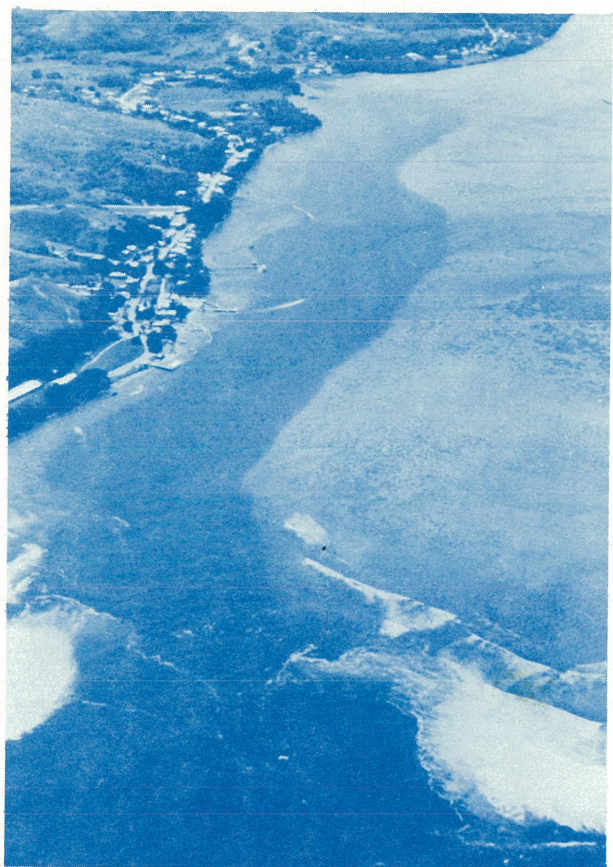


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MARINE BIOLOGICAL RESOURCES WITHIN THE GUAM SEASHORE STUDY AREA AND THE WAR IN THE PACIFIC NATIONAL HISTORICAL PARK

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UNIVERSITY OF GUAM MARINE LABORATORY

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MARINE BIOLOGICAL RESOURCES WITHIN THE
GUAM SEASHORE STUDY AREA
AND THE
WAR IN THE PACIFIC NATIONAL HISTORICAL PARK

by

L. G. ELDREDGE

Submitted to
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INTRODUCTION

The marine areas of the Guam Seashore Study Area encompass a major portion of the reef flats of the island from the Nimitz Beach and Taleyfac Bay area southward, including Cocos Lagoon and Cocos Island; and eastward to Ajayan Bay. Of the two discontinuous shorelines of the War in the Pacific National Historical Park, the Asan Unit includes the shore from Adelup Point westward, including Asan Bay and Asan Point, as well as Gapan Islet (Camel Rock). The Agat Unit encompasses the reef flat at Rizal Beach southward to Bangi Point and includes Bangi and Alutom Islands. A major part of Guam's reefs and beaches falls within this entire geographic area and constitutes a prime resource of the island by containing the only natural lagoon-barrier reef system on the island, one of the two prime mangrove swamps, and some of the most extensive seagrass communities, as well as limestone and volcanic intertidal reef flats.

The majority of the physiographic descriptions and discussions of the biotic communities are drawn from the reef and beach atlas (Randall and Eldredge, 1976) and from the marine geology (Emery, 1962). A number of specific studies contributed to this overall review. The majority of reports describe the west and southwest coasts which include the Agat Unit and the Seashore Study Area. Very little is recorded for the Asan Unit.

A number of pristine communities are discussed by Stojkovich (1977); four are within the Seashore Study Area. A pristine community is defined as an "area that has retained or successfully reestablished its natural character" (p.3). Such areas are valuable natural resources and contain many recreational, scientific, and aesthetic elements.

An appendix contains several tabular listings of species. These are compiled from a number of sources, mainly Randall et al. (1975) for Cocos Lagoon, Eldredge et al. (1977) for Agat Bay, and Chernin et al. (1977) for the Bangi and Taleyfac areas. Other important sources are Randall and Birkeland (1978) for Fouha Bay and Jones et al. (1974) for Toguan Bay. The maps are redrawn from Randall and Eldredge (1976).

ASAN UNIT

Physiography

The Asan Unit of the War in the Pacific National Historical Park encompasses the shore and reef flat from the seaward end of Adelup Point westward along the village of Asan including Asan Bay to the west of Asan Point at the Matgue River and seaward to Camel Rock (Gapan Islet) (Figs. 1-4).

The intertidal beaches are composed mainly of bioclastic material with intermixed volcanic detrital debris. The volcanics increase toward the headland near the Coral Reef Marine Center (Fig. 2) and toward the Matgue River. The low coastal cliffs at Adelup Point and at the west side of Asan Point are composed of Mariana Limestone. The volcanic headland near the Coral Reef Marine Center is capped with limestone and buttressed with limestone boulders. The shore from the area of the Asan River to Asan Point is mainly a man-altered, artificial coastline, much of which is filled. A boulder riprap mole enclose a shallow area to the east of Asan Point (Fig. 4). Three abandoned sewer lines extend from the shore to the reef margin at Asan and Adelup Points.

Gapan Islet (also known as Camel Rock) is composed of raised, pinnacled limestone with a narrow bench developed along the seaward side and with nips along the shoreward side.

The reef flat varies in width from 91 m at the Asan Bay channel to 978 m west of Asan Point. The majority of the reef-flat platforms are slightly more than 300 m in width. A wide inner reef flat, low-tide moat is developed to the east and west of Asan Bay (Fig. 3), whereas an undifferentiated intertidal reef flat is found at Asan Bay itself. To the west of Asan Point, a wide and unusually deep low-tide moat is enclosed by a shallow, barrier reef-like complex. The narrow outer reef flat along most of the Asan Unit is exposed at low tide, except for a small depressed area west of Adelup Point.

The substrate of most of the inner reef flat is a combination of scattered sand, gravel, coral-algal rubble, and boulders. Most of the outer reef flat is reef-rock pavement which contains small silt-veneered and sand-filled patches and scattered boulders.

Biotic Communities

The coral community dominates the Asan Unit waters. Seagrass (Enhalus acoroides) is found in widely scattered patches east of Adelup

Point near the Fonte River and near the volcanic headland at Coral Reef Marine Center.

Corals are widely scattered to abundant in the low-tide moat along the inner reef flat. The densest corals are found immediately west of Adelup Point and seaward of the volcanic headland. Abundant areas of soft corals are found west of Asan Point. Although no systematic collecting has been carried out along the Asan Unit, a wide variety of invertebrates has been observed, especially sea cucumbers, sea urchins, and sea stars. Fiddler crabs (Uca) have been collected along the sandy beach at the Asan River mouth.

Resources and Recreation

Unfortunately, little research has been carried out along the Asan Unit. The shallow areas contain a moderate number of coral species, but most of the area is too shallow for snorkeling. The Asan Unit is the site of coastal census zones 20 and 21; the Division of Aquatic and Wildlife Resources (Department of Agriculture) has conducted inshore creel censuses here for the past several years. Fishermen are periodically interviewed so that data on fishing activities can be obtained. Fishermen are often observed at the depressed reef margin west of Adelup Point and at the margin of Asan Bay (Fig. 3).

The reef flat west of the volcanic headland (Fig. 2) may be suitable for a shallow-water or elevated walk, since there is a good diversity of organisms and the area is reasonably accessible. Specialized underwater nature (snorkel) tours could be offered over the extensive soft corals west of Asan Point, for this area contains a particularly high density and diversity of soft coral species and associated animals. A submerged military vehicle is found in about 30 feet of water on the east side of Asan Bay itself (see Map No. 2). Snorkeling in Asan Bay may be hazardous because of the steep margin dropoff and unpredictable currents.

AGAT UNIT

Physiography

The Agat Unit extends from north of Rizal Beach along the west coast at Agat to south of Bangi Island at Bangi Point (Figs. 5-8).

The intertidal beaches at Rizal Beach, Togcha Beach (Fig. 5), and Salinas Beach to the south are composed primarily of bioclastic material; some volcanic detrital debris is especially common near the mouths of the numerous streams which enter along the coast. Low limestone cliffs with sealevel boulders border Apaca Point south of Rizal Beach. Artificial shore is present mainly at the sewer outfall peninsula at Gaan Point (Fig. 7). Sea walls and an altered shoreline occur at Rizal Beach.

Four offshore island groups--Pelagi Islets and Yona, Bangi, and Alutom Islands (Fig. 8)--are bordered by low limestone cliff and sloping shores.

The reef flat widens generally toward the south from a width of 52 m at Rizal Beach to 808 m south of Gaan Point (Fig. 6). At the north end of the Agat Unit, an intertidal reef flat with scattered depressions grades to the south into an irregular inner reef flat and low-tide moat south of Apaca Point. The inner reef flat is interrupted at Gaan Point by the man-made peninsula (Fig. 7). The outer reef flat is cut by depressed channels at Togcha Beach and south of Gaan Point. Alutom Island lies on the outer reef flat margin to the south (Fig. 8).

The inner reef-flat reef rock is generally veneered with patches of silt, sand, gravel, coral-algal-mollusk rubble and scattered boulders. Scattered boulders are also found on the outer reef flat pavement where depressions contain some sand. An accumulation of boulders into a boulder tract partially divides the inner reef flat just north of the Togcha River area (Fig. 5).

Biotic Communities

The major biotic community throughout the entire Agat Unit is the seagrass (Enhalus acoroides) community. Rare at the north end near Rizal Beach, seagrass becomes more abundant in the low-tide moat which begins at Apaca Point. Southward the seagrass increases, especially

seaward of the Togcha River and Bangi Point. Corals are widely scattered throughout the Agat Unit, being more abundant in the low-tide moat. Only a few corals are found on outer reef flat except for those in small holes and depression. A wide assortment of invertebrates and fish are known from the Unit. Tables 1-7 outline the major organisms found, specifically at Agat Bay and Bangi Point (Eldredge et al., 1977; Chernin et al., 1977).

The reef flat at Rizal Beach is composed mainly of rubble. The alga Padina tenuis is prominent and sponges (Cinachyra australiensis) are scattered. Many gastropods are present as is the sea urchin Echinometra mathaei.

South of the Pelagi Islets the reef-flat pavement becomes substrate for animals such as Holothuria atra, Echinometra mathaei, and a few crustaceans. A number of gastropod species have been observed. Further south the shore is littered with domestic trash, and the ghost crab Ocypode ceratophthalmus was found. At the north side of the peninsula at Gaan Point, the snail Cerithium moras is found in great abundance.

Resources and Recreation

Stojkovich and Smith (1978) conducted three transects north of the Pelagi Islets in their shellfish and sea urchin survey. Of the sea urchins noted, Echinothrix diadema was more abundant than Diadema savignyi, and both appeared to have clumped distributions. The topshell Trochus niloticus was found most abundantly on the outer reef flat. Specimens of the clam Ctena were found within seagrass patches. The beach along the Agat shore is littered with broken shells of the clam Quidnipagus palatum, even though no living individuals were found; this may indicate that many have been harvested. Smith (pers. comm.), during his thesis research has found large populations of T. niloticus on the outer reef flat and reef slope between Gaan Point and Alutom Island.

The Agat Unit includes the Division of Aquatic and Wildlife Resource's coastal creel census zones 35, 36, and 37. Snorkeling during high tides would allow a view of a limited seagrass community. Most of the Unit is too shallow to establish snorkel trails which could be used under all tide and weather conditions.

SEASHORE STUDY AREA

Physiography

The Guam Seashore Study Area extends along the coast at the north from an area near Nimitz Beach and the Taleyfac River southward including all of Cocos Lagoon and Cocos Island, and eastward to include Ajayan Bay (Figs. 9-20). For descriptive purposes the study area is divided into two major physiographic zones--the southwest coast area and the Cocos Lagoon to Ajayan Bay area.

The beaches along the southwest coast are composed primarily of bioclastic material; volcanic detrital content increases toward river and stream mouths and embayments. At Facpi Point, along much of the shore from Achugao Point south to Cetti Bay, and from Fouha Bay southward, the shoreline is composed mostly of a narrow band of low, pitted and pinnacled limestone (Fig. 10). In many areas patches of sand and rubbles interrupt the low limestone.

Volcanic headlands of varying sizes occur at Taelayog Creek and southward to Facpi Point where there are steep slopes and low cliffs. A wave-cut, volcanic sea-level beach is found at Achugao Point (Fig. 10). Small exposures of volcanic rocks are also found at Chii Point and at the volcanic stack south of Sella Bay (Fig. 11). Steep volcanic slopes and cliffs occur north of Cetti Bay (Fig. 12), at Fouha Point and north and south of Fouha Bay, including Lalas Rock (Fig. 13). Similar slopes and cliffs also occur at the north and south points of Umatac Bay (Fig. 14).

Of the two islands which are present along the southwest coast, Anae Island is larger. The low limestone slopes and cliffs are buttressed with blocks and boulders, especially toward the shallow, landward patch reef. Facpi Island is also buttressed with large limestone blocks and has some small intermittent patches of rubble along the landward side. A volcanic platform with several different sized volcanic dikes connects Facpi Island to Facpi Point.

Except for a subdivided reef flat in the Nimitz Beach-Taleyfac Bay area (Fig. 9), the remainder of the southwest coast is basically an intertidal reef flat with numerous holes and depressions scattered along the entire length. At the north end, the irregular inner and outer reef flats are cut by channels at Nimitz Beach and Taleyfac River. Two deeper holes are just landward of the reef margin north of Nimitz Channel. The deeper inner reef flat moat extends irregularly south of Taleyfac Bay.

Several large embayments line the southwest coast, all but the Nimitz Channel terminate at one or more streams. The margins of most of the embayments are somewhat depressed. Limited estuarine conditions with reduced salinity occur at the Cetti River mouth.

The north shore at Umatac Bay is primarily an artificial wall and slope. This is lined to the seaward side with many boulders.

The substrate along the intertidal reef flats is mainly reef-rock pavement with irregularly scattered boulders and sand, gravel, and coral-algal rubble. Holes and deeper areas may contain some silt sand, and gravel.

The Cocos Lagoon area contains all of the lagoon itself, Cocos Island (Fig. 17), the shore at Merizo, and the eastward reef flats to Ajayan Bay.

There are few beaches along the landward side of the lagoon, except near the Pigua River and between Piga and Aba Beaches. These are mixed bioclastic and volcanic sand beaches, containing gravel and rubble. The beach on the lagoon side of Cocos Island is composed entirely of bioclastic material, as is the small unnamed sand island east of Cocos Island.

One of the only rocky shorelines along the lagoon occurs north of the Mamaon Channel where low, pitted and pinnacled limestone is seaward of a band of sand and alluvial deposits. Low, narrow bands of pitted and pinnacled limestone are found along the seaward side of Cocos Island (Fig. 17) and Babe Island (Fig. 18). A small sand island is found east of Cocos Island itself.

Along the village of Merizo at the Mamaon Channel, most of the shore has been altered by artificial fill (Figs. 15 and 16). Two finger piers have been built at Achang Bay.

Much of the remaining shore along the lagoon itself from the Geus River and eastward to the Suyafe River is composed of mangroves which forms a somewhat typical mangrove-swamp shoreline.

As a true barrier-reef lagoon, Cocos Lagoon is subdivided into a five distinct subzones (Randall and Eldredge, 1976):

- a. Inner Lagoon Fringing Reef Flat
- b. Outer Lagoon Fringing Reef Flat
- c. Inner Barrier Reef Flat
- d. Outer Barrier Reef Flat
- e. Shallow Lagoon Terrace
- f. Deep Lagoon

The inner lagoon fringing reef flat along the landward side is exposed during low tide, and it is interrupted by the depressed margin at Achang Bay and along the Mamaon (Fig. 16) and Manell Channels (Fig. 19). East of Manell Channel the inner lagoon fringing reef flat grades into a wide

inner reef flat and irregular outer reef flat with an intermediate middle reef flat and low-tide moat.

The outer lagoon fringing reef flat is an irregular zone extending along the landward side of the Mamaon Channel eastward to the middle of the Manell Channel. The angular barrier reef is exposed during low tides along the outer barrier reef flat and is usually submerged over the inner barrier reef flat. The remaining area of the lagoon is a shallow lagoon terrace which surrounds a deep lagoon with numerous patch corals.

East of Achang Reef the reef flat is cut by two small embayments-- Sumay Bay and Asgado Bay. Several small limestone islands are scattered in this area; Agrigan Island (Fig. 20) at Ajayan Bay is the largest. Three small volcanic headlands line the shore west of the Ajayan River.

The shore along the inner lagoon fringing reef flat and the major part of the inner and outer barrier reef flats is mostly reef rock with varying thicknesses of silt, sand, and coral-algal mollusk rubble. Accumulation of silt are found at the mouths of the Geus, Achang, Sumay, Lujog, and Ajayan Rivers. The substrate of the middle reef flat at Achang Reef is mainly sand, coral-algal-mollusk rubble with scattered boulders, and exposed reef rock. The outer lagoon fringing reef flat and most of the shallow lagoon terrace are sand and rubble. The deep lagoon consists mostly of sand with some silt and rubble and numerous patches of coral.

Biotic Communities

Corals are scattered widely throughout the length of the southwest coastal reef flat and are usually restricted to holes, depressions, and depressed embayment margins. Seagrass is found only at the north end on the inner and outer reef flats to the north of Nimitz Channel and to the south of Talefac Bay. Widely spaced seagrass patches are most abundant toward Bangi Point.

Detailed descriptions of the marine biota of the Nimitz Channel-Talefac Bay region have been provided by Chernin et al. (1977) in their study of a proposed small boat harbor. A brief marine survey was conducted in conjunction with the proposed ammunition wharf at Sella Bay (Caperon et al., 1971). Additional detailed studies include Randall and Gawel (1974) at Umatac, Randall and Birkeland (1978) at Fouha Bay, and Jones et al. (1974) at Toguan Bay.

One of the most diverse coral communities on Guam is found within Cocos Lagoon itself. The distribution is, however, widely variable. Corals are mostly absent on the intertidal reef flats and along the inner lagoon fringing reef flat except in deeper, less turbid pools. The soft mangrove-derived sediments are unsuitable for coral settlement. The corals on the outer fringing reef flat and on the inner and outer

barrier reef flats vary from absent on the low-tide exposed pavement to very abundant in deeper pools. On the shallow lagoon terrace, corals are widely scattered, and in the deep lagoon corals are abundant, forming scattered patch reefs, mounds, knolls, and pinnacled (see shaded parts on map).

East of Achang Reef corals are widely scattered to absent along the reef flat except in depressions. At Achang Reef some corals grow among the seagrass. Corals are abundant on the depressed channel margin at Sumay, Asgadoo, and Ajayan Bays.

Seagrass patches (Enhalus acoroides) are widely scattered along the intertidal reef flat north of the Mamoan Channel but increase in number toward the Geus River mouth, becoming very abundant in the Manell Channel and Achang Reef area. To the east the seagrass is scattered along the inner reef flat. Between Agrigan Island and Asmaile Point, the seagrass patches grow together, forming one of the most dense aggregations around Guam (Fig. 20). A large patch of the seagrass Halophila minor is found north of Cocos Island on the shallow lagoon terrace.

A mixture of mangrove-tree species forms a swamp which lines much of the shore from the village of Merizo to Suyafe River. Rhizophora forms the densest swamp at the dredged areas of Achang Bay. Less than five percent of the mangrove community is Avicennia, and Bruguiera is scattered throughout. The mangrove are discussed more fully by Wilder (1976).

Resources and Recreation

In the study of pristine marine communities, Stojkovich (1977) described four within the Seashore Study Area:

- Area VII -- Anae Island Patch Reef and Terrace
- Area VIII -- Cetti Bay
- Area IX -- Cocos Lagoon, Barrier Reef and Channels
- Area X -- Ajayan Bay

The Guam Environmental Protection Agency rated Areas VII and VIII as "AA" or conservation. Areas IX and X are rated "A" or recreational. No point source discharges were located in Areas VII, VIII, and X; there were more than twenty-five such discharge points in Area IX around Merizo. For most of the areas, Stojkovich (1977) provided lists of the algae, invertebrates, and fishes.

Three rare and endangered marine animals have been observed in the shallow water and along the shore of the Seashore Study Area. The hawksbill turtle Eretmochelys imbricata and the green turtle Chelonia mydas have been observed in Cocos Lagoon. Randall et al. (1975) reported sighting a hawksbill only once during the Cocos Lagoon study. Six green turtles nested along the shore at Sella Bay in June 1976 (Pritchard, 1977). Local residents say that turtles "were always" nesting at Cocos Island fifty or more years ago. Since the end of World War II, Cocos

Island has had much human use.

A seven-to eight-foot-long dugong (Dugong dugon) was seen in Cocos Lagoon during February 1974 (Randall et al., 1975). Dugongs occur naturally in Palauan waters. The Guam individual was probably a freak occurrence, since it has not been seen since.

Porpoises are regularly sighted near the mouth of the Mamaon Channel, but no systematic survey has been carried out. A 30-foot whale, tentatively identified as a Bryde whale, was found beached south of Facpi Point during September 1978.

Two artificial reefs have been constructed in Cocos Lagoon to investigate methods of improving lagoon habitat (see Map No. 00). The first (AR-A) was built during 1969, a total of 357 tires were tied together and scattered over a roughly 5000 square-foot area. The second (AR-B), also constructed in the early 1970's contains nearly 2500 tires. During March and June, 1978, 20 and 18 fish species, respectively, were observed on AR-A; during June 1978, 30 species were observed on AR-B which is the greatest number of fish species recorded since construction. Only a few colonies of the coral Pocillopora damicornis have settled on these artificial reefs (Kami et al., 1978). Algal succession on these reefs during a 26-month period ending in February 1972 was studied by Tsuda and Kami (1973).

An artificial reef was constructed from a 54-foot sunken, LCM barge. Placed in 60 feet of water in Agat Bay in October 1977, this barge was modified in an attempt to enhance fish habitat. The number of fish has greatly increased with time, and both carnivorous and herbivorous fish communities have developed.

During the summer of 1978, Stojkovich and Smith (1978) carried out a survey of edible shellfish and sea urchins. They divided Cocos Lagoon into five sectors and ran transects parallel to the barrier reef and across the inner lagoon fringing reef flat west of Mannel Channel. Echinothrix diadema was the only sea urchin found in large numbers. Significant differences in shell size were found for the topshell Trochus niloticus. Of the several bivalve species collected in Cocos Lagoon, Quidnipagus palatum and Ctena spp. were the most abundant and were found in seagrass beds. A total of eighteen bivalve species were reported.

Many corals are harvested for personal and commercial use from the Study Area. Acropora irregularis has been harvested at the Nimitz Channel-Taleyfac Bay Area from depths to 30 ft (10 m). The black coral Antipathes dichotoma has been harvested from depths to 200 ft (70 m) off the reef north of Umatac Bay (Hedlund, 1977).

The coastal census zones for the Division of Aquatic and Wildlife Resources inshore creel census extend from Toguan Bay to Ajayan Bay. No census taking is carried out north of Toguan Bay. Zones numbered 40-47 are included within the Study Area. At the same time other information such as the number of picknickers along the shore may be taken.

These data are not yet analyzed, but preliminary information is available in the Division's annual job progress reports.

Fish weirs continue to be allowed in the Cocos Lagoon area, although they are being phased out by reducing annual permits. During 1978 twelve weirs were available, but only eight permits were given. In the 1979 review, seven fish weirs were permitted in the Merizo-Cocos Lagoon area only. At present the 1980 permit application period is still open. Weirs not permitted this year will not be available next year.

The Division also carries out a periodic offshore aerial surveillance program.

Three boat launching areas are present within the Study Area. The one at Nimitz Beach is used periodically for medium-sized boats. The U. S. Corps of Engineers contracted a study to investigate three areas--Bangi Point, Nimitz Beach, and Talefac Bay--for a small marina. Detailed mapping and species inventories have been prepared (Chernin et al., 1977). The launching site at the village of Umatac is not widely used because of the unstable shoreline.

The main launching site in the Study Area is at the Merizo Pier Park. Numerous boats use this site regularly for fishing inside and outside Cocos Lagoon, water skiing, and diving. Several glass-bottomed boats carry visitors across the reefs yearly. No marinas have been built, although studies for three near Merizo (Randall and Jones, 1972; Jones and Randall, 1973; Randall and Eldredge, 1974) and one at Achang Bay (Randall et al., 1973) have been conducted.

Both motor and sail boats are used in Cocos Lagoon. The Marianas Yacht Club held many regattas inside the Lagoon many years ago and still has occasional races from Apra Harbor along the southwest coast.

Diving and snorkeling are also popular activities in Cocos Lagoon and along the southwest coast. Deep-water diving is readily available from the narrow reef flat at Bile Bay. In the lagoon a wide variety of habitats can be observed while snorkeling. Guided underwater tours could be regularly available. A well marked underwater trail could be established on the shallow lagoon terrace and in the deep lagoon.

A wide range of water activities takes place annually during Umatac's Magellan Day in March and Merizo's Water Festival in November. These include sail and motor races, a float parade, and sometimes a pageant.

Cocos Island is a favorite picnic area. The white sand beach attracts many thousands of off-island visitors each year. A new pier is being considered, as well as an underwater viewing tower. The west end of Cocos Island is U. S. Navy owned but not maintained.

There are several places along the intertidal reef flats where nature trails could be established. These could be guided and scheduled in order to take the best advantage of the tide and sea conditions.

Cocos Lagoon owes its high diversity to the wide range of habitats. A total of 276 fish species have been recorded from the southern end of Guam. Forty-two of them occur only outside Cocos Lagoon. Therefore 234 fish species have been reported from the Lagoon itself (Randall et al., 1975). These species constitutes 40% of the total number (598) of fish species known to occur at Guam.

A total of 159 coral species have been reported from the Cocos Lagoon area (Randall et al., 1975). This is more than two times the total number of corals known from the Caribbean island of Jamaica where 64 species have been collected to depths of 100 m over many years. Birkeland et al. (1976) used this comparison in his Malakal Island, Palau, survey where he found 163 coral species; a similar number to that from Cocos Lagoon. He further stated that these were more species than known for the entire tropical Atlantic Ocean. Randall et al., (1978) listed 117 species from Arakabesan Island, Palau, and Eldredge et al. (1979) reported 105 species from Okat, Kosrae, in the eastern Caroline Islands. Neudecker (1978) studied 170 coral species from the Yap Lagoon. Only 42 corals species are known from the shallow water of Hawaii. Cocos Lagoon itself has nearly four times that number. From Guam 152 species are known from Toguan Bay (Jones et al., 1974), 159 from Ylig Bay (Randall and Birkeland, 1978), 164 from Agat Bay (Eldredge et al., 1977) and 136 and 146 from Tanguisson and Tumon Bay, respectively (Jones et al., 1976). Gawel (1974) reported 72 species from the Saipan Lagoon. In all cases the total number of species known depends on the intensity of the collecting effort, although, there appears to be a similar number of corals from a variety of wide-ranging areas.

Cocos Lagoon is a very rich marine system which offers a great range of opportunities in recreation, conservation, and education.

Significance

The Guam Seashore Study Area includes almost every major type of habitat found on Guam and is representative of all the southern islands of the Marianas. The volcanic shoreline is the most extensive on Guam and is only location of volcanic wave-eroded benches. The major part of the shore is limestone, including beaches and raised, pitted and pinnacled patches; however, the high, wave-eroded benches like those found along the Northeast coast are not found within the Seashore Study Area.

Some of the richest coral areas on Guam are included within the Seashore Study area. The total number of species found in the lagoon is a good indication of the richness. The barrier reef encompasses the relatively deep lagoon which is the only undisturbed true lagoonal habitat on Guam. One of the two mangrove areas on the island is found along the Merizo shore, and the densest seagrass area on Guam's reefs is near the Ajayan River mouth. Both of these habitats constitute an important "nursery" ground for commercial and recreational fishes. Continual preservation of these habitats will help insure continual availability of the important fish species.

In all, the Guam Seashore Study Area, along a single continuous coastal area, includes the major habitats of the Marianas and the western Pacific. It is a microcosm whose significance must not be underrated. The Seashore Study Area should be available for recreation, for conservation, and for research.

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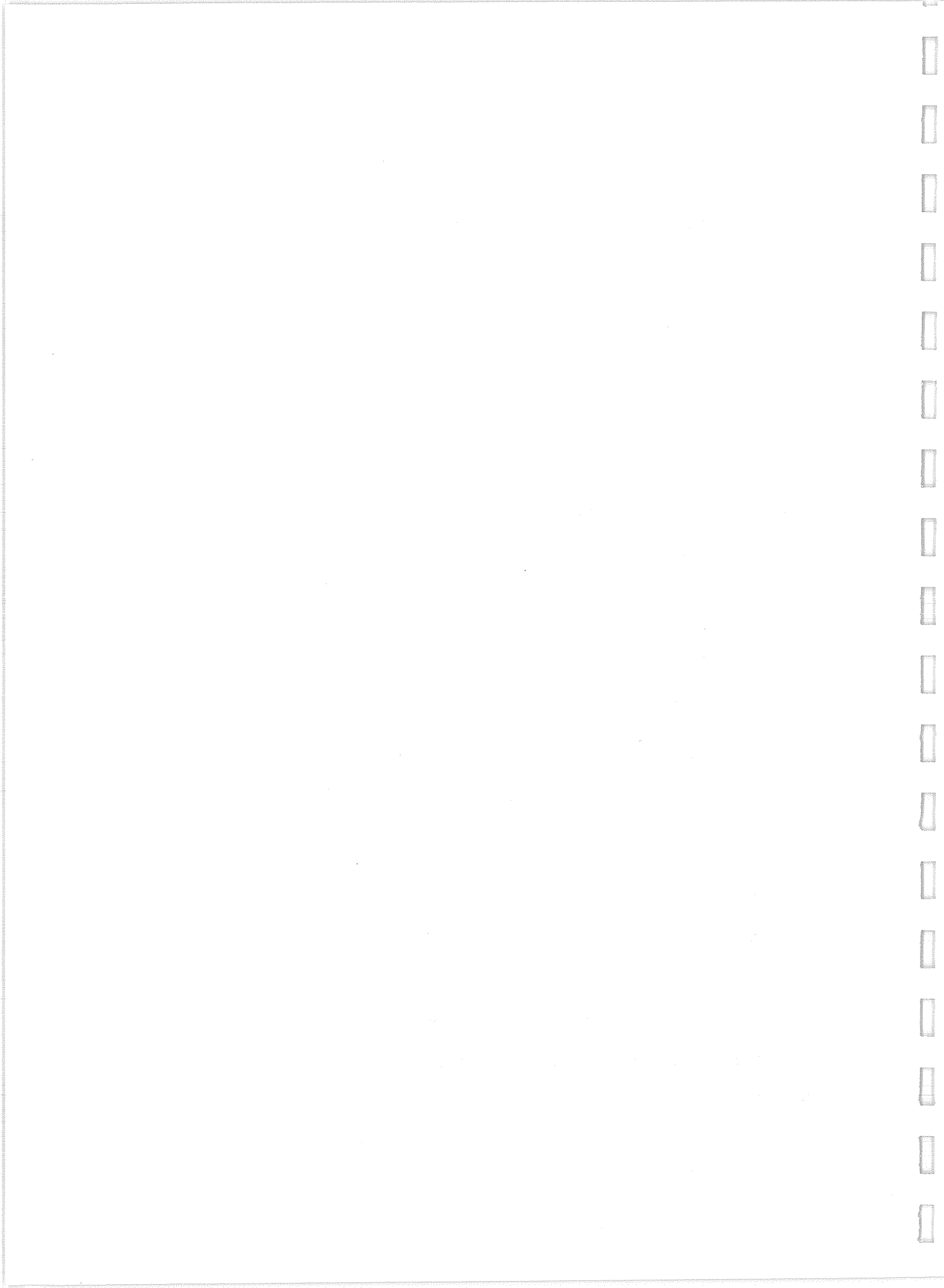
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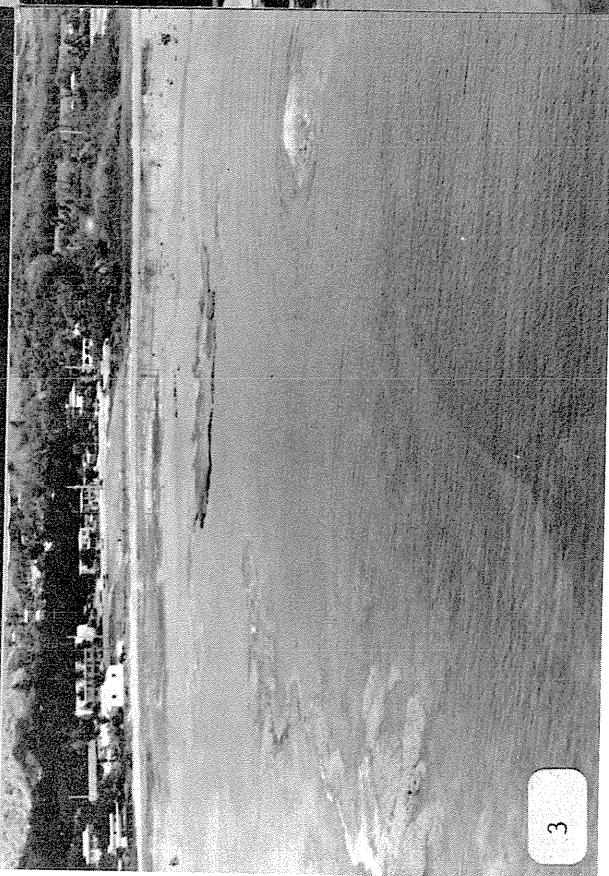
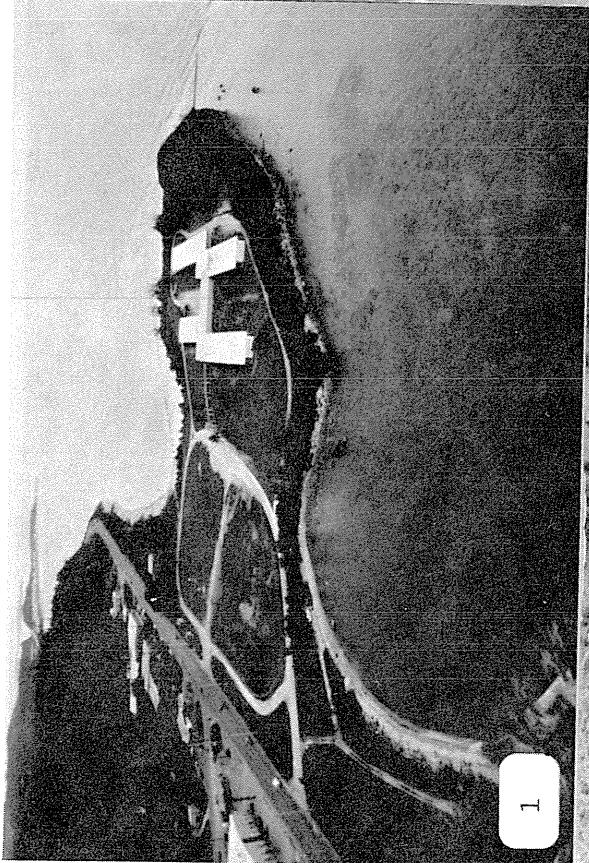
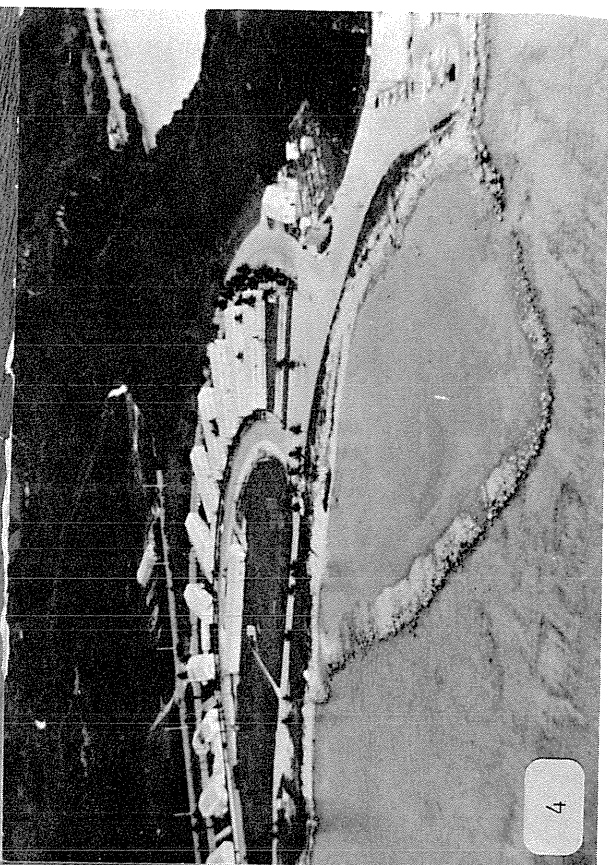
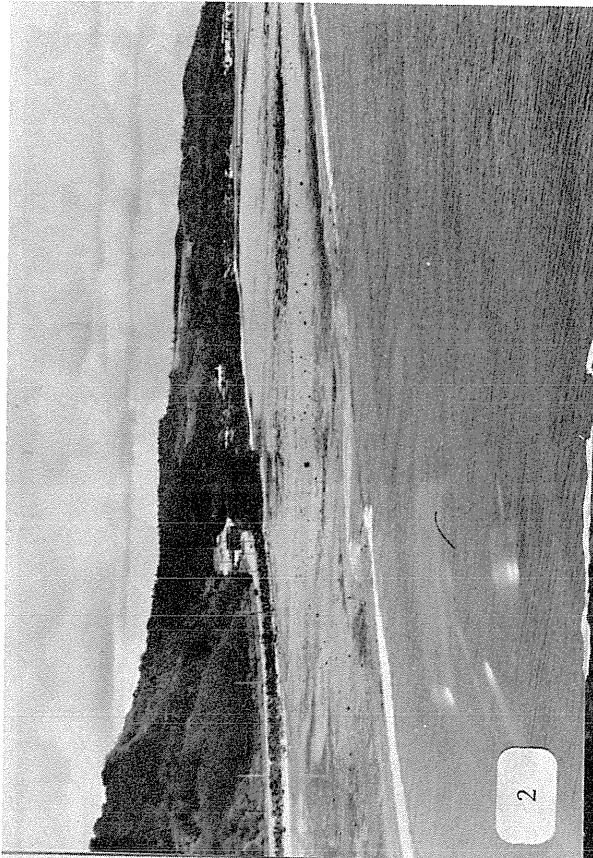
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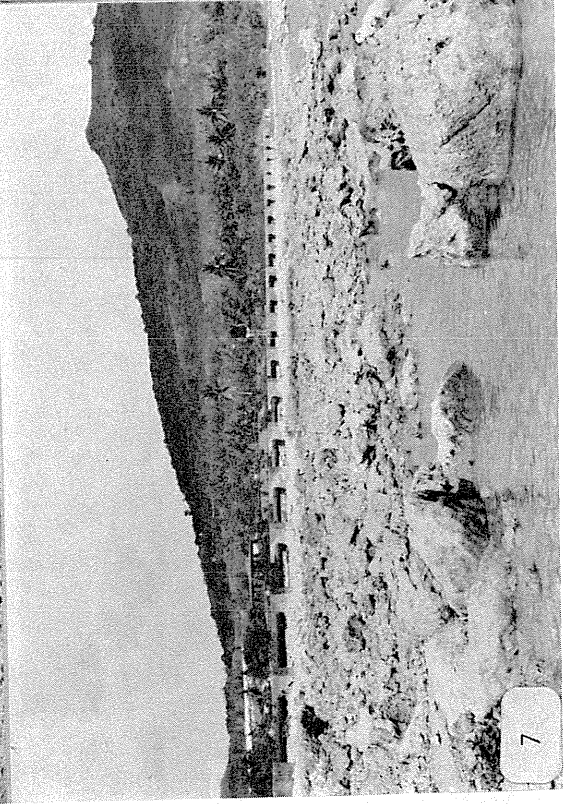
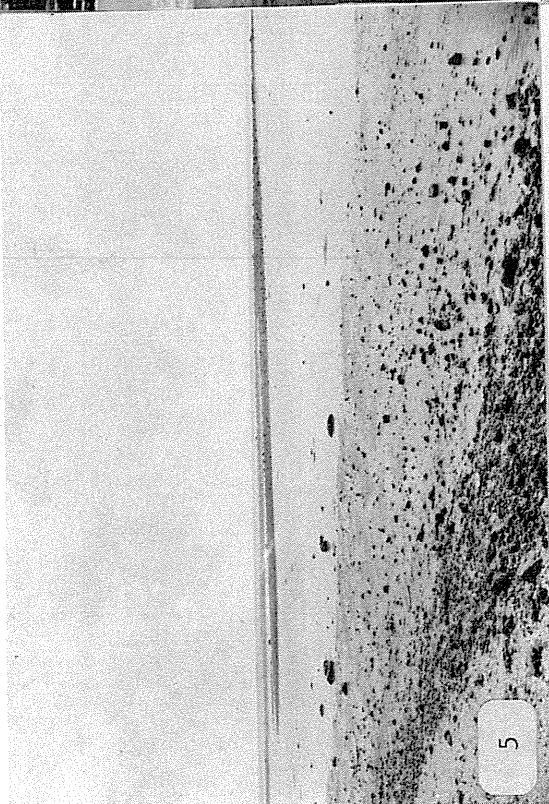
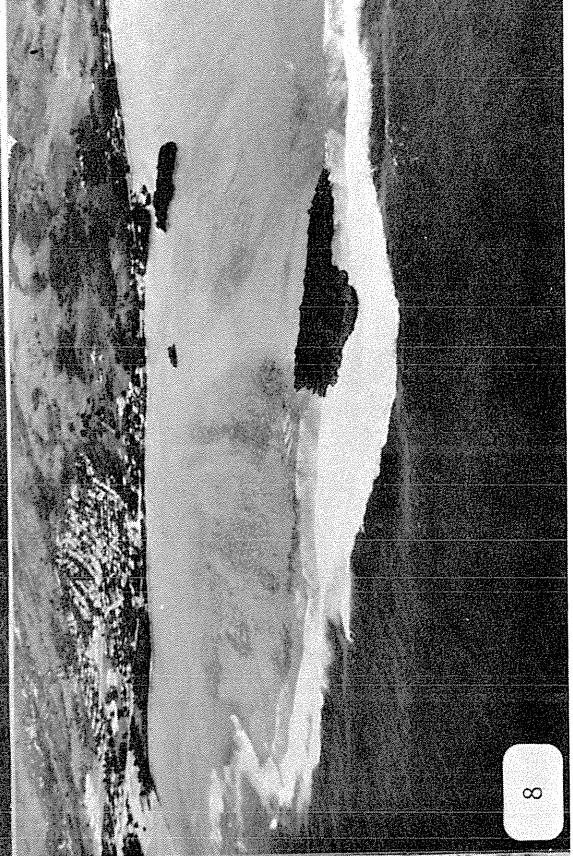
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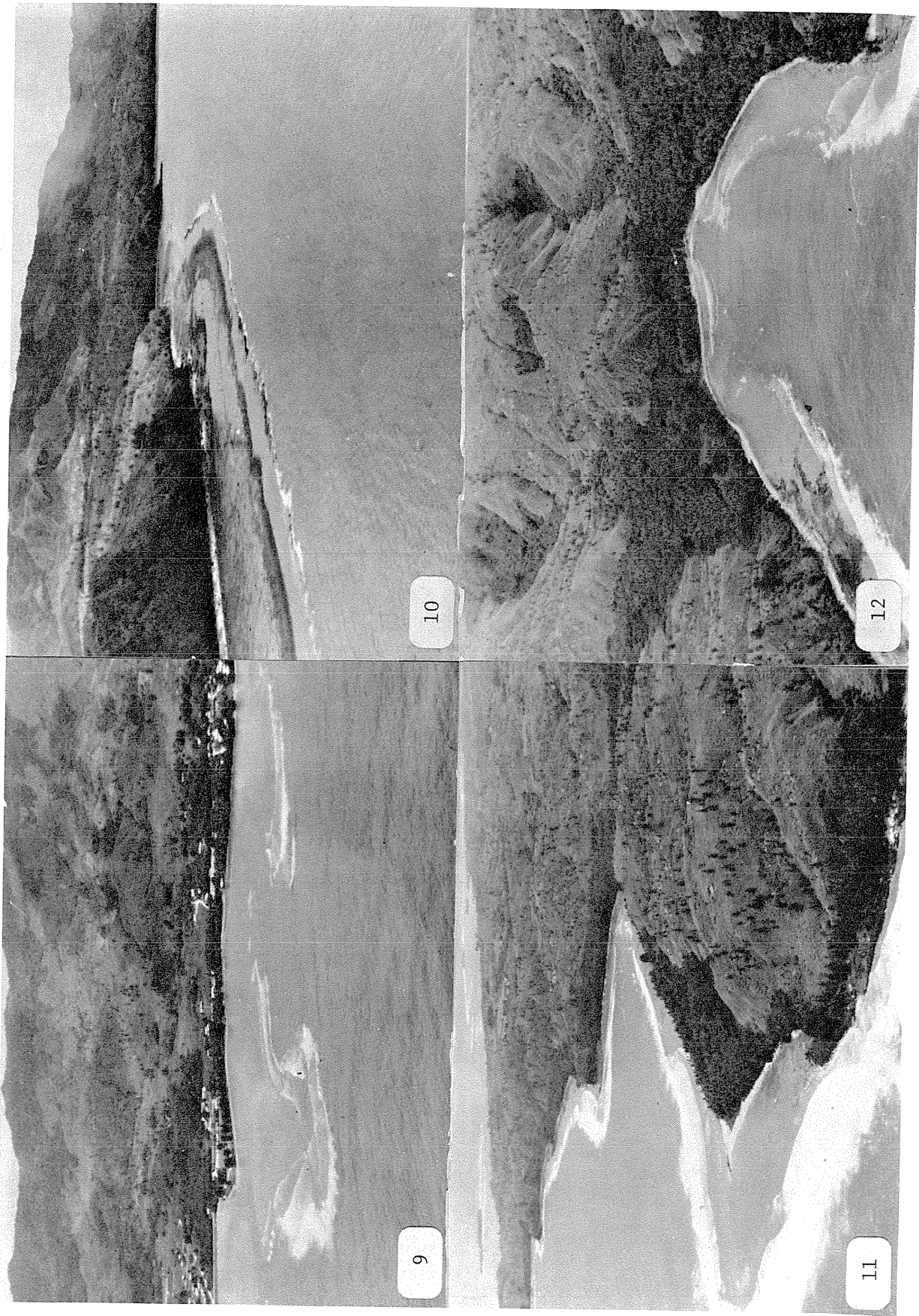
FIGURES

1. Adelup Point, Fonte River mouth in foreground
2. Reef flat west of Adelup Point, showing reef margin depressed area in foreground and volcanic and limestone headland along the shore in center
3. Head of Asan Bay with irregular channel margin and small patch reef
4. Mole enclosing part of inner reef flat at Asan Point
5. Reef flat at Togcha Beach with boulder tract at exposed outer reef flat
6. Gaan Point fringing reef and shoreline
7. Man-made peninsula at Gaan Point
8. Wide reef flat at Bangi Point with three reef-flat islands
9. Nimitz Channel (left) and Taleyfac Bay (right)
10. Intertidal reef flat between Facpi Point and Achugao Point exposed at low tide
11. Sella Bay embayment with Pinay Point in foreground and Chii Point to left
12. Cetti Bay, dark truncated volcanics at left
13. Fouha Bay with Lalas Rock at Chalan Anite Point
14. Umatac Bay and Machadgan Point
15. Mouth of Mamaon Channel and narrow inner lagoon fringing reef flat
16. Mamaon Channel
17. Cocos Island
18. Babe Island and seaward outer barrier reef flat
19. Achang Reef with Sumay Bay and Channel
20. Agrigan Island







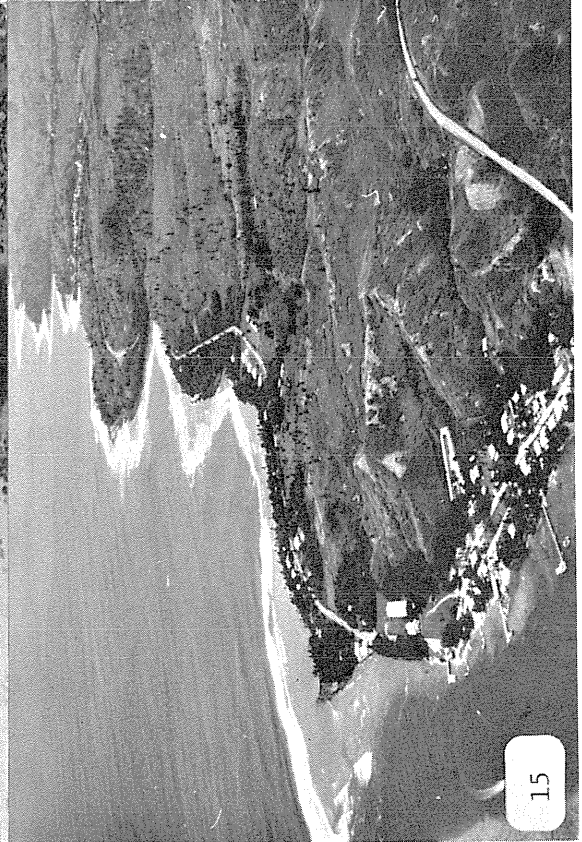


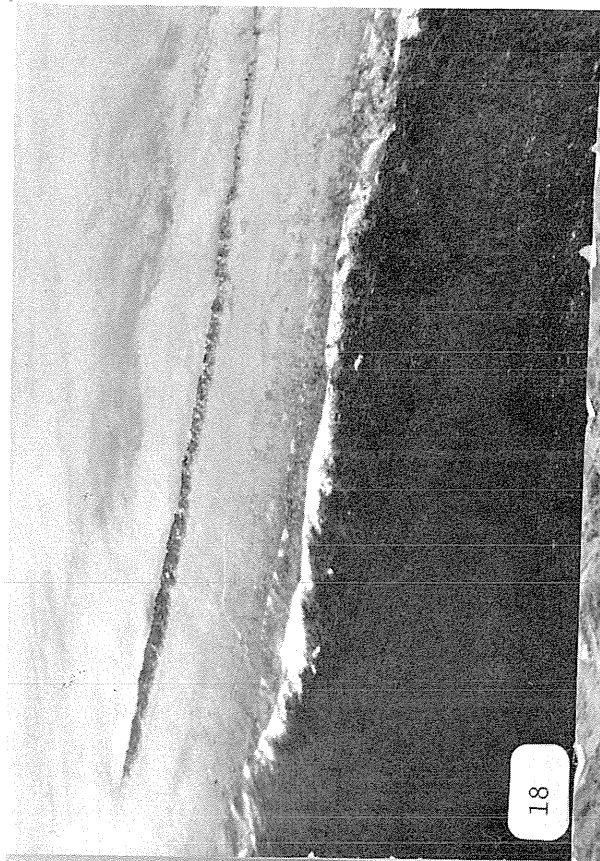
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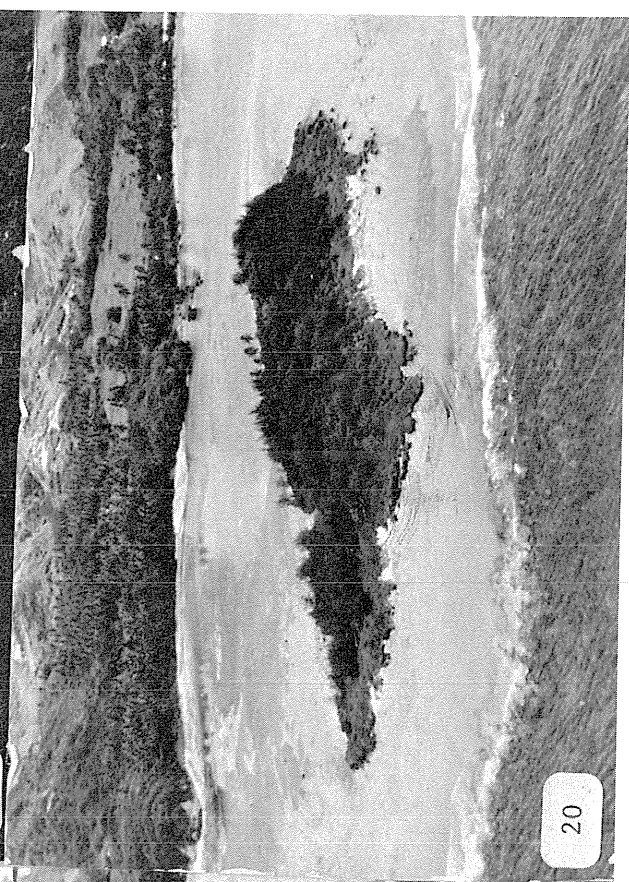
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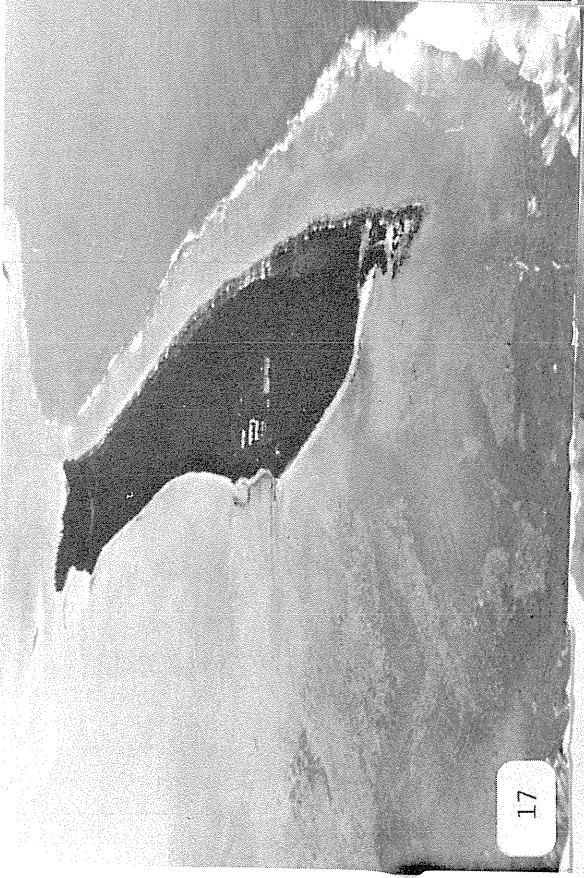




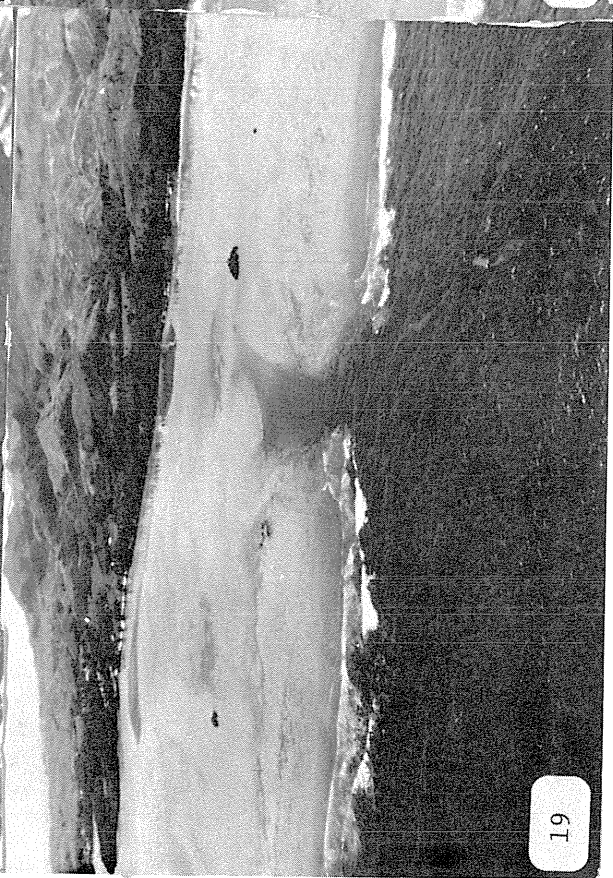
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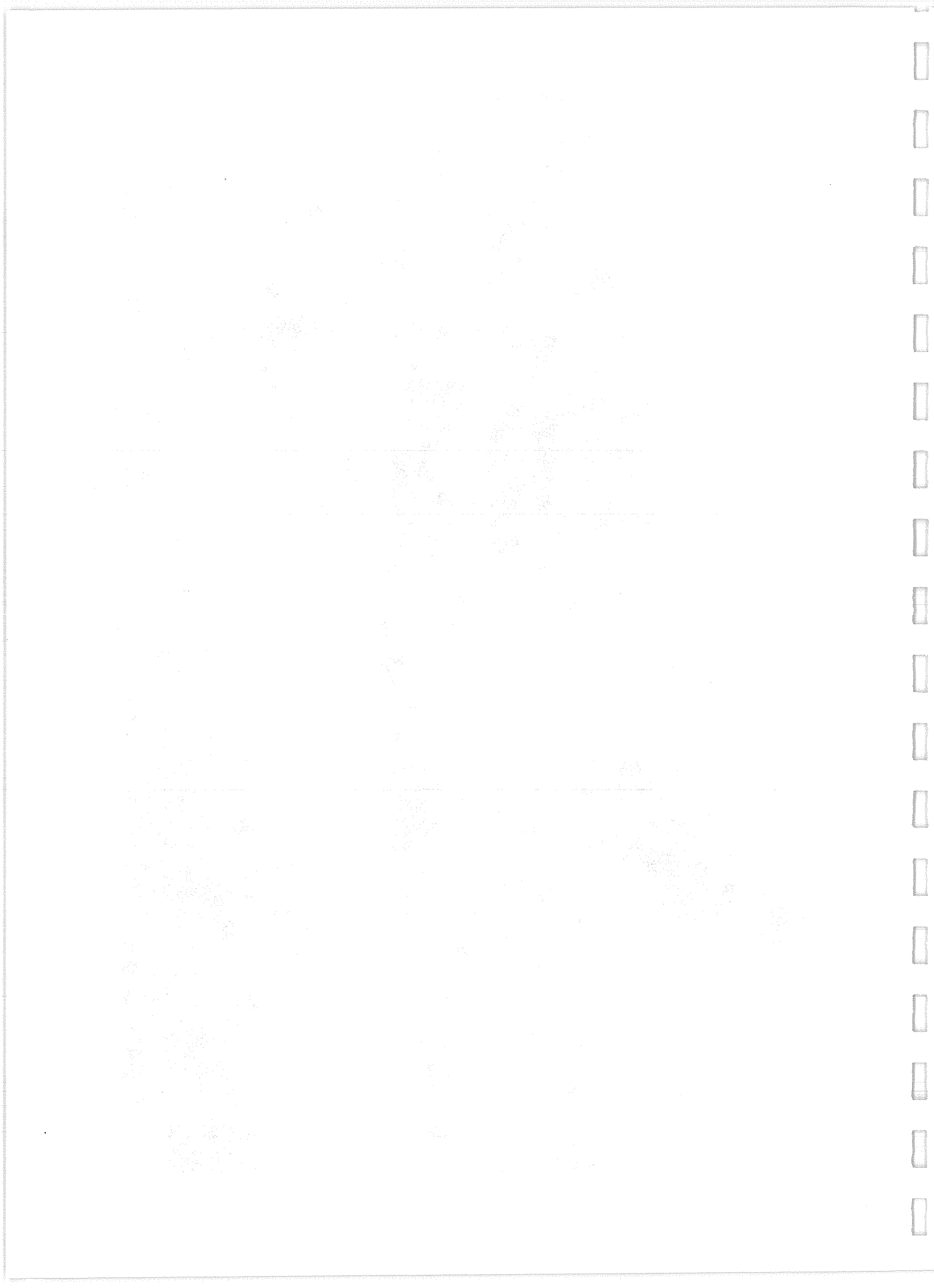


Table 1. Marine Plants. A list of species known to occur in the Agat Unit and along the Seashore Study Area.

	Cocos Lagoon	Agat	Bangi	Taleyfac
Cyanophyta				
<u>Calothrix crustacea</u> Thuret	x	-	-	-
<u>Hormothamion enteromorphoides</u> B. & F.	x	x	x	x
<u>Microcoleus lyngbyaceus</u> (Kutz.) Crouan	x	x	x	x
<u>Schizothrix calcicola</u> (Ag.) Gomont	x	x	x	x
<u>Schizothrix mexican</u> Gomont	x	x	x	x
<u>Rivularia atra</u> B. & F.	x	-	-	-
Chlorophyta				
<u>Acetabularia moebii</u> Solms-Laubach	x	-	-	x
<u>Avrainvillea obscura</u> J. Ag.	x	x	-	-
<u>A. lacerata</u> Gepp	-	-	x	x
<u>Boergesenia forbesii</u> (Harv.) Feldmann	x	-	-	-
<u>Boodlea composita</u> (Harv.) Brand	x	x	x	x
<u>Bryopsis pennata</u> Lamx.	-	x	-	-
<u>Caulerpa cupressoides</u> (West) C. Ag.	x	-	-	x
<u>Caulerpa filicoides</u> Yamada	x	-	-	-
<u>Caulerpa lentillifera</u> J. Ag.	x	-	-	-
<u>Caulerpa racemosa</u> (Forssk.) J. Ag.	x	x	x	x
<u>Caulerpa serrulata</u> (Forssk.) J. Ag.	x	-	x	x
<u>Caulerpa sertularioides</u> (Gmel.) Howe	x	-	-	x
<u>Caulerpa taxifolia</u> (Vahl) C. Ag.	x	-	-	x
<u>Caulerpa verticillata</u> J. Ag.	x	-	x	x
<u>Chlorodesmis fastigiata</u> (C. Ag.) Ducker	x	-	x	x
<u>Cladophoropsis membranacea</u> (Ag.) Boerg.	x	-	-	-
<u>Codium edule</u> Silva	x	x	-	-
<u>Dictyosphaeria cavernosa</u> (Forssk.) Boerg.	x	-	x	x
<u>Dictyosphaeria versluysii</u> W-v. Bosse	x	x	x	x
<u>Enteromorpha clathrata</u> (Roth) Ag.	-	x	x	-
<u>Enteromorpha compressa</u> (L.) Grev.	x	-	-	-
<u>Halimeda copiosa</u> Goreau & Graham	x	-	-	-
<u>Halimeda discoidea</u> Decaisne	x	x	x	x
<u>Halimeda gigas</u> Taylor	x	-	-	x
<u>Halimeda incrassata</u> (Ellis) Lamx.	x	x	x	x
<u>Halimeda macroloba</u> Decaisne	x	x	x	x
<u>Halimeda micronesica</u> Yamada	-	x	-	-
<u>Halimeda opuntia</u> (L.) Lamx.	x	x	x	x
<u>H. velasquezii</u> Taylor	-	-	x	x
<u>Neomeris annulata</u> Dickie	x	x	x	x
<u>Neomeris vanbosseae</u> Howe	x	-	x	x
<u>Rhipilia orientalis</u> A. & E. S. Gepp	x	-	x	x
<u>Rhizoclonium samoense</u> Setchell	-	-	x	x
<u>Tydemannia expeditionis</u> W-v. Bosse	x	-	x	-
<u>Udotea argentea</u> Zanardini	x	x	-	x
<u>U. geppi</u> Yamada	x	x	-	-
<u>U. palmetta</u> Decaisne	-	-	x	x
<u>Valonia fastigiata</u> Harv.	x	x	x	x
<u>V. utricularis</u> (Roth) C. Ag.	-	-	x	x
<u>V. ventricosa</u> J. Ag.	x	x	x	x

Table 1. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
Phaeophyta				
<u>Chnoospora implexa</u> (Hering) C. Ag.	x	-	-	-
<u>Dictyota bartayresii</u> Lamx.	x	x	x	x
<u>Dictyota cervicornis</u> Kutz.	x	-	-	-
<u>Dictyota divaricata</u> Lamx.	x	-	-	-
<u>Dictyota friabilis</u> Setchell	x	-	x	x
<u>Dictyota patens</u> J. Ag.	x	-	-	-
<u>Ectocarpus breviarticulatus</u> J. Ag.	x	-	-	-
<u>Feldmannia indica</u> (Sonder) Womersley & Bailey	x	-	-	-
<u>Hydroclathrus clathratus</u> (C. Ag.) Howe	x	-	x	-
<u>Lobophora variegata</u> (Lamx.) Womersley	x	x	x	x
<u>Padina jonesii</u> Tsuda	x	-	x	x
<u>Padina tenuis</u> Bory	x	x	x	x
<u>Ralfsia pangoensis</u> Setchell	-	x	x	x
<u>Sargassum cristaefolium</u> C. Ag.	x	x	-	-
<u>Sargassum polycystum</u> C. Ag.	x	x	x	x
<u>Sphacelaria tribuloides</u> Meneghini	x	-	x	-
<u>Turbinaria ornata</u> (Turner) J. Ag.	x	x	x	x
Rhodophyta				
<u>Acanthophora spicifera</u> (Vahl) Boerg.	x	-	-	-
<u>Actinotrichia fragilis</u> (Forssk.) Boerg.	x	x	x	x
<u>Amansia glomerata</u> C. Ag.	-	-	x	x
<u>Amphiroa foliacea</u> Lamx.	x	x	x	x
<u>Amphiroa fragilissima</u> (L.) Lamx.	x	x	x	x
<u>Asparagopsis taxiformis</u> (Delile) Collins & Harvey	x	-	-	x
<u>Botryocladia skottsbergii</u> (Boerg.) Levring	x	-	-	-
<u>Centroceras clavulatum</u> (C. Ag.) Montagne	x	-	x	-
<u>Champia parvula</u> (C. Ag.) Harvey	x	-	-	-
<u>Chondria repens</u> Boerg.	-	x	-	-
<u>Desmia hornemanni</u> Lyngbye	x	-	x	x
<u>Galaxaura fasciculata</u> Kjellman	x	x	x	x
<u>G. filamentosa</u> Chou	-	x	x	x
<u>Galaxaura marginata</u> Lamx.	x	-	x	x
<u>Galaxaura oblongata</u> (E. & S.) Lamx.	x	x	x	x
<u>Gelidiella acerosa</u> (Forssk.) Feldmann & Hamel	x	x	x	x
<u>Gelidiopsis intricata</u> (Ag.) Vickers	x	x	x	x
<u>Gelidium divaricatum</u> Martens	x	-	-	-
<u>Gelidium pusillum</u> (Stackh.) Le Jolis	x	x	-	-
<u>Gracilaria arcuata</u> Zanardini	x	-	x	x
<u>G. crassa</u> Harvey	x	-	-	-
<u>G. edulis</u> (Gmelin) Silva	-	-	-	x
<u>Halymenia durivillaei</u> Bory	x	-	x	x
<u>Hydrolithon reinboldii</u> (W-v. Bosse & Foslie) Foslie	-	-	x	x
<u>Hypnea cervicornis</u> J. Ag.	x	-	-	-
<u>Hypnea pannosa</u> J. Ag.	x	-	-	-
<u>Hypnea valentiae</u> (Turn.) Montagne	x	-	-	-
<u>Jania capillacea</u> Harvey	x	x	x	x
<u>J. tenella</u> Kutz.	-	x	-	-

Table 1. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>Laurencia</u> sp.	x	-	x	x
<u>Lithophyllum</u> sp.	x	-	x	x
<u>Mastophora</u> sp.	x	-	x	-
<u>Metagoniolithon graniferum</u> (Harv.) Weber van Bosse	-	-	x	x
<u>Neogoniolithon</u> sp.	x	x	x	x
<u>Peyssonelia</u> sp.	x	-	-	-
<u>Polysiphonia</u> spp.	x	-	x	x
<u>Porolithon onkodes</u> Foslie	x	x	-	-
<u>Rhodymenia</u> sp.	x	-	x	x
<u>Spyridia filamentosa</u> (Wulf.) Harvey	x	-	-	-
<u>Tolypiocladia glomerulata</u> (Ag.) Schmitz & Hauptfleisch	x	-	-	x
<u>Wrangelia argus</u> (Mont.) Montagne	-	-	x	-
Spermatophyta				
<u>Enhalus acoroides</u> (L. F.) Royle	x	x	x	x
<u>Halodule uninervis</u> (Forssk.) Ascherson	x	-	-	-
<u>Halophila minor</u> (Zoll.) Hartog	x	-	x	x

Table 2. Corals. A list of species known to occur in the Agat Unit and along the Seashore Study Area.

	Cocos Lagoon	Agat	Bangi	Tafeyfac
Astrocoeniidae				
<u>Stylocoeniella armata</u> (Ehrenberg)	x	x	-	-
<u>S. quentheri</u> (Bassett-Smith)	x	x	-	-
Thamnasteriidae				
<u>Psammocora contigua</u> (Esper)	x	x	x	x
<u>P. nierstraszi</u> van der Horst	x	x	-	-
<u>P. profundacella</u> Gardiner	x	x	-	x
<u>P. stellata</u> (Verrill)	x	-	-	-
<u>P. verrilli</u> Vaughan	x	x	-	-
<u>P. (S.) togianensis</u> Umbgrove	x	x	x	x
<u>P. (P.) haimeana</u> Milne Edwards & Haime	-	x	-	x
Pocilloporidae				
<u>Stylophora mordax</u> (Dana)	x	x	x	x
<u>Seriatopora hystrix</u> (Dana)	x	x	-	x
<u>Pocillopora brevicornis</u> Lamarck	x	x	-	-
<u>P. damicornis</u> (Linnaeus)	x	x	x	x
<u>P. danae</u> Verrill	x	x	x	x
<u>P. elegans</u> Dana	x	x	x	x
<u>P. eydouxi</u> Milne Edwards & Haime	x	x	x	-
<u>P. ligulata</u> Dana	x	x	-	x
<u>P. meandrina</u> Dana	x	x	x	x
<u>P. setchelli</u> Hoffmeister	x	x	x	x
<u>P. verrucosa</u> (Ellis & Solander)	x	x	x	x
<u>P. woodjonesi</u> Vaughan	-	x	x	x
Acropoidae				
<u>Acropora abrotanoides</u> (Lamarck)	x	x	-	-
<u>A. acuminata</u> Verrill	x	-	-	-
<u>A. arbuscula</u> (Dana)	x	-	-	-
<u>A. aspera</u> (Dana)	x	-	-	-
<u>A. brueggemanni</u> (Brook)	x	x	x	x
<u>A. convexa</u> (Dana)	x	x	x	x
<u>A. delicatula</u> (Brook)	x	x	x	x
<u>A. echinata</u> (Dana)	x	x	x	x
<u>A. formosa</u> (Dana)	x	x	x	x
<u>A. hebes</u> (Dana)	x	-	-	-
<u>A. humilis</u> (Dana)	x	x	x	x
<u>A. hystrix</u> (Dana)	x	x	x	x
<u>A. kenti</u> (Brook)	x	x	-	x
<u>A. murrayensis</u> Vaughan	x	x	x	-
<u>A. nana</u> (Studer)	x	x	x	-
<u>A. nasuta</u> (Dana)	x	x	x	x
<u>A. nobilis</u> (Dana)	x	-	-	-
<u>A. palifera</u> (Lamarck)	x	x	-	x
<u>A. palmerae</u> Wells	x	x	x	-

Table 2. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
<u>Acropora rambleri</u> (Bassett Smith)	x	x	-	-
<u>A. rayneri</u> (Brook)	x	x	-	-
<u>A. smithi</u> (Brook)	x	x	x	x
<u>A. squarrosa</u> (Ehrenberg)	x	x	-	-
<u>A. surculosa</u> (Dana)	x	x	x	x
<u>A. syringodes</u> (Brook)	x	x	-	-
<u>A. studeri</u> (Brook)	x	-	-	-
<u>A. teres</u> (Verrill)	x	-	-	-
<u>A. tubicinaria</u> (Dana)	x	-	-	-
<u>A. valida</u> (Dana)	-	x	x	-
<u>A. virgata</u> (Dana)	x	-	-	-
<u>A. wardii</u> Verrill	x	x	x	x
<u>Astreopora gracilis</u> Bernard	x	x	x	-
<u>A. listeri</u> Bernard	x	x	x	-
<u>A. myriophthalma</u> (Lamarck)	x	x	x	-
<u>A. profunda</u> Verrill	-	x	-	-
<u>Montipora composita</u> Crossland	x	x	-	-
<u>M. conicula</u> Wells	x	x	-	-
<u>M. ehrenbergii</u> Verrill	x	x	-	x
<u>M. elschneri</u> Vaughan	x	x	x	x
<u>M. floweri</u> Wells	x	x	-	-
<u>M. foliosa</u> (Pallus)	-	x	-	x
<u>M. foveolata</u> (Dana)	x	x	-	-
<u>M. granulosa</u> Bernard	x	x	-	-
<u>M. hoffmeisteri</u> Wells	x	x	x	x
<u>M. lobulata</u> Bernard	x	x	-	x
<u>M. monasteriata</u> (Forskaal)	x	x	x	-
<u>M. patula</u> Verrill	x	x	x	-
<u>M. socialis</u> Bernard	-	x	x	-
<u>M. subtilis</u> Bernard	x	x	-	x
<u>M. tuberculosa</u> (Lamarck)	x	x	x	x
<u>M. verrilli</u> Vaughan	x	x	x	x
<u>M. verrucosa</u> (Lamarck)	x	x	x	x
Agariciidae				
<u>Pavona clavus</u> (Dana)	x	x	x	x
<u>P. decussata</u> (Dana)	x	-	-	-
<u>P. divaricata</u> (Lamarck)	x	-	-	-
<u>P. frondifera</u> (Lamarck)	x	-	-	-
<u>P. maldivensis</u> (Gardiner)	-	x	x	-
<u>P. gardineri</u> van der Horst	x	x	-	-
<u>P. minuta</u> Wells	x	x	-	x
<u>P. varians</u> Verrill	x	x	x	x
<u>P. (P.) pollicata</u> Wells	x	x	-	x
<u>P. (P.) planulata</u> (Dana)	x	x	x	x
<u>P. (P.) obtusata</u> (Quelch)	x	x	-	-
<u>P. (P.) venosa</u> Ehrenberg	-	-	-	x

Table 2. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
<u>Leptoseris hawaiiensis</u> Vaughan	x	x	-	x
<u>L. incrustans</u> (Quelch)	x	x	-	x
<u>L. mycetoseroides</u> Wells	x	x	-	x
<u>Pachyseris speciosa</u> (Dana)	x	x	-	x
Siderasteridae				
<u>Coscinaraea columna</u> (Dana)	x	x	-	-
Fungiidae				
<u>Fungia concinna</u> Verrill	-	x	-	-
<u>F. fungites</u> (Linnaeus)	x	x	-	x
<u>F. paumotensis</u> Stutchbory	-	x	-	-
<u>F. scutaria</u> Lamarck	x	x	-	x
Poritidae				
<u>Goniopora arbuscula</u> Umbgrove	x	x	-	x
<u>G. columna</u> Dana	x	x	-	-
<u>Stylaraea punctata</u> Klunzinger	x	-	-	-
<u>Porites andrewsi</u> Vaughan	x	x	x	x
<u>P. annae</u> Crossland	x	-	-	-
<u>P. australiensis</u> Vaughan	x	x	-	-
<u>P. cocosensis</u> Wells	x	x	x	x
<u>P. compressa</u> Vaughan	x	x	-	-
<u>P. duerdeni</u> Vaughan	x	x	-	-
<u>P. lichen</u> Dana	x	x	x	x
<u>P. lobata</u> Dana	x	x	x	x
<u>P. lutea</u> Milne Edwards & Haime	x	x	x	x
<u>P. murrayensis</u> Vaughan	x	x	-	x
<u>P. matthaii</u> Wells	x	x	-	x
<u>P. (S.) convex</u> Verrill	x	x	-	x
<u>P. (S.) hawaiiensis</u> Vaughan	x	x	-	x
<u>P. (S.) horizontalata</u> Hoffmeister	x	x	x	x
<u>P. (S.) iwayamaensis</u> Eguchi	x	x	-	x
<u>Alveopora japonica</u> Eguchi	x	-	-	-
<u>A. verrilliana</u> Dana	x	x	-	x
Faviidae				
<u>Favia fava</u> (Forskaal)	x	x	-	x
<u>F. matthai</u> Vaughan	-	x	x	-
<u>F. pallida</u> (Dana)	x	x	x	x
<u>F. rotumana</u> (Gardner)	-	-	-	x
<u>F. russelli</u> (Wells)	x	x	-	-
<u>F. speciosa</u> (Dana)	x	x	-	x
<u>Favites abdita</u> (Ellis & Solander)	x	x	x	-
<u>F. complanata</u> (Ehrenberg)	x	x	-	-
<u>F. favosa</u> (Ellis & Solander)	x	x	-	-
<u>F. flexuosa</u> (Dana)	x	x	x	-
<u>F. virens</u> (Dana)	x	x	-	x

Table 2. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
<u>Oulophyllia crista</u> (Lamarck)	x	x	x	-
<u>Plesiastrea versipora</u> (Lamarck)	x	x	x	x
<u>Goniastrea parvistella</u> (Dana)	x	x	x	x
<u>G. pectinata</u> (Ehrenberg)	x	x	-	x
<u>G. retiformis</u> (Lamarck)	x	x	x	x
<u>Platygyra pini</u> (Milne Edwards & Haime)	-	-	x	x
<u>P. rustica</u> (Dana)	x	x	x	x
<u>P. lamellina</u> (Ehrenberg)	x	x	-	-
<u>P. sinensis</u> (Milne Edwards & Haime)	x	x	-	-
<u>Leptoria phrygia</u> (Ellis & Solander)	x	x	x	x
<u>Hydnophora microconos</u> (Lamarck)	x	x	-	x
<u>H. tenella</u> Quelch	-	-	-	x
<u>Leptastrea bottae</u> (Milne Edwards & Haime)	x	x	-	-
<u>L. purpurea</u> (Dana)	x	x	x	x
<u>L. transversa</u> (Klunzinger)	x	x	-	x
<u>Cyphastrea chalcidicum</u> (Forskaal)	x	x	-	-
<u>C. serailia</u> (Forskaal)	x	x	-	x
<u>Echinopora lamellosa</u> (Esper)	x	x	x	x
<u>Diploastrea heliopora</u> (Lamarck)	x	x	x	x
Oculinidae				
<u>Galaxea clavus</u> (Dana)	-	-	-	x
<u>G. fascicularis</u> (Linnaeus)	x	x	x	x
<u>G. hexagonalis</u> Milne Edwards & Haime	x	-	-	-
<u>Acrhelia horrescens</u> (Dana)	x	x	-	-
Merulinidae				
<u>Merulina ampliata</u> (Ellis & Solander)	x	x	-	x
Mussidae				
<u>Lobophyllia corymbosa</u> (Forskaal)	x	x	x	x
<u>L. costata</u> (Dana)	x	x	x	x
<u>L. hemprichii</u> (Ehrenberg)	x	x	-	x
<u>Acanthastrea echinata</u> (Dana)	x	x	x	x
Pectiniidae				
<u>Echinophyllia asper</u> Ellis & Solander	x	x	-	x
Caryophyllidae				
<u>Polycyathus verrilli</u> Duncan	-	x	-	x
<u>Plerogyra sinuosa</u> (Dana)	x	x	-	x
<u>Euphyllia glabrescens</u> (Chamisso & Eysenhardt)	x	x	-	x
Helioporidae				
<u>Heliopora coerulea</u> (Pallas)	x	x	x	x
Milleporidae				
<u>Millepora dichotoma</u> Forskaal	x	x	-	x

Table 2. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
<u>Millepora exaesa</u> Forskaal	x	x	x	x
<u>M. platyphylla</u> Hemprich & Ehrenberg	x	x	x	x
Stylasteridae				
<u>Distichopora violacea</u> (Pallas)	x	x	x	x
Tubiporidae				
<u>Tubipora musica</u> (Linnaeus)	-	-	x	x

Table 3. Gastropods. A list of species known to occur in the Agat Unit and along the Seashore Study Area.

	Cocos Lagoon	Agat	Bangi	Taleyfac
Acmaeidae				
<u>Acmaea</u> sp.	x	x	-	-
Architectonicidae				
<u>Heliacus</u> sp. [cf. <u>H. variegatus</u> (Gmelin)]	-	x	-	-
Buccinidae				
<u>Cantharus fumosus</u> (Dillwyn)	x	x	x	-
<u>C. undosus</u> (Linnaeus)	x	-	-	-
Bursidae				
<u>Bursa bufonia</u> (Gmelin)	-	-	x	-
<u>B. cruentata</u> (Sowerby)	-	x	-	-
Catyptraeidae				
<u>Cheilia equestris</u> (Linnaeus)	-	-	x	-
Cerithiidae				
<u>Cerithium aluco</u> (Linnaeus)	-	x	-	-
<u>C. columna</u> Sowerby	x	-	-	-
<u>C. morus</u> Bruguiere	-	x	-	-
<u>C. nesioticum</u> Pilsbry & Vanatta	x	-	-	-
<u>C. nodulosum</u> Bruguiere	x	x	x	x
<u>C. pfefferi</u> Dunker	-	x	-	-
<u>C. ravidum</u> Philippi	x	x	-	-
<u>Rhinoclavis asper</u> (Linnaeus)	x	-	x	x
Conidae				
<u>Conus arenatus</u> Bruguiere	x	-	-	-
<u>C. catus</u> Bruguiere	-	-	x	-
<u>C. chaldaeus</u> (Roding)	-	x	-	x
<u>C. distans</u> Bruguiere	x	-	-	-
<u>C. ebraeus</u> Linnaeus	x	x	-	-
<u>C. flavidus</u> Lamarck	x	x	-	x
<u>C. imperialis</u> Linnaeus	x	-	-	-
<u>C. lividus</u> Bruguiere	x	x	x	x
<u>C. litteratus</u> Linnaeus	x	-	-	-
<u>C. marmoreus</u> Linnaeus	x	-	-	-
<u>C. miles</u> Linnaeus	-	x	x	x
<u>C. miliaris</u> Bruguiere	x	x	-	x
<u>C. pulicarius</u> Hwass	x	-	x	-
<u>C. rattus</u> Bruguiere	x	x	x	x
<u>C. sponsalis</u> Bruguiere	x	x	x	x
<u>C. striatus</u> Linnaeus	-	x	-	-
<u>C. virgo</u> Linnaeus	-	x	-	-
<u>C. vitulinus</u> Bruguiere	-	x	-	-

Table 3. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
Cymatiidae				
<u>Cymatium hepaticum</u> (Roding)	-	x	-	-
<u>C. muricinum</u> (Roding)	x	x	-	-
<u>C. nicobaricum</u> (Roding)	-	x	x	-
<u>C. pileare</u> Linnaeus	x	-	-	-
Cypraeidae				
<u>Cypraea annulus</u> Linnaeus	-	x	-	-
<u>C. arabica</u> Linnaeus	-	x	-	-
<u>C. caputserpentis</u> Linnaeus	-	x	x	x
<u>C. carneola</u> Linnaeus	x	-	x	-
<u>C. cassiaui</u> Burgess	-	x	-	-
<u>C. erosa</u> Linnaeus	-	x	x	x
<u>C. lynx</u> Linnaeus	-	-	x	x
<u>C. moneta</u> Linnaeus	x	x	x	x
<u>C. poraria</u> Linnaeus	-	-	x	x
<u>C. tigris</u> Linnaeus	x	x	-	-
Fasciolariidae				
<u>Peristernia nassatula</u> (Lamarck)	-	x	-	x
<u>Latirus barclayi</u> Reene	x	-	-	-
<u>L. polygonus</u> (Gmelin)	x	-	-	-
Littorinidae				
<u>Littorina coccinea</u> (Gmelin)	-	x	x	-
<u>L. scabra</u> (Linnaeus)	-	x	-	-
<u>L. undulata</u> Gray	-	x	-	-
Magilidae				
<u>Coralliophilia violacea</u> (Kiener)	x	x	x	x
<u>Quoyula madreporarum</u> (Sowerby)	-	x	-	-
Mitridae				
<u>Imbricaria olivaeformis</u> (Swainson)	-	x	-	-
<u>I. conulari</u> Lamarck	x	-	-	-
<u>I. punctata</u> (Swainson)	-	-	-	x
<u>Mitra acuminata</u> Swainson	x	-	-	-
<u>M. cucumerina</u> Lamarck	-	x	x	-
<u>M. mitra</u> Linnaeus	x	x	x	-
<u>Strigatella pauperula</u> (Linnaeus)	-	x	-	-
<u>Strigatella</u> sp. [cf. <u>S. litterata</u> Lamarck]	-	x	-	-
Muricidae				
<u>Chicoreus brunneus</u> (Link)	x	-	-	-
<u>C. penchinati</u> (Crosse)	-	x	-	-
<u>Drupa grossularia</u> (Roding)	-	x	-	x
<u>D. morum</u> (Roding)	x	x	x	x
<u>D. ricinus</u> (Linnaeus)	x	x	x	x
<u>D. rubisidaeus</u> (Roding)	x	x	-	x
<u>Drupella cornus</u> (Roding)	x	x	-	-
<u>Maculotriton digitata</u> Reene	x	-	-	-

Table 3. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>Mancinella tuberosa</u> Roding	-	-	x	-
<u>Morula granulata</u> (Duclos)	-	x	-	x
<u>M. penistrada</u> Blainville	-	x	-	-
<u>M. triangulata</u> Pease	-	x	-	-
<u>M. uva</u> (Roding)	x	x	x	-
<u>Nassa sarta</u> (Bruguiere)	-	x	x	-
<u>Thais armigera</u> (Link)	x	x	x	-
<u>T. tuberosa</u> Roding	x	-	-	-
Nassariidae				
<u>Nassarius graniferus</u> (Kiener)	x	-	x	-
<u>N. margaritiferus</u> (Dunker)	-	x	-	-
Naticidae				
<u>Mamilla opaca</u> (Recluz)	-	x	-	-
<u>Natica gualtieriana</u> Recluz	-	x	-	-
<u>N. marochiensis</u> (Gmelin)	x	-	-	-
<u>Polinices melanostomus</u> (Gmelin)	-	x	-	-
Neritidae				
<u>Nerita albicilla</u> Linnaeus	-	x	-	-
<u>N. plicata</u> Linnaeus	-	x	x	-
<u>N. polita</u> Linnaeus	-	x	-	-
<u>Neritina bensoni</u> (Recluz)	-	x	-	-
Olividae				
<u>Oliva annulata</u> Gmelin	-	-	-	x
<u>O. miniacea</u> Roding	x	-	-	-
Patellidae				
<u>Patella</u> sp.	-	x	x	x
Planaxidae				
<u>Planaxis decollatus</u> Quoy & Gaimard	-	x	-	-
<u>P. sulcatus</u> (Born)	-	x	-	-
Pyramidellidae				
<u>Otopleura auriscati</u> (Holten)	x	-	-	-
Siphonariidae				
<u>Siphonaria guamensis</u> Quoy & Gaimard	-	x	-	-
Strombidae				
<u>Lambis lambis</u> (Linnaeus)	-	x	-	x
<u>L. truncata</u> (Humphrey)	-	x	-	-
<u>Strombus gibberulus</u> (Roding)	x	-	x	-
<u>S. luhuanus</u> Linnaeus	x	x	-	-
<u>S. mutabilis</u> Swainson	-	x	-	-
<u>S. urceus</u> Wood	-	x	-	-

Table 3. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
Terebridae				
<u>Terebra affinis</u> Gray	x	-	-	-
<u>T. areolata</u> Link	x	-	-	-
<u>T. babylonia</u> Lamarck	x	-	-	-
<u>T. dimidiata</u> Linnaeus	x	-	-	-
<u>T. guttata</u> Roding	x	-	-	-
<u>T. maculata</u> Linnaeus	x	-	-	-
<u>T. subulata</u> Linnaeus	x	-	-	-
Tonnididae				
<u>Tonna perdix</u> (Linnaeus)	x	-	-	-
Trochidae				
<u>Tectus pyramis</u> (Born)	-	x	-	x
<u>Trochus maculatus</u> Linnaeus	-	-	x	-
<u>T. niloticus</u> Linnaeus	x	x	x	x
<u>T. ochroleucus</u>	x	-	-	-
Turbinidae				
<u>Astraea rhodostoma</u> (Lamarck)	-	-	-	x
<u>Australium petrosum</u> (Martyn)	x	x	-	-
<u>Turbo argyrostomus</u> Linnaeus	-	-	x	-
Vasidae				
<u>Vasum ceramicum</u> (Linnaeus)	-	x	-	x
<u>V. turbinellus</u> (Linnaeus)	x	x	x	x

Table 4. Bivalves. A list of species known to occur in the Agat Unit and along the Seashore Study Area.

	Cocos Lagoon	Agat	Bangi	Taleyfac
Arcidae				
<u>Arca ventricosa</u> Lamarck	-	-	x	x
Carditidae				
<u>Cardita variegata</u> Bruguiere	-	x	-	-
<u>Fragum fragum</u> (Linnaeus)	=	-	-	x
Chamidae				
<u>Chama</u> sp.	-	x	x	-
Donacidae				
<u>Donax</u> sp.				
Limidae				
<u>Lima</u> sp.	-	x	-	-
Lucinidae				
<u>Codahia divergens</u> (Philippi)	x	-	-	-
<u>C. tigerina</u> (Linnaeus)	-	-	x	-
Mytilidae				
<u>Modiolus auriculatus</u> Krauss	x	x	-	-
<u>Septifer bilocularis</u> (Linnaeus)	x	x	-	-
Pectinidae				
<u>Chlamys</u> sp.	x	x	-	-
<u>Pecten</u> sp.	-	x	-	-
Pinnidae				
<u>Pinna muricata</u> Linnaeus	-	x	-	x
Pteriidae				
<u>Pinctata margaritifera</u> Linnaeus	x	x	-	x
Tellinidae				
<u>Arcopagia scobinata</u> (Linnaeus)	-	x	-	-
<u>Quidnipagus palatam</u> Iredale	x	x	x	x
<u>Scutarcopagia scobinata</u> (Linnaeus)	-	-	x	-
<u>Tellina rostellata</u> Hanley	-	-	x	-
Tridacnidae				
<u>Tridacna maxima</u> (Roding)	-	x	x	x
Veneridae				
<u>Gafrarium pectinatum</u> Linnaeus	x	x	x	x
<u>Periglypta reticulata</u> (Linnaeus)	x	x	x	-

Table 5. Crustaceans. List of species known to occur in the Agat Unit and along the Seashore Study Area. [Note that there are no printed records of crustaceans from Cocos Lagoon.]

	Agat	Bangi	Taleyfac
Cirripedia			
Lepadidae			
<u>Lepas</u> sp.	x	-	-
Stomatopoda			
Gonodactylidae			
<u>Gonodactylus</u> (?) <u>platysoma</u> Wood-Mason	x	-	-
<u>Ondontodactylus</u> <u>cultrifer</u> (White)	x	-	-
Decapoda			
Alpheidae			
<u>Alpheus</u> sp.	x	-	-
Hippolytidae			
<u>Saron neglectus</u> de Man	x	-	-
<u>S. marmoratus</u> (Olivier)	x	-	-
Stenopodidae			
<u>Stenopus hispidus</u> (Olivier)	x	x	-
Palinuridae			
<u>Panulirus versicolor</u> (Latreille)	x	-	-
Galatheidae			
<u>Munida</u> sp.	x	-	-
Porcellanidae			
<u>Petrolisthes lamarcki</u> (Leach)	x	-	-
Callianassidae			
<u>Callianassa</u> sp.			
Diogenidae			
<u>Calcinus gaimardi</u> (H. Milne Edwards)	x	-	-
<u>C. laevimanus</u> (Randall)	x	-	-
<u>C. latens</u> (Randall)	x	-	-
<u>C. minutus</u> Buitendijk	x	-	-
<u>Clibanarius striolatus</u> Dana	x	-	-
<u>Dardanus deformis</u> (H. Milne Edwards)	x	-	-
<u>D. guttatus</u> (Olivier)	x	-	-
<u>D. lagopodes</u> (Forsk.)	x	-	-
<u>D. megistos</u> (Herbst)	x	-	-
<u>D. scutellatus</u> (Dana)	x	-	-
<u>Trizopagurus strigatus</u> (Herbst)	x	-	-

Table 5. (continued)

	Agat	Bangi	Taleyfac
Coenobitidae			
<u>Coenobita cavipes</u>	x	-	-
<u>C. brevipanus</u>	x	-	-
Hapalocarcinidae			
<u>Hapalocarcinus marsupialis</u> Stimpson	x	x	-
Calappidae			
<u>Calappa gallus</u> (Herbst)	x	-	-
<u>C. hepatica</u> (Linnaeus)	x	-	x
Portunidae			
<u>Portunus granulatus</u> (Milne Edwards)	x	-	-
<u>Thalamitoides quadridens</u> Milne Edwards	x	-	-
Xanthidae			
<u>Domecia hispida</u> Eydoux and Souleyet	x	-	-
<u>Eriphia sebana</u> Rathbun	x	-	x
<u>Tetralia glaberrima</u> (Herbst)	x	-	-
<u>Trapezia cymodoce</u> (Herbst)	x	-	-
<u>T. intermedia</u> Miers	x	-	-
Grapsidae			
<u>Grapsus tenuicrustatus</u> (Herbst)	x	x	-
<u>Metapograpsus messor</u> (Forsk.)	x	-	-
<u>Percnon guinotae</u> Crosnier	x	x	x
<u>Plagusia immaculata</u> Lamarck	x	-	-
Ocypodidae			
<u>Ocypode ceratophthalmus</u> (Pallas)	x	-	-
<u>O. laevis</u> Dana	x	-	-
Majidae			
<u>Menaethuis monoceros</u> Latreille	x	-	-
Parthenopidae			
<u>Daldorfia horrida</u> (Linnaeus)	x	-	-

Table 6. Echinoderms. A list of species known to occur in the Agat Unit and along the Seashore Study Area.

	Cocos Lagoon	Agat	Bangi	Taleyfac
Asteroidea				
<u>Acanthaster planci</u> (Linnaeus)	x	x	-	x
<u>Asterina anomola</u> Clark	x	x	-	-
<u>Asterina</u> sp.	-	x	-	-
<u>Astropectin polyacanthus</u> Müller & Troschel	x	-	-	-
<u>Cistina columbiae</u> Gray	-	x	-	-
<u>Choriaster granulatus</u> Lutken	x	-	-	-
<u>Culcita novaguineae</u> Müller and Troschel	x	x	x	x
<u>Dactylosaster cylindricus</u> (Lamarck)	-	x	-	-
<u>Echinaster luzonicus</u> (Gray)	x	-	-	-
<u>Fromia hemiopl</u> a Fisher	x	x	-	-
<u>Gomophia egyptiaca</u> Gray	x	x	-	-
<u>Leiaster leachi</u> (Gray)	-	x	-	-
<u>Linckia guildingi</u> Gray	x	x	-	-
<u>L. laevigata</u> (Linnaeus)	x	x	x	x
<u>L. multifora</u> (Lamarck)	x	x	x	x
<u>Mithrodia clavigera</u> (Lamarck)	x	x	-	-
<u>Ophidiaster granifer</u> Lutken	x	x	-	-
<u>O. robillardi</u> deLoriot	x	-	-	-
<u>O. squameus</u> Fisher	-	x	-	-
Echinoidea				
<u>Diadema savignyi</u> Michelin	x	x	-	x
<u>D. setosum</u> (Leske)	x	x	-	-
<u>Echinometra mathaei</u> (de Blainville)	x	x	x	x
<u>Echinostrephus aciculatus</u> A. Aggasiz	x	x	x	x
<u>Echinothrix calamaris</u> (Pallas)	x	x	x	x
<u>E. diadema</u> (Linnaeus)	x	x	x	x
<u>Eucidaris metularia</u> (Lamarck)	-	x	x	x
<u>Heterocentrotus mammillatus</u> (Linnaeus)	x	x	x	x
<u>Toxopneustes pileolus</u> (Lamarck)	x	-	x	-
<u>Tripneustes gratilla</u> (Linnaeus)	x	x	x	x
Holothuroidea				
<u>Actinopyga echinites</u> (Jaeger)	x	x	x	x
<u>A. mauritiana</u> (Quoy and Gaimard)	x	x	x	x
<u>Afrocucumis africana</u> (Semper)	-	x	-	-
<u>Bohadschia argus</u> (Jaeger)	x	x	x	-
<u>B. bivittata</u> (Mitsukuri)	x	x	-	-
<u>Euapta godeffroyi</u> (Semper)	-	x	-	-
<u>Holothuria atra</u> Jaeger	x	x	x	x
<u>H. difficilis</u> Semper	-	x	x	-
<u>H. edulis</u> Lesson	x	x	-	x
<u>H. hilla</u> Lesson	x	x	x	-
<u>H. inhabilis</u> Selenka	x	-	-	-
<u>H. impatiens</u> (Forsk.)	-	x	-	-
<u>H. leucospilota</u> Brandt	x	x	x	x
<u>H. nobilis</u> (Selenka)	x	x	-	-

Table 6. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>Holothuria pervicax</u> Selenka	-	x	-	-
<u>Stichopus chloronotus</u> Brandt	x	x	x	x
<u>S. horrens</u> Selenka	x	x	x	x
<u>S. variegatus</u> Semper	x	-	-	-
<u>Synapta maculata</u> (Chamisso & Eysenhardt)	x	x	x	x
<u>Thelanota ananas</u> (Jaeper)	x	x	-	x
Ophiuroidea				
<u>Macrophiothrix longipeda</u> (Lamarck)	x	x	-	-
<u>Ophiarthrum elegans</u> Peters	-	x	x	-
<u>O. erinaceus</u> Müller and Troschel	x	x	-	-
<u>O. pica</u> Müller and Troschel	-	x	x	-

Table 7. Fishes. A list of species known to occur in the Agat Unit and along the Seashore Study Area. [Note that fish from only the reef flat are recorded here.]

	Cocos Lagoon	Agat	Bangi	Taleyfac
Acanthuridae				
<u>Acanthurus glaucopareius</u> Cuvier	x	-	x	x
<u>A. lineatus</u> (Linnaeus)	x	-	-	x
<u>A. mata</u> Valenciennes	x	-	-	-
<u>A. nigrofuscus</u> (Forsk.)	x	-	-	-
<u>A. nigrorus</u> Cuvier & Valenciennes	-	x	-	-
<u>A. olivaceous</u> (Bloch & Schneider)	x	x	-	-
<u>A. pyroferus</u> Kittlitz	x	-	-	x
<u>A. thompsoni</u> (Fowler)	x	-	-	-
<u>A. triostegus</u> (Linnaeus)	x	x	x	x
<u>A. xanthopterus</u> (Cuvier & Valenciennes)	x	-	-	x
<u>Ctenochaetus binotatus</u> Randall	x	-	-	-
<u>C. striatus</u> (Quoy & Gaimard)	x	x	-	-
<u>Naso brevirostris</u> (Cuvier & Valenciennes)	x	-	-	-
<u>N. hexacanthus</u> (Bleeker)	x	-	-	-
<u>N. lituratus</u> (Bloch & Schneider)	x	-	x	x
<u>N. unicornis</u> (Forsk.)	x	-	x	x
<u>Zebrasoma flavescens</u> (Bennett)	x	-	-	x
<u>Z. scopas</u> (Cuvier)	x	-	-	x
<u>Z. veliferum</u> (Bloch)	x	-	x	x
Apogonidae				
<u>Apogon exostigma</u> (Jordan & Starks)	x	-	-	-
<u>A. leptacanthus</u> Bleeker	x	-	-	-
<u>A. mydrus</u> (Jordan & Starks)	x	-	-	-
<u>A. nigrofasciatus</u> Schultz	-	x	-	-
<u>A. novemfasciatus</u> Cuvier & Valenciennes	x	x	-	x
<u>A. robustus</u> (Smith & Radcliffe)	x	-	-	-
<u>A. trimaculatus</u> Cuvier & Valenciennes	x	-	-	-
<u>Cheilodipterus macrodon</u> (Lacepede)	x	-	x	-
<u>C. quinquelineata</u> (Cuvier & Valenciennes)	x	-	x	x
Atherinidae				
<u>Pranesus insularum</u> (Jordan & Evermann)	x	-	-	-
Aulostomidae				
<u>Aulostomus chinensis</u> (Linnaeus)	x	-	-	-
Balistidae				
<u>Balistapus undulatus</u> (Mungo Park)	x	-	x	x
<u>Balistoides niger</u> (Bloch)	x	-	-	-
<u>Melichthys niger</u> (Bloch)	x	-	-	-
<u>M. vidua</u> (Solander)	x	-	x	-
<u>Pseudobalistes flavomarginatus</u> (Ruppell)	x	-	x	x
<u>Rhinecanthus aculeatus</u> (Linnaeus)	x	-	x	x

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>Rhinecanthus rectangulus</u> (Bloch & Schneider)	x	-	x	x
<u>Sufflamen bursa</u> (Bloch & Schneider)	x	-	x	x
<u>S. chrysoptera</u> (Bloch & Schneider)	x	-	-	x
Blenniidae				
<u>Aspidontus taeniatus</u> Quoy & Gaimard	x	-	x	x
<u>Cirripectes sebae</u> Fowler	x	-	x	x
<u>C. variolosus</u> (Cuvier & Valenciennes)	x	-	x	x
<u>Ecsenius bicolor</u> (Day)	x	-	-	-
<u>E. opsifrontalis</u> Chapman & Schultz	x	-	-	-
<u>Exallias brevis</u> (Kner)	x	-	x	-
<u>Istiblennius coronatus</u> (Gunther)	x	x	-	-
<u>I. periophthalmus</u> (Valenciennes)	-	-	x	-
<u>Meiacanthus atrodorsalis</u> (Gunther)	x	-	x	x
<u>Petroscirtes mitratus</u> (Ruppell)	x	-	-	-
<u>Plagiotremus tapeinosoma</u> (Bleeker)	x	-	x	x
<u>Salarias fasciatus</u> (Bloch)	x	-	-	-
Bothidae				
<u>Bothus mancus</u> (Broussonet)	x	-	-	-
Canthigasteridae				
<u>Canthigaster amboinensis</u> (Bleeker)	x	-	-	-
<u>C. coronatus</u> (Randall)	x	-	-	-
<u>C. janthinopterus</u> (Bleeker)	x	-	-	-
<u>C. solandri</u> (Richardson)	x	x	-	-
Caracanthidae				
<u>Caracanthus maculatus</u> (Gray)	x	-	-	-
Carangidae				
<u>Carangoides malabaricus</u> (Bloch & Schneider)	x	-	x	x
<u>Caranx melampygus</u> Cuvier & Valenciennes	x	-	-	-
<u>Gnathanodon speciosus</u> (Forsk.)	x	-	-	x
Carapidae				
<u>Carapus homei</u> (Richardson)	x	-	-	-
Chaetodontidae				
<u>Centropyge bispinosus</u> (Gunther)	x	-	-	-
<u>C. flavissimus</u> (Cuvier)	x	-	-	-
<u>C. heraldi</u> Woods & Schultz	x	-	-	-
<u>Chaetodon auriga</u> Forskal	x	-	x	x
<u>C. bennetti</u> Cuvier	x	-	-	x
<u>C. citrinellus</u> Cuvier	x	x	x	x
<u>C. ephippium</u> Cuvier	x	-	x	x
<u>C. falcula</u> Bloch	x	-	-	-
<u>C. kleini</u> Bloch	x	-	-	-

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>C. lunula</u> (Lacepede)	x	x	-	-
<u>C. melannotus</u> Schneider	x	-	x	x
<u>C. mertensii</u> Cuvier	x	-	-	x
<u>C. ornatissimus</u> Solander	x	-	x	x
<u>C. punctatfasciatus</u> Cuvier & Valenciennes	x	-	-	x
<u>C. quadrimaculatus</u> Gray	x	-	x	-
<u>C. reticulatus</u> Cuvier	x	-	x	x
<u>C. strigangulus</u> (Gmelin)	x	-	-	-
<u>C. trifasciatus</u> Mungo Park	x	-	x	x
<u>C. ulietensis</u> Cuvier & Valenciennes	-	-	-	x
<u>C. unimaculatus</u> Bloch	x	-	x	-
<u>Forcipiger flavissimus</u> Jordan & McGregor	x	-	x	x
<u>Heniochus chrysostomus</u> Cuvier & Valenciennes	-	-	-	x
<u>H. varius</u> (Cuvier)	x	-	-	-
<u>H. monoceros</u> Cuvier	x	-	-	-
<u>Holacanthus trimaculatus</u> Cuvier	x	-	-	-
<u>Pomacanthus imperator</u> (Bloch)	x	-	-	-
<u>Pygoplites diacanthus</u> (Boddaert)	x	-	-	-
Cirrhitidae				
<u>Cirrhitus pinnulatus</u> (Schneider)	x	-	x	x
<u>Neocirrhites armatus</u> Castelnau	x	-	-	-
<u>Paracirrhites arcatus</u> (Cuvier & Valenciennes)	x	-	x	-
<u>P. forsteri</u> (Bloch & Schneider)	x	-	x	-
<u>P. hemistictus</u> (Gunther)	x	-	-	-
Dasyatidae				
<u>Dasyatis kuhlii</u> (Muller & Henle)	x	-	-	-
Diodontidae				
<u>Diodon hystrix</u> (Linnaeus)	x	-	-	-
Engraulidae				
<u>Thrissina baelama</u> (Forsk.)	x	-	-	-
Fistularidae				
<u>Fistularia petimba</u> Lacepede	x	-	x	x
Geridae				
<u>Gerres argyreus</u> (Bloch & Schneider)	-	-	x	x
Gobiidae				
<u>Acentrogobius belissimus</u> Smith	x	-	-	-
<u>A. ornatus</u> (Ruppell)	-	-	x	x
<u>A. triangularis</u> Weber	x	-	-	-
<u>Amblygobius albimaculatus</u> (Ruppell)	x	-	x	-
<u>A. decussatus</u> (Bleeker)	x	-	-	-

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Taleyfac
<u>Asterropteryx semipunctatus</u> Ruppell	x	-	-	-
<u>Bathygobius fuscus</u> (Ruppell)	x	-	-	-
<u>Eleotriodes strigata</u> (Bleeker)	x	-	-	-
<u>Eviota prasites</u> Jordon & Seale	x	-	-	-
<u>Gnatholepis deltoides</u> (Seale)	x	-	-	-
<u>Gobius ornatus</u> Ruppell	x	-	-	-
<u>Nemateleotris magnificus</u> Fowler	x	-	-	-
<u>Obtortioophagus koumansi</u> (Whitely)	x	-	-	-
<u>Oxyurichthys guibei</u> Smith	x	-	-	-
<u>Periophthalmus koelreuteri</u> Eggert	x	-	-	-
<u>Pogonoculius zebra</u> Fowler	x	-	x	-
<u>Ptereleotris microlepis</u> (Bleeker)	-	-	x	x
<u>Rhinogobius decoratus</u> Herre	x	-	-	-
<u>Trimma caesiura</u> Jordon & Seale	x	-	-	-
Hemiramphidae				
<u>Hyporhamphus laticeps</u> (Gunther)	x	-	-	-
Holocentridae				
<u>Adioryx caudimaculatus</u> (Ruppell)	x	-	-	-
<u>A. diadema</u> (Lacepede)	-	-	x	x
<u>A. microstomus</u> (Gunther)	x	-	-	-
<u>A. spinifer</u> (Forsk.)	x	-	-	-
<u>A. tiere</u> (Cuvier & Valenciennes)	x	-	x	-
<u>A. lacteoguttatus</u> (Cuvier)	x	-	-	-
<u>Flammeo sammara</u> (Forsk.)	x	-	-	x
<u>Myripristis adustus</u> Bleeker	-	-	-	x
<u>M. amaenus</u> (Castelnau)	x	-	-	-
<u>M. kuntee</u> (Cuvier & Valenciennes)	x	-	-	x
<u>M. microphthalmus</u> Bleeker	x	-	-	-
<u>M. murdjan</u> (Forsk.)	x	-	-	-
Kuhliidae				
<u>Kuhlia taeniura</u> (Cuvier & Valenciennes)	x	-	-	-
Kyphosidae				
<u>Kyphosus cinerascens</u> (Forsk.)	x	-	x	-
Labridae				
<u>Anampses caeruleopunctatus</u> Ruppell	x	-	x	x
<u>Bodianus axillaris</u> (Bennett)	-	-	-	x
<u>Cheilinus celebicus</u> Bleeker	x	-	-	-
<u>C. chlorourus</u> (Bloch)	x	x	x	x
<u>C. fasciatus</u> (Bloch)	x	-	-	-
<u>C. rhodochrus</u> Gunther	x	-	x	x
<u>C. trilobatus</u> Lacepede	x	x	x	-
<u>C. undulatus</u> Ruppell	x	-	-	-
<u>Cheilio inermis</u> (Forsk.)	x	-	x	-

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
<u>Cirrhilabrus temmincki</u> Bleekerx	-	-	-	-
<u>Coris aygula</u> Lacepede	x	-	-	-
<u>C. gaimardi</u> (Quoy & Gaimard)	x	-	-	x
<u>Epibulus insidiator</u> (Pallas)	x	-	-	-
<u>Gomphosus varius</u> Lacepede	x	-	x	x
<u>Halichoeres biocellatus</u> Schultz	x	-	x	x
<u>H. centiquadrus</u> (Lacepede)	-	-	x	x
<u>H. hoeveni</u> (Bleeker)	x	-	-	-
<u>H. hortulanus</u> (Lacepede)	x	-	-	-
<u>H. margaritaceus</u> (Cuvier & Valenciennes)	x	x	x	x
<u>H. marginatus</u> Ruppell	x	-	x	x
<u>H. trimaculatus</u> (Quoy & Gaimard)	x	x	x	x
<u>Hemigymnus fasciatus</u> (Bloch)	x	-	-	x
<u>H. melapterus</u> (Bloch)	x	-	x	x
<u>Hemipteronotus</u> sp.	x	-	-	-
<u>Labrichthys unilineata</u> Bleeker	x	-	-	-
<u>Labroides bicolor</u> Fowler & Bean	x	-	-	x
<u>L. dimidiatus</u> (Cuvier & Valenciennes)	x	-	-	-
<u>Macropharyngodon meleagris</u> Seale	x	-	-	x
<u>M. pardalis</u> (Kner)	x	-	-	-
<u>Pseudocheilinus hexataenia</u> (Bleeker)	x	-	-	-
<u>Pteragogus guttatus</u> (Fowler & Bean)	x	-	-	-
<u>Stethojulis bandanensis</u> Bleeker	x	-	x	x
<u>S. strigiventer</u> (Bennett)	x	-	x	x
<u>Thalassoma amblycephalus</u> (Bleeker)	x	-	x	x
<u>T. fuscum</u> (Lacepede)	-	-	x	x
<u>T. hardwickei</u> (Bennett)	x	-	x	x
<u>T. lutescens</u> (Lay & Bennett)	x	-	-	x
<u>T. purpureum</u> (Forsk.)	x	-	-	-
<u>T. quinquevittata</u> (Lay & Bennett)	x	x	x	x
<u>Xyrichtys taeniourus</u> (Lacepede)	x	x	-	-
Lutjanidae				
<u>Aphareus furcatus</u> (Lacepede)	x	-	x	x
<u>Aprion virescens</u> Valenciennes	x	-	-	-
<u>Caesio caeruleus</u> Lacepede	x	-	-	-
<u>Gnathodentex aureolineatus</u> (Lacepede)	x	-	-	x
<u>Lethrinus harak</u> (Forsk.)	-	-	x	x
<u>L. rhodopterus</u> Bleeker	x	-	-	-
<u>Lutjanus argentimaculatus</u> (Forsk.)	x	-	-	-
<u>L. (vaigiensis) fulvus</u> (Bloch & Schnieder)	x	-	x	x
<u>L. janthinuropterus</u> (Bleeker)	-	x	-	-
<u>L. kasmira</u> (Forsk.)	x	-	-	x
<u>L. monostigmus</u> (Cuvier & Valenciennes)	x	x	-	-
<u>Macolor niger</u> (Forsk.)	x	-	-	x
Malacanthidae				
<u>Malacanthus latovittatus</u> (Lacepede)	x	-	-	-

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
Monacanthidae				
<u>Alutera scripta</u> (Gmelin)	x	-	-	-
<u>Amanses carolae</u> Jordan & McGregor	x	-	-	-
<u>A. sandwichensis</u> (Quoy & Gaimard)	x	-	-	-
<u>A. scopas</u> (Cuvier)	-	-	x	-
<u>Oxymonacanthus longirostris</u> (Bloch & Schneider)	x	-	-	x
<u>Paraluteres prionurus</u> Bleeker	x	-	-	-
<u>Pervagor melanocephalus</u> (Bleeker)	x	-	-	x
Monodactylidae				
<u>Monodactylus argenteus</u> (Linnaeus)	x	-	-	x
Mugilidae				
<u>Chelon vaigiensis</u> (Quoy & Gaimard)	x	-	-	-
<u>Crenimugil crenilabis</u> (Forsk.)	x	-	-	-
<u>Liza vaigiensis</u> (Quoy & Gaimard)	-	-	x	x
<u>Mugil cephalus</u> Linnaeus	x	-	-	-
Mugiloididae				
<u>Parapercis cephalopunctatus</u> (Seale)	x	-	-	x
<u>P. clathrata</u> Ogilby	x	-	-	-
Mullidae				
<u>Mulloidichthys auriflamma</u> (Forsk.)	x	-	-	-
<u>M. samoensis</u> (Gunther)	x	-	-	-
<u>Parupeneus barberinus</u> (Lacepede)	x	-	x	x
<u>P. bifasciatus</u> (Lacepede)	x	x	-	x
<u>p. cyclostomus</u> (Lacepede)	x	-	x	x
<u>P. multifasciatus</u> (Quoy & Gaimard)	x	-	-	-
<u>P. pleurostigma</u> (Bennett)	x	-	-	-
<u>P. porphyreus</u> (Jenkins)	x	-	-	-
<u>P. spilurus</u> (Bleeker)	-	-	x	x
<u>P. trifasciatus</u> (Lacepede)	-	x	x	x
<u>Upeneus vittatus</u> (Forsk.)	x	-	-	-
Muraenidae				
<u>Echidna nebulosa</u> (Ahl)	x	-	-	-
<u>E. zebra</u> (Shaw)	x	-	-	-
<u>Gymnothorax gracilicaudus</u> Jenkins	x	-	-	-
<u>G. javanicus</u> (Bleeker)	x	-	-	-
<u>G. meleagris</u> (Shaw & Nodder)	-	-	x	-
<u>G. pictus</u> (Ahl)	x	-	-	-
<u>G. undulatus</u> (Lacepede)	x	-	-	-
<u>Uropterygius concolor</u> Ruppell	x	-	-	-
Myliobatidae				
<u>Aetobatus narinari</u> (Euprasen)	x	-	-	-

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
Ophichthidae				
<u>Leiuranus semicinctus</u> (Lay & Bennett)	x	-	-	-
Ostraciontidae				
<u>Lactoria cornutus</u> Linnaeus	x	-	-	-
<u>Ostracion cubicus</u> Linnaeus	x	-	-	-
<u>O. meleagris</u> (Shaw)	x	-	x	x
Pempheridae				
<u>Pempheris oualensis</u> Cuvier & Valenciennes	x	-	-	x
Pomacentridae				
<u>Abudefduf amabilis</u> (deVis)	x	x	-	-
<u>A. curacao</u> (Bloch)	x	-	-	-
<u>A. dicki</u> (Lienard)	x	-	-	-
<u>A. glaucus</u> (Cuvier & Valenciennes)	x	-	-	-
<u>A. imparipinnis</u> (Sauvage)	x	x	-	-
<u>A. johnstonianus</u> (Fowler & Ball)	x	-	-	-
<u>A. lacrymatus</u> (Quoy & Gaimard)	x	-	-	-
<u>A. leucopomus</u> (Lesson)	x	x	-	-
<u>A. leucozona</u> (Bleeker)	x	x	-	-
<u>A. saxatilis</u> (Linnaeus)	x	-	-	-
<u>A. septemfasciatus</u> (Cuvier & Valenciennes)	x	-	-	-
<u>A. sexfasciatus</u> (Lacepede)	x	-	-	-
<u>A. sordidus</u> (Forsk.)	-	x	x	-
<u>Amphiprion bicinctus</u> Ruppell	x	-	-	-
<u>A. chrysopterus</u> Cuvier	x	-	-	x
<u>A. melanopus</u> Bleeker	x	-	-	x
<u>A. perideraion</u> Bleeker	x	-	-	-
<u>Chromis atripectoralis</u> Welander & Schultz	x	-	-	-
<u>C. caeruleus</u> (Cuvier & Valenciennes)	x	-	-	-
<u>C. margaretifer</u> Smith	x	-	-	-
<u>C. leucurus</u> Gilbert	x	-	-	-
<u>C. vanderbilti</u> (Fowler)	x	-	-	-
<u>C. xanthochir</u> (Bleeker)	x	-	-	-
<u>Dascyllus aruanus</u> (Linnaeus)	x	-	x	x
<u>D. reticulatus</u> (Richardson)	x	-	-	x
<u>D. trimaculatus</u> (Ruppell)	x	-	-	-
<u>Pomacentrus albofasciatus</u> Schlegel & Muller	x	x	-	x
<u>P. amboinensis</u> Bleeker	x	-	-	-
<u>P. jenkinsi</u> Jordan & Evermann	x	-	-	-
<u>P. lividus</u> (Bloch & Schneider)	x	-	-	-
<u>P. nigricans</u> (Lacepede)	x	-	-	-
<u>P. pavo</u> (Bloch)	x	-	-	x
<u>P. traceyi</u> Schultz	x	-	-	-
<u>P. vaiuli</u> Jordan & Seale	x	-	x	x

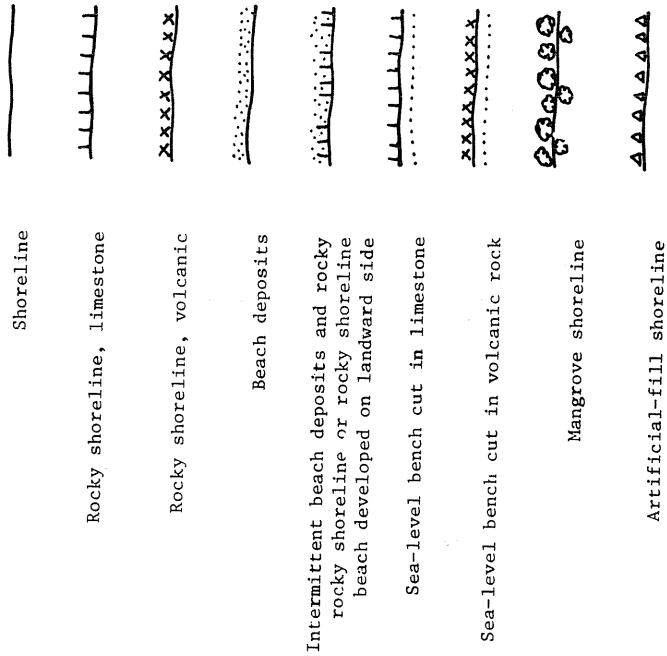
Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
Pseudochromidae				
<u>Plesiops corallicola</u> Bleeker	x	-	-	-
Scaridae				
<u>Calatomus spinidens</u> (Quoy & Gaimard)	x	-	-	-
<u>Chlorurus bicolor</u> (Ruppell)	x	-	-	-
<u>C. gibbus</u> (Ruppell)	x	-	-	-
<u>Cetoscarus bicolor</u> (Ruppell)	-	-	x	x
<u>Leptoscarus vaigiensis</u> (Quoy & Gaimard)	x	-	x	-
<u>Scarus chlorodon</u> Jenyns	-	-	x	x
<u>S. dubius</u> Bennett	x	-	-	-
<u>S. lepidus</u> Jenyns	x	-	-	-
<u>S. sordidus</u> Forskal	x	-	x	x
<u>S. venosus</u> Cuvier & Valenciennes	x	-	-	x
Scolopsidae				
<u>Scolopsis cancellatus</u> Cuvier & Valenciennes	x	-	x	x
Scorpaenidae				
<u>Pterois antennata</u> (Bloch)	x	-	-	-
<u>P. volitans</u> (Linnaeus)	x	-	-	-
<u>Scorpaenopsis diabolus</u> (Cuvier & Valenciennes)	-	-	-	x
<u>S. gibbosa</u> (Bloch & Schneider)	x	-	-	-
<u>Synanceia verrucosa</u> Bloch & Schneider	-	-	-	x
Serranidae				
<u>Aethaloperca rogae</u> (Forskal)	-	-	-	x
<u>Cephalopholis argus</u> Bloch & Schneider	x	-	x	-
<u>C. pachycentron</u> (Cuvier & Valenciennes)	-	-	-	x
<u>C. urodelus</u> (Bloch & Schneider)	x	-	x	x
<u>Epinephelus emoryi</u> Schultz	x	-	-	-
<u>E. merra</u> Bloch	x	-	x	x
<u>Grammistes sexlineatus</u> (Thunberg)	x	-	-	-
Siganidae				
<u>Siganus argenteus</u> (Quoy & Gaimard)	x	-	x	x
<u>S. guttatus</u> (Bloch)	-	-	x	-
<u>S. punctatus</u> (Bloch & Schneider)	x	-	-	-
<u>S. spinus</u> (Linnaeus)	x	x	x	x
Sparidae				
<u>Monotaxis grandoculis</u> (Forskal)	x	-	-	-
Sphyraenidae				
<u>Sphyraena</u> sp.	x	-	x	-
Syngnathidae				
<u>Corythoichthys intestinalis waitei</u> (Jordan & Seale)	x	-	-	x

Table 7. (continued)

	Cocos Lagoon	Agat	Bangi	Tafeyfac
Synodontidae				
<u>Saurida gracilis</u> (Quoy & Gaimard)	x	-	x	x
<u>Synodus variegatus</u> (Lacepede)	x	-	-	-
Tetraodontidae				
<u>Arothron alboreticulatus</u> (Tanaka)	x	-	-	-
<u>A. hispidus</u> (Linnaeus)	-	x	-	-
<u>A. immaculatus</u> (Bloch & Schneider)	x	-	x	-
<u>A. nigropunctatus</u> (Bloch & Schneider)	-	-	x	-
Zanclidae				
<u>Zanclus cornutus</u> (Linnaeus)	x	-	x	x

SHORELINE FEATURES



REEF-FLAT PLATFORM FEATURES

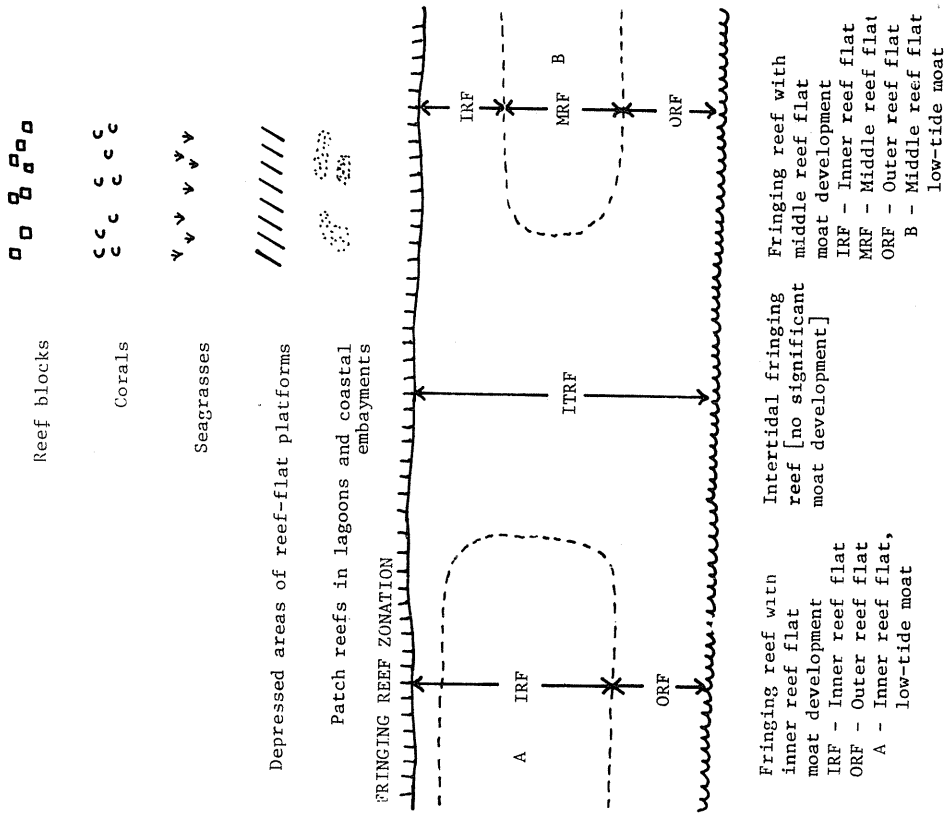
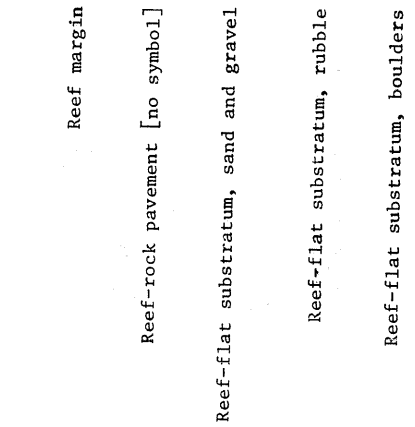
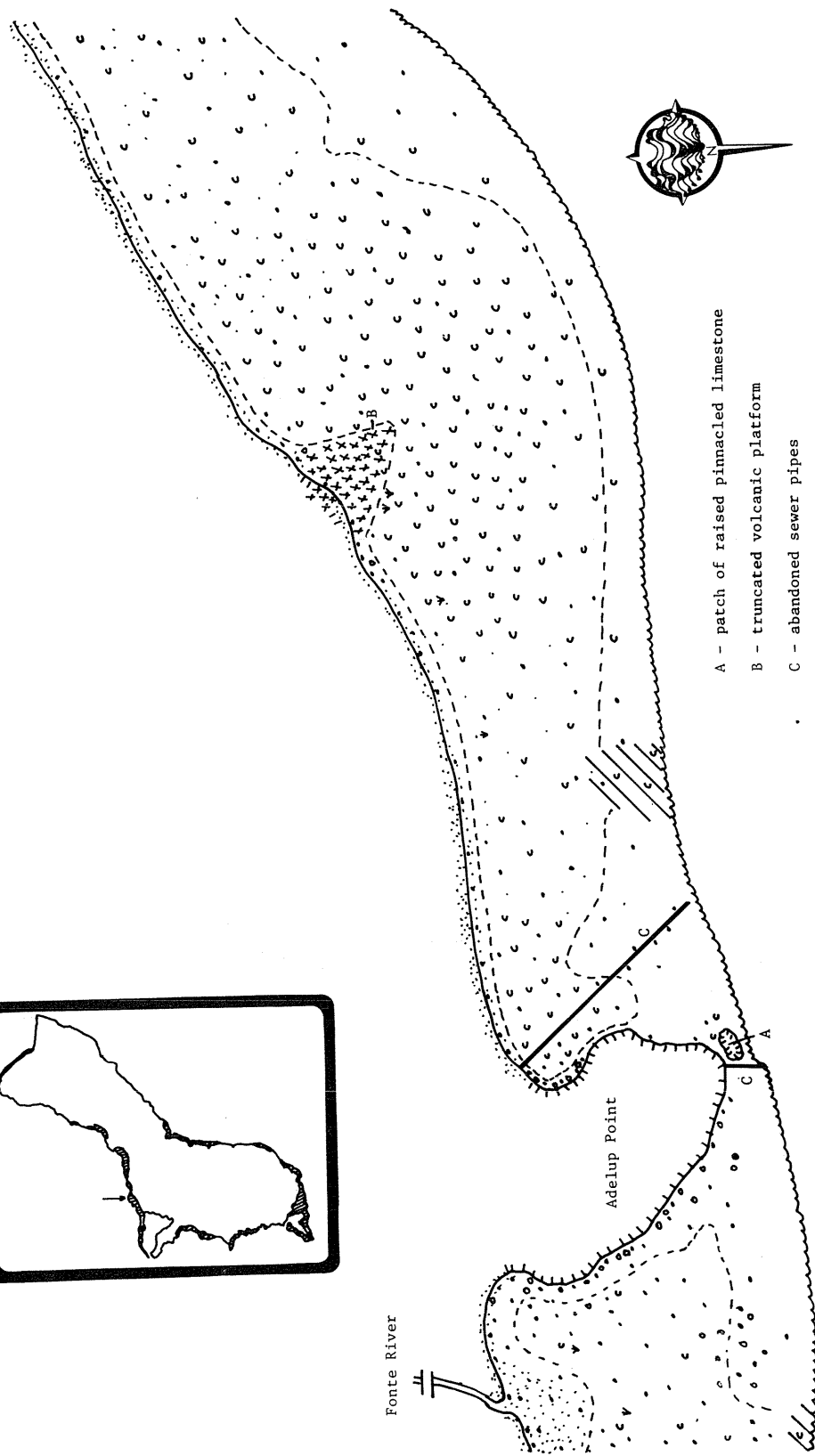


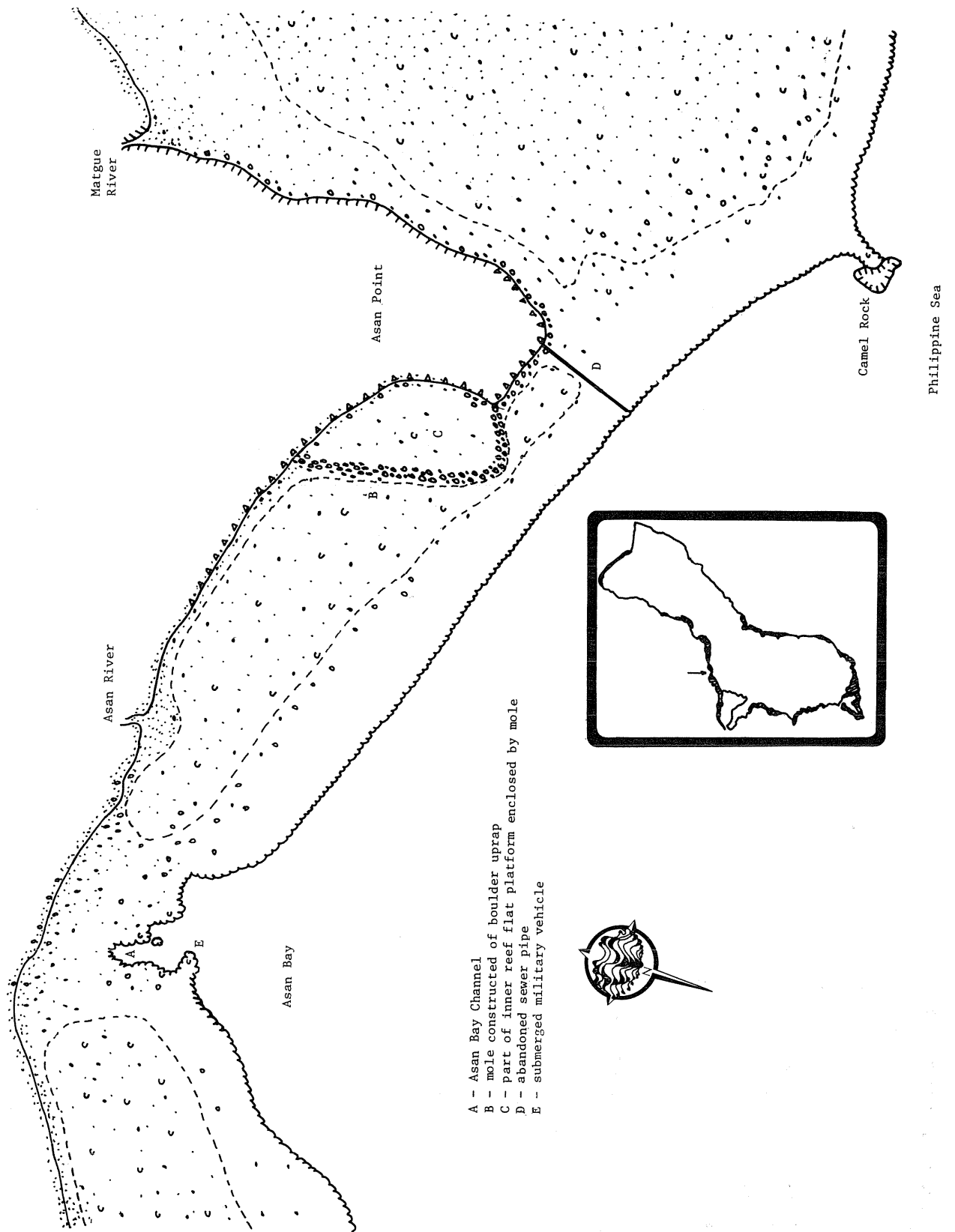
Figure Lengend for Maps with Scale.



- A - patch of raised pinnacled limestone
- B - truncated volcanic platform
- C - abandoned sewer pipes

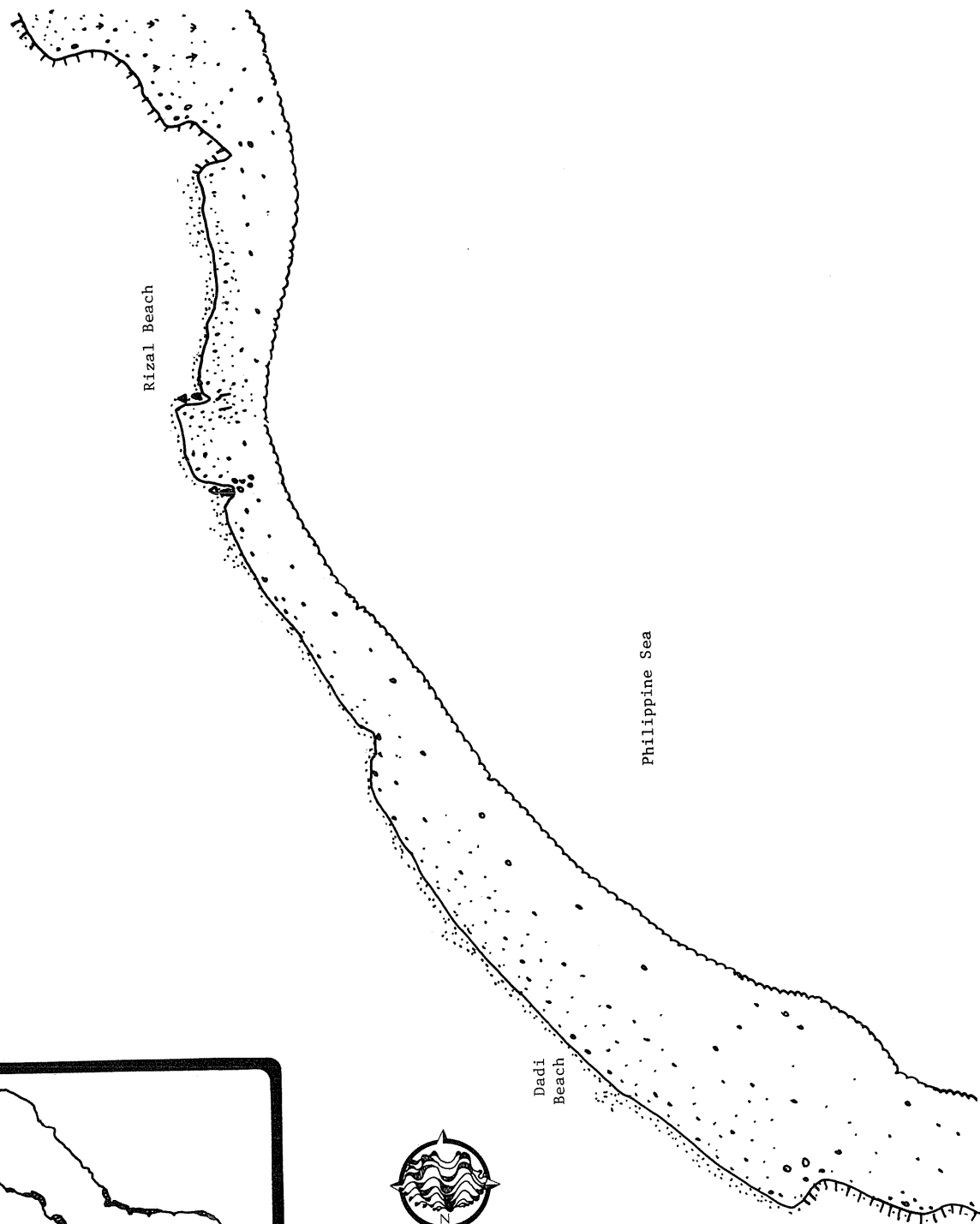
Philippine Sea

MAP NO. 1. Asan Unit--Adelup Point.

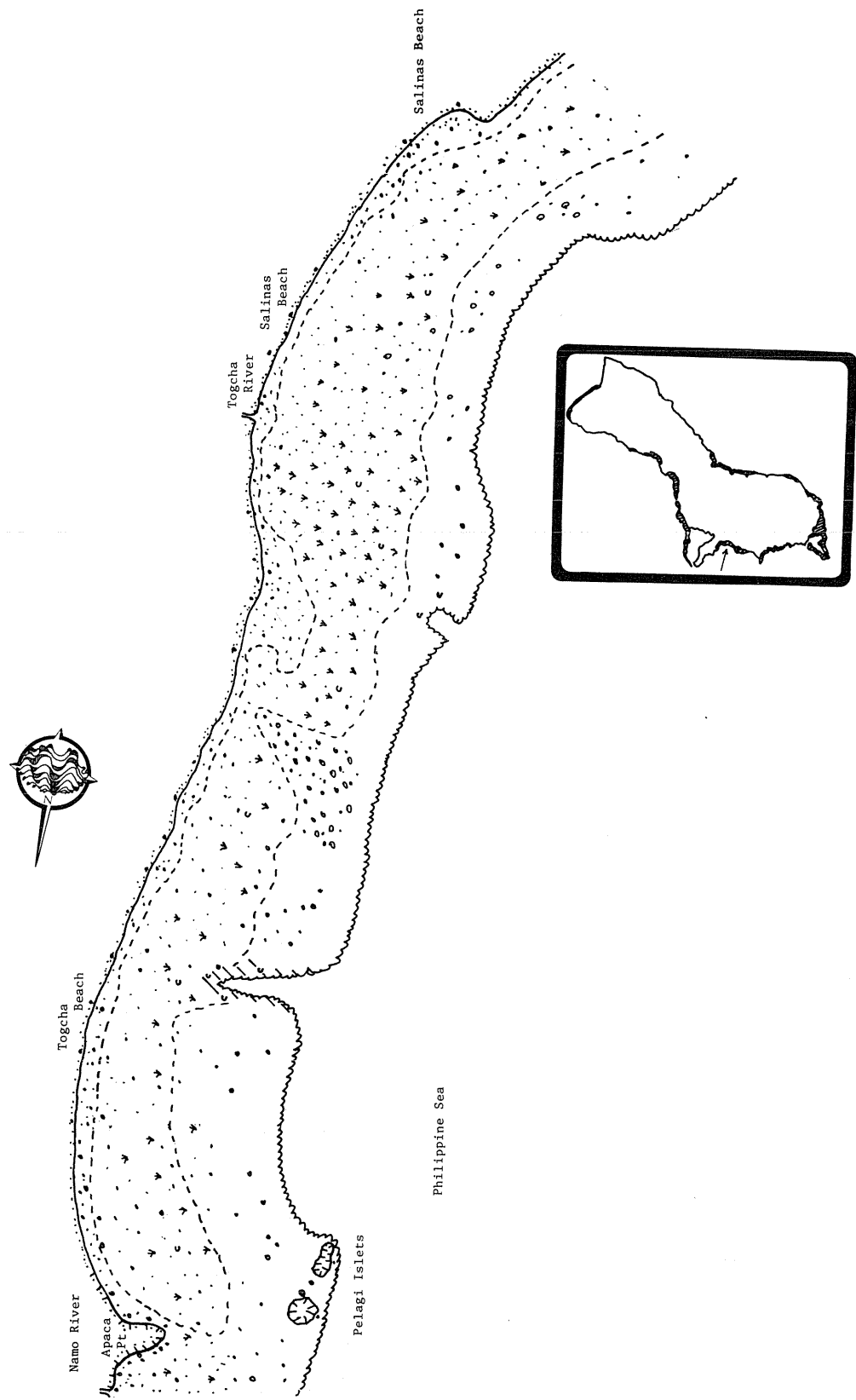


- A - Asan Bay Channel
- B - mole constructed of boulder uprap
- C - part of inner reef flat platform enclosed by mole
- D - abandoned sewer pipe
- E - submerged military vehicle

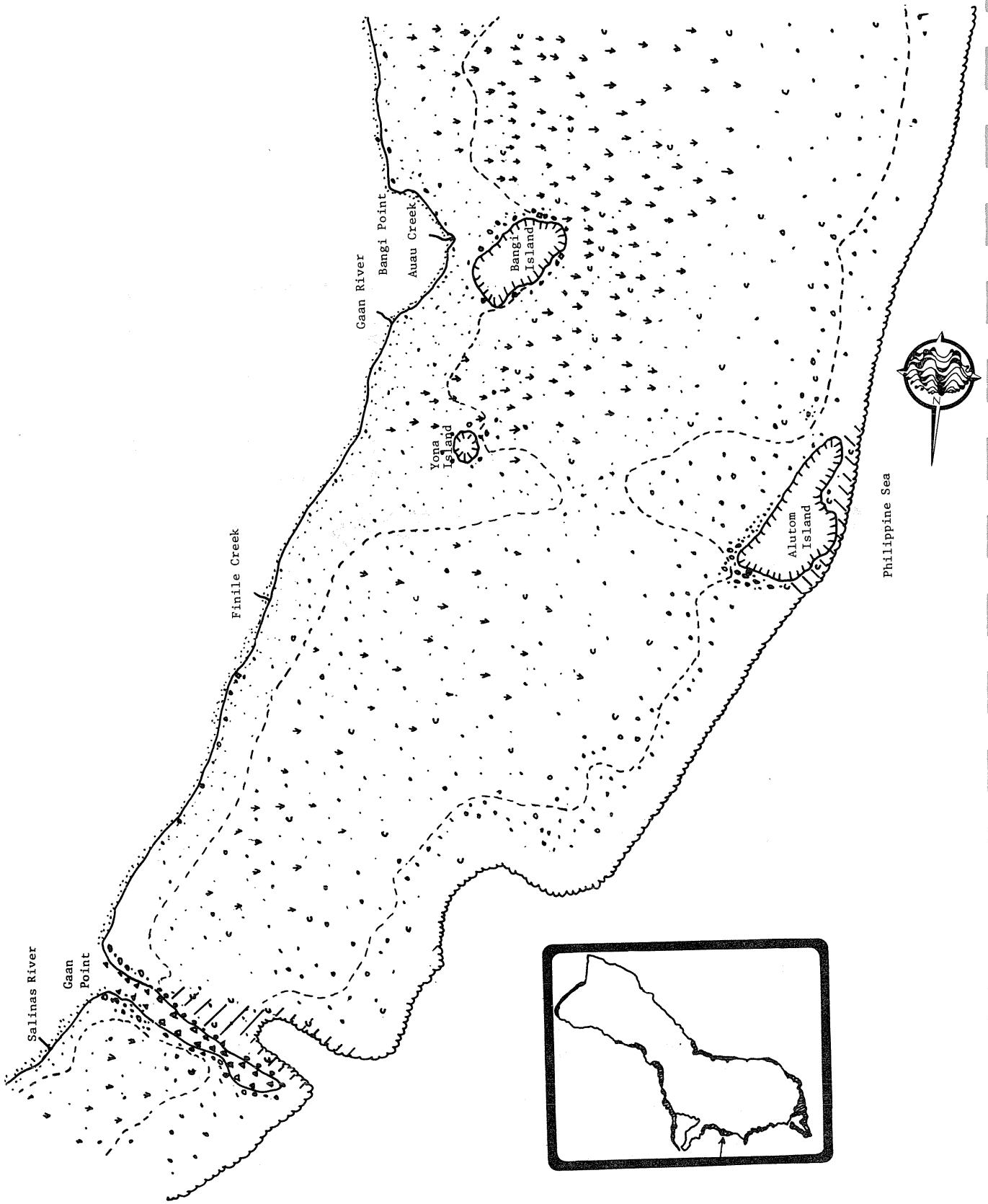
MAP NO. 2. Asan Unit--Asan Bay and Asan Point.



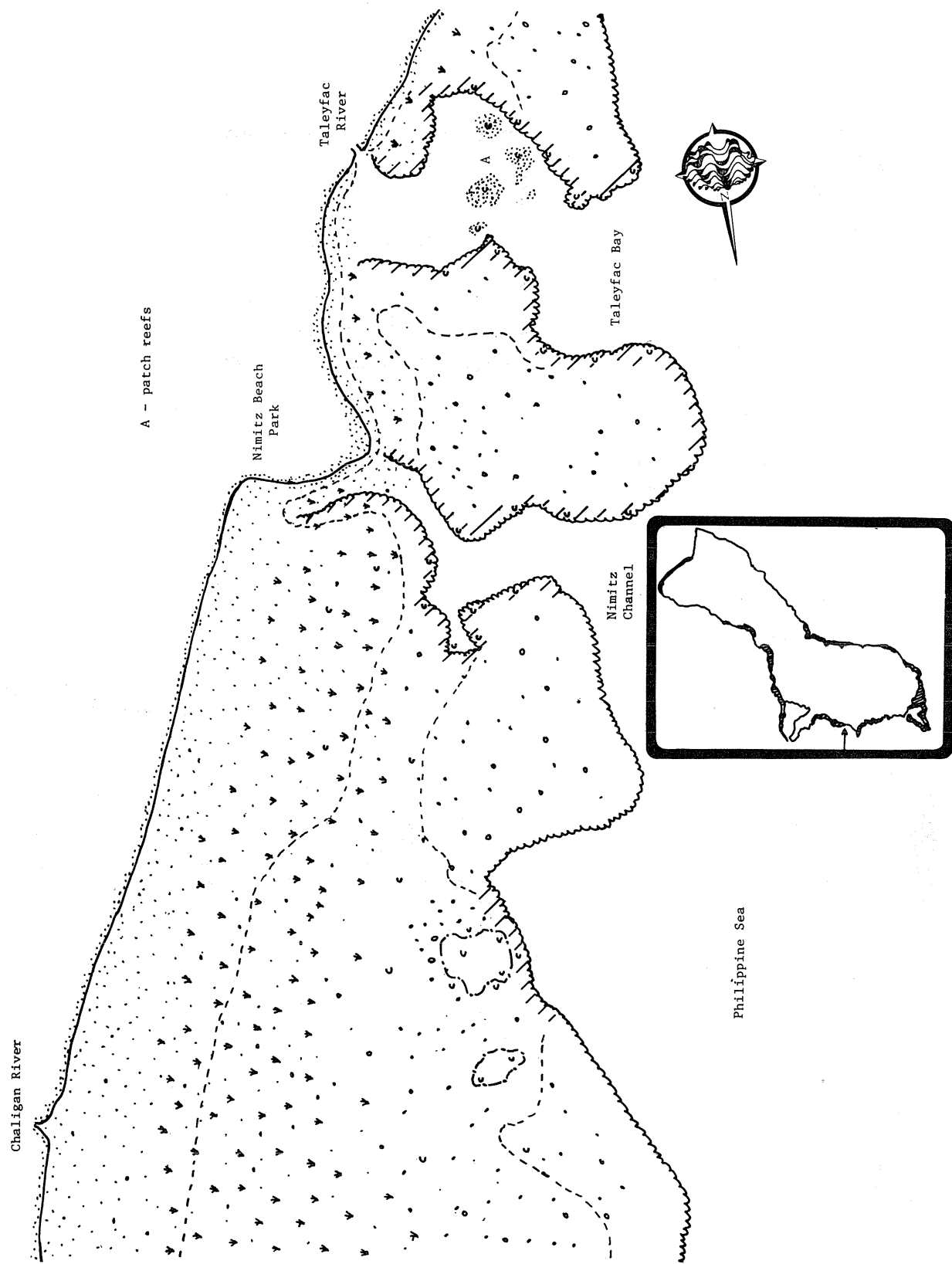
MAP NO. 3. Agat Unit--Rizal Beach.



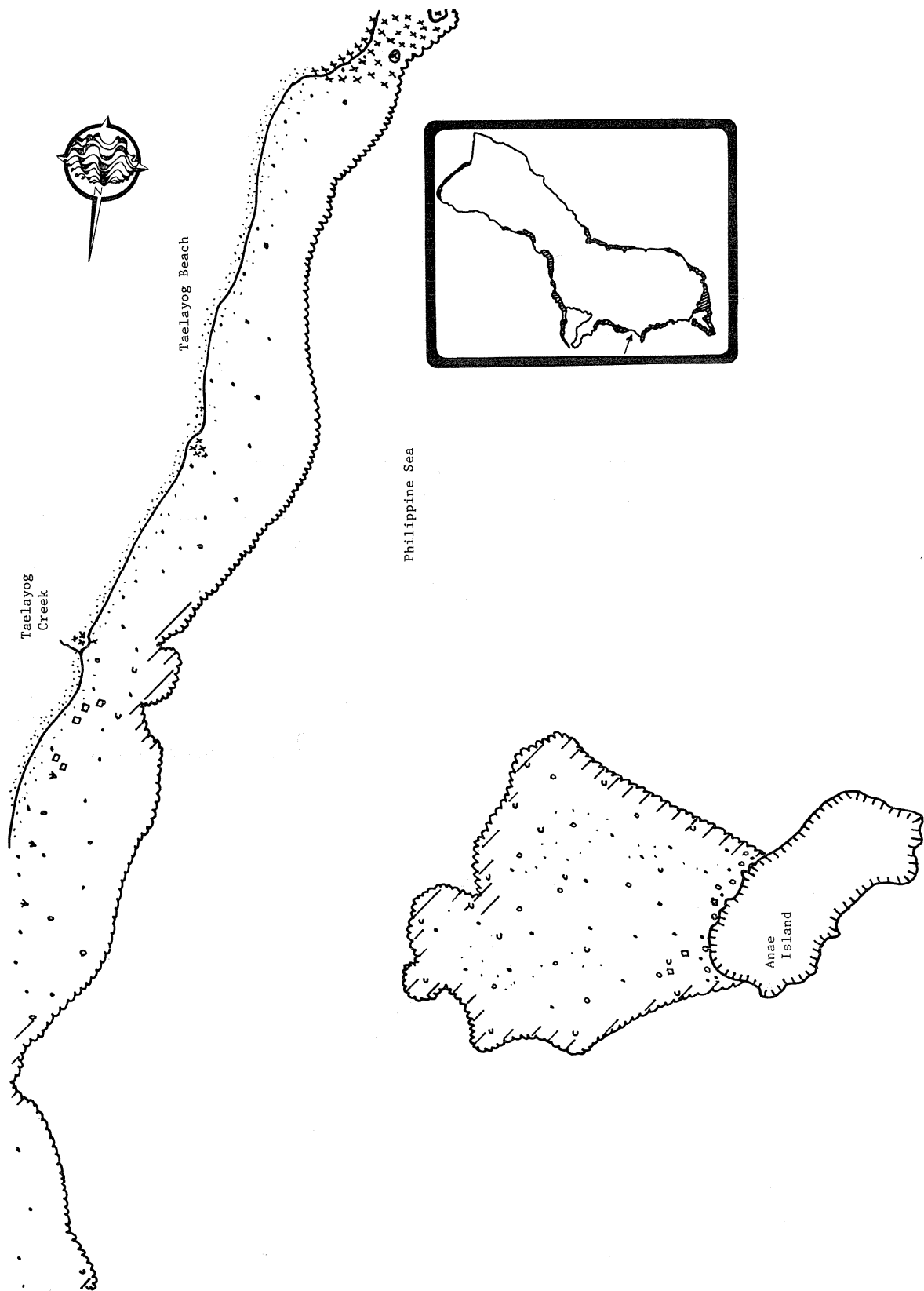
MAP NO. 4. Agat Unit--Togcha Beach and Salinas Beach.



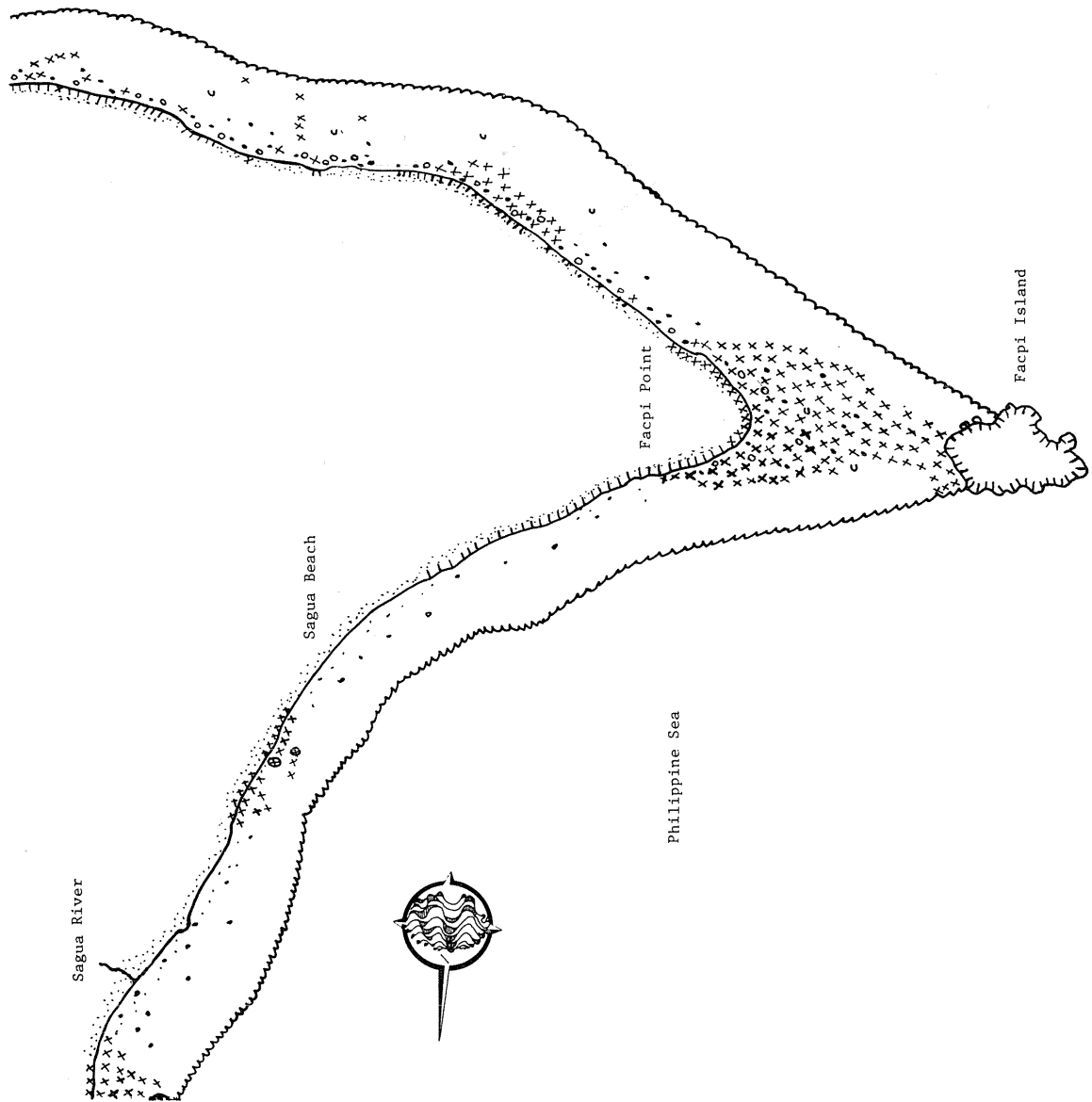
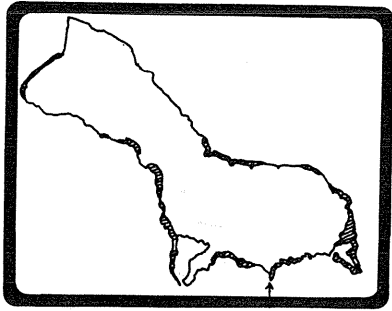
MAP NO. 5. Agat Unit--Gaan Point to Bangi Point.



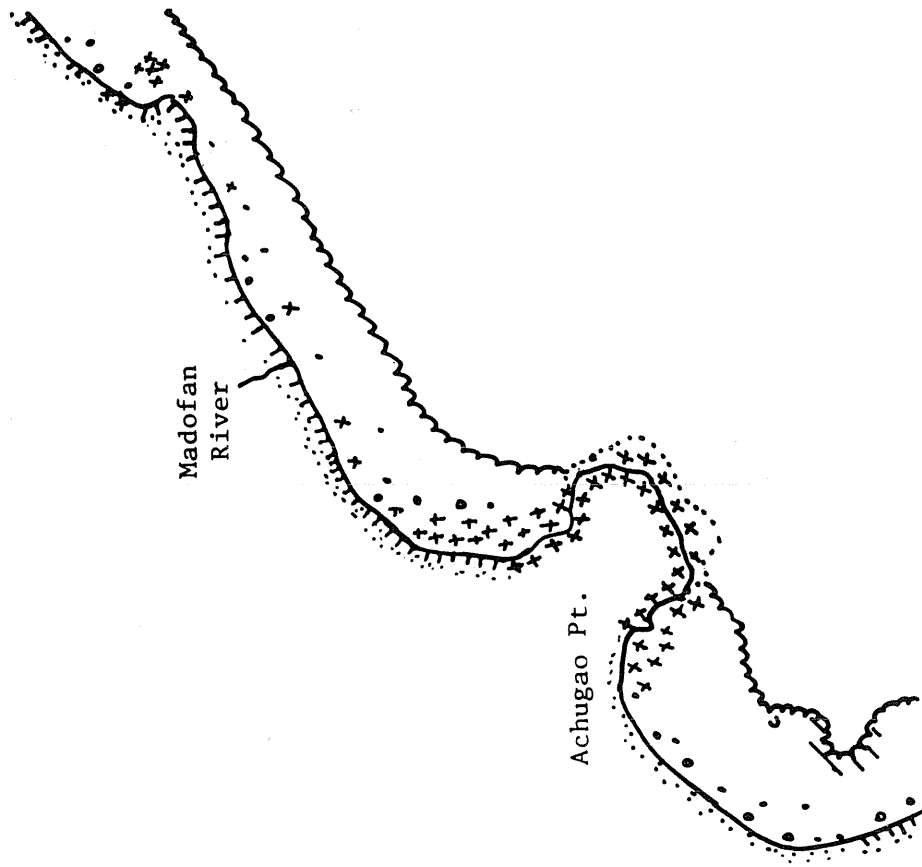
MAP NO. 6. Seashore Study Area--Nimitz Channel and Taleyfac Bay.



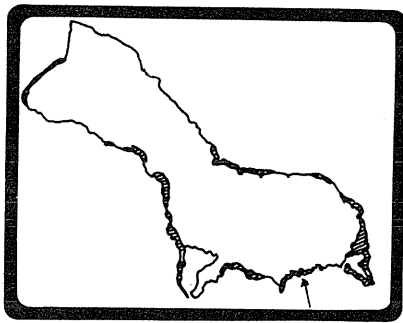
MAP NO. 7. Seashore Study Area--Anae Island.



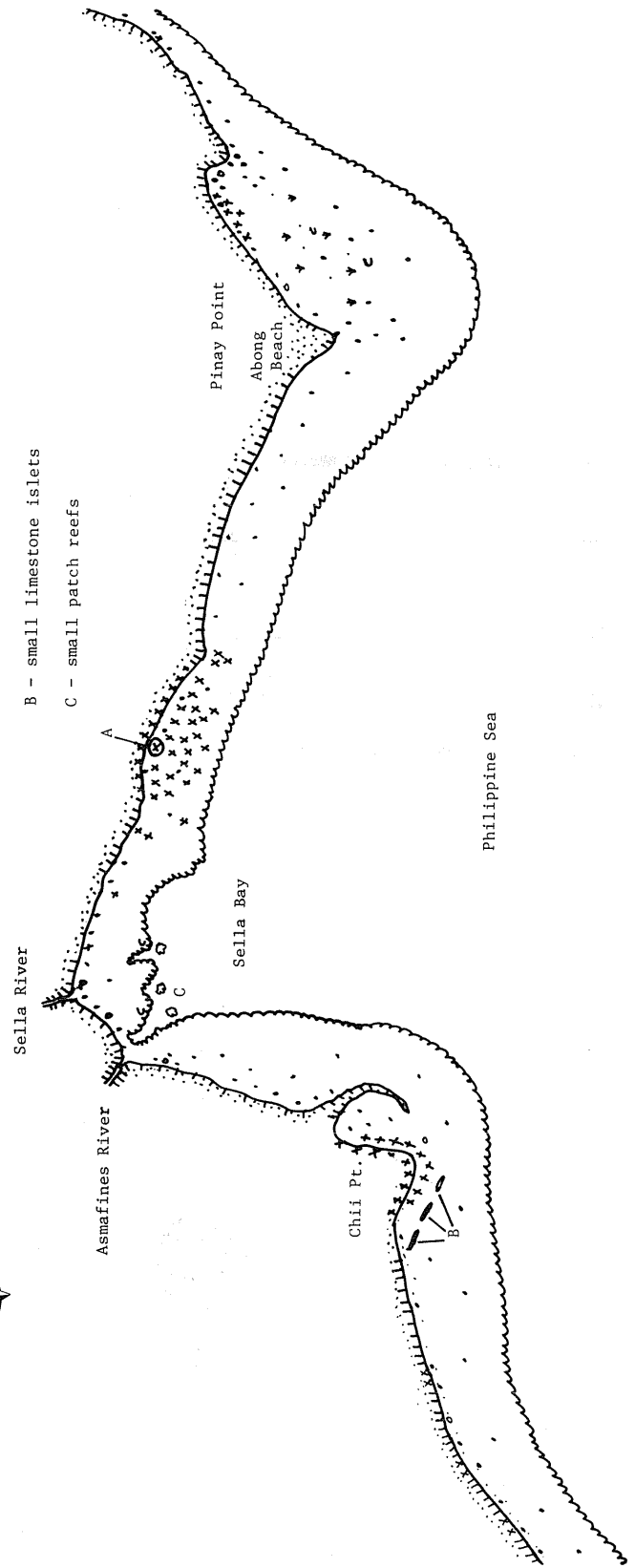
MAP NO. 8. Seashore Study Area--Facpi Point.



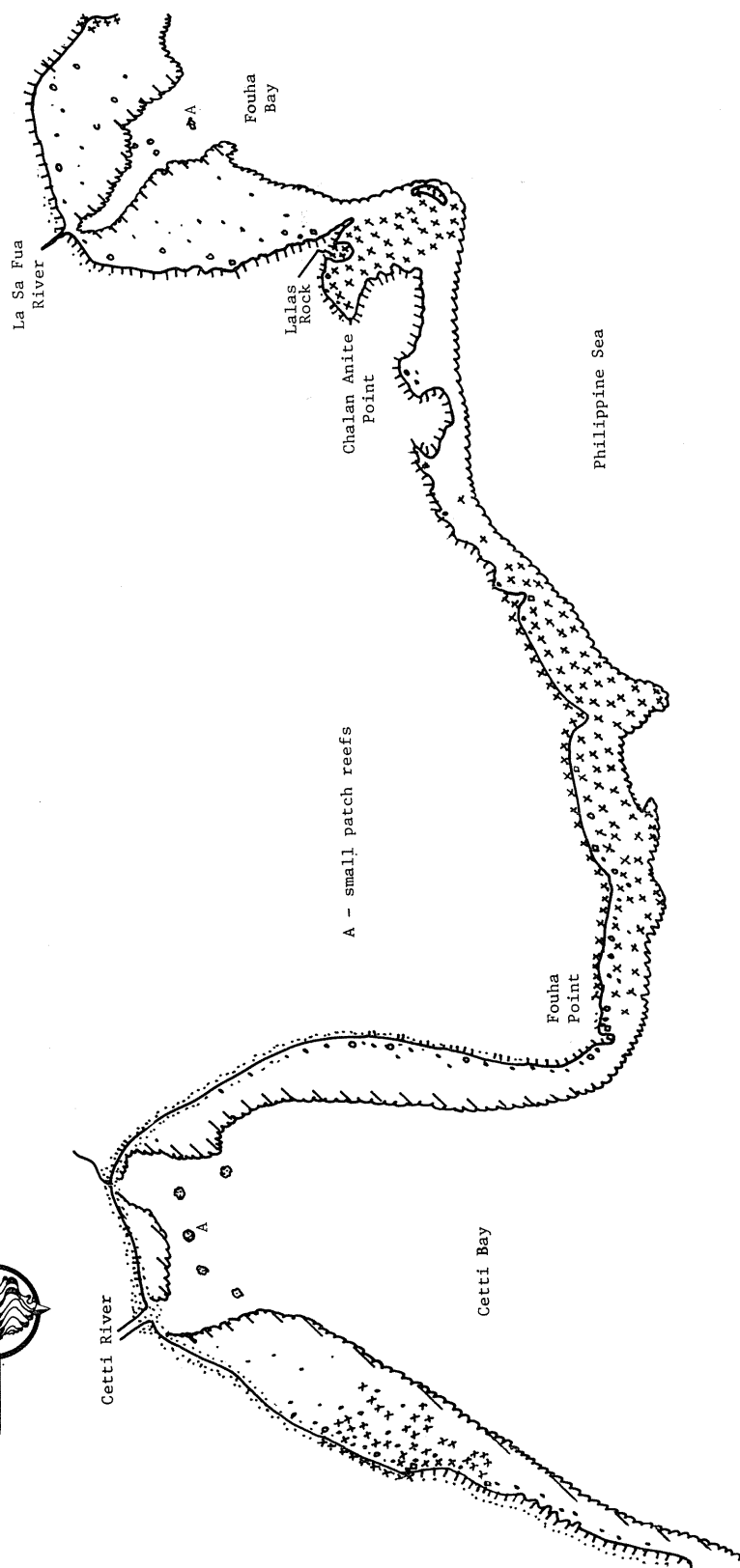
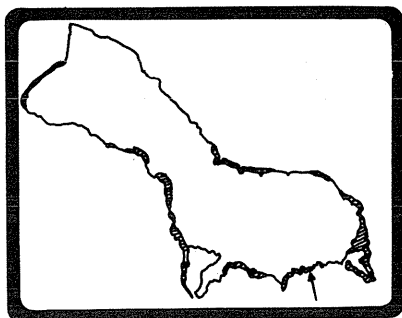
MAP NO. 9. Seashore Study Area--Achugao Point.



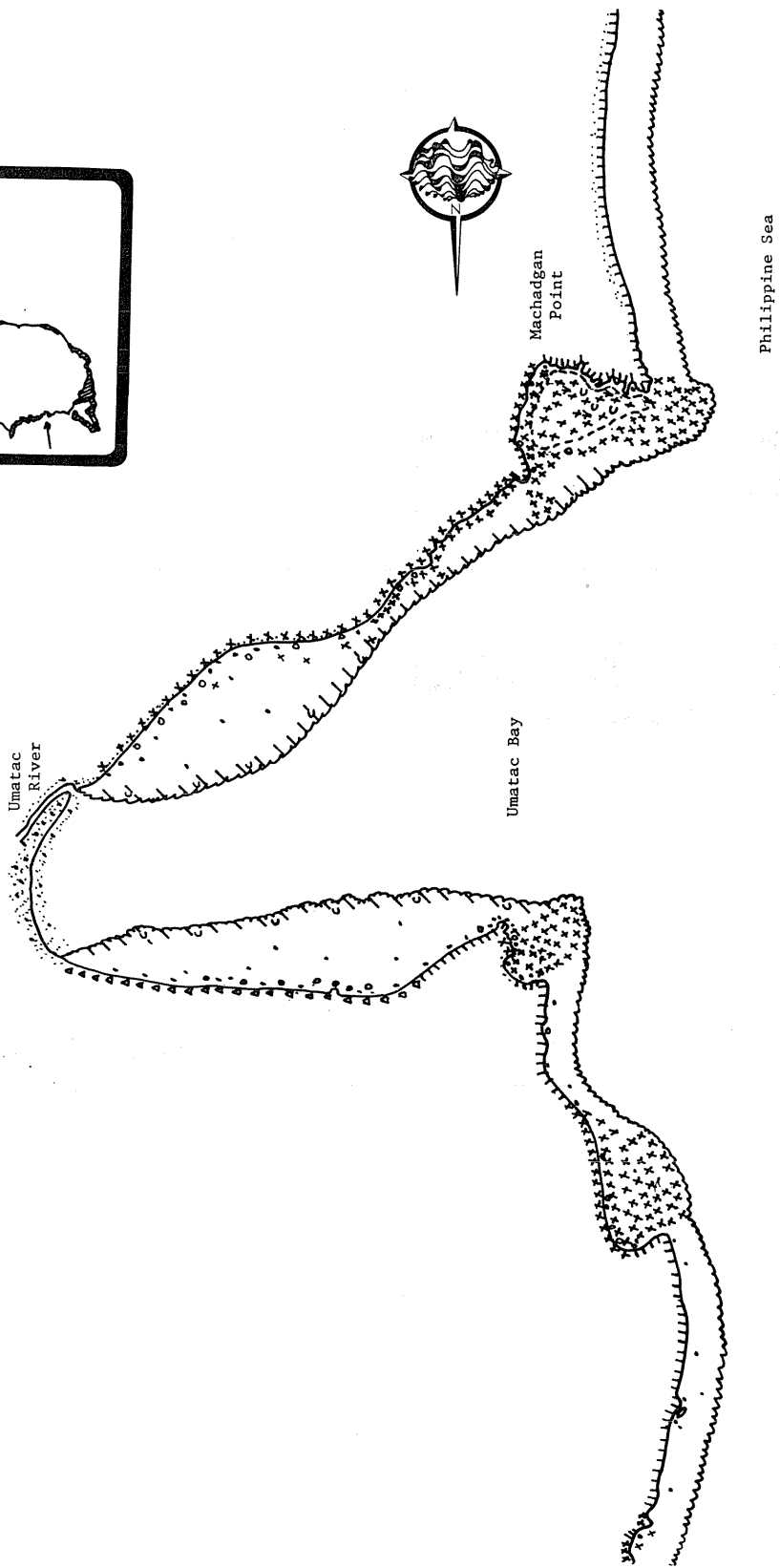
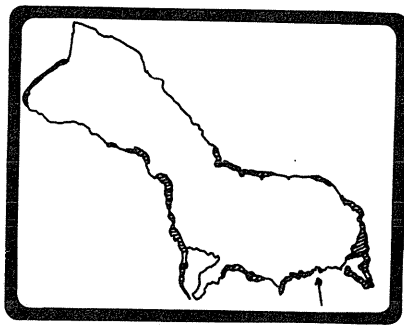
- A - volcanic stack
- B - small limestone islets
- C - small patch reefs



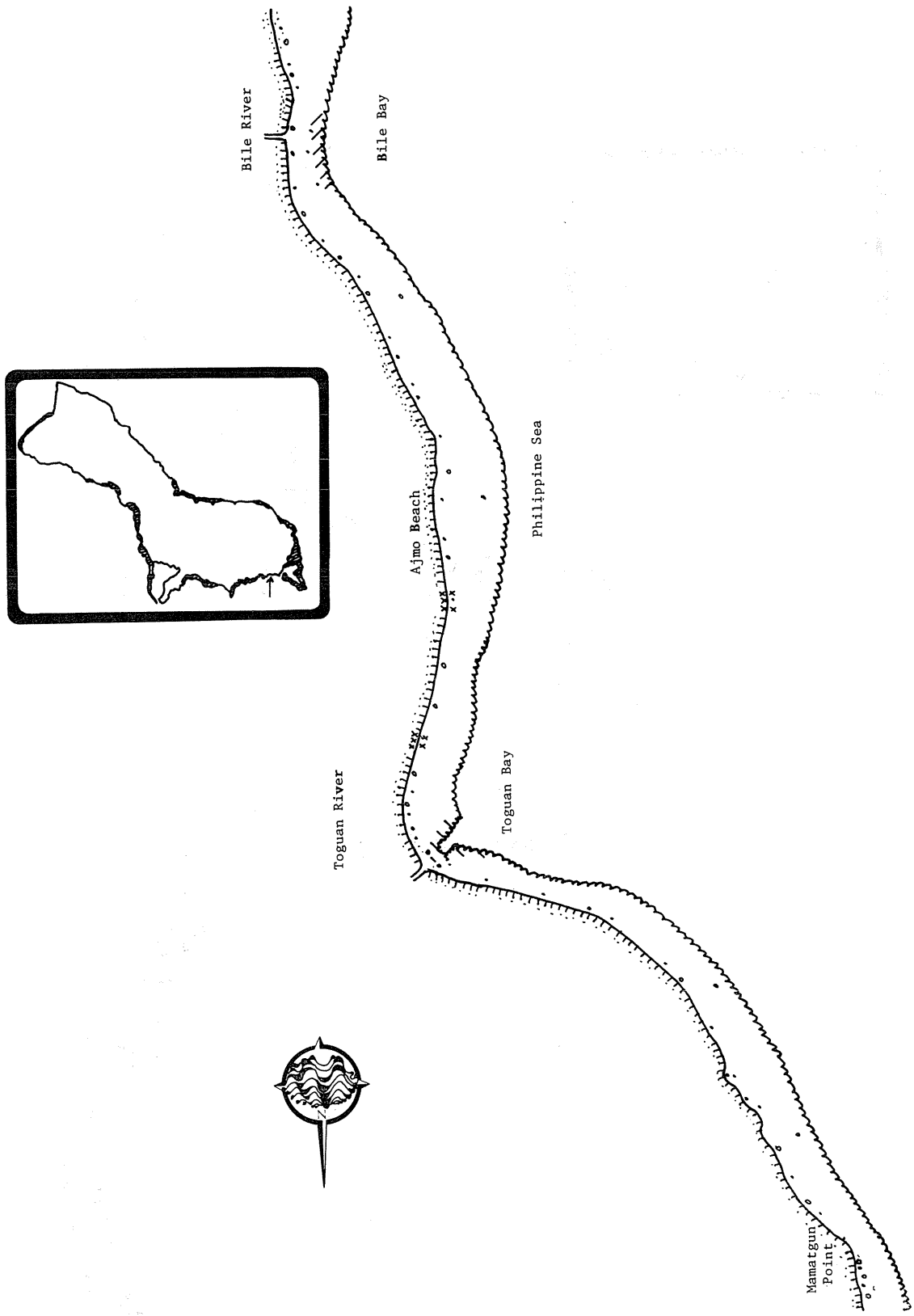
MAP NO. 10. Seashore Study Area--Sella Bay.



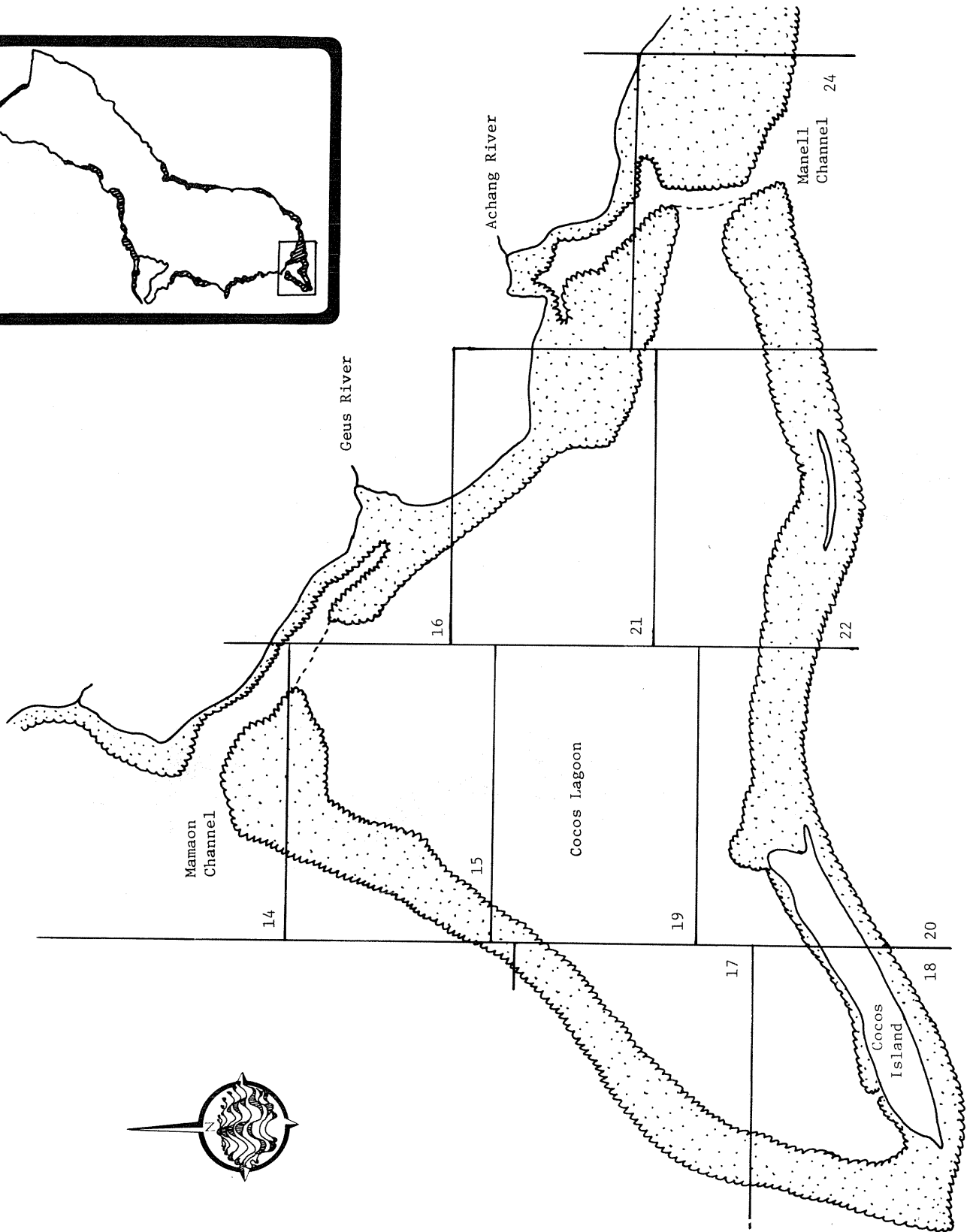
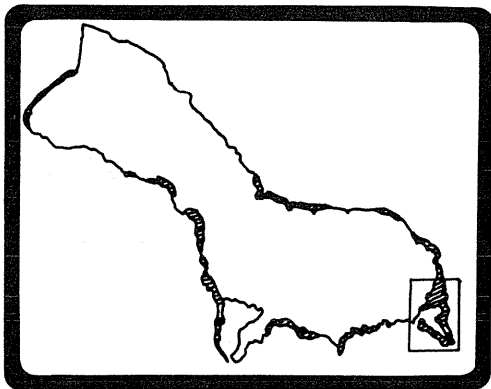
MAP NO. 11. Seashore Study Area--Cetti Bay to Fouha Bay.



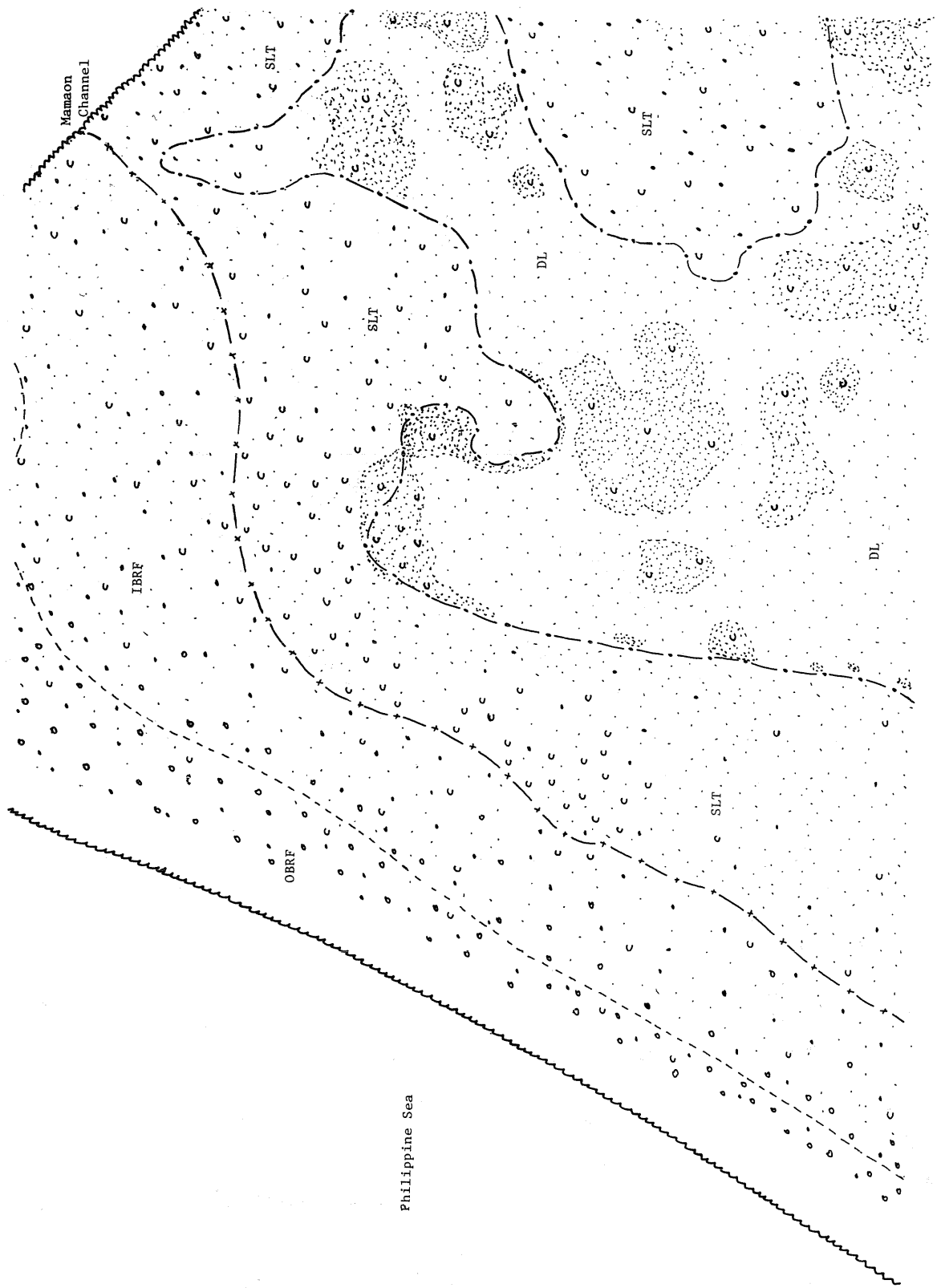
MAP NO. 12. Seashore Study Area--Umatac Bay.



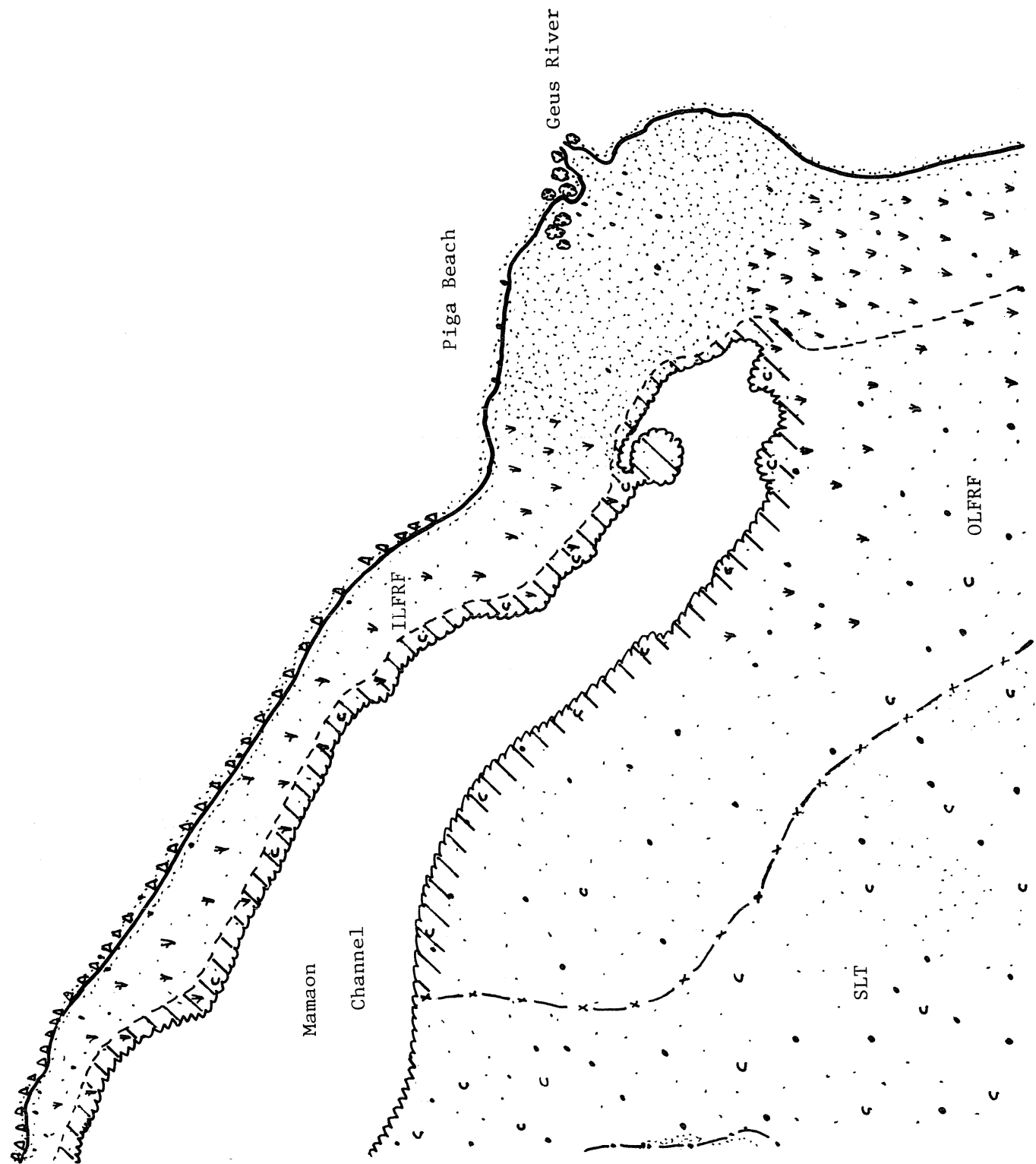
MAP NO. 13. Seashore Study Area--Toguan Bay.



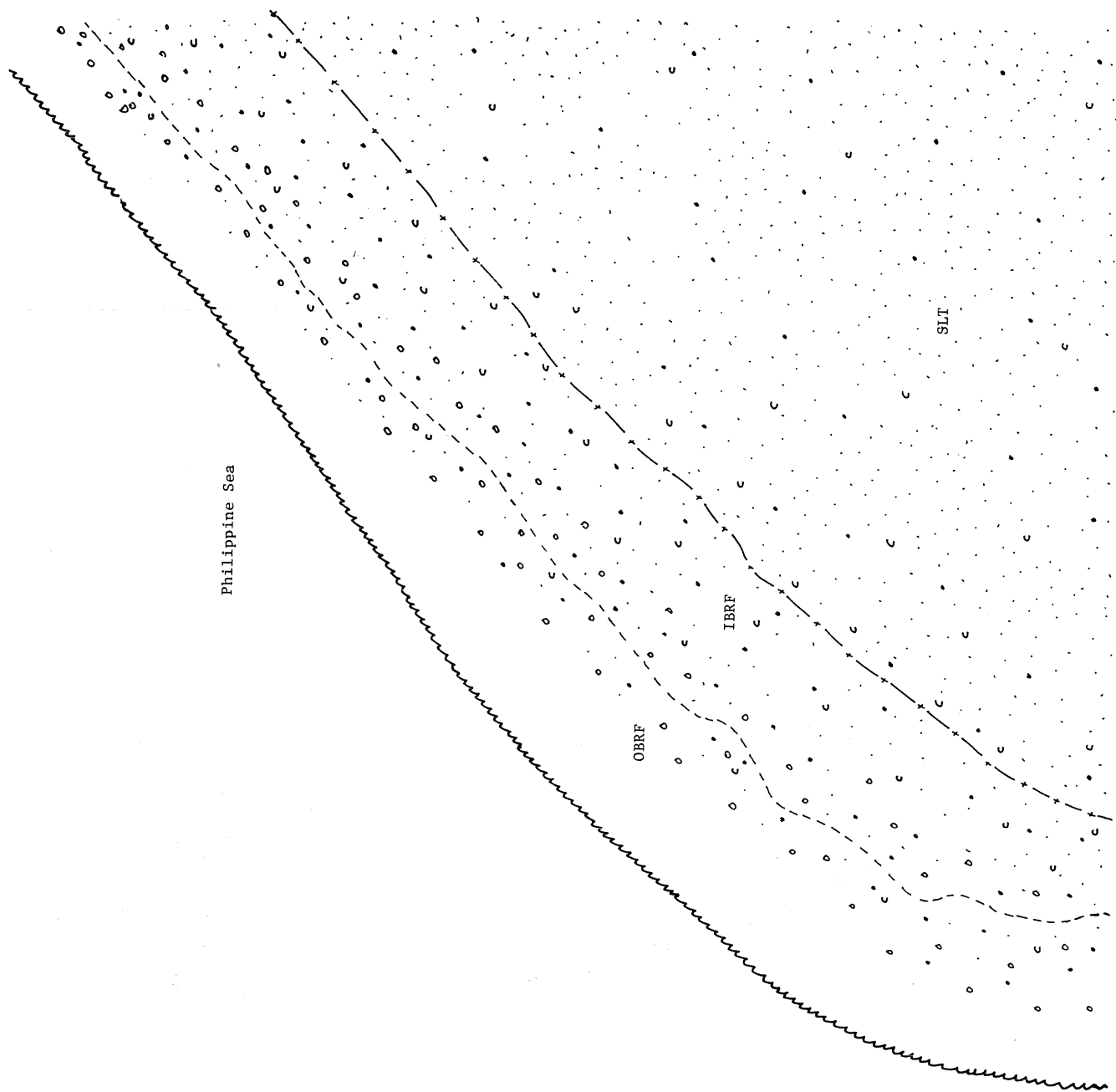
MAP NO. 14. Cocos Lagoon and Barrier Reef Location Map.



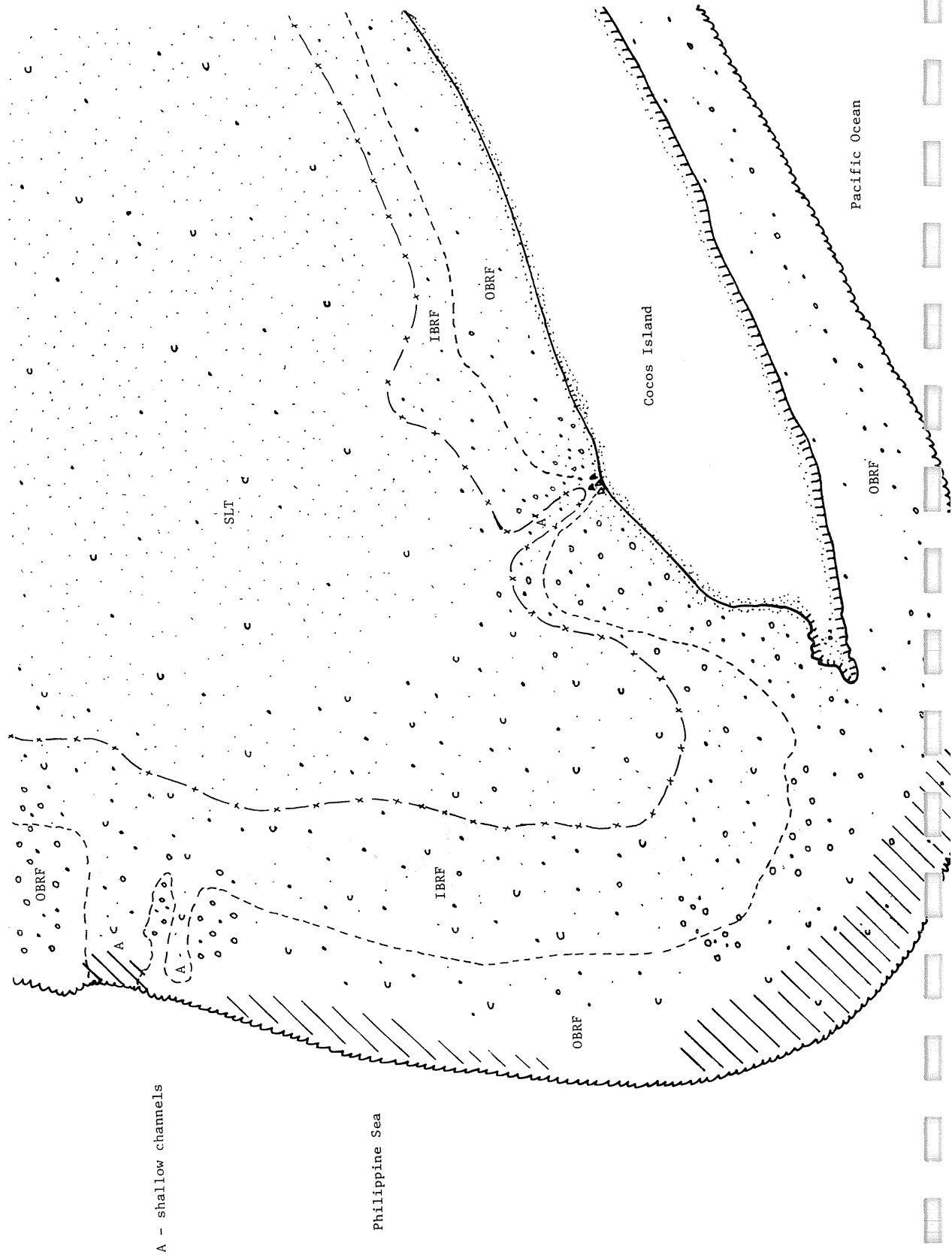
MAP NO. 16. Seashore Study Area--Cocos Lagoon.



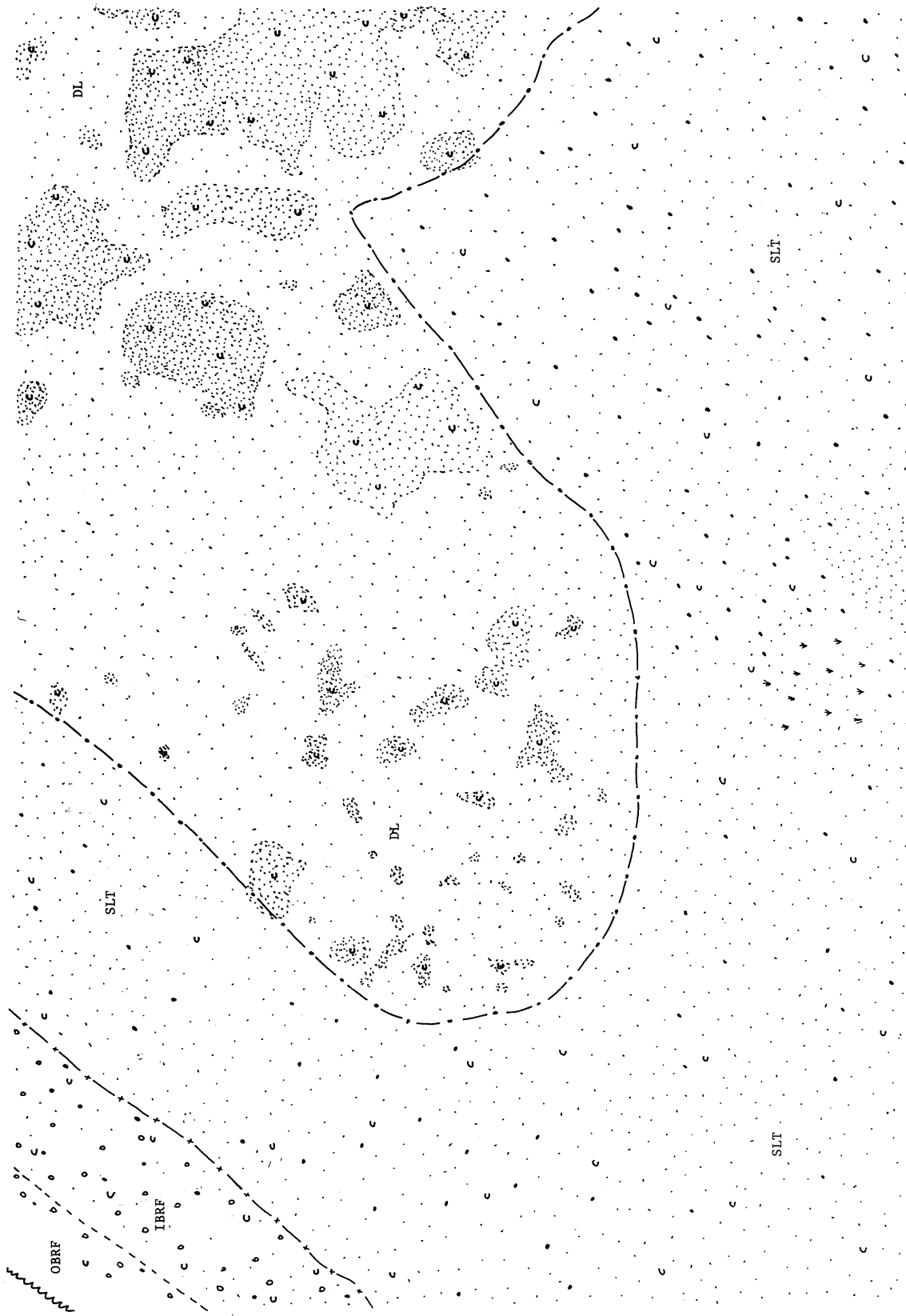
MAP NO. 17. Seashore Study Area--Cocos Lagoon.



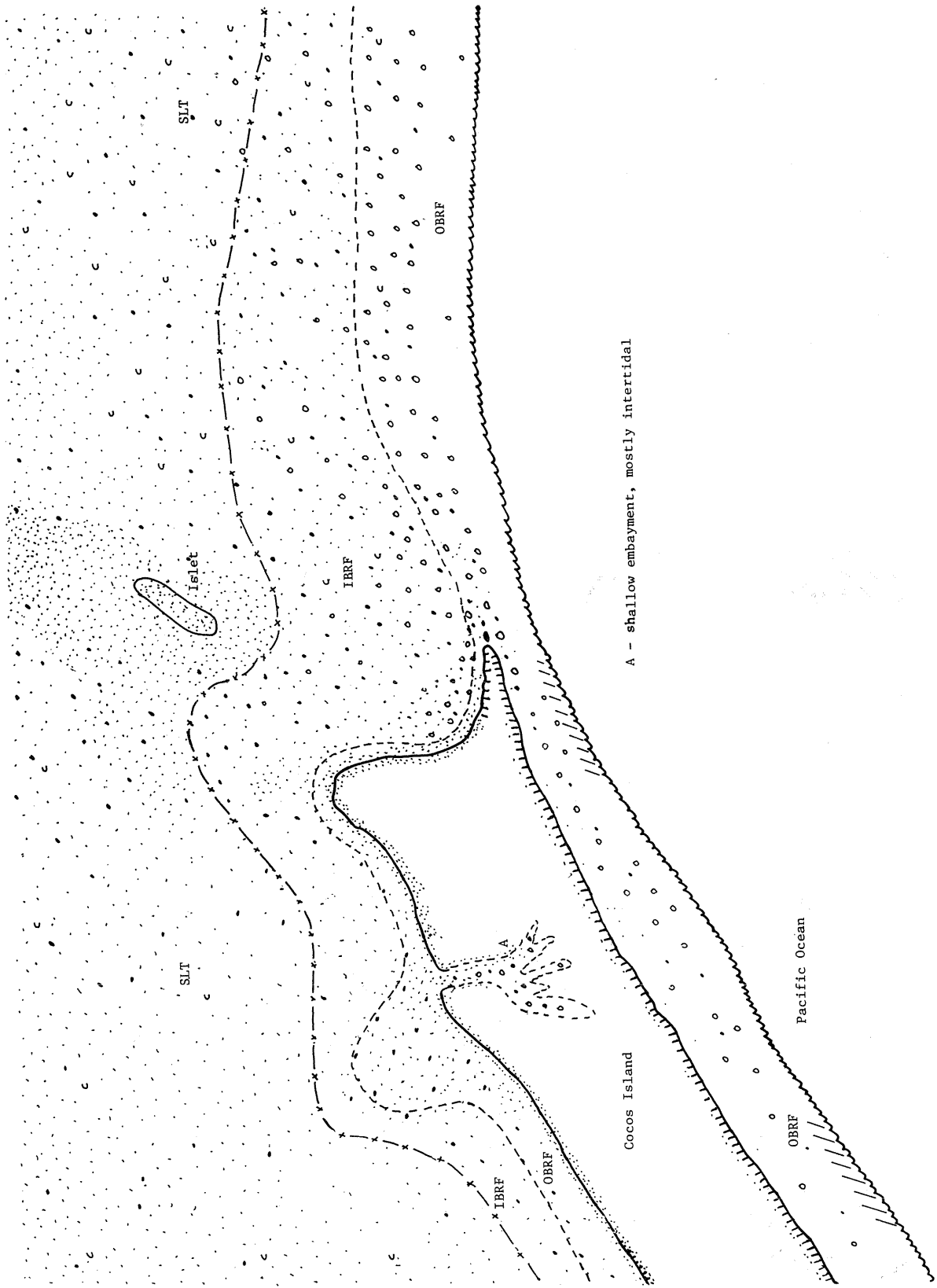
MAP NO. 18. Seashore Study Area--Cocos Lagoon.



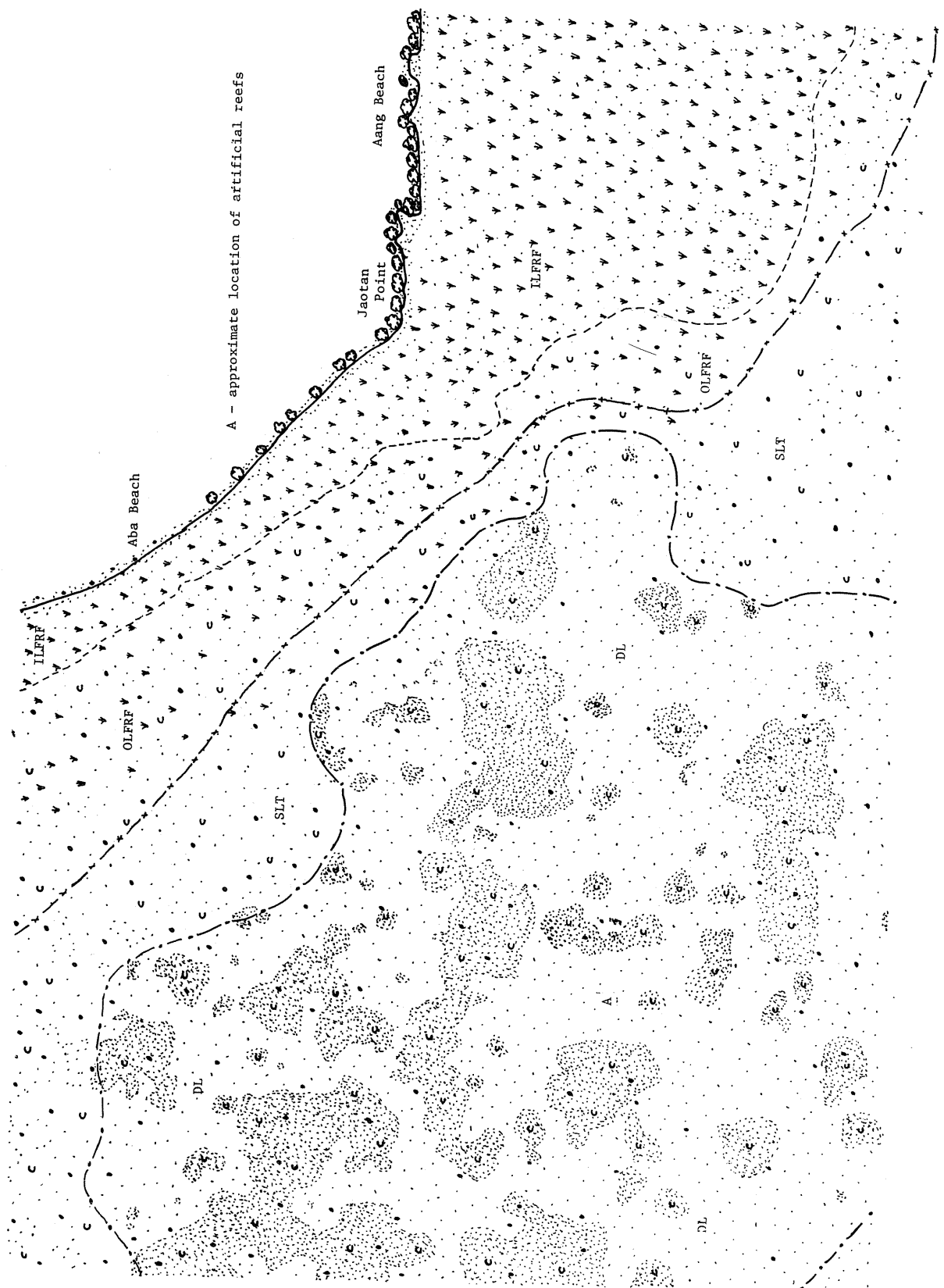
MAP NO. 19. Seashore Study Area—Cocos Lagoon.



MAP NO. 20. Seashore Study Area--Cocos Lagoon.



MAP NO. 21. Seashore Study Area--Cocos Lagoon.

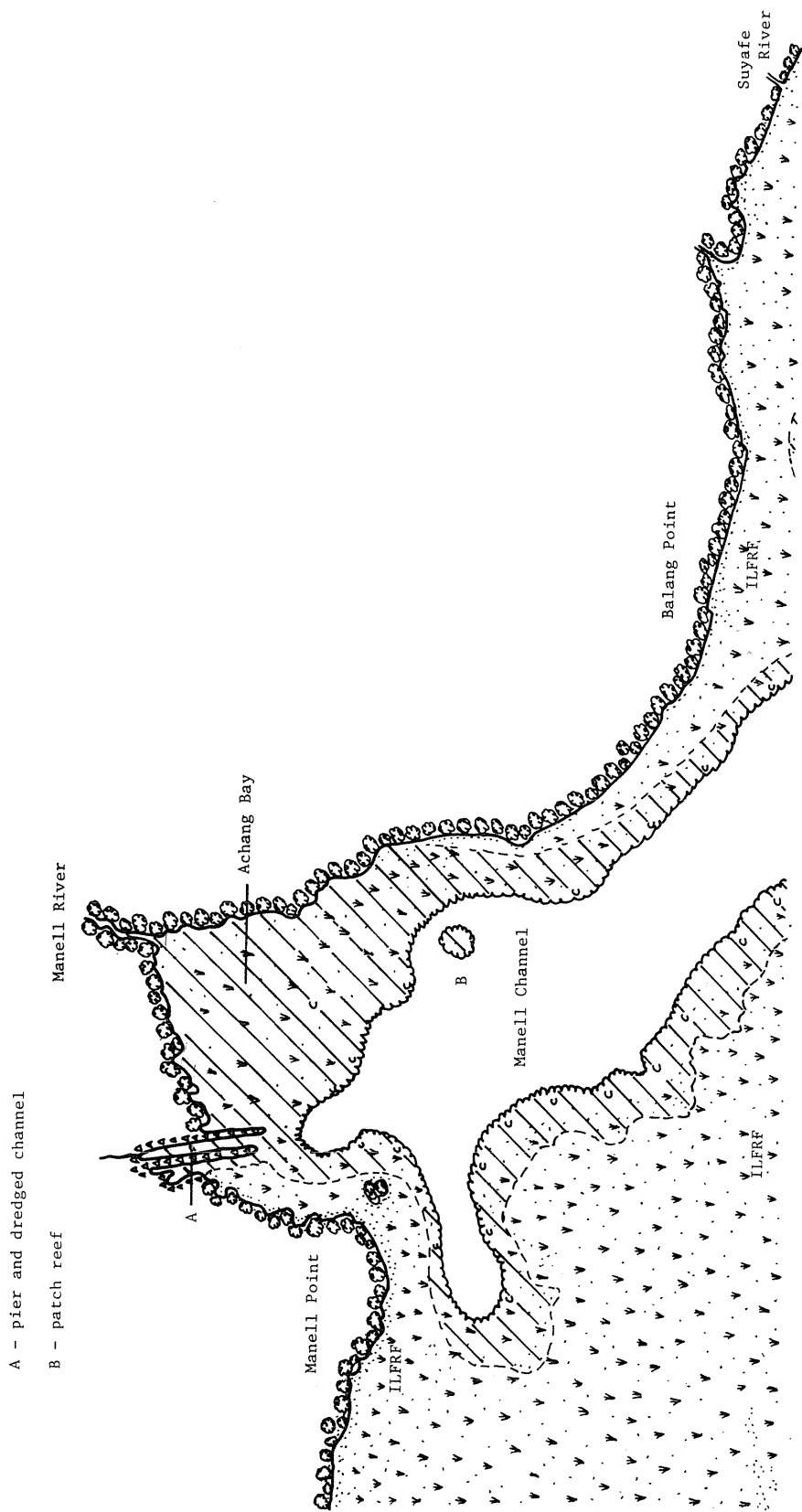


A - approximate location of artificial reefs

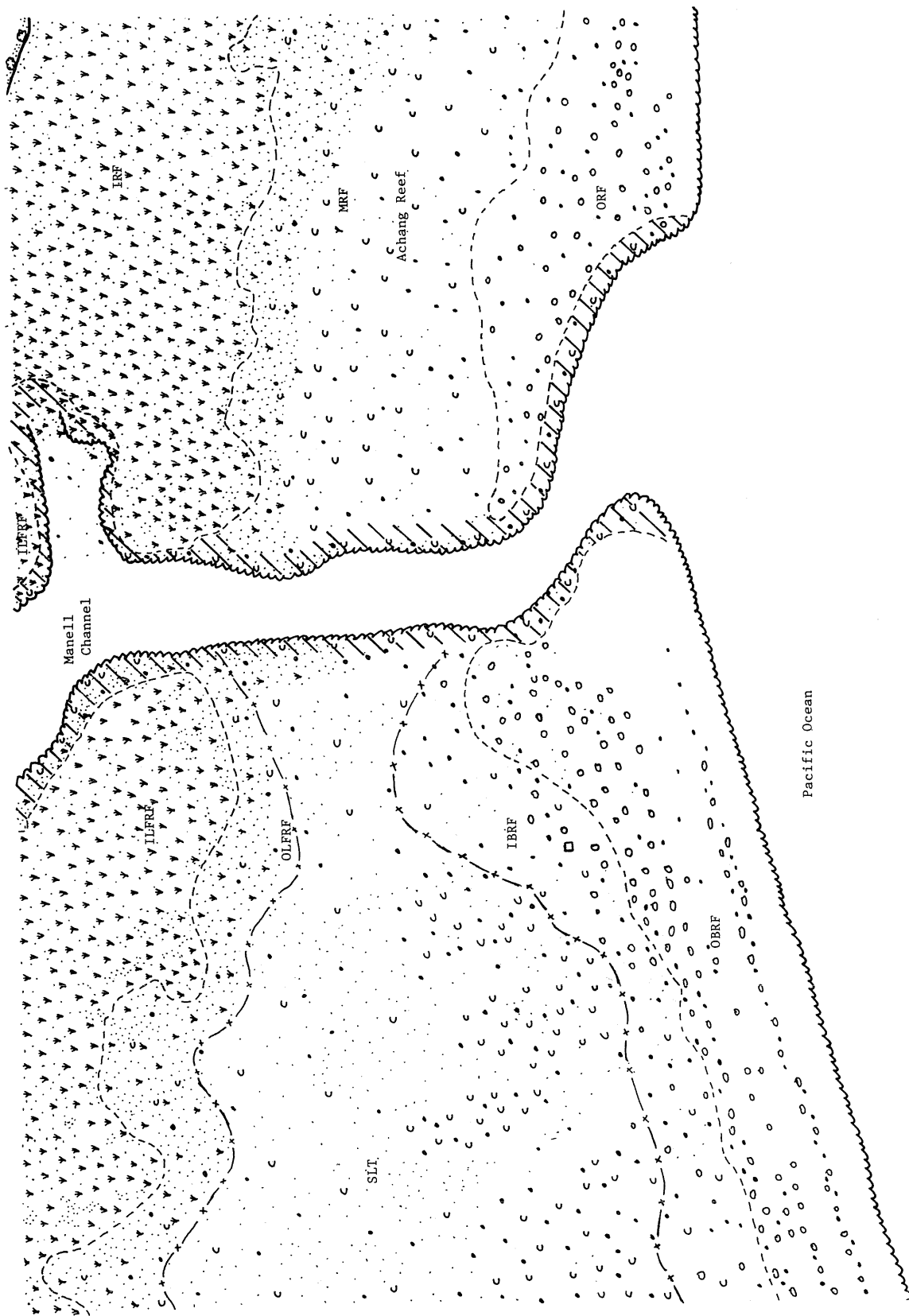
MAP NO. 22. Seashore Study Area--Cocos Lagoon.



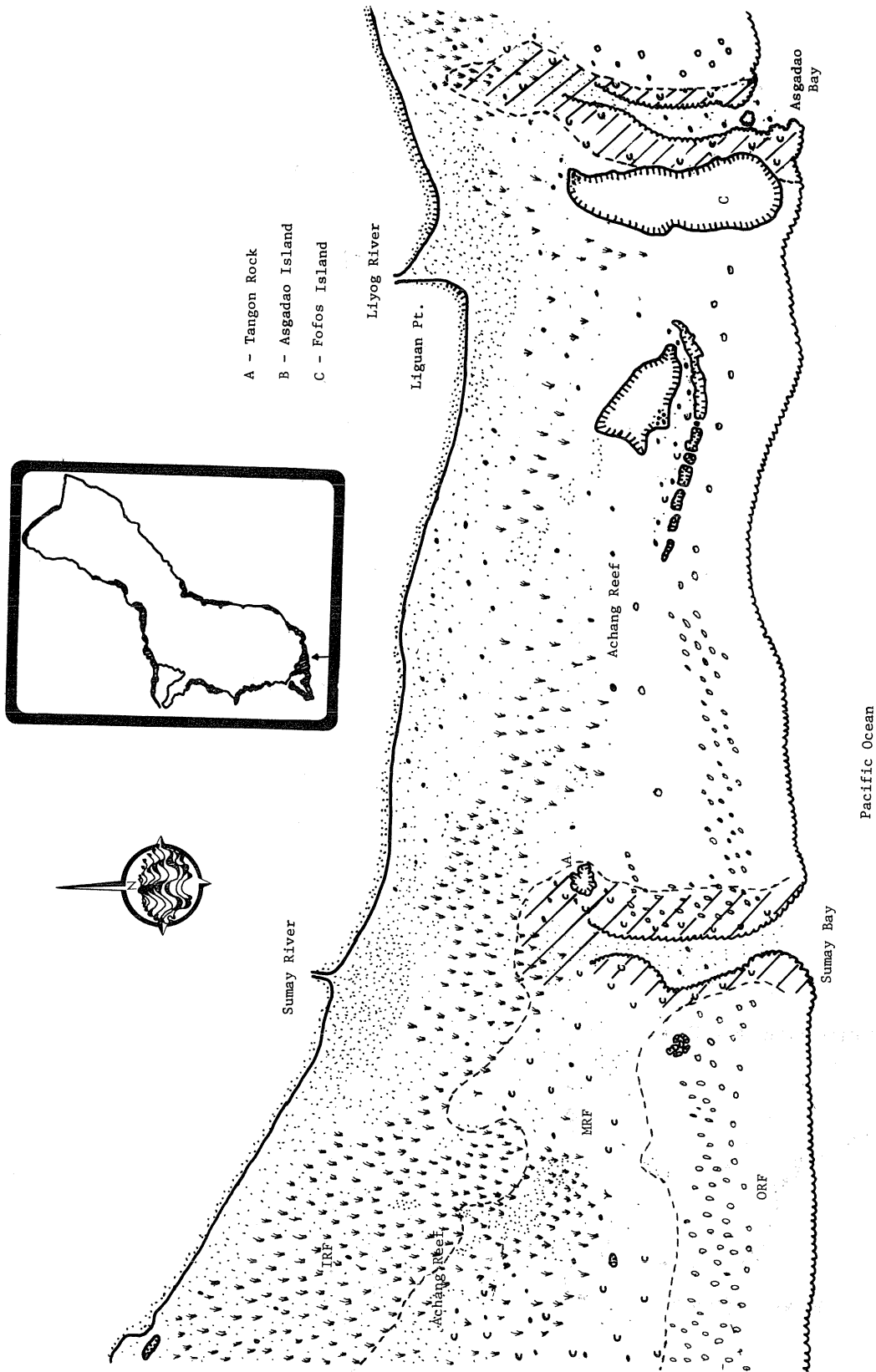
MAP NO. 23. Seashore Study Area--Cocos Lagoon.



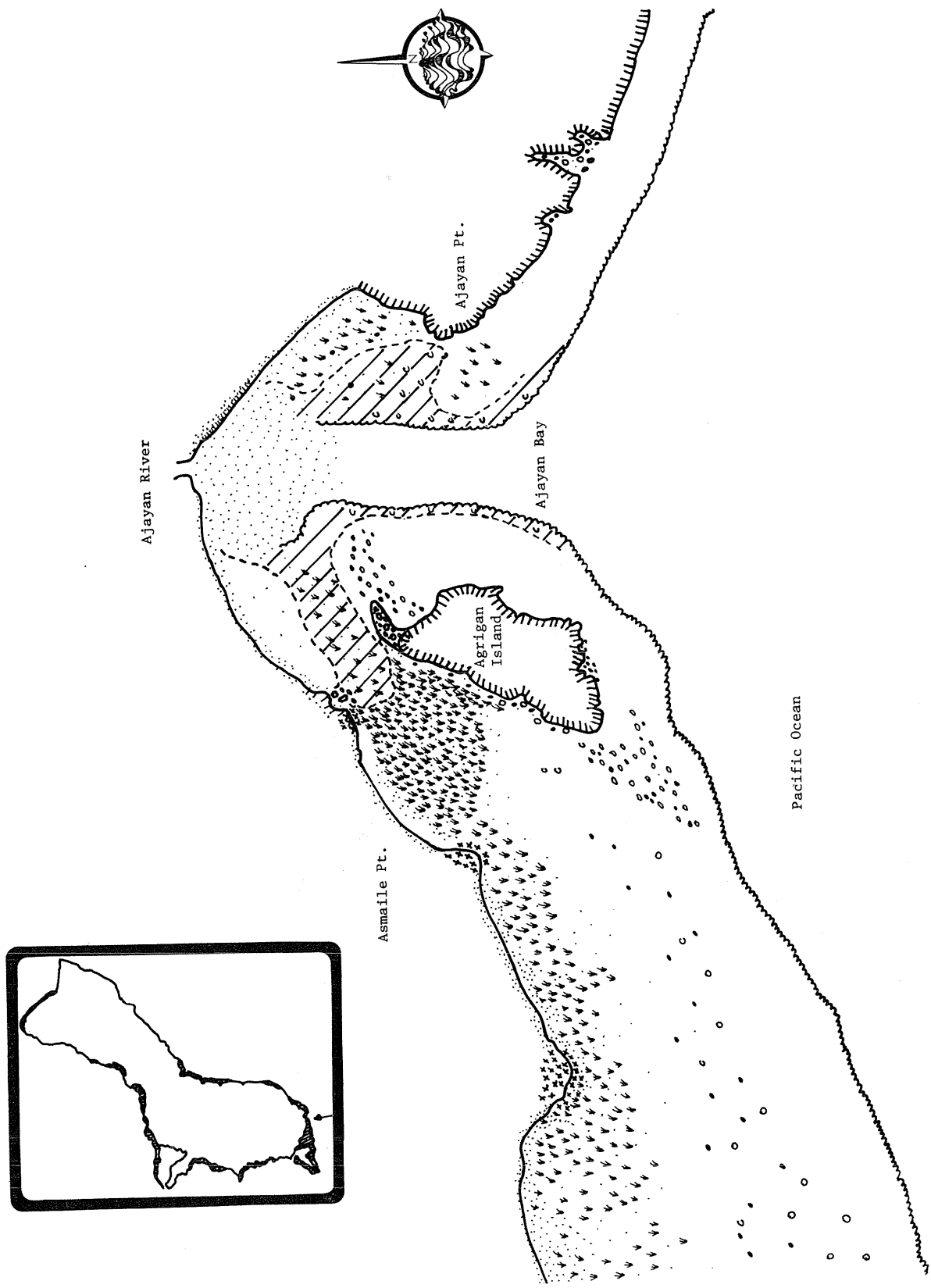
MAP NO. 24. Seashore Study Area--Cocos Lagoon.



MAP NO. 25. Seashore Study Area--Cocos Lagoon.



MAP NO. 26. Seashore Study Area--Achang Reef to Asgadao Bay.



MAP NO. 27. Seashore Study Area--Agrigan Island and Ajayan Bay.