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RAPID ECOLOGICAL ASSESSMENT OF THE CAYOS MISKITOS MARINE  
RESERVE WITH NOTES ON THE SHALLOW-WATER STONY CORALS  
FROM NICARAGUA

BY

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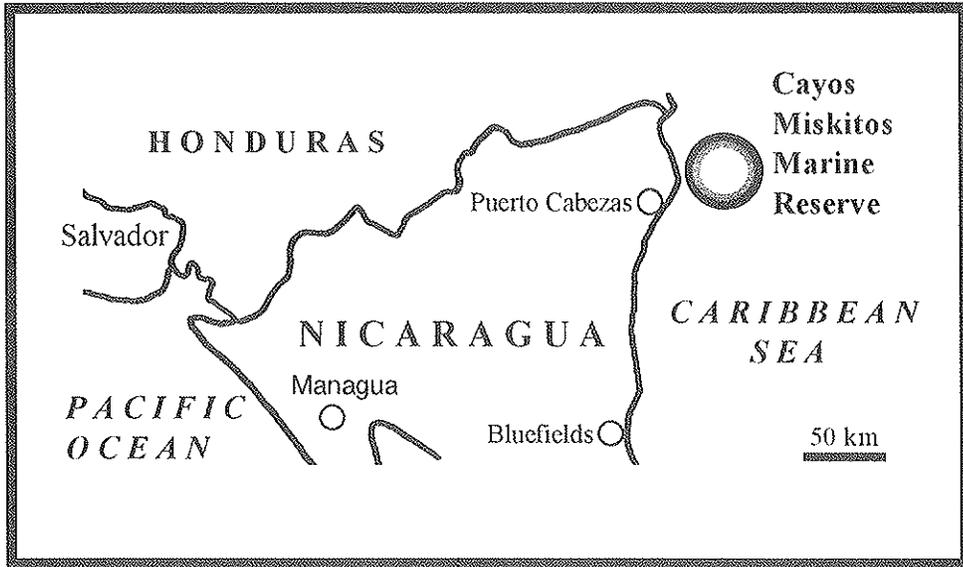


Figure 1. Regional map showing the location of Cayos Miskitos Marine Reserve off the Caribbean coast of Nicaragua. Puerto Cabezas was used as the headquarters for survey operations.

**RAPID ECOLOGICAL ASSESSMENT  
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SHALLOW-WATER STONY CORALS FROM NICARAGUA**

**BY**

**STEPHEN C. JAMESON<sup>1</sup>**

**ABSTRACT**

At the present time, most of the coral reef ecosystem of the Miskito Coast Marine Reserve is in good condition. However, increased sedimentation and eutrophication, as well as a reduction in fish abundance, could easily tip the balance toward an unhealthy condition. Sedimentation and eutrophication are stressing reefs closest to the Honduran border (northwest reefs). Other reefs are experiencing higher than normal sedimentation but are viable. The abundant and diverse herbivorous fish populations help keep algal overgrowth in check. High lobster and turtle fishing pressure is severely stressing these populations. While lobster populations seem to be maintaining themselves, albeit at a young age-class population structure, this is probably not the case for turtle populations. The remote location of the Cayos Miskitos reefs has saved them from the fate of most Caribbean reefs near large population centers. Natural storm damage, has caused most of the physical change on the reefs, but this in turn has provided new habitat for the abundant coral recruits and is part of the natural evolution of the coral reef ecosystem. Twenty-seven shallow-water stony coral species were collected during the survey. This list could be increased with more field effort. Considering the habitat availability and favorable environmental conditions all Caribbean coral species should be found in the Cayos Miskitos Marine Reserve. This is the first listing of stony coral species from the Caribbean coast of Nicaragua.

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## INTRODUCTION

The purpose of this three day USAID Environmental Initiative of the Americas (EIA) fisheries project expedition in Nicaragua was to make a rapid assessment of the condition of the coral reef ecosystem of the Miskito Coast Marine Reserve (Figure 1), determine coastal issues that directly affect coral resources of the area, identify the dominant coral species in the Reserve, and prepare a comparative analysis of similar areas and conditions. Recommendations for management to adequately protect the coral resources of the Cayos Miskitos Marine Reserve are provided. Voucher stony coral and gorgonian collections were made for the Nicaragua natural resources ministry (MARENA) and for the Smithsonian Institution National Museum of Natural History.

## METHODS

Surveys were conducted off the 10 m vessel PALPA using scuba and by snorkeling. Underwater and topside photographs were taken to document habitats, biota and users. Navigational fixes were obtained using GPS. Reef condition assessments were made based on field experience in other areas of the Caribbean, by interviewing local fishermen, government officials and local environmental NGO staff and by consulting and coordinating with other EIA team members (Trott 1996) involved in ancillary surveys. Stony coral identifications were made by the author. The black coral identification was made by Dennis M. Opresko.

## THE HABITATS

Cayos Miskitos Marine Reserve coral reefs vary from small patches and pinnacles to large complicated platforms (tens of meters in diameter) and well-defined belts (kilometers wide). Some reefs are close enough to sea level to be observed from the surface and some are even exposed at low tide (Roberts and Murry 1983). The intricate structure of the Cayos Miskitos coral reef makes it a perfect habitat for lobster and other commercially important fin and shellfish. During this expedition four coral reef areas were surveyed (Figure 2).

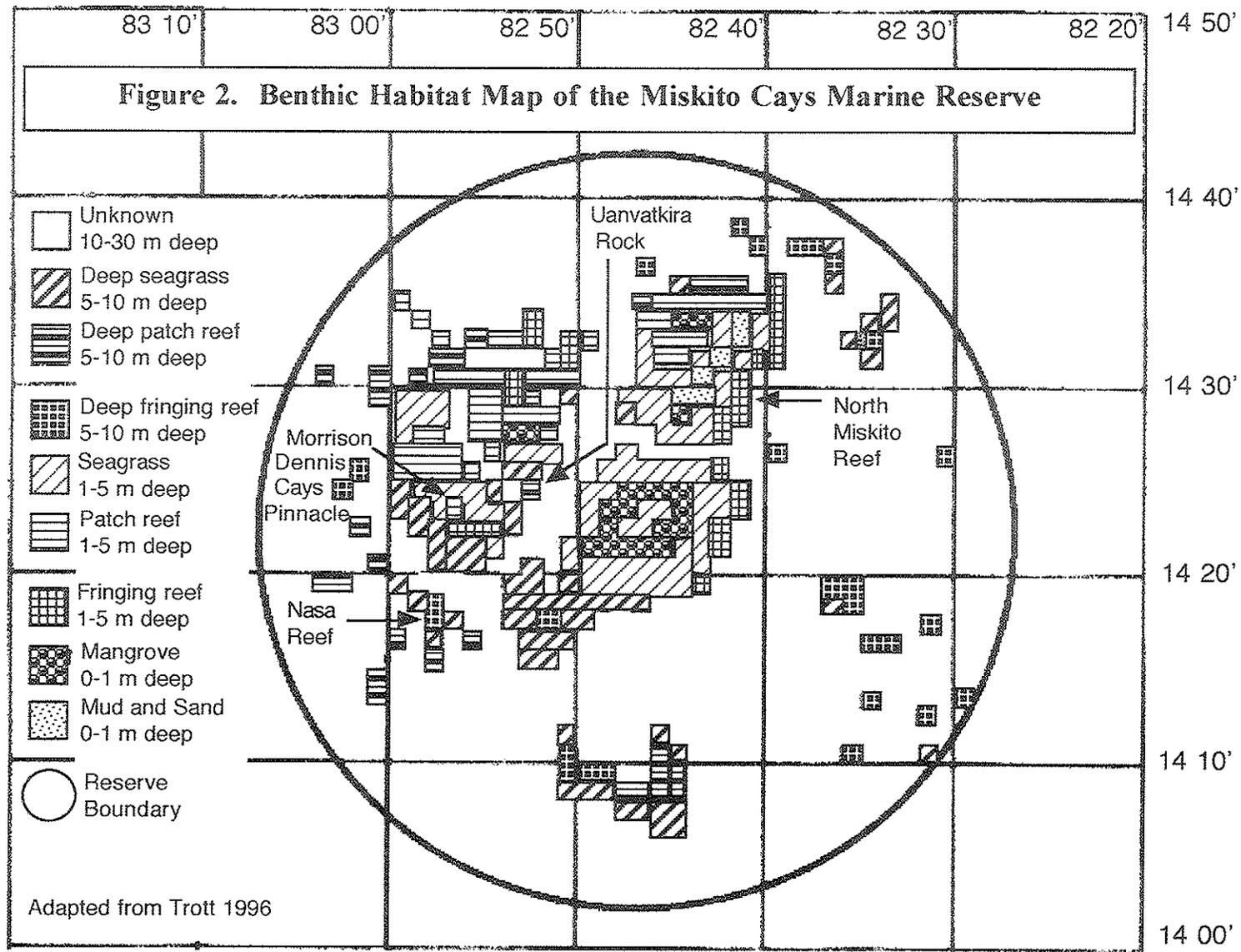
### 1. Nasa Reef

Date: April 30, 1996

Location: 14°18.43'N, 82°57.20'W

Depth: 1 - 2 m

Dominate coral species: *Acropora palmata*, *Montastraea annularis*,  
*Millepora complanata*, *Porites astreoides*



**2. Uanvatkira Rock**

Date: May 1, 1996

Location: 14°25.30'N, 82°52.50'W

Depth: 3 - 4 m

Dominate coral species: *Acropora palmata*, *Porites astreoides*, *Porites porites*, *Diploria clivosa*

**3. North Miskito Reef**

Date: May 1, 1996

Location: 14°29.60'N, 82°41.80'W

Depth: 1 - 4 m

Dominate coral species: *Acropora palmata*, *Millepora complanata*

**4. Morrison Dennis Cays Pinnacle**

Date: May 2, 1996

Location: 14°24.22'N, 82°57.16'W

Depth: 10 - 15 m.

Dominate coral species: *Montastraea cavernosa*, *Montastraea annularis*, *Porites porites*, *Porites astreoides*, *Agaricia agaricites*

## COASTAL ISSUES

### Sedimentation and Eutrophication

The Cayos Miskitos lie about 50 km from Puerto Cabezas and represent the northern most coral reef ecosystems off the coast of Nicaragua.

Water turbidity is relatively high (average visibility 10 m). NOAA satellite imagery shows that most of the sedimentation and eutrophication affecting the Miskito Coast Marine Reserve comes from the Honduran coast where coastal deforestation combined with heavy rainfall and river inputs contribute to this situation.

### Fishing Impacts

No turtles were sighted during the expedition providing qualitative evidence that fishing pressure is very high. Upon landing back at Puerto Cabezas there were over a dozen green turtles captured and being held alive on the beach. They are sold locally as a beef/pork substitute. A sampling of shallow water (snorkel depths) lobster populations found specimens less than a year old and not in great abundance.

Reef fish populations do not appear to be heavily impacted by fishing. However, there is concern that the aquarium fishery developing at Corn Island may expand into the Reserve (Marshall 1996).

### **Anchor Damage**

Most of the vessels using the Cayos Miskitos Marine Reserve are light weight and not abundant, so at present, anchor damage to the coral reef is light compared to other Caribbean reefs with high recreational use. Anchor damage is small compared to the natural storm damage that has occurred. However, steps should be taken to reduce this easily controlled impact through the installation of mooring buoys.

## **REEF CONDITION AND QUALITATIVE COMPARATIVE ANALYSIS**

### **Indicators of Good Reef Condition**

- *Coral recruitment high*

There was clear evidence of young coral recruits in all areas. The frequency of storms undoubtedly produces abundant new habitat for coral settlement.

- *Healthy reef fish populations*

Reef fish populations were in fairly good shape and reflect the habitat in which they are found (Marshall 1996). Populations were characteristic of a more remote Caribbean location that has experienced less intense fishing pressure. Species diversity and abundance was relatively high - much more so than in coral reef ecosystems near large population centers in other parts of the Caribbean where spear and trap fishing have decimated populations and allowed algal overgrowth of coral reefs (Jameson et. al. , 1995). There was evidence of commercial species (i.e., jewfish, snappers, groupers, parrot fish). Sharks (*Carcharinus perezii* and *Ginglymostoma cirratum*) were seen on the reef during the day and were also abundant at night which is a good indicator of a healthy ecosystem.

- *High algal diversity*

The diversity of algae was high in all the coral reefs surveyed. On most reefs surveyed there was no indication of fleshy macroalgae dominating. The abundance of seagrass beds (*Thalassia testudinum* and *Syringodium filiforme*) provides a luxuriant habitat for sea turtle and other species.

- *Little coral disease*

No corals were observed with active disease. During the survey less than 20 colonies were sited that had experienced disease in the past.

- *Little coral bleaching*

Only a single colony of *Agaricia agaricites* and a single colony of *Siderastrea radians* were observed to be bleached.

- *Normal sea urchin densities*

The abundance of sea urchins appeared in balance with the ecosystem.

- *Little anchor damage*

Most vessels using the Reserve are light-weight sailing boats. During the day they are anchoring on the coral reef, but at night most tie up to a casitas.

### **Indicators of Stress**

- *High turbidity*

Visibility was poor (less than 10 meters) compared to most other Caribbean marine parks. Most coral specimens with flat growth forms showed an unusually large amount of sediment on their exterior surface. Bottom sediments were fine grained and easily stirred-up, creating low visibility.

- *Eutrophication effects*

Overgrowth of corals by fleshy macroalgae was seen on northwest reefs (closest to the Honduran border).

- *Lobster population overfished*

Specimens were small in size and not abundant in shallow water.

- *No turtles observed*

No turtles were observed by any members of the team during the expedition. Local net fishing methods are very effective.

- *Storm damage evident*

Storm damage was evident on all reefs, but more so on seaward reefs.

### **Diagnosis**

Sedimentation and eutrophication are stressing reefs closest to the Honduran border (northwest reefs). Other reefs are experiencing higher than average sedimentation but are viable. The abundant and diverse herbivorous fish populations help keep algal overgrowth in check. The high lobster and turtle fishing pressure is severely stressing

these populations. While lobster populations seem to be maintaining themselves, albeit at a young age-class population structure (Childress and Herrnkind 1996), this is probably not the case for turtle populations.

At the present time, most of the coral reef ecosystem of the Cayos Miskitos Marine Reserve is in good condition. However, increased sedimentation and eutrophication, as well as a reduction in fish abundance, could easily tip the balance toward a stressed condition. The remote location of the Cayos Miskitos reefs has saved them from the fate of most Caribbean reefs near large population centers. Natural storm damage, has caused most of the physical change on the reefs, but this in turn has provided new habitat for the abundant coral recruits and is part of the natural evolution of the coral reef ecosystem.

### CORAL SURVEY

The following twenty-seven stony coral species were collected during the survey (Table 1). Without doubt, this list could be increased with more field effort. Considering the habitat availability and favorable environmental conditions all Caribbean coral species should be found in the Cayos Miskitos Marine Reserve. A voucher collection was left in Puerto Cabezas with MARENA officials along with identification keys and collecting materials. A voucher collection was also made for the Smithsonian Institution National Museum of Natural History (USNM). This is the first listing of stony coral species from the Caribbean coast of Nicaragua.

A sample of 12 gorgonian species was also collected. Gorgonian specimens were left with MARENA officials in Puerto Cabezas and specimens were also taken to the Smithsonian for identification. One specimen of black coral was identified and cataloged into the USNM collection (*Stichopathes occidentalis* Brook [USNM 99350]).

**Table 1.** Shallow-water stony coral specimens from the Caribbean coast of Nicaragua. Smithsonian Institution National Museum of Natural History catalog numbers: USNM 99321 - 99349.

#### Class HYDROZOA

##### Order MILLEPORINA

##### Family MILLEPORIDAE

*Millepora alcicornis* Linnaeus, 1758 [USNM 99338]

*Millepora complanata* Lamarck, 1816 [USNM 99338]

#### Class ANTHOZOA

##### Order SCLERACTINIA

##### Suborder ASTROCOENIINA

##### FAMILY POCILLOPORIDAE

*Madracis mirabilis* (Duchassaing and Michelotti,  
1860) [USNM 99326]

*Madracis decactis* (Lyman, 1859) [USNM 99342]

Family ACROPORIDAE

*Acropora cervicornis* (Lamarck, 1816) [USNM 99332]

*Acropora palmata* (Lamarck, 1816) [USNM 99323]

*Acropora prolifera* (Lamarck, 1816) [USNM 99346]

Suborder FUNGIIDA

Family AGARICIIDAE

*Agaricia agaricites* (Linnaeus, 1758) [USNM 99321 and  
99348]

*Agaricia tenuifolia* (Dana, 1848) [USNM 99328]

*Leptoseris cucullata* (Ellis and Solander, 1786) [USNM  
99349]

Family SIDERASTREIDAE

*Siderastrea siderea* (Ellis and Solander, 1786) [USNM  
99334]

*Siderastrea radians* (Pallas, 1766) [USNM 99335]

Family PORITIDAE

*Porites porites* (Pallas, 1766) [USNM 99339]

*Porites furcata* Lamarck, 1816 [USNM 99345]

*Porites divaricata* Lesueur, 1821 [USNM 99343]

*Porites astreoides* Lamarck, 1816 [USNM 99337]

Suborder FAVIINA

Family FAVIIDAE

*Favia fragum* (Esper., 1795) [USNM 99344]

*Diploria clivosa* (Ellis and Solander, 1786) [USNM 99322]

*Diploria strigosa* (Dana, 1848) [USNM 99327]

*Manicina areolata* (Linnaeus, 1758) [USNM 99347]

*Montastraea annularis* (Ellis and Solander, 1786) [USNM  
99329 and 99336]

*Montastraea cavernosa* (Linnaeus, 1767) [USNM 99330]

Family MEANDRINIDAE

*Meandrina meandrites* (Linnaeus, 1758) [USNM 99340]

Family MUSSIDAE

*Isophyllastrea rigida* (Dana 1848) [USNM 99331]

*Scolymia lacera* (Pallas, 1766) [USNM 99333]

*Mycetophyllia danaana* Milne Edwards and Haime,  
1849 [USNM 99325]

Suborder CARYOPHYLLIINA

Family CARYOPHYLLIIDAE

*Eusmilia fastigiata* (Pallas, 1766) [USNM 99324]

## MANAGEMENT RECOMMENDATIONS

The following recommendations are limited to the marine component of the Miskito Coast Marine Reserve because, during my short visit, I was not able to visit the land component.

**1. Focus the purpose of the Cayos Miskitos Marine Reserve on marine biodiversity conservation and research.** Ecotourism and recreational diving/snorkeling should be only a minor focus. This conclusion is based on the following analysis of the strengths and weaknesses of the area.

### Weaknesses:

Unlike most marine protected areas in the Caribbean that have a strong recreational focus, the Cayos Miskitos Marine Reserve does not lend itself to attract large numbers of ecotourists or sport divers for the following reasons.

- The unsafe pier facilities and rough harbor wave conditions make commercial dive boat operations unavailable and unfeasible in the future.
- It is a very rough 4+ hour boat ride to the Cays and reefs when conditions are good.
- The high water turbidity provides a low quality dive experience in most cases.
- The lack of any tourist class hotel or restaurant facilities discourages visitors. In addition, the present modest hotel accommodations are very limited in capacity.
- For most tourists, water and food must be consumed with special precautionary procedures.
- The airline transportation from Managua to Puerto Cabezas does not meet common safety standards and baggage handling is unreliable.
- The long rainy season (May - October) does not provide an attractive tourist climate or lend itself to pleasant marine operations.
- The chance of getting malaria and/or dengue fever from mosquitoes is always present. Precautions to reduce this risk are not attractive to most tourists looking for a relaxing vacation.

### Strengths:

Unlike many coral reef ecosystems in the Caribbean, the Cayos Miskitos Marine Reserve is a remote ecosystem that is not being stressed by man to the point of major or irreversible degradation. Positive environmental indicators include the following:

- Reef fish populations are relatively diverse and abundant. There are no large-scale commercial fishing enterprises operating in the area.
- Coral populations are for the most part in good condition and recruitment is evident. Coral disease and bleaching are minimal.
- The local fishermen, the predominate users of the area, are not causing major negative impacts to the ecosystem via physical damage to the coral reef.

- While there is overfishing of lobster and turtle by the local inhabitants, this can be managed effectively through regulation and enforcement.
- There is no expected large increase in the number of users.
- There is no expected change in the type of user (fishermen).
- There is no significant sport diving use of the area.

To accomplish the purpose stated above I recommend that Reserve regulations be centered around two types of permanent zones within the reserve.

**1. Harvest refugia zones** - where no entry is allowed except by permit. These zones should be strategically placed within the reserve in several locations. Demarcation buoys should be installed to locate these zones. These zones would not only insure the conservation of biodiversity and breeding stock (especially important for maintaining viable lobster and turtle populations) but would also seed neighboring multi-use areas and help maintain commercial and sport harvesting enterprises (Davis et. al., 1991). Harvest refugia areas would also provide unique laboratories for scientists studying the evolution and characteristics of minimally impaired coral reef ecosystems and the value of harvest refugia.

**2. Multi-use zones** - where fishing is allowed along with other appropriate activities.

The following temporary zones could also be specified in the regulations and used, as needed, to provide flexibility to the zoning system and provide for more effective management.

- **Closed Areas** - to allow for research or recovery of the living resources.
- **Limited Access Areas** - with the following designations and corresponding objectives.
  - (a) **"Recovery areas"** to provide for the recovery of Reserve resources from degradation or other injury attributable to human uses.
  - (b) **"Restoration areas"** to provide for restoration of degraded or otherwise injured resources.
  - (c) **"Research-only areas"** to provide for scientific research or education relating to protection and management.
  - (d) **"Facilitated-use areas"** to provide for the prevention of use or user conflicts or the facilitation of access and use, or to promote public use and understanding, of reserve resources through the issuance of special-use permits.

**2. Give as much management and enforcement authority as possible for the Cayos Miskitos Marine Reserve to the Miskito Indians.** These lands and waters have been their territory for thousands of years. They are the prime users of the Reserve and were instrumental in its creation. They have the desire to maintain the viability of the ecosystem for their long-term fishing use and are capable of creating a self-enforcement mechanism.

Before regulations can be drafted it must be clear who will be in charge of the Cayos Miskitos Marine Reserve. The Nicaraguan constitution divides the Atlantic Coast into two autonomous regions, each with its own regional government. However, there is no common agreement on the role of each. In addition, the waters of the Cayos Miskitos Marine Reserve were not included in the autonomy plan that created the two regional governments. The central government believes it should regulate and manage all natural resources including those off the Caribbean coast and grant official permits for resource exploitation. Regional governments disagree and insist that they should be in charge. Miskito Indians from local communities argue that they are never consulted by any level of government and demand a say in who uses the resources and how. The disorderly conditions created by these misunderstandings have been both embarrassing for the central and autonomous governments and painful for the local indigenous people.

On top of this, conflicts between the Miskito Indians and Honduran poachers have led to violence. The Nicaraguan Navy plans to enlarge its enforcement fleet from one to three vessels, with one stationed at the Honduran border. Miskito Indian Reserve enforcement rangers could work in conjunction with the Navy to enforce reserve regulations.

Until clear management authority is agreed upon and designated for the Cayos Miskitos Marine Reserve the process of drafting regulations and a management plan can not effectively go forward.

**3. Create a high quality poster for the Cayos Miskitos Marine Reserve.** The poster will help solidify the image of the reserve in the minds of policy makers and stake-holders and can be used as an effective publicity and fund-raising tool. It will also show that the creation of the reserve is now in "new hands". It would be one of the best initial investments in getting the reserve off on the right foot as it helps create an identity.

**4. In a democratic Nicaragua, a draft environmental impact statement (EIS) that evaluates a range of reasonable alternative approaches to Reserve management should be produced.** The alternatives should be presented in comparative form to facilitate analysis of their effects. The preferred alternative for Reserve management should be presented based on the management authorities analysis of its impacts. A draft management plan for the preferred alternative should be produced that includes draft regulations. Draft regulations should be produced working closely with the management

authority. The "Preliminary Management Plan" produced by the Caribbean Conservation Corporation is a good feasibility study and can be of use in drafting the above documents. Public hearings should be held to discuss the Draft EIS/Management Plan and appropriate comments incorporated into the Final EIS/Management Plan.

Detailed face-to-face discussions between the EIS/Management Plan writer and the Reserve management authority are the quickest way to resolve regulatory and management issues. Option papers, if read and understood by authorities, can also be helpful to the management authority when trying to decide on issues.

In a non-democratic situation, a zoning plan, Reserve regulations, and a management plan should be drafted, in consultation with the management authority, as soon as possible.

**5. The circular Reserve boundary should be changed to be rectangular and should run along easily identified latitude and longitude lines.** Trying to locate this circular boundary position when at sea during enforcement operations is very difficult.

Operationally, a rectangular boundary with easy to identify coordinates is more practical.

**6. Mooring and demarcation buoys should be installed to provide vessels with non-destructive mooring facilities and to designate harvest refugia areas.**

**7. Obtain a 50 foot diesel powered vessel that can be used for research, enforcement, and maintenance work in the Reserve.** This vessel will be large enough to handle the weather conditions offshore and will allow research teams to spend extended periods of time in the Reserve in relative comfort. This would be a better alternative than trying to build and maintain an offshore research station in the Reserve that would be subject to hurricane damage. A large vessel will provide more flexibility to Reserve staff and visitors for accomplishing the various missions necessary to manage the area. Efforts should be made to obtain this vessel via donation.

**8. CARICOMP coral reef ecosystem monitoring protocols (Smith and Ogden 1993) should be established and maintained as the backbone of the Reserve monitoring program.** Steps should be taken to join the CARICOMP program and Reserve staff should be trained in CARICOMP monitoring procedures. CARICOMP monitoring is presently being conducted off Great Corn Cay (seaward of Bluefields) in Nicaragua. CARICOMP monitoring sites will be incorporated into the new Global Coral Reef Monitoring Network.

**9. Use patterns should be determined so management can understand the cumulative impact to the resource and set realistic carrying capacities.** Periodic overflights and fishermen interviews would be the best way to accomplish this.

**10. Nicaragua should join the International Coral Reef Initiative (ICRI).** USAID should help Nicaragua draft a letter to the ICRI Coordinator, requesting to join ICRI. Being a member of ICRI could help Nicaragua obtain additional grant funds to manage the Reserve.

**11. Obtain Biosphere Reserve Status from UNESCO for the Cayos Miskitos Marine Reserve.** The main advantage of joining this program is that it certifies the unique and important status of the resource and makes it part of an international network. This in turn can be helpful in obtaining grant funding for Reserve management from the International Man and the Biosphere (MAB) Program and other sources. MAB training opportunities are also available from time to time.

There is no change of ownership or sovereignty by being part of the International Man and the Biosphere Network. Therefore, this designation is not a substitute for Cayos Miskitos Marine Reserve regulations passed by the Nicaraguan government. Fishing can still be done in a biosphere reserve.

The application of the biosphere reserve concept primarily results in the adoption of a cooperative community framework for promoting conservation programs and regional activities. An ecosystem approach to management and sustainability hopefully will be achieved, not through increased legal means and zoning laws, but through open and democratic dialogue, education and community participation.

**12. SCUBA diving training capacity should be developed in Puerto Cabezas and other appropriate villages.** This could be done through MARENA or on a commercial basis by training a few people interested in setting up a small business. In either case, the goal is to provide some place that offers diver certification training. This will help reduce the number of diving related deaths and injuries to the local population. Since this is a major problem in the Reserve, Reserve regulations could also state that only certified divers are allowed to dive in the Reserve.

### ACKNOWLEDGEMENTS

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