked by buoys to lead snorkelers and divers along the trail and would have underwater markers to provide information and identification of the marine life. Significant historic properties within the park (terrestrial and marine) would also be located, buoyed and identified for protection and visitor observation.

C. Park Parameters

Depending upon the final designs for the underwater park and trail, the size of the park's conservation area (Zone C), natural environmental zone (Zone B) and the underwater nature trail (Zone A) may be altered. Based upon numerous dives and underwater towing throughout the entire area, PBEC is recommending boundaries as illustrated in Figure 5. The southeast boundary of the conservation area includes the diverse patch reef which is awash at low tide. In close proximity to this reef is a large airplane wing, fuselage, pontoon and an intact upside down Japanese airplane. Some of the best developed patch reefs are found within this Conservation Zone and it also encompasses a section of the barrier reef out to the 10 fathom (60 ft.) contour. The top of the barrier reef and the northern boundary of the main channel form a natural southwestern boundary.

The approximate size of the entire proposed park is 2.6 km^2 or 1.0 mi^2 (640 acres). This represents approximately 5 percent of the total Saipan Lagoon area.

D. Zoning

1. Outstanding Natural Feature Zone (A)

This zone encompasses coral reefs and features of unusual intrinsic value that led to the establishment of the Managaha Island

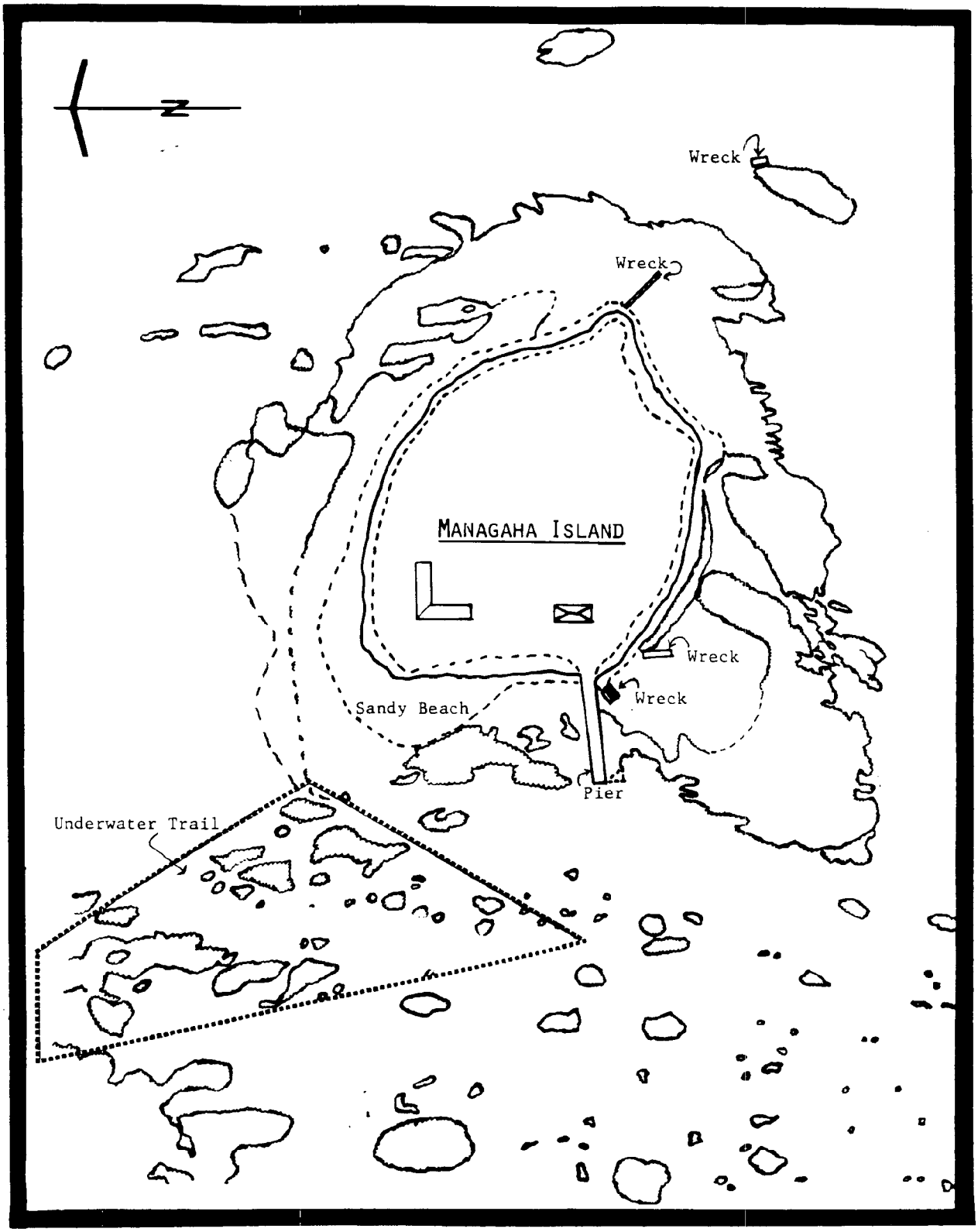


FIGURE 4 LOCATION OF UNDERWATER TRAIL IN PROXIMITY TO MANAGAHA ISLAND.

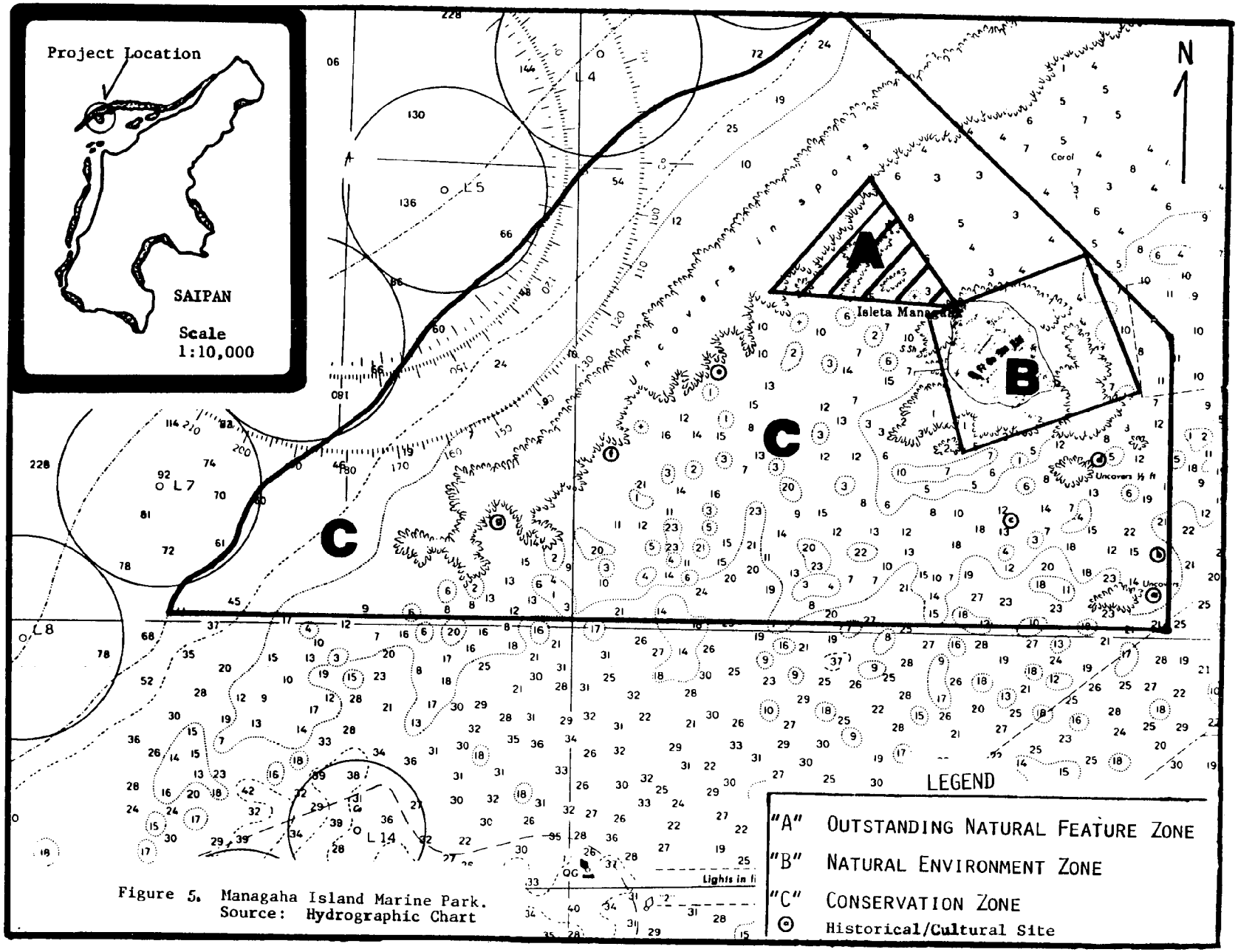


Figure 5. Managaha Island Marine Park.
Source: Hydrographic Chart

Marine Park (see section IV. C. for details). The Managaha Island Marine Park encompasses one particularly outstanding natural feature zone in the diverse coral reef designated for the Underwater Trail. This zone will be managed to protect the unique aquatic resources and to provide for public appreciation and enjoyment to the extent that natural resources are not impaired. There will be no taking of any marine life or other artifacts in areas designated as Outstanding Natural Features (Zone A). This zone is very rich in marine life with patch reefs supporting luxurious coral growth. The approximate size of the Underwater Trail is 73,000 m^2 (18 acres) although underwater markers for individual scenic stations will be clustered in a smaller area. The location for the Underwater Nature Trail (Zone A) was chosen for easy entry and exit either from the beach on Managaha Island or by boat (Figure 5). This Underwater Trail represents approximately 2.8 percent of the total park area, a very small portion where all fishing and collecting would be prohibited.

2. Natural Environment Zone (B)

Land and water in this zone will be managed to allow for environmentally compatible physical structures, work and recreational activities (Figure 5). Existing physical structures on Managaha Island include shelters, shop, restaurant/bar, showers and toilets which are limited to low profile and aesthetically pleasing styles. No structures should be placed in the water permanently. For the most part, recreational activities involve swimming, diving, wind surfing, sailing, motor boating and other low profile and low density activities. The entire island of Managaha including the

immediate nearshore environment is included in this zone. This management zone has traditionally been the most active portion of the park and will continue to receive the most use within the park both on land and in the water. This plan proposes that strict compliance with CRMO regulations regarding development in this zone be followed.

3. Conservation Zone (C)

Land and water areas in this zone possess particular value as a natural wildlife habitat and should be protected for the sake of the resource, the park and/or for future scientific research. These zones will be managed to perpetuate and improve their ecological value and natural resources with limited human intrusion. However, controlled subsistence harvesting is not contrary to the intent of a conservation zone and is allowed in other similar areas and preserves elsewhere.

In this park most of the water surrounding the island of Managaha is designated for conservation purposes (Figure 5). Fishing, harvesting, gathering and collecting in this zone will be permitted for subsistence purposes only and limits regarding species, bag limits and seasonality may be imposed as regulatory controls. To exclude subsistence taking of all marine life would likely be met with strong opposition by the public, particularly the Carolinian community and residents of Tanapag who consider the reefs around Managaha Island as their traditional fishing grounds.

This management plan contains the basic information upon which numerous policy decisions can be made. The aid of natural resources maps, assessment of marine and terrestrial wildlife, present

level of development and resource assessment provides a clearer picture of the park now and what it can become. This document represents the first detailed resource assessment for this portion of the Saipan Lagoon.

III. RESOURCES

A. Natural Resources

1. Managaha Island

The Division of Fish and Wildlife reported that Managaha Island was once a nesting site for a species of Sherwater (Puffinus sp.). During several visits to Managaha Island no shorebirds were observed. Only a few forms of wildlife exist on the island that would be of interest to a park user or for incorporation into a nature trail. One common bird, however, is frequently seen on the island. The White Fairy Tern (Gygis alba) frequents the island and nests in the tall ironwood trees (Casuarina equisetifolia). The only other species observed besides the White Tern was the Golden Plover (Pluvialis dominica). Although not observed, the following species of birds are expected to visit or inhabit Managaha Island: Mongolian Dotteral (Charadrius mongolus); Reef Egret or Heron (Egretta sacra); Cardinal Honeyeater (Myzomela cardinalis); Golden Honeyeater (Cleptornis marchei); Common Sandpiper (Actitis hypoleucos); Sharp-tailed Sandpiper (Calidris acuminata); Wandering Tattler (Heteroscelus incanus); Brown Noddy Tern (Anous stolidus); and the Ruddy Turnstone (Arenaria interpres).

Other animals that occur on Managaha Island include the Anole or Chameleon (Anolis carolinensis), Gecko (Hemidactylus frenatus), Blue-tailed Skink (Emoia cyanura), Brown Skink (Emoia sp.), Musk Shrew (Suncus murinus) and Rat, (Rattus sp.). The rats have been a problem on the island for many years and have discouraged local residents and visitors alike from picnicking or camping overnight. One cause of the high rat population has been open

dumps and generally unsanitary conditions on Managaha. However, Pacific Development Inc. (PDI), the current MPLC lease-holder, has recently filled in these dumps and now transports garbage off the island. The Marianas Visitors Bureau (MVP) also cleans up trash on the island. Hopefully the problem has been alleviated. Evidently, PDI has also imported a few cats to help control the rodent population. While this might seem to be a logical thing to do, introducing cats to the island will eventually serve to decimate the bird population. Cats are notorious bird predators and they should be removed from the island as soon as possible. Rats could be effectively controlled using traps and perhaps poison bait in selected locations. With the clean-up of Managaha Island and the tremendous amount of planting of various trees, flowers and ornamentals it is possible that the bird life will increase.

Natural resources on Managaha Island are limited primarily to vegetation, most of which has been introduced from Saipan and that which has been recently planted as part of a clean-up and beautification program. Terrestrial flora on Managaha Island is quite varied with numerous species including medicinal plants and a number of introduced ornamentals, Table 1 is a checklist of plants found on the island and along the nature trail. Vegetation on the island can be divided into two distinct zones: beach strand and inland. Although somewhat similar, these zones are distinct with some introduced species in each.

a. Beach Strand Vegetation

Beach strand vegetation is usually defined as those plants most often found growing in the immediate vicinity of the sea.

With few exceptions, plants growing on the strand can be found elsewhere on the island, however, not as a dominant form. For the most part the nature trail meanders along the beach strand usually within 10 meters of the waters edge. On occasion the trail winds inland (southern area) and also exits onto the beach (west coast). For this resource beach strand vegetation represent that which is found along the nature trails. Because the island is surrounded by a sandy beach, plants with runners like the Beach Morning Glory (Ipomoea pes-caprae) and the Beach Sunflower (Wedelia biflora) can be found. The soft tolerant shrub Phemphis acidula is found on the upper part of the beach. Occasionally one can find the small tree Messerschmidia argentia right along the nature trail along with the Australian Pine (Ironwood) tree (Casurina equisetifolia). Other plants found in the beach strand community include Scaevola taccada, Cocos nucifera (coconut), the Spider Lilly (Hymenocallis littorolis), Poinsittia (Poinsettia plucherriwa) and the common Tangan-tangan tree (Leucaena leucocephala). A few grasses and weeds like the Begger's Itch (Bidens pilosa) and False Verbena (Stachytarpheta indica) are found throughout the strand community.

b. Inland Vegetation

Although not separated by more than a few meters, most of the plants found inland are not found on the strand. For the most part these plants are larger forms like the Banyan tree (Ficus prolixa), Breadfruit tree (Artocarpus sp.), the Soursop tree (Annona muricata) and Thespesia populnea.

Some of those plants found along the strand are also found inland such as Scaevola taccada, Coconut trees and Ironwood trees. One dominant plant, the parasitic climbing vine Cascuta (Campestris) sp. covers a large percent of the low shrubs like Scaevola taccada in the interior of Managaha Island. This vine sucks the life juices of the host plant and eventually kills it. If not controlled it can become a serious pest to other plants.

c. Introduced Vegetation

With the recent influx of tourists to Managaha Island and the development of support facilities has come the planting of ornamentals to beautify the island. Planting, for the most part, has been limited to those areas where tourists spend most of their time along the west coast usually near the main beach and nearby buildings. However, some decorative planting has been done along the nature trail, in the vicinity of individual pala-palas and near the Carolinian Burial Site.

Introduced species include a variety of Crotons, Spider Lilly, Poinsettia, Plumeria, Bougainvillea, Tapioca, Hibiscus, and dwarf Coconut trees. Most of these either do or could exist naturally like Coconut, Plumeria, Spiderlilly, Poinsettia and Hibiscus. This additional vegetation does not pose a threat to endemic species and adds beauty to otherwise barren areas of the island, particularly after construction of the facilities.

2. Marine Resources

The marine resources of the Managaha Island Marine Park represents some of the most diverse coral reefs and fish fauna found anywhere within the Saipan Lagoon. Reef flats, patch reefs,

the barrier reef, sand flats, rubble zones and sandy beaches are all found within the confines of the park. Very few studies have been done which describe or evaluate the marine resources near Managaha Island.

A complete survey was conducted over several days during November 1984 and January and February 1985 to assess the corals, fishes and conspicuous macroinvertebrates at 11 stations within the underwater trail. Photography and limited collections were done at each station to aid in species identification and ocurance. A total of 31 species of corals and 107 species of fishes were observed. Section IV. C. of this report gives a detailed account of the marine life found at these stations. A complete listing of corals and fishes by station is presented in Table 2 and Table 3 (Appendix).

B. Cultural Resources

1. Carolinian Grave Site on Managaha

The first recorded event of historic significance on the island of Managaha was the arrival of Chief Aghurub and his small group of Yapese immigrants sometime around 1815 (approximately 31 years after the Spanish removed all Chamorros from Saipan). These Carolinians occupied Managaha Island for many years, however, Chief Aghurub died in 1819. He was buried on Managaha Island (exact location unknown) and a monument commemorating his life and journey to the Northern Marinans has been erected (Refer to Figure 25 for location of the Monument). The island of Managaha is considered sacred by the Carolinians because of Chief Aghurub's burial site. Culturally, the island is also special and sacred

because "Firowrowa" is performed here, the traditional practice of burning clothes and other personal possessions of the deceased.

2. Traditional Fishing and Gathering

Managaha Island and the surrounding water support numerous resources used daily by local residents. The coral reef surrounding the island supports a variety of marine life which has been harvested traditionally by the Chamorro and Carolinian populations. Everyday fishermen can be seen using numerous fishing techniques to catch the desired species. This is the site where the largest fish was speared during the 1984 Santa Remedio spearfishing tournament.

The island itself supports at least 28 species of medicinal plants still used by local residents. These plants were thought to be nurtured by the Carolinian Chief Aghurub possibly even brought to Managaha from his distant Yap island. Local Carolinian residents are aware of medicinal plants on Managaha. However, they are reluctant to harvest them because of the sacred nature of the island and prefer to harvest them elsewhere on Saipan.

C. Historical Resources

The underwater areas of Tanapag Harbor and the Saipan Lagoon contain numerous historical properties. The majority of these are related to military activities conducted by the Japanese and American forces prior to, during and immediately after World War II. The recently completed "Underwater Survey of Tanapag Lagoon for Historic Properties" (PBEC, 1985) located and described 18 properties including aircraft, ships, barges, landing craft and miscellaneous objects. Eight of the properties described in this report are located within the

boundaries of the proposed Managaha Island Marine Park. None exist within the boundaries of the proposed Underwater Trail. These underwater relics as well as some historic properties near Managaha Island are discussed below.

1. Underwater Historic Properties

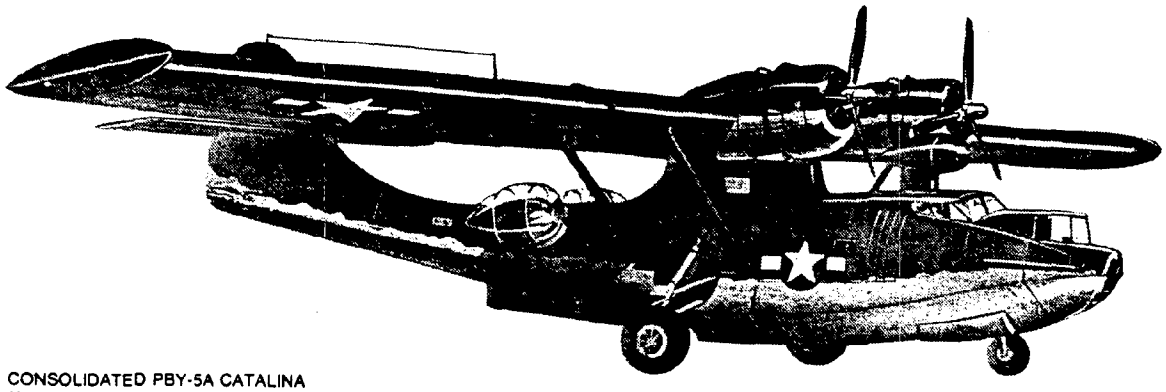
The following underwater properties are located within the boundaries of the Managaha Island Marine Park (Figure 5).

a. American Airplane

The wing section and other small pieces of what appear to be the remains of an American airplane are located on both sides of an awash patch reef situated approximately 595 m (650 yards) southsoutheast of Managaha Island (Figures 6, 7, and 8). The larger wing section, engines and miscellaneous wreckage are located in 15 ft of water approximately 50 m (165 ft) northeast of this patch reef, while a piece of fuselage and a tail section are located in 25 feet of water about 76 m (250 ft) south of the patch reef.

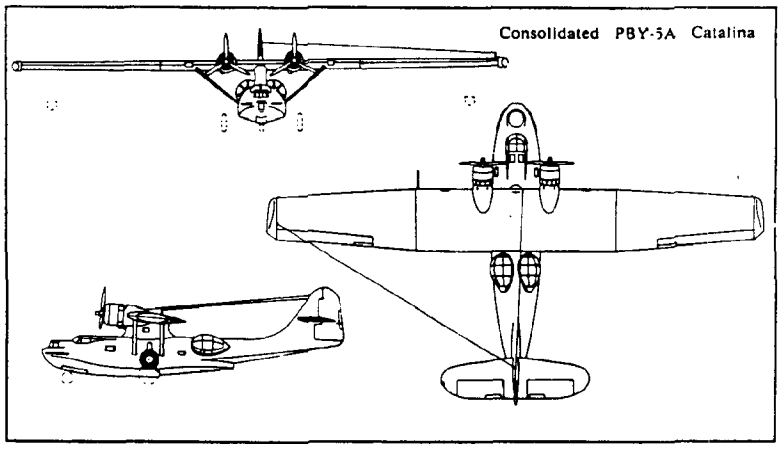
The wing measures approximately 25 m (82 ft) long and is in fairly good shape. The airplane was powered by two engines. Each time the wing was inspected, there were three to five sharks resting underneath it. Caution should be exercised as most of the sharks were whitetip reef sharks.

It is believed that all the pieces of wreckage around the patch reef are from the same plane as they are oriented in a line across the reef into the normal northeast winds. The pilot may have tried to ditch the plane in shallow water near the reef.



CONSOLIDATED PBY-5A CATALINA
Nation: USA; *manufacturer:* Consolidated Aircraft Corp; *type:* reconnaissance; *year:* 1941; *engine:* two Pratt & Whitney R-1830-82 Twin Wasp 14-cylinder radial air-cooled, 1,200 hp each; *wingspan:* 104 ft (31.70 m); *length:* 63 ft 10 in (19.45 m); *height:* 20 ft 2 in (6.14 m); *weight:* 35,420 lb (16,066 kg) (loaded); *maximum speed:* 175 mph (281 km/h) at 7,000 ft (2,135 m); *ceiling:* 18,100 ft (5,520 m); *range:* 2,350 miles (3,780 km); *armament:* 5 machine guns; 4,000 lb (1,814 kg) of bombs; *crew:* 7-9

A



B

Figure 6 A and B. The PBY-5A Catalina twin-engine seaplane, the possible identity of the airplane wreckage.

Figure 7. Wing section from an American airplane. The airplane is upright with sections of the plane scattered about the area as far as 200 yards away on the other side of an exposed coral patch reef.

Figure 8. Same airplane wing viewed from the opposite direction as in Figure 7.

No positive identification has been made for this property although local dive guide Ben Concepcion reports that a radio and other electronic instruments on board have American makings. It was on this evidence that the wreck was tentatively identified.

A former Navy pilot who crashed off Managaha Island believes that the wreck of his airplane is visited by the glassbottom boat tours. The aircraft alleged to be at this location is an OS2U Kingfisher, however the remains do not seem to be those of a single-engine plane. One source feels the wreckage might be a PBY-5A Catalina based on overall construction and existence of a radio cable attached to the wing (Denfeld, pers. comm.). At this point a definite identification is not possible and further research is needed to provide enough data to properly identify this property.

Although this airplane is scattered over a large area, the wing section is very shallow and impressive to view. Its close proximity to Managaha Island and the fact that it may be the only American airplane known to exist in the Saipan Lagoon are strong factors to give it historical significance and include it as a part of the underwater park.

b. Small Pontoon

A small aluminum pontoon is located in 6 m (20 ft) of water approximately 100 m (325 ft) northeast of the exposed patch reef not far from the airplane wing just described (Figures 9 and 10). It is flat-bottomed, pointed at the front and approximately 3 m (10 ft) long. It may be a part of the American

Figure 9. Unidentified pontoon of unknown origin or use. Possibly could have been part of a seaplane.

Figure 10. Same pontoon identified in Figure 9. Note flat bottom and sharply pointed bow.

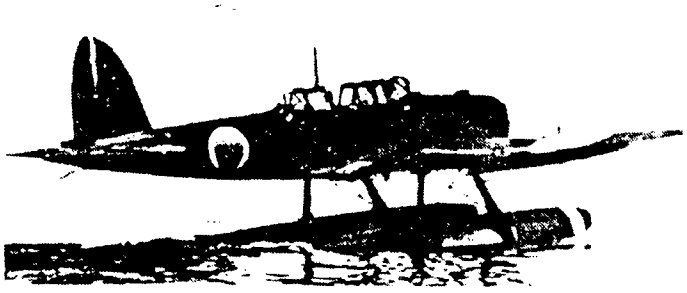
airplane or one of the pontoons from a seaplane. A hook on the front may have been used for lifting, towing or as a tie-down point. One source believes it could be the outer edge pontoon of an observation plane such as an OS2U, Kingfisher.

This property could easily be moved closer to the airplane or into shallow water if desired. It could also be moved to the underwater trail as an attraction for snorkelers.

c. Unidentified Japanese Aircraft

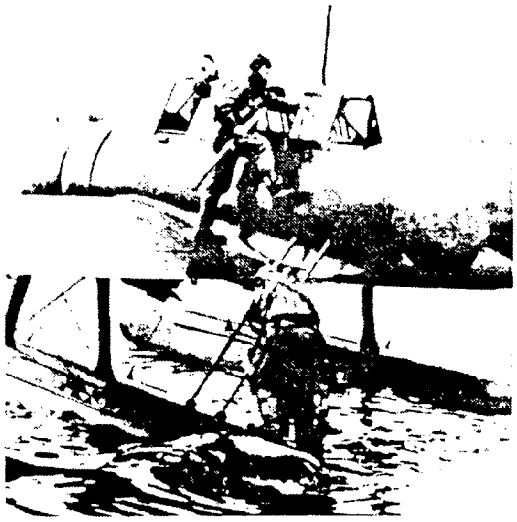
This unidentified Japanese airplane rests upsidedown in approximately 6 m (20 ft) of water approximately 365 m (400 yds) due south of the eastern edge of Managaha Island and nearly 275 m (300 yds) westnorthwest of the exposed coral patch reef (Figures 11, 12, 13, and 14). The plane is in very good condition with the exception of the tail section which is either missing or completely buried in the sand. This wreck is mistakenly referred to locally as the "upsidedown zero" and is one of the stops made by all the glassbottom boat tours to Managaha Island.

This plane has a wingspan of approximately 46 feet (14 m) and is approximately 36 feet (11 m) long. It was powered by a single radial engine with a 3-bladed propeller. A pontoon-like object rests just forward of the wing. There is no landing gear present, only the partial remains of wheel or pontoon supports. On the underside of the plane, near the center of the wing, is a small sliding door with gears, which may represent the remains of a camera housing, but which is more likely a weapon release mechanism.



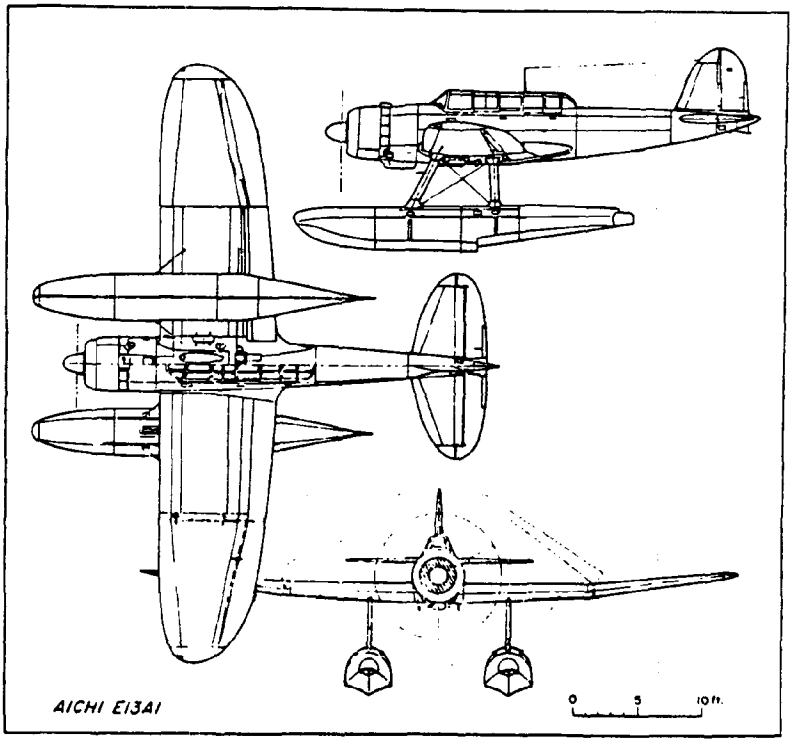
An Aichi E13A1 Navy Type 0 Reconnaissance Seaplane Model 11. (*S. Tanaka.*)

A



Crew boarding an Aichi E13A1. (*S. Tanaka.*)

B



C

Figure 11 A, B, and C. Photographs and schematic of the Aichi E13A1 "Jake" seaplane

Figure 12. Upsidedown airplane of Japanese origin, commonly referred to as the "upsidedown Zero". However it is likely a small seaplane used for reconnaissance known as the "Jake" (Aichi E13A1).

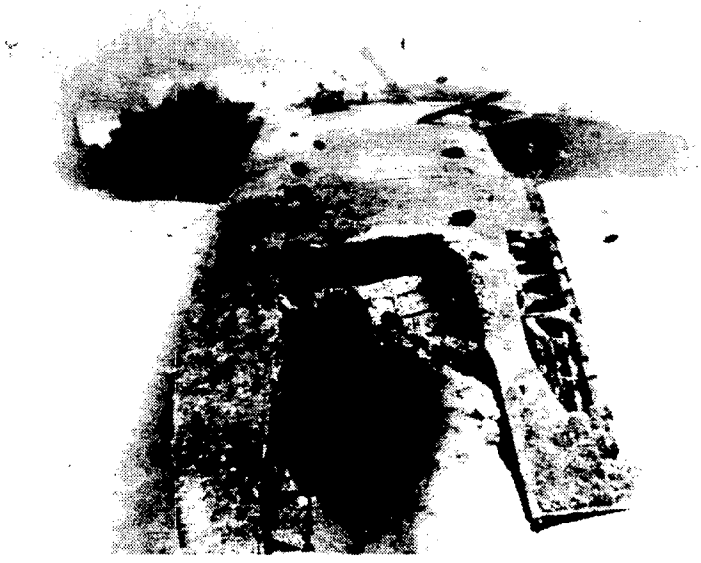


Figure 13. View of the same plane identified in Figure 12 from the starboard wing tip. Note that the tail section is missing or buried in the sand.

Figure 14. View of the same plane identified in Figure 13 from the tail section which is missing or buried under the sand. The object in front of the wing in the upper right portion of the photo is believed to be one of the two float pontoons.

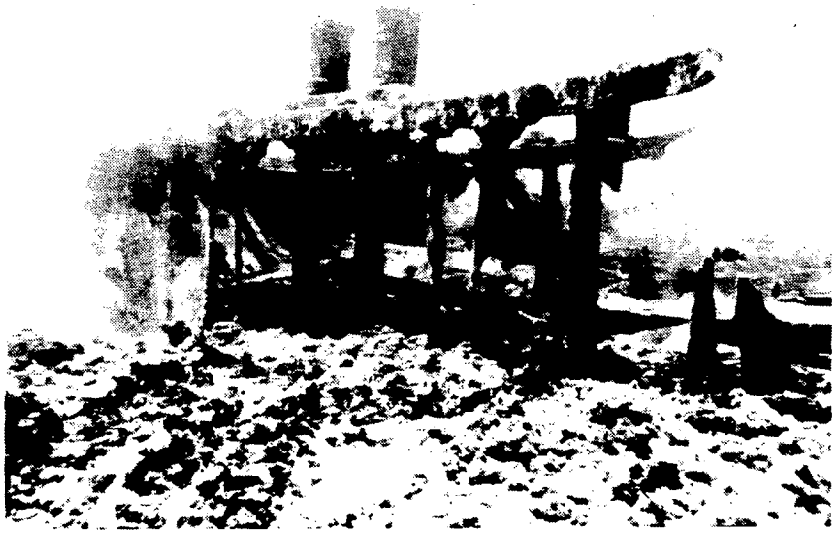


Figure 15. Coal barge or temporary pier located just underwater near Managaha Island.

Because this plane is resting upsidedown, positive identification has not been possible. However, based on the dimensions of this wreck, it is likely an Aichi E13A1 reconnaissance seaplane, referred to by the Allies as a "Jake" or an Aichi D3A1 divebomber, code named "Val." Both aircraft were produced in large numbers by Japan during World War II and were known to have been assigned to units operating in the Central Pacific. These two aircraft are very similar in size and general features which makes positive identification difficult. The leading edge shape of the wing is a distinctive feature of the Val. However, one difference between the airplanes is that the E13A1 Jake has a propeller shaft cover while the Val does not. This feature, the pontoon-like structure and a couple of comparrison points suggests this airplane is a "Jake" (Denfeld, pers. comm.). If the sliding door had been used for radar equipment the aircraft might be the naval radar model E13A1B.

This airplane is in good condition and should be incorporated as part of the marine park. A recommendation to try and turn the airplane over has been made. However, this would not only prove to be very difficult but would very likely result in damage to the property. In addition to its value as an underwater exhibit, the aircraft possesses research potential, and it is likely that detailed study would reveal the plane's identity as well as information relating to its sinking.

d. Barge

A large, badly deteriorated barge is located at the edge of the reef near the southeast tip of Managaha Island approxi-

mately 229 m (250 yds) from shore (Figures 15 and 16). Water depth here varies from 2 to 4 m (6-12 ft) with portions of the wreck exposed at low tide. Although no positive identification was made, it is presumed to be of Japanese origin and may have been used as a cargo barge or as a temporary dock or mooring. Another source suggests that this property might be a U.S. Coal Barge.

The barge is in bad shape with only one forward section partly intact. Most of the lighter metal has rusted away leaving only heavier beams and ribs. It is encrusted with corals and other marine life and serves as an artificial reef attracting numerous species of fish. This property is of no particular historical significance, however it is an attraction to snorkelers due to its closeness to shore and shallow depth. In addition, a fairly large number of fish are attracted to the structure making it ideal for viewing and underwater photography.

e. Fishing Boat

A small steel hull boat, possibly a fishing boat or small cargo vessel, is located on the inside of the barrier reef approximately 870 m (950 yds) westsouthwest of Managaha Island. The boat is in poor shape and sits in approximately 4.5 m (15 ft) of water.

The steam engine, boiler and other parts of the vessel are intact but it is impossible to determine its size or shape. Coal, presumably to fire the steam engine, is scattered on the bottom

Figure 16. Another view of the same barge or temporary pier identified in Figure 15. Mooring cleats can be seen in the foreground.

in the vicinity. No identification has been made on this property.

f. Landing Craft

The remains of what appear to be two separate landing craft are located in 4.5 m (15 ft) of water on the lagoon side of the barrier reef approximately 1097 m (1,200 yds) west-southwest of Managaha Island. The vessels are in poor condition and it appears that they were blown apart when sunk.

g. Unidentified Japanese Airplane

A small, single engine airplane is located just inside the barrier reef near the north edge of the main channel entrance to Tanapag Harbor (Figures 17 and 18). The plane rests upsidedown in approximately 3 m (10 ft) of water. The airplane is in poor shape with only the wing and a small section of the fuselage remaining. It is heavily covered with corals and other encrusting forms and therefore quite difficult to discern from the surrounding reef. Two landing gear supports stick upwards and nearly reach the surface at low tide.

The wing measures approximately 15 m (50 ft) long and is 2.5 m (8 ft) wide at the fuselage. The engine and propeller are missing. The plane is likely a one-man reconnaissance plane or perhaps a small dive bomber or fighter. No armament is visible on the wings, and the wingspan is too long for it to be a "Zero". With so little of the plane intact and covered by corals a positive identification is difficult.

This airplane remnant is in shallow, clear water and could be included as an attraction in the marine park. As the reef is

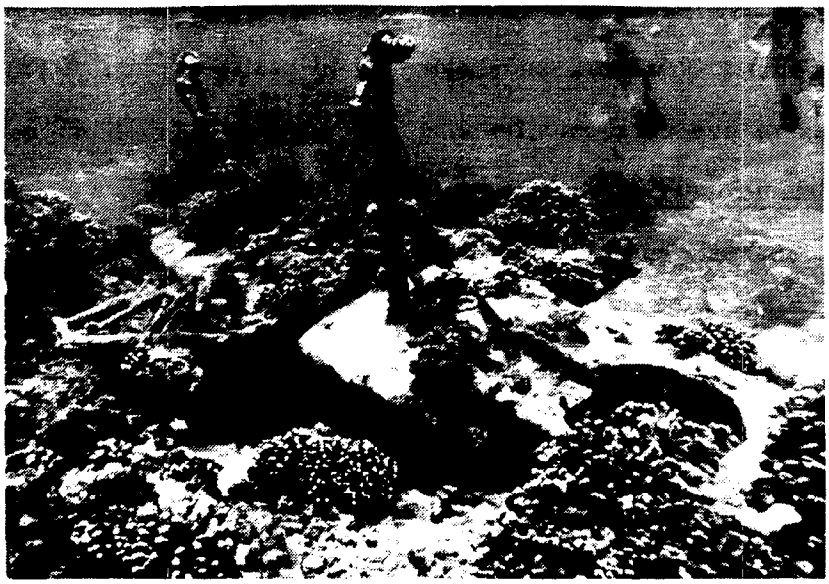


Figure 17. Upsidedown single engine Japanese airplane possibly used for reconnaissance. Note landing gear standing upright and extensive coral growth in the vicinity.

Figure 18. View of the same airplane identified in Figure 17.

very shallow here, glass bottom boats would not be able to view this plane. However, snorkelers could easily explore it and see extensive live coral and fish.

2. Historic Properties on or near Managaha Island

The Japanese constructed a concrete pier, buildings, bunkers and gun emplacements on Managaha Island as it is strategically located close to the Tanapag Harbor channel entrance. Any vessels entering the Harbor and northern Lagoon via the main channel, would be easy prey for these guns.

After the invasion of Saipan by U.S. forces in June of 1944 considerable time and effort was expended in locating small pockets of Japanese soldiers scattered in the numerous caves and remote areas of the island. American forces were aware that Maniagassa Island, as it was referred to then, was fortified and still occupied by a small group of Japanese. The occupation forces termed it a nuisance and a threat to American shipping (Crowl, 1960).

On July 13, 1944, the 3rd Battalion, 6th Marines conducted an amphibious landing and assault on the island. The mission was taken very seriously and was proceeded by careful reconnaissance and an aerial bombardment. Several LVT's were used to transport the marines to the island. A total of 29 Japanese soldiers were found to be occupying Managaha. Fifteen were taken prisoner and the remainder killed during the battle. Only one U.S. Marine was wounded (Hoffman, 1950).

A number of historic or cultural properties can be found on Managaha Island (Figure 25). The majority of these properties are related to war activities. Following is a list of the most important.

a. Coastal Defense Guns

Two large (15 cm) coastal defense guns are located on the west coast of the island near the concrete pier. One of these is situated in a bombed-out concrete shell probably used for protection and munitions storage. The second, only 20 m (65 ft) away, is pad mounted out in the open (Figure 19). Both are aimed toward the harbor entrance obviously used for protection of Tanapag Harbor during the war.

b. Japanese Bunkers

One large and two smaller Japanese bunkers can be found along the northern coast of the island (Figure 20). These bunkers are mostly above ground and covered with sand and vegetation camouflaging them extremely well. The smaller bunkers are in close proximity to two anti-aircraft guns located just offshore in the shallow cove at the southeastern corner of the island (Figures 20 and 21). These guns were probably on fast land located nearby the bunkers, the bunkers providing shelter for gun operation or for ammunition storage. The largest bunker was most likely used for personnel protection during active shelling by American forces. This bunker has ventilation pipes and at least two entry/exit points.

c. Anti Aircraft Guns

Two anti-aircraft guns are located in shallow water in a small cove along the southeast coast of the island. One gun still has its barrels pointing skyward (Figure 21). The second has toppled over with its barrels either broken off or pointing into the sand.

Figure 19. One of the 15 cm coastal defense guns on Managaha Island.

Figure 20. One of the two smaller Japanese bunkers located on the northern point of Managaha Island.

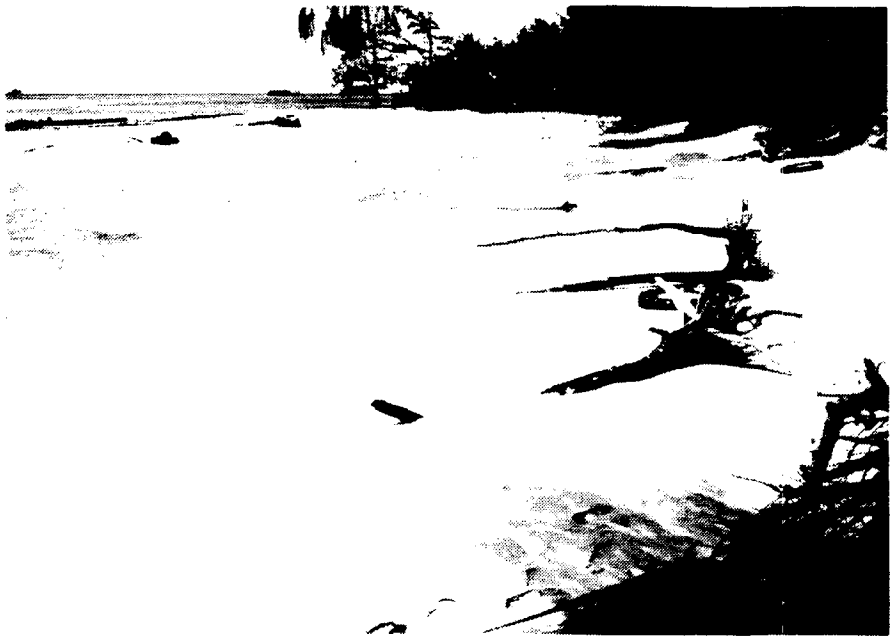


Figure 21. One of the two anti-aircraft guns located in shallow water on the southeastern coast of Managaha Island.

Figure 22. Barge or pontoon pier located on the beach and partly submerged on the east side of Managaha Island.

d. Landing Craft

A small landing craft (M-Boat), possibly American, lies partially exposed in shallow water just south of the concrete pier. This M-Boat has twin engines and rudder posts.

e. Barge or Pier

Remains of an old barge or pier (possibly a temporary pontoon structure) is located on the beach and in shallow water on the easternmost tip of Managaha Island (Figure 22). No positive identification of the structure has been made and it is in very poor shape. It is likely of WWII origin and suspected to be an American pontoon pier. It is possible that this structure was placed here to further protect the small adjacent cove. This cove has a natural protection barrier on the other side. Because it is located on the island, tourists often use it to photograph from. This poses serious safety problems since it is badly deteriorated. The property should be posted with warning signs indicating that it is dangerous and individuals should not climb on it.

f. Barge

A large rusting hulk, probably the remains of a barge or pontoon, can be found at the base of the main pier on the west coast (Figure 23). This wreck is unidentifiable but most likely of Japanese origin used during war activities to haul equipment.

D. Existing Facilities

Facilities on Managaha Island have been recently upgraded (1984) by PDI, a private concessionaire with local interests in hotel and tour operations. The original Japanese pier which was in disrepair and

Figure 23. A large rusting hulk, probably the remains of a barge or pontoon near the main pier.

dangerous was partially repaired and a solar-powered light was installed on a pole at the end to add night lighting and reduce its potential as a navigation hazard.

A well-built, attractive L-shaped pavillion has been constructed opposite the main beach and swimming area at Managaha Island. This structure provides sheltered seating at picnic style tables, a bar, barbeque facilities, restrooms and showers, office, small gift shop and limited rental facilities. Four smaller pavillions are located at other sites around the island.

Other facilities include a volleyball court, a buoyed swimming area, snorkeling and rental of scuba diving equipment, windsurfers, and beach mat/floats and food and drink concessions. Due to some recent drowning incidents, properly trained lifeguards are now on duty whenever tour groups are present on the island. Water skiing, diving and sightseeing tours by boat are also available at Managaha. Plans have been recently approved by the CNMI government to permit a para-sailing operation on the north side of the island.

E. Access

Access to and from Managaha Island via large glass-bottom boats is provided on a regular basis three times daily at 9 a.m., 1 and 4 p.m. from Smiling Cove Marina in Garapan. These trips are provided by PDI for a nominal fee. Numerous smaller, faster boats are available upon request by PDI and other private boat owners at the Smiling Cove Marina. Numerous private motor boats and sailboats bring visitors to Managaha Island usually on weekends and holidays. The large glass-bottom boats tie up alongside the pier. Smaller boats anchor in shallow water and some of these prefer to pull their boats up on the

beach. All boats should moor in shallow water rather than pulling them up on the beach. Mooring areas should be identified for the protection of the boats and nearly swimmers snorkelers and divers.

IV. INTERPRETATION

A. Orientation Center

Interpretive displays and programs at the Managaha Island Orientation Center should allow the first-time visitor to quickly ascertain what the island and marine environment have to offer. The visitor can then decide which activities and attractions he or she wishes to participate in or observe and plan their limited time on the island effectively.

A large map/display board showing the island, location of facilities, historic and cultural sites, nature trail, swimming area and underwater trail should be strategically located so that visitors can quickly and easily orient themselves (Figure 24). This display map should be located near the pier in a small kiosk to protect it from the elements or in a conspicuous location within the pavillion/orientation center complex. All wordage must be bilingual and whenever possible photographs, drawings and symbols should be used to excite the visitor and make interpretation of what the park has to offer as simple as possible. A small printed map or pamphlet should be available to visitors that depicts locations of all the facilities and sights. This handout could also include a brief description of the park, rules and regulations and a brief overview of the underwater trail.

Depending upon the budget available for the orientation center, an audio-visual presentation of some kind could be produced. This could range from an automated slide/sound show to a videotape production. The presentation should be short, from 10-15 minutes in length, and would present the visitor with an impressive introduction to the park concept, nature trail, historic/cultural resources, underwater trail and

Interpretive Display Concept

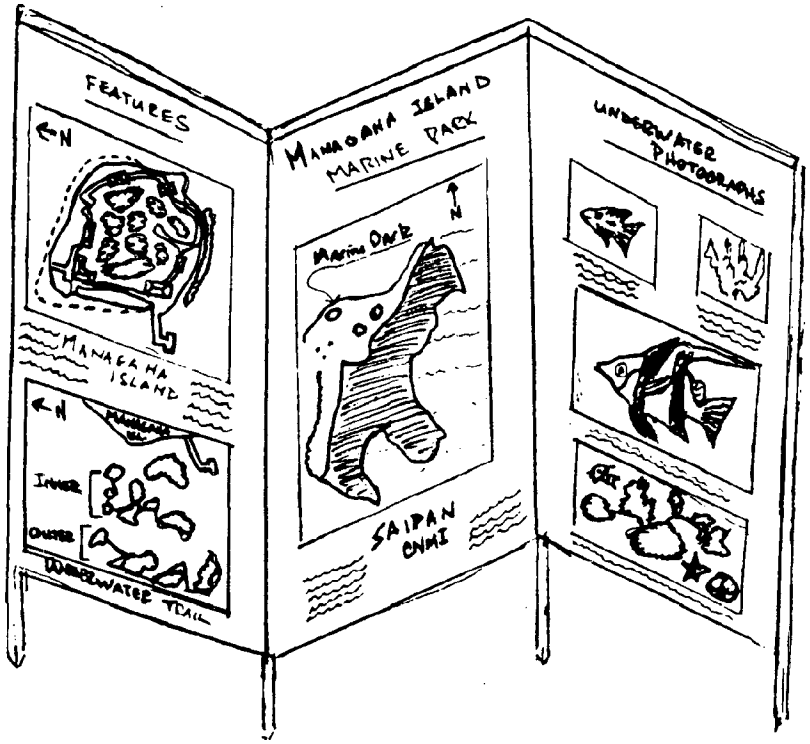


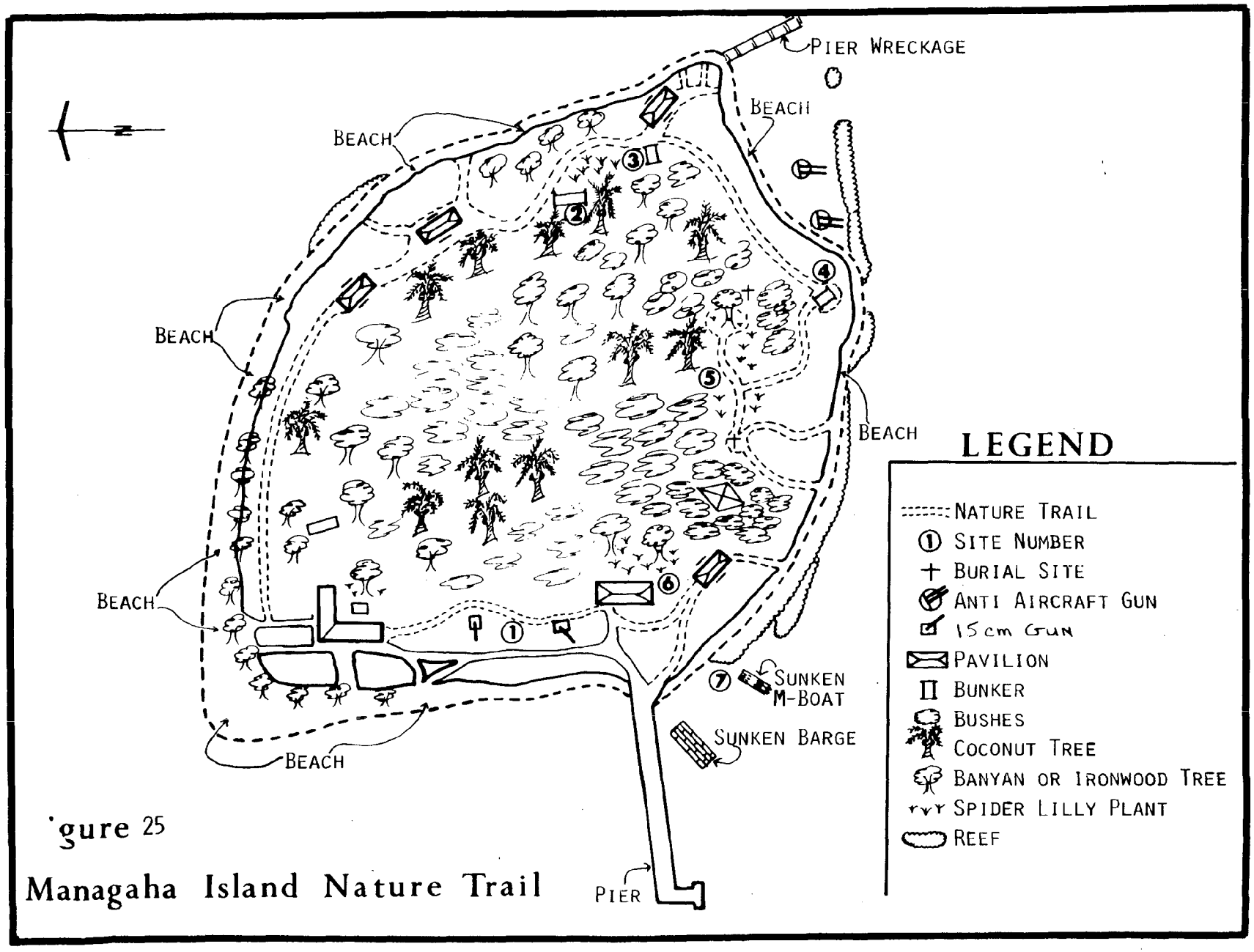
Figure 24. Marine Park Interpretive Display. Two-sided, free standing plexiglass display framed in wood with matt liner between plexiglass sheets. The panels are 3'x6' and detatchable with handles for easy transporting between display sites. Text will be in English and Japanese.

marine life. The sound track/tape would need to be bilingual or there could be English and Japanese versions. Copies of the production could be used by the Marianas Visitors Bureau or loaned via the mail to tour operators, dive clubs, travel groups and other organizations as a form of advertising.

The audio-visual presentation could be continuously running, shown at regularly scheduled times or timed to the arrival of tour boats. The operator could be a park employee or someone hired by a major tour operator or concessionaire. The production could also be shown at the airport in the baggage arrival area or other appropriate places where arriving tourists could view it. This would attract those visitors who are not part of a package tour to Managaha to visit the island on their own.

B. Managaha Island Trail

A nature trail should be established on Managaha Island (Figure 25). The trail should be self-directing and easy to follow and should wind through various types of vegetation and include the Carolinian grave site, Japanese guns and bunkers and other historic sites. Simple signs (bilingual) and arrows would guide and inform the visitor. Signs identifying a site or type of tree should be engraved in aluminum or laminated plastic. Vegetation identification plaques should be displayed on a pedistal near the base of the tree or attached to the top of a stake that will elevate the plaque approximately 1 m (3 ft) from the ground. The scientific name, common name, local names(s) and a brief description or a few facts should be included.



'gure 25

Managaha Island Nature Trail

The following are suggested sites that should be included in the Managaha Island Trail including types of vegetation, natural features and historic and cultural resources.

Seven separate sites have been identified on Managaha Island for inclusion in the nature trail (Figure 25). Sites chosen were based on the following criteria: historical or cultural significance, aesthetic beauty and proximity to existing trail.

Site 1. Located in close proximity to the central pavillion are two, large Japanese 15 cm (6 in) coastal defense guns. One of these is situated inside a large concrete bunker probably used to store ammunition. The second gun is pad mounted just north of the first. Both guns are aimed toward the harbor entrance obviously used to protect the harbor from enemy intrusion.

Site 2. Located on the eastern side of Managaha Island is a large Japanese bunker probably used for supply storage and troop protection. This bunker is situated inland of the nature trail on a slight rise and difficult to see since it is covered with low vegetation and large trees. In the vicinity is a small field of Spiderlilly plants and a young stand of Ironwood trees. The setting is quite unique offering a splendid view of the northern end of Saipan Lagoon and the Marpi area of Saipan.

Site 3. A small Japanese bunker is located at this site on the southwest corner of the island. The bunker sits back in the brush inland from the nature trail and is barely visible. Behind the bunker is a small stand of large Banyan trees and a few Breadfruit trees. Ironwood trees can be found scattered about on the

point toward the beach. On the sandy point extending into the water is the ruins of a 53 m long (175 ft) metal structure. Most likely his was used as a temporary wharf or pier. Looking out into the small bay at this point one can see the remains of old concrete and metal pipes probably used as ocean outfalls during the Japanese occupation. The small cove protected at both ends may have been dredged and used for small boat landings.

Site 4. Another small Japanese bunker can be found at the southern tip of the island. This bunker, unlike the rest, is situated on the beach side of the nature trail on a slight rise. Medium size Ironwood trees are growing on top of the structure obscuring it from view. Two anti-aircraft guns, (one with twin barrels pointing skyward) can be seen in shallow water within the small protected cove. Jutting out into the water toward the east and continuing along the western coast of the island is an uplifted edge of consolidated sand deposits. A walk out on this structure brings one closer to small reef fish and other unique marine life like starfish and an occasional juvenile octopus.

Site 5. This site is the burial site of an ancient Carolinian leader, Chief Aghurub, who led his people from the western Carolines to the Marianas in the mid-1700's. His grave site near a large Banyan tree area is considered sacred to local Carolinians. The site is aesthetically beautiful with natural Banyan and Ironwood trees scattered about. In addition, many ornamentals have been planted in the area. These include Plumeria, Spider Lilly, Papaya and a variety of Crotons.

Site 6. This site is the location of large Banyan trees with numerous trailing vines. These trees are believed to be the source of legendary taotaomonas, the spirits that dwell within them.

Site 7. Located just to the south of the pier in shallow water near the beach is the ruin of a small landing craft (M-Boat). With snorkel gear one can see twin engines and rudder posts, superstructure and bow ramp.

C. Underwater Trail

Interpretation of the underwater trail off the west side of Managaha Island will primarily be through the use of underwater plaques and a waterproof guide that will be carried by the snorkeler/ scuba diver along the trail. The underwater guide will be a two-sided, plasticized "slate" keyed to each of the underwater stations. Brief wordage will describe the major or unusual features of each station and will possibly include drawings or photographs. A simple visual key could be used to identify major families or species of fish and coral.

The underwater markers will be cast concrete bases to which an engraved plastic or glass plaque will be attached (Figure 26). The upper surface will be at an angle (30° - 45°) to the bottom which will reduce the amount of sand and silt that would otherwise tend to accumulate on a flat, level surface. Algae and other marine organisms tend to grow rapidly on objects in shallow water where light penetration is good, so frequent cleaning of these plaques will be necessary.

Smaller plaques or arrow markers could be used between stations to direct swimmers to the next stop. To further orient the visitor, surface buoys will be placed at or near stations to mark the major attractions. These buoys should be highly visible and lettered to enable a

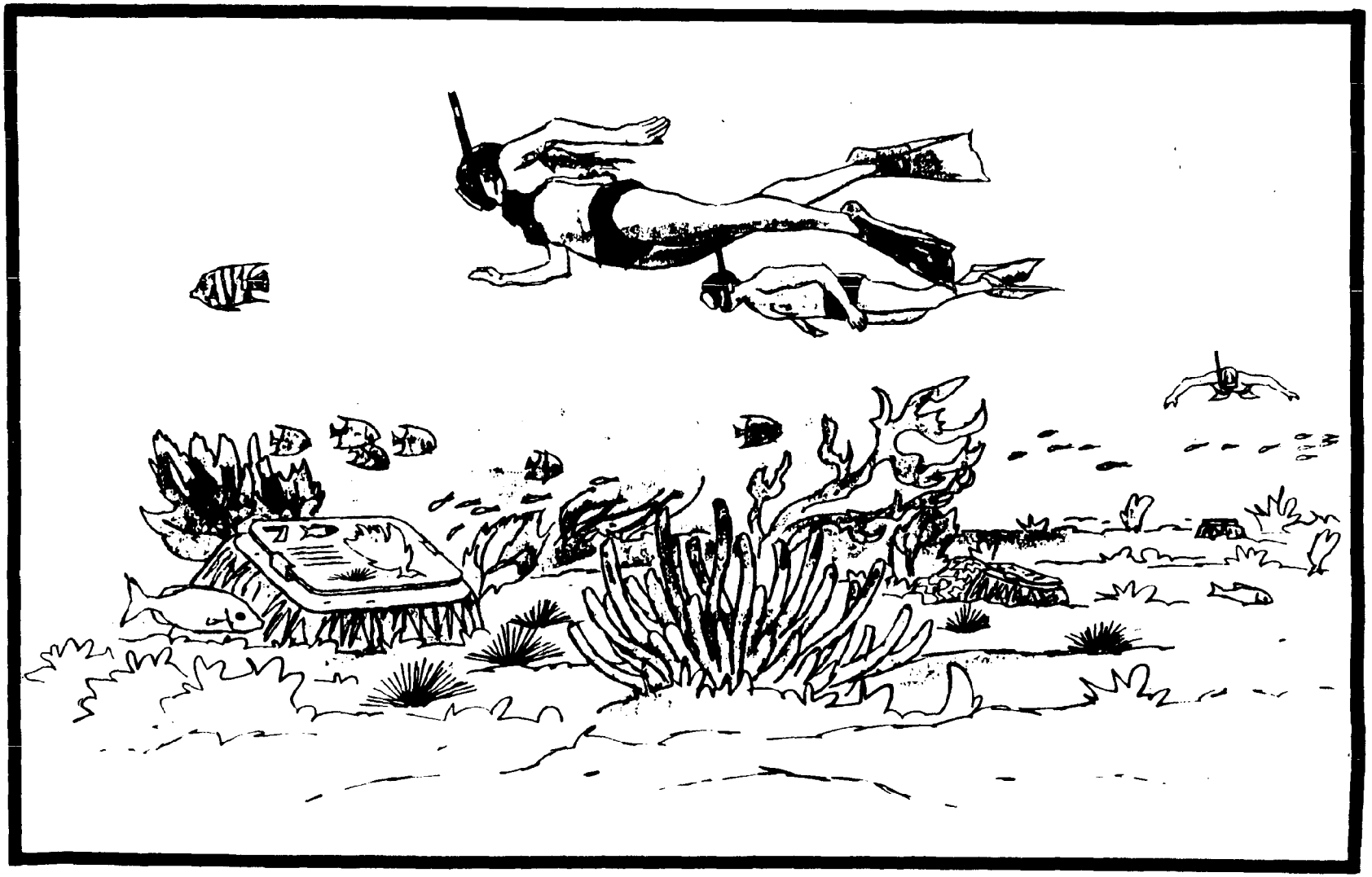


Figure 26. Example of an underwater marker system for the marine trail.

person in the water to quickly orient himself or locate his position on the trail by referring to the waterproof guide. Larger resting buoys with lines or handles should be placed at the beginning, middle and end of both trails (Figure 27).

The patch reefs which encompass the trail naturally separate into two underwater trails, an inner trail close to the island (I), and an outer trail (II) separated from the inner trail by a deeper 4.5 m (15 ft) sand channel (Figure 27). Novice snorkelers or weaker swimmers should use the inner trail as much less swimming is required to explore it. Both trails will begin at their north ends so that the visitors will be moving along the trail with the current and not fighting it.

Water movement in the area is from the northeast but because Managaha Island blocks direct lagoon currents the water tends to move more north-south (Figure 27). Strongest current velocity in the area is 3-4 knots, occuring along the shore and across shallow sand flats, and alsi tends to pulse in channels between coral formations. Currents of this nature prevail during the months of October - April (dry season). During the remainder of the year (wet season) current velocity drops to 0.5-1 knot with higher velocities during storms and high winds. A 3-4 knot current is difficult to swim against even for an experienced swimmer. Therefore, some form of protection (safety line) should be available during periods of strong currents. The inner trail could be "connected" to the beach area by attaching lines with floats to both the beginning and end buoys and running them to shore. A safety line could also connect the inner and outer trails but all boat traffic would have to be kept out of the channel area between the trails if this were done. For the safety of all trail users two additional rest

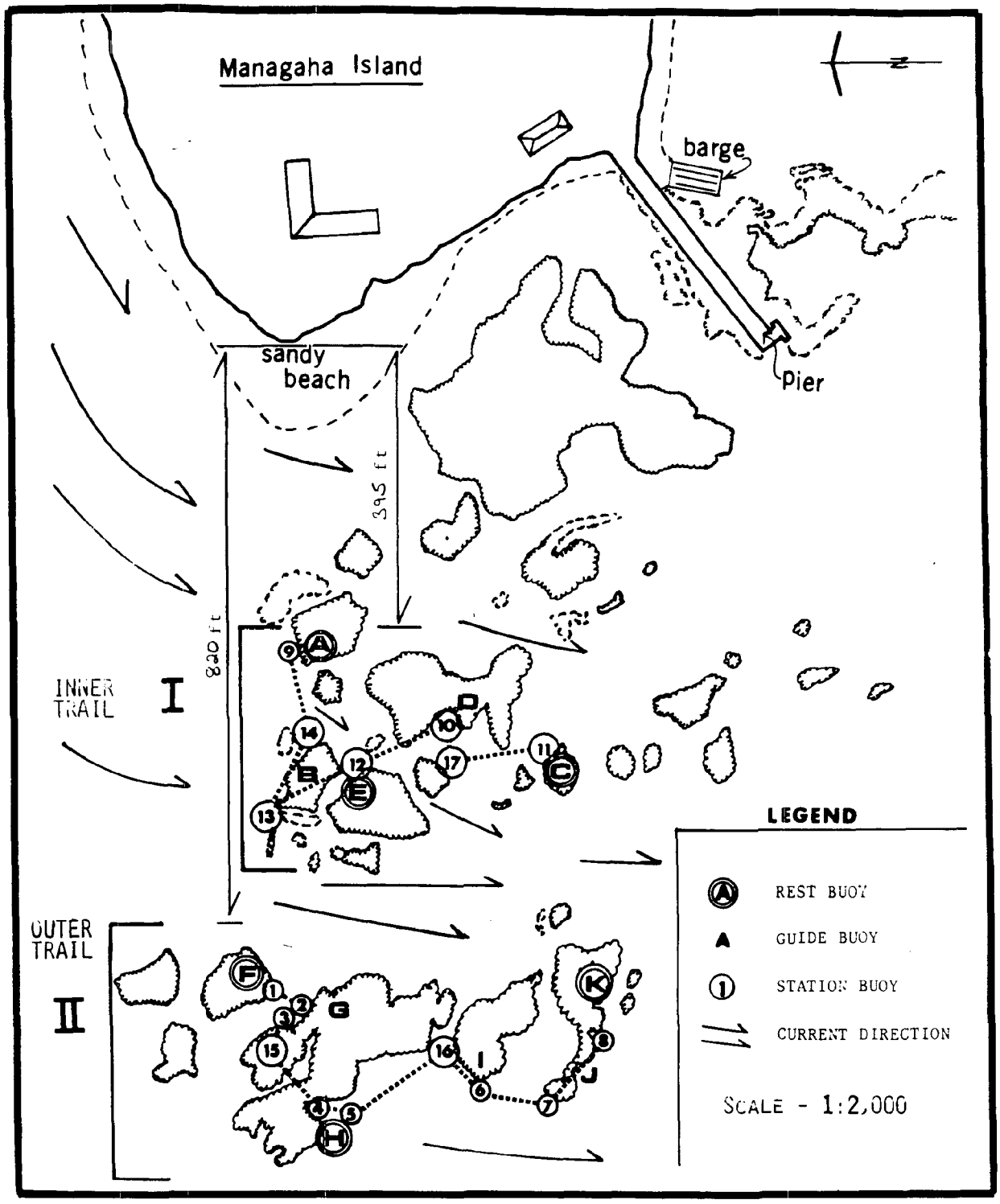


Figure 27. DETAILED MAP OF THE UNDERWATER TRAIL. Source: 1976 Ortho Photo.

buoys should be positioned on existing patch reefs downstream (south) of each trail system.

The inner trail begins approximately 120 m (395 ft) from the beach on Managaha Island and ends approximately 200 m (656 ft) from the beach. The total length of the trail (from station to station) is about 220 m (722 ft).

The outer trail begins approximately 130 m (426 ft) west of the inner trail or 250 m (820 ft) from the beach. The total length of the outer trail from station to station is 230 m (755 ft). The inner trail contains a total of seven stations while the outer trail has ten stations.

The following is a station by station description of both underwater trails. Specific information as to species of fishes and corals found at each station is given in Tables 2 and 3 (Appendix). For purposes of this report the station numbers are those used in the field survey and are not necessarily in numerical order. When the trail is marked with the plaques stations should be numbered from north to south beginning with the inner trail. Refer to Figure 27 for location of each station. Depths in this section are given in feet only because of shallowness. However, distances are still given in meters and feet.

1. Inner Trail

   a. Station 9 is located on a shallow patch reef (4-10 ft deep) and contains a large, impressive patch of soft coral (Sarcophyton sp., Figure 28). The underwater plaque at station 9 should definitely point out the soft coral patch. Under most conditions, the swim from the beach is rather short and not too taxing even for a beginner. During periods of increased waves and current, however, a safety

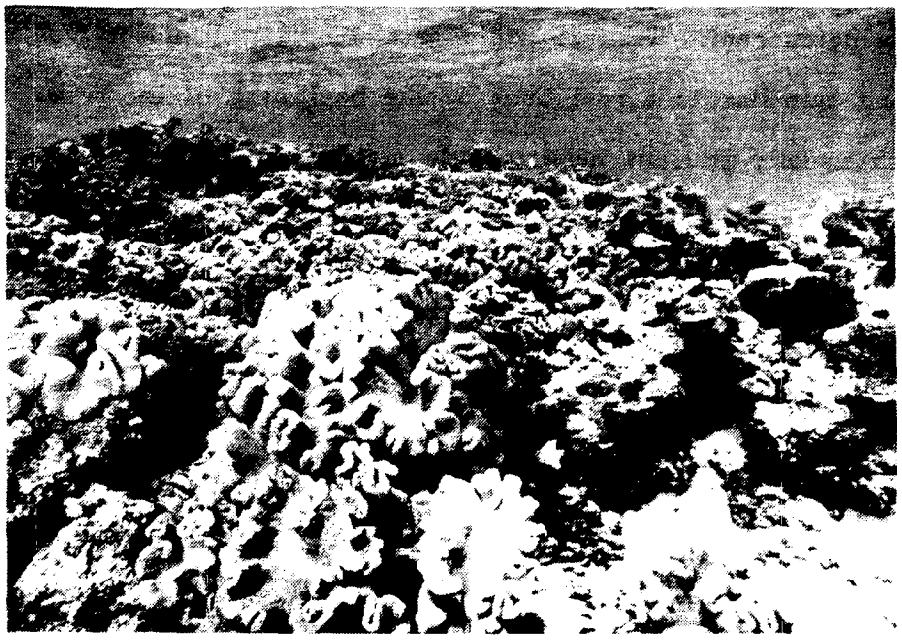


Figure 28. Station 9 showing the extensive are of soft corals.

Figure 29. Station 14 on the inner trail.

line with floats could be easily installed from the beach to this patch reef. Visitors could then simply pull themselves along this line to a rest buoy at the beginning of the trail. Fish usually present here include several colorful wrasses, surgeonfish, damselfish and goatfish.

Fish are numerous here and it is a good location for photography and fish feeding. The cobalt blue starfish Linckia laevigata and the sea cucumber Holothuria atra are also usually observed here.

From this first station the observer then swims towards the outer reef (WSW) approximately 40 - 50 m (135-165 ft) to Station 14. This swim is over a sandy, coral rubble bottom where sea cucumbers and fishes such as goatfish, emperors and wrasses can usually be observed. The swim is perpendicular to the current and not difficult.

b. Station 14 is located at the edge of a large patch reef. Depth here varies from 6-12 ft. Species of branching and massive corals and a reef structure containing many holes and crevices attract a large variety of fish (Figure 29). Squirrelfish, moorish idols and false moorish idols or bannerfish (Heniochus) are common in crevices and under coral overhangs. Teardrop butterflyfish (Chaetodon unimaculatus), yellow tangs (Zebrasoma flavescens), goatfish, several wrasses including the bird wrasse (Gomphosus varius) and the black and white stripe damselfish (Dascyllus aruanus) are common here. The underwater plaque at station 14 should identify the fish that are almost

always found under coral overhangs and in holes (bannerfish, morrish idols and squirrelfish).

From Station 14 the visitor has a short and leisurely swim along the north edge of the patch reef westward to Station 13. The distance is approximately 30 meters (100 ft) and there is usually little if any current in this area.

c. Station 13 is a large, single Porites lutea coral head approximately eight feet in diameter (Figure 30). It rests on a sand bottom (in 10 ft of water) but is adjacent to the northwest edge of patch reef "B". For many park visitors, especially those that have never seen a coral reef, a large coral head like this is very impressive. There is also good coral development on the nearby reef where the orange sponge stands out. Fishes in the area include some butterflyfish, goatfish and yellow tangs. The underwater marker here should feature the large blue Porites head.

The swim to Station 12 is easy and with the current, passing over a shallow patch reef. Swimming distance is approximately 40 m (130 ft) and many corals and fishes can be seen along the way.

d. Station 12 is located on the northeast corner of a large patch reef and varies from 3-9 ft deep. A rest float is located at this station. There is brain coral (Platygyra daedalea), Porites heads, blue coral (Heliopora) and the only patch of staghorn coral (Acropora formosa) found in either trail (Figures 31 and 32). The reef structure provides good relief and crevices and there are a lot of fish

Figure 30. The large Porites lutea head at Station 13.

Figure 31. Brain corals (Platygyra daedalea) at Station 12.

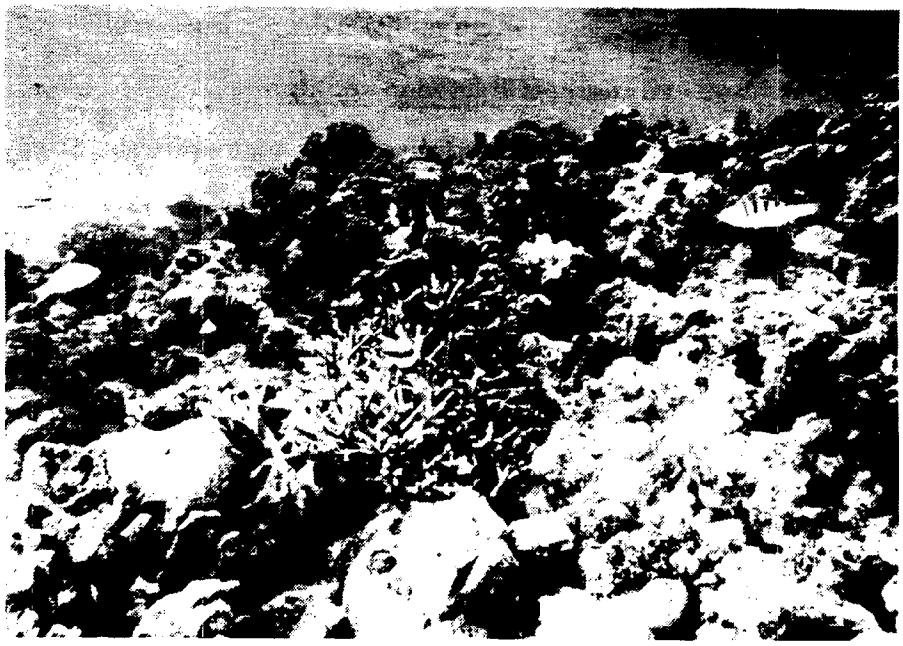


Figure 32. Staghorn coral (Acropora formosa), several species of wrasses, yellow tangs and the bannerfish (Heniochus chrysostomis) at Station 12.

Figure 33. Large aggregations of the blue-lined snapper (Lutjanus kasmira) and th yellow-spot emperor bream (Gnathodentex aureolineatus) at Station 10.

here. Common species include teardrop butterflyfish, saddleback butterflyfish (Chaetodon ephippium), the blue damselfish (Chromis), several wrasses and bannerfish. The plaque at this station should point out the brain corals and the staghorn Acropora thicket. The fragile nature of the Acropora should be stressed on the plaque.

Leaving this station the visitor swims approximately 50 m (165 ft) across one of the deepest areas of the trail, a sandy bottom channel that runs through the center of the inner trail. Depths here approach 20 ft and the current is generally strong along the bottom as the water funnels through this channel. However, the diver is swimming either perpendicular or at an angle to the prevailing current.

e. Station 10 is located at an indentation in the largest patch reef in the inner trail. To the west, this spot slopes from within three ft of the surface to a depth of 15 ft where it merges with the sand channel. This station contains the greatest numbers of fish and some are frequently observed in schools. The most common fish here include the blue-lined snapper (Lutjanus kasmira), monacle bream (Scolopsis cancellatus), yellow-spot emperor bream (Gnathodentex aureolineatus), goatfish, and several species of wrasses (Figure 33). Coral development is also good here with species of Acropora, Pocillopora and Stylophora being the most common. An underwater marker here should point out

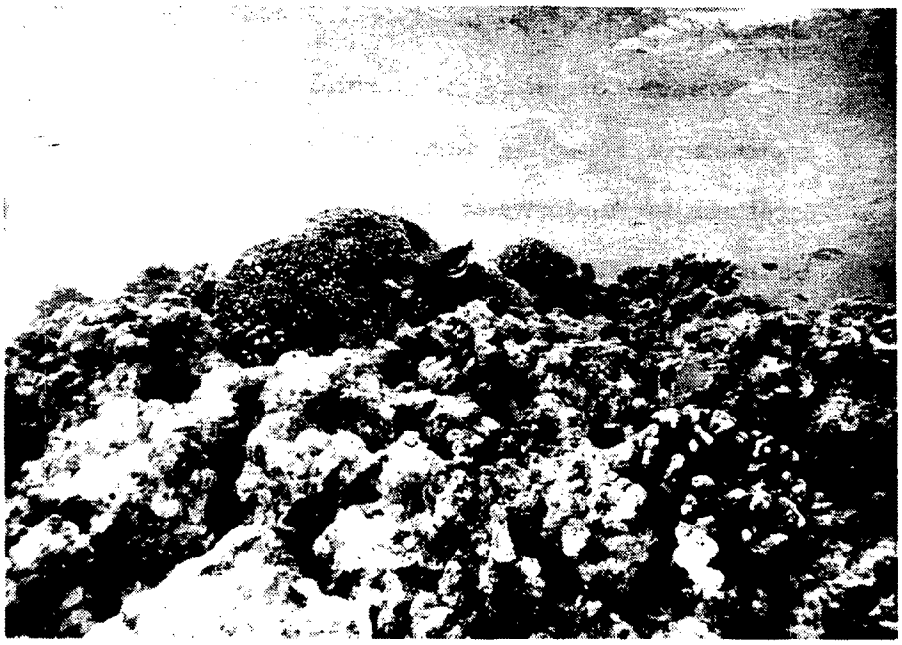


Figure 34. Station 17 on the inner trail.

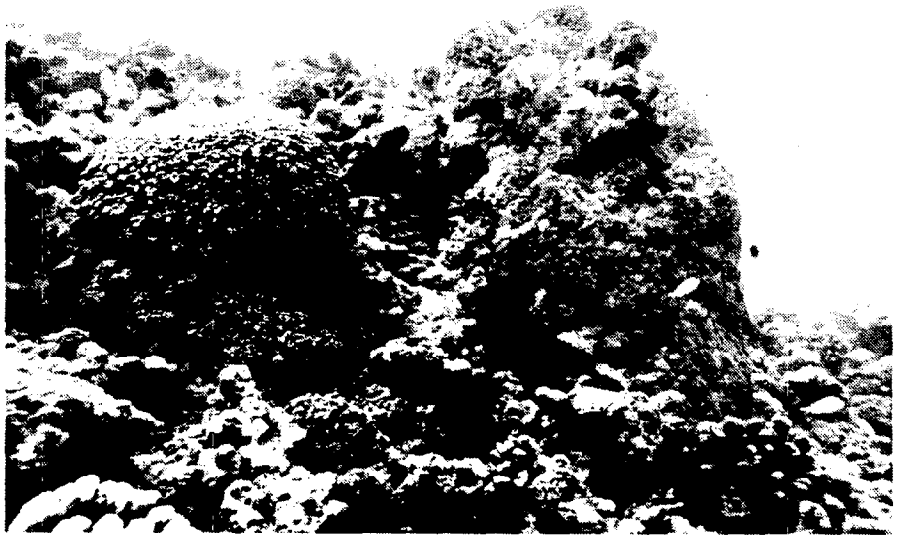


Figure 35. Station 11 showing the large Porites rus (left) and Porites lutea coral heads. The blue damselfish are Chromis caerulea.

the schooling fish (snapper and breams) which seem to always be in this location.

Because of the rich coral development and large numbers of schooling fish, this station is one of the best locations for underwater photography. It is deep enough to be an interesting spot for scuba divers also. Due to the large fish population, this is also a potential location for a feeding station. When fish are fed by guides and visitors on a regular basis they become somewhat tame and come in very close to the divers. The more aggressive wrasses will take food such as hotdogs or fish right out of a person's hand.

The swim to the next station (17) is across the channel a short distance (25 m or 82 ft) to a small patch reef.

f. Station 17 is located on a small patch reef opposite Station 10 (Figure 34). Depth here ranges from approximately 4-10 ft. There is only moderate coral development with mostly Acropora palifera and small forms, however, it was the only station where Galaxia fascicularis was observed. Fishes here include wrasses, breams, butterflyfish, moorish idols and small parrotfish. This station is more of an intermediary stop on the way to Station 11 than a unique site. The coral Galaxia could be pointed out on a plaque or a directional arrow could be used here directing the visitor to the next station.

The swim to the last station is the longest one in the trail covering some 50 m (165 ft). The visitor will be

swimming mostly over a sandy bottom that varies from approximately 10-15 feet deep. The entire distance however is with the current and one can simply drift leisurely along to reach the last station.

g. Station 11 is the final site for the inner trail. A rest float is located here which can be used as a waiting point until the group is ready to return to shore. It consists of a rather high coral patch reef which rises from some 15 feet to approximately four feet from the surface (Figure 35). A very large Porites lutea head with a crevice or cave through it attracts fish such as squirrelfish, soldierfish and trumpetfish (Aulostomus chinensis) to its protective habitat (Figure 36). Other corals such as Porites rus, Pavona, Montipora and Pocillopora are also found here. Surgeonfish, damselfish and several species of wrasses and butterflyfish are also common. The underwater marker here should label this station as the end of the trail. It could also point out the large Porites head and cave with the associated trumpetfish and/or squirrelfish which are very likely to be consistently observed here.

The swim back to the beach after viewing the inner trail should be towards the eastern portion of the swimming area and not back towards the point of the beach where the visitor entered the water. This is to reduce the effect of the current and make the return swim safer and more enjoyable. The total distance to the beach is approximately 250 m (820 ft), and passing over several patch reefs

Figure 36. The small cave underneath the large Porites head at Station 11. Squirrelfish, bannerfish and trumpetfish (Aulostomus chinensis) are frequently seen here.

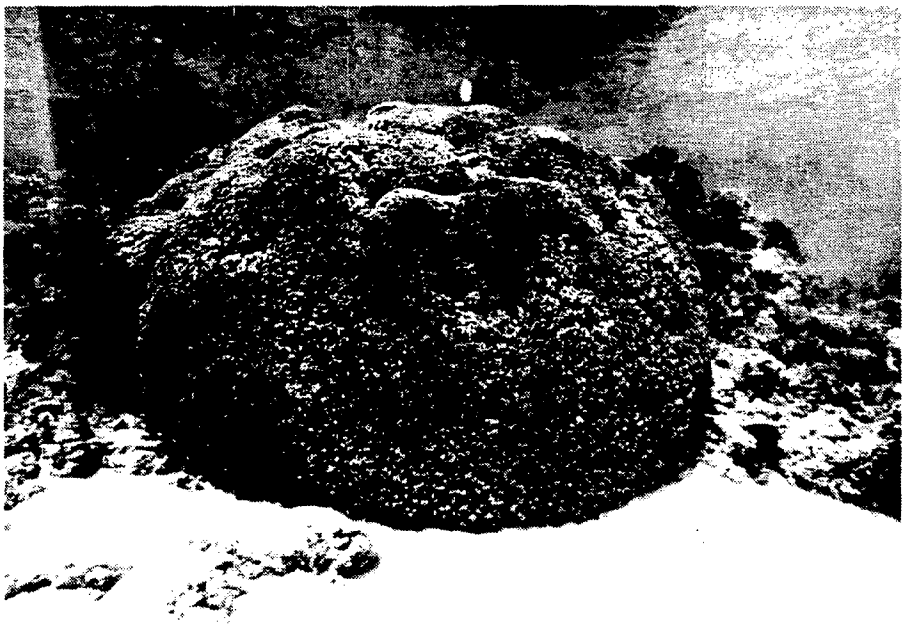


Figure 37. The very large head of Porites rus at the beginning of the outer trail (Station 1).

offering the diver additional glimpses of colorful corals, reef fish and other marine life.

When conditions are windy and rough and the current is strong, trail users could be transported back to shore by boat. As an alternative, a safety line with floats could be stretched from Station 11 to shore allowing the visitors to pull themselves along while still viewing the reefs. As an added safety feature an additional safety/rest float should be installed downcurrent from Station 11 in case anyone were to drift beyond the station and not able to swim back against the current.

2. Outer Trail

To reach the start of the outer trail a visitor would need to swim approximately 250 m (820 ft) from the beach (Figure 27). The path would take the diver over parts of the inner trail as well as across a deeper, sandy bottom channel which boats sometimes use. Rest stops could be achieved by using the rest buoys at Station 9 and/or Station 12 along the inner trail. Proper and adequate use of buoys and warning signs and a 3 mph speed limit for boaters would help to minimize the potential risk of someone being hit by a boat in the channel. It is not feasible to completely close to area to boats as the channel is necessary for navigation purposes.

Transporting divers to the beginning station by boat is a safer option for less experienced swimmers and eliminates the danger of crossing the boat channel. This method could also be used to return the trail users to shore at the end of their dive. Swimming distance back to the beach is approximately 320 m (350

yds), with a rest stop possible at Station 11 on the inner trail on the way back.

a. Station 1 is primarily a large, 8-foot diameter Porites rus head which sits in approximately 12 feet of water at the southern tip of patch reef "F" (Figure 37). Other corals are present nearby including the solitary razor coral Fungia fungites. Numerous individuals can be seen in the depressions along the top (4-5 feet deep) of the patch reef just behind the Porites head (Figure 38). There is only sparse fish fauna here including some wrasses, surgeonfish and the blue Chromis. The underwater plaque for this station should point out the Porites head and razor coral.

   Getting to the next station is a short 20 m (66 ft) swim across a sandy bottom in the direction of the current.

b. Station 2 is a very small coral area surrounded by a sand bottom approximately 10 ft deep. The attraction here are the three small clumps of the branching coral Acropora palifera (Figure 39). Within its protective branches lives the black and white damselfish Dascyllus aruanus, where it feeds on algae, zooplanktoon and small invertebrates. Between the coral colonies shading provided by a mostly dead rock/reef overhang lures a few bannerfish. The marker here should point out the relationship between the damselfish and coral.

   Station 3 can be found just a few feet west along the edge of the patch reef.

Figure 38. The solitary razor coral (Fungia fungites) found on the reef top and in depressions at Station 1.

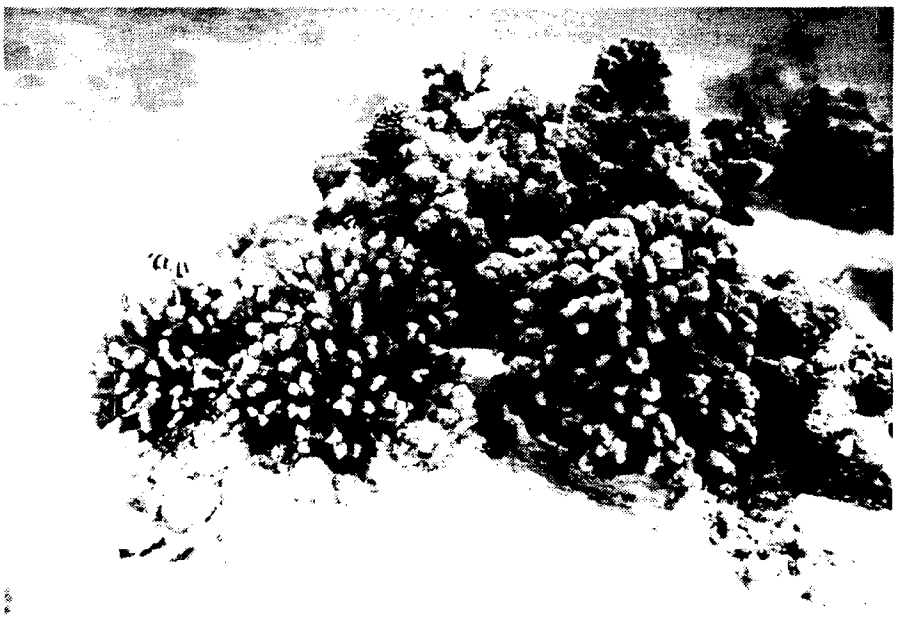


Figure 39. Colonies of Acropora palifera and the associated damselfishes Dascyllus aruanus at Station 2.

c. Station 3 is located on the northern edge of the large patch reef "G". Besides some good coral cover including Acropora palifera, Goniastrea and Lobophyllia and quite a few fish, the main attractions at Station 3 are two anenomes nestled in the holes and depressions on top of the patch reef (Figure 40). Water depth here is only 2-3 ft and one needs to hang onto the reef in order to observe the tomato anenomefish Amphiprion melanopus. The underwater plaque here should point out the symbiotic relationship that exists between the anenome and the fish. The marker should be placed in front of the area with the anenomes but on the front of the reef with an indicator arrow as the shallow depth of the reef top makes it a very unsafe location. Placing the marker on top of the reef would make it both difficult to read and vulnerable to wave assault.

Just a few meters to the west of Stations 2 and 3 is Station 15. The water here is usually quite clear and there is generally little or no current present.

d. Station 15 is a depression and nook in the patch reef and as such has good coral development and a healthy fish population. Water depth here is approximately 5-6 feet. Several species of wrasses, the trumpetfish, yellow tangs, moorish idols and a few species of butterflyfish including the spot-banded butterflyfish (Chaetodon punctatofasciatus) can be observed here (Figure 41). The small and very attractive long-nosed filefish (Oxymonacanthus longirostris) is normally observed swimming in pairs as it feeds on coral

Figure 40. The anenome is barely visible in the center of the photo.

Figure 41. Station 15 with branching corals and a brain coral. A spotbanded butterflyfish (Chaetodon punctatofasciatus) is in the foreground.

polyps. Acropora palifera, common at this site, appears to be one of the filefish's favorite foods. Also found at this site are some brain corals (Lobophyllia and Platygyra) and other branching and encrusting forms. The marker at this station could point out one of the common corals or one or two species of fish.

From Station 15 one swims south across the shallow top of the reef and across a small depression for 30-40 m (100-130 ft) to a nook on the south edge of the patch reef. This is an easy swim with the current and takes the diver over some nice corals where many fish can also be seen.

e. Station 4 is a very large bed of soft coral (Sarcophyton sp.) lying along the southern edge of the patch reef in approximately 4-6 feet of water(Figure 42). Few fish are found here but wrasses and surgeonfish can usually be seen swimming in the area. The blue damselfish Chromis caerulea is common along the periphery of the soft corals. The main attraction here is the extensive bed of soft corals and the plaque should highlight these. However, information here should be different from that at Station 9.

Reaching the next station (15) involves a very brief swim of some 20 m (66 ft) south to a solitary coral mound sitting on a sandy bottom.

f. Station 5 is a large, solitary patch reef with massive heads of Porites lutea, some finger-like soft coral (Sinularia sp.) and orange sponges (Figure 43). This is one of the deeper marked sites ranging in depth from approximately 10-15

Figure 42. The large patch of soft coral (Sarcophyton sp.) at Station 4.

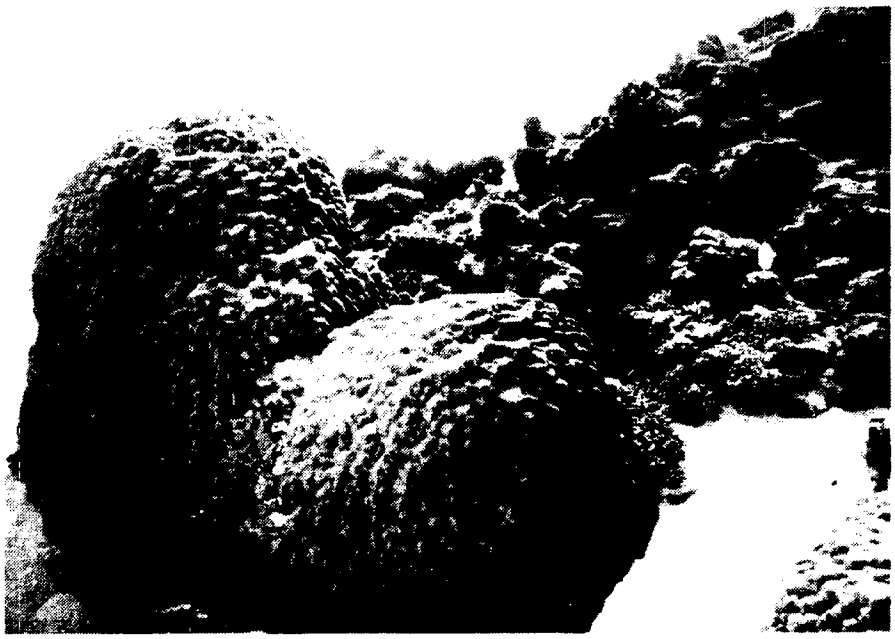


Figure 43. Large Porites lutea heads, fingerlike soft coral (Sinularia sp., near marker) and orange sponge (background) at Station 5.

feet. Fishes observed here include hawkfish (Paracirrhites forsteri), wrasses, moorish idols and grouper (Epinephelus merra). Due to its depth, this station does not necessarily need an underwater marker and it is recommended that a rest buoy be placed here. Information about this station could be given on the waterproof slates carried by the snorkelers.

To get to Station 16 the observer can either swim directly to it across a sand and silt bottom expanse or work his way along the southern edge of the very large patch reef "G". The distance to the station is approximately 60 m (197 ft) but the swim is an easy one with the current. Prior to reaching Station 16 a wheel from a landing craft can be observed on the southwestern edge of patch reef "G" just across from the station.

g. Station 16 is located along the northern side of a sloping patch reef with very good live coral coverage and a lot of fish. Depth here varies from approximately 4-10 feet. This station and Station 10 on the inner trail have the greatest fish populations and species diversity of all the stations. With several species of corals and fishes the underwater plaque here could point out any number of interesting things. Some of the common fishes observed here include the yellow tang, moorish idol, parrotfish, goatfish, bannerfish and several species of wrasses and surgeonfish (Figure 44). A spotted moray eel (Lycodontis meleagris) was consistently observed in a cluster of the

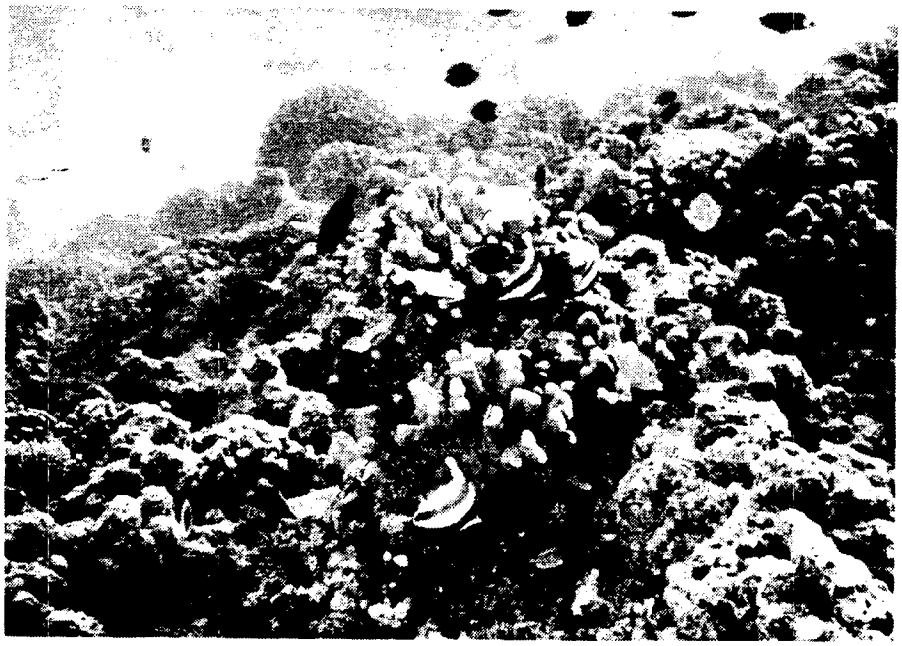


Figure 44. Lush coral growth at Station 16. Fishes include yellow tangs (Zebrasoma flavescens), parrotfish, goatfish, bannerfish and the surgeonfish Acanthurus glaucopareius.

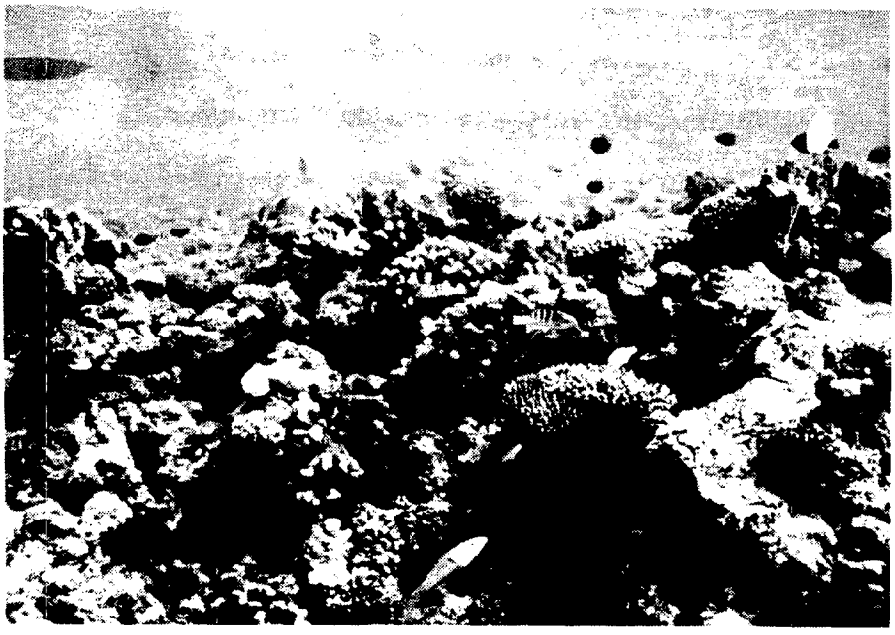


Figure 45. Upper portion of Station 6 with several species of wrasses and surgeonfishes. A spotted moray eel makes his home in this location.

branching coral Acropora palifera during several visits to this site over a two-month period. Corals common at this location include A. palifera, Fungia, Goniastrea, Pocillopora eydouxi and Stylophora.

Due to the large and diverse fish population and live coral coverage, this location is one of the best for fish watching and underwater photography. It is an ideal spot for a fish feeding station as well.

The swim to Station 6 takes the diver south along the edge of the patch reef to the point closest to the barrier reef. The swim is an easy one covering approximately 20 m (66 ft).

h. Station 6 is located a short distance from Station 16 on the southwestern tip of patch reef "I". The top of the reef here is 4-5 feet deep with the bottom approximately 15 feet deep. As at Station 16, this site also has numerous fish including teardrop butterflyfish, yellow tangs, wrasses and blue Chromis (Figure 45). A small cave near the bottom provides shelter for squirrelfish and bannerfish. Near the marker float another spotted moray eel (Lycodontis meleagris) has made his home in reef holes. Moray eels do move around although he was observed on most visits to this station. The marker plaque could notify the visitor to look around the area (including Station 16) for the moray. Tour guides often impress visitors by hand-feeding raw fish or hotdogs to eels but this should not be suggested to the snorkelers.

To reach the next station the visitor swims across a patch of silt and sand approximately 15 feet deep to the tip of the last patch reef on the trail. The swim is easy covering a distance of approximately 30 m (100 ft).

i. Station 7 is located on the extreme southwestern tip of the last patch reef in the outer trail. Depth here ranges from approximately 6-15 feet. Coral growth is good here with the blue coral Heliopora, soft coral, Pocillopora and Porites rus being the most common. The Porites rus here assumes a plate-like growth form with a light yellow growing edge (Figure 46). A cave at the base of the patch reef provides sanctuary for several squirrelfish, moorish idols, wrasses and other fishes. An interesting brown sponge is also located here (Figure 47). The plaque here should point out the plate-like Porites rus coral, sponges and perhaps the squirrelfish as these are all found in the cave and overhang area.

To reach the last station on the outer trail the snorkeler merely swims around the corner of the patch reef and follows the edge approximately 40 m (130 ft) to Station 8. There is good coral development and quite a few fish to observe during this swim.

j. Station 8 marks the end of the outer trail. The coral growth here is rather sparse but includes some nice brain corals and Acropora palifera (Figure 48). Depth ranges from approximately 6-8 feet. The underwater marker here should point out one or both of the brain corals,

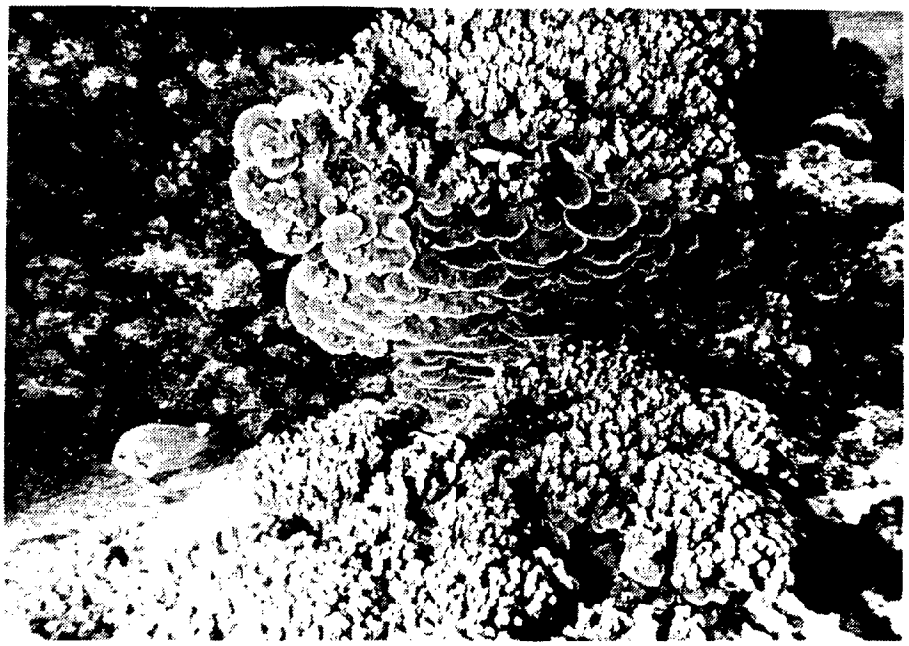


Figure 46. Plate-like formations of the coral Porites rus next to the cave at Station 7.

Figure 47. One group of brown sponge in the cave at Station 7.

Figure 48. Large brain coral (Platygyra daedalea) and other branching corals (Acropora palifera) at Station 8, the end of the outer trail.

Lobophyllia corymbosa and Platygyra daedalea. A rest float will be located here so divers can wait for a ride to shore or depart as a group for the swim back to the beach. The rest float at Station 11 on the inner trail can be used as an intermediary stop on the way back.

V. IMPACTS ON THE RESOURCES

A. Human Impacts

Managaha Island with its surrounding reefs, pristine water and cultural and historical resources is a jewel in the Pacific Ocean. Because of this, and its proximity to a large population base, the area is already well known.

1. Visitors Use

It is estimated that 75 - 85 percent of all Saipan tourists visit Managaha Island for a day trip which means as many as 145,000 tourists may utilize the island in 1985, estimating a 14% increase in tourism over 1984 visitor arrivals. To this number must be added a portion of local residents (estimated 21,000) who visit and revisit the island for recreational and subsistence fishing and gathering purposes. Based on conservative estimates the total number of visitors to the Managaha Island area could reach 150,000 in 1985. The impact of this many people and all their equipment poses a serious threat to the fragile environment which makes the area so unique

There are significant cultural and historical resources worth viewing on Managaha Island and easy access is provided by a natural trail. Most visitors walk around the island and through it to take advantage of the natural beauty and see these sights. People touch, step on, walk over, run through, break off, pick, tramp over and generally damage the natural environment for the sake of their desire to experience it. Visitor uses include beach combing, swimming, skin and scuba diving, water skiing, windsurfing, fishing and collecting and gathering. Each of these uses

impacts on the environment to some degree. The current and expected impacts are potentially serious.

Visitors should know to treat terrestrial and marine resources with care so they are not damaged. Visitors should not be allowed to take away or damage terrestrial or marine resources from selected conservation zones within park boundaries. Suffice to say, general environmental damage occurs to all environments as a natural part of use, particularly when used by people in high numbers. One thing is certain, the number of potential visitors to Managaha Island is increasing and the potential threat to the environment will not only continue but increase as well.

2. Development

With people comes a level of development proportional to the number and specific use. Development associated with tourism can be on the largest scale, witness Honolulu, Hawaii. However, it does not have to be that way if decisions are made early regarding use patterns. Fortunately, for Managaha Island, a relatively low-level use pattern already exists (it can be argued that 300 - 500 visitors per day is not low-level use, and many local people feel the numbers are too high already with an indication that it is rapidly increasing). This is a positive step toward protecting the environment. At the present time, only day time uses are permitted and no overnight accomodations are present on the island. The last boats operated by PDI and other regular carriers of tourists departs Managaha at approximately 4:30 p.m.

Present level of development on Managaha Island includes: a large L-shaped open air building for office, shops, bar and grill,

barbeque pits, tables, restrooms and showers, several smaller open air pavillions (Pala-palas) located around the island, picnic tables, dock, walkways, gardens, and a roped off swimming area. Refer to Figure 25 for the location of many of these facilities.

Future developement should only deal with improving existing facilities or removing dangers and debris in the water, on the beaches and elsewhere on the island. Constitutionally, hotels are not allowed on Managaha Island. Efforts should be made to develop the natural fresh water source in order to provide an adequate supply. Proper studies can eliminate unneeded drilling and associated damage to the environment. An efficient wastewater disposal system should be developed to protect the environment. Solid waste should be controlled and carried back to Saipan for disposal.

3. Equipment

People use equipment when they work and recreate. Some of this equipment poses serious threat to the environment. On land, earth moving equipment, vehicles, generators and associated types create general damage to the environment. Fortunately, this impact has been minimal on Managaha Island. Unique to Managaha is the heavy use of equipment in the water. Large and small boats bring visitors to the island, pull skiers and take tourists diving to nearby areas. Small sailboats and windsurfers sail the shallow waters surrounding the island and pull right up on the beach. Jet skiers zoom throughout the Saipan lagoon including the area around Managaha Island. Motorboats spew exhaust and residue fuel into the water and damage coral when props hit shallow reefs. Anchors are usually thrown indiscriminatly overboard often damaging delicate coral reefs. Motorboats should operate in established channels

where water is sufficiently deep. No fueling facility should be allowed on Managaha Island.

B. Natural Impacts

1. Tropical Storms and Typhoons

Storms represent a natural threat to the natural environment as well as physical structures. The threat of storms capable of major damage is serious in the Mariana Islands. Although nothing can be done to protect the physical environment from direct impact, much can be done to minimize indirect impacts. Structures should be built to withstand substantial winds and water forces (155 mph wind). Adequate tie-downs are essential to keep equipment from blowing away and keeping the area clear of debris that can blow around is essential.

2. Pests

Two pests are found within the Managaha Island Marine Park. Rats on land and the crown-of-thorns starfish in the water. Rats are common on the island and their population is related to available food and shelter. Both of these are abundant on the island. Off island disposal of solid waste and garbage is essential as is extreme cleanliness. Coupled with an extermination program, rats can be controlled. Fumigating boats importing goods to the island is the final step in reducing the problem of rats.

The crown-of-thorns starfish is a pest of major concern. Thomas F. Goreau, noted ecologist, witnessed over 90 percent coral destruction by the starfish on the patch reefs west of Managaha Island in 1969 (Goreau, 1969). Regrowth has been excellent particularly in light of the 1973 starfish infestation. In only 15

years the majority of the patch reef area has been completely restored. However, the threat of destruction of the corals within the underwater trail is very real now. Birkeland's 1983 starfish infestation prediction was extremely accurate and the animal is well established along Saipan's western reef system (Birkeland, 1982). From the south, the starfish has moved into the Lagoon through the Tanapag Harbor Channel entrance and through depressions in the barrier reef and is making its way north along the inside of the barrier reef directly toward the reefs proposed for the Managaha Marine Park Underwater Trail.

Preliminary counts estimated the starfish at 250 for the 18 acre (73,000 m^2) site. This is a significant and recent increase. Removal of obvious animals has been undertaken on three occasions by PBEC staff. A 1984 letter from PBEC to the Coastal Resources Management Office suggested removal of these animals is needed on selected reefs in the vicinity of Managaha Island, specifically at the underwater trail site and nearby reefs. This should be an ongoing process to ensure protection of the small patch reef area that comprises the underwater trail.

It must be realized that an Acanthaster removal program, even though it will only cover the reefs within the underwater trail and will likely be sporatic in nature, is apt to be labor intensive and costly. If volunteer help from a local dive club and other concerned citizens is not feasible then the program will require an undetermined amount of operational funding. Realistic cost estimates need to be provided before an abatement program is decided

upon. It is suggested that Marianas Visitors Bureau funds be utilized for such a program. The implementation and scope would be a matter for the Advisory Board to decide.

This starfish removal program is not designed to eliminate all the starfish in the Saipan Lagoon or even all the animals within the park. It is merely a protective measure to ensure healthy, viable coral communities on the patch reefs along the underwater trail. Although the corals do eventually regrow in a damaged area, and often the species diversity actually increases, if the percent damage is high enough the beauty and attraction of the underwater trail will be seriously degraded and would likely have a negative impact on the numbers of tourists who would visit the park.

It is now generally accepted by most contemporary biologists that Acanthaster infestations are cyclic phenomena triggered by periods of drought followed by heavy rainfall and subsequent runoff from land areas (high islands). The increased nutrients that enter the water result in a higher survival rate for the starfish which drift about and filter feed on planktonic organisms during their larval stage. The end result is much greater numbers of adult starfish approximately three years following such an event. Observations support the belief that the Acanthaster outbreaks eventually "run their course" and return to normal populations on the reefs. Since Acanthaster are a natural part of Pacific coral reefs and therefore play a role in the ecosystem as a whole, a credible argument can be made to leave the starfish alone even if they enter the park area. They then become a dynamic part of the

coral reef community and as such are an "attraction." If they do enter the park area and it becomes obvious that a substantial quantity of corals will be lost, then perhaps the Board can vote on whether or not to initiate control measures within the park.

C. Most Used Areas

Presently, the most used area within the park is the southwest beach and associated pavillion. Foot traffic is heavy between the dock and the pavillion where visitors check in. A roped off swimming zone and shallow water snorkeling zone are heavily used. Once the underwater trail is completed it will also be heavily used.

VI. MANAGEMENT PLAN

A. Management Goals

The following management goals are designed to protect and preserve the unique resources and delicate ecological balance found within the boundaries of the Managaha Island Marine Park.

1. Conservation of Natural Resources

- To assure long-term perpetuation of the coral reef and associated biota as well as native vegetation, wildlife and other natural resources of the park and to minimize adverse effects of human activities on these resources.
- To maintain the highest possible habitat quality for any rare, threatened or endangered species found within the park.
- To reduce the adverse impact of nuisance or undesireable species (pests), such as Acanthaster planci (crown-of-thorns starfish), jellyfish, rats and any others, on native flora and fauna.
- To ensure that the aesthetic quality of the barrier and fringing reefs is not impaired by structures or other intrusions.
- To ensure that the subsistence taking of selected marine life, such as lobsters, shells, fish and others does not adversely effect the ecological balance of the general area.

2. Preservation of Cultural and Historical Resources

- To preserve and protect the park's cultural and historical resources in a manner consistent with executive and

legislative requirements and the CNMI Historic Preservation Program.

3. Acquisition of Information

   - To enable efficient and effective management of the park's natural, cultural and historical resources by gathering needed information for scientific research and to monitor changes. It is recommended that the DEQ's Marine Monitoring Program incorporate the park into it's monitoring scheme.
   - To evaluate the continued effects of subsistence fishing and shellfishing on selected areas of the park
   - Evaluate sources of pollution that may be having adverse effects on the condition of the park's ecosystem.

4. Visitor Use

   - To develop opportunities for day use recreational activities, such as picnicking, sailing, waterskiing, jet skiing, fishing, shellfishing, swimming and snorkeling in locations and at levels where they are compatible with long-term perpetuation of the park's terrestrial and marine resources.

5. Visitor Safety

   - To promote public awareness of potential hazards associated with boating, snorkeling and other activities and thereby help ensure a safe, enjoyable park experience for all visitors.
   - To minimize congestion, promote sound seamanship practices and ensure public safety in the vicinity of the underwater trail.

- To ensure that visitors are well informed on the dangerous characteristics of certain marine animals and terrestrial flora.

6. Interpretation

- To promote public understanding and appreciation of the ecology of the barrier and fringing reef and the sensitivity of the fragile ecosystem to the adverse effects of human activities.
- To ensure that the techniques used for underwater interpretation are effective and provide the visitor with high quality experiences that do not adversely affect the reef ecosystem.
- To foster public awareness of natural terrestrial and marine flora and fauna resources in the CNMI as well as the increasing importance of the park to conserve these resources as the CNMI continues to develop.

7. Operations

- To improve efficiency of operating the park and in monitoring environmental conditions for the benefit of all park visitors.

B. Managaha Island Marine Park Regulations

These regulations are taken directly from the General CNMI Marine Parks Regulations established in the CNMI Marine Parks Management Plan and have been slightly modified to fit the specific purposes of this park. Sections within these regulations include:

1. Authority
2. Purpose
3. Boundaries
4. Definitions

5. Activities Permitted
6. Activities Prohibited
7. Penalties
8. Permit Procedures
9. Other Permits
10. Appeals

1. Authority

The Managaha Island Marine Park has been designated by the Governor of the CNMI pursuant to the authority of Legislation Proclaiming Marine Parks in the CNMI and this marine park. The following rules and regulations are also issued pursuant to the authority of these Legislation.

2. Purpose

The purpose of designating the Managaha Island Marine Park is to protect and preserve the coral reef ecosystem and other natural resources of selected waters in the Saipan Lagoon and to ensure the continued availability of the area for public educational purposes and as an ecological research and recreational resource. This area supports a particularly rich and diverse marine biota. The area is accessible to, and is widely used by private boaters, commercial boat operators, recreational divers, fishermen, tourists and local residents. Consequently, both present and potential levels of use may result in harm to this area in the absence of long-term planning, research, monitoring and protection.

3. Boundaries

The Managaha Island Marine Park consists of an area as scribed below. The precise boundaries are:

MARINE PARK	LATITUDE	LONGITUDE
Saipan Managaha Island Marine Park	15° 14' 0" N	145° 41' 30" E
	15° 14' 45" N	145° 42' 50" E

4. Definitions

A. "Advisory Board, Marine Parks" is chaired by the CRMO with representatives from the Department of Natural Resources, Division of Fish and Wildlife and Parks and Recreation, Marianas Visitors Bureau, Department of Public Safety Division of Boating Safety, Historic Preservation Office, Division of Environmental Quality and the CNMI Legislature.

B. "Director" means the Director of the Coastal Resources Management Office.

C. "Chief" means Chief of the Division of Fish and Wildlife DNR.

D. "Person" means any private individual, partnership, corporation, or other entity; or any officer, employee, agent, department, agency or instrumentality of the Federal government, or any local unit of the government.

5. Activities Permitted

All activities except those specifically prohibited herein may be carried on within the Managaha Island Marine Park subject to all prohibitions, restrictions and conditions imposed by any other authority.

6. Activities Prohibited

A. Unless permitted by the Director through the Advisory Board or as may be necessary for the national defense or to respond to an emergency threatening life, property or the environment, the following activities are prohibited within the Marine Park. All prohibitions must be applied consistently with International law.

1. Removing or damaging distinctive natural features.

a. No person shall break, cut or similarly damage any coral except as an accidental result of anchoring. Sand anchoring is encouraged but not required. Divers and snokelers are prohibited from handling coral or standing on coral formations.

b. No person shall take any tropical fish or marine animal or plant from those zones designated (A) Outstanding Natural Features.

c. Marine life taken from zones designated as (C) Conservation shall be done so for subsistence purposes only. No commercial or sport fishing is allowed in this zone.

d. There shall be a rebuttable presumption that any items listed in this paragraph found in the possession of a person within the Marine Park have been collected or removed from within the Marine Park.

2. Operation of watercraft. All watercraft shall be operated in accordance with Federal Coast Guard rules and regulations that would apply if there were no Marine Park. The following constraints shall also be imposed.

a. No person shall place any anchor on coral within (A) zones of the reef of the Marine Park nor allow any chain or rope to touch the reef in a way that injures any coral in these

areas. When anchoring dive boats, the first diver down will inspect the anchor to ensure that it is placed away from corals in such a way so as not to damage them. No further diving is permitted until the anchor is placed in accordance with these requirements. Exceptions are permitted where there is danger of drifting. Anchoring in other zones is permitted on coral reefs but should be done so with caution so as not to damage the reef.

b. Watercraft must use mooring buoys, stations or anchoring areas when such facilities and areas have been designated and are available.

c. Watercraft shall not be operated in such a manner as to strike or otherwise cause damage to the natural features of the Marine Park.

d. All watercraft from which diving operations are being conducted shall fly in a conspicuous manner, the red and white "divers down" flag and/or the blue and white international divers flag.

3. Using harmful fishing methods.

a. No person shall use, possess or place fish or lobster traps within any zone of the designated Marine Park.

b. No person shall use or possess poles, spears, Hawaiian slings, rubber-powered spearguns, pneumatic and spring loaded spearguns or similar devices known as spearguns within zones designated (A) of the Marine Park, and only for subsistence purposes in other zones.

c. No person shall use or possess poisons, bleach, electric charges, explosives or similar methods whatsoever within any zones of the Marine Park.

4. Removing or damaging distinctive historical or cultural resources.

a. No person shall remove, damage or tamper with any historical or cultural resources, including cargo pertaining to submerged wrecks.

5. Discharges.

a. No person shall deposit or discharge any materials or substances of any kind (including those listed in 3. c., above) within the Marine Park.

6. Markers.

a. No person shall mark, deface or damage in any way or displace, remove or tamper with any signs, notices, or

placards, whether temporary or permanent, monuments, stakes, posts or other markers installed within the Marine Park.

b. The prohibitions in this section are not based on any claim of territoriality and will be applied to foreign persons and vessels in accordance with principles of International law, including treaties, conventions and other International agreements to which the United States is signatory.

7. Penalties

A civil penalty of not more than $100 will be levied against any person for each violation of any regulation and further authorizes a proceeding in rem against any vessel and equipment used in violation of any such regulation.

8. Permit Procedures and Criteria

A. Any person in possession of a valid permit issued by the Director in accordance with this section may conduct the specific activity in the Marine Park including any activity specifically prohibited if such activity is:

1. Scientific research related

2. For educational purposes

3. For salvage or recovery operations.

B. Permit applications shall be addressed to the Marine Parks Advisory Board. ATTN: Director CRMO, Saipan, CNMI, 96950. An application shall include a description of all activities proposed, the equipment, methods, and personnel (describing relevant experience) and a timetable for completion of the proposed activity. Copies of all other required licenses or permits shall be attached. If a CRM Coastal Permit is required for the proposed activity this permit shall be obtained first.

C. When considering whether to grant a permit the Director shall evaluate such matters in terms of:

1. Professional and financial responsibility of the applicant(s).

2. Appropriateness of the methods proposed to accomplish the purpose(s) of the activity.

3. Extent to which the conduct of any permitted activity may diminish or enhance the value of the Marine Park as a source of recreational, educational or scientific value.

4. End value of the activity.

5. Other matters as deemed appropriate.

D. In considering any application submitted pursuant to this section, the Director shall seek the views of the Advisory Board and may seek and consider the views of any person or entity, within or outside of the CNMI Government, and may hold a public hearing as deemed appropriate.

E. The Director may not at his/her own discretion, grant a permit which has been applied for pursuant to this section, in whole or in part without the majority vote of the Advisory Board. The Director may require the submission of one or more reports regarding status or progress of such activity. Any information obtained shall be made available to the public.

F. Any permit granted may not be transferred without written consent of the Advisory Board.

G. The Director through the Advisory Board may amend, suspend or revoke a permit granted pursuant to this section, in whole or in part, temporarily or indefinitely, if the permit holder has acted in violation of the terms of the permit or of the applicable regulations. Any such action shall be set forth in writing to the holder, and shall set forth the reason(s) for the action taken. The holder may appeal the action to the Advisory Board.

9. Other Permits

All permits, licenses and other authorizations issued pursuant to any other authority remain valid. Any person may request an appeal hearing from the Director if an activity is prohibited by these regulations.

10. Appeals

A. Any person (the appellant) may appeal the granting, denial or conditioning of any permit to the Advisory Board through the Director. In order to be considered such appeal shall be in writing and shall state previous action(s) by the Board. The appellant may request a formal hearing before the Advisory Board on the appeal.

B. Upon receipt of an appeal authorized by this section, the Director shall notify the applicant, if other than the appellant, and may request such additional information and in such form as will allow action upon the appeal. Upon receipt of sufficient information, the Director through the Advisory Board shall decide the appeal based upon information relative to the application on file with the Advisory Board and any additional information. A summary record shall be kept of any such hearing. The Director shall notify all interested persons of the decision, and the reason(s) in writing within 30 days unless additional time is needed for a hearing.

C. If a hearing is requested or if the Director determines one is appropriate, he/she may grant an informal hearing before the Advisory Board after first giving notice of the time, place and

subject matter. Such hearing shall normally be held no later than 15 days following publication of the notice. The appellant, the applicant (if different) and, at the discretion of the Advisory Board, other interested persons may appear personally or by counsel at the hearing and submit material and present such arguments determined appropriate.

D. The Director will adopt the Advisory Board's recommended decision, in whole action by the Advisory Boards shall constitute the final decision on the matter.

E. Any time limit prescribed in this section may be extended for a period not to exceed 30 days by the Director for good cause, either upon his/her own motion or upon written request from the Appellant or Applicant stating the reason(s) therefor.

C. OPERATION

1. General Statement

Marine parks generally function to protect underwater environments while providing safe and enjoyable recreational opportunities for visitors. They help to educate people about the ocean and its ecosystems and provide interpretive programs of the marine environment for everybody's enjoyment.

2. Advisory Board

The essence of efficient operation and proper management is vested in the Advisory Board. This Board establishes policy and determines the direction the Managaha Island Marine Park will take. Suggested representation on the Advisory Board should include the following agencies:

- Coastal Resource Management Office (Lead Agency)
- CNMI Legislature
- Historic Preservation Office
- Department of Natural Resources (Division of Fish and Wildlife and Department of Parks and Recreation)

- Division of Environmental Quality
- Marianas Visitors Bureau
- Department of Public Safety
- Division of Boating Safety

Figure 49 represents a flow diagram of the Advisory Board and how the different agencies interact. Each agency will be represented by one individual appointed for a term of one year except the CRMO and Legislature. The latter two groups will have a representative appointed for two (2) years. CRMO is the only non-voting representative except to break a tie when an equal number of representatives make a quorum. Appointments will be staggered in order to provide consistancy to the Board.

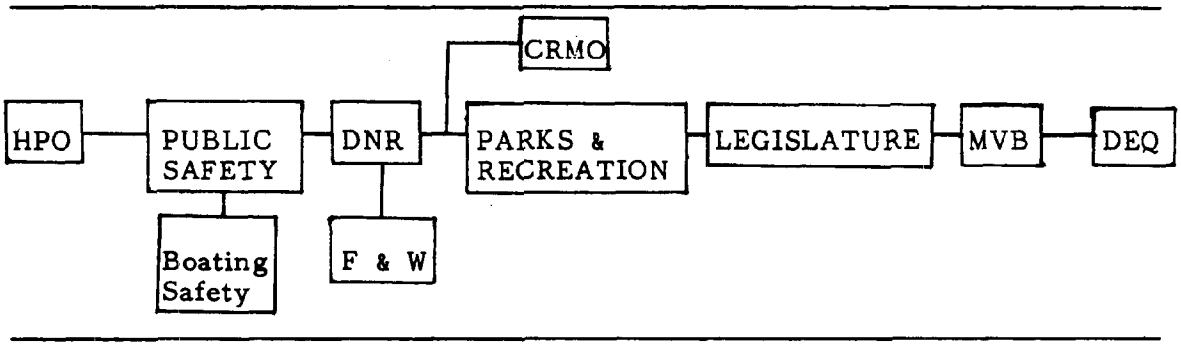


Figure 49. Flow Diagram of CNMI Marine Parks Advisory Board.

Meetings will be held monthly and will be comprised of a quorum (at least four). The CRMO will be responsible for coordinating these meetings, establishing an agenda and deciding a convenient time and place. Each agency, by the nature of their responsibilities within the CNMI Government, will add input to these meetings and carry out any projects delegated within their jurisdiction by majority vote of the Board.

3. Staff

A small, well trained and effective staff will add much to the park operation and public's enjoyment and safety. Each staff member should have a working knowledge of specific park features and be able to present them to visitors in an enthusiastic and interesting manner. Personnel assigned to specific areas of the marine park need not be scuba divers. However, in the case of this park, it would be very helpful. Park staff must be able to recognize and evaluate unsafe practices or activities that may be damaging to the environment and hazardous to visitors, particularly scuba divers.

Some effort should be made to select staff personnel who have specific academic skills and interest in the underwater environment, who are willing to continually upgrade their knowledge and who can pass this interest and enthusiasism on to others. The use of volunteer groups to help patrol and work within the framework of the marine parks system has been proven as a viable adjunct to any interpretation program. Some fluency in the Japanese language would be very helpful but may not be required of all staff.

One Park Ranger will be required to oversee the development and day-to-day operations of the Managaha Island Marine Park. Temporary appropriate staff can generally be selected from existing positions within government ranks. This individual(s) might be found in the following CNMI government agencies:

- Department of Natural Resources, Division of Fish and Wildlife
- Coastal Resources Management Office

For the sake of reducing costs in start up operations an existing government employee(s) should be utilized. A new and permanent position of Park Ranger must be established and a qualified individual hired as soon as possible. This individual should possess the expertise necessary to set up various programs and get the park moving in the right direction. As the park grows, additional employees can be added based on need. Individuals participating in this program should be given special interpretive and diver training as needed.

4. Policy Guidelines for Visitor and Diver Use

Evidence of diving qualification (SCUBA) will be requested from divers who intend to scuba dive within the park boundaries. Evidence shall consist of certification cards issued by a nationally recognized instructional association, such as the National Association of Underwater Instructors (NAUI), Young Mens Christian Association (YMCA), Professional Association of Diving Instructors (PADI), Scuba School International (SSI), National Association of Skin Diving Schools (NASDS) or an appropriate international organization. Only in a training class will uncertified divers be permitted to use scuba within the park and only under supervision of a certified instructor. Such diving will be conducted in a typical instructional manner. All scuba diving shall be conducted in at least buddy pairs.

Refusal by staff personnel to allow a dive should be avoided except under unusual circumstances. A person should be dissuaded through a friendly discussion on equipment requirements and hazardous conditons which could be encountered or by recommending

alternate diving areas (outside park boundaries) or methods (skin-diving only) within the limits of the diver's experience skill and equipment. Should dissuasion fail, it should be made clear that, as in any dive, the diver assumes full responsibility for his actions. Staff members should file a waiver of park responsibility for this diver.

Use of a log-in/log-out system for scuba diving will provide a record of diver's using the park system. It will also add to their personal safety. Diving logs should list the name of the certifying organization for each diver, level of certification, location of dive, time of water entry, expected time of return and actual time out.

Where organized groups dive in any park area, there must be a designated dive master who will be responsible, in charge of co-ordinating the dive and ultimately ensure diver safety. Diving parties will be responsible for removing all dive buoys or other objects used during the dive.

All of the same requirements will be in effect except diver certification for skin divers. However, each diver must know how to swim before entering the water. Divers who plan on utilizing the underwater trail system or designated skindives within the park should sign a diver's log located at the Park Rangers' stand. This information will ensure the safety of each person using the park for diving purposes.

5. Emergency Procedures

There should be a set of emergency procedures developed for Managaha Island Marine Park. These procedures shall be put into a manual available on site and provide for:

- Diver Rescue

- First Aid for minor wounds
- Transportation to a hospital for those requiring treatment
- Oxygen and First Aid for emergencies
- Phone numbers of emergency facilities kept readily available and updated

6. Enforcement and Monitoring

Monitoring and enforcement are essential elements in effective management of a marine park. Without these elements, natural, historic and cultural resources within each park suffers some degree of degredation. An on-going monitoring program becomes the eyes and ears of what is really happening to the park, how it is holding up to increased visitor pressure and natural impacts. How the negative impacts of these pressures can be mitigated is the outcome of effective monitoring.

Monitoring of Marine Parks in the CNMI should be the responsibility of the Department of Natural Resources through the Department of Fish and Wildlife. Monitoring activities for the Managaha Island Marine Park should be implemented as a routine part of regular departmental monitoring activities. Findings should be reported to the Director of the Department of Natural Resources in writing or verbally, if the matter is urgent, but followed by a written report within 24 hours.

The CRM Office monitors coastal resources and activities on a regular basis. Their effort in this area could enhance other monitoring activities by the Department of Fish and Wildlife and even supplement those monitoring activities on shore. The CRM and Fish

and Wildlife Offices should coordinate their efforts in order to avoid duplication of effort.

Enforcement of basic park rules and regulations will be left primarily to park personnel. Park personnel will have the responsibility of enforcing park policy, maintaining order within the park and assisting park users.

Based on operation procedures in similar parks, it is essential that enforcement situations within the park be handled on a low-key basis. When an incident presents itself, all effort should be made to inform the users of park policy and the potential negative impacts that may result from his/her actions. In no way should the user be embarrassed or harassed by a park representative. If, after a reasonable period of time, the user still wishes to pursue his/her own course of action (barring serious consequences) the user should be informed of his/her negligent conduct and that the park will not be held responsible for his/her action. These matters should than be written into a daily log to document them on a case by case basis.

7. Violations and Fines

Violations of park regulations can be minimized considerably through proper park management and monitoring activities. However, violations are bound to occur since many thousands of people will be using the facility for a variety of purposes. The vast majority of these violations will be minor infractions that can be handled in an informal manner through discussions with park users in the same fashion a life guard would. However, occasions do arise

when such informal discussions do not bring about the desired results. In these cases police officers should be called in to deal with the situation. In most cases severe violators are likely to try and escape after warning. Many times they will evade park employees and actually get away. In these cases all pertinent information should be taken down so that it can be turned over to the police department for further action. Warnings can be given first offenders based on the severity of the action.

Fines will only be assesed for major violations where persons are declared to be negligent or purposely violating existing regulations and for repeated offenses.

D. Resource Management

1. Natural Resources

Fragile coral formations in the vicinity of each marine park can be protected by zoning and through proper regulations to protect them further. Rare, threatened and endangered species will continue to be protected as an intergal part of the Managaha Marine Park. Refer to sections III-A and IV for an evaluation of natural resources identified within the boundaries of the park.

2. Cultural and Historical Resources

Cultural and historic resources within the Managaha Marine Park will be managed according to Management Policies of the CNMI Historic Preservation Office and this plan. Refer to Section IV-B & C for a complete evaluation of cultural and historical resources found within the boundaries of this marine park.

The Managaha Marine Park was created to preserve all natural beauty. The process of seashore dynamics and island geomorphology

might uncover presently unknown cultural or historic resources. Accordingly, the following program will be implemented to identify, evaluate, and determine future management actions for such presently unknown cultural resources:

- Following any natural phenomena that results in significant alteration of the present configuration of any portion of the island, appropriate park and historic preservation personnel will dvelop and implement a strategy to ascertain the presence or absence of cultural resources in the altered area.
- Should a cultural resource be identified, it will be recorded and evaluated as to its integrety and significance by appropriate CNMI historic preservation personnel.

E. Cost Estimates

Preliminary evaluation of the Managaha Island Marine Park site was carried out by the CNMI government in 1982. Only a brief report was prepared and little information was organized. Fortunately, Managaha Island including the Saipan Lagoon is the only site where more than preliminary data exist. This entire lagoon was extensively surveyed during recent field studies related to the Saipan Lagoon Use Management Plan (Prepared for CRMO, 1985).

Results of this study suggest that the entire island of Managaha, surrounding reef and selected historic wrecks nearby be included in a marine park. The underwater trail becomes the focal point of the Managaha Island Marine Park project.

Costs for implementing this marine park program fall into the categories of management planning, interpretation, development of facilities, personnel, equipment and additional studies.

1. Management Planning

This management plan represents the first phase of management planning for the development of the Managaha Island Marine Park. It specifies the purpose, needs and goals and identifies park boundaries. Additionally this plan identifies the resources around which the park is being designed and is designed to protect. Interpretative themes are discussed in terms of the underwater trail and land based displays. Impacts on these resources are considered in the plan. The plan also details zoning and resource management for the park.

	COST
Initial cost for consultant services	$ 5,000
Additional management planning includes the following elements:	
Integrate management plan to existing policy	3,000
Implement management plan	1,500
Contract marine park illustration guide-book project	6,500
	$ 16,000

2. Interpretation

Development costs for the Managaha Island Marine Parks will depend on the level of interpretation, infrastructure and related facilities. Preliminary studies have been done on the Managaha Island Marine Park Plan in the form of data collection and development concepts. In-depth site specific plans have also been completed and the following development costs have been initilized for this site.

MANAGAHA ISLAND MARINE PARK	COST
- Visitor orientation center (1-unit) (Graphic display of park layout and features and photographs)	$ 15,000
- Underwater trail (20 stations with identification plaques and marker buoys)	20,000
- Marker buoys and identification plaques for 10 additional sites in the park	10,000
- Signs and identification plaques for terrestrial sites	5,000
- Interpretive literature (maps, species identification charts, general information handouts does not include printing costs)	5,000
- Interpretive video	15,000
Total	$ 70,000

3. Development of Facilities

At the present time facility needs within the proposed park boundaries are adequate. Pacific Development Incorporated (PDI) currently leases from Marianas Public Land Coporation the right to provide concession services to tourists. In order to secure this lease arrangement PDI promised to construct certain facilities to improve the island, provide for tourist needs better and make tourists more comfortable. Existing facilities adequately handle the volume of day time visitors.

An interpretation display of the park will be located within one of the existing structures. Specific location will depend on size and

type of display. The site must be out of the weather and adequately protected from the wind and rain. Additionally, a secure locked up site must be provided. The storage site might only be a small space such as an existing storage room big enough to hold a 6x3x1 ft folding screen.

The screen can be placed on a wall, set up as a room divider or a corner display. It will be moveable and should be shown at various locations.

4. Personnel

The number of staff required to properly operate a marine park depends on a number of factors such as size of park, activities and number of daily visitors. The Managaha Island Marine Park is small by comparison and can be managed by one individual. Furthermore, since this park will take years to develop fully, a single individual will be adequate in the short term. This individual might easily handle the marine park management tasks as a routine part of on-going CNMI government activities and become full-time as the need arises. Selecting an individual at this time should come from within selected agencies of the CNMI government, such as the CRMO or Department of Natural Resources, Division of Fish and Wildlife. Initially, this individual might only require 15 percent of his work time toward the development of the marine park program.

	COST
One (1) employee at 15% of average income of $7,000	$ 1,050
Diver training if needed	150
Total First year	$ 1,200
Total Successive years (as amended)	$ 7,000

5. Equipment (costs are based on January 1985 estimates)

The following equipment will be needed for the first year but will be useable for subsequent years until replacement is required.

	COST
14-foot inflatable boat	$ 2,000
25 HP outboard engine	1,500
Pick-up truck	8,000
1 set scuba gear	800
Total	$ 12,300

6. Annual Operation and Maintenance Expenses

Boat and motor	$ 500
Pick-up truck	750
Visitor orientation center 500	
Underwater park	1,000
Total	$ 2,750

7. Land Acquisition

The island of Managaha is owned by the CNMI government which eliminates the high cost of land aquisition for this park. Only an insignificant in-house administrative cost of land transfer is involved if needed.

REFERENCES

Birkeland, C. 1982. Terrestrial runoff as a cause of outbreaks of Acanthaster planci (Echinodermata: Asteroidea). Mar. Biol. 69: 175-185.

Biscayne National Park, Florida. 1983. Summary, General Management Plan, Development Concept Plan, Wilderness Study. Homestead, Florida. 18p.

California, State of. 1979. Underwater Parks Master Plan. Department of Parks and Recreation, Sacramento, California. 32p.

California State Dept. of Parks and Recreation. 1971. Pt. Lobos State Reserve, Underwater Resource Expansion Study. 21p.

Claringbould R. Deakin, J. and P. Foster. 1984. Data Review of Reef Related Tourism 1946-1980. Great Barrier Reef Marine Park Authority. 120p.

Craig, B. 1982. Developing Attitudes and avoiding Pitfalls in Marine Interpretation. The Interpreter. Channel Islands National Park.

Crowl, Philips A. 1960. Campaign in the Marianas. U.S. Army in WW II - The War in the Pacific. Office of the Chief of Military History, U.S. Army, Washington, D.C. 505p.

Dawson, K.J. 1983. Assessing and Managing Coral Reef Visual Resources. Coastal Zone '83. pp. 1507 - 1517.

Denfeld, Dwayne, Ph.D. 1985. Pers. Communication (letters).

Denver Service Center, National Park Service, U.S. Dept. of Interior. 1978. General Management Plan, Development Concept Plan, Gulf Islands National Seashore, Mississippi - Florida. 91p.

_____. 1980. General Management Plan, Point Reyes National Seashore, California. 46p.

_____. 1982. General Management Plan, Assateague Island National Seashore, Maryland - Virgina. 94p.

Division of Interpretive Planning, Harpers Ferry Center. 1984. Buck Island Reef National Monument, Interpretive Prospectus. St. Croix, U.S. Virgin Islands. 10p.

Dolan, R., Hayden, B. and J. Heywood. 1975. Managing Coastal Biome Interfaces. A Discussion Paper. UNESCO/UNEP Project No. 0605-74-002. 15p.

Economic Associates Australia. 1983. Green Island Economic Study. Great Barrier Reef Marine Park Authority. 68p.

Eldredge, L.G. and R.H. Randall. 1980. Atlas of the reefs and beaches of Saipan, Tinian and Rota. Univ. Guam Mar. Lab. 161p.

Francillon, R.J. 1970. Japanese Aircraft of the Pacific War. Funk and Wagnalls, New York.

Goreau, T.F., et. al. 1969. The Acanthaster Survey of Saipan, Mariana Islands, 1969. Structure and Ecology of the Saipan Reefs in Relation to Predation by Acanthaster planci (Linnaeus). Office of Naval Research and State University of New York. 35p.

Gray, J.E. 1978. Park Systems Based on Underseascope - The Japanese Experience. Aust. Parks and Recreation. November 1978. pp. 28 - 32.

Great Barrier Reef Marine Park Authority. 1982 - 1983. Annual Report. 128p.

Great Barrier Reef Marine Park Authority and the Queensland Department of Tourism. 1981. Papers and Proceedings of the Workshop "Tourism and the Great Barrier Reef." Workshop Series No. 4. 182p.

Gregg, W. P. Jr. 1984. The International Network of Biosphere Resources: A New Dimension in Global Conservation. Presented at Miami International Symposium on Biosphere. 19p.

Harpers Ferry Center. 1984. Buck Island Reef National Monument Interpretive Prospectives. 10p.

Hoffman, Carl W. 1950. Saipan: The Beginning of the End. Historical Division, U.S. Marine Corps, Washington D.C. 286p.

Jones, R.S., R.H. Randall and R.T. Tsuda. 1974. A Candidate Marine Environmental Impact Survey for Potential U.S. Military Projects on Tinian, Mariana Islands. Univ. Guam Mar. Lab. Tech. Rpt. No. 9. 143p.

Kelleher, G.C. and R.A. Kenchington. 1982. Australia's Great Barrier Reef Marine Park: Making Development Compatible with Conservation. Research Paper.

Leatherman, S.P., Godfrey, P.J. and P.A. Buckely. 1978. Management Strategies for National Seashores. Presented at Symposium on Technical, Environmental Socioeconomic and Regulatory Aspects of Coastal Zone Planning and Management, San Francisco, CA.

Mehlert, C. 1982. The State Department of Parks and Recreation, It's Role in the Marine Environment. Prepared for the California Coastal Commission Ocean Study Project. 12p.

Michigan Sea Grant College Program. 1984. Underwater Reserves: A Definite Future in Michigan. Michigan Planner Spring 1984. pp. 14 - 15.

PBEC Inc., 1985. Underwater Survey of Tanapag Lagoon for Historic Properties. Prep. for Historic Preservation Office, Saipan, CNMI. 94p.

Pollard, D.A. 1980. N.S.W. Marine and Estuarine Reserves. Australian Parks and Recreation, February Issue.

Price, R.S. 1982. Interpretive Prospectus for Assateague Island National Seashore. United States Dept. of Interior National Park Service. 53p.

Randall, J.E. 1969. Conservation in the Sea: A Survey of Marine Parks. Oryx Vol. X, No. 1. pp. 31 - 38.

Robinson, A. H. 1983. Marine Parks: Planning for Recreation, Interpretation and Environmental Evoluation. Excerpted from IUCN Confernce Tokyo.

Sakuda, H.M. 1970. Underwater Park. Department of Land and National Resources. Aloha Aina Vol. 1, No. 2. pp 4 - 7.

Smiley, T.E. and D.F. Holeck. 1982. Aquatic Park Management Symposium Proceedings. Department of Parks and Recreation Resources. Michigan State University. 39p.

State of California. The Resources Agency. California State Park System. 1979. Underwater Parks Master Plan. 32p.

State of Hawaii, Division of Fish and Game. 1970. Kealakekua Bay Marine Life Conservation District and Underwater Park. 14p.

Tenorio, J.C. and Associates, Inc. 1979. Ornithological Survey of Wetlands in Guam, Saipan, Tinian and Pagan. Prep. for U.S. Army Corps of Engineers, Pacific, Div., Honolulu. 202 p.

U.S. Dept. of Commerce, NOAA, CZM, National Ocean Survey, Klein Asso. Inc., ACOE and Harbor Branch Foundation, Inc. 1979. Operations Manual, Key Largo Coral Reef Marine Sanctuary. Deepwater Resource Survey. 56p.

U.S. Dept. of Commerce, NOAA, Office of Coastal Zone Management. 1979. Key Largo coral reef marine sancutary, management plan. 41p.

U.S. Dept. of Commerce, NOAA, Office of Ocean and Coastal Resource Management Sanctuary Program. 1983. Draft Environmental Impact Statement and Management Plan for the Proposed Fagatele Bay National Marine Sanctuary. Development Planning Office Terriroty of American Samoa. 112p.

U.S. Dept. of Commerce, NOAA, Sanctuary Program Division. 1983. Looe Key National Marine Sanctuary Mangement Plan. Prepared by: James Dobbin Asso. Inc. 58p.

U.S. Dept. of Interior/National Park Service. 1983. Buck Island Reef National Monument U.S. Virgin Islands. General Management Plan, Development Concept Plan and Environmental Assessment. 56p.

U.S. Man and the Biosphere Program. 1983. Project 8: Biosphere Reserves. Guidelines for Identification, Evaluation and Selection of Biosphere Reserves in the U.S. 37p.

_____. 1974. Task Force on: Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves. Final Report. 61p.

_____. 1981. Interim Guidelines for Identification and Selection of Coastal Biosphere Reserves. Report No. 6. 33p.

_____. 1983. Man and the Biosphere Information System, Biosphere Reserves. Prepared for UNESCO. 61p.

Veverka, J.A. and S.A. Poneleit. 1981. Interpretation as a Management Tool for Underwater Parks. Association of Interpretive Naturalists Journal of Interpretation. Vol. VI No. 2.

Wallis, O.L. 1971. Establishing Underwater Parks Worldwide. 36th American Wildlife and Natural Resources Conference Proceedings. pp. 98 - 117.

Appendix A

Legislation

AN ACT PROCLAIMING
THE MANAGAHA ISLAND MARINE PARK
IN THE COMMONWEALTH OF THE
NORTHERN MARIANAS

Date _____

Establishing the Managaha Island Marine Park in the CNMI of the United States of America.

Whereas: Saipan island is situated in the Commonwealth of the Northern Marianas (CNMI) in the Western Pacific at Latitude 15° 12' 00" and Longitude 145° 43' 00" E. This island was ceded to the United States Government by Japan in a mandate at the end of WWII.

Whereas: All property acquired by the United States at the end of WWII by mandate not reserved by the United States for public purposes was placed under control of the Marianas Public Land Corporation with legal title remaining with the CNMI Government.

Whereas: Not all offshore exposed and submerged lands, including Managaha Island, have been reserved by the CNMI or United States Governments for specific purposes.

Whereas: The island of Managaha and its adjoining shores, rocks and undersea coral reef formations possess some of the finest marine habitats in the CNMI.

Whereas: This land and related features are of great scientific interest and educational value to students of the sea, tourists and local residents.

Whereas: This unique natural area and the rare marine life which is dependent upon it is subject to the constant threat of commercial exploitation and destruction by natural and unnatural elements.

Whereas: The Coastal Resources Managment Office, impressed by the high caliber and scientific importance of Managaha Island and associated coral reefs, has urged their prompt protection to prevent further degredation.

Whereas: The Governor of the CNMI under authority vested in him by the Legislature wishes to protect the following marine habitat as

a marine park for the protection of natural historic and cultural resources for scientific endeavors and other purposes so all people may enjoy them forever.

1. Saipan: Managaha Island Marine Park
   Lat. 15° 14' 0" N and 15° 14' 45" N
   Long. 145° 41' 30" E and 145° 42' 30" E

Whereas: It is in the public interest to preserve this area of outstanding scientific, aesthetic and educational importance for the benefit and enjoyment of all people.

Now, therefore, I _____, Governor of the CNMI under and by virtue of the authority vested in me do proclaim that, subject to valid existing rights, there is hereby reserved and set apart the Managaha Island site as a Marine Park within the CNMI.

Warning is expressly given to all unauthorized persons not to appropriate, injure, destroy, deface, or remove any feature of this Marine Park and not to locate or settle upon any of the lands reserved for this Park by this Act.

The Coastal Resources Management Office through the Marine Parks Advisory Board shall oversee the supervision, management and control of these Marine Parks.

In withness whereof I have unto set my hand and caused the seal of the CNMI to be affixed.

Done at the village of _____ this _____ day of _____ in the year of our Lord _____.

_____
Governor

Appendix B

Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING

To: Directors
Department of Natural Resources
Division of Fish and Wildlife
Division of Parks and Recreation
Division of Environmental Quality
Department of Public Safety
Historic Preservation Office
Marianas Visitors Bureau
CNMI Legislature

From: Director
Coastal Resources Management Office

Subject: Establishment of Marine Parks Advisory Board

It is understood in this memorandum that an Advisory Board is established for the proper managment of marine parks in the CNMI. The board will consist of one representative from each of the seven (7) aformentioned agencies and chaired by a non-voting representative from the CRMO, voting only to break a tie. Appointments to the Advisory Board will be for one (1) year except for the CRMO and Legislature which are appointed for two (2) years for the sake of Board continuity.

Meetings will be held monthly on a regular schedule established by the CRMO. A quorum of four (4) representatives excluding the CRMO constitute a legal meeting. Special meetings can be called at the descretion of any board member by contacting the CRMO. All representative agencies will assume responsibilities vested in them by majority vote of the board.

Signed _____ Date _____
Director CRMO

Signed _____ Date _____
Director DNR

Signed _____ Date _____
Chief F&W

Signed _____ Date _____
Chief P&R

Signed _____ Date _____
Chief DEQ

Signed _____ Date _____
Director Public Safety

Signed _____ Date _____
Director MVB

Signed _____ Date _____
Legislature

Appendix C

TABLES

Table 1. Checklist of Terrestrial Flora identified along the Natural Trail and elsewhere on Managaha Island. Plant Type: (T) Tree, (Sh) Shrub (S) Sedge, (B) Bush, (F) Fern, (V) Vine, (W) Weed, (G) Grass, (H) Herb, (M) Medicinal Plant.

Scientific Name	Common Name	Chamorro Name	Plant Type	Trail
Acrostichum aureum	Fern	Langayao	(F)	x
Annona muricata	Soursop	Laguanaha	(T)	x
Artocarpus sp.	Breadfruit	Lemai	(T)	
Bidens pilosa	Beggar's-Tick		(W)	x
Bougainvillea sp.	Bougainvillea	Putitainobo	(Sh)	
Carica papaya	Papaya	Papaya	(T)	x
Cascuta (campestris)sp.	Parasitic Vine	Dodder	(V)	x
Cassytha filiformis		Mayages	(V) (M)	
Casuarina equisetifolia	Ironwood	Gago	(T) (M)	x
Cocos nucifera	Coconut	Niyog	(T)	x
Colubrina asiatica		Gasoso	(Sh) (M)	x
Corda subcordata		Niyoron	(T) (M)	
Cyperus kyllingia	Cyperus	Chaguan Lemae	(S) (M)	
Ficus prolixa	Banyan	Nunu	(T) (M)	x
Guettarda speciosa		Panao	(T) (M)	
Hernandia nymphaeifolia		Nonak	(T) (M)	x
Hibiscus tiliaceus	Hibiscus	Pago	(B) (M)	x
Hymenocallis littoralis	Spiderlilly	Lirio	(H) (M)	x
Ipomoea pes-caprae	Beach Morning-Glory	Alalag-Tasi	(V) (M)	x
Jatropha integerrima	Rose-flowered	Tuba-Tuba	(Sh)	
Leucaena insularum var. guamense	Tangan-tangan		(T)	x
Leucaena leucocephala	Tangan-tangan		(T)	x
Messerschmidia argentia		Hunig	(T) (M)	
Morinda citrofolia	Indian Mulberry	Lada	(Sh) (M)	
Neisosperma oppositifolia	Fagot		(T) (M)	
Pandanus fragraus	Pandanus	Kafu	(T) (M)	
Passiflora foetida ver. hispida	Love-in-a-mist	Kinahulo' Atdao	(V) (M)	x
Pemphis acidula		Nigas	(Sh) (M)	
Pipturus argenteus		Amahatyan	(T) (M)	
Pithecellobium dulce	Kamachile		(T) (M)	
Plumeria obtusa	Plumeria	Frangipani	(T)	x
Poinsettia plucherriwa	Poinsettia		(Sh)	
Sesuvium portulacastrum	Seaside purslane	Chara	(H) (M)	

Table 1 continued

Scientific Name	Common Name	Chamorro Name	Plant Type	Trail
Scaevola taccada		Nanaso	(Sh) (M)	
Sophora tomentosa			(Sh) (M)	
Stachytarpheta indica	False Verbena		(W)	
Terminalia catappa	Tropical Almond	Talisai	(T) (M)	x
Thespesia populnea		Banalo	(T) (M)	
Wedelia biflora	Beach Sunflower		(V) (M)	x

Total Species: 39

Table 2. Checklist of corals by station, Managaha Island Marine Park Underwater Trail.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Acropora aspera							x	x				x					
A. formosa													x				
A. palifera	x	x	x	x		x		x	x	x	x	x			x	x	x
Acrhelia horrescens	x																
Favia matthaii									x								
F. stelligera										x							
Fungia fungites	x													x			
F. scutaria							x									x	
Galaxia fascicularis																	x
Goniastrea edwardsi		x	x			x		x	x	x				x	x	x	
Heliopora coerulea							x			x		x		x			
Leptoseris explanata								x									
Lobophyllia corymbosa	x	x	x					x	x			x		x	x		
Montipora hoffmeisteri									x								
M. verrucosa									x		x		x				
M. sp. 5		x	x									x			x		
Pavona varians										x	x			x			
P. sp. 2							x				x						
Platygyra daedalea								x				x			x		

Table 2 continued.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
P. pini								x						x			
Pocillopora damicornis	x					x			x							x	
P. elegans							x										
P. eydouxi	x	x				x	x	x	x	x	x		x			x	
P. setchelli	x																
Porites annae											x						
P. lutea					x							x	x				
P. rus	x						x				x		x				
Seriatopera hystrix	x										x						
Stylophora mordax	x					x	x			x						x	
(Soft Corals)																	
Sarcophyton sp.				x					x								
Sinularia sp.					x												

Total Species: 31

Table 3. Checklist of fish species observed in the vicinity of the proposed Underwater Trail at Managaha Island by station.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Carcharhinidae (Sharks)																	
Triaenodon obesus						x											
Muraenidae (Moray Eels)																	
Lycodontis meleagris						x										x	
Synodontidae (Lizardfish)																	
Saurida gracilis				x					x		x				x	x	
Holocentridae (Squirrelfish)																	
Adioryx diadema							x			x							
Flammeo sammara							x			x		x		x		x	
Flammeo opercularis											x	x					
Myripristis murdjan											x	x		x	x	x	
Aulostomidae (Trumpetfish)																	
Aulostomus chinensis								x			x	x		x	x	x	
Fistulariidae (Coronetfish)																	
Fistularia commersonii											x						
Syngnathidae (Pipefish)																	
Corythoichthys sp.					x							x			x	x	
Apogonidae (Cardinalfish)																	
Apogon novemfasciatus														x			
Apogon sp.								x									
Cheilodipterus quinquelineatus																x	
Serranidae (Groupers)																	
Epinephelus merra					x												
Cephalopholis sp.											x					x	
Lutjanidae (Snappers)																	
Lutjanus fulvus										x						x	
L. kasmira									x	x							

Table 3 cont.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Lethrinidae (Emperors)																	
Gnathodentex aureo-lineatus									x	x		x		x		x	
Lethrinus harak											x			x			
L. ramak											x						
Lethrinus sp.										x							
Nemipteridae (Breams)																	
Scolopsis cancellatus										x						x	
Mullidae (Goatfish)																	
Mulloidichthys flavo-lineatus	x		x						x			x	x				
M. vanicolensis										x							
Parupeneus barberinus	x											x		x			
P. pleurostigma											x						
P. trifasciatus		x										x					
Cirrhitidae (Hawkfish)																	
Paracirrhites arcatus				x													
P. forsteri					x			x			x				x		
Chaetodontidae (Butterflyfish)																	
Chaetodon auriga		x									x	x	x	x			
C. bennetti		x						x		x				x	x		x
C. citrinellus																x	
C. ephippium	x					x	x					x		x			
C. lunula										x		x		x			
C. ornatissimus												x	x	x		x	
C. punctatofasciatus										x		x				x	
C. reticulatus															x		
C. trifasciatus	x						x					x					
C. ulietensis			x				x		x			x		x		x	
C. unimaculatus		x										x		x	x	x	x
Heniochus chrysostomus			x					x			x	x		x	x		x
Megaprotodon trifas-cialis	x										x						

Table 3 cont.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pomacanthidae (Angelfish)																	
Centropyge flavissimus						x			x			x			x	x	x
Pomacanthus imperator									x								
Pomacentridae (Damselfish)																	
Abudefduf sexfasciatusx						x					x	x				x	
Amphiprion melanopus			x	x					x								
Chromis atripectoralis																	
C. caerulea	x			x		x	x	x	x					x		x	x
C. margaritifer																x	
Dascyllus aruanus		x					x					x		x	x	x	
Plectroglyphidodon dickii						x					x						
P. johnstonianus												x					
P. lachrymatus											x						
Pomocentrus pavo	x					x		x				x				x	x
P. vaiuli															x		
Stegastes albifasciatus				x							x						
S. fasciolatus								x								x	
S. nigricans	x										x						
Labridae (Wrasses)																	
Anampes twisti												x					
Cheilinus chlorurus								x									
C. oxycephalus										x							
C. trilobatus											x						
Cheilio inermis	x									x		x		x			x
C. gaimard									x	x				x	x	x	
Epibulus insidiator											x						
Gomphosus varius						x			x			x		x			
Halichoeres centriquadrus													x				
H. hortulanus												x		x		x	
H. margaritaceus																	
H. marginatus										x							
H. trimaculatus	x			x				x	x		x	x		x			x
Labroides dimidiatus											x	x		x	x	x	
Stethojulis bandanensis	x														x		

Table 3 continued.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Thalassoma fuscum															x		
T. hardwicke	x			x				x	x			x		x		x	
T. lutescens						x					x	x		x		x	
T. quinquevittata									x		x	x				x	
Xyrichtys taeniourus																	
Scaridae (Parrotfish)																	
Calotomus spinidens																x	
Scarus chlorodon													x				
S. ghobban											x						
S. psittacus												x				x	
S. sordidus										x		x				x	
juvenile scarids						x			x	x		x					
Acanthuridae (Surgeonfish)																	
Acanthurus glaucopareius							x									x	
A. lineatus											x					x	
A. mata	x		x						x		x	x		x			
A. nigricans										x							
A. nigrofuscus				x												x	
A. olivaceous											x						
A. triostegus	x								x			x			x	x	
Ctenochaetus striatus									x		x						
Naso brevirostris										x							
N. literatus												x				x	
N. unicornis								x									
Zebrasoma flavescens	x	x				x			x		x	x	x	x	x	x	x
Z. veliferum												x					
Zanclidae (Moorish Idols)																	
Zanclus cornutus					x		x	x			x	x		x	x	x	x
Siganidae (Rabbitfish)																	
Siganus argenteus																x	
S. punctatus																	
S. spinus	x								x					x			

Table 3 continued.

SPECIES	STATIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Blenniidae (Blennies)																	
Salarias fasciatus												x					
Gobidae (Gobies)																	
Valenciennea strigata													x				
Balistidae (Triggerfish)																	
Rhinecanthus aculeatus					x				x		x	x			x		
Monacanthidae (Filefish)																	
Cantherines pardalis																x	
Oxymonacanthus longirostris													x	x			
Tetraodontidae (Puffers)																	
Arothron nigropunctatus							x						x				
Canthigaster solandri								x			x		x				

Total Number Families = 27
Total Number Species = 107

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