

WISE USE
OF THE MANGROVE RESOURCES
IN ESTERO REAL, NICARAGUA
AND
TERRABA-SIERPE, COSTA RICA:

A proposal submitted
by
CATIE/UICN
to
DANIDA

August, 1990

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1. INTRODUCTION

Mangroves are tropical ecosystems characterized by the presence of trees adapted to survive in the intertidal zone in protected coasts. In addition, mangroves are populated by a vast number of vertebrate and invertebrate species, most of them of economic importance.

Mangroves are among the ecosystems with the highest primary -and associated secondary- productivity in the world. As such, mangroves provide many goods and services of great importance to human societies, specially those living on the coast in developing countries.

Firewood, charcoal, timber, and tannins are among the most common forest products of the mangroves directly harvested by local people. In addition, these ecosystems provide habitat and food for fish, shrimp, crabs and shellfish, which are the base of important commercial and artisanal fisheries, and are also source of income and dietary protein for local communities.

Mangroves are also important for the indirect services they provide, such as storm protection, coastal erosion control, water quality maintenance, water transport and sediment retention.

CATIE (Centro Agronómico Tropical de Investigación y Enseñanza) and IUCN (The World Conservation Union), recognizing the important role mangroves play in coastal rural communities in Central America, have undertaken jointly some precise actions in some specific mangroves throughout the Region. These actions could be group in three main areas:

1. Field demonstration projects. These projects are designed to understand the reasons why local communities use mangrove resources the way they do, and by doing so, to promote environmentally sound practices.

2. The development of a methodology for the economic evaluation of the goods and services provided by tropical wetlands, included mangroves.

3. The identification of key mangrove areas where an involvement by CATIE/IUCN will promote the conservation of Central American mangroves and their resources, as well as the improvement of the quality of life of the people dependent upon them.

The experience gained in these three areas has given CATIE/IUCN a wealth of empirical knowledge which, linked to their institutional capacity, has allowed for the successful implementation of specific field projects.

CATIE and IUCN at the request of DANIDA, have prepared, in consultation with governmental, non-governmental and academic institutions in Costa Rica and Nicaragua, the present proposal, consisting of two field demonstration projects, one in each country

For clarity purposes, this proposal is divided into two segments. The first segment corresponds to the proposed activities in Estero Real, Nicaragua, while the second segment presents the proposed activities in the Térraba-Sierpe Forest Reserve in Costa Rica.

ESTERO REAL, NICARAGUA

2. BACKGROUND

2.1 The mangroves of Nicaragua

Studies conducted by the Instituto de Recursos Naturales y del Ambiente de Nicaragua (IRENA; formerly DIRENA) indicate that about 30% of the Pacific coast of Nicaragua is covered by mangroves (DIRENA, 1988). It is estimated that Nicaragua has about 60,000 Ha. of mangroves (Saenger, Hegerl and Davie, 1983). One third of them are located in Estero Real (DIRENA, 1988). The mangroves of Estero Real are, in fact, part of the large mangrove complex of Golfo de Fonseca, which is shared by Nicaragua, Honduras and El Salvador (Fig. 1).

Preliminary studies performed by CATIE/IUCN in Estero Real allowed for the identification of the following mangrove species: *Rhizophora mangle*, *R. harrisonii*, *R. racemosa* (this species has not been reported before for the Pacific coast of Nicaragua), *Avicennia germinans*, *A. bicolor*, *Laguncularia racemosa* ("angelín") and *Conocarpus erectus* ("botoncillo"). Local people make no distinction among the *Rhizophora* species; all are locally known as "mangle rojo." Nevertheless, they mention that some "mangle rojo" are better than others (of similar size) for wood extraction and particularly in the quality of their bark for tannin extraction. Local people make no distinction either among the *Avicennia*; both are called "curumo."

Four major types of mangrove forests have been identified by CATIE/IUCN elsewhere in Nicaragua. These types differ not only in species composition and structure, but on the kind of extractive activities that are been undertaken in them. In general, firewood extraction is heavier near population centers. Woodcutters have a ratio-of-action of about 8 Km. Their activities are generally performed only during low tide but, in order to travel along the mangrove channels, they depend on the high tides. No woodcutter has outboard engines. Therefore, they must row to the areas where they conduct their extraction activities. As a result, most mangrove forests near population centers are under heavy extraction pressure. Mangrove trees in these areas are seldom above 5 m high, while mangrove trees at more distant localities reach up to 20 m in height. Taller, and therefore older trees, are used for bark production. Debarked trees are seldom used for firewood.

2.2 Importance of the mangroves of Estero Real

As stated before, mangroves provide habitat and food for a number of marine and estuarine species which are the base of important commercial and artisanal fisheries, and are also source of income and dietary protein for local communities. Estero Real is no exception.

There is a wide range of scientific publications stressing the direct relationship between the extent of mangroves (and other coastal wetlands) and the commercial, sport and artisanal fisheries (Turner, 1977; Martosubroto and Naamin, 1977; Deegan et al., 1986), specially the shrimp fisheries. It is estimated, for example, that close to 90% of the fisheries of the Gulf of México is composed by species that are dependent on mangroves and coastal wetlands. These fisheries are valued at over US\$ 700,000,000 per year (Maltby, 1986). D'Croze and Kwiecinski (1980) estimated that 94% of the shrimp fisheries of the Gulf of Panamá are dependant on their mangroves and associated estuaries.

No similar estimates are available for Estero Real. Nevertheless, important commercial and artisanal -mangrove dependant- fisheries occur in Estero Real and the Gulf de Fonseca. Based on the geomorphology of these areas, it is estimated that a the percentage of coastal wetlands dependant fisheries be similar, or even higher, than those estimates for the Gulf of México and the Gulf of Panamá.

The equation developed by Martosubroto and Naamin (1977) for Indonesia could be used to obtain some estimates of the value of the fisheries associated to Estero Real. This statistically highly-significant equation ($e = 0.01$) correlates the surface area of mangroves to the catches of the commercial shrimp fleet in the following manner:

$$Y = 5.473 + 0.1128 X, \text{ where}$$

Y = shrimp production in thousand of tons

X = mangrove surface in hectares (tens of thousands)

The estimated surface area of the mangroves of Estero Real is close to 20,000 hectares (DIRENA, 1988). Based on the above mentioned equation, it is expected that the potential shrimp fisheries (coastal and estuarine) associated to Estero Real are close to 5,700, 000 Kg. (heads-on) per year. For most species of penaeid shrimp, the processing yield of shrimp tails is about 65% of the harvested live weight (International Finance Corporation, 1987). Therefore, the potential yield of shrimp tails associated to Estero Real is 3,700,000 Kg. Sutinen, Broadus

and Spurrier (1989) indicate that average FOB prices for Ecuadorean shrimp were US\$ 3.58 per pound of tails (equivalent to US\$ 7.88/Kg.). Consequently, it can be stated that the potential economic value of the shrimp fisheries associated to Estero Real is above US\$ 29,000,000 per year. Value of other fisheries (fish, mollusks, other crustaceans) should be added to this estimate. Close to 5,000,000 individuals of the mollusk *Anadara* are extracted annually from the mangroves of Térraba-Sierpe, Costa Rica.

Besides the natural role mangroves play in coastal and estuarine fisheries, these ecosystems are source of many different products of commercial and domestic importance. In Estero Real, mangroves are source of lumber used for rural construction, firewood for domestic consumption and "varules" (long, thin poles, 5 cm DBH, 3.5 m long), used for support for banana plants. Red mangrove's bark is rich in tannins, which are used to preserve leather. In some other countries, mangrove wood is used for charcoal production.

At present, there are no estimates of the potential value of the forest products of the mangroves of Estero Real. Chong (1988) estimates that an hectare of mangrove in Sierpe, Costa Rica, can produce US\$ 619 annually in forestry products.

Snedaker (1982) states that mangrove forest products in Bangladesh have an annual value of US\$ 36,000,000. Ong (1982) reports that in the Matang Reserve, in Malaysia, with 35,000 hectares of productive, almost monospecific forests of *Rhizophora apiculata*, the value of mangrove wood is close to US\$ 9,000,000 per year. It must be pointed out, however, that these are forests where silviculture has been practiced for over 100 years, with cutting cycles between 25 and 30 years. As a result, these forests should be considered as plantations, having consequently, higher yields. Estero Real, on the other hand, is a natural forests that has been disturbed by men for many years. In addition, rainfall, which is directly related to the development of good stands of mangroves, is higher in Matang than in Estero Real.

FAO (1985) based on statistics from Thailand, Malaysia and Indonesia, estimates that the ratio between the value of forest products to fisheries products is 1:4. Nevertheless, given the climatologic conditions of Estero Real (relatively arid with large areas of salt flats), it does not seem appropriate to use these same figures here.

Mangroves are recognized by local people to act as wind barriers in areas where tropical storms occur annually. In the words of a villager from Puerto Morazán, the main community in Estero Real, "had not been for the mangroves in front of the town, we would have to replace every year our roofs because of the northern winds."

Mangroves are effective in protecting coastal communities from the force of the winds because friction over the tops of the trees is much higher than over the water. This leads to a quick reduction in wind speed (Oliver, 1982). Mangroves are also notorious for their ability to stabilize the coasts, particularly those areas subject to erosion resulting from wave action during tropical storms. The Sunderbans mangrove forests in Bangladesh and India, help in reducing the wave force, protecting property and human life. The Government of Bangladesh, a country with great flooding problems, is actively promoting coastal reforestation with mangrove species. In 1986, close to 25,000 hectares had been planted, and there were plans to plant 40,000 hectares more (Maltby, 1986).

3. PRESENT CONDITIONS IN ESTERO REAL

3.1 Socioeconomics of Estero Real

Estero Real is composed by a number of small, dispersed community, of which Puerto Morazán, El Tempisque and Colonia Luis Mairena are the most important. In addition, small groups of houses are found scattered throughout the area (Figure 1).

3.1.1. Puerto Morazán

This is the largest community in Estero Real, with a total population of about 1500 people (200 to 250 families). Economy of this community is based on artisanal fishing and a very rudimentary shrimp mariculture. Some other economic activities are the extraction of forest products from the mangroves, particularly "varules" and firewood, and occasionally bark for tannin extraction and wood for rural construction.

The main economic activity in this community is the shrimp fishery, which takes place in the estuarine lagoons and canals during the rainy season (June to November). Between 250 and 300 adults are involved in this activity, most of them grouped into seven cooperatives, included an exclusively women's cooperative. Up until last year, all the cooperatives sold their product to ALINSA, a governmental company, which had installed some facilities in Puerto Morazán with a storing capacity of 3,000 lbs. Nevertheless, as a result of the very high shrimp productivity of the area, these facilities cannot handle all the catches. Catches are estimated at around 300 lbs per person per week. All the shrimp that cannot be handle by ALINSA is sold to other authorized intermediaries, who sell the shrimp elsewhere. In 1989, twelve women were involved in this activity.

Some of the Puerto Morazán's cooperatives have a few ponds for rearing shrimp in captivity. These ponds, which range between 20 and 60 hectares, could be classified as artisanal ponds according to Snedaker, Dickenson, Brown and Lahmann (1985). This means that there is no control over water quality or stocking rates, and no supplemental feeding is provided. Pond management is minimal; almost non existing. As a result, yields are very low; between 50 and 70 Kg. (heads-on) per hectare for the first harvest of the year, and between 20 and 45 Kg. per hectare for an occasional second harvest. Unfortunately, it is not uncommon to lose all the production as a result of the impossibility of controlling water quality. Oxygen deficits, high salinity and high temperatures are the major problems in the area. Large number of predators (fishes and crabs) are also a

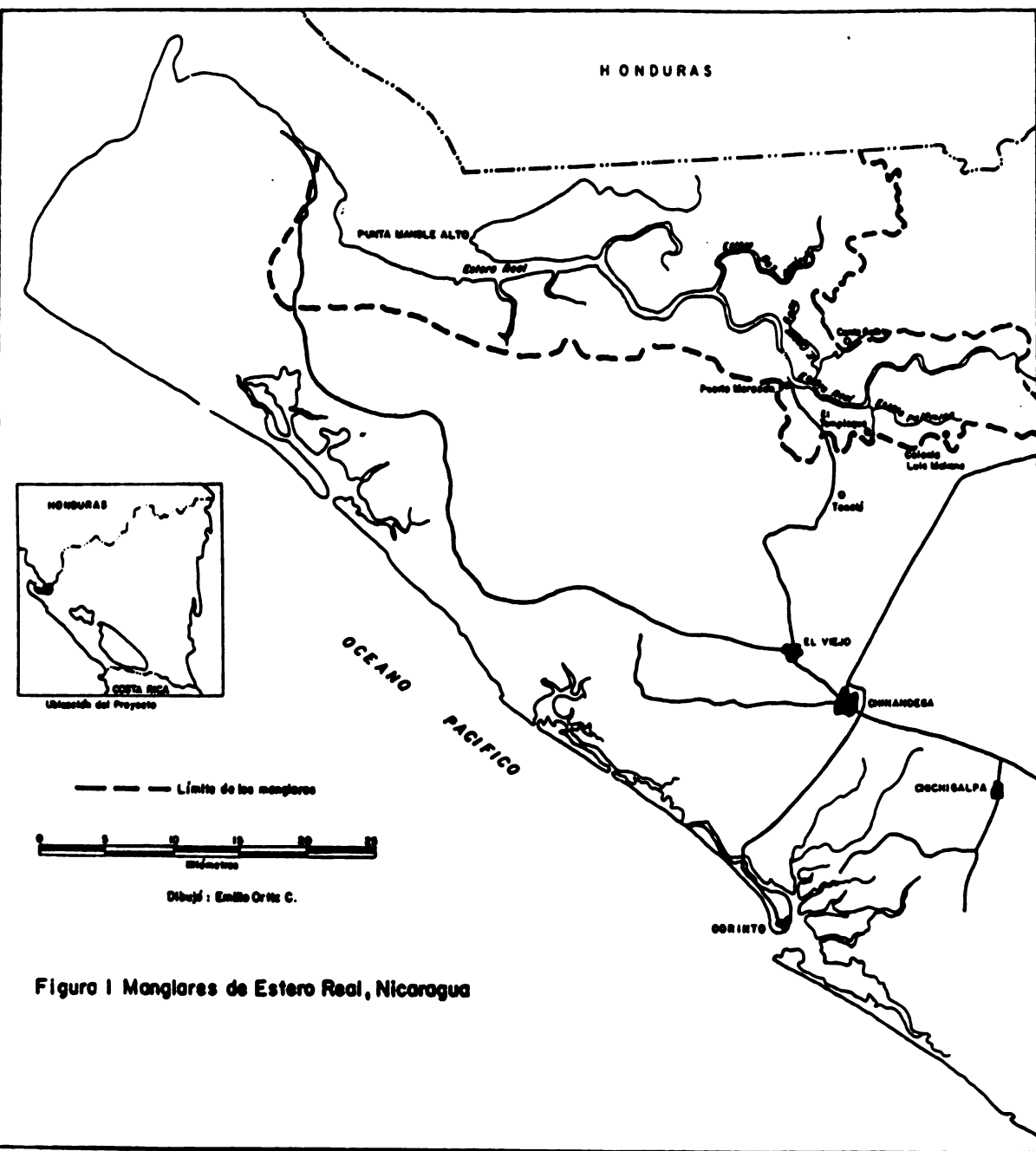


Figura 1 Manglares de Estero Real, Nicaragua

factor to deal with. It should be pointed out, however, that investment and production costs are minimal at the artisanal level. There is some concern, however, about the effect these low yield practices might have on the natural system. Using Martosubroto and Naamin (1977) figures, a mangrove in its natural stage, produces about 185 Kg of shrimp and an average of 667 Kg of fish (Turner, 1977).

During the dry season (December to May), most associates to the cooperatives are involved in fishing, since they have the necessary equipment for this activity. Non-associates are either involved in fishing as well, or in the extraction of crabs from the mangroves (*Ucides occidentalis*). Some 30 people from Puerto Morazán gets involved in wood extraction from the mangroves. The main forest product extracted here are the "varules", which are purchased at very low prices by BANANIC, a State-owned banana company. All mangrove species are used as "varules". In contrast, *Rhizophora spp* are the preferred species for construction and are much better paid. A *Rhizophora* pole with twice the diameter of a "varul" has a price ten times higher.

People from Puerto Morazán complements their diet, as well as their income, by raising domestic animals such as chicken and pork.

3.1.2. *El Tempisque*

This community has between 1000 and 1200 inhabitants (150 to 200 families). The dominant activity here is agriculture, mainly corn, and cattle raising, both at a very small level, almost only for autoconsumption.

Some ten families are involved in fishing all year around. These families also have small pieces of land, between four and eight hectares per family. About 15 families are organized into a cooperative for shrimp mariculture (one 20 ha. pond). Close to 25 people work in the mangrove all year, extracting "varules" and firewood. This number increases during the dry season. During this time of the year, a good number of people from El Tempisque work in the cotton fields picking cotton.

3.1.3. *Colonia Luis Mairena*

Close to 700 people (120 families) live in this community. Most of them are involved in agriculture (corn and rice) for auto consumption and some also raise a few domestic animals. During the dry season some people pick cotton, while others extract "varules" and firewood from the mangroves. Very few people is involved in fishing in this community.

This area is used by people from Tonalá, a larger town 7 Km away, for firewood extraction. According to people from "Colonia Luis Mairena," pressure on the mangroves by people from Tonalá is heavy. During some field visits to the area, it was possible to detect that chainsaws had been used here.

By the preceding paragraphs, it is evident the close and direct dependency of these communities on the mangroves of Estero Real.

3.2. Condition of the mangroves of Estero Real

The following description is based on a series of field trips performed in 1989 and 1990 with the purpose of determining the condition of the mangroves of Estero Real. To facilitate the description, the area will be divided in sections corresponding to different locations.

Field trips included a number of transects, perpendicular to the canal, to visually assess the condition of the forest, degree of human intervention, species present (their distribution and zonation), degree of regeneration, presence of crabs and shellfish (*Ucides occidentalis* and *Anadara tuberculosa*), as well as any other relevant aspect of the forest.

3.2.1. West of Puerto Morazán

In general terms, extraction levels are low and almost non-existing as you get farther from Puerto Morazán. There is a very well marked zonation, with *Rhizophora spp* close to the shoreline. Trees of *Rhizophora* are well developed, 15 to 20 m high, DBH (diameter at breast height) between 20 and 30 cm. However, the band dominated by *Rhizophora* is a narrow one, 20 to 40 m, occasionally up to 70 m wide. *Rhizophora* is rapidly replaced by a 100 to 150 m wide band of less developed trees of *Avicennia*, up to 7 m high, and a DBH of 10 cm. Deeper into the forest, the trees of *Avicennia* become even smaller, reaching less than 1 m in height. These are fully mature, dwarf individuals of *Avicennia*. Further into the mangrove the *Avicennia* band disappears and it is replaced by extensive salt flats with no vegetation. Some of these flats are inundated during the rainy season. It is in these flats where important artisanal shrimp-fisheries take place.

The zonation described above is characteristic of arid regions with low runoff. In these areas, mangroves trees with forestry potential occur only close to the canals.

3.2.2. *Estero Dos Agüitas*

Species distribution pattern in Estero Dos Agüitas is very similar to the one described for the area West of Puerto Morazán. There are, however, several areas where sediments have accumulated near the shoreline. As a result, the topographic micro-profile is higher than the surrounding areas. These elevations have been colonized by *Avicennia*.

Natural regeneration in this area is good. This area is also abundant in crabs ("punches"), which are harvested for local consumption and for sale in other towns such as Tonalá and El Viejo. Shellfish (*Anadara*) is not abundant here.

3.2.3. *Esteros Cantagallo y Cantagallito*

Zonation is similar to the one described previously. The *Rhizophora* band, however, is slightly wider (50 to 75 m) and the trees are also bigger (20 to 25 m high; DBH 25 to 30 cm). There are signs of extraction of "varules" and bark. Taller, and therefore older trees, are the ones used for bark production. Debarked trees are seldom used for firewood.

Natural regeneration is variable throughout both "Esteros", but in general it could be considered acceptable. Not much wood is currently being extracted in this area. Crabs are also extracted here, but not shellfish.

3.2.4. *East of Puerto Morazán*

Extraction of mangrove wood is much higher on this side of Estero Real as compared to the previously described sites. Heaviest pressure is on areas close to the canals because of easiest access and also because the best developed trees are found along the shorelines. Consequently, *Rhizophora* is the genus most heavily extracted.

Extraction intensity is variable East of Puerto Morazán. There are areas which have barely been touched, and areas that have been almost cleared-cut. As a result, natural regeneration is very inconsistent, and it is almost nonexistent in those areas that have been cleared-cut. In these areas, crabs and shellfish are also missing. It is evident, therefore, that clear-cutting of mangroves should not be practiced in arid climates.

Zonation East of Puerto Morazán is similar to the other locations of Estero Real. There is a narrow band (40 to 60 m wide) of very well developed *Rhizophora* trees (up to 25 m tall and DBH of 40 cm). Density, however, is low. *Rhizophora* is quickly replaced by *Avicennia*, whose height decreases with increasing distance from the canal. Inner areas of the

mangrove are devoid of vegetation as a result of the very high interstitial salinity. These inner areas are washed only by the highest tides. Consequently, and because of the high evaporation and low runoff of the region during the dry season, sediments become hipersaline. This hipersalination has a negative impact in the development of the mangrove as an extensive forest. It does not, however, affect the important role the mangrove has in supporting coastal and estuarine fisheries, particularly during the rainy season.

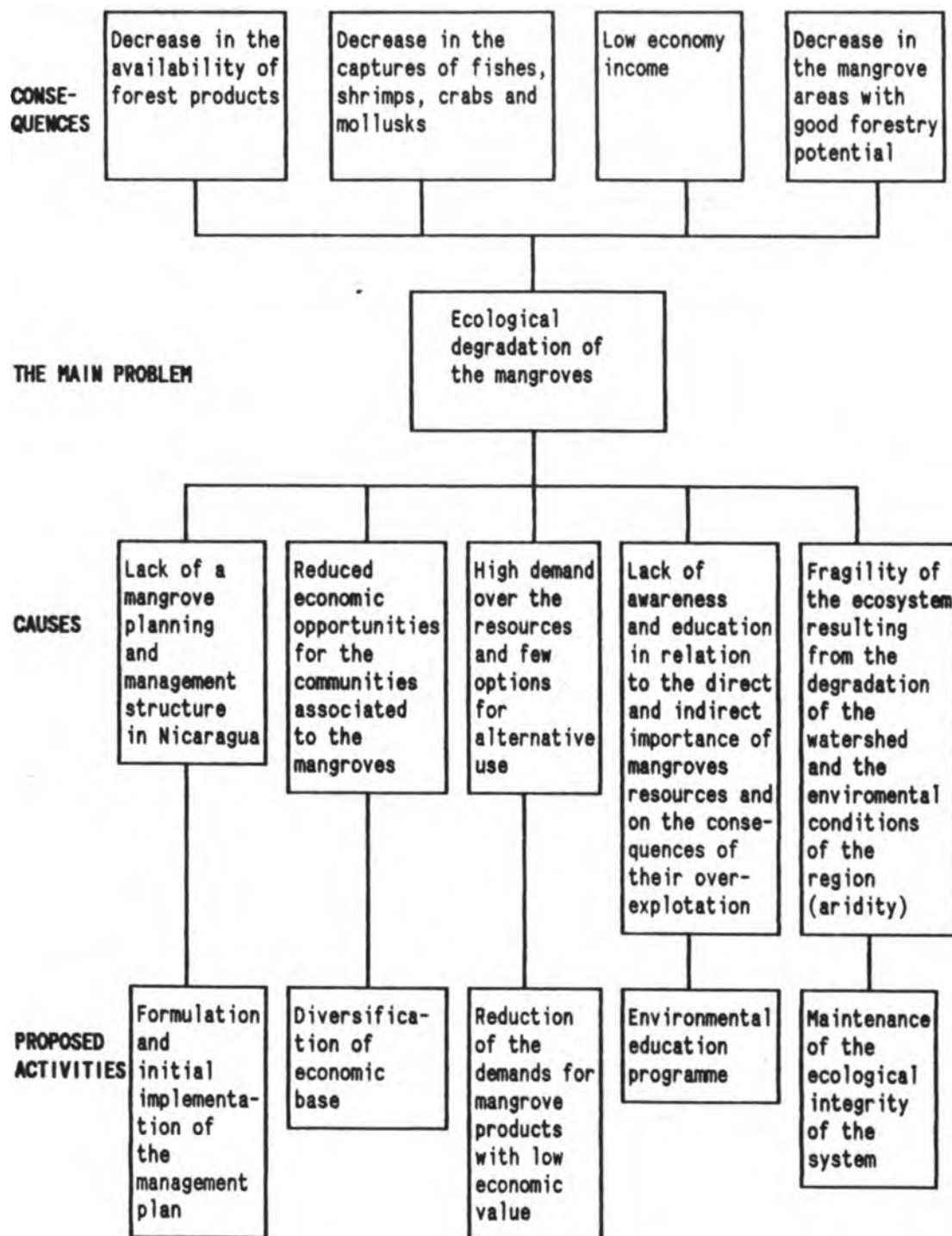
3.2.5. *Estero Tempisque*

This "Estero" is located near the community of Tempisque. Extraction levels in this area are the highest of Estero Real and regeneration is poor. Although the untrained eye could see some vegetation cover in the mangroves of the area, local people that has extracted wood for years complain that "there is nothing left in Estero Tempisque." Consequently they have to spend more energy and time in reaching better areas. The problem is that the trees left do not have the structural characteristics to be used as "varules" or for construction.

3.2.6. *Estero Palomino*

Although extraction levels are lower than those observed in Estero Tempisque, they are still high in this area. There are some good *Rhizophora* remaining, but they are not very extensive and are limited to a narrow band along the shoreline. There are, however, some lower lying areas that local people call "ensenadas", which are washed by almost every tide. In these "ensenadas" large *Rhizophora* stands occur. Natural regeneration in Estero Palomino is adequate.

FIGURE 2. TREE OF PROBLEMS FOR ESTEREO REAL, NICARAGUA



4. DIAGNOSIS OF THE PROBLEMS SURROUNDING MANGROVE USE IN ESTERO REAL

The diagnosis of the problems surrounding the use of the mangroves of Estero Real is presented in a schematic form in a tree of problems, in which the main problem is identified as the trunk, the causes as the roots, and the consequences as the branches. The tree of problems for Estero Real is presented graphically in Figure 2, and it is explained in the following paragraphs.

4.1. The main problem and its consequences

The ecological degradation the natural renewable resources of Estero Real is the major problem that the region faces.

The rapid degradation of the mangroves of Estero Real is evident in a number of aspects. The ever increasing difficulty in obtaining "varules" and good construction poles in areas close to the communities, as well as the poor natural regeneration, particularly of *Rhizophora* in those areas that have been clear-cut are good indicators of the on-going degradation. In addition, in those areas with poor natural regeneration, *Rhizophora*, which has the highest commercial value of all mangrove species in Estero Real, is being replaced by *Avicennia*, that has a lower commercial value here. In other words, there is a constant reduction of the mangrove areas with good forestry potential.

The reduction in the availability of "varules" and construction poles, together with the heavy waste of wood products (it has already been mentioned that debarked trees are seldom used for firewood) and the uncontrolled selective extraction, have resulted in a residual forest with poor silvicultural characteristics. As a result, economic yields per unit area are very low. Since economic yields per unit area are low, people is forced to use more and more areas of mangrove per unit time to meet their needs. This situation worsens because extraction is almost exclusively in areas close to the communities because of transportation problems.

Mangroves are economically important, not only for the forest products they provide, but for the role they play in providing food and habitat to a number of species of economic and ecologic importance. Therefore, one of the most serious consequences that the degradation of the mangrove can have is the alteration or interruption of the life cycles of these aquatic species. It must be stressed that fishing, and especially shrimping, is the major economic activity of a good portion of the people of Estero Real. A reduction in the export of organic matter, or a destruction

of certain habitats (c.f., Thayer, Colby and Hettler, 1987) could, for example, lower the availability of shrimp post-larvae. This would have a very negative impact in the mariculture projects, particularly those at the artisanal level. Adverse effects would also be felt in the natural shrimp fisheries and in the availability of fish and crabs, which are an important source of dietary protein for the people of Estero Real.

The reduction in the mangrove areas with good forestry potential, the increasing difficulty in reaching good *Rhizophora* stands, and the degradation of some natural areas for artisanal fisheries, have resulted in an increase in the costs of production, reflected primarily in increased efforts per unit income. The direct result is a reduction in the family income which, linked to a reduction in the sources of animal protein, is having a direct impact in the quality of life of the people of Estero Real.

4.2. Causes

Five major factors have been identified as immediate causes of the main problem surrounding the use of the mangroves of Estero Real. These are:

- a. Lack of a mangrove planning and management structure in Nicaragua.
- b. Reduced economic opportunities for the communities associated to the mangroves.
- c. High demand over the resources and few options for alternative use.
- d. Lack of awareness and education in relation to the direct and indirect importance of mangroves resources, and on the consequences of their over-exploitation.
- e. Fragility of the ecosystem resulting from the degradation of the watershed and the environmental conditions of the region (aridity).

Several factors play a major role on the over-exploitation observed on the mangroves East of Puerto Morazán.

The reduced economic opportunities for the communities associated to mangroves in Estero Real has lead to an increased over-exploitation of the mangrove resources. Wood extraction is based upon immediate demands and no silvicultural guidelines are followed. Consequently, as a result of these unsound practices, much wastage is produced. For example, wood extraction is based on occasional contracts for single-purpose use which do not take into

account the conditions of the system, nor its natural production. If the contract calls for a particular type of construction material, chances are that the whole tree will be cut, but only the specific piece of wood demanded will be extracted. It would be possible to extract several different products from one same tree. However, under the present extraction practices, whatever does not meets the "specifications" of the particular contract is usually discarded.

No storing practices for future sales are implemented. The problem is that usually what is discarded is much more than what is used (or sold). There is no multiple-use planning at all.

This problem has two main causes. First, the reduced economic opportunities for the communities associated to mangroves in Estero Real, and second, that there is no clear understanding among the people of Estero Real of the long-term economic benefits that could be derived from sustainable multiple-use of the mangrove forests.

Closely related to the above-mentioned problem is the high demand placed upon mangrove forest products, and the scarcity of alternatives. For example, the disproportionate extraction of "varules", which results from the high demand on this product by the banana companies is, most probably, the major anthropogenic factor leading to the degradation of the mangroves of Estero Real, and conceivably, of all of the mangrove forests on the Pacific coast of Nicaragua.

There is also a major lack of awareness in relation to the direct and indirect importance of mangroves, as well as of the consequences of the over-exploitation of its resources. For example, the irreversible destruction of mangrove forests for shrimp-pond construction is a major problem in many tropical countries. Although it has not manifested in all of its extension in Nicaragua, there are already plans in this direction. Based on experiences developed elsewhere (Snedaker et al., 1985, Lahmann et al., 1988), it can be stated that the major economic expectations surrounding shrimp mariculture are far from real, particularly in terms of the benefits derived by the lower income classes. Environmental impacts, loss of fisheries and overall social impact, usually far overweights the financial gains derived from shrimp mariculture.

Finally, it should be mentioned the fragility of the Estero Real mangrove ecosystem resulting from watershed degradation and overall environmental conditions, particularly the prevailing low rainfall rates.

Species spatial distribution and mangrove forest structure is determined by variations in topography,

sediments, hydroperiods (seasonal variations in freshwater and saltwater inundation) -which could result from unwise management practices in the watershed- as well as variations in salinity gradients within the intertidal zone. For example, soil salt accumulation in arid environments, such as Estero Real, could place a limit on the extent of the areas that can be colonized by mangroves. By the same token, as a result of the high metabolic cost of living in highly-saline, arid environments, mangrove forests have a lower structural development, as well as a more restricted spatial coverage, compared to mangrove forests in areas of higher precipitation and higher runoff. Consequently, since red mangroves (*Rhizophora spp.*) are more sensitive to higher salinity than black mangroves (*Avicennia spp.*), red mangroves in Estero Real are restricted to a narrow band along the canals.

Red mangroves have a higher direct commercial value than black mangroves. As a result, it is the species more heavily exploited in the area. Clearly, there is presently a strong pressure over a limited resource. The situation could worsen if freshwater runoff into Estero Real diminishes.

In conclusion, sustainable use of the goods and services provided by mangrove ecosystems is possible only as long as the integrity of the hydrological systems is maintained.

5. PROPOSAL PRESENTATION

5.1. General Objective

- A. To develop the mechanisms necessary to achieve a sustainable use of the natural resources of Estero Real for the benefit of the human populations living in the area.**
- B. To develop a series of management alternatives for neotropical mangroves located in arid environments.**

5.2. Specific Objectives

- A. To determine the wise use potential of the different mangrove areas in Estero Real. These could be:**
 - i. areas with forestry potential,**
 - ii. areas with alternate use potential (for aquaculture, agriculture, etc.)**
 - iii. preservation areas for the benefit of commercial and subsistence fisheries, as well as for educational, scientific and recreational purposes.**

These preservation areas will also serve as propagule sources for areas under silvicultural management, as storm protection for coastal populations, as control against shoreline erosion, and for the protection of ecologically important species.

- B. To minimize those activities which adversely affect the mangrove resources of Estero Real.**
- C. To promote the wise and sustainable use of the natural resources of Estero Real.**
- D. To promote the recovery of over-exploited areas and resources in Estero Real.**
- E. To find alternatives to the indiscriminate use of "varules" by the banana companies.**
- F. To elaborate a management plan which clearly defines the activities that should be executed in order to achieve the above-mentioned objectives.**

5.3. Activities

The activities described in the following paragraphs are specifically targeted at addressing the main problem and

its consequences (section 4.1), by promoting actions to offset the causes of the main problem.

This project is designed in such a way as to make possible, from the onset, the identification of those activities and mechanisms that will allow to work directly with the local communities and local authorities in reducing the existing pressure on the mangrove resources of Estero Real. Consequently, the following proposed actions are grouped into the five major areas that were identified as the leading causes of the main problem (see Figure 2 and section 4.1). These activities are designed to be executed over a four year period.

5.3.1. Formulation and initial implementation of the management plan.

Because of the very little available information on the biophysical and socioeconomic conditions of Estero Real, this project should be divided into three phases.

The first phase will consist of a biophysical and socioeconomic diagnosis. The second phase will be the formulation of a management plan in accordance to the above-mentioned objectives, and the third phase will focus on the implementation and execution of the management plan. Concurrently to these three phases, a series of pilot projects will be carried out from the onset of the project. These pilot projects will have two main objectives: firstly, to involve the local communities in the management of Estero Real from the very beginning of the project, and secondly, to take immediate actions to significantly reduce the over-exploitation of the mangrove resources in Estero Real.

As a first step, the project will promote the creation of a local committee in charge of managing the mangrove resources of Estero Real. This committee will be composed by representatives of the different social groups and organizations of the area. The project will coordinate activities with the committee, and will provide technical assistance in issues such as extraction of forest products, and the implementation of more adequate techniques for the extraction, processing and marketing of these products. Other specific responsibilities of the committee are discussed elsewhere.

Parallel to the conformation of this local committee and of the implementation of the pilot projects, a series of activities are proposed in order to determine the capacity of the different mangrove resources of the area to support a sustainable use. Four major actions are proposed:

- i. Mapping of those areas where extraction activities are being carried out (firewood, lumber, varules, tannins,

shrimp fishing, crabs, shellfish and fishes).

- ii. Quantification of the amounts being extracted of each of the products mentioned above.
- iii. Quantification of the primary productivity and regeneration rates of the mangrove forest
- iv. Identification of the critical areas for faunal reproduction.

5.3.2. *Socioeconomic study and development of activities designed to diversify the economic base of those communities using mangrove resources.*

The socioeconomic study will focus on the identification of the mangrove resources used by local communities, placing special interest in estimating the frequency of use of these resources, as well as estimating the contribution these resources make to the family and local economies. Attention will also be placed upon other economic activities not related to the mangrove ecosystem.

As it was mentioned previously, one of the major problems of the area are the limited economic opportunities available for local residents. This project will explore the different productive alternatives available that might contribute to improve the local economy. These alternative activities should also contribute in lowering the present rates of over-exploitation of the mangroves of Estero Real.

Therefore, this socioeconomic study will be designed in order to identify those areas that offer the best development opportunities for these alternative economic activities.

Once the proposed activities are initiated, the socioeconomic group will closely monitor the impact that the implementation of the management plan might have on the communities in Estero Real. This monitoring will serve two purposes: To take corrective actions, if necessary, and to obtain further experience to be used elsewhere.

5.3.3. *Reduction on the demands for those mangrove forestry products with low economic value.*

The project will work closely with the local committee on the implementation of pilot projects. These pilot projects are designed to promote the multiple integrated-use of the mangrove resources in order to alleviate the existing over-exploitation of some of these resources. Particular interest will be placed upon improving the existent market

value of those mangrove resources currently being extracted. For example, if instead of using *Rhizophora spp* as "varules" (5 cm DAP), these species are used as building material (poles, etc., 10 cm DAP), their market value would increase 10 times. Use of species with lower direct-commercial value, such as *Avicennia* and *Laguncularia*, will be promoted in order to satisfy the demand for "varules". These two species have the additional advantage of being capable of coppicing, peculiarity not present in *Rhizophora* (Gill and Tomlinson, 1971). One of the first pilot projects to be carried out will be the design of appropriate silvicultural practices for the production of "varules" from *Avicennia* and *Laguncularia*.

The project will also seek ways of reducing the demand for "varules" from *Rhizophora*. For this purpose, the project will work with IRENA and the banana companies in order to promote incentives for the use of "varules" only from *Avicennia* and *Laguncularia*. The project will also explore the possibilities of using non-mangrove "varules", such as those from bamboo or eucaliptus, which are species with higher growth rates. Parallel to these activities, tests will be performed on the possibilities of using technologies employed in other countries, which do not require the use of "varules." The search for these alternatives will be made following the recommendations stemming from the socioeconomic study, so these "new" technologies will be acceptable to local communities.

Another pilot project that will be started at the very beginning of this project will be to improve the current tannin-extraction techniques. Presently, tannins are extracted from mangrove bark in a very rudimentary way, with very low efficiency rates. If tannin-extraction techniques are improved, and the product to be sold is the extract and not the bark (raw material), local communities will benefit from the added value. At the same time, tanneries will benefit by obtaining a better quality product.

5.3.4. *Environmental education programme*

Lack of knowledge regarding the direct and indirect importance of natural resources in general, and of mangroves in particular, is one of the main contributing factors leading to their degradation. It is proposed, therefore, to establish an environmental education programme, which will also be started concurrently with the other initial activities. The programme will have activities targeted both to the children and adult populations in an attempt to incorporate the Estero Real communities in all of the activities proposed in this project.

With regard to the adult population, the activities

will be carried-out in coordination with the local committee. The activities designed for the children will be carried-out in coordination with the local schools.

Some of objectives of this programme are:

- i. To explain and disseminate the objectives and results of the project.
- ii. To increase the awareness level of the populations in relation to the importance of mangroves and their natural resources.
- iii. To open the dialogue in relation to the possibilities of multiple sustainable use of the resources of the mangroves. Analyze and discuss the advantages and limitations of multiple sustained-use.

A series of activities to promote the conservation and wise use of all natural resources will be carried-out concurrently with the environmental education programme. For example, guided field trips to different locations will be made in order to better understand the interrelationships among different ecosystems and the importance of their natural resources (water, soil, forests, fauna). Differences between renewable and non-renewable resources will also be discussed. Reforestation of degraded areas, both with mangrove species and upland species, will also be part of the environmental education programme.

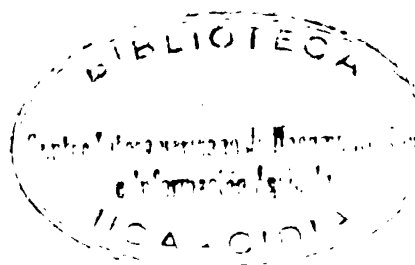
In addition to the above-mentioned environmental education activities, the project will provide technical assistance to the communities of Estero Real in order to improve their capacity to manage their own natural resources, concurrently to the improvement on their quality of life.

Finally, under the environmental education programme, the project will carry-out a number of activities, at the national level, which will target the decision-makers in key institutions such as IRENA, the Fisheries Institute, the Ministry of Agriculture, and the Ministry for Agrarian Reform.

5.3.5. Maintenance of the ecological and hydrological integrity of the system.

Both, the project personnel and the local committee in charge of managing the mangrove resources of Estero Real, will look into the measures that must be taken, at all levels, to insure the long-term viability of the mangrove ecosystem. These measures will include the coordination of activities with, and the persuasion of, those institutions

and individuals that conduct activities upstream in the Estero Real watershed. Emphasis will be placed upon those activities that may affect the quality, quantity or frequency of freshwater input to Estero Real.



6. PROJECT STRUCTURE

6.1. Permanent staff

- A. Coordinator.** He/she will be responsible for the day-to-day operation of the project. The coordinator will answer administratively to CATIE and will coordinate with the CATIE/IUCN wetland experts on the activities to be executed on this project. The coordinator will elaborate annual operative plans in coordination with the other members of the team and with the CATIE and IUCN advisors.
- B. Governmental counterpart.** A staff member for IRENA will work in close cooperation with the project coordinator. The counterpart will also have the responsibility of coordinating with other governmental agencies that might have an interest in the region.
- C. Responsible for the socioeconomic studies.** He/she will be responsible for the execution of the activities described under 5.3.2, and will be working directly with the communities, particularly with fishermen, artisanal mariculturists, and woodcutters. A socioeconomic specialist will be appointed for this position. To fulfill his/her duties, the responsible for the socioeconomic studies will have two assistants.
- D. Responsible for community activities and environmental education programme.** He/she will be responsible for the coordination of all the activities that the project will carry out with the community. He/she will also be responsible for the environmental education programme. He/she will have one assistants.
- E. Responsible for the biological studies.** He/she will be responsible for the field- verification of the photo-interpretation studies, as well as the vegetation analysis described under 5.3.1. He/she will also be responsible for identifying and supervising the national consultants who will carry-out the faunal studies described under 5.3.1. The responsible for the biological studies will be a biologist with forestry training. He/she will be aided by two assistants.
- F. A secretary,** who will also have the responsibility for the project's accounting.

6.2. In-country consultancies

The following consultancies will be required during the first year of activities:

- A. Photointerpretation and elaboration of vegetation maps. 1 consultant, six months full time.
- B. Biological studies. Fauna: 1 consultant, 1 assistant. One year, part time.

These consultancies will be commissioned to Nicaraguan specialists.

6.3. International consultancies

The project will benefit from the input and advise of international experts from different disciplines who will be hired as consultants for some specific tasks. The following are the minimum requirements:

- A. A socioeconomist; 1 month per year.
- B. An expert on mangrove associated fisheries; 1 month per year.
- C. An eco-development expert; 1 month per year.

6.4. Technical assistance

Specific technical assistance throughout the different phases of the project will be provided by IUCN's Wetlands Programme's technical staff. IUCN's participation will include:

- a. Detailed design of each project's component.
- b. Training of field personnel.
- c. Technical supervision of the project activities.
- d. Annual analysis and interpretation of the information generated by the project.
- e. Assist on the preparation of the annual operative plans.
- f. Technical input in the elaboration of the Integrated Management Plan for the mangroves of Estero Real.
- g. Supervise the implementation of the Integrated Management Plan.

All of the above-mentioned activities will be carried out in coordination with CATIE's technical staff and the Nicaraguan team.

7. CRONOGRAM

This field-project will be part of the Programme "Conservation for Sustainable Development in Central America", a joint CATIE/IUCN effort currently underway. As such, this field-project has been designed to start on 1 March 1991 and to run for four years.

The proposed activities for the first two years of the project are detailed in Table 1. The Integrated Management Plan for the mangroves of Estero Real will be ready at the end of these two years. The management plan will detail the activities for the following two years.

A series of pilot projects will be carried-out during the first two years of this project. These pilot projects are designed to significantly diminish the over-exploitation of the mangrove resources in Estero Real. The biophysical and socioeconomic studies of the area will be conducted simultaneously with the pilot projects. The environmental education and community involvement programmes will also be initiated from the very onset of the project.

A workshop is planned for the second semester of the second year of the project to discuss the management plan draft. All the project personnel, interested Nicaraguan authorities and invited international experts will participate on this workshop. The product of this workshop will be the basis for the Integrated Management Plan for the mangroves of Estero Real. This management plan will be published at the beginning of the third year of activities of the project.

The proposed activities for years three and four will derived from the results of the pilot projects, the evaluation of the natural resources of the area and from the prevailing socioeconomic conditions in Estero Real, and will be detailed on the Management Plan.

8. BUDGET

The proposed budget for this project is presented in Table 2. The budget includes permanent staff, equipment, operating costs, pilot projects, national and international consultant, and running expenses.

Table 2. Budget, Mangroves of Estero Real, Nicaragua, Project (in US \$)

Activity	Year 1	Year 2	Year 3	Year 4
PERSONNEL				
At CATIE				
Mangrove specialist (half salary)	18000	18000	18000	18000
Programme coordination	5000	5000	5000	5000
Administrative support	5000	5000	5000	5000
In Estero Real				
Coordinator	15000	15000	15000	15000
Responsible socioeconomic studies	10000	10000	10000	10000
Responsible community activities and environmental programme	10000	10000	10000	10000
Responsible for biological studies	10000	10000	10000	10000
Secretary/accountant	6000	6000	6000	6000
5 assistants	15000	15000	15000	15000
Sub-total:	94000	94000	94000	94000
EQUIPMENT				
1 Four-wheel drive vehicle	16000			
1 Motorcycle	2500		2500	
2 boats	3000			
2 outboard motors (25 HP)	4000			
1 AT computer with hard disk and UPS	3000			
1 printer (136 columns)	1000			
Office equipment	2000		2000	
Rehabilitation of field facilities	10000			
1 portable typing machine	300			
Aerial photos and maps	1500			
Photographic camera and lenses	1000			
Film and developing	200	200	200	200
Slide projector and screen	600			
Environmental education material	2000	2000	2000	2000
Sub-total	47100	2200	6700	2200
OPERATING EXPENSES				
Travel	6000	6000	6000	6000
Per diem	6000	6000	6000	6000
Fuel	6000	6000	6000	6000
Two-stroke oil	600	600	600	600
Vehicles and outboard motors maintenance	1500	1500	2000	2000
Office material	1500	1500	1500	1500
Mail and communications	1500	1500	1500	1500
Miscellaneous	1000	1000	1000	1000
Sub-total	24100	24100	24600	24600

OTHER ACTIVITIES

Training	5000	3000	3000	3000
Pilot projects	7500	12000	15000	15000
Workshop		10000		
Publishing	1000	1000	6000	2000
Sub-total	13500	26000	24000	20000

CONSULTANCIES

Photointerpretation	6000			
Fauna	6000			
Institutional support for IRENA	5000	5000	7500	7500
International consultants	20000	20000	20000	20000
IUCN technical assistance	15000	15000	15000	15000
Sub-total	52000	40000	42500	42500

Unforeseen expenses(10%)	23070	18630	19180	18330
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CATIE's Overhead (18%)	45679	36887	37976	36293
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GRAND TOTAL	299449	241817	248956	237923
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PROJECT COST (4 YEARS)	1028146			
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TERRABA-SIERPE, COSTA RICA

9. BACKGROUND

9.1. The mangroves of Costa Rica

The Pacific coast of Costa Rica is characterized by the presence of a large number of bays, gulfs, estuaries and other protective embayments which favour the development of large extensions of mangrove forests. Close to 99% of the estimated 39,000 ha of mangroves in Costa Rica occur on the Pacific coast (Saenger, Hegerl and Davie, 1983).

Mangrove forests in Costa Rica are protected by law. All mangrove forests were declared forest reserves in 1977 (executive decree # 7210-A), under the jurisdiction of the Fisheries and Wildlife General Directorate. Two years later, in 1979, by executive decree #10005-A, all mangroves forests became under the jurisdiction of the Forestry General Directorate (DGF, for "Dirección General Forestal"), who currently regulate the use of all Forests Reserves. In order to legally extract any forest product from a Forest Reserve it is necessary to have a management plan approved by the DGF.

The mangroves of Costa Rica have been more studied than those in Nicaragua, particularly from a floristic perspective (c.f. Soto and Jiménez, 1982, Jiménez, 1987). The species described for Costa Rica are: *Rhizophora mangle* ("mangle gateador"), *R. harrisonii*, *R. racemosa* (both are known indistinctly by different names: "mangle caballero", "rojo", "granadino" and "blanco"), *Avicennia germinans*, *A. bicolor* (both called "palo de sal"), *Laguncularia racemosa* ("mariquita"), *Conocarpus erectus* ("botoncillo" and *Pelliciera rhizophorae* ("pifa" or "pifuela"). This last species has the most restricted distribution of all mangrove species in the New World. The North-Pacific coast of Costa Rica is the northernmost limit of its distribution.

On a worldwide basis, mangroves have a greater structural development, higher net primary productivity and higher species diversity in areas with high precipitation or considerable terrestrial runoff (Lugo and Snedaker, 1974; Cintrón and Schaeffer-Novelli, 1985).

The Pacific coast of Costa Rica has been divided into two zones on the basis of rainfall and river discharge: the North, dry-Pacific and the South, wet-Pacific. Mangrove forests in Costa Rica reflect this division. The mangroves on the South Pacific coast have a greater structural development and higher species diversity. Although productivity studies have not been conducted in these areas, it is expected to be higher than in the North Pacific coast.

9.2. The importance of the mangroves of Térraba-Sierpe

The Térraba-Sierpe Forest Reserve is located in the South Pacific coast of Costa Rica. It is the largest mangrove forest in the country with an estimated surface area of 16,700 ha. This Forest Reserve covers close to 40% of the total mangrove forest extension in Costa Rica (Chong, 1988).

Although extraction activities have been conducted for many years in the Térraba-Sierpe mangrove forest, it is in the last seven years that this Reserve has been subjected to increased pressure as a result of the unemployment created by the departure of the banana company. Large numbers of families depend now on the mangroves for their subsistence.

The most important resources presently extracted from the Térraba-Sierpe Mangrove Forest Reserve are: wood for charcoal production, bark for tannins, firewood, construction materials and mollusks (*Anadara*). Crabs are not harvested as in Nicaragua, and fisheries inside the mangroves are only for subsistence, since commercial or even artisanal fisheries are presently forbidden inside the mangrove channels. Article 43 of Law No. 6919 of the Fisheries and Wildlife General Directorate regulates the type of fishing gear that can be used inside confined water bodies, including mangrove channels. Gill, and trawling nets are forbidden.

The close direct-relationship between mangrove forests and commercial, sports and artisanal fisheries was discussed previously for Nicaragua (see 2.2). Therefore, it will not be repeated here. Suffice to mention that some of the most important commercial shrimping-grounds in Costa Rica are located in Bahía de Coronado, offshore the Térraba-Sierpe Mangrove Forest Reserve. Artisanal fisheries could be an important activity in the area in view of the prevailing biological conditions. Technical and financial assistance are the missing elements.

Based on the estimated area (16,700 ha), and using the equation developed by Martosubroto and Naamin (1977) (see 2.2), the potential shrimp fisheries associated to Térraba-Sierpe are estimated to be close to US\$ 29,000,000 per year, in addition to the value of other fisheries. Close to 5,000,000 individuals of the mollusk *Anadara* are extracted annually from this Mangrove Forest Reserve.

Indirect services provided by mangrove forests are also present in the Térraba-Sierpe Mangrove Forest Reserve. During the 1988 floodings caused by Hurricane Joan, houses and property were spared of greater damage by drifting wood and other debris by of the natural barrier offered by neighboring mangroves.

In terms of the potential value of forest products, Chong (1988) estimated that an hectare of mangrove in this reserve can produce US\$ 619 annually. Some of the activities proposed in this project are designed to increase this value even more.

10. PRESENT CONDITIONS IN TERRABA-SIERPE

10.1. Description of the area

The Térraba-Sierpe Mangrove Forest Reserve is part of the "Unidad Regional de Osa", composed by the Corcovado National Park, the Golfo Dulce Forest Reserve, Golfito Wildlife Refuge and the Térraba-Sierpe Mangrove Forest Reserve. Térraba-Sierpe is located in the Cantón de Osa¹, in the Province of Puntarenas. The Reserve is located between 8°47' and 9°03' Latitude North, and from 83° 29' to 83°38' Longitude West (Figure 3).

Annual average temperature and rainfall are 26.7 °C and 3,676 mm. The rainy season extends from April to November, while the dry season occurs from December to March. According to Holdridge's classification, the Térraba-Sierpe Forest Reserve is located within the Tropical Forest Life Zone.

The Forest Reserve is a river and wave-dominated delta system. The Térraba river and the Sierpe river are the most important sources of freshwater to the area.

It is estimated that about 63% of the Térraba watershed is eroded and close to 29% is considered to be severely eroded. The volume of sediments in suspension recorded for the Río Térraba range from 548,000 to 4,120,000 tons/year (Chong, 1988). No estimates are available for the Río Sierpe. The high silt load transported by the rivers is physically checked by tidal currents and waves at the river mouths. This leads to the formation of a large delta characterized by the presence of elongated shoals and sand bars.

10.2. Socioeconomic characteristics of the Cantón de Osa.

The Cantón de Osa covers 1930 Km² (3.5% of Costa Rica). González (1990) estimates a total of 31,406 inhabitants in Osa, with a population density of 16.3 people per Km². The main economic activities are linked to agriculture, mainly rice, cocoa, corn, sorghum, beans, oil palm and lately,

¹ Costa Rica is divided politically into 7 provinces and 81 "cantones."

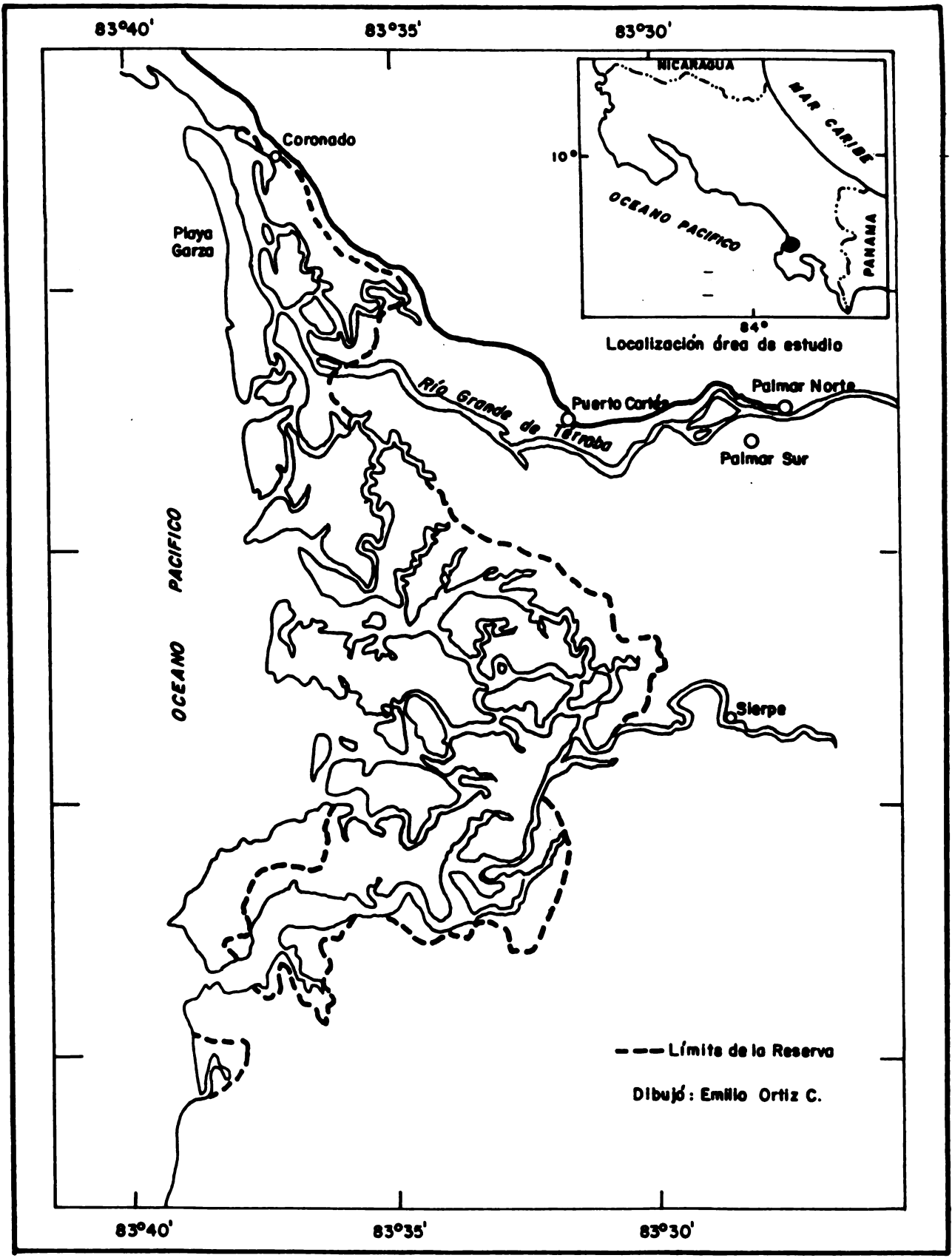


Figura 3 Reserva Forestal Terraba - Sierpe

pineapples. Cattle ranching is also present.

González (1990) provides the following figures for the Cantón de Osa:

Analphabetism.....	12%
Unemployment.....	11.9%
Economically active population.....	47.7%
Birth rate (per thousand).....	24.9%
Death rate (per thousand).....	13,8%

Mangrove related activities occur mainly within the Forest Reserve, but also affect neighboring towns such as Palmar Norte, Palmar Sur, Ciudad Cortés and Sierpe. These four towns are the most important markets for mangrove products, particularly charcoal, fish and mollusks. Bark is sold in Golfito, about 80 Km distant from Coronado.

10.3. Communities inside or close to the Térraba-Sierpe Mangrove Forest Reserve.

There is a large number of small communities dispersed within and adjacent to the Térraba-Sierpe Mangrove Forest Reserve. The most important are: Coronado (215 inhabitants), Tres Ríos (205), San Marcos (200), Tortuga Arriba (113) and San Buenaventura (110) (González, 1990). There are also several villages located in the different mouths of the rivers Sierpe and Térraba. These villages named Boca Brava, Boca Chica, Boca Zacate, Boca Guarumal, Boca de Sierpe, Sábalo y Potrero, and Punta Mala have between 50 and 100 inhabitants each, most of them with family ties. In total, there are close to 1700 people living within the Térraba-Sierpe Mangrove Forest Reserve. All of these people depend, in one way or another, on the natural resources provided by this Mangrove Forest Reserve.

10.4. Main activities of some communities associated to the Térraba-Sierpe Mangrove Forest Reserve.

10.4.1. Coronado

It is the largest community adjacent to the Forest Reserve. Located on the northern shore of the Río Térraba.

The economy of this community is based on the extraction of wood and bark from the mangrove forests. There is one established cooperative, "COOPEMANGLE", a grassroot organization constituted by "mangleros"². COOPEMANGLE is the only group legally authorized to extract forest products from a mangrove reserve in Costa Rica.

² People that make their living extracting wood and bark from the mangroves.

IUCN/CATIE have been working with COOPEMANGLE for over a year, providing them with technical assistance in order to fulfill COOPEMANGLE's obligations under the Forest Reserves regulations. COOPEMANGLE will be one of the focal points of this project.

Charcoal is produced by COOPEMANGLE in earth-pit kilns and it is sold in sacks with an average volume of 0.06 m³/sack. Current charcoal production by COOPEMANGLE is around 1500 sacks per month. Charcoal is sold to intermediaries right off the kilns, as COOPEMANGLE does not have the means to transport the charcoal to the main markets (Palmar Norte, Palmar Sur and Puerto Cortés, where mangrove charcoal is preferred over any other type of charcoal. Charcoal has been used traditionally in this communities for cooking purposes, and it is still used because of its lower cost as compared to electricity or natural gas.

In addition to charcoal, COOPEMANGLE sells mangrove bark, which is used for tannin extraction. Mangrove tannins have been used for years for leather preservation. However, demand for mangrove tannin has decreased in recent years, as the tannery industry is importing tannin extracts, which speeds-up the process. These extracts, however, are not only about 20 times more expensive per unit weight, than the mangrove bark, but must be paid in hard currency. COOPEMANGLE has expressed its interest on processing mangrove bark to obtain tannin extract.

Mangroves are also a source of firewood, which is used for cooking by some families. In addition, firewood is sold to some bakeries for bread-making.

People from Coronado complement their income by growing some crops, mainly corn, beans, rice and some vegetables.

10.4.2. Punta Mala

Punta Mala is located at the main mouth of the Río Térraba. This community is composed mainly by fishermen.

The most important fish species captured are of the following families: Lutjanidae, Scianidae, Centropomidae, Mullidae, Mugilidae, Arridae and Carangidae. The shrimp species that are regularly captures are: *Penaeus brevirostris*, *P. stylirostris*, *P. californiensis* and *Solenocera*. All of these species are mangrove-dependent species.

There are basically three fishing modalities: (i) artisanal open-water, (ii) inside the estuary, and (iii) associated to commercial shrimping boats. In this last modality, people get close to the shrimp boats and collect those species that are caught together with the shrimp, but

that are discarded by the commercial boats.

Most of the fish catches are sold to intermediaries; part is used for local consumption.

People from Punta Mala complements their diet, as well as their income, by raising domestic animals and growing some crops, mainly grains.

10.4.3. "Las Bocas"

The term "Las Bocas" is used in a generic sense to refer to a group of communities located in the different mouths of the T rraba-Sierpe delta: Boca Chica, Boca Brava, Boca Zacate and Boca Guarumal.

Most of the people from these small communities are "piangueros".³ According to Campos (pers. comm., 1990), one of the largest populations of pianguas in Central America is located in T rraba-Sierpe. There is however, concern that over-exploitation might be occurring here, as captures of individuals below legal-size⁴ are common. Pianguas are the most craved mollusks from mangroves in Central America.

All of the estimated 5,000,000 *Anadara* captured annually in the Mangrove Forest Reserve are sold in the "Bocas" to intermediaries who sell them in the capital city.

Other mollusk species regularly captured inside the mangroves are: *Anadara grandis*, *Polymesoda inflata*, *Prothotaca sp.*, *Melongena patula* and *Noetia reversa*.

There are also some people in the "Bocas" that produce mangrove charcoal. Their activity, however, is considered illegal, as they do not have a permit from the DGF to operate (see 11.2, d).

10.5. Condition of the mangroves in T rraba-Sierpe.

The structural characteristics of particular mangrove stands within the T rraba-Sierpe Forest Reserve have been subjected to brief analysis by several researchers (Jim nez and Soto, 1985; S nchez, 1986; Chaves y Fonseca, 1986; Chong, 1988). Based on these reports, and on our own observations, it can be stated that, although some areas are currently under some pressure, the general condition of the mangrove stands within the Forest Reserve is satisfactory.

3 "Piangueros" are people that make their livelihood by collecting "pianguas" -bivalve mollusks of the genus *Anadara*-.

4 Executive decree 13375, 16 February 1982 indicates a minimum capture size of 47 mm for "pianguas."

Jiménez and Soto (1985) reported a basal area of 27 m²/ha, with trees up to 25m high. The inventory carried out by Chong (1988) yielded plot volumes from 34.6 m³/ha to 373.2 m³/ha for stems above 10 cm DBH, with an average stand volume of 280.52 m³/ha. Contributions by genus to this average volume are: *Rhizophora*: 163.04 m³/ha and *Pelliciera*: 117.48 m³/ha.

For comparison purposes, the average density for 30 years old stands of *Rhizophora apiculata* in Matang, Malaysia is 1,343 trees/ha, with an average stand volume of 153 m³/ha. In Thailand, reported average density of well developed mangrove forests is 812 trees, with a volume of 226 m³/ha (Chong, 1988).

Chong (1988) provided the following distribution of mangroves in the Terraba-Sierpe Mangrove Forest Reserve:

Table 3: Distribution and extent of mangroves

Description	Area (ha)	Percent
Commercial forest	5 218.75	23.00
Non-commercial forest	8 850.00	39.01
<i>Acrostichum</i> thickets	3 668.75	16.17
Others (non-forest)	4 950.00	21.82
Total	22 687.50	100.00

(Source: Chong, 1988)

There are two commentaries that should be made in relation to Table 3:

a. Until very recently, *Pelliciera* has been considered as a species with little or no commercial value. The reason being that the quality of the charcoal from *Pelliciera* is lower, as compared to the excellent quality of the charcoal produced from *Rhizophora*. Local people will not buy charcoal from *Pelliciera*. In addition, the bark from *Pelliciera* is not used for tannin extraction. The only use for *Pelliciera* was, occasionally, as fence posts in cattle ranches.

For these reasons, *Pelliciera* was considered by some authors as a non-desirable species, which should be eliminated (Chaves and Fonseca, 1986). This view was shared by the members of COPEMANGLE. Chong (1988) considered the stands dominated by *Pelliciera* as non-commercial forest.

IUCN/CATIE, working in close collaboration with the

DGF, have been able to modify this negative attitude towards *Pelliciera*. It is apparent now that *Pelliciera*'s wood is a very good quality lumber for furniture and general construction purposes. It is our opinion, that *Pelliciera* might even attain a higher commercial value than *Rhizophora*.

b. *Acrostichum* is a fern that invades mangrove areas that have been heavily disturbed, particularly in higher grounds which are not washed by daily tides. *Acrostichum* is a very fast-growing, light-demanding, plant that is able to prevent establishment of mangrove propagules. The fact that close to 20%⁵ of the total Mangrove Forest Reserve has been invaded by *Acrostichum* call for great concern. Exact causes for the invasion by this fern, and ways to prevent it must be investigated.

5 There are some discrepancies between Chong's figures in the text and on Table 3. If surface extent of "others" (Table 3) is ignored, the mangrove coverage in the Forest Reserve is 17,737.5 ha. *Acrostichum* coverage (3,668.75 ha) amounts to 20.7%

11. DIAGNOSIS OF THE PROBLEMS SURROUNDING THE USE OF MANGROVE RESOURCES IN TERRABA-SIERPE.

As with the diagnosis of the problems surrounding the use of the mangroves in Estero Real (section 4), the case of Térraba-Sierpe is presented in a schematic form in a tree of problems. The main problem is identified as the trunk, the causes as the roots, and the consequences as the branches. The tree of problems for Térraba-Sierpe is presented graphically in Figure 4, and it is explained in the following paragraphs..

11.1. The main problem; its causes and consequences

The major problem in the Térraba-Sierpe Mangrove Forest Reserve is the lack of proper utilization of the economic potential of the natural renewable resources of Estero Real.

11.2. Causes

The major factors that have been identified as immediate causes of the main problem surrounding the use of the natural resources of the Térraba-Sierpe Mangrove Forest Reserve are:

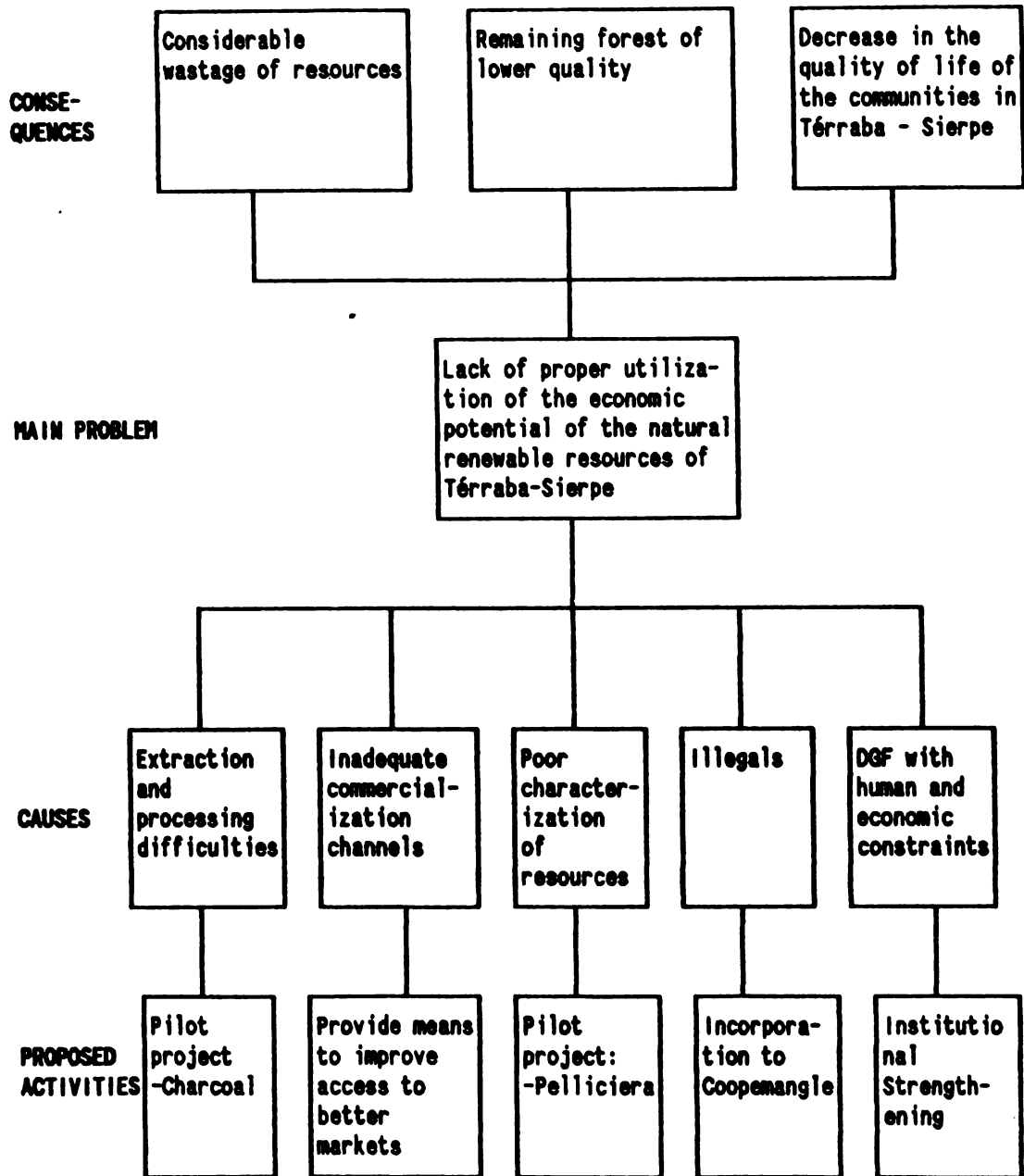
a. Lack of proper techniques for the extraction and processing of charcoal and tannins.

There are several factors involved in the extraction of the wood from the forest, and the subsequent process to produce charcoal, that are contributing to a considerable waste of resources.

Charcoal is produced by heating wood under conditions that carefully restrict the quantity of oxygen available for combustion. Trossero (1978), divided the process of charcoal production into four phases on the basis of time and temperature: Drying, pre-carbonization, self-carbonization and carbonization. Carbonization occurs at temperatures between 280°C and 400°C.

The higher the moisture content of the wood, the greater is the heat energy needed to dry the wood. Mangrove wood used by COPEMANGLE does not receive any air drying treatment. On the contrary, logs are usually "soaking-wet" when stockpiled in the earth-kilns. As a result, a considerable amount of the energy that could be used for charcoal production is used during the drying phase in the earth-kilns. Consequently, charcoal yields are lower and the impact on the forest is greater since more wood needs to be extracted to make for the production deficit. This implies a waste of human and forest resources.

FIGURE 4. TREE OF PROBLEMS FOR TERRABA - SIERPE, COSTA RICA



Earth-kilns are very inefficient systems. The traditional system used in Térraba-Sierpe, and in most mangrove areas in Costa Rica, consists on placing a pile of wood with the logs parallel to the ground. The pile is covered with leaves of *Acrostichum*, over which soil is laid. Under the present techniques being used, entrance of air is not properly controlled. This results in over-burned charcoal, with a significant portion being burned into ashes. This again results in the need of having to extract larger amounts of wood than what should be necessary.

Mangrove bark is sold directly to the tanneries as raw material. Tannins are extracted at the tanneries in a very rudimentary way, with very low efficiency rates, as in Nicaragua. Because of the much longer periods needed to preserve leather using unprocessed mangrove bark as compared to tannin extracts (for example, from "quebracho"), demand for mangrove bark has decreased considerably. Currently, close to 75% of the mangrove logs used for charcoal production are not de-barked.

b. Commercialization of mangrove products is not in the hands of the "mangleros."

COPEMANGLE does not have, at the present moment, the possibility of selling their products, particularly charcoal, directly in the markets because they lack the appropriate means of transportation. Consequently, they must sell the charcoal to intermediaries. Selling price of charcoal is ₡100 colones (US\$ 1.10) per sack in Coronado. In Ciudad Cortés and Palmar, 20 Km away, selling price is ₡160 (US\$ 1.75). In San José, wholesale price is ₡350 (US\$ 3.85). Good quality mangrove charcoal, properly marketed, could reach much higher prices in San José.

In view of these constraints, COPEMANGLE has to sell their products at very low prices. Consequently, impact on the forest is greater because the "mangleros" must extract greater amounts of wood in order to survive economically.

c. Poor characterization of the resources and their potentiality.

The case of *Pelliciera* been considered as an undesirable species (see 10.5) stresses the problem of the poor characterization of the resources of the Térraba-Sierpe Mangrove Forest Reserve. Should the natural resources of the Reserve be used at its full potential -in a sustainable way- the economic return per unit area will be greater.

Eco-tourism is another possibility whose potential has not been explored in this Reserve.

d. The existence of "ilegales" (illegals)

The term "ilegal" is used to refer to those "mangleros" that do not have permits to operate within the Mangrove Forest Reserve. Most of the "ilegales" live on the "Bocas"

The problem with the "ilegales" has two main dimensions. Firstly, since their activity is unlawful, wood extraction is clandestine with no other concern than not being caught. As a result, impact on the forest is greater, both in terms of damage and waste. Secondly, the "ilegales" sell their product, at under-the-market price, to an individual in Ciudad Cortés. This is creating a heavy burden on COPEMANGLE, on the one hand, and on the "ilegales" themselves, on the other, who do not receive a fair price for the work.

The situation is self-perpetuating because, in order to operate under the law, the "ilegales" must obtain the permit from the Dirección General Forestal (DGF). To obtain this permit they need a Management Plan and the "ilegales" do not have the financial resources, nor the technical capability to formulate a Management Plan.

e. The lack of manpower and resources by the Dirección General Forestal to carry-out their programmes.

As is the case of most institutions in charge of natural resources in developing countries, the DGF has great economic constraints. At present, there is only one person assigned to the whole Térraba-Sierpe Mangrove Forest Reserve. The situation is similar in other Mangrove Forest Reserves.

The difficulties of the DGF could be grouped in two broad categories:

- i. No experience in the management, protection and integrated use of mangrove resources.
- ii. Insufficient funds, vehicles and boats, equipment and tools to undertake large scale mangrove management activities.

11.3. Consequences

The consequences could be summed-up as follows:

- a. There is a considerable wastage of resources. In spite of the good silvicultural conditions of the area, it is estimated that present yields are only 1 to 2 m³/ha/yr

(Jiménez, pers. comm., 1990). As a result of this wastage, a much larger forest area must be impacted, per unit time, in order to satisfy the needs of the "mangleros."

- b. These practices are resulting in a remaining forest of lower quality. Although presently this might not be as obvious to the untrained eye, there is clear evidence that this degradation is taking place in some areas. Examples are those stands surveyed by Chong (1988) with plot volumes of 34.6 m³/ha, as well as the vast extensions dominated by *Acrostichum*.

Perhaps the reason why present management practices have not adversely impacted most of the Térraba-Sierpe Mangrove Forest Reserve is that population density here is low. It is expected, however, that population density will increase in the near future and pressure over the mangrove resources will rise. There is still time to take corrective actions which will promote a wise use of the natural resources of the Térraba-Sierpe Mangrove Forest Reserve.

- c. The ultimate, and most serious consequence of the improper use of the mangrove resources is that a large proportion of the inhabitants of the different communities are living at, or below, the poverty level.

12. PROPOSAL PRESENTATION

12.1. General Objectives

- A. To promote the wise use of the natural resources of the T rraba-Sierpe Mangrove Forest Reserve.**
- B. To develop a series of management alternatives for neotropical mangroves located in humid environments.**

12.2. Specific Objectives

- A. The consolidation of COPEMANGLE as a grassroot organization capable of managing in a sustainable way their mangrove resources.**
- B. The implementation of *in situ* pilot projects to demonstrate the economic viability, of using mangrove resources in a sustainable way.**
- C. To disseminate, at the community, technical, and decision-making levels, the potential of mangrove resources for rural development.**
- D. The institutional strengthening of the Direcci n General Forestal as the Governmental Institution in charge of Mangrove Forest Reserves.**

12.3. Activities

The activities described in the following paragraphs are specifically targeted at addressing the main problem and its consequences (sections 11.1 and 11.3), by promoting actions to offset the causes of the main problem (section 11.2).

This project is designed in such a way as to make possible, from the onset, the identification of those activities and mechanisms that will allow to work directly with the local communities and local authorities in reducing the existing pressure on the mangrove resources of the T rraba-Sierpe Mangrove Forest Reserve. Consequently, the following proposed actions are grouped into the six major areas. Five of them were identified as the leading causes of the main problem (see Figure 4 and section 11.1), while the sixth one refers to other activities that, although they do not address an specific cause of the main problem, are considered essential to fulfill the objectives of this project. These activities are designed to be executed over a four year period.

12.3.1. *Improvement of the extraction and processing of wood for charcoal production.*

This will constitute the first pilot project to be developed with COOPEMANGLE and it will consist of the following phases:

- i. Testing of different methods for extraction of wood from the forest. Emphasis will be placed upon a more efficient operation, with a lesser amount of disturbance to the regeneration.
- ii. The construction of two barges that will permit the transport of the wood to the kilns in a more cost-effective way.
- iii. The construction of simple facilities to store enough logs for the air drying of the wood previous to charcoal production. The amount of wood stored will be sufficient as to allow for a sustained production.
- iv. The construction of three brick kilns in order to produce a higher quality charcoal and increase the efficiency of the process. Associates of COOPEMANGLE will be trained in the construction and management of the brick kilns.

The problem of the poor efficiency of the tannin extraction process is common to Nicaragua and Costa Rica. The search for a solution to this problem is proposed as a pilot project for Estero Real (section 5.3.3). The results of the tannin pilot project will also be implemented in Térraba-Sierpe.

12.3.2. *Improvement of the commercialization channels.*

Two actions are proposed:

- i. A market-study for red mangrove charcoal and tannins, and timber wood from *Pelliciera*.
- ii. The purchase of a truck in order to make possible for COOPEMANGLE to reach better markets for their products. This truck will also enable COOPEMANGLE to bring goods not available in Coronado at a better price.

12.3.3 *Pilot project with Pelliciera.*

Preliminary experiments conducted jointly by COOPEMANGLE, DGF and IUCN/CATIE indicate that *Pelliciera* has very good properties for timber wood. Three main activities are proposed for this pilot project:

- i. An analysis of the mechanical properties of *Pelliciera* and of the economic feasibility of its sustainable use.
- ii. The installation of a portable saw-mill to process *Pelliciera*
- iii. To start a plan for the improvement of the dwellings of COOPEMANGLE's associates using *Pelliciera* and other local resources.

12.3.4. *Incorporation of the "ilegales" to COOPEMANGLE.*

COOPEMANGLE has agreed to accept any "illegal" as a member. In this way, it will be possible to extend the benefits derived from this project to other communities. At the same time, the negative impact of unregulated wood extraction will be significantly reduced.

It is foreseeable that in the future some other mangrove cooperatives will be established within the Mangrove Forest Reserve, particularly in areas far-away from Coronado. In this regard, it is intended that the activities undertaken in this project will serve as a model to follow.

12.3.5. *Institutional strengthening of the DGF.*

Three areas of action are proposed here:

- i. Training of the DGF's staff in aspects related to management, protection and integrated use of mangrove resources. The proposed training activities will include seminars, workshops and field-training courses. These training activities will be extensive to DGF staff in other Mangrove Forest Reserves.
- ii. The IUCN Wetlands Programme for Central America runs a computerized Wetlands Documentation Center based at CATIE. At the present moment, the documentation center has over 2500 books, scientific articles and reports dealing with a broad range of wetlands related topics. It is proposed to link the DGF electronically to the database and provide immediate access to the Documentation Center.
- iii. Assist the DGF in obtaining the necessary tools to undertake large scale mangrove management activities.

12.3.6. Other necessary activities.

A. Biological studies.

The following activities are proposed in order to determine the capacity of the different mangrove resources of the area to support a sustainable use:

- i. Mapping of those areas where extraction activities are being carried out (wood for charcoal, firewood, lumber, bark, shrimp fishing, shellfish and fishes).**
- ii. Quantification of the amounts being extracted of each of the products mentioned above.**
- iii. Quantification of the growth rates of the mangrove species in different areas of the Forest Reserve.**
- iv. Comparison of the quality and quantity of regeneration under different management schemes, particularly clear-cutting and selective extraction.**
- v. Identification of the critical areas for faunal reproduction.**

B. Socioeconomic studies.

Socioeconomic studies will be conducted once the proposed activities are initiated to closely monitor the impact that the implementation of the activities might have on the communities in the Térraba-Sierpe Mangrove Forest Reserve. This monitoring will serve two purposes: To take corrective actions, if necessary, and to obtain further experience to be used elsewhere.

C. Environmental Education Programme.

The Delegate from the DGF in Térraba-Sierpe has been running a very successful and innovative environmental education programme with the children of the Elementary School in Coronado. The project will provide all necessary assistance to this programme, and will seek to emulate it in other communities of the Mangrove Forest Reserve.

D. Disseminate the accomplishments of the project.

It is necessary to reach the high-decision levels in the different governmental institutions to inform and sensitize them on the multiple benefits derived from mangrove forests, and on the importance of maintaining the ecological and hydrological integrity of the watershed.

E. Formulation of an Integrated Management Plan.

Existing management plans are inadequate (Chaves and Fonseca, 1986) or do not take into consideration the ecological and socioeconomic conditions of the region (Chong, 1988). As a result, none of these two management plans are being implemented.

The activities to be carried-out in this project will provide a wealth of biophysical and socioeconomic information of the Terraba-Sierpe Mangrove Forest Reserve. This information will be used by the Project's technical staff to formulate an integrated management plan for the different resources of the Forest Reserve.

13. PROJECT STRUCTURE

13.1. Permanent staff

- A. Coordinator.** He/she will be responsible for the day-to-day operation of the project. The coordinator will answer administratively to CATIE and will coordinate with the CATIE/IUCN wetland experts on the activities to be executed on this project. The coordinator will elaborate annual operative plans in coordination with the other members of the team and with the CATIE and IUCN advisors. The coordinator will be responsible for the implementation of the pilot projects.
- B. Governmental counterpart.** A staff member of the DGF will work in close cooperation with the project coordinator. The counterpart will also have the responsibility of coordinating with other governmental agencies that might have an interest in the region.
- C. Responsible for socioeconomic studies and environmental education programme.** He/she will be responsible for monitoring the impact that the implementation of the activities might have on the communities in the Terraba-Sierpe Mangrove Forest Reserve. He/she will also be responsible for the environmental education programme.
- D. Three field-assistants.** They will be general-purpose assistants. Efforts will be made to hire local people.

13.2. In-country consultancies and thesis projects

The following consultancies will be required during the first three years of activities:

- A. Biological studies.** The activities described in 12.3.6 will be carried-out by graduate students of CATIE and the Universidad Nacional under the supervision of faculty staff of both institutions. The studies will include vegetation and faunal studies.
- B. Photointerpretation and elaboration of resource maps.** 1 consultant, six months full time.

13.3. International consultancies

The project will benefit from the input and advise of international experts from different disciplines who will be hired as consultants for some specific tasks. The following are the minimum requirements:

- A. A socioeconomist; 1 month per year.**

- B. An expert on mangrove silviculture; 1 month per year.
- C. An eco-development expert; 1 month per year.

13.4. Technical assistance

Specific technical assistance throughout the different phases of the project will be provided by IUCN's Wetlands Programme's technical staff. IUCN's participation will include:

- a. Detailed design of each project's component.
- b. Training of field personnel.
- c. Technical supervision of the project activities.
- d. Annual analysis and interpretation of the information generated by the project.
- e. Assist on the preparation of the annual operative plans.
- f. Technical input in the elaboration of the Integrated Management Plan for the Térraba-Sierpe Mangrove Forest Reserve.
- g. Supervise the implementation of the Integrated Management Plan.

All of the above-mentioned activities will be carried out in coordination with CATIE's technical staff and the Costarrican team.

14. CRONOGRAM

This field-project will be part of the Programme "Conservation for Sustainable Development in Central America", a joint CATIE/IUCN effort currently underway. As such, this field-project has been designed to start on 1 March 1991 and to run for four years.

The proposed activities for the first two years of the project are detailed in Table 4. The Integrated Management Plan for the mangroves of the Térraba-Sierpe Mangrove Forest Reserve will be ready at the end of these two years. The management plan will detail the activities for the following two years.

A series of pilot projects will be carried-out during the first two years of this project. These pilot projects are designed to significantly diminish the improper utilization of the economic potential of the natural

renewable resources of the Térraba-Sierpe Mangrove Forest Reserve. The biological and socioeconomic studies of the area will be conducted simultaneously with the pilot projects.

The environmental education programme currently in operation will be strengthened and expanded with the initiation of the project.

A workshop is planned for the second semester of the second year of the project to discuss the management plan draft. All the project personnel, interested Costarrican authorities and invited international experts will participate on this workshop. The product of this workshop will be the basis for the Integrated Management Plan for the mangroves of the Térraba-Sierpe Forest Reserve. This management plan will be published at the beginning of the third year of activities of the project.

The proposed activities for years three and four will derived from the results of the pilot projects, the evaluation of the natural resources of the area and from the prevailing socioeconomic conditions in Térraba-Sierpe, and will be detailed on the Management Plan.

15. BUDGET

The proposed budget for this project is presented in Table 5. The budget includes permanent staff, equipment, operating costs, pilot projects, national and international consultant, and running expenses.

Table 5. Budget, Mangroves of Terraba-Sierpe Project (in US \$)

Activity	Year 1	Year 2	Year 3	Year 4
PERSONNEL				
At CATIE				
Mangrove specialist (half salary)	18000	18000	18000	18000
Programme coordination	5000	5000	5000	5000
Administrative support	5000	5000	5000	5000
In Terraba Sierpe				
Coordinator	21000	21000	21000	21000
Responsible socioeconomic studies	18000	18000	18000	18000
3 assistants	15000	15000	15000	15000
Sub-total:	82000	82000	82000	82000
EQUIPMENT				
1 Four-wheel drive vehicle	16000			
1 Motorcycle	2500			
2 boats	4000			
2 outboard motors (25 HP)	4000			
1 AT computer with hard disk and UPS	3000			
1 printer (80 columns)	400			
Construction of field facilities	10000			
Office equipment	2000		2000	
1 portable typing machine	300			
Aerial photos and maps	1500			
Photographic camera and lenses	1000			
Film and developing	200	200	200	200
Slide projector and screen	600			
Environmental education material	2000	2000	2000	2000
Sub-total	47500	2200	4200	2200
OPERATING EXPENSES				
Travel	3000	3000	3000	3000
Per diem	3000	3000	3000	3000
Fuel	6000	6000	6000	6000
Two-stroke oil	600	600	600	600
Vehicles and outboard motors maintenance	1500	1500	2000	2000
Office material	1500	1500	1500	1500
Mail and communications	1500	1500	1500	1500
Miscellaneous	1000	1000	1000	1000
Sub-total	18100	18100	18600	18600

OTHER ACTIVITIES

Training	5000	3000	3000	3000
Pilot project: charcoal	15000			
Pilot project: commercialization	20000			
Pilot project: Pelliciera	3000	15000		
Workshop		10000		
Publishing	1000	1000	6000	2000
Sub-total	44000	29000	9000	5000

CONSULTANCIES

Photointerpretation	6000			
Biological studies	15000	15000	15000	15000
Thesis support	15000	15000	15000	15000
Institutional support for DGF	5000	5000	7500	7500
International consultants	20000	20000	20000	20000
IUCN technical assistance	15000	15000	15000	15000
Sub-total	76000	70000	72500	72500

Unforeseen expenses(10%) 26760 20130 18630 18030

CATIE's Overhead (18%) 52985 39857 36887 35699

GRAND TOTAL 347345 261287 241817 234029

PROJECT COST (4 YEARS) 1084479

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