

PN-AAW-876

AN INVENTORY OF BENEFICIAL MARINE LIFE  
OF COSTA RICA'S ATLANTIC CORAL REEF

Steve Robinson  
March 1987

936-5517

Environmental Planning and Management Project  
International Institute for Environment and Development

This document was produced for the Environmental  
Planning and Management Project of the  
International Institute for Environment and  
Development under the  
NGO Contract #NGO/FA/87-02

The Environmental Planning and Management Project is a  
cooperative agreement between the International Institute  
for Environment and Development and the U.S. Agency for  
International Development to respond to requests for  
assistance from developing countries in a variety of  
environmental and natural resource management problems.

Single copies of this document are available free from:

International Institute for Environment and Development  
1717 Massachusetts Ave. N.W.  
Washington, D.C. 20036  
(202) 462-0900

"AN INVENTORY OF BENEFICIAL  
MARINE LIFE OF COSTA RICA'S ATLANTIC  
CORAL REEF"

BY

STEVE ROBINSON  
MARINE CONSULTANT AND FIELD DIRECTOR OF  
INTERNATIONAL MARINELIFE ALLIANCE (IMA)  
WITH THE COLLABORATION OF  
ALBERTO SALAS

FOR

INTERNATIONAL INSTITUTE FOR  
ENVIRONMENT AND DEVELOPMENT (IIED)

ASOCIACION ANAI (ANAI)

CORPORACION DE INVESTIGACIONES  
PARA EL DESARROLLO SOCIO-AMBIENTAL (CIDESA)

MAR. 1987

CONTENTS

ABSTRACT.....page i

INTRODUCTION..... 1

ORNAMENTAL FISHES..... 4

MISCELLANEOUS SPECIES.....13

INVERTEBRATES.....15

SUSTENANCE AND COMMERCIAL FOOD SPECIES.....16

SUSTENANCE FISHING.....18

GANDOCA LAGOON.....21

WHY THE CORAL REEFS ARE DYING?.....22

THE EFFECT OF SEDIMENTATION.....24

THE BANANA CONNECTION.....27

CAHUITA NATIONAL PARK.....29

CORAL GROWTH RATES.....30

RECOMMENDATIONS.....32

CONCLUSION.....38

MAPS

ABSTRACT

It was the original intention of this project to survey the available living marine life resources of Costa Rica's Caribbean coast and perhaps suggest areas where unexploited fishing potential could be engineered on a sustainable basis for local community benefit.

The collection and export of ornamental tropical marine fishes, it was suggested by previous research could, if promulgated successfully, take fishing pressure off of the lobster population and provide diversification of livelihood for fishermen;

Unfortunately, in the last 10 years and increasingly so in the last five, the entire coral reef system has been dying. As of March 1987, approximately 75% of the reef building corals throughout the region are dead. Similarly about 90% of the gorgonians and sea fans are dead.

The dramatic decline in available, living reef habitat has been predictably accompanied by an equally dramatic decline in sea life and sea food generation.

Many fishermen are now out of business, others are struggling along. Lobster production is declining despite increasing effort. Tropical fishes are scarce and low in diversity. Sustenance fishing has suffered greatly and the previously taken for granted "wind fall" of food fishes is disappearing.

Isla Uvita Park and Cahuita National Parks biological diversity and aesthetic beauty has been compromised.

Young fishermen especially have been migrating to the cities rather than switch to farming and cultural and familial patterns of the villages of Puerto Viejo and especially Manzanillo is disintegrating.

The region, as preliminary evidence suggests, may be significant as a nursery and rearing area for baby tarpon, the basis of the multi-million dollar sport fishery in the Tortuguero region. The unwitting sabotage of the tarpons life cycle as with other important sea life cycles may have grave and far reaching negative impacts, just when Costa Rica's need for protein, livelihood and income has never been greater.

The preponderance of evidence; circumstantial, observational and empirical, points to the huge sedimentation load emanating from the Rio Estrella as the primary cause of coral deaths.

The interference of photosynthetic activity on coral and other reef life's zooxanthellae algae from greatly increased water turbidity has caused general metabolic sabotage.

Most of the sedimentation appears to be coming from run-off erosion from the banana fields along the Rio Estrella.

Recommendations are offered as to how the banana companies can begin to make reforms of their field practices, reforms toward rebuilding coral reef productivity and/or restitution for the fishermen whose livelihoods they are erasing.

## INTRODUCTION

As the first white explorer to discover this country in 1502, Christopher Columbus, was so impressed with the richness and diversity of the Atlantic Coast near Limón that he named it "Costa Rica" or Rich Coast.

It was precisely this richness in the abundance and diversity of marine life that led to the establishment of Cahuita National Park in 1971 just 40 miles to the South.

As the entire coral reef system of Costa Rica's Atlantic side is only 22 kilometers long, the establishment of this park was deemed an important step to insure the perpetuation of the country's caribbean marine life complex. The high productivity of the area's rich, living coral reef colonies gave rise to large, thriving populations of lobsters, red coral crabs, queen conchs, helmet shells, turtles, food fishes of all kinds, particularly snappers, basses, and jacks, and a variety of colorful tropical fishes.

Especially noteworthy was the area's rich concentrations of some of the most popular tropical fishes in the world wide aquarium trade.

Unlike many other countries with large coral reef coastlines such as Indonesia, the Philippines or Mexico, where longer range fishing trips may compensate for any productivity loss near home, Caribbean Costa Rican fishermen literally have no where else to go.

In view of the scarcity of geographical marine habitat, in few places is necessity of prudent, rational and sustainable marine resource management as clear as in Costa Rica's Atlantic Coast.

The welfare of thousands of people is very much dependent upon the continued productivity of this area, particularly the shoreline villagers who have historically been so closely tied to the sea.

It is with this very much in mind that the following study was conducted. It was hoped that an "inventory" of living marine resources of the region and a closer inspection of trends and patterns in productivity and recoverability of such resources could suggest areas where local benefit and income could be enhanced and diversified.

Currently, a single resource is taking most of the fishing pressure, the lobster (Panulirus argus). Alternative yet equally rewarding enterprises could perhaps take some of the "heat off" and help insure the future of lobster fishing.

It has been suggested that the non-utilized, yet fast growing and resilient ornamental fishes could take up the slack. In many tropical countries, including Costa Rica (Pacific Coast only) the trade in ornamentals is a well established and profitable business.

The world wide trade in marine tropical fishes and invertebrates now exceeds 100 million dollars in retail livestock sales and demand is especially high in caribbean species, especially in view of the fact that the traditional, primary supply line (Florida) is rapidly losing ground due to over fishing of the resource and ecological deterioration of critical habitats.

As a result, some primary species have enjoyed considerable escalation in prices.

A non-socially exploitive and responsibly run Atlantic collecting enterprise could establish significant local benefit in coastal communities in exchange for a minimum of highly renewable resource.

Village divers could be trained in non destructive collecting techniques involving various types of nets (no chemicals or crowbars as in some countries) and given training in coral reef biology, conservation and diving safety.

Furthermore they could be, unlike most of the world's fishing collectors, trained in the fine arts of fish decompression, handling, maintenance, packing and marketing.

A truly skilled and quality oriented 'Costa Rican Caribbean Connection' would enter a ready made sellers market and literally choose its suitors.

To translate this vision into a concrete, working reality was the primary purpose of this effort: however, in the last very few years a frightening and ecologically devastating momentum has developed in the entire coral reef complex and shows no signs of abating, in fact, it is accelerating.

Within the first week of the coral reef survey it became very apparent that something was terribly wrong.

Costa Rica's coral reef is dying.

Approximately 90% of the gorgonians (Gorgonia flabellum and ventalina) and 75% of the hard, reef building corals (Acropora palmata, Porites porites, Porites Astreoides, Monstatraes annularis, Siderastrea siderea, Agaricia lamarcki, Agaricia agaricites, Agaricia tenuifolia, Diploria labyrinthiformis, Diploria natans) as well as others, are already dead.

As the percentage of living coral cover on a reef is the primary determiner of productivity in fish and invertebrate populations, the alarming and continuing loss of living coral cover is both an environmental and social tragedy of grave consequence. The social implications of this are now unfolding before us as the diminution of both sustenance and livelihood giving sea life is now being felt by residents all up and down the Limón and Talamanca coast.

Divers and fishermen are currently reaping the survivors of an already rapidly deteriorating situation and no doubt accelerating the pace of depletion.

Clearly, further, significant depredations are not going to be beneficial.

It is with reference to current development or perhaps more appropriately, to the current "unraveling" of a once diverse, abundant and living eco-system that the future outlook of the food and ornamental fish resources must be seen.

### ORNAMENTAL FISHES

As ornamental marine fishes are perhaps the most coral dependent of all fishes, they are predictably and with few exceptions, declining in numbers. Their recruitment (recoverability) schedule seems to be severely affected and many species are represented only by exceptionally large and old specimens.

Furthermore, a number of Caribbean reef species are missing or represented by very few specimens, sometimes a single one.

To establish a point of reference for future evaluations and to define the immediate though declining state of the ornamental fish resource, the following species by species survey was conducted.

Every single marketable aquarium fish observed is recorded herein.

#### FRENCH ANGEL FISH (Pomacanthus paru)

By far the most sought after tropical marine fish in the Caribbean today is the French Angel. Due to its relative disappearance in Florida waters and the lack of another reliable source of fishes, the wholesale value of the French Angel has risen from \$10 to \$20 in the last 3 years.

It was hoped that this would be the flag carrier of the project as good sustainable numbers of the species would virtually guarantee success.

Unfortunately the marketable size French Angel fish are largely restricted to a particular region between Manzanillo and halfway to Punta Mona (2.5 kilometers long). This region contains the requisite shallow water ledges and eel grass expanses preferred by juvenile frenches. Unfortunately there is little of this habitat elsewhere in the entire reef system. Almost every single sighting of a market size "French" 1.5 to 5 inches was in this small area.

During the entire survey only 24 market size specimens were observed, not enough for even a single good shipment.

Large, old adults roaming about in pairs were encountered infrequently throughout the survey area.

As the large adult pairs of Frenches have few enemies (they are rarely eaten) and are still in sufficient numbers to produce significant offspring it can only be surmised that the lack of juveniles throughout the region must be attributed to environmental factors and diminished habitat. A very small percentage of spawnings are surviving and only in a very restricted area.

The aggressive, territorial nature of juveniles insures a "spacing" of inhabitants and given the already small habitat, few vacancies are available to support individuals.

If any aquarium fish project is to go ahead it should harvest only a half dozen or so fishes at a time and then never a specimen less than 1.5 inches or larger than 5 inches. Only if new, secret grounds could be discovered (which is doubtful) the number of harvestable specimens could perhaps amplified.

GREY ANGEL (*Pomacanthus arcuatus*):

A close relative to the French Angel, the Grey Angel does not enjoy the same exalted status in the aquarium trade. This is because its coloration tends to fade from rich black into grey rather quickly when only 3 - 4 inches long.

Still, small ones are in demand in most tropical fish collecting areas in the Caribbean. The Grey Angel is more abundant than the French Angels, much to the chagrin of traders.

Here in Costa Rica the French is more abundant than the Grey. Only three very large adult Grey angels were observed and no juveniles.

Of this species there is simply nothing to monitor, manage or harvest.

QUEEN ANGEL FISH (Holacanthus ciliaris):

Perhaps the Queen Angel is the most beautiful of all Caribbean tropicals and certainly the one most often appearing on tourist posters.

As with the French Angel, the supply of this popular tropical, is no where near the demand.

An excellent market exists for whatever supply could be engineered. Unfortunately, such a supply is not to be found along the Atlantic coast.

Although the species does exist here, only about two dozen specimens were observed and not a single one of them small enough to market. All were adults; some very big, (1.5 feet) and very old.

Despite the fact that several gravid females were observed the lack of even a single juvenile was an ominous signal.

Expanses of healthy coral covered reef are essential for the production of Queen Angels and such habitats no longer exist in this region.

The totality of old, large specimens would seem to indicate that they are survivors, holdovers from more productive times when more coral was alive.

Most of the critical habitat of the Queen Angel has apparently died in the last few years, sabotaging its reproductive success and foreclosing its chances of recovering.

ROCK BEAUTY ANGEL FISH (Holacanthus tricolor):

This pretty angel fish is another staple of any Caribbean marine tropical fish price list and in most places is more common than the other Angels. Here is no exception.

Being not as coral dependent as the Queen Angel, the Rock Beauty is more adaptable and often can be found in shale ledge and spongeladen areas.

As the region has more of this secondary type habitat it is not surprising to find Rock Beauties, not in abundance but more frequently than the other angels.

This is one Angel that does appear more commonly from other areas in the Caribbean and carries about half the price of the French Angel - \$4.00 F.O.B.

Large specimens are in low demand and should not be taken anyway. Juveniles and medium specimens are in evidence and could sustain a moderate level of harvesting.

SPOTFIN BUTTERFLY FISH (Chaetodin ocellatus):

This pretty but only moderately popular Butterfly Fish enjoys a vast range throughout the Caribbean.

Still, a good, perpetual supply of smaller specimens would make a good addition to any traders list.

Unfortunately, almost all of the Spotfins encountered were full size adults, 5 - 7 inches, travelling in pairs.

Only six juveniles in pairs were seen. As with the Queen Angel, this predominantly coral - dependent species does not seem to be reproducing well along the Talamanca coast. When small specimens are not often encountered the temptation increases for divers to take larger ones. This further insures that whatever numbers are reproducing will be even less so.

BANDED BUTTERFLY (Chaetodon striatus)

The population status of the Banded Butterfly is almost a carbon copy of that of the Spotfin. Only the full adults are a little smaller and still not a good collecting proposition.

FOUR EYE BUTTERFLY FISH (Chaetodon capistratus):

The commonest and cheapest Butterfly in the Caribbean, the Four eye is rare in Talamanca. Less than a dozen were observed and only a quarter of them small enough to collect and export.

REEF BUTTERFLY FISH (Chaetodon sedentarius):

This moderately popular butterfly enjoys a fair market demand and is not uncommon. It lives in the deeper reefs of Talamanca, particularly in front of Puerto Viejo over hard bottom areas in waters from 50 - 100. Good size pairs (3") can be encountered on nearly every dive. Owing to its less "coral dependent" requirements the carnivorous reef butterfly seems to be holding its own.

Unfortunately, despite its occurrence in the depths, it still does not command a price worthy of the dangers and efforts required to secure it in good numbers. If other more valuable fishes could also be taken on deep dives, its incidental capture could be considered a better proposition. Aside from this butterfly however, (and good size rock beauties) Talamanca's depths seem to be lacking in other desirable fishes.

ATLANTIC SPADE FISH (Chaetodipterus faber):

With the Atlantic Spade fish the demand is only for smaller specimens, ideally 1-4 inches. Since the fish grows to three feet in length these are the first young of the year.

A few tiny spades were encountered and good size schools of ten inches specimens were occasionally seen.

Normally Spade fishes occur seasonally and are seen floating about the surface like dead leaves.

Local fishermen do not recall any period of abundance of small specimens and encountering small ones is largely a matter of luck.

BLUE TANG (Acanthurus coeruleus):

Despite the deteriorating condition of the Talamanca coral reef complex this is one fish that seems to suffer the least. It is a strict algae feeder and dead coral only increases the preponderance of algae in an area.

Large shoals of Blue adults can be frequently seen, though nothing like the abundance of Yucatan Mexico's coral coasts.

Bright yellow juveniles can be seen at a good percentage of outcrops as well as a few yellow tailed small specimens. Both of these phases are marketable yet do not carry the higher prices of the more popular Tangs of the Pacific. They whole sale for about \$ 2.00 each.

This is one fish that could right now sustain a fair amount of collecting.

QUEEN TRIGGERFISH (Balites vetula):

This is one of the more popular triggerfishes in the aquarium trade and enjoys high demand for small specimens up to about four inches, ideally two and a half. Large specimens are available in fair numbers and their shale ledge habitat is fairly large, extending throughout the length of the reefs and beyond them.

Not so many juveniles were encountered (8) but this is due to the fact that most of the survey was conducted over reef areas.

Shale areas are noted primarily for containing lobster, Rock Beauty Angels and Queen Triggers.

As the Queen trigger lives in shale habitat and is strictly a carnivore, it has not suffered to the degree of many coral reef dwellers.

No other species (e) of triggerfish in the area is really marketable. Queen triggers whole sale for about \$ 5.00 each and could be collected in small numbers.

ROYAL GRAMMA (Gramma loreto):

One of the top tropical world wide trade, the Royal Gramma enjoys tremendous demand.

As a result, it has also been eagerly by sought by every Caribbean dealer and the resultant quantity collected and shipped have served to keep its price down. Haitian exporters sell this beautiful fish in great numbers for a single dollar each.

Still, it is a "volume fish" and large orders are always welcome by importers. Normally, the limiting factors in collecting operations is the skill and bottom time of the collectors as this fish is normally very abundant in healthy reef areas containing large overhanging ledges.

Once again, in Talamanca we have the same pattern emerging. Although habitat structure, over hanging cliffs and ledges, are fairly common yet the fishes are not.

The record observation in one day was 4 specimens in the deepest ledges of Punta Mona. Once again the few specimens encountered were large sized and old.

Throughout the entire survey from Puerto Viejo to Punta Mona, only 18 specimens were encountered.

This is unfortunate as a single healthy ledge of 5 meters square off Glovers Reef in Belize or Palancar Reef in Yucatan, Mexico can yield the same number.

NURSE SHARK (*Gingly-mostana cirratum*):

Small nurse sharks 1'-2' have recently become very popular with aquarists, yet in few places are they ever found with any regularity. Four larger specimens were encountered in Talamanca and none small enough to market. Lobsters divers testify to finding small ones at times but infrequently.

SPANISH HOGFISH (*Bodianus pulchellus*):

Some of the best news on this tropical fish survey is the Spanish Hogfish. It is quite abundant and in perfect sizes. It is the one species in the Talamanca Coast that is both highly marketable and available in numbers that would far exceed shipment orders. Wrasse family members are noted for their adaptability anyway and perhaps it is profiting from decreased competition.

As it is the only good demand fish which could be harvested sustainably and in good numbers. It would be a primary fish in any shipments originating from Talamanca.

It is hardy, ships well and keeps its value in the market which is around \$3.00 export price. Specimens from 1/2 inches up to 5 inches are commonly available and are to found in every single survey site.

Adults are rarely ordered and this further serves to insure that the supply line will stay strong.

BLUEHEAD WRASSE (*Thalassoma bifasciatum*):

Unfortunately, this extremely common wrasse has suffered in the market place from over exposure.

The drab yellow females are difficult to give away yet can be "pushed" on buyers if enough other good specimens are leading the shipments.

The bluehead male has a better market and can be sold for about \$1-\$1.50 each. Still few importers would want more than 50 per shipment. The abundance of this fish is not an indicator of good enviromental conditions as it fills in where other species disappear.

PUDDING WIFE WRASSE (*Halichoeres radiatus*):

This wrasse is of value only in its juvenile stage which is completely different from the adult. It is one of the most difficult of all wrasses to capture but can be done consistantly as the skill level of collectors increases.

Prices wise its worth is about that of a Bluehead male wrasse. It is seldom collected because in most places divers prefer to spend their time chasing less difficult, more valueable specimens.

In the case here, perhaps it would be seen as a "better than nothing" fish. The pudding wife is not really abundant anywhere but is frecuently encountered in Talamanca reefs.

SERGEANT MAJOR (Abudefduf saxatilis):

Though generally in low demand small (up to one inch) juveniles do have a market. It is very adaptable, common fish especially in failing reefs, and probably could not be exterminated if one tried. It is also a bully and a heavy competitor often displacing less aggressive species. Hundreds of small juveniles can be taken and could be shipped for about 25 ¢ each. There are fairly good numbers in evidence.

BEAUGREGORY (Pomacentrus leucostictus):

The Beaugregory and its cousin the Threespot damsel (Pomacentrus planifrons) are in fair abundance in Talamanca and could be safely taken by a few hundreds per month at about 30 ¢-40 ¢ each.

The adults as in all damselfishes in the area are commercially worthless and would therefore never be bothered.

YELLOW TAIL DAMSELFISH (Microspathoden chrysurus):

This common, highly, aggressive damsel is a viable proposition only when quite small 1"-2". It exists in fair abundance owing to its adaptability and competitiveness. In most places it is considered to be a difficult fish to catch and as a result enjoys a pretty good market. High priced for a damsel, it could be sold in consistent numbers for about a dollar a piece.

REDLIP BLENNY (Ophioblennius atlanticus):

This locally common, algae eating, surge zone blenny has low value and low demand but on a small scale could be collected and shipped for about 75 ¢ each.

REDSPOTTED HAWKFISH (Amblycirrhitus pinos):

Surprisingly uncommon, this elsewhere abundant fish must have suffered from depletion of critical habitat. It requires living coral heads for protection. It can still be taken and sold on a modest scale for about 75 ¢ to a dollar.

REMORA (Remora remora):

One interesting fish in Talamanca with a good market is the Remora. They are not abundant anywhere but a few can be seen here almost everyday. The demand is good, the supply always low.

This is a one of the "good ones" that helps to make the species list more attractive. Remoras are attached not only to sharks, rays and turtles here, but also to parrot fishes. Even one foot long parrot fishes may have small remoras riding on them.

They tend to be good size, less than 10" long usually and are very hardy. Market value FOB is about \$6.00.

ATLANTIC PORK FISH (Anisotremus virginicus):

The Atlantic Pork Fish occupies a small niche in every Atlantic tropical fish connection.

The demand is never high and most orders could probably be filled from Talamanca. The Pork Fish is in the Grunt family which seems to be holding on better than other predators in the region. Only juveniles can be marketed, up to 3" for about 1.25 each.

MISCELLANEOUS SPECIES

The following species were seen only very rarely or perhaps only once. They would be commercially marketable if the numbers were there. It is possible that some are actually more abundant in a particular season or under particular circumstances.

CORAL TOAD FISH (Genus/species unknown):

Two specimens of this nocturnal rather unattractive yet interesting fish were observed. Both about a foot long. A brightly colored and equally secretive species occurs in Cozumel, Mexico.

TABACCO FISH (Serranus tabacarius):

Normally a very common sand dwelling fish. Only one specimen.

GREATER SOAP FISH (Ripticus saponaceus):

An unpopular fish with very limited demand and then only when very small.

HIHAT (Equetus acuminatus):

A common Caribbean aquarium fish but apparently uncommon in Talamasca, only one observed.

MIDNITE PARROT FISH (Scarus coelestinus):

A few magnificently colored large specimens (1 1/2 feet) were observed. No juveniles. The most beautiful of all Parrot fishes.

TRUNKFISH (Lactophrys trigonus):

Several over size adult specimens encountered. The trunkfish is popular only when smaller, ie, below 4". None in this size range were found.

SHARPNOSE PUFFER (Canthigaster rostrata):

A normally common fish throughout the Caribbean. Only a few small ones observed.

NEON GOBY (Gobiosoma oceanops)

A common popular aquarium fish throughout the Caribbean. Only a dozen observed.

### INVERTEBRATES

If the fish life was generally disappointing in the Talamanca Coast, the invertebrate life was much more so. The lack of invertebrates was very unfortunate to behold.

#### BANDED CORAL SHRIMP (Stenopus hispidus):

Normally the commonest of ornamental shrimp, this species was observed in only two locations— a pair of each.

#### RED CORAL CRAB (Carpilius corallenus):

A very attractive crab observed on three separate occasions and always of large size. Two inch specimens would be in high demand but are just not around.

#### PURPLE CORAL (Stylaster rosacea):

Apparently, this small species of semi-precious ornamental coral has not been adversely affected like every other species of coral in the region.

In fact, in its sun shaded, or deeper water under ledge habitats, it seems to be doing very well. Large aggregations were observed especially at Punta Mona and two dozen samples taken for market analysis.

At 30 feet deep off Punta Mona, a 10 feet high wall by 20 meters long contained specimens within every single meter.

Besides the entire Punta Mona area feet. every other reef from contained specimens. In shallower water it was more likely to be found inside ledges and crevasses. Only below 20 feet were specimens relatively open.

This coral, has a marginal commercial value. It could be taken by lobsters divers using only snorkeling equipment and screwdrivers to pry the specimens off their rock bases. Once taken the specimens must be handled with extreme care as they are very brittle. Transporting them in a boat would have to be done very carefully, with a carrying compartment for each specimen. Perhaps padded coca cola boxes of 24 compartments would do.

Before harvesting any level it would be advisable to secure whatever studies are currently available on this genus of semiprecious coral.

All factors considered, it does not appear to be a very good proposition.

### SUSTENANCE AND COMMERCIAL FOOD SPECIES

#### LOBSTER (Panulirus argus):

There is much reason to believe that the lobster fishery in Limón and the Talamanca coast is in serious trouble. In fact, it shows all the signs of a dying industry.

From its inception as a commercial enterprise in 1979 until 1983 the abundance of lobster was both a blessing and a problem. The over-crowding of heavy catches in floating live well cages often lead to high losses and a sorry waste of the resource. Today, just a few years later in this 8 year old industry, fisherman catches have declined dramatically. In view of this, divers feel increasingly "driven" to discard former wisdom and take the egg bearing females as well as undersize lobsters. This was observed in the case of every single diver. The buyer himself encourages and accepts every undersize lobster tail he can get.

Perhaps the only reason that there are any lobsters left at all is because for about half the year, heavy seas and difficult conditions do not permit divers to operate. During this time, nearly half of the divers return to their homes in Panamá as they are not native Costa Ricans. The months that do permit regular lobster fishing are the calmer periods of february, march and april and september, october and part of november.

Aside from bad weather, the lobster may profit from decreased predation from natural enemies. Few snappers and basses today are large enough to swallow a lobster of any significant size.

It is very important that the effects of sedimentation and pesticide poisoning in the lobsters' life cycle be known as it contrasts with the present fishing pressure.

At present it is not precisely known how much of the rapidly declining lobster catches are as a result of the over fishing or deteriorating environmental factors.

Although the species grows to a hefty two feet in length excluding antennae and may weigh up to 20 pounds, no lobster today even approach that size. The average size is a slender foot long and only a pound or two.

A popular mythology was circulated for years about lobsters migrating in from "now where" in great numbers to replace "insignificant" fishermen's catches. The last great migrations occurred 3 years ago. Since then the deepwater lobster numbers have been depleted to the point that they no longer migrate into the shallows.

Aside from the aforementioned concerns, the already dwindling lobsters of Limón and Talamanca have attracted the attention of city based poachers using deep water diving apparatus employing hoses 150', these poachers launch from Puerto Viejo and range into Manzanillo waters in search of lobster. Picking off the few remaining deepwater reserves by these outsiders further guarantees the poverty of lobster fishing in years to come.

### SUSTENANCE FISHING

Subsistence fishing which is more of a tradition in the Talamanca Coast than commercial fishing, has also suffered severely in recent years.

Interviews with a number of local fishermen in their homes and at sea revealed an incredible disparity between fish catches in the 1970's and fish catches today. Just ten years ago, fishermen would catch several kinds of Jacks (Caranx sp) with just machetes, wading out silently and chopping them as they chased the ever abundant shoals of sardines driven to the shallows by their predations. Today sardines exist in a fraction of their former abundance, Their fortunes declining commensurate with the decline of coral reef productivity.

Accordingly, the Jack population (about 5 - 7 different edible species) have taken a demographic nose dive.

On several six hour dive surveys the author observed no Jacks at all or only 2 or 3 specimens.

Moreover almost all sightings were of the smallest species of Jacks, the bar Jack (Caranx ruber). The decline in jacks has been so great that locals can no longer 'catch' them at will. The loss of so much of this "free food" resource is most regrettable.

THE KING MACKEREL (Scomberomorus cavalla) and the SPANISH MACKEREL (Scomberomorus maculatus) which are still one of the most often caught food fishes by Talamancan fishermen are suffering an identical fate as the jacks.

As sprat and sardine feeders, their fortunes are determined by the abundance of their food source.

Today's catches are but a fraction of former ones and as slower growing reef dwelling food fishes are becoming scarce, the fishing pressure on mackerels is increasing.

Especially disturbing during the course of this survey was the scarcity of groupers and basses, significant predators on any healthy reef system.

One small Jewfish (Epinephelus itajara) was encountered at 35 feet off Punta Mona.

A lone Black Grouper (Mycteroperca bonaci) off of Manzanillo and exactly 2 Rock Hinds (Epinephelus adscencionis)

The only basses of any numbers at all are the Coney (Epinephelus fulvus) and even they could hardly be considered abundant. Locals call them Butterfish and regard them as the tastiest of fishes. Perhaps the butterfish is surviving on account of decreased competition from other predators, especially larger ones which are so very scarce. Even the deepest drop offs of Punta Mona, a place previously known for its gatherings of larger basses, (except for the one jewfish, one rock hind) were barren of specimens.

Another group of food fishes important to the local people are the snappers. For decades snappers have been a staple in their diet, catchable by handlines from shore or just a short paddle out.

Only two species were easily observed every day, the School Master Snapper (Lutjanus apodees) and the Lane Snapper (Lutjanus synagris) and once again their numbers could not be described as anywhere near abundant nor their sizes very good. Almost all were on the small side, under a pound.

The much sought after and very tasty Yellow Tail Snapper (Ocyurus chrysurus) appears to be doing very poorly. On an average day only 3 - 5 would be seen and most of them as lone specimens. In most of the caribbean's healthy coral reefs, this is a common fish. According to fishermen's testimonies, it used to be a common fish here as well.

The huge Cubera Snapper (Lutjanus cyanopterus) was observed on a single occasion in the deepest area of Punta Mona (60 feet). A single rock grotto contained 4 or 5 specimens approaching 80 pounds.

Local fishermen all recall a great Silk Snapper (Rhomboplites aurorubens) bounty on some deepwater banks 5 miles out to sea from Manzanillo.

In the early 1970's some local fishermen accidentally "discovered" fantastic, large Red Silk Snapper fishing and let it slip to some Puerto Limon operators about their good fortune.

As Manzanillo fishermen were accustomed to take only what they needed their numbers could have been supported by this rich bank indefinitely.

Furthermore, they lacked capital, icing facilities and access to a large market to exploit the species on a large scale.

Commercial operations from Puerto Limon however launched their own enterprise in or about 1976 with ice, trucks and power boats.

The boom only lasted 5 years and by 1981 the Silk Snapper population was considerably reduced.

Today the fish can still be caught and is, but they are harder to find and are generally much smaller than in "the good days."

One group of fishes that always seems to hold on the longest in depleted areas is the half dozen or so species of local Grunts (Haemulon sp.) They exist in fair numbers in the reef areas but are seldom taken by fishermen. Traditionally fishermen have preferred to take Jacks, Basses or Snappers and rarely "stoop" to eating Grunts. They have always been considered to be a "junkfish". The prolific, carnivorous, adaptable Grunts must surely benefit from diminished competition from other more efficient predators.

Some of them are attractively colored and upon encountering a school of them a tourist may be inclined to believe that the reef is doing well.

The most commonly occurring species are the Spanish Grunt (Haemulon macrostomum), the Black Grunt (Haemulon bonaeriense), the Cottonwick (Haemulon melanurum), the Pork Fish (Anisotremus virginicus) and the Black Margate (Anisotremus surinamensis).

Aside from food fishes, another traditional food item of coastal people in the region was the Queen Conch (Strombus gigas). Divers tell of great congregations of this delicious mullock carpeting the sandy bottoms of virtually any depth in "the old days". Not any more. Let it suffice to say that during the entire survey only one specimen of this slow growing snail was discovered.

Incidentally, another large, edible very attractive shell mullock has also disappeared from a former abundance, the Helmut Shell. Likewise a solitary specimen was encountered.

## GANDOCA LAGOON

(Special Emphasis)

The Gandoca Lagoon may be far more important than previously suspected. In addition to its aesthetic qualities, it is the repository of the Atlantic Coast of Costa Rica's only population of Oysters (Crassostrea rizophorae).

These delicious and highly marketable Oysters that are produced in the lagoon could also be cultured from spats (congregations of babies) outside the lagoon in front of fishing villages.

As they are filter - feeders however, they take in whatever water borne residues and particles are around.

Poisonous chemicals, pesticides and excessive siltation are all threats to this potentially valuable but as of yet non-utilized resource.

Perhaps the most valuable living marine organism in the entire region is also the most overlooked, the Tarpon (Megalops atlanticus). It appears that juveniles frequent the lagoon. (3 inches long). This is potentially very significant, because juvenile Tarpon are hardly ever encountered anywhere.

The importance of a productive Tarpon nursery ground grows when we consider the fact that the multi-million dollar sport fishing industry in and about Tortuguero is very much dependent upon its world famous Tarpon fishing. Any threats to the reproductive cycle of this valuable fish must be taken very seriously.

Eggs are broadcasted by the millions by large female tarpon. They hatch and drift in the larval stages on ocean current for weeks until they find suitable mangrove, lagoon habitat to settle into and grow. The prevalence of these critical habitat determines the totality of the tarpons prospects for survival.

Aside from nursery habitat, young tarpon are also dependent on the general biological productivity of lagoon, nearshore and coral reef complexes to feed them as they grow towards sizes (5-7 feet) that make them such a dynamic and powerful sportfish.

Possible threats exist from up river deforestation and ill-advised proposals to build a channel from the Rio Sixaola to the Lagoon by banana interests and to establish an oil pipe line terminal complete with port facilities.

More research is clearly warranted on this mysterious animal to prevent possible unwitting sabotage of its life cycle and the consequent sabotage of the lucrative sport fishery.

Another important food fish of the Gandoca lagoon that deserves mention is the Snook (Centropomus undecimalis) which doubles as a sport fish in the Tortuguero region and elsewhere.

The Snook like the Tarpon, is absolutely dependent upon healthy, mangrove lagoon habitat for its survival.

The Gandoca Lagoon is the only such habitat in Costa Rica south of Limon but may be important out of proportion to its modest size as a major recipient of tarpon larvae carried on Southern currents from northern spawning grounds. Aside from the aforementioned species, the lagoon serves as a common fishing ground for several other lesser food fishes for Gandoca residents.

As of now the lagoon is in good condition having so far escaped the harmful pressures and impacts that have been exerted on the coastal reefs. As such it continues to contribute more than its fair share to benefit Costa Rican society.

#### WHY THE CORAL REEFS ARE DYING

When we understand what the necessary conditions are to sustain and promote the growth of reef building corals, it becomes obvious how easy it is to kill them and why they are dying.

First of all they need a water temperature that is normally above 21 centigrade degrees (71 F) and a stable salinity (degree of saltiness). Moderate wave or current action is also important to keep corals free of debris, to carry wastes away and to bring nutrients in.

Tropical marine waters tend to be extremely poor in nutrients, and hence low in productivity.

Coral reefs however, abound with life and all research studies have indicated very high primary productivity. A 1979 report by the Marine Science Institute at the University of the Philippines indicated the productivity of a healthy square kilometer of Philippine coral reef to be an astounding 20 metric tons per year in fish and an equal amount of invertebrates.

Similar studies on reefs in various stages of living coral decline revealed a corresponding decline in sea life productivity.

The secret to a coral reefs great life generating capacity is in its ability to hold on to nutrients flowing through it and to act as a "sink" for all brought in from outside.

Of critical importance for reef building corals to prosper is the existence of shallow, clear, sediment-free water where sunlight can support the photo synthetic activities of symbiotic algae called zooxanthellae.

This zooxanthellae grows in and on the tissues of corals and is present in all species of reef building corals. The zooxanthellae algae are known to be absolutely critical in the process of rapid calcium formation and the growth of coral structures which over thousands of years come to constitute the coral reef structure itself.

This important algae also aids in the nutrition of corals as well as that of sponges, anemones, gorgonians, sea fans and so many other organisms that make up the living reef.

As sunlight does not penetrate the depths very well it is not surprising that the zooxanthellae algae growth there is much less than in the shallows of ten meters or less.

As a result we find a much poorer and less diverse growth of corals in the depths.

To further illustrate the importance of this life bearing algae-coral connection, we find that a corals calcium creation rate is twice as much on a sunny day than what it is on a cloudy day.

In nature, cloudy days come and go but the vast majority of sunny days make up for the temporary slowdown.

The crucial point is that anything that absorbs or prevents

the tropical sunlight from reaching the zooxanthellae algae bearing coral surfaces will inhibit or stop coral growth.

### THE EFFECT OF SEDIMENTATION

For thousands of years "acceptable" levels of mud, silt and forest debris have washed into the sea from creeks and rivers along Costa Rica's Caribbean coast.

The amount and density of these "natural sediments" has always been of a degree 'absorbable' by the coral reef system.

The seawater over the coral reefs has always been clean and clear enough to let the sun work its magic on them.

In today's rapidly changing Costa Rica however, we have a completely different situation emerging. Human "development" activities have been "unravelling" the forests topsoil maintenance system and the sea's coral reef formation system.

Commercial, municipal and private operations particularly in the City of Limon, have been steadily increasing the degree of garbage, pollution, oil, chemicals, sewage and mud that flows into the sea.

Aside from this and more than urban generated impacts the coral reefs are being threatened by the kind of upland agriculture and forestry practices that have predictably produced the same consequences in countries all around the world.

Timber deforestation and the resultant loosening of topsoil and ground cover has caused great amounts of "mud" to flow in to creeks and rivers, expanding destructive impacts far beyond the City of Limon.

Aside from irresponsible timber and land clearing activities, erosion on a massive scale from banana plantations along the Sixaola, Estrella and Matina rivers have sent inestimable volumes of precious topsoil out to smother valuable coral reefs.

Of all man's activities that have driven material, debris and wastes into the sea, none can equal the sheer annual tonnage of sediments that flow from the Atlantic slopes banana plantations.

Short term, high level production schedules are standard procedure in modern banana growing as they are in many industries.

This is perhaps just the problem. The distinction between agriculture (i.e. the production of living crops from living bacterially active soil) and industry, the production of non-living things from non-living or no longer living material) has become confused.

Costa Rica's banana companies, like other mono crop agrobusinesses seem determined to apply to rural agriculture the principles of urban industry.

The intention is to minimize the uncertainties associated with living soil compatible growing practices and substitute the more "measureable, calculable and controllable" practices of chemical farming and toxic pest and fungus control.

The dangers in this "industrialization" of agriculture is one of scale. It depends on just how much of the nations's centuries old topsoil and coral reefs are traded in for temporary production. The aggressive, relentless application on a massive scale of farming methods in violation of universal biological realities gambles seriously with the entire chain of life in the region of influence.

As contemporary banana mono-culture is promulgated with a need for great drainage capacity, huge networks of canals run throughout vast fields of banana plants and carry the soil waste into the rivers.

This highly unnatural quantity of sedimentation has not only been in tremendous excess of the coral reefs natural biological tolerance and capacity to absorb, but has also been transported over the reefs for excessive periods of time. Even after a heavy rain, a mud cloud persists for days and often weeks at a time. As one rain may follow another and another, all sending their silt clouds out to combine with others, an entire month may even go by with hardly a day of normal zooxanthellae promoting, sun generating, photo synthetic activity.

If enough time goes by without clear, sunlit water, the zooxanthellae dies and without it, coral growth and biological processes slow to a minimum.

The coral now in a weakened state due to metabolic sabotage, dies much more readily, succumbs to disease and infections more easily and of course cannot renew what it loses to degenerative processes, natural or otherwise.

Yet, as sediments settle on coral surfaces, accelerated levels of energy are required by the coral to purge itself of the nuisance. Having less energy in its weakening state to spare, it requires more in attempt to keep itself from being smothered.

Still more stress is inflicted as suspended particles mix with nutrients and interfere with digestion. This is in addition to the digestive sabotage already promoted from the loss of vital zooxanthellae algae.

The impact of a descending cloud of sedimentation on the coral reef is compounded even further by the incremental accumulation of sediments over time and the consequent re-suspension of them when waves and currents agitate them and raise them off the bottom. New sediments combine with this old sediment load, damage increases in density and prevalence year after year.

In fact, instead of arithmetically, the damage to corals begins to increase geometrically.

In addition to this kind of damage, sediment clogs a fishes gills, impedes respiration, often permanently damaging gill surfaces. The depletion of oxygen supply to fish and marine life causes it to suffocate and die.

The fish of whatever river system receives this kind of treatment generally suffers so do their young, larvae and food webs. Food fishing, especially for guapote (bass like cichlids) used to be common in the Sixaola and Estrella rivers. The fishing production is now a fraction of its former self.

### THE BANANA CONNECTION

18 kilometers out of Costa Rica's 22 kilometers of coastal reefs lie between the Estrella and Sixaola rivers. The remaining 4 kilometers of reef just a few miles south of the Matina River and fronts Limon.

As the heavy coffee colored river load from the Rio Sixaola shears offshore at Punta Mona as a result of current flow patterns there, it is doubtful if the Sixaola is responsible for much more than general decimation of Punta Monas Reefs.

Although they are the deepest and most isolated reefs and therefore should be the most productive, they are not.

They appear to be the most damaged reefs in the system.

They are both ugly to behold and are very low in fish productivity. Historically, the exact opposite was true. Considering the very high level of silt emanating from the Sixaola river, coral reefs north of Punta Mona are lucky that favorable currents protect them.

For the last 10 years, there has been controversy generated by observers to the killing of corals in Cahuita National Park by the heavy siltation load emanating from the Rio Estrella.

Marine scientists at C.I.M.A.R. (Centro de Investigacion en Ciencias del Mar y Limnologia) have been monitoring its sediment, fungicide and pesticide levels and keeping year by year records of the deterioration of the reef since 1977.

Dr. Manuel Murillo, Director of C.I.M.A.R. lays most of the blame squarely on the doorstep of the banana plantations alongside the Estrella River in the Valle de la Estrella.

Timber deforestation caused sedimentation is negligible compared to banana field caused sedimentation on the Rio Estrella he points out because of the obvious fact that just kilometers above the banana fields is the Biological Reserve of Hitoy Cerere, the Talamanca Indian Reserve and the International National Park "La Amistad" where timber cutting is prohibited.

To further isolate the Rio Estrella banana complex as the chief culprit, observes Dr. Murillo, is the fact that the Rio Estrella sits just north of the 18 kilometers of coral coast and the currents run south, transporting the deadly sediment load

throughout the entire Talamanca reef system.

In an investigation into the impact of sedimentation on coral reefs in Cahuita National Park, Jorge Cortes and Michael J. Risk used landsat satellite photos to confirm the preponderance of sedimentation flowing from the Rio Estrella.

In their report published in Revista de Biologia tropical 32 (1): 109-121, 1984 they state:

"Analysis of the currents and type of minerals present in the non carbonate fraction of the sediments at the reef point to Rio Estrella as the source of sediments."

Hitting Cahuita towns reefs first, the sediments move on throughout Cahuita National Park. From there they pass through the once rich fishing grounds of long shoal and on to Puerto Viejo's reefs, Punta Uva's reefs, Manzanillo and up to Punta Mona where they combines with the sediments from the Rio Sixaola.

Riverside, shoreline and on-site observations at sea after heavy rains readily bear this scenario out. Fishermen regard it as a matter of fact.

Frankly, a better way to threaten every single coral head on the Talamanca Coast could not be devised if one tried.

The classic coral reef gardens of tourist brochure covers, buzzing with fish life, color and beauty were not in evidence in even a single area.

In fact, the coral reefs of Talamanca Coast are some of the worst this author has ever seen outside of some of the silted, cyanided poisoned, and dynamited reefs of the Philippines.

CAHUITA NATIONAL PARK

In 1979 the alarming news that the corals of the Cahuita National Park were being killed by siltation and run-off from the Rio estrella was brought to the attention of then President Rodrigo Carazo.

President Carazo sent a letter to the manager of the Standar Fruit banana complex in the Valle de la Estrella (with copies to JAPDEVA and the Municipalidad de Talamanca) asking him to see what he could do to reduce the harmful effects his company was having on the Park.

To the Cahuita National Park Director, Sigifredo Marin Zuffiga the manager asked, "Do you want to know what I think of this?" He then proceeded to tear the President's letter in half.

As he tore up the President's letter, he remarked that the banana trade is much more important than a little Park like Cahuita. Perhaps he really believed that the only harm caused by his companies operations was limited to some damage to the Park's aesthetic beauty. As the need for National Parks and wildlife refuges is often promoted by urban environmentalists and scientists, the case for them is often not presented as well or as far-reaching as it could be. Indeed, the case for environmentally sound policies is often perceived as a city based, recreationally oriented high minded, elitist crusade which is out of touch with local needs and national realities.

In the case of Cahuita, its value as a breeding sanctuary for fish and lobster production should have been promoted as much as its value for scientific, aesthetic or recreational purposes.

Cahuita was a seafood factory that sent a regular supply of eggs and larvae on water currents to the villages where so many divers and fisherman made their living and hoped that their children could do so in kind.

Today, what little sealife eggs and larvae are generated in the Park mixes with the mud and sediments and travels the water currents to dying coral reefs where they have slight chance to settle and grow.

### CORAL GROWTH RATES

When considering the extent and degree of coral reef destruction, the question naturally poses itself:

- How long does it take the corals to grow back?

Assuming proper conditions, a healthy coral colony of the kind that made Cahuita National Park famous (Acropora palmata) may grow as much as 3-4" a year once it is mature and has already well developed branches. When just getting started from scratch, its rate of growth is less than half that.

Another species like the massive stoney brain coral (Diploria strigosa) or the star coral (Monastrea annularis) may not even reach a half an inch a year in growth to reach full maturity may take these species over a hundred years.

Most coral species however can replace themselves between 20 - 40 years.

In keeping with their general metabolic slowness, it should be noted that it takes about 10 years for most corals to mature enough to be able to broadcast sperm and eggs into the water.

Aside from the question of individual coral species growth rates is the more involved question of reef growth rates.

Corals live, grow and die at different rates in alternating succession. When they die, their skeletal structure disintegrates and packs down, becoming a fraction of their former mass. New corals form on top of this material that may have been accumulating for thousands of years. Caribbean coral reefs are about 5,000 years old and grow from between one to fifteen feet every one thousand years depending on favorability of environmental conditions.

The loss of the contemporary, living coral cover however, may cause them to disintegrate faster than normal. When this happens waves of the sea begin to break through more and more accelerating the incidence of shoreline erosion.

As reef barriers decline, foot paths, palm trees and even houses may begin washing into the sea.

For the millennia that it takes to grow a full size barrier coral reef, it takes by comparison an extremely short time to destroy it.

For Talamanca's and Limon's coral reefs to grow back will require something more than just time. They will require a cessation of coral killing hostilities and optimum conditions to recover their lost vitality.

They must have clean, clear, nutrient-laden water free of excessive sedimentation.

Failing this there is no way they can even begin the slow process of recovery.

### RECOMMENDATIONS

The question of what should be done in light of this rapidly deteriorating situation in Costa Rica's Atlantic coral reefs is easy to say and difficult to achieve.

The deadly combination of effluents, mainly pesticides and soil sedimentation must be curtailed to a far greater degree than now. If this lethal run-off is not cleared up and cleared up soon, other conservation measures and coral reef management schemes will be pointless.

There is no time to be "penny-wise and pound foolish" in this matter. The dramatic decline in coral reef productivity has come about through the almost total ignorance of basic ecological principles and naive, political or arrogant refusals to act more prudently and responsibly.

In the case of timber cutting, it is an open secret that the good majority of logs are taken out with crooked paper work and bribes. Outside timber interests commonly masquerade as local farmers, processing permits in their names and paying them a consideration for the trees they cut down. The farmer often sees this as free money, a wind fall and a pleasant bonus. Many wood cutters, perhaps most, do not replant what they cut - least of all outside "hit and run" outfits.

The appropriate, regulatory "paper work" does exist. However, the glaring loopholes are easy to get around. Those that are not are often "fixed" at the toll booths out on the highway. Those that do not have an understanding with a "choricero" (bribe taking official) simply pass through in the night after the toll booth closes. This is a commonly known, "open secret" and enforces the notion among many that the government is corrupt at worst and incompetent at best.

Not to sound too simplistic, it is recommended that the booths be kept open 24 hours a day, that corrupt personnel be fired, and that more strict review on "fancy paper work" be enacted.

A farmer's right to cut some timber to satisfy his own needs should not be confused with the limitless demand of outside, pirate operators. Their "carte-blanche" to freely and safely operate should be revoked. Their harmful impact on the forest, the watershed, the river and the coral reef are too great to tolerate.

Reforestation projects, especially around creek and river banks should be continually promoted and encouraged as well as the establishment of "viveros" (nurseries) to prompt crop diversification, tree cover and erosion control. vivero programs such as those established by A.N.A.I. are also an excellent way to reach out to the farmer, impart the wisdom of soil conservation, and to explain the critical connection between the forest and the Sea.

Today in Costa Rica there is much talk of reforestation. The need for it is a readily accepted matter. Though not nearly enough yet, consciousness among many is growing, programs are underway and some serious progress is being made.

The attention therefore must automatically turn to the greatest factor among coral reef killing riverside operations - the Banana Companies.

Public consciousness on the matter is low, public and political pressure practically non-existent and since they let President Carazo know what they thought of his appeal to them to act more prudently no one seems to think they can ever be made to operate in a socio-environmentally responsible manner.

This is most unfortunate as far as the Rio Estrella problem is concerned because banana field run off is more responsible for loading the river with mud than the wood cutters and solely responsible for what pesticide and chemical poisoning there is on the coral reef and in the food chain. Among the fungicides and pesticides employed by the banana companies are Gramoxone (paraquat), Namacur (fenamifos), Furadan (carbofuran), Bravo 500 (clorotalonil), Mocap (ethoprop) with an estimated cost of US\$13,962,351 for 1983.

During heavy rains, the drainage ditches between the banana rows all empty into canals which flow into the river. Instead of more benign or soil-compatible fertilizers and pesticides, banana companies generally employ harsh chemical fertilizers and pesticides, which also flow out with the silted rain water.

The prolonged intensive use of hard chemicals exhausts the top soil and tends to insure that heavy and diverse plant cover will not carpet the bases of banana stalks and hold down the soil when the rains come. The result is a heavy washing of the consequently loose soil into the river.

Rather than promote less destructive, more sustainable methodologies, the banana companies have taken the hard-nosed cheaper way out. The killing of corals becomes a deficit to society but not to them.

It is hereby suggested that they be "influenced" to employ their considerable expertise, capital, resources and ingenuity to find ways to keep their harmful effluents from reaching the rivers and the reef. The following are some suggestions that could bear further development.

- 1) Devise a series of sediment traps and filters in the canal networks. Experiment with complex, densely rooted plants as soil retainers at the river bank.
- 2) Research and establish hardy densely rooted plant carpet covers to hold down soil at the bases of the banana stands
- 3) Keep banana plants away from the river banks by at least 50 meters to avoid direct pesticide bombing of the river.
- 4) Do away with contracting pesticide sprayers who get paid by the "quantity of pesticide dumped" instead of the amount of crops covered.
- 5) Utilize more bio-degradable pesticides or promote more biological pest controls.
- 6) Regulatory laws concerning "allowable" pesticide and silt concentrations should be studied and promulgated. Heavy fines should be levied for violations. Repeated refusal to comply with the law should result in prison sentences for executives.
- 7) Assist in the establishment of "artificial reef systems" to help compensate for some of the damage caused. Such reefs should in no way be construed as being substitutes for the real, living thing. To help buy time and lessen multiplying pressures on the reef as it tries to recover, we might consider the possibility of promoting artificial reef systems offshore of the communities of Moin, Limon, Cahuita, Puerto Viejo, Manzanillo and Gandoca.

Cleaned out hulls of old, non-operative ships towed out and sunk offshore can and in many instances have, provided fish and lobster habitats to generate sealife where there was none. Numbers of Jacks, Mackerals, Tunas, Snappers and Basses especially would arise from this increase in available habitat.

Before this option could be pursued however, an important question for research must be answered. That is to what degree such project generate new life from the available larval pool as opposed to how much they attract it from existing reef areas.

The danger of attracting already existing fishes from natural reef areas is that artificial reefs would tend to concentrate them in one place, setting them up for even faster extermination.

Perhaps the new reefs would have to be placed far enough away from existing habitats to insure that "migration" will be kept minimal.

Such an artificial reef deployment scheme would be counter productive if it would be taken as an excuse to allow existing reef systems to continue to be damaged. What is still alive in the existing reef system of Limon and Talamanca would be vital to the production of zooplankton, eggs, larvae, sardines, etc. whose "excess" could settle in the artificial reefs newly created "housing areas".

Better suggestions could be offered by others and are certainly welcome. The point is that Costa Rica must get moving on this problem and start working towards solutions.

However, it is really the responsibility of the Banana Company to operate itself appropriately and within the focus of "whatever does not do violence to coral reef productivity." Their role in killing it is far too great to ignore. They must be made responsible like any other corporation that must defer to civilian authority. If the Costa Rican civilian authority is not disposed to act and if it is true that the banana trade is indispensable "as is" and not reformable, then it necessarily follows that the coral reefs, fishes and fishermen of the coast are deemed expendible.

If this is the case, then it logically follows in a democratic society that restitution is in order for those whose livelihoods have been ruined in the trade off.

In 1978 a similar trade-off of fishing peoples interests occurred on the coast of Brittany, France when the oil tanker Amoco Cadiz ran aground spilling a great quantity of oil into the sea.

The destruction of sealife in the region was very great, particularly that of commercial seafood species as lobsters and oysters. In the aftermath of this assault on their livelihoods, local fishermen united and filed a class action lawsuit against the tanker company. The court agreed that the fishermen had suffered a criminal denial of trade and awarded them several million dollars in compensation.

In 1984 the freighter M/V Wellwood ran aground on the rich coral banks of Molasses Reef in Key Largo National Marine Sanctuary on the Florida Coast.

The State of Florida sued the freighter company for damages for the value of the coral destroyed. The worth of the reef was determined by calculating the annual tourist income generated by it and divided by the square meterage of the reef.

The Wellwood was fined \$20,000 in damages. Incidentally, the tourist value of the reef alone was placed at 400 million dollars.

In a similar case, an offshore oil drilling vessel, the 'Maloy G' ran aground in Looe Key National Marine Sanctuary and was fined several dozen square meters of coral damage at \$850.00 per square meter.

Understanding the immense value of coastal mangrove areas, the government of Puerto Rico sued the oil tanker S.S. ZOE Colocotrini when it caused an oil spill that destroyed 20 acres of them in 1973.

Clearly responsible, the ships insurers settled with Puerto Rico for 2 million dollars, about \$100,000.00 per acre of destroyed mangroves! This landmark victory in the establishment of "value beyond the aesthetic" to natural resources was not without sacrifice however. The Puerto Rican legislature had to appropriate \$750,000.00 for attorney fees and expert witness costs and then it took 8 years to get their money back.

In 1984 the 632 foot tanker T/V Puerto Rican sunk inside the Pt. Reyes --Farallon Islands national Marine Sanctuary off California and spilled great quantities of fuel oil and petroleum based fuel additives. To recover the costs of marine resources destroyed, the U.S. Government sued the tanker's owners and won a \$100,000 settlement.

As much as French and Americans may generate income from healthy marine habitats, it could be argued that such habitats are not as valuable to them as productive fishing grounds are to Costa Rican and Puerto Rican fishermen whose lives hang much more in the balance and whose people are in more need of locally generated protein.

Costa Rican fishermen may not be as organized and motivated as were the French victims of the Amoco Cadiz oil spill or have the U.S. Government go to bat for them over loss of productive marine habitat, but their cause is no less sound.

They are well within their rights, if they could muster the resources, to file a class action suit against the banana company that has robbed and generally destroyed their coral reef "potrero" (pasture).

Ironically, their increasing poverty and consequent fatalism may serve to keep them in a submissive position. They may well give up and suffer silently as poor people generally do when they perceive that they have little chance to succeed and when they are convinced that their government just does not care about them because they are "just poor fishermen".

If they are right, then another serious question instantly poses itself; the question of the government's lack of awareness, competence, disposition and courage to address such problems which only multiply with continued institutional neglect.

### CONCLUSION

On account of the threats to the Limon and Talamanca coral reef's continued existence as a benefit to coastal people, the question of a significant scale tropical fish collecting enterprise has already been compromised. As it stands today, the reef can not sustain any high level of harvesting and it does not have the numbers required to make it work.

Beyond this, it does not have the "mix" or variety to be a self contained enterprise.

However, on a smaller scale, certain fishes could be combined with Pacific collecting operations and the resultant variety could constitute viable shipments for export.

In this case, a short list of Atlantic fishes could be "icing on the cake" to the longer Pacific lists.

Perhaps 3 or 4 divers could gain a livelihood in this way. It is not much, but then again there is not much left on the reefs. No one makes a profit on dying coral reefs.

It is dearly hoped that the people of the coast will involve themselves actively to try and improve conditions that so directly threaten their livelihood.

Requisite to most any effective action would be greater community organization and solidarity.

This may be difficult as many people, especially in the towns of Cahuita, Puerto Viejo and Manzanillo (combined population 2,600) are not accustomed to organizing and working together. Perhaps the growing threats to their marine life support system will serve to galvanize them.

Manzanillo especially should take note. It is clearly a dying community. If it does not work to help insure the survival of its coastal food and income factory it will no doubt continue to lose its children to the city who go in search of employment.

On the other hand, a number of people there, especially older people, have no where to go.

Their lives are there as were many of their parents, nourished for generations by the productivity of the sea now disappearing before their eyes. Although they will suffer the most from the dying coral reef, it is ironic to note that they had little to do with it. They are victims of greater outside forces who are believed to be totally insensitive and invincible.

Perhaps, they are right. But to walk away and abandon them to their fate at the hands of forces who are being increasingly identified as guilty for the predicament, would be a violation of public responsibility on the part of whatever relevant officials do it.

The loss of traditional livelihood support that the sea has largely provided can only exacerbate the exodus to already crowded cities, where employment opportunities are scarce and where the cash economy replaces the more self sufficient one of the coast. Leaving their aging parents behind to tend increasingly ill-kept farm plots, the young who do not take to farming as they did the more free wheeling work of a fisherman head for the cities and integrate into the urban culture. The rich heritage of the Jamaican-Columbian immigrant is lost along with all of the uniqueness, the flavor and the wisdom it had.

Along with the breakdown of traditional economic support systems in struggling Talamanca Coastal communities, there necessarily follows a fragmentation of family and cultural diversity.

Furthermore there are profound and incalculable social cost in promoting still more urban crowding unemployment and poverty and crime. The main recipient of this restless migration of young, disenchanted people is Limon, which is ill prepared to cope with an exacerbation of its existing problems and has a big enough unemployment situation as it is.

If economic decline affecting Talamanca coastal people is to be reversed, Costa Rica has no choice but to persuade, pressure or force upland banana and timber cutting interest to implement environmentally sustainable methodologies.

What income is generated by such interests must no longer be tacitly accepted as "payment" to divert the call for them to act responsibly.

Indeed, the significance of this income to Costa Rican society diminishes considerably when we regard the social and economic deficits incurred from the sabotage of natural, traditional life and livelihood support systems.

Focusing on the speed at which so much living coral cover and its resident sea life populations have disappeared begs an important question.

At the current trend, what does the next 5 years and 10 years hold in store for the people of the coastline?

What is the value of the resource that has been and continues to be lost? What is the worth of all the fishes denied for the people's dinner tables from now on? Indeed, how much have they and how much will they suffer from diminished livelihood and income potential?

With reference to such concrete concerns we must ask the question: How much are the people's coral reef worth?

Surely their worth should increase yearly as does the people's need for food and income.

Yet in the face of this, productivity is diminishing.

The historical, Central American trade-off between banana and timber concerns and the welfare of coastal people, not to mention the interests of the tourist, sporting and scientific communities, is eventually a losing proposition on all counts.

Activities that gradually and predictably exhaust soil and forest reserves as well as river and marine resources will ultimately leave people poorer and more dependent. As more accelerated scenarios in the Philippines and Africa have recently shown, such narrowly focused activities constitute a sure-fire recipe for ecological collapse and consequent social and economic disaster.

To mortgage nature's original social support systems in favor of immediate yet highly concentrated capital leaves little other livelihood save for the artificial kind promoted by distant lending agencies with strings and high interest rates attached.

The wisdom of falling for such artificial support systems is clearly seen now for the folly it is as the tropical world sinks incrementally and ever further into perpetual debt.

Perhaps urban and western inspired artificial support systems could be somewhat justified if they in fact achieved some serious degree of permanence and self perpetuating benefit to society.

Generally they have failed to do this because the narrow "expertise" that concocts such schemes has nearly always failed to understand that the true basis of wealth of any lasting society originates from living resources that can be renewed easily again and again within the lifetime of the users.

Routinely sending tons of loose chemical laden soil by vast banana plantations and rich, precious layers of top soil by thoughtless timber cutters into rivers that carry the load out to sea to kill the people's coral reefs, is a harmful & counter productive proposition and must be stopped.

One of the primary reasons that so many agricultural and fishing societies seem to exist now in a state of permanent, never ending crisis is because their city-based government representatives often tend to operate with more temporary agendas designed to "slide by", "gloss over" and minimize problems. Politicians often become "career political personalities" and decision making by political expediency and convenience prevent them from embracing the more risky but requisite tasks involved in concrete social problem solving.

Leadership tempered with wisdom and moral courage and "hands on", practical village level experience describes a very rare kind of public servant.

Professional decision makers, who are legally just employees in the common public interest, are usually very far removed from the realities of poor rural people and the complex interplay of agricultural, environmental and social factors that determine the quality of their lives. In place of a more enlightened consciousness on such vital concerns (i.e., instead of doing their homework and earning their pay) many decision makers have discovered an easier way out.

They have embraced the simplicities of "rule by quantification" and have developed the habit of looking for big, round numbers on the bottom line of an export produce balance sheet and the tax revenues generated from it. It is easy to see why so many have been seduced by the "windfall" generated by taxes on each box of bananas exported. After all, Costa Rica exported 46 million boxes in 1986, more than any other country in Central America.

Banana box revenue which fluctuates between 35 ¢ to 50 ¢ a box, generally goes to San Jose where it figures significantly in the big time issues of Costa Rica's balance of payments and the external debt.

Having little conception of what it really costs Costa Rican society to host the banana trade the way it is currently run, it is tacitly regarded as a "good thing" in the cause of national development.

Before accepting the gross figures generated for government coffers by banana commerce however, decision makers should, as any good businessman would, subtract the real costs to society. It is in the net revenues generated not the gross, that they should be considering.

The costs to Costa Rica for allowing the present form of banana mono-culture to predominate so heavily are considerable. To summarize such costs, an invoice of "lost revenue potential" could be prepared for every year.

INVOICELOST REVENUES OF 1986

NON REALIZED  
VALUE IN  
COLONES

COMMERCIAL FOOD FISH LOSSES TO LOCAL FISHERMEN

1.	Jacks	\$ ?
2.	Mackerels	?
3.	Tunas	?
4.	Basses	?
5.	Groupers	?
6.	Reef snappers	?
7.	Off shore snappers	?
8.	Tropical fishes	?
9.	Lobsters	?
10.	Conchs	?
11.	Red crabs	?

SUSTENANCE FOOD FISH LOSSES, TO LOCAL CONSUMERS

1.	Jacks	?
2.	Mackerels	?
3.	Tunas	?
4.	Basses	?
5.	Groupers	?
6.	Reef snappers	?
7.	Off shore snappers	?
8.	Lobsters	?
9.	Conchs	?
10.	Red crabs	?

- |    |   |   |
|----|---|---|
| 1. | Snorkling and scuba divers tourism losses   | ? |
|    | a. Hotel, restaurant, dive boat and guides  | ? |
|    | b. Damage to Isla Uvita Park  | ? |
|    | c. Damage to Cahuita National Park  | ? |
| 2. | Research, scientific, educational value losses  | ? |
| 3. | Aesthetic benefit losses  | ? |
| 4. | Shore line erosion losses   | ? |
| 5. | Losses of Estrella, Sixaola and Matina rivers fish and shrimp productivity                          | ? |
| 6. | Damage to Costa Rica's international reputation as a world leader in environmentally sound policies | ? |
| 7. | General increase of poverty among coastal peoples   | ? |
| 8. | General increase in migrations to Limon   | ? |
|    | a. crowding   | ? |
|    | b. unemployment increase  | ? |
|    | c. crime  | ? |

---

???

The difficulty involved in calculating unrealized economic benefits is considerable in view of the fact that little published data exists of former productivity of the coastal reefs beyond the testimonies of fishermen and other residents.

Each area of loss could be an area for considerable research. One thing is certain however, never has the value of each area been as high as today and the calculation of such values could escalate yearly.

In the years to come, which is where all of Costa Rica's children must live and make a living, the losses to society from the not so harmless way in which bananas are currently grown for maximum, immediate efficiency, may actually come to outweigh the benefits.

For many coastal Costa Ricans this is already, undeniably true.

Banana commerce and box revenues bring them nothing and do not trickle down to constitute even the most token livelihood restitution for them.

Developers, loggers and mono-crop industries must be mandated the burden of proving that their "use" or "rental" of crucial living resources is of a sustainable nature and will not foreclose the viability of other people's future. If it does they should have to pay for it, commensurate with damages inflicted.

Environmental damage control, agricultural reforms and reforestation should not be timid requests for voluntary compliance, they must be compelled in the spirit of law and in the interest of perpetual, national survival.

Costa Rica cannot afford to burn its reserves of natural capital at both ends and at a rate many times faster than it is generated.

In economics, this is a superior strategy for bankruptcy.

The notion that a "poor" tropical country like Costa Rica cannot afford responsible environmental, agricultural and resource management policies is a false, insulting and suicidal error. Costa Rica cannot afford not to implement them.

Unlike some wealthier nations, Costa Rica has no other nation's natural resources to exploit or expend.

It has been "given" only so much to maintain its growing population with, fully half of which is under 20 years of age.

The perpetuation and constant renewal of living soil, forest, fresh water and marine resources is an uncompromisable requisite in the maintenance of living, "renewable societies".

Such a legacy of living wealth is also a birthright, passed down from previous generations so that this one may have the right to share the benefits also. In turn this generation has an obligation to keep the torch alive and pass it on to the emerging generation so that they may partake in their birthrights as well.

The sheer arrogance that would be required to extinguish the surviving wealth of generations of Costa Ricans history would border on something Napoleonic and evil.

Of course contemporary extinguishers of this wealth, generally perceive their actions to be urgent, separate and unrelated to anything of consequence greater than their own designs. The degree of success that they will enjoy in the uninterrupted promotion of these designs remains to be seen. It is largely a question of might, economic power and political influence.

That of course has nothing to do with the moral question of people's rights however.

In as much as large scale resource consuming enterprises violate public rights, the limits of their own rights should be reviewed.

It is they that have no right to force ill-advised, socially, culturally and environmentally irresponsible consequences on innocent and defenseless citizens.

To the extent in which powerful men exceed their authority, their importance and their education and naively attempt to rewrite the laws of biological reality in pursuit of limited, immediate and transitory ambitions; the quality of life and eventual life of Costa Rica hangs in the balance.

Such unrestrained, unaccountable and unsustainable living resource killing activities it could be argued, constitute a form of treason against the village fishermen, the public and posterity.

Costa Rica, Central America and the world desperately needs living, working compromises between high impact, resource consuming interests and the less organized, less defined, yet no less sacred rights and interests of people down the river, on the coast and in the future.

It is hoped that Costa Rica, whose powerful and longrunning tradition of peaceful and democratic institutions, which can only survive through an inherent disposition towards prudence, rationality and farsightedness, will show the way.

Very Sincerely,  
*John Robinson*