

MARINE AREA SURVEY

an inventory of the natural and
cultural marine resources
of
St. Eustatius,
Netherlands Antilles



Jeff Sybesma, Tom van 't Hot & Leon P.J.J. Pors
CARMABI, August 1993
A Contribution to the Tourism Development Program for
the Netherlands Antilles, by CHL

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SUMMARY

As a contribution to the tourism development program for the Netherlands Antilles, CARMABI was sub-contracted by CHL Consulting Group to conduct a marine area survey in St. Eustatius in March and April, 1992. The purpose of this survey was to describe and map the natural and cultural resources of the marine environment with a view to sustainable development of these resources for tourism.

The following main habitat types were identified: coral-encrusted rock, true coral reefs, sand with algal beds, and artificial habitat (wreck sites). The most important areas for recreational use and further tourism development are the reef complex south of the city pier, the reefs of Jenkins Bay and the archaeological sites in Oranjebaai.

In addition to describing and mapping the resources, an inventory of uses of the marine environment was made, being fisheries, diving and snorkeling, anchoring and ship's traffic. Individual uses were mapped and these maps were overlaid to show areas of conflict between uses.

The overlays formed the basis for a zoning plan for the marine environment. This plan identifies certain zones for different uses, so as to avoid conflicts between users. The zoning plan proposes two marine park zones, two archaeological zones, a large anchorage/harbor zone, traffic zones and a fisheries management zone.

Since the institutional structure for managing the marine environment and enforcing the regulations of the zoning plan is not available at present, creation of a new non-governmental body is recommended for management. All interest groups should be represented in such a body.

Once the Island Government approves the recommendations and the proposed zoning plan, a detailed project proposal and budget need to be drafted and submitted for funding.

I. INTRODUCTION

Sint Eustatius is one of the five islands of the Netherlands Antilles. It is situated in the northeastern Caribbean (17° 20' N; 63° 00' W). The topography of the island and the bathymetry are shown in map 1. The island has a surface area of 21 km² and a population of 1781 (N.A. Statistical Orientation 1992, Central Bureau of Statistics).

1.1. Why a marine area survey?

The leeward shore of St. Eustatius is only about 10 km long. Yet four kinds of user activities, each with their own specific and often incompatible interests are competing for space in this small area:

1. Fishing
2. Transportation (commercial harbor)
3. Oil transshipment
4. Recreation and tourism (diving and snorkeling, beach recreation and swimming, yachting)

The Island Government of St. Eustatius wants to promote tourism, including dive tourism, it wants to improve its harbor facilities, it facilitates expansion of the oil terminal and construction of a small refinery, and it also wants to protect its natural and cultural resources for the benefit of its own people and that of visitors. The challenge which lies ahead is whether or not a peaceful coexistence of all these activities is indeed feasible, and if so, how this can be achieved.

The Tourism Strategic Master Plan for the Island of St. Eustatius (Horwath and Horwath, 1988) recognizes the combination of marine life along with the historic shipwrecks as unique diving and snorkeling opportunities for tourism. At the same time the Master Plan notes the need for legislation to protect the historical shipwrecks and other remains, as well as the marine life, from unwanted or harmful activities.

The Master Plan recommends that a number of studies be carried out, amongst others:

"A detailed Marine **Area Survey**, leading to recommendations in respect of protection and appropriate facilities for recreational use of Statia's coastal waters." As a result of this recommendation a marine area survey in St. Eustatius was included in the terms of reference of the Tourism Development Program for the Netherlands Antilles (CHL Consulting Group Consortium, 1990).

1.2. Objective

The objective of the Marine Area Survey is described in the terms of reference as: "to deliver a document with suggestions and recommendations for the protection of possible archaeological and biological features, such as shipwrecks, ruins and coral reefs, including the possible sustainable recreational use of these resources."

1.3. Approach to the survey

To achieve this objective a dive survey was conducted to investigate the physical and biological structure of the coastal and marine environment around the island. Emphasis was placed on those areas that are or can be considered suitable for recreational development such as the leeward shore in general and Oranjebaai in particular.

This report presents the results of the survey and the distribution of biological and cultural resources and their uses. The report describes the tourism potential of these resources and gives recommendations on zoning, including the designation of marine park and historic zones. The zoning recommendations are not only based on the survey, but also on active involvement of the different users of the marine environment.

II. USES OF THE MARINE ENVIRONMENT

2.1. Transportation

The island of St. Eustatius is heavily dependent for its supplies on transportation over sea. Construction material, food and other goods are being shipped mostly from St. Maarten to the island. Small boats bring fruits and vegetables, while bigger boats bring larger items. For unloading of cargo the small pier (RoRo pier) and the big City pier are used.

2.2. Fisheries

There are about 15 fishermen on the island. Only four of them work full time while the others are part time fishermen. The catch consists of lobster, reef fish, pelagic fish and conch. No fishing statistics are available, but lobster is clearly the most important product. The main lobster season runs from October to April.

Fishing methods used are traps, hook and line, trolling, and occasionally nets. About 300 lobster and fish pots are laid out around the island from shallow to deeper water (40 m maximum). As these shallow areas around the islands extend relatively far out from shore, the fishing grounds are quite large. The fishermen have small vessels (less than 5 m). Only one full time fisherman has a bigger vessel and uses a winch to haul his traps. All of them operate out of lower town Oranjestad. Soak time of the traps varies from two to four days, depending on the fisherman.

All fish is sold locally. Some of the larger predators such as Barracuda are poisonous because of ciguatera and are therefore not targeted. Still, people are regularly treated for ciguatera symptoms in the hospital (pers. comm. F. van Stekelenburg, MD). Ciguatera is a disease caused by fish poisoning. The culprit is a paralytic neurotoxin found in the tissues of the fish of prey which can be lethal to human beings, causing various gastro- intestinal and neurological disturbances.

Lobster is mostly shipped to St. Maarten by air. Female berried lobster are kept in a holding pot until the eggs are hatched.

Some conch is caught by using scuba gear. Because it is quite labor intensive not very much is caught.

2.3. Oil Terminal

Statia Terminals N.V. began operating in 1982. It started as a relatively small operation but is today a major facility. Upon completion of the expansion (in 1992) the terminal will have approximately 40 tanks for different kinds of petroleum products with a total capacity of 6 million barrels. These products are taken as cargo by major tankers. The terminal also offers bunkering facilities.

The average number of ship movements for the Terminal is about 2 per day. Of these, 30% are cargo transshipments and 70% are bunker vessels. Bunker vessels average 200 - 350 tons SDWT (Summer Dead Weight Tonnage) and cargo vessels 55,000 tons SDWT. The Terminal has one big jetty for two big tankers and a floating dock for cargo transshipments. The jetty can accommodate vessels up to 150,000 tons SDWT maximum. The floating dock is anchored at the north side of the jetty and connected by sub-sea lines to shore facilities. From the floating dock floating hoses are connected to vessels to transship gasoline and butane, and other highly flammable liquids.

The Terminal operates 3 tugboats, two utility boats and a work barge. Altogether, these are responsible for a large number of ship's movements in Oranjebaai harbor. The tugs also make use of the City pier, but are on a mooring buoy in the Bay when not otherwise engaged.

On the premises of the Terminal a small second hand oil refinery (topping unit) is built. The total capacity of this unit will be 10,000 to 15,000 barrels a day. The refinery does not form part of the Terminal, it only leases tank space and land from the Terminal. Additional data on the topping unit are not available

2.4. Recreation

2.4.1. Beach Recreation and Swimming

St. Eustatius used to have a broad volcanic sandy beach all along the south coast of lower Oranjestad. This beach decreased considerably over the years, sometimes disappearing completely. South swells take away the sand while north swells bring the sand back. Scientific reasons for the disappearance are not available, although many stories claim different causes. The Dundalk, a small freighter stranded on the north side of the beach, is' said to have caused the disappearance of the sand, while others claim the pier. Not much beach recreation is seen, and mostly by locals. Swells and erosion make swimming unattractive sometimes. Other beaches on the island are Concordia Bay, and some other pocket beaches such as Corre Corre Bay. Beaches on the east side of the island (Atlantic side), are exposed to the high wave action and are dangerous for swimming.

2.4.2. Yachting

St. Eustatius is part of the yachting route along the Lesser Antilles island chain. Arriving from one of the neighboring islands of Saba, St. Maarten, St. Barth or St. Kitts and Nevis, many yachts spent some time in the harbor of Oranjestad. However, Oranjebaai is not a safe anchorage, as the bay is not protected from sudden swells that may approach either from the north or the south. These make the anchorage very unpleasant and often force yachts to leave unexpectedly. Some charter companies do not even allow their boats to call at St. Eustatius. Facilities for yachts are not available. Due to the nature of the anchorage, the lack of facilities, and the commercial traffic in the harbor, yachts seldom spend more than a few days in the harbor.

2.4.3. Diving and snorkeling

St. Eustatius has one dive operation called Dive Statia. This small operation has a 31 ft cabin cruiser, two inflatable (17 and 11 ft) and a 16 ft aluminium boat. Their maximum handling capacity is 20 divers, but they prefer to limit themselves to 8-10 people. It is the only air filling station on the island. They offer resort courses and full certification courses in accordance with PADI, NAUI and SSI standards, as well as a variety of specialty courses. Dive Statia provided the following dive statistics:

year	diver's	dives
1987	35	73
1988	172	392
1989	118	436
1990	213	796
1991	443	1809
1992	558	2370 (estimate based on growth rate)

Note: In 1989 and through August 1990 a second dive operation was on the island. According to Dive Statia, the capacity was about 1/4 to 1/3 of their own. In September 1989 the island was hit by hurricane Hugo.

The dive locations are all on the sheltered west coast of the island and can be grouped in three main areas: the area south of the big city pier, Oranjebaai and the reefs at Jenkins Bay.

Diving and snorkeling in Statia is known for the many shipwrecks in Oranjebaai, remains of its rich historical past. Less well-known are the well-developed reefs in the southern part of the island and the coral structures in Jenkins Bay. Most other places are not very interesting because of mostly sandy bottoms (see "Results of the Survey" for more details).

The conditions for diving and snorkeling in Statian waters are not always good. Swells make boarding a small boat from shore difficult, sometimes impossible. A small boat dock for the dive boats is not available. Swells also bring sand into suspension, reducing the visibility in shallow water. Heavy rains on the island cause significant erosion bringing also large amounts of sand into the water. This also decreases visibility for several days.

Snorkeling in Statia is done at the submerged city wall which stretches from the Roro pier all the way to the north part of the beach. Other areas used by the dive shop are Jenkins Bay and Kay Bay, where coral-encrusted rock formations can be seen in shallow water.

III. CONFLICTS BETWEEN DIFFERENT USES

As mentioned earlier the protected leeward side of the island is only 10 km long. It is evident that the interests of the different uses are not always compatible and may cause conflicts. The individual uses are represented in maps 2-5.

We have identified the following areas of conflict or potential conflict between uses (see map 6)

1. Conflict between ship's traffic and diving/snorkeling.

For safety reasons traffic needs to keep a safe distance from vessels flying the so-called divers down flag. Several dive sites in the southern reef complex are located quite a distance from shore and are thus situated in the shipping route between Oranjestad harbor and St. Kitts. The dive sites in and off Oranjebaai are located in the traffic route between the City pier and the terminal, in the traffic route between the city pier and anchored tankers and bunker vessels, as well as in the traffic route to and from the northwest.

2. Conflict between ship's traffic and anchorage.

The anchorage just north of the city pier is used by visiting yachts, small cruise ships (such as the Polynesia and the Star flyer), and by local people who have their boats moored some distance from shore where swells are less dangerous. Traffic between the city pier and the terminal, and between the city pier and anchored tankers or bunker vessels passes right through the anchorage posing a danger and inconvenience to the vessels at anchor or at a mooring.

3. Conflict between ship's traffic and fishing.

Fishermen complain that the floats of their fish traps are often cut off by ships accidentally running over them. This not only represents a loss to the fishermen, it also makes the traps irretrievable and turns them into "ghost traps" (i.e. the trap continues to catch fish - which will die of starvation - until the wire is finally corroded through). The main conflict areas are off Oranjebaai (the approach for bunker vessels and the area where waiting tankers are anchored) and off Jenkins Bay. The conflict exists with all traffic even big cruise ships pass so close to the island (for "island viewing") that they probably cut off trap floats.

4. Conflict between anchoring and fishing.

A sizable area off Oranjebaai, in about 27 to 35 m of water is covered with live coral reef (see Annex I, under E). This same area is also being used for anchoring waiting tankers. Their anchors and anchor chains cause serious destruction to the coral reefs which are habitat for lobster and grouper. This habitat destruction will reduce the fishing potential of this area considerably.

5. Conflict between anchoring and diving.

The historic wreck sites presently visited by divers are - for obvious reasons - located in the same area as the present anchorage of Oranjebaai. They are also located dangerously close to the southernmost bunker vessel anchorage, while further research would almost certainly reveal additional wreck sites in the bunker vessel anchorages. Especially medium-sized vessels, which anchor outside the 10 m depth contour, are causing frequent damage to the wreck sites. Anchored or moored vessels are not always disposing of their refuse in a responsible manner, causing another conflict with the interest of the diving tourist.

6. Conflict between fishing and diving.

Divers want to see fish, something they will not in areas which are over fished or where the fish have been conditioned by frequent spear fishing and go into hiding. Most divers also do not like the look of fish in traps. There is little conflict between fishing and diving in St. Eustatius because very few fish traps are

placed in the areas visited by divers. We did notice, however, that the larger groupers - where present - were rather shy, indicating some impact from spear fishing.

7. Conflict between oil transshipment and tourism and fishing.

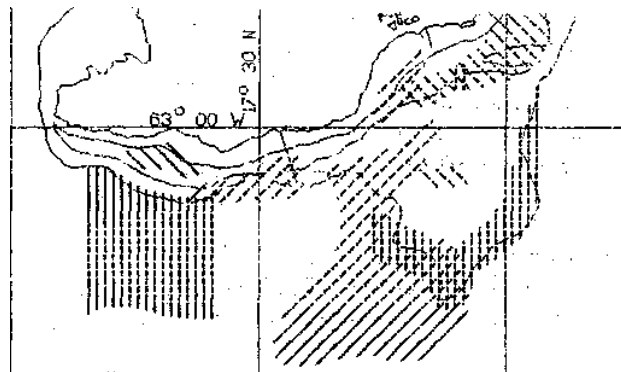
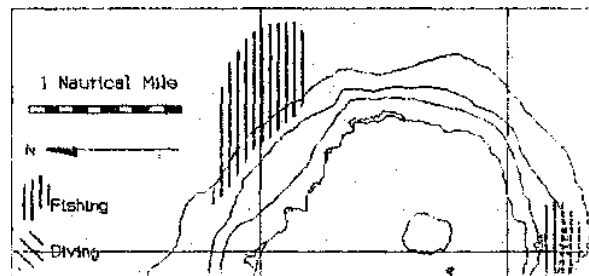
As long as the risks of oil spills cannot be eliminated altogether, there will always be some negative impact of the oil terminal on tourism. Spills pollute the beaches and make diving impossible for one to several days, depending on the scale of the spill. Small but frequent spills may also have a chronic toxic effect on marine life (fishermen blame oil pollution for fish diseases) and the effect of dispersants combined with oil is believed to be even more harmful to marine life than the oil itself. With the expansion of the terminal the risks seem only to increase.

Small boat traffic (fishermen and divers) passing in between the floating dock and shore north of the terminal jetty, present another conflict. Such traffic poses a distinct safety hazard as gasoline and butane are being loaded at this dock and sparks from cigarette smoking or outboard engines may cause explosions. Although at present no restrictions on traffic are considered (Gafney, personal communication), it is conceivable that restrictions on small boat traffic may be needed in the future.

Depending on the developments on the oil market, long range plans could include a single point mooring in deep water (100,m) north of Jenkins Bay for transshipments to and from large and very large crude carriers (LCC and VLCC). This would again increase the risk of spillage and pose another threat to fishing and diving in the Jenkins Bay area.

Possible solutions to these conflicts will be discussed in the section on zoning.

Conflicts between uses



IV. RESULTS OF THE SURVEY

4.1. Marine Natural Resources 4.1.1.

Distribution and abundance

Very little literature on the distribution and abundance of the marine resources of St. Eustatius exists. Roos (1971) describes reef development in St. Eustatius as relatively poor, with coral growth taking place at the foot of cliffs and on scattered boulders in front of it. Although Roos' conclusions may have been somewhat influenced by the fact that he depended on free diving and that he did not survey the area in between Gallows Bay and Compagnie baai, Bak (1977), in his survey using SCUBA down to a depth of 35 m, came to very similar conclusions. The Virginia Institute of Marine Science (VIMS) conducted an assessment of beaches and offshore sand resources in 1988 (Boon et al., 1989).

Our survey included observations at 30 different sites (see map 7), as well as a number of tow surveys (whereby a diver is towed behind a boat and scans the bottom) in Oranjebaai and south of the city pier. Detailed descriptions of all sites surveyed are given in Annex I. The results of the survey indicate that the marine areas along the leeward coast of the island are characterized by six main habitat types (map 8):

1. Encrusted rock boulders and rock ledges [symbol **f**]. These are rock formations, most likely of volcanic origin, which are encrusted with a variety of reef invertebrates (e.g. hard corals, soft corals and sponges), thus resembling reefs.
2. Coral reefs (defined as structures built by hard corals and other calcium carbonate producing organisms) [symbol **£**]. There are intermediate forms between this habitat type and the encrusted rock type, as the latter can develop into coral reefs over time when the environmental circumstances are right.
3. Sand with algal beds [symbol **¥**]. This habitat type is dominated by algae (mostly green and brown algae). Several authors have referred to these algal beds as sea grass beds (ECNAMP, 1980, Meytan, 1983, Boon et al., 1989). However sea grass beds are dominated by sea grasses which are true flowering plants and these hardly occur in the algal beds of St. Eustatius. The sand/algal bed habitat is nevertheless extremely important because it supports an extensive population of Conch.
4. Sand/rubble [symbol *****]. This habitat consists of sand with rubble which is more or less cemented together by coralline algae. It also represents an important habitat for Conch.
5. Artificial habitat [symbol **A**]. This type includes the wreck sites which consist mostly of encrusted ballast stones.
6. Offshore coral reefs [symbol **O**].

The distribution of habitat types is shown in map 8. The most extensive system of encrusted rock ledges and coral reefs is found between Crooks Castle and White Wall. This area contains both ledges that have a patchy distribution, as well as ledges that are aligned in a parallel pattern running out from shore, and scattered rock and coral. Cover by hard corals on these ledges is typically 20-40%. The cumulative number of hard coral species found at all sites is 34.

in the northern part of this area the encrusted ledges (either aligned parallel to one another or in a labyrinth-like pattern) dominate. The southern part, on the other hand, features a series of steep "buttresses", high coral ridges which drop off steeply to seaward and are intersected by deep sand channels. Coral cover on the buttresses can be as high as 80%. Inshore from these buttresses one finds a sandy area with algal beds and Conch.

Off Crook's Castle and the City pier we find a sand/rubble habitat with abundant Conch at a depth of about 20 to 22 m.

The center of Oranjebaai has a sandy bottom. According to Nagelkerken (1991) in 1977 a wide and extensive zone of Manatee grass (*Syringodium filiforme*) was found at 150 to 200 m from shore, which fields were less dense in 1983 and hardly present in 1991. At depths of 15 to 20 m we found algal beds with Conch but with little or no *Syringodium*. Several known wreck sites are located at a distance of 600 m or more from shore. Coral cover in this artificial habitat is low (generally less than 10%.) Further offshore, at a depth of 21 -24 m, we find an encrusted rock ledge, which is supposedly part of the same ledge system that is found south of Crook's Castle. At about 1.5 miles from the end of the City Pier an extensive deep coral reef system begins.

Jenkins Bay and surroundings are characterized by a labyrinth of encrusted ridges and sand channels, as well as huge encrusted rocks. Large encrusted boulders are found close to shore, at depths of 0-3 m.

4.1.2. Condition of marine natural resources

In order to characterize the condition of the resources with reasonable objectivity, we distinguished four categories based on the following criteria.

Condition	Criteria
Pristine	<ol style="list-style-type: none"> 1. no physical damage 2. no signs of stress 3. no diseases 4. no garbage
Healthy	<ol style="list-style-type: none"> 1. minimal physical damage 2. no signs of stress 3. no diseases 4. few garbage
Stressed	<ol style="list-style-type: none"> 1. showing one or more of the following symptoms: diseases, high cover by algae (especially blue-green and red algae), bleaching, high sediment cover 2. evident physical damage 3. much garbage
Degraded	<ol style="list-style-type: none"> 1. many dead or partly dead corals 2. evident physical damage 3. much garbage

On the basis of these criteria we classified nearly all of the sites surveyed as healthy. The buttress formations in the south would have been classified as pristine if not for some garbage found there.

A few sites were classified as stressed because of high siltation. However, this siltation can most likely be considered natural, being the result of groundswells and runoff. Coral development at such sites may be poor, but is probably in equilibrium with the impact from siltation.

4.1.3. Human impacts

We encountered garbage on all sites surveyed in Oranjebai and in the Jenkins Bay area, but much less so in the south. Garbage included anchor line, monofilament fishing line, cloth, plastics, metal, tires, bottles, soda cans and industrial garbage (heavy rope, rubber fenders).

Anchor damage is evident in Oranjebai on and around the wreck sites, manifesting itself as anchor scars in the algal beds and toppled or damaged sponges and soft corals.

The third impact observed is that of fishing. We find the reef fish community somewhat impoverished in terms of numbers of fish. Also we noted the absence of - or low numbers of the larger predators such as Groupers and Snappers. This is generally assumed to be an indication of over fishing (see Plan Development Team, 1990). We also did not observe large numbers of Parrotfish. These species have become much more abundant since the mass mortality of the Long-spined black sea urchin in 1983, wherever fishing pressure is low. Another indicator is the relative high abundance of an unfished species, the Barracuda, which is not normally eaten in St. Eustatius for fear of fish poisoning (Ciguatera). Fishermen consent to a decline of the fishery, but blame this on habitat destruction by anchoring and on oil/dispersant pollution causing a reduction in the number of eggs and larvae produced.

4.1.4. Tourism potential

We rate the tourism potential of the marine areas of St. Eustatius high. This rating is based on the following factors:

1. The high quality and generally healthy condition of the resources.
2. The large variety of dive sites (reefs, rock ledges, wreck sites), adding to the overall attraction of diving.
3. The relatively large number of shallow dive sites (20 m or less), promoting the attraction for less experienced divers and decreasing safety hazards.
4. The opportunities offered for both SCUBA divers and snorkeler.
5. The close proximity of nearly all dive sites to town (most boat rides are 10 minutes or less).

We identified the following constraints for developing diving tourism to its full potential:

1. North swells occurring during the period October to April and resulting from distant storm fields, reduce the visibility in Oranjebai and Jenkins Bay to almost zero and rule out diving on most shallow dive sites.
2. South swells, resulting from a windshiff to the South, create unfavorable diving conditions at the shallow dive sites south of the City pier.
3. The absence of small boat docks for loading divers/snorkeler and gear creates a tremendous inconvenience, especially for less experienced divers. It eliminates diving completely in the case of a ground swell, when people cannot swim out to the boats with their gear.

4. The loading of gasoline and butane into large tankers at the floating fuel dock North of the Terminal jetty creates a safety hazard and may result in restricted access to Jenkins Bay.
5. Lack of regulations in the harbor (Oranjebaai) creating possible dangerous situations, such as divers and boat traffic in the same area.

4.2. Marine Historical Sites

4.2.1. General description

Research carried out by Nagelkerken (1985) indicates that the main historical anchorage is about 900 m long and lies some 500 to 900 m offshore on a central bearing of 60° from the Dutch Reformed Church Tower. The greatest width (approximately 325 m) was found in the area in between the Fort and the Dutch Reformed Church. Nagelkerken (1988a) also conducted test excavations on two wrecks in Oranjebaai. Other marine archaeological investigations conducted by the College of William and Mary and by the Archaeological and Anthropological Institute of the Netherlands Antilles (AAINA) includes research on the ceramics found in Oranje baai (Nagelkerken, 1988b), the wine bottles of Oranje Baai (Nagelkerken, 1987) and the sea walls (De Passalacqua, 1987). More recent excavations in the area of the proposed Multi-purpose Terminal yielded some sites rich in historical artifacts, but did not reveal additional historical wrecks (Nagelkerken, 1991).

Archaeologists of the College of William and Mary have identified 38 historic wrecks, but it is not unlikely that there are many more. Five wreck sites at about 700 m offshore are commonly visited by divers. Another frequently visited site is 1,800 m offshore and features a series of historic anchors. The wreck sites consist of round ballast stones (supposedly river boulders) and bricks, some in a pattern still closely resembling the contours of a ship's hull, others completely scattered. Artifacts such as pipe stems and bowls, earthenware and bottle shards are frequently found around these wreck sites.

4.2.2. Human impacts

As indicated above, we found all kinds of garbage in this area (as could be expected of a harbor area/ anchorage). We also observed recent anchor damage, manifesting itself by overturned or damaged soft corals and sponges. Anchor damage to the wrecks itself is less easy to detect unless one monitors the condition of these wrecks over time, but considering their location they have almost certainly been affected by anchors.

4.2.3. Scientific and educational significance

Since no large-scale excavations of these wrecks have been carried out to date, there may still be a wealth of information buried underneath the sand and among the piles of ballast stones. Such information is of great scientific and educational value as it will teach us more about 17th and 18th century ships and life on board these ships. These values alone are significant enough to make every effort to preserve these historic wreck sites.

4.2.4. Tourism potential

The wreck sites have a high tourism potential. Although these wrecks are nowhere near as spectacular as a large freighter totally overgrown with coral, wrecks in general are a tremendous selling point for dive tourism. In the case of 17th and 18th century shipwrecks the possibility of finding valuable historic

artifacts adds considerably to that selling point. This same feature also presents a risk, of course: those historic sites are being disturbed by "treasure hunters". The diving on these wrecks therefore needs to be strictly controlled and follow clear guidelines as to the collecting of any artifacts. Although there is no island ordinance that prohibits collection of artifacts, the Lieutenant Governor has issued a decree forbidding collection. We strongly recommend to include collection of any kind of natural-historic specimen, dead or alive, into new legislation (see legislation under Recommendations).

Apart from the historic aspect, the wreck sites are also biologically attractive. They are little oases of life in the sand which attract lots of fish. They are located close to town and in intermediate depths.

The wreck sites may have a special potential for the development of so-called scientific tourism. This is a form of tourism whereby lay persons pay good money to do scientific studies under the supervision of experts. It is also a "killing two birds with one stone" approach: revenues are generated from tourism, while at the same time the base of marine archaeological knowledge is increased. Earth watch and CEDAM International are examples of organizations which promote this kind of tourism.

The major constraint to further developing dive tourism for this area is the interference from ship's traffic and anchoring. Suggestions to overcome the constraints to development of dive tourism will be discussed in the next chapter.

V. RECOMMENDATIONS FOR FURTHER ACTION

5.1. The zoning concept

The conflicts between different uses as outlined in an earlier section clearly demonstrate the need for comprehensive management of the marine environment and its resources. Such management needs to be firmly anchored in legislation and should be based on the concept of zoning. The zoning will attempt to accommodate the different uses of the marine environment and its resources, while minimizing conflicts between them.

We recommend that the following zones be established (see map 9):

1. Marine Park zones.

One would be situated south of the city pier, with the following bounds: from Gallows Bay at latitude 17° 28'.5 along the high-water mark to White Wall, south and out to sea for 0.5 nautical mile, west following the 30 m depth contour or 0.5 nautical mile from shore (whichever is farthest out) up to the point where the 30 m line crosses latitude 17° 27'.7, due north to latitude 17° 28'.5 and back to the point of origin.

The other zone would be located in the Jenkins Bay area with the following bounds: from latitude 17° 30'.5 along the high-water mark to the northernmost tip of the island, due north to the 30 m depth contour, west and south along the 30 m depth contour until this line crosses the 17° 30'.5 latitude and back to the point of origin.

The main objective of marine park zones is to preserve fragile coral reefs. As these systems are well developed both south of the city pier and at Jenkins Bay, these two areas need to be included in the marine parks zones.

Regulations and restrictions in these areas should include:

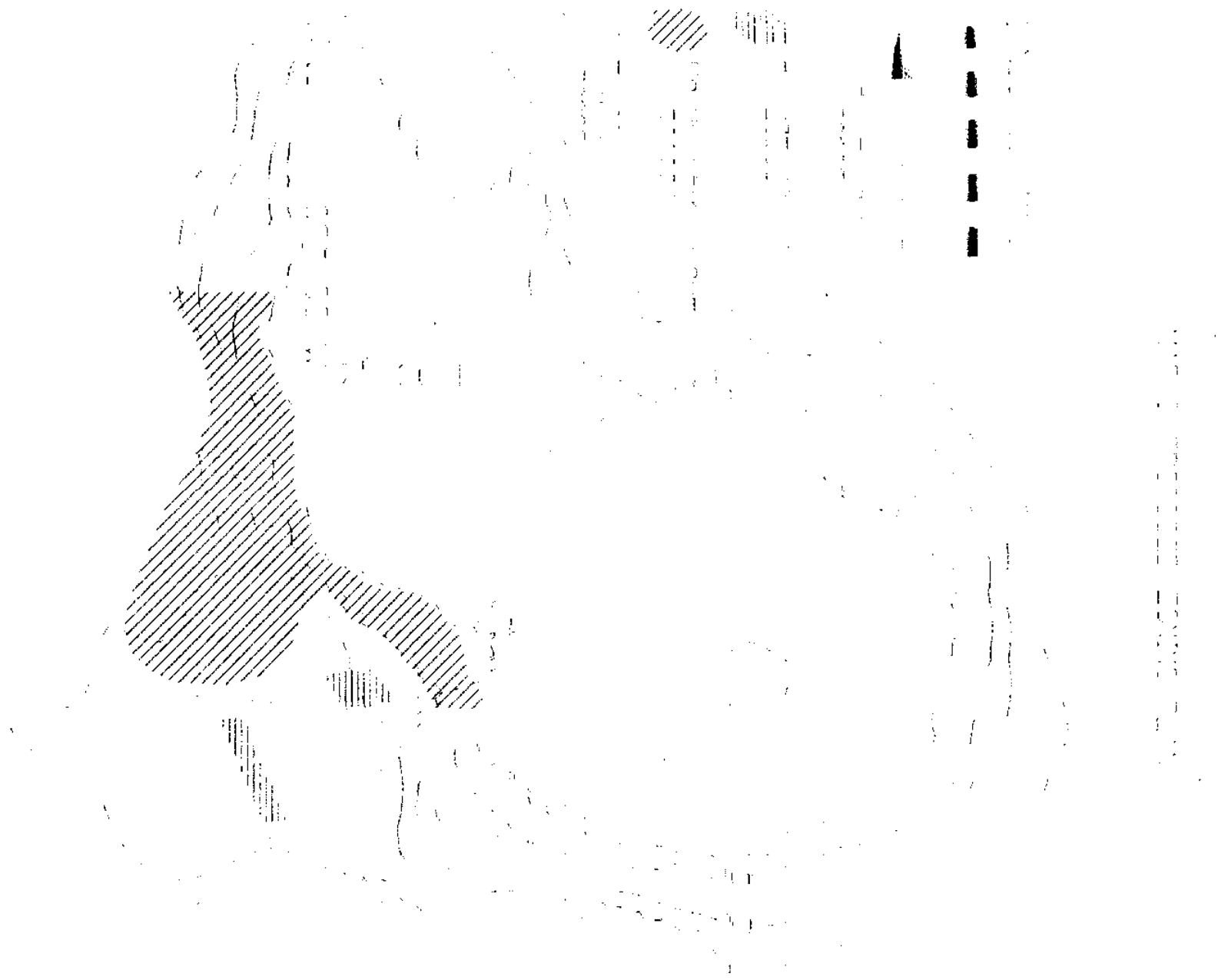
No anchoring in or near coral, no taking of any reef invertebrates or plants and no activities that may harm the reef system. Permanent moorings will be provided in these areas. Fishermen will retain the right to fish and to fish for lobster during the lobster season. However, no traps will be placed within a 100 m radius from any buoyed dive site in a marine park zone. Spear fishing will also be prohibited.

2. Archaeological zones.

These zones are established to provide full protection to shipwrecks and their artifacts. Many of these wrecks are not or poorly described and have a very important scientific, educational and touristy value. Anchoring will be prohibited in these zones and permanent moorings will be provided. Since the zones are located in shipping routes, through passage will also be prohibited and their boundaries need to be clearly marked with buoys. Diving and research will be regulated through a permit system. The suggested boundaries for these zones are indicated in map 9 but need to be further defined.

3. Harbor/anchorage zones.

These zones include most of Oranjebai (excluding the archaeological zones), Tumble Down Dick Bay and bunker, vessel anchorages. It is bound by the marine park zones to the north and the south. These zones provide an anchorage for local vessels and visiting yachts, as well as for bunker vessels and waiting tankers. Inshore yacht moorings will be provided as a service to the yachting community and as a means to regulate use of the harbor by yachts.



The Tumble Down Dick Bay area may require additional restrictions as to traffic because of safety concerns. The southernmost anchorage for bunker vessels as presently indicated on the nautical charts is too close to the archaeological zones and needs to be abandoned.

4. Fisheries management zones.

The remaining territorial waters around the island will be designated as a fisheries management zone (not distinguished on map 9). This means that activities that could jeopardize the interests of the local fishermen will be prohibited. The rights of the local fishermen will be protected by a system of licensing. Local fishermen should receive a fishing license free of charge. The license will be issued by the Executive Council as part of the island ordinance that designates the zones. This fishing license will be additional to the Central Government's fisheries legislation (see Annex II).

5. Traffic zones.

In order to allow safe diving at the archaeological sites and a safe anchorage, ship's traffic in Oranjebaai must be regulated. This will be achieved by shipping lanes for traffic approaching and leaving the harbor. Traffic to the city pier or RoRo pier approaching from the south should stay at least 8 cables (1 cable is 0.1 nautical mile) off shore, cross latitude 17° 28' at a distance of between 8 and 10 cables and then head straight to the pier. Traffic approaching from the north should avoid the two archaeological zones, but can approach either north or south of the inshore archaeological zone. Traffic between the terminal jetty and the city pier must also avoid the archaeological zones, but can pass in between the anchorage zone and the inshore archaeological zone. Traffic passing the island without the intention to call at Oranjestad harbor should stay a minimum of 2 nautical miles off shore.

5.2. Legislation.

Marine environmental legislation can be found on several levels. The highest level will be international or regional legislation if the Kingdom of the Netherlands has signed these conventions or treaties on behalf of the Netherlands, the Netherlands Antilles and Aruba. Sometimes the legislation is not applicable to a part of the Kingdom of the Netherlands, if additional national legislation has not been put in place. A step lower we have national legislation made by the Central Government in Curacao. The lowest level, but presumably also the most effective, is the island level (see Annex II). For a more detailed study of the environmental legislation in the Netherlands Antilles we refer to Van Rijn (1992) and Richardson and Sybesma (1990). An example of proposed legislation is included under Annex II: Legislation.

5.2.1. Proposed new legislation.

The marine environment of the island of St. Eustatius must be protected. This has been mentioned in several reports in the past and must be restated. In the absence of legal control means, damage has already been inflicted to the natural and archaeological resources. The proposed zoning regulations and the designation of specially protected areas must be based on legislation in order to be effective. High priority must therefore be given to the introduction of new marine environmental legislation.

A potential conflict exists with regards to the respective jurisdiction over the marine environment, between the central government and the island governments. The division of responsibility between central and island governments is regulated through the ERNA (Island Regulations Netherlands Antilles). In art.-2 and 2a all subjects belonging to the jurisdiction of the central government are mentioned. Environment and nature protection are not mentioned. All subjects not mentioned belong therefore to the island governments' responsibilities (art. 1(2) ERNA).

Only those aspects regarding international law and subsequent responsibilities will be regulated by the central government. Bonaire and Saba have introduced their own marine environmental legislation and these ordinances have never been appealed by a higher authority. Cases based on these ordinances have been brought to court and processed without a judge or defense lawyer ever questioning the legitimacy of the ordinances. It can therefore be concluded that the island government has the right to produce island ordinances regarding the protection and management of its territorial waters (Van Rijn, 1992).

We suggest that the new Marine Environment Ordinance for St. Eustatius be a framework island ordinance, with implementation of details through EHAMs (Island Resolution Containing General Provisions). The Marine Environment Ordinances of Bonaire and Saba could function as models and the new ordinance should contain the following elements:

1. Definitions.
2. General provisions regulating the use of marine natural and archaeological resources,
3. Specific regulations governing the use of resources in the different zones.
4. Regulations concerning the use and installation of permanent moorings.
5. Regulations concerning coastal development (e.g. dredge and fill operations, construction of dams, piers and groins).
6. Discharge of pollutants.
7. Revenue enhancement (e.g. user fees).
8. Permitting (e.g. watersports operations, scientific research).
9. Management authority.
10. Closing articles and penalties.

The designation and delimitation of the different zones should be done by EHAM, as this may need further refinement after some experience has been gained with the actual functioning of the zones.

We feel that all aspects of the proposed legislation can be dealt with at the level of the Island Government (Island Council), perhaps with the exception of the traffic zones. The Executive Council can make recommendations to the Chief Hydrographic of the Royal Netherlands Navy on shipping lanes, which would then be included in the navigational charts issued by this office. The recommendations are likely to be observed by commercial traffic, but they carry no legal weight. It is possible, however, to get so-called "areas to be avoided" legally declared by the International Maritime Organization, but this requires a procedure that may take several years.

5.3. Management.

The underlying thought for creating marine environmental legislation and zoning is to have a base for managing the marine resources in a responsible and sustainable manner. Although enforcement of the legislation is an important element of management, it is certainly not the only element.

We consider management of such a resource management program to include:

1. administrative and financial management.
2. patrolling, surveillance and enforcement.
3. providing information and education to users
4. providing facilities to users.
5. conducting research and monitoring of the resources and user activities.
6. maintenance of facilities and equipment.

In order to implement marine environmental resource management with success, four main conditions must be fulfilled:

1. An appropriate institutional structure for management must be established.
2. Funds to carry out management must be available.
3. Trained staff to carry out management must be found.
4. Adequate equipment and materials to carry out the day-to-day work must be available.

5.3.1. Institutional structure.

Following our discussions with representatives of Government, the private sector, fishermen and non-governmental organizations (NGOs), we recommend that management be delegated by Government to an independent NGO. Since none of the existing NGOs seem sufficiently prepared or equipped to take on such a task, it seems inevitable to create a new body. The advantages of an NGO are well-known: they are more flexible and less bureaucratic than Government, they can tap into a wider variety of funding sources, and they can generate revenue and receive donations and subsidies.

The most common form of NGO in the Netherlands Antilles is a Foundation. The other islands of the Netherlands Antilles also have environmental foundations, three- of which are formally charged by Government with the management of marine parks. In the case of St. Eustatius, where we face so many conflicting interests in the use of the marine environment, we recommend that a new foundation for managing the marine environment be created and that the board of directors of such a foundation includes representatives from Government, Harbor Office, tourism sector, fishermen, oil terminal, Historical Foundation, Stinapa and Environment Committee.

5.3.2. Staffing.

Even in a very modest setup a staff of two is the minimum required to run a resource management program: a manager, with some background in natural resources management, with an assistant. It is very unlikely someone with the required background for the manager's position could be found locally. An assistant could most likely be hired locally and receive subsequent on-the-job training.

Since law enforcement will be an important task, staff should have special police authority. In addition cooperative agreements regarding law enforcement should be made with the Harbormaster and the Police Corps including the Police boat which is based in St. Maarten.

Further assistance can be obtained from volunteers who can perform a variety of functions, both in the office as well as on or in the water. Volunteer assistance will be especially valuable as funds are likely to be very limited.

5.3.3. Equipment and materials.

Staff must have an office with telephone and VHP radio, a vehicle and small boat for transportation, diving equipment, underwater photo equipment, and equipment and materials for mooring installation and maintenance. Since public education and information are important elements of their task they should also have word processing and desktop publishing facilities so that flyers and other information materials can be produced in-house.

5.3.4. Funding.

It is not clear at present how a marine environmental management program can be funded. Start-up funds could be obtained through aid agencies, but considering the financial situation of the small Island Territories, it is unlikely that sufficient long-term funding from Government sources would become available.

The best option seems to be a combination of funding sources and revenue generating mechanisms. Such a funding strategy would combine subsidies with user fees, watersports concessions, private sector funding, donations, sales and proceeds from research licenses. The income will increase with further growth of the tourism sector.

5.3.5. Proposed budget for implementation.

Start up costs (equipment):

vehicle	NAf. 25,000
boat (inflatable)	NAf. 20,000
diving equipment (2x)	NAf. 8,000
u.w. photo equipment	NAf. 3,500
office installation	NAf. 9,500
mooring installation (20)	NAf. 30,000
communications	NAf. 5,000
miscellaneous	<u>NAf. 10,000</u>
total	NAf. 110,000

Annual costs:

manager (NAf. 5000/month)	NAf. 60,000
assistant (NAf. 3000/month)	NAf. 36,000
office space	NAf. 12,000
office supplies	NAf. 5,000
tel/fax	NAf. 5,000
education/P.R.	NAf. 20,000
depreciation	NAf. 15,000
miscellaneous	<u>NAf. 15,000</u>
total	NAf. 168,000

VI. CONCLUSION

The objective of this study, "to make suggestions and recommendations for the protection of possible archaeological and biological features, including the possible sustainable recreational use" has certainly been met. The biological and archaeological resources are described in detail and several areas are identified for possible recreational use. Conflicts between uses in the different areas are mapped and suggested solutions to these conflicts are provided through proposals for zoning, including marine park zones and archaeological zones. Suggestions for practical implementation of the recommendations are also provided.

We believe that the quality of the marine resources justifies further sustainable development of marine tourism, but that such a development can only be reconciled with other conflicting uses through the rigid implementation of a zoning plan.

Once the recommendations have been accepted in principle by the Island Government of St. Eustatius, a project proposal with a detailed budget for implementation will have to be prepared and submitted for funding.

VII. TERMS OF REFERENCE

Project Proposal and Budget 'Implementation Statia Marine Park'¹

The following are proposed terms of reference for implementation of a follow up project regarding the establishment of the Statia Marine Park.

1. An outline of necessary legislation, both on an island as national level
2. A time frame for setting up an organization for implementation
3. A time frame for the establishment of the Statia Marine Park
4. A budget and financial breakdown for:
 - the initial phase (set-up)
 - mid term planning (5 year) and long term planning (30 years)
5. Personnel requirements (see staffing in chapter "Recommendations...")
6. An economic assessment of the self sustainability of the Statia Marine Park

ACKNOWLEDGEMENTS

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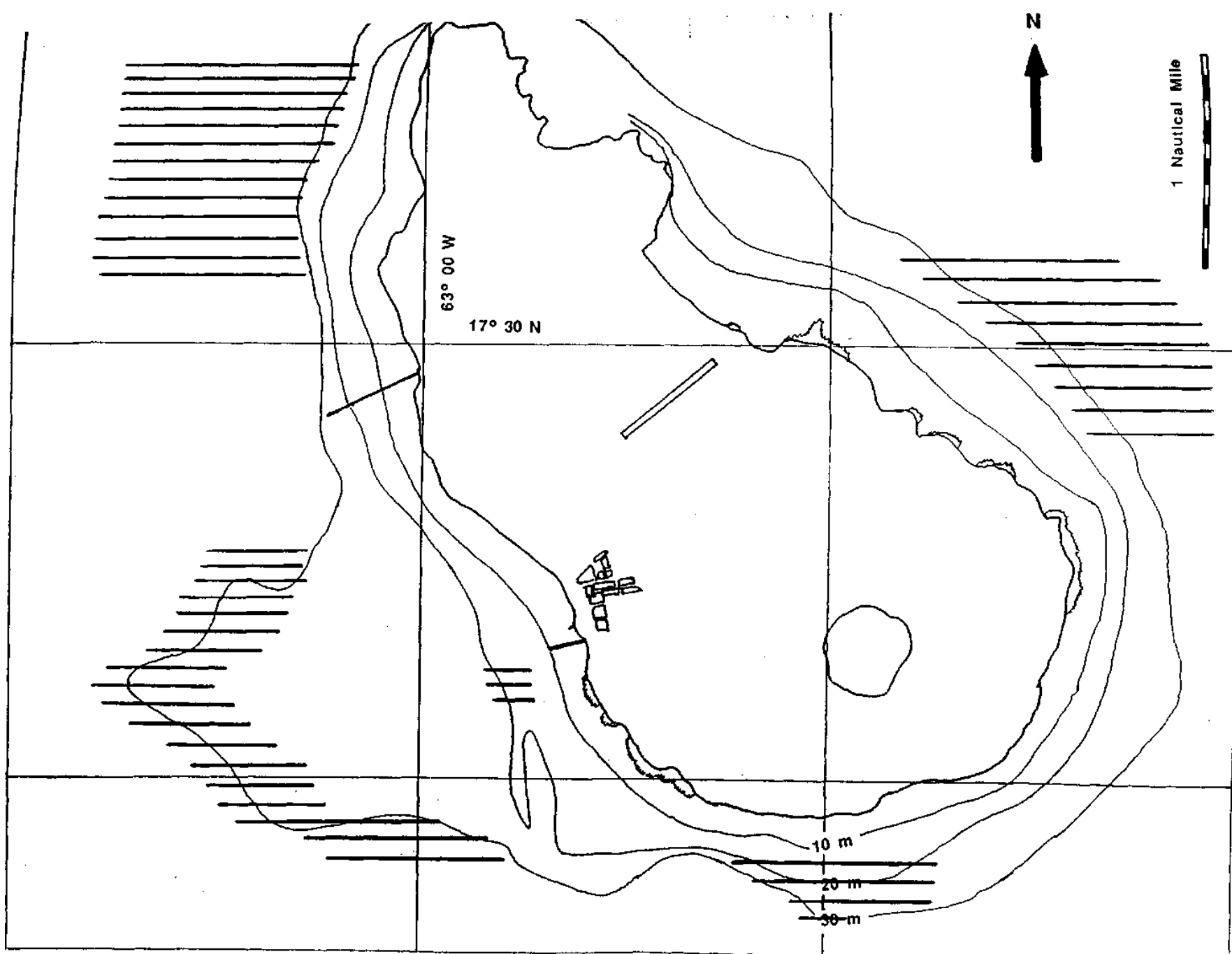
MAPI

Nautical chart of the island of St. Eustatius

Dienst Hydrografie Koninklijke Marine
(Hydrographic Office Royal Netherlands Navy)

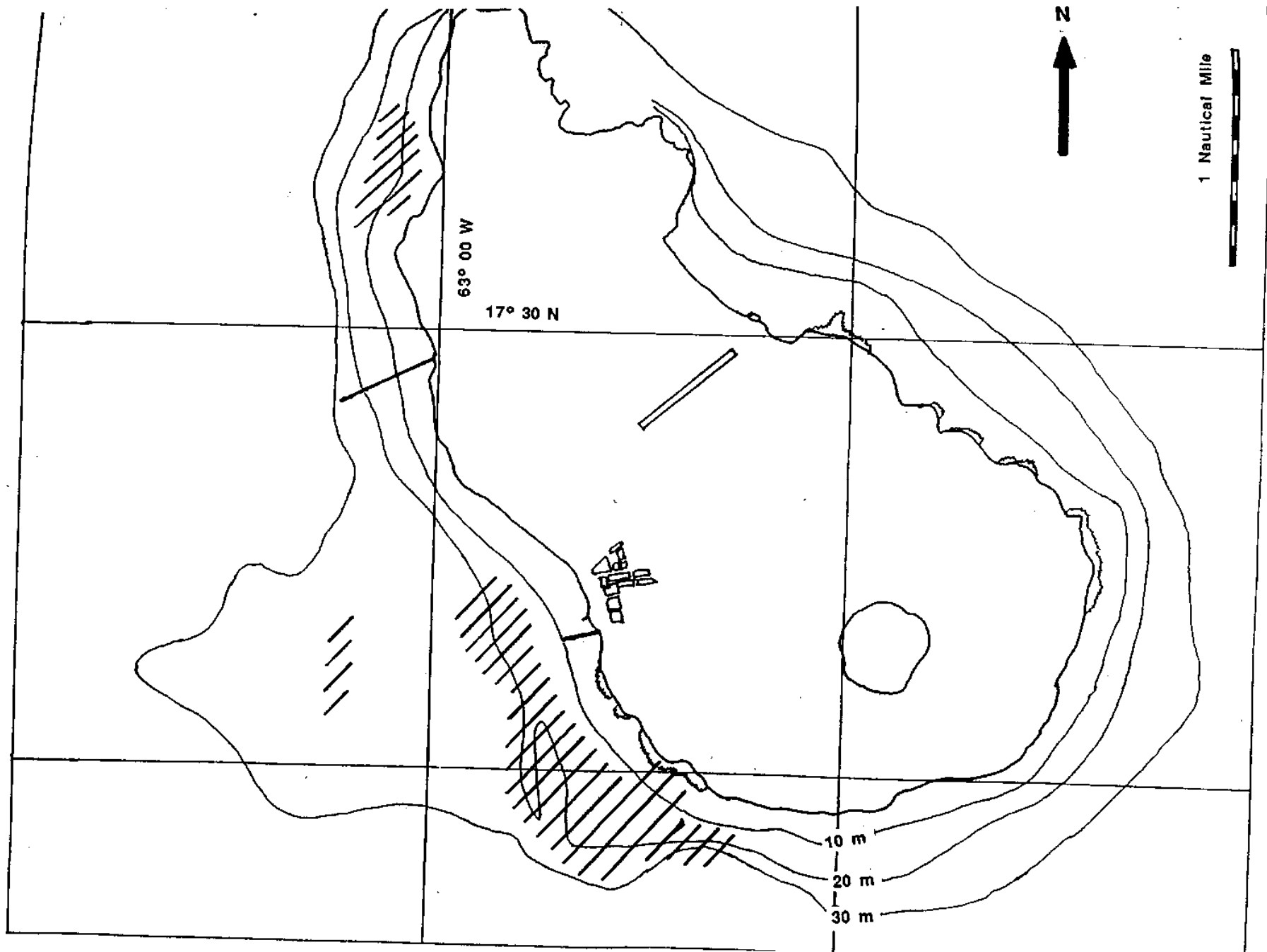
MAP 2

Distribution of trap fisheries and conch fisheries



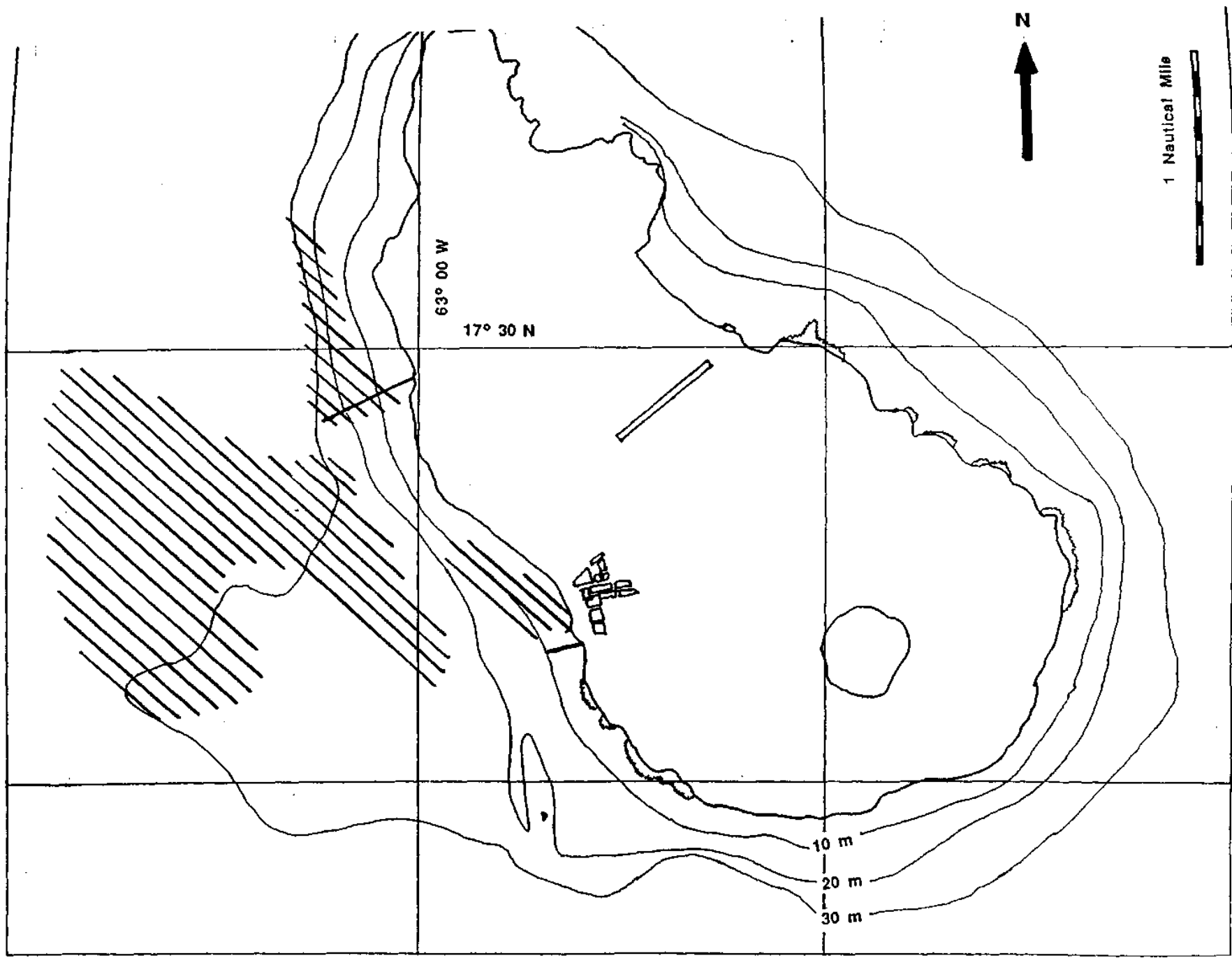
MAP 3

Distribution of recreational diving and snorkeling



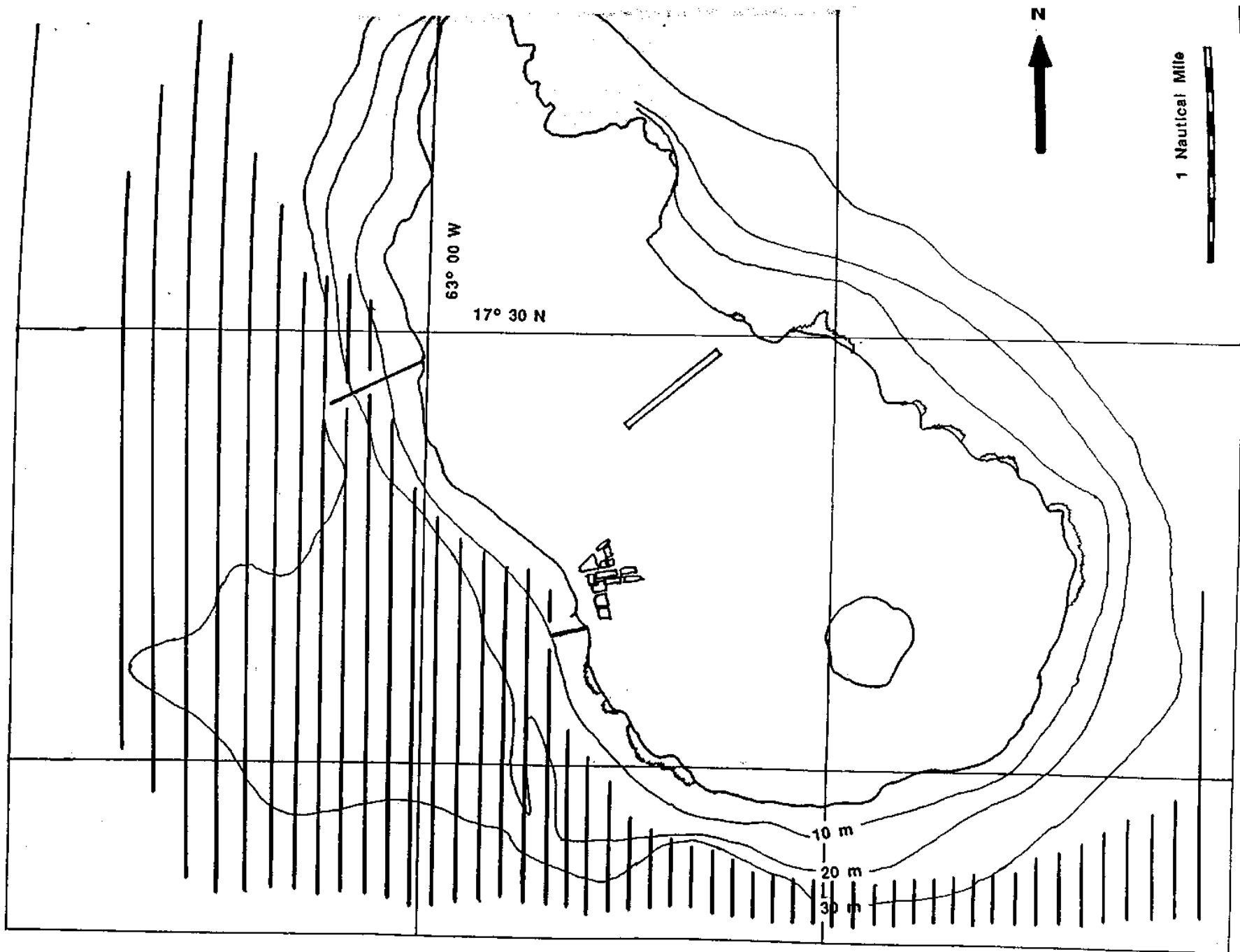
MAP 4

Distribution of anchoring



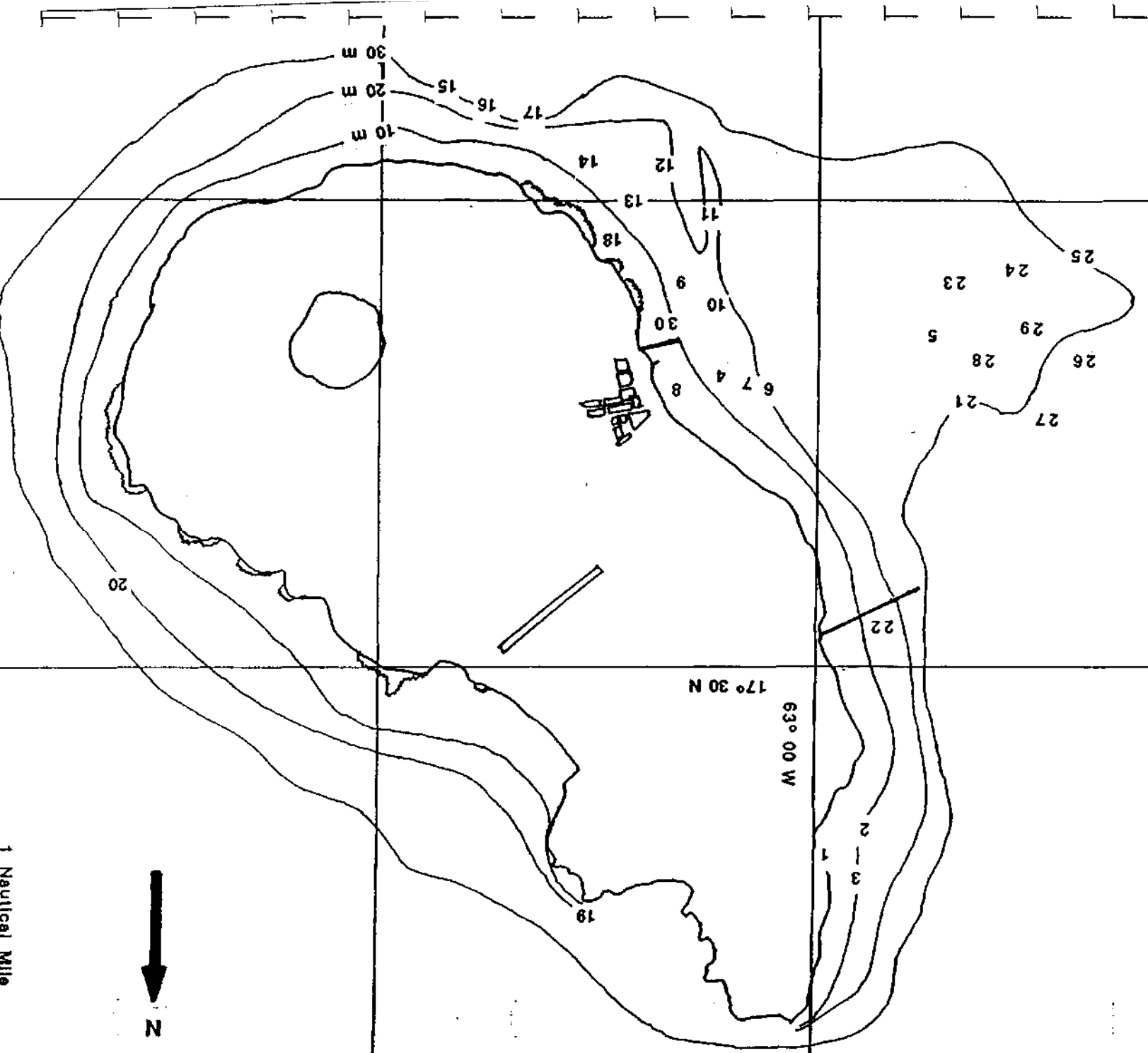
MAPS

Distribution of ship's traffic



MAP 6

Conflicts between different uses of the marine environment



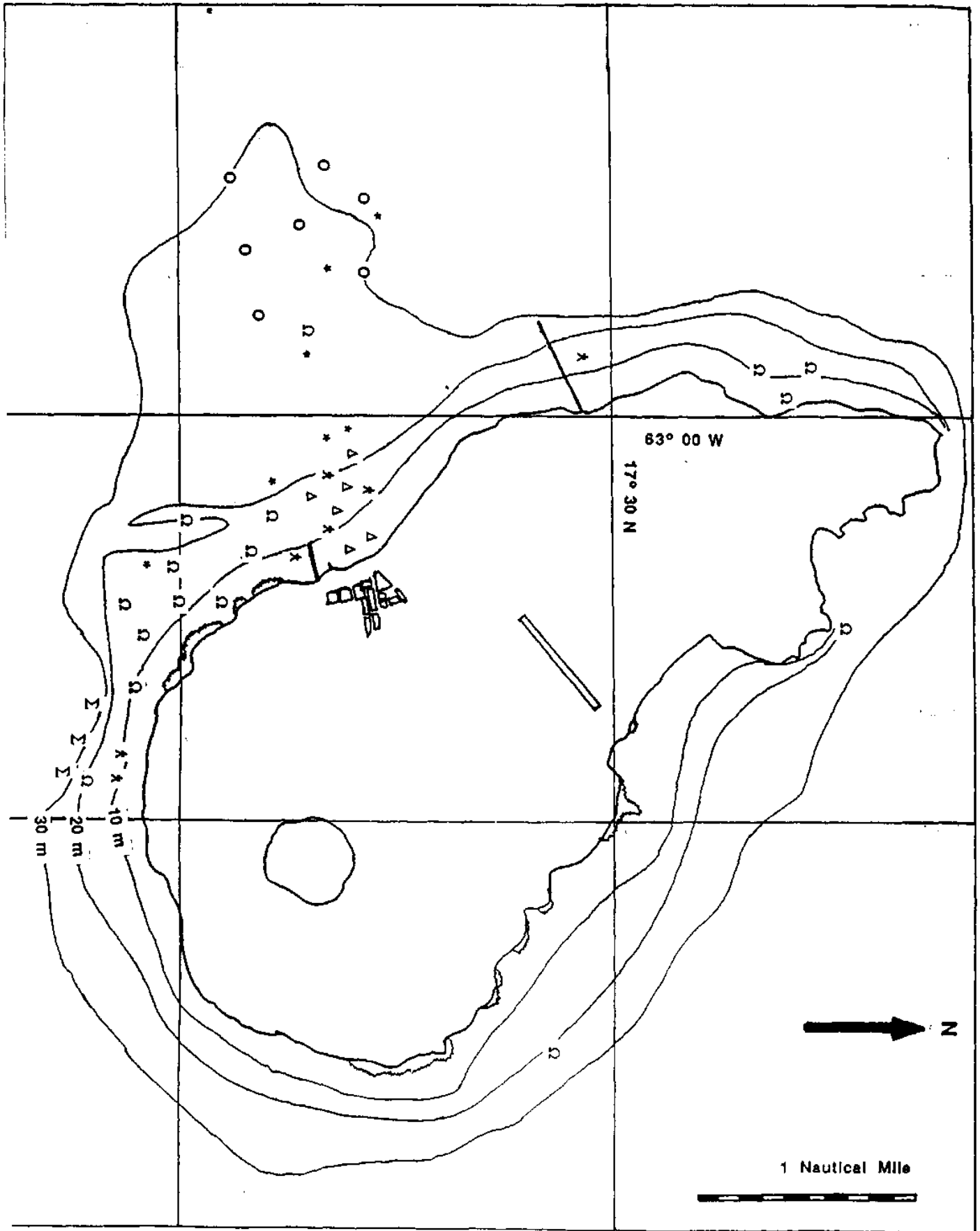
1 Nautical Mile



MAPS

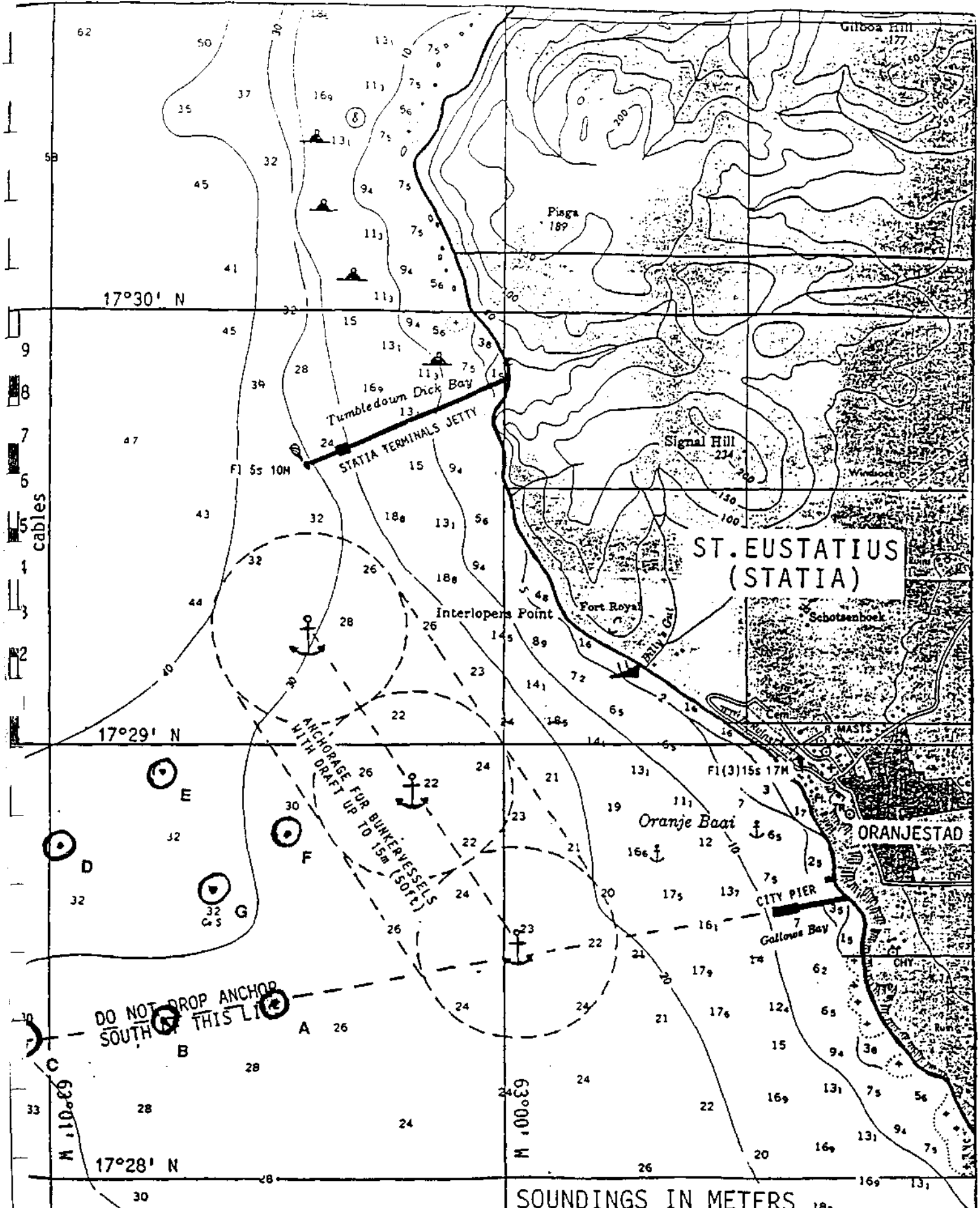
Habitat types

n	Encrusted rock boulders and rock ledges
I	Coral reefs
¥	Sand with algal beds
.	Sand/rubble
A	Artificial habitat
^	Offshore coral reefs



MAP 9

Proposed zoning plan



SOUNDINGS IN METERS

ANNEX I: SITE DESCRIPTIONS

A. JENKINS BAY AREA

DATE: 26/03/92
LOCATION: Jenkins Bay (snorkel site, from south end of bay towards Two sisters)

DEPTH RANGE: n.a.
CURRENT: none
VISIBILITY: HABITAT 12-15m
TYPE: COMMUNITY encrusted rocks and boulders
TYPE: CONDITION: mixed (hard, soft corals and sponges)
stressed (sediment/swells)

DESCRIPTION:
INVERTEBRATES: Rock and boulders encrusted primarily with *Millepora alcicomis*, *Diploria clivosa*, *Montastrea cavemosa*, *Gorgonia ventalina* and *Palythoa*. Encrusting sponges present but not common. Most boulders not covered with invertebrates but with algal turf in which sediment is trapped. Many dead colonies of *Acropora palmata*.

Total number of species of hard corals observed: 10
Species list:
M. mirabilis
Acropora palmata
Agaracia agaricites
Siderastrea radians
P. astreoides
P. porites
D. strigosa
D. clivosa
Montastrea cavemosa
M. annulaha

Dominant soft coral species: *Gorgonia ventalina*

Other common soft coral genera/species present: few other species, slightly deeper.

Sponges: Very few

FISH: Palometa, Needlefish, school of Blue Tang and Ocean surgeonfish,
HUMAN IMPACTS: Barracuda.

Garbage (rope, net)

RECREATIONAL POTENTIAL: Limited; good for inexperienced snorkelers because of protected conditions, but low diversity in living organisms.

REMARKS: Maimed octopus, low density of sea urchins (*Diadema*), big colonies of *Trididemnum*.

DATE: 14/03/92
LOCATION: Jenkins Bay
DEPTH RANGE: 0-1 Om
CURRENT: none
VISIBILITY: 18m
HABITAT TYPE: sand with coral-encrusted ledges
COMMUNITY TYPE: mixed hard/soft coral/sponge community
CONDITION: healthy

DESCRIPTION: Labyrinth-like system of ledges with low coral cover, significantly affected by siltation (which probably is a normal condition for a shallow reef system regularly affected by ground swells). Coral cover less than 10%. *Montastrea cavernosa* relatively abundant. Sponges few in number and species. Hard and soft coral colonies small in size. Generally low numbers of fish. Many Southern stingrays at the southern end of the ledge system in the sandy area near the "arch". Fish more abundant locally where coral is less affected by siltation or more prolific.

INVERTEBRATES: Total number of species of hard corals observed: 19

Species list:

Stephanocoenia michelinii
Madracis decactis
Madracis mirabilis
Agaracia agaricites
Helioseris cucullata
Siderastrea siderea
Porites astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans
Montastrea cavernosa
M. annulata
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Mycetophyllia sp.
Eusmilia fastigiata
Manicina areolata

Dominant soft coral species: *Gorgonia ventalina*, *Plexaura flexuosa*, *P. homomalla*.

Other soft coral genera present: *Muricea*, *Eunicea* and *Pseudopterogorgia*.

Sponges: Few species; some *Xestospongia muta*

FISH: Low numbers. Blue tang, Spanish grunts and Smallmouth grunts, including juveniles, Mahogany snappers.

HUMAN IMPACTS: Some garbage, including plastics.

DATE: 30/03/92
LOCATION: Two Sisters to Jenkins S (drift)

DEPTH RANGE: 6-13 m
CURRENT: none
VISIBILITY: 18m
HABITAT TYPE: encrusted rock, sand patches
COMMUNITY TYPE: mixed, dominated by hard and soft coral
CONDITION: healthy

DESCRIPTION: This site is characterized by a labyrinth of ridges, boulders and sand patches. Closer to Jenkins South ridges running out from sand shore, alternated by sand channels prevail. There are a number of huge rocks (e.g. the Two Sisters) that are encrusted with colorful sponges, fire coral and hard corals. In general hard and soft corals dominate. In shallow water dead colonies of *Acropora palmata* are found. The entire area is rather poor in fish.

INVERTEBRATES: Total number of species of hard corals observed: 25

Species list:

Stephanocoenia michelinii
Madracis decactis
M. mirabilis
Acropora palmata
A. cervicornis
Agaracia agaricites
Helioseris cucullata
Siderastrea siderea
Siderastrea radians
Porites divaricate
P. astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
D. clivosa
Colpophyllia natans
Montastrea cavernosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Isophyllastrea rigida
Mycetophyllia sp.
Eusmilia fastigiata
Tubastrea aurea

Dominant soft coral species: None

Other common soft coral genera/species present: *Gorgonia ventalina* (large colonies), *Pseudoplexaura*, *Plexaura flexuosa*, *P. homomalla*, and to a lesser extent, *Pseudopterogorgia* and *Eunices*.

Sponges: *Xestospongia muta*, *Chondrilla nucula*, *Cinachyra sp.* common. Many encrusting and boring species.

FISH: Few species and individuals. Common occurrences are Blue tang (including school), Sergeant major, Spanish hogfish, Yellowtail damselfish. Some small Black durgon and small Coneyes.

HUMAN IMPACTS: Some garbage (heavy rope, plastic strap, rubber fender)

RECREATIONAL POTENTIAL: Good, because of shallow depths; excellent for novice divers and snorkelers.

REMARKS: Coral development is restricted by sediment movement. Turtle (resident).

B. ORANJE BAAI AREA

DATE: 16/03/92
LOCATION: Stingray

DEPTH RANGE: 16-18 m
CURRENT: light, to north
VISIBILITY: HABITAT 18-20m
TYPE: COMMUNITY artificial (wreck), sand
TYPE: mixed sponge/gorgonian community on artificial habitat; algae and seagrass community in sand
CONDITION: wreck site good; algae/seagrass community stressed

DESCRIPTION: The top of the wreck site is at 16 m. It has low cover by hard coral (< 1%), but abundant and diverse sponges and gorgonians. Macroalgae (amongst other *Sargassum sp.*) are also common. The surrounding sandy area is dominated by the alga *Penicillus sp.* and has a population of Conch and Flying gurnards.
Southern stingrays are common around the wreck. Other algae include *Halophila sp.*, *Halimeda monile* and a gelatinous and slippery brown alga, often dislodged and free floating (possibly *Cladosiphon occiden-talis*).

INVERTEBRATES: Total number of species of hard corals observed: 16
Species list:
Stephanocoenia michelinii
Madracis decactis
Madracis pharensis
Agaracia agaricites
Helioseris cucullata
Siderastrea siderea
Forties astreoides
P. porites
Montastrea cavemosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Scolymia lacera
Isophyllastrea rigida
Eusmilia fastigiata
Manicina areolata

Dominant soft coral species: *Pterogorgia sp.* is the dominant species.

Other common soft coral genera/species present: *Pseudopterogorgia*, *Plexaurella*, *Gorgonia ventalina* and *Eunicia*.

Sponges: Yellow tube sponges (*Aplysina sp.* possibly *A. fistularis*) is dominant. Others include *Xestospongia muta*, *Ircinia strobolina*, *Ircinia campana* and several encrusting species.

FISH:
HUMAN IMPACTS: Typical for this habitat are Southern stingrays, Flying gurnards, Lizard-fish, Sandtile fish and schools of Yellow goatfish. Cottonwick are schooling under a ledge in the wreck.
Also observed, but not common, are White grunt and Greater amberjack. Juveniles common.

Garbage (plastic, metal, glass, industrial) and anchor scars in the nearby algae/grass community.

RECREATIONAL POTENTIAL: Excellent; interesting site especially because of abundant and diverse life on and around the wreck site.

REMARKS: Two species of Tunicates present on wreck: social species *Clavelina sp.* and solitary Giant tunicate, probably *Herdmania momus*.

DATE: 30/03/92
LOCATION: Anchor Row

DEPTH RANGE: 21-24m
CURRENT: moderate, to north
VISIBILITY: 25m
HABITAT TYPE: sand/rubble; encrusted rock ledge
COMMUNITY TYPE: mixed hard/soft coral and sponges
CONDITION: healthy

DESCRIPTION:
INVERTEBRATES: The "reef" is an encrusted rock ledge with top at 21 m, running in an east-west direction. Sponge diversity is high, hard and soft coral diversity are less. Coral colonies generally small in size. Coral cover is 10%. *Lobophora* is common on the ledge, and to a lesser extent *Dictyota*. The sand/rubble habitat is characterized by patches of hard and soft corals and sponges.

Total number of species of hard corals observed: 16

Species list:

Stephanocoenia michelinii
Madracis decactis
M. pharensis
Agaracia agaricites
Siderastrea siderea
P. astreoides
Diptoria labyrinthiformis
D. strigosa
Montastrea cavemosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Mussa angulosa
Isophyllastrea rigida
Eusmilia fastigiata

Dominant soft coral species: *Pseudoplexaura* and *Plexaura flexuosa*.

Other common soft coral genera/species present: *Gorgonia ventalina*, *Eunicea*, *Iciligorgia schrammi*.

Sponges: Good diversity of species. Common species include: *Ircinia strobilina*, *I. campana*, *Chondrilla nucula*, *Aplysina lacunosa*. *Neofibularia nolitangere*, *Cliona langae*. *Xestospongia muta* is common in the sand/rubble habitat.

FISH:
HUMAN IMPACTS: Many Barracuda (at least 50), mostly up to 50 cm. Many Yellowhead jawfish in the sand/rubble. Generally few reef fish. Common sightings include Black durgon, Queen triggerfish, French and Grey angelfish, Black margate. Also observed: Black jack.

Some anchor rope. Two ghost traps, one with 1 m Nurse shark and a spider crab.

RECREATIONAL POTENTIAL: Good, because of attractive large old anchor (photo opportunity), extensive ledge with many possibilities for exploring.

REMARKS: Hawksbill turtle, Spiny lobster

DATE: 25/03/92
LOCATION: Supermarket

DEPTH RANGE: 17-20 m
CURRENT: moderate to N
VISIBILITY: HABITAT 12m
TYPE: COMMUNITY sand, sand/rubble, artificial (wrecks)
TYPE: CONDITION: mixed soft coral/sponge community, algal beds
healthy

DESCRIPTION: The site consists of two wrecks. A northern wreck (top at 18 m) which is mostly covered with sand and has patchy cover by soft corals and sponges, but very few hard corals (1-2% cover, and very small colonies). The southern wreck (top at 16.5 m) has more prolific growth, but still few hard corals (about 5% cover). Ballast stones and bricks are more easily recognized on the southern wreck. Both wrecks show a distinct ledge on the southern side. Scattered bottle shards can be found. An algal bed is located east of the wreck sites. The green alga *Udotea flabellum* is dominant in this bed. Others include *Penicillus capitatus*, *Penicillus sp.* (probably *P. dumetosus*) and *Cladosiphon occidentalis*. Queen conch, Milk conch and Helmet are common.

INVERTEBRATES: Total number of species of hard corals observed: 14
Species list:
Stephanocoenia michelinii
Madracis decactis
Agaracia agaricites
Siderastrea siderea

P. astreoides P.
porites D.
strigosa
Montastrea cavernosa M.
annularis Meandrina
meandrites Dichocoenia
stokesi Isophyt/astrea
r/gida Mycetophyllia
lamarcki Eusmilia
fastigiata

Dominant soft coral species: No dominant species.

Other common soft coral genera/species present: *Pseudopterogorgia*,
Pterogorgia, *Gorgonia ventalina*, *Eunicea*, *Pseudoplexaura*, *Plexaurella*,
Plexaura flexuosa, *Plexaura homomalla*.

Sponges: *Xestospongia muta*, *Aplysina fistularis*, *Ircinia strobilina*, *Cliona*
langae and several other encrusting species.

FISH:
HUMAN IMPACTS:

Few species and individuals, especially on the northern wreck. Generally small individuals (juveniles or intermediate forms). Sandtile fish common, some Yellowhead jawfish. Around the southern wreck a large mixed school is present with Mahogany snapper, Lane snapper, Schoolmaster, Yellow goatfish, Cesar grunt, Bluestriped grunt, Cottonwick, Black margate, Blue tang and Ocean surgeonfish.

Probably anchor damage (toppled sponges and gorgonians) and garbage (beer bottles, cloth, ropes, car tire)

RECREATIONAL POTENTIAL: Good (proximity to dive shop, medium depth range, extensive wreck site - especially southern wreck).

REMARKS:

Low visibility because the site was surveyed just after a northern swell. Sea cucumbers observed here.

DATE:
LOCATION.

13/03/92
Double Wreck

DEPTH RANGE:
CURRENT:
VISIBILITY: HABITAT
TYPE: COMMUNITY
TYPE: CONDITION:

15-19 m
none
15m
artificial substrate (wreck), sand
mixed hard/soft coral/sponge
healthy

DESCRIPTION:

Wreck sites consisting of large ballast stones (river boulders) encrusted with hard and soft corals and sponges. High diversity of hard corals, but low abundance (cover 10% or less). Moderate diversity of soft corals, low abundance and small size colonies. High diversity of sponges. Barren sandy areas in the immediate surrounding of the wreck sites, but sand

with *Penicillus capitatus*, *Syringodium filiforme* and some *Halimeda* sp. further away from the wreck sites. Healthy population of Queen Conch.

INVERTEBRATES:

Total number of species of hard corals observed: 16.

Species list:

Stephanocoenia michelinii

Madracis decactis

Siderastrea s/derea

Porites astreoides

P. porites

Diploria strigosa

Colpophyllia natans

Montastrea cavernosa

M. annularis

Meandrina meandrites

Dichocoenia stokesi

Isophyllastrea rigida

Scolymia lacerata

S. cubensis

Mycetophyllia sp.

Eusmilia fastigiata

Dominant soft coral species: *Gorgonia ventalina* (small colonies only)

Rerogorgia sp.

Other soft coral genera present: Not recorded

Sponges: *Aplysina* sp. (possibly *A. fistularis*) and *Ircinia campana* particularly abundant.

FISH:
HUMAN IMPACTS:

Schooling behavior of Cesar grunt, Squirrelfish, Yellow goatfish, White margate, juvenile French grunt. Other common species include Sand diver, Flying gurnard, Garden eels, Sandtile fish and Spotted goatfish. Incidental observations: Nassau grouper, Queen triggerfish, Southern stingray, Porgy.

Garbage (metal, plastic, industrial). Several damaged or dislodged Gorgonians and sponges (possible anchor damage).

RECREATIONAL POTENTIAL: High because of archaeological value.

REMARKS:

Mats of red algae indicating disturbances. Large number of cleaning shrimp (*Pericleminespedersoni*). Some Spiny lobster.

DATE:

25/03/92

LOCATION:

City wall

DEPTH RANGE:

2-4 m (snorkel)

CURRENT:

none

VISIBILITY:

6 m

HABITAT TYPE:

artificial

COMMUNITY TYPE:

Millepora/sponge community

CONDITION:

stressed (sediments: natural)

DESCRIPTION: Artificial rock boulder wall. Made of ballast stones Encrusted primarely with
INVERTEBRATES: *Millepora alcicornis*. Abundant *Diadema antillarum*. Wall extends from the
Roro pier to at least the public beach. Silted on the seaward side and
eroded on the landward side. *Palythoa caribaeorum* common

Total number of species of hard corals observed: 4
Species list:
Acropora palmata
Siderastrea radians
P. astreoides
P. porites

Dominant soft coral species: None

Other common soft coral genera/species present: Hardly present

Sponges: Some encrusting species

FISH: Very poor in species and individuals. Some Bluestriped grunt.

HUMAN IMPACTS: Garbage, including bottles, wood, pvc pipes, iron.

RECREATIONAL POTENTIAL: Low, except for inexperienced snorkelers; most interesting is area
between Dive Statia and Golden Era Hotel, in particular the chunks of
wall/foundation with the cannon in front of the Golden Era swimming pool.

REMARKS: None.

C. SOUTHERN REEF COMPLEX

DATE: 12/03/92 Outer
LOCATION: Crooks

DEPTH RANGE: 10-13 m
CURRENT: to north, surface only
VISIBILITY: 20m
HABITAT TYPE: encrusted rock, sand
COMMUNITY TYPE: mixed hard/soft coral/sponge community
CONDITION: healthy

DESCRIPTION: Patches of coral growth on volcanic rock, with high abundance of soft corals
INVERTEBRATES: and sponges, alternated by sandy areas. Cover by live hard corals is 25-30%. Dominant hard coral species, if any, *Montastrea cavernosa*. Fish not abundant, except few schools of Smallmouth grunt and Striped grunt; diversity of fish species not high.

Total number of species of hard corals observed: 15

Species list:

Madracis decactis
Agaracia agaricites
Siderastrea siderea
Porites astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans
Montastrea cavernosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Mycetophyllia sp.
Eusmilia fastigiata

Dominant soft coral species: *Gorgonia ventalina*, *Pseudopterogorgia americana*, *P. acerosa*

Other soft coral genera/species present: *Plexaurella*, *Plexaura*, *Pseudoplexaura*, *Eunicea*, *Muricea*, *Pterogorgia*

Sponges: Highly diverse sponge fauna. Many large *Xestospongia muta* specimens. Abundant branching and encrusting species.

FISH: Mostly small reef fishes, few predators (some Coneys and Graysbys), no large snappers or groupers. Relatively few herbivorous grazers, some Ocean surgeonfish, but few Parrotfish.
Species that are relatively abundant include: Sandtile fish, Sergeant major (with nests), Schools of Smallmouth grunt, French grunt and Striped grunt, Yellow goatfish, Glasseye snapper, Squirrelfish, Bluehead wrasse, Yellowtail snapper (small specimens)

HUMAN IMPACTS: Discarded monofilament fishing line, anchor lines, plastic cups, cloth, soda cans.

RECREATIONAL POTENTIAL: The reef area is extensive and diverse. Except for some visual pollution no impacts were observed. The recreational potential is high.

REMARKS: *Trididemnum soiidum* clearly present though not abundant; colonies small in diameter. Some young *Diadema antillarum* present. Lobster trap parked as holding pen.

DATE: 26/03/92 Blair's
LOCATION: Wreck

DEPTH RANGE: 17-2,1 m
CURRENT: light, to north
VISIBILITY: HABITAT 18m
TYPE: COMMUNITY sand/rubble, encrusted rock and boulders
TYPE: CONDITION: mixed, hard and soft coral dominated
healthy

DESCRIPTION:
INVERTEBRATES: Rock/boulder ledge running in NE/SW direction, with top at 16-17 m. Ledge is encrusted with abundant hard and soft coral, and to a lesser extent with sponges. Ledge has many cracks and holes. High coral diversity but mostly small coral colonies. Ledge is surrounded by sand/rubble bottom at 19-20 m, with scattered hard and soft corals. Some *Lobophora* and *Dictyota*.

Total number of species of hard corals observed: 23
Species list:
Stephanocoenia michelinii
Madracis decactis
M. pharensis
A. cervicomis
Agaracia agaricites
Helioseris cucullata
Siderastrea siderea
P. astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans
Montastrea cavemosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Mussa angulosa
Scolymia lacera
Isophyllastrea rigida
Mycetophyllia lamarcki
Mycetophyllia sp.
Eusmilia fastigiata

Dominant soft coral species: None

Other common soft coral genera/species present: *Pseudopterygia*, *Pseudoplexaura*, *Plexaura flexuosa*, *Eunicea*, *Gorgonia ventalina*, *Erythropodium caribaeorum*; mostly small colonies.

Sponges: *Xestospongia muta*, *Chondrilla nucula*, *Ectyoplasia ferox*, *Agelas dispar*.

FISH: Low in numbers. Common species include French grunt, Cesar grunt, Blackbarsoldierfish. Occasional Queen triggerfish, Queen angelfish, French angelfish, Grey angelfish, Yellowhead jawfish.

HUMAN IMPACTS: None

RECREATIONAL POTENTIAL: Good

REMARKS: Few *Trididemnum solidum*, several Spiny lobster

DATE: 15/03/92
LOCATION: Barracuda

DEPTH RANGE: 15-20m
CURRENT: very mild, to south
VISIBILITY: HABITAT 18m
TYPE: COMMUNITY coral-encrusted ledge
TYPE: CONDITION: mixed hard/soft coral/sponge community
healthy

DESCRIPTION: Ledge running parallel to shore with a flat surface on top, a vertical 2-3 m drop-off on the shore side, and a gentle slope to seaward. Top of the ledge is at about 16 m, the sand bottom on the inside of the ledge is at 17-20 m. Sand is mostly carbonate sand, indicating a reef-like formation. Conspicuous features are a high incidence of the alga *Lobophora variegata*, good diversity of both hard and soft corals, and particularly of sponges. Coral cover is 30-40%. Mostly small colonies, except for some large colonies of *Dendrogyra cylindrus*.

INVERTEBRATES: Total number of species of hard corals observed: 18

Species list:
Madracis decactis
Madracis pharensis
Acropora cervicornis
Agaricia agaricites
Helioseris cucullata
Siderastrea siderea
Porites astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans

Montastrea cavernosa M.
annularis Meandrina
meandrites Dichocoenia
stokesi Dendrogyra cylindrus
Isophyllastrea rigida
Mycetophyllia lamarckiana
Eusmilia fastigiata

Dominant soft coral species: *Pseudoplexaura* sp., *Gorgonia ventalina*,
Pseudopterogorgia sp.

Other common soft coral genera/species present: *Plexaura flexuosa*,
Eunices, *Briareum asbestinum*

Sponges: High diversity. Many large *Xesiospongia* mute. Encrusting species abundant along the steep cut of the ledge. A brown encrusting species *Hemectyon ferox* is common throughout.

FISH: Good diversity of reef fish. Mostly small species. Black durgon common. Several species of Grunt. Some Honeycomb cowfish and Four-eye butterflyfish. Few Coneys and Schoolmasters, but no other predators recorded. Some large Parrotfish, but generally low numbers of herbivorous grazers. Small schools of Brown and blue Chromis.

HUMAN IMPACTS: None; perhaps some impact from fishing.

RECREATIONAL POTENTIAL: Good. Extensive area, healthy and diverse in species.

REMARKS: Some *Trididemnum* present. Site is geologically interesting because the ledge represents an area that has been in the surf zone during a previous lower sea level. This is demonstrated by the flat top of the ledge and the dislodged blocks on the side of the ledge.

DATE: 27/03/92

LOCATION: Anchor Reef

DEPTH RANGE: 15-21 m

CURRENT: moderate to N

VISIBILITY: HABITAT 25m

TYPE: COMMUNITY sand/rubble; encrusted rock

TYPE: mixed, soft coral/sponge dominated in the sand/rubble habitat; mixed, hard/soft coral dominated in the encrusted rock habitat

CONDITION: healthy

DESCRIPTION: Interesting formation of ridges and ledges, some with steep edges, some undercut. Top of the ridges at 15 m. Diverse community of hard and soft corals. Hard coral cover up to 30%. *Dictyota* and *Lobophora* clearly present but not abundant. Sand/rubble habitat (at 18-19 m) around the ridges has scattered soft coral and sponges but low coral cover.

INVERTEBRATES: Total number of species of hard corals observed: 24
 Species list:
Stephanocoenia michelinii
Madracis decactis
M. pharensis
M. mirabilis
Agaracia agaricites
A. lamarcki
Helioseris cucullata
Siderastrea siderea
Porites divaricate
P. astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans
Montastrea cavemosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Isophyllastrea rigida
Mycetophyllia lamarcki
Mycetophyllia aliciae
Eusmilia fastigiata

Dominant soft coral species: *Pseudoplexaura*, *Plexaura flexuosa*

Other common soft coral genera/species present: *Eunicea*, *Pseudoptero-*
gorgia

Sponges: *Xestospongia mute* (especially in the sand/rubble habitat),
Cliona delitrix, *Ectyoplasia ferox*.

FISH: Low abundance. Black durgon, some French grunt, few Graysbys, Rock hind and Red hind; juvenile Spanish hogfish and juvenile Creole wrasse. All species of Angelfish are common.

HUMAN IMPACTS: Very few (anchor rope)

RECREATIONAL POTENTIAL: Good (attractive depth range, diverse reef community, old anchor)

REMARKS: Few *Trididemnum*, some mats of red alga; Spiny lobster (very abundant during the season).

DATE: 14/03/92 and 01/04/92
 LOCATION: Caroline's Reef

DEPTH RANGE: 13-19 m
 CURRENT: none or light, to north
 VISIBILITY: 18 and 25 m on respective dates

HABITAT TYPE: encrusted rock
COMMUNITY TYPE: mixed hard/soft coral/sponge community
CONDITION: healthy

DESCRIPTION: The area consists of a system of reef-like ledges, running in a southeast-northwest direction (perpendicular to the direction of the swell, as indicated by the orientation of the sea fans). Ridges are separated by sand channels, sometimes anastomosing and often undercut. The ridges have a high diversity of hard and soft corals and sponges. Coral cover at least 30%. Most coral colonies are small in size, with the exception of some large *Montastrea annularis* heads. Many encrusting sponge species cover the steep sides of the ledges. On their exposed sides the sides of the ledges are more covered with hard corals and other invertebrates, while the other sides have more cover by algae (*Dictyota sp.* and *Lobpphora variegata*). Conspicuous are also the presence of Bryozoans and the colonial anemone *Palythoa*. The ledges are surrounded by a sand bottom starting at 18 m. The sand contains mostly carbonate sand.

INVERTEBRATES: Total number of species of hard corals observed: 24

Species list:

Stephanocoenia michelinii

Madracis decactis

M. pharensis

Acropora cervicornis

Agaracia agahcites

Agaricia lamarcki

Helioseris cucullata

Siderastrea siderea

Forties astreoides

P. portes

P. divaricata

Diploria labyrinthiformis

D. strigosa

Colpophyllia natans

Montastrea cavemosa

M. annularis

Meandrina meandrites

Dichocoenia stokesi

Dendrogyra cylindrus

Isophyllastrea rigida

Scolimia lacera

Mycetophyllia lamarcki

Mycetophyllia sp.

Eusmilia fastigiata

Dominant soft coral species: *Pseudopterogorgia sp.*, *Pseudoplexaura sp.*

Other soft coral genera present: *Plexaura flexuosa*, *P. homomalta*, *Plexaurella sp.*, *Pseudopterogorgia*, *Eunicea*, *Iciligorgia schrammi*, *Gorgonia ventalina*.

Sponges: High diversity, both on the ledges as well as in the sand channels. Many boring sponges on the ledges. Common species include: *Xestospongia mute*, *Callyspongia vagina/is*, *Ectyoplasia ferox*. *Agelas conifera*, *Chondrilla nucula*, *Ircinia strobilina*, *Neofibularia noli-tangere*.

FISH: High species diversity, but not rich in individuals. Low abundance of herbivorous grazers. Conspicuous are large number of Black durgon, Barracuda. Other species include Permit, Coney, French angelfish, Grey angelfish, Queen angelfish, Tiger grouper, Nassau grouper, Bermuda chubs, Margates, Schoolmasters and Spanish grunt. Southern sennets are often seen here.

HUMAN IMPACTS: None, other than limited fishing impact.

RECREATIONAL POTENTIAL: High, extensive area, diverse and attractive because of changing scenery. Shallow depth makes for considerable bottom time.

REMARKS: Some *Trididemnum solidemnum*. Bryozoans (*Trematooeicia aviculifera*). *Dictyota* and *Lobophora* present but not abundant.

DATE: 07/04/92
LOCATION: Barry's Bowl

DEPTH RANGE:
CURRENT: none
VISIBILITY: HABITAT 20m
TYPE: COMMUNITY encrusted rock ledges
TYPE: CONDITION: mixed, hard and soft coral dominated
healthy

DESCRIPTION: Ledges running out from shore, separated by sand patches, encrusted with mixed community of hard and soft corals, and sponges. Gorgonians very abundant. Small coral patches occur in the sandy areas. High diversity of hard and soft corals. Substantial coverage by *Dictyota*. Hard coral cover 30%. One area is characterized by huge encrusted boulders with steep edges.

INVERTEBRATES: Total number of species of hard corals observed: 23
Species list:
Stephanocoenia michelinii
Madracis decactis
M. pharensis
Agaracia agaricites
Helioseris cucullata
Siderastrea siderea
Siderastrea radians
Porites divaricate
P. astreoides
P. porites
Diploria labyrinthiformis

D. strigosa *Colpophyllia*
natans *Montastrea cavernosa*
M. annularis *Meandrina*
meandrites *Dichocoenia*
stokesi *Dendrogyra cylindrus*
Mussa angulosa *Isophyllastrea*
rigida *Mycetophyllia*
lamarckiana *Mycetophyllia*
aliciae *Eusmilia fastigiata*

Dominant soft coral species: *Gorgonia ventalina*, *Pseudoplexaura*,
Plexaura flexuosa

Other common soft coral genera/species present: *Pseudopterogorgia*,
Plexaura homomalta

Sponges: Most common species are *Callyspongia vaginalis* and *Xestospongia* mute; others include *Agelas conifera*, *Ectyoplasia terox*,
Neofibularia nolitangere.

Rather poor in fish. Some Parrotfish, Creole fish, Yellow goatfish, Black
durgon, Grey angelfish and Coneys. Near the huge boulders a Tiger
grouper and Yellowmouth grouper.

FISH:

HUMAN IMPACTS: None

RECREATIONAL POTENTIAL: High, extensive shallow area, attractive coral community.

REMARKS: Nurse shark, Rock lobster, fairly high cover by *Trididemnum*.

DATE: 17/03/92

LOCATION: Drop-off

DEPTH RANGE: 15-40m

CURRENT: none

VISIBILITY: HABITAT 20m

TYPE: COMMUNITY reef/encrusted rock

TYPE: CONDITION: mixed hard and soft coral community

fair to good

DESCRIPTION:

Flat plateau in the 15 m range with sand and scattered coral growth. Hard
and soft corals are dominant, sponges not very abundant. Cover by hard
coral 20-30%. Two species of *Dictyota* abundant (one possibly *D. mertensii*).
At intermediate depth low coral ridges develop, with coral cover of 50% and
more, and with large boulder-shaped *Montastrea annularis* colonies (bumpy
growth form). Brown alga *Lobophora variegata* common. Large *Gorgonia*
ventalina occur both at intermediate and shallow depths. A

vertical drop-off is present at 23 m, down to a sloping sand bottom at 40 m. Towards the northwest there are plateaus and additional vertical drop-offs at 44 m, 60 m and 75 m. Along the drop-off the gorgonians *Iciligorgia schrammi*, *Telesto riisei*, the black corals *Antipathes pen-nacea*, *A. dichotoma*, and *Stichopathes lutkeni*, and the sponge *Agelas conifera*, are common.

INVERTEBRATES:

Total number of species of hard corals observed: 21

Species list:

Madracis decactis

A. cervicornis

Agaracia agaricites

A. lamarcki

Siderastrea siderea

P. astreoides

P. porites

Diploria labyrinthiformis

D. strigosa

Colpophyllia natans

Montastrea cavemosa

M. annularis

Meandrina meandrites

Dichocoenia stokesi

Dendrogyra cylindrus

Mussa angulosa

Scolymia lacera

Mycetophyllia lamarcki

Mycetophyllia aliciae

Eusmilia fastigiata

Dominant soft coral species: none

Other common soft coral genera/species present: *Gorgonia ventalina*, *Plaxaura flexuosa*, *Plaxaura hotnomalla*, *Pseudopterogorgia*, *Pseudoplexaura*, *Plexaurella*, *Eunicea*.

Sponges: Rather low in number of species and in abundance. Common species include *Xestospongia mute*, *Cliona langae*, *Callyspongia plicifera*, *Callyspongia vaginalis*.

FISH:

HUMAN IMPACTS:

Low abundance. Common species include Black durgon, Creole wrasse, Stoplight parrotfish, Yellow goatfish, Mahogany snappers (small). Special observations include Gray angelfish and Rock hind.

None

RECREATIONAL POTENTIAL: Very good, but experience required (deep dive).

REMARKS:

Some *Trididemnum solidum*. Intermediate and deep reef healthier than shallow community (less sediment stress?).

DATE: 26/03/92
LOCATION: Drop off 2

DEPTH RANGE: 20-40m
CURRENT: light to North
VISIBILITY: 25m
HABITAT TYPE: reef
COMMUNITY TYPE: mixed; hard and soft coral dominated
CONDITION: healthy to pristine

DESCRIPTION: Ridges running in Northeast to Southwest direction and forming buttresses on seaward edge. Cover on the deep buttresses 70-80%, lower at intermediate depths. In between ridges active sand channels. Dominated by *Montastrea annularis*, huge colonies (massive and bumpy type). Drop off steep with *Iciligorgia*. Also *Lobophora* and *Dictyota*.

Total number of species of hard corals observed: 22

Species list:

Madracis decactis
A. cervicomis
Agaracia agaricites
A. lamarcki
Helioseris cucullata
Siderastrea siderea
P. astreoides
P. porites
Diploria labyrinthiformis
D. strigosa
Colpophyllia natans
Montastrea cavemosa
M. annularis
Meandrina meandrites
Dichocoenia stokesi
Dendrogyra cylindrus
Mussa angulosa
Scolymia lacera
tsophyllastrea rigida
Mycetophyllia lamarcki
Mycetophyllia sp.
Eusmilia fastigiata

Dominant soft coral species: None

Other common soft coral genera/species present: large colonies, but relatively low abundance on the the deep reef, higher abundance at intermediate depth. *Pseudopterogorgia*, *Pseudoplexaura*, *Eunicea*, *Gorgonia ventalina*, *Iciligorgia schrammi*.

Sponges: Low abundance and few species. Some encrusting brown *Cliona langae*.

FISH: Fairly low numbers. Black durgon, Queen triggerfish, Ocean triggerfish, Creole fish (school), Yellowmouth grouper, Red hind, juvenile Tiger grouper.

HUMAN IMPACTS: Minimal (car tire and rope)

RECREATIONAL POTENTIAL: Good (diverse, true reef, high cover)

REMARKS: Hawksbill turtle, two Reef sharks, virtually no *Trididemnum*, Sea cucumbers in the sandy areas.

DATE: 06/04/92

LOCATION: Dropoff 3 (off the solar house)

DEPTH RANGE: 24-40 m (and over)

CURRENT: none

VISIBILITY: HABITAT 25m

TYPE: COMMUNITY sand and coral reefs

TYPE: CONDITION: mixed, hard coral dominated
healthy

DESCRIPTION:
INVERTEBRATES: Sand flat at 24 m, with high coral buttresses and steep sand cayons. Coral cover is high (40-50%). Black coral is common (*Antipathes di-chotoma*, *A. pennacea* and *Stichopathes lutkeni*), as well as *Iciligorgia schrammi*. The deeper parts of the buttresses are predominantly covered with soft corals. Southern stingrays and Garden eels are common in the sand habitat.

Total number of species of hard corals observed: 18

Species list:

Stephanocoenia trichelinii
Madracis decactis
M. pharensis
Agaracia agaricites
A. lamarcki
Helioseris cucutlata
Porites divaricate
P. astreoides
P. porites
Colpophyllia natans
Montastrea cavernosa
M. annularis
Meandrina meandrites
Scolymia lacera
S. cubensis
Isophyllastrea rigida
Mycetophyllia sp.
Eusmilia fastigiata

Dominant soft coral species: None

Other common soft coral genera/species present: *Pseudoplexaura*, *Iciligorgia schrammi* and *Elisella barbadensis*. Generally large colonies.

Sponges: *Pseudoceratina crassa*, *Agelas conifera* (very common), *Agelas clathrodes*, *Callyspongia vaginalis*, and an unidentified sponge with clusters of small blueish-grey tubes.

FISH: Very poor in numbers and species. Notable were a few Red hinds, a Tiger grouper and a Yellowmouth grouper.

HUMAN IMPACTS: Most likely impact from fishing.

RECREATIONAL POTENTIAL: Limited because of great depth, but otherwise spectacular scenery.

REMARKS: None.

DATE: 27/03/92

LOCATION: Bay north of Kay Bay

DEPTH RANGE: 0-4 m

CURRENT: none

VISIBILITY: 5 m

HABITAT TYPE: encrusted rock

COMMUNITY TYPE: mixed hard and soft coral

CONDITION: stressed to degraded due to sediment.

DESCRIPTION: Beach slopes into the sea. Cobble stones merge into sand. After a few meters encrusted rocks start to dominate. Rocks are poorly covered with a mixed community. Most common species are small colonies of *Gorgonia ventalina*, *Diploria strigosa*, *D. clivosa*, *Palythoa caribaeorum*. Also *Millepora squarrosa*. Cover of living invertebrates is less than 5%. Lots of *Acropora palmata* skeletons, but hardly any living colonies.

INVERTEBRATES:

Total number of species of hard corals observed: 10

Species list:

Acropora palmata

Agaracia agaricites

Siderastrea radians

Porites divaricate

P. porites

D. strigosa

D. clivosa

Montastrea cavemosa

M. annularis

Isophyllastrea rigida

Dominant soft coral species: *Gorgonia ventalina* (small colonies), *Ple-axaura homomalta*.

Other common soft coral genera/species present: *Erythropodium caribaeorum*.

Sponges: Encrusting and boring sponges (*Cliona langae*)

FISH: Poor; mostly Doctorfish and Blue tangs, some small Parrotfish; Bermuda chubs.

HUMAN IMPACTS: Garbage (nets, rope, cloth)

RECREATIONAL POTENTIAL: Very limited; attractive for inexperienced snorkelers if visibility and wave conditions are favorable. Beach recreation and swimming potential.

REMARKS: *Trididemnum solidum* and *Diadema* rather common.

D. ATLANTIC SIDE

05/04/92 Venus Bay
south

DATE:

LOCATION:

12-18 m

none

DEPTH RANGE:

15m

CURRENT: VISIBILITY:

encrusted rock

HABITAT TYPE:

mixed hard/soft coral/sponge community

COMMUNITY TYPE:

healthy

CONDITION:

DESCRIPTION:

Submarine continuation of mountain slope down to a sand flat at 60 ft. Many huge boulders/rocks encrusted with hard, soft corals and sponges. Coral coverage 10%. Dominant hard coral was *Montastrea cavemosa* and to a lesser extent *Meandrina meandrites*. The near absence of *Montastrea annularis* was noticeable. Flattened form and also big colony size of several species such as *Porites astreoides* and *M. meandrites* was remarkable. Also *Palythoa* was very abundant. Impacted by sediment. Fish abundance was low, but first observation of many big Par-rorfish.

Total number of species of hard corals observed: 20

Species list:

INVERTEBRATES:

Stephanocoenia michelinii

Madracis decactis

M. pharensis

Acropora palmata

Agaracia agaricites

Helioseris cucullata

Siderastrea siderea

P. astreoides

P. porites

Diploria labyrinthiformis

D. strigosa

D. clivosa

Colpophyllia natans

Montastrea cavemosa

M. annularis

Meandrina meandrites

Dichocoenia stokesi

Dendrogyra cylindrus

Mycetophyllia lamarcki

Mycetophyllia sp.

Dominant soft coral species: None

Other common soft coral genera/species present: *Pseudopterogorgia*, *Eunicia*, *Plexaura flexuosa*, *Pseudoplexaura*, *Pterogorgia* (lower in sand), *Gorgonia ventalina*.

Sponges: *Xestospongia muta*, *Callyspongia vaginalis*, *Ectyoplasia ferox*, *Aplysina fulva*, *Pseudoceratina crassa*.

FISH:
HUMAN IMPACTS: Tiger grouper, Yellowmouth grouper, relatively large number of Coneys, Stoplight parrotfish, Mahogany snappers, Sergeant majors, White margates, Porgys and Bermuda chubs.

Little; some rope and plastic.

RECREATIONAL POTENTIAL: Low unless conditions are favorable.

REMARKS:

Lots of *Trididemnum solidum* especially in lower depth range. *Solanderia gracilis*.

DATE: 19/03/92
LOCATION: Corre Corre Bay; Atlantic

DEPTH RANGE: 22m
CURRENT: light, to north
VISIBILITY: HABITAT 25m
TYPE: COMMUNITY encrusted rock and sand
TYPE: CONDITION: mixed: algae, corals, sponges
healthy

DESCRIPTION:

100 m offshore, ridges running almost perpendicular to the shoreline, separated by sand. The ridges are not smooth but form a lot of crevices and niches. Also bigger coral colonies are eroded at the bottom forming many holes. The ridges are of volcanic origin and encrusted abundantly by algae (*D/cfyofa sp.*). Hard coral cover is low (10%), **soft** corals are mostly small in size. Many encrusting sponges, some *Xestospongia muta*, mostly in the sand. Fish are not abundant.

INVERTEBRATES: Total number of species of hard corals observed: not counted
Species list: -

Dominant soft coral species: *Gorgonia ventatina*, *Eunicia*, *Plexaura*, *Pseudopterogorgia*.

Other common soft coral genera/species present: -

Sponges: *Agelas conifera*, *Callyspongia vaginalis*, *Xestospongia muta*, *Ectyoplasia ferox*.

FISH:
HUMAN IMPACTS: Black durgons, Barracuda's, Queen triggerfish, French and Grey angel-fish.

None visible

RECREATIONAL POTENTIAL: Low because the site is located on the exposed windward side of the island. High wave action, only accessible by means of a boat.

REMARKS:

Known to fisherman as excellent lobster grounds Structure of reef confirms this.

E. MISCELLANEOUS DIVES.

- 17/4/92. Off Oranjestad, 1.5 miles offshore (Ed Sheer's fishing grounds). 94 ft.
Flat coral habitat. Dominated by flattened *Montastrea annularis* and *Colpophyllia natans*. Other species present: *Ponies astreoides*, *P. porites*, *M. cavernosa*. Mixed community with sponges and soft corals. Coral cover 30-40%. High cover by *Lobophora*. Few fish (some Red hinds). Fresh anchor scar!
- 17/4/92. North of terminal jetty. 43 ft.
19/4/92. Sand with algae and sparse *Syringodium fliforme*. Algae include *Penicillus sp.* (many dead plants), *Halimeda monile*, *Caulerpa prolifera*, and a free-floating gelatinous red alga. Some Garden eels.
- A. 89 ft. Offshore fishing grounds (diving off tug Saba). Sites A thru G refer to map 10.
- B. 89 ft. Flat bottom with coral and rubble. High cover by *Lobophora*.
- C. Coral reef, high cover (40-50%), with *Dictyota* and *Lobophora*. Much more profile than A. Coral ridges and sand gullies. Common species are *Montastrea annularis*, *Colpophyllia natans*, *M. cavernosa*. Also *Porites astreoides* and *Mycetophyllia sp.* are relatively abundant.
- D. Very similar to B. Coral cover 50%. Sand gullies through the reef. High cover by *Lobophora*.
- 105ft. E. Coral with sand patches. Fairly high profile. Same species composition as B.
- 99 ft. Unconsolidated coral rubble. Fresh anchor scar. Abundant juveniles, a.o. Cherubfish.
- F. 91 ft. Sand, rubble, scattered coral and sponges. *Lobophora*.
- G. 91 ft. Coral with small sand patches. Sponges, *Lobophora*. Schooling Grunts, Bermuda chubs.
- 19/4/92. Just south of City pier. 34 ft. Sand with Algae and few *Syringodium*. Mostly *Penicillus* and. Tugs dislodge many algae with the prop blast.

ANNEX II: LEGISLATION

The following laws are of importance to the marine environment of St. Eustatius: A.

international level.

MARPOL: This international law prohibits pollution of the sea by ships that transport various hazardous substances Annex 1 deals with oil, both as cargo and as part of its operational use. Annex 2 deals with chemicals in bulk, 3 with packed cargo, 4 with sewage produced by the ship and 5 with garbage as part of its operation. At the moment this law is not (yet) in effect in the Netherlands Antilles because the national legislation has not been put into place. It is very likely that this will happen in the course of 1992 with regards to annex 1,2 and 5. OILPOL, which is the predecessor of MARPOL, is still in effect for the Netherlands Antilles. It regulates the cleaning of oiltanks in our territorial waters. When MARPOL comes into force OILPOL will be withdrawn.

London Dumping Convention: An international law to regulate the intentional dumping of waste into the sea. Two lists are attached. The black list contains products that are totally prohibited to be dumped into the sea, while the grey list gives substances that can be dumped under certain conditions. A national law was published in 1983 but never came into effect. There is no indication that this will happen in the nearby future. As the island government has the intention to dump the stranded Dundalk in the nearby future, it should be aware that under the London Dumping Convention, when it comes into effect for the Netherlands Antilles, the intentional dumping of a shipwreck is not permitted.

The Cartagena Convention with two protocols: This regional treaty under the auspices of the United Nations Environment Program, forms the regional basis to protect the marine environment of the Wider Caribbean. The Cartagena Convention was ratified in 1983 and is a framework for different actions detailed in the protocols.

Together with the Convention a first Protocol was accepted 'concerning the co-operation of parties in combating oil spills in the Wider Caribbean'. Through bilateral and multilateral agreements (e.g. mutual contingency plans) with surrounding countries, actions in the case of oil pollution and accidents can be taken in the most efficient way. Because this regional treaty is dealt with on a regional level the central government has the responsibility to implement this Protocol. Therefore the central government should be urged to put such a system in place. Also on the local level an island contingency plan is of the utmost urgency. A first draft has been written but not finished (Richardson, 1989).

A second Protocol deals with 'Specially Protected Areas and Wildlife'. This Protocol was signed by the Netherlands Antilles in 1990, and gives the possibility to protect marine areas of biological significance and/or other reason, and to protect flora and fauna that are threatened or endangered on a regional basis. This protocol has not yet come into force. The Netherlands Antilles has already three well-managed marine parks in Bonaire, Curacao and Saba which are eligible for inclusion in this regional law. Wildlife that should be protected under this Protocol, is listed in three annexes. Total protection of flora (annex 1), total protection of fauna (annex 2) and a mixed list of fauna and flora that should be regulated in annex 3. Under annex 2 all sea turtles are listed and therefore totally protected. Under annex 3 relevant species for St. Eustatius are listed 'that need to be regulated as to minimize the possibility for their depletion'. Species are: The Queen Conch, lobsters, all corals including black corals and all sea turtles.

The Convention on International Trade of Endangered Species (CITES) or the Convention of Washington, prohibits and regulates trade in species of flora and fauna because of the endangered or threatened status. The list of protected species is very similar of the ones used in the 2nd Protocol of the Cartagena Convention. For St. Eustatius it is important to know that all species of sea turtles are protected and may not be traded.

Also under the Bonn Convention for the protection of migratory species, sea turtles are listed as protected.

B. National level.

Relevant national legislation regarding the marine environment and/or species of marine plants and animals, is:

The new fisheries legislation (1991) regulating commercial fisheries in the territorial waters of the Neth. Antilles. This law which is accepted by parliament has not yet come into effect. It is the intention that it will be effectuated in 1992. This new law regulates commercial fisheries (ships with a capacity bigger than 6 bit or bigger than 12 m) in all the waters of the Netherlands Antilles towards the border of the territorial sea (12 miles). The Central Government has requested the Government of the Kingdom of the Netherlands to officially declare an Exclusive Fisheries Zone (EFZ), as so many other countries in the Caribbean already did. Once in effect, the EFZ stretches out to the 200 miles boundary or equidistance lines between countries. All commercial fishing boats will be required to carry fishing permits to fish. The law prohibits catching of marine mammals and sea turtles. For the Leeward islands of the Netherlands Antilles the Saba Bank will be part of the Netherlands Antilles' EFZ. Problems will arise with regards to enforcement.

A law from 1976 to protect marine areas in the Netherlands Antilles was published but never came into effect. While we mention this law for completeness it has no value whatsoever at the moment.

C. Island level.

On an island level, St. Eustatius has an old 1966 law that regulates lobster fishing and trade of lobsters. It provides for a minimum size and regulates trade by means of permits.

Other specific island legislation to protect the marine environment does not exist.

D. Sample Legislation.

Reef Management Ordinance of the Island of Curacao

Article 1. Definitions

Article 2. It is prohibited to break, saw or detach in any way, corals in Island waters. It is prohibited to make products of corals, deal in, sell, buy or transport corals from Island waters.

Article 3. It is prohibited to kill, to possess dead or alive, to sell, buy, deliver, transport or make products of marine animals and plants which are designated by Decree of the Island Government.

(The intention of this article is that marine organisms that are threatened by over-exploitation or otherwise, may receive protection. Protective measures may include a minimum size or closed season as applicable.)

Article 4 The Island Government may exempt persons from the prohibitions of article 3 by issuing permits to collect certain marine organisms. The permits will specify the conditions under which collecting may take place.

Article 5. The Island Government may exempt persons from the prohibitions of article 2 for scientific and educational purposes or in the general interest Permits will specify the conditions under which collecting may take place.

Article 6. It is prohibited to hunt, catch or kill marine animals in Island waters with spears or spear guns. It is prohibited to possess, sell, transport or deliver marine animals from island waters that are caught or killed by spear fishing.

Article 7. It is prohibited to collect marine animals and plants in island waters using means or substances that may be harmful to the marine environment. Such means or substances may be designated by Decree of the Island Government.

Article 8 & 9. The persons mentioned in articles 4 & 5 must be able to present their permits at all times at the request of law enforcement officers.

Article 10. The offense of art. 2 will be punished with a penalty of not more than 2 months imprisonment or Naf. 5,000 (\$2,800). The offense of all other prohibited acts of this island ordinance or of the regulations contained in the decrees will be punished with a penalty of not more than 1 month imprisonment or Naf.2,500 (\$1,400). Recidivism within one year of former conviction may lead to doubling of fines.

Article 11. Spears, spear guns and all other means used in committing the offense, as well as the marine organisms obtained in the offense, may be confiscated by law enforcement officers.

Article 12. The objects mentioned in article 11 may be forfeited by the Court.

Article 13. The prohibitions mentioned in this island ordinance are considered offenses, with the exception of those mentioned in article 2, which are considered a crime.

Proposed legislation: Island Ordinance on Nature Reserves.

Article 1. Definitions.

Article 2 & 3. Description of the composition and the work procedures of an advisory commission on nature reserves.

Article 4. Areas that are to be protected will be declared nature reserves by Decree of the Island Government.

Article 5. Detailed regulations needed to maintain the nature reserve can be issued by Decree of the Island Government, (e.g. regulations on anchoring, mooring use, coastal construction (piers), fishing methods etc.)

Article 6. The Island Government appoints an organization or agency that will be responsible for administrating the nature reserve. The administrative organization issues, with the approval of the Island Government, regulations with regards to admission, vehicles that may be used, equipment that may be admitted in the reserve and the behavior of visitors.

Article 7. Admission may be subjected to permits. Should permits be required unauthorized entry into a nature reserve is not allowed.

Article 8. No activities are permitted that may affect the scientific or touristic value of the nature reserve.

Article 9. No person shall take or possess plants, animals or other items designated in the regulations, of which can reasonably be presumed that they have been taken from the nature reserve.

Article 10. The offense of any off the regulations of this ordinance or the decree will be punished with a penalty of not more than Naf1.5,000 (\$2,800) or a 2 month imprisonment.

Article 11. Animals, plants or other items as mentioned in article 9, and the equipment used in committing an offense, may be confiscated and forfeited.