CONSIDERATIONS FOR DEVELOPMENT OF A COASTAL ZONE MANAGEMENT PROGRAM IN THE STATE OF COLIMA, MEXICO

by

Juan Carlos Chavez Comparan

Special Project Report

Submitted to

Marine Resource Management Program
College of Oceanography
Oregon State University

in partial fulfillment of the
requirements for the degree of

Master of Science

Completed August, 1985
Commencement June, 1986

ACKNOWEDGEMENTS

My study grant for a masteral program in Marine Resources Management (MRM) came in part from the Instituto Oceanografico de Manzanillo and by the University of Colima, through its director Dr. Gustavo Calderon R., that I am particularly indebted. Also by a grant for Foreign Student Scholarship (Oregon State Scholarship Commission) through the Finacial aid of Oregon State University.

I am indebted to Dr. Victor Neal for his advise, help, and patiency, that I will never forget.

My appreciation to Jim Good for his advise and help in this project.

I would like to express my gratitude to the following persons that in some how support me: Isidoro Hinojosa, and Mario Comparan

My appreciation and thanks of my MRMers fellows and friends for their frienship: Sergio and Rosalba Lau, David Ham, Hector Manzo, Takaruyi Hirai, Tom Norris, Lino Gallo, Pat Stenkamp, Enoc Burgos, Tom Zetkulic, Cristian Lagos, Gustavo Montero, Carlos Massad, Ed Brunson, Lynn Morrill, John Stegall, Luis Pinto, Bob Rose, Josue Alvarez, Olga and Bruce Sutherland and Deborah Brooker.

To my fathers and brothers

To my wife and son

In Memoriam

Katsuo Nishikawa K.

CONTENTS

page

I. INTRODUCTION.....1

1.1 Objective of this Project.....2

1.2 The Need of Coastal Zone Management in Colima.....2

II. CHARACTERISTICS OF THE COAST OF COLIMA

2.1 Geography.....4

2.2 Climate.....6

2.3 Coastal Water Bodies.....11

2.3.1 Coastal-Lagoon System.....14

2.3.2 Estuarine System.....20

2.3.3 Riverine System.....24

2.3.4 Lacustrine System.....25

2.3.5 Palustrine System.....25

III. COASTAL ZONE MANAGEMENT

3.1 Definition.....26

3.2 The U.S. Approach in the Coastal Zone Management.....27

3.3 Background in Mexico.....27

3.4 Plan Colima.....31

IV. TECHNICAL CONSIDERATION FOR PLANNING COASTAL DEVELOPMENT

4.1 Definition of Management Boundaries.....34

4.2 Identification of Problems and Opportunities.....35

4.3 Policy Formulation.....36

4.4 Implementation Strategy.....39

V. MANAGING THE COASTAL RESOURCES.....41

5.1 Mangrove Forests.....41

5.2 Coral Reefs.....45

5.3 Beach and Dune Ecosytems.....47

5.4 Estuaries and Coastal Lagoons.....51

VI. MANAGEMENT OF COASTAL DEVELOPMENT

6.1 Coastal Agriculture.....53

6.2 Fisheries and Aquaculture.....54

6.3 Energy.....60

6.3.1 Oil Operations.....60

6.3.2 Coastal Power Generation.....62

6.4 Transportation.....69

6.4.1 Ports, Harbors and Marinas.....69

6.4.2 Airport.....72

6.4.3 Roads and Railways.....73

6.5 Coastal Recreation and Tourism.....73

6.6 Coastal Pollution.....82

6.7 Coastal Mineral Resources.....87

VII. INSTITUTIONAL ASPECTS OF COASTAL MANAGEMENT.....91

VIII. CONCLUSIONS AND RECOMMENDATIONS.....99

X. LITERATURE CITED.....105

LIST OF FIGURES

page

1. Colima.....5
2. Fault lines and Earthquakes within the State of Colima....7
3. Distribution of maximum seismic intensity.....8
4. Climatic condition of the State of Colima.....9
5. Common trajectory of hurricanes in North America.....10
6. Classification of wetlands and deepwater habitats.....12
7. Juluapan Lagoon.....15
8. San Pedrito Lagoon.....17
9. Cuyutlan Lagoon.....19
10. Alteration of Cuyutlan Lagoon.....21
11. Chupadero Lagoon.....22
12. Potrero Grande Estuary.....24
13. Coastal States of Mexico.....28
14. Exclusive Economic Zone of Mexico.....30
15. Various shoreline engineering structures.....49
16. Total catch in Mexico.....57
17. Location of the thermoelectric power plant.....66
18. Manzanillo Port Area.....71
19. Road System of Colima.....74
20. Road System in the Manzanillo Area.....75
21. Sand beaches of Manzanillo Area.....78
22. Tourist map of the State of Colima.....79
23. Tourist map of Manzanillo Area.....81
24. Source of pollution in Manzanillo Area.....86

25. Manganese Nodules Area of Greatest Interest for Initial Commercial Mining Operations.....90
26. Coastal Zone Management for Colima: Tentative Organizational Framework.....94

LIST OF TABLES

page

I. Catch by species in Mexico, 1981-1983.....57

LIST OF ABBREVIATIONS

CFE	- Federal Commission of Electricity
COCOMABA	- Conurbanization Commission Manzanillo-Barra de Navidad
CONACYT	- National Council of Science and Technology
CZM	- Coastal Zone Management
EEZ	- Exclusive Economic Zone
EPA	- Environmental Protection Agency
INP	- National Institution of Fisheries
IOM	- Oceanographic Institution of Manzanillo
OTEC	- Ocean Thermal Energy Conversion
PEMEX	- Petroleos Mexicanos
SAHOP	- Secretariat of Human Setlement and Public Work
SARH	- Secretariat of Agriculture and Hydraulic Resources
SCT	- Secretariat of Communication and Transportation
SECTUR	- Secretariat of Tourism
SEDUE	- Secretariat of Urban Development and Ecology
SEMIP	- Secretariat of Mines and Parastatal Industry
SEP	- Secreatariat of Public Education
SEPESCA	- Secreatariat of Fisheries
SM	- Secretariat of Navy

I. INTRODUCTION.

The coastal zone is the area where the land, sea, air meet. It has a unique combination of characteristics which favor human development, trade and industry.

"Coastal climates are more moderate and stable than those of the interior of the continents, and are usually associated with sufficient rainfall to sustain agriculture. Lagoons, estuaries, and bays provide sheltered nutrient rich water for many species of animals, while the coastal seas are a rich repository of resources, both living and non-living. The large proportion of marine life is said to be found in the shallow coastal waters over the continental shelves. At the present 90% of the world's fish supply comes from the major coastal upwelling areas. Placer and weathering deposits of heavy metals are common near coasts, both onshore and offshore. For several decades coastal areas have supported continuous large-scale extraction of construction materials, sand, gravel and carbonates (shells)" (Chacko, 1973). In a world critically dependent upon energy, it is estimated that 68% of the world's ultimate recoverable hydrocarbon resources lie under the coastal waters of 200m depth or less (United Nations, 1973).

Water transport along the coast is the cheapest form of transport for bulk materials. In addition the modern power stations needed to provide energy require vast quantities of water. Finally, the coastal area is a major source of human benefit in terms of recreation, tourism and general well being. The complexity of interaction between social, industrial and

ecological requirements is unique.

For the reasons mentioned above there is a need to manage the coastal areas in order avoid conflicts between uses and to protect the environment from irreversible deterioration. Many nations already have some kind of coastal zone management program or regulations to try to deal with different aspects of protection and development of the coast. In Mexico over the last five years a strong concern has developed for protection of the natural resources in general but no specific coastal zone management legislation or program has been developed.

1.1 Objective of this Project.

The objective of this research project is to identify factors that are important in the development a Coastal Zone Management program and establish a framework for a program for the State of Colima.

This report could or may be used as:

1. A background in developing a coastal zone management program for the State of Colima.
2. A background for an environmental impact assessment of specific coastal areas in the State of Colima.
3. An information source for any kind of coastal marine resources development in the State of Colima.
4. An information source for improving any functions of existing environmental agencies at all levels.

1.2 The Need of Coastal Zone Management in Colima.

The State of Colima, Mexico, is the smallest coastal state

of the Pacific coast of Mexico, with only 160 kilometers of coast line. Colima is divided by four districts ("municipios") of which three are coastal (Manzanillo, Armeria and Tecoman) and the other is the Colima district. In the last ten years Colima has experienced very high level of coastal development in several sectors of the economy. In the area of marine transportation, the Port of Manzanillo has become one of the most important in the nation with the expansion and construction of new marine terminals in the interior port of San Pedrito. In tourism and recreation, the coast of Colima, especially in the Manzanillo area, has become an important tourist center with the construction of one of the worlds most beautiful hotel and tourism facilities. A number of other tourism oriented projects have followed in the surrounding areas. At the coast near Manzanillo a thermoelectric energy complex has been developed which provides electrical energy for the entire region. Colima is the planned center for the concentration of the tuna fisheries of Mexico. It has good prospects for other fisheries development, as well as with a good environment for an aquaculture industry. With a reliable source of electrical energy and the marine transportation facilities, the coast of Colima also has good potential for industrial development, which has already started with a big mining complex. In the agricultural field, Colima is the main producer of coconuts and lemons in Mexico; production is mainly concentrated in the coastal plain of the state. The state of Colima has already established several schools and a marine research center. Because of industrial

uses, over-development, poor management and ignorance, the coast of Colima has become increasingly polluted. For that reason it is necessary to implement a management program to deal with the different aspects of coastal zone uses so as to preserve amenities and establish wise utilization of the different coastal resources.

II. CHARACTERISTICS OF THE COAST OF COLIMA.

2.1 Geography.

The State of Colima is located between $103^{o}30'20"$ W and $104^{o}37'10"$ W and between parallels $18^{o}41'10"$ N and $19^{o}27'20"$ N and has an area of 5,455 Km^2 (Figure 1). In the north part of the state is separated from the State of Jalisco by the Marabasco River, and the south is separated from the state of Michoacan by the Coahuayana River.

The geography of the region is varied. There is an important natural barrier (Perote Ridges) which makes the communication between the inland and coastal populations difficult. The coast has a variety of land forms: beaches, barriers, islands, coastal lagoons, sea cliffs.

The Sierra Madre of Chiapas is close to the coast and there is a deep oceanic trench which also may have some relationship to the morphology of the littoral zone. This has contributed to the formation of a coast that is in general juvenile in which the erosion process of the mountains is just beginning with the filling of valleys and the formation of a small coast plain, averaging 25 Km wide and with a mean height above sea level of 100 meters (COCOMABA, 1980).

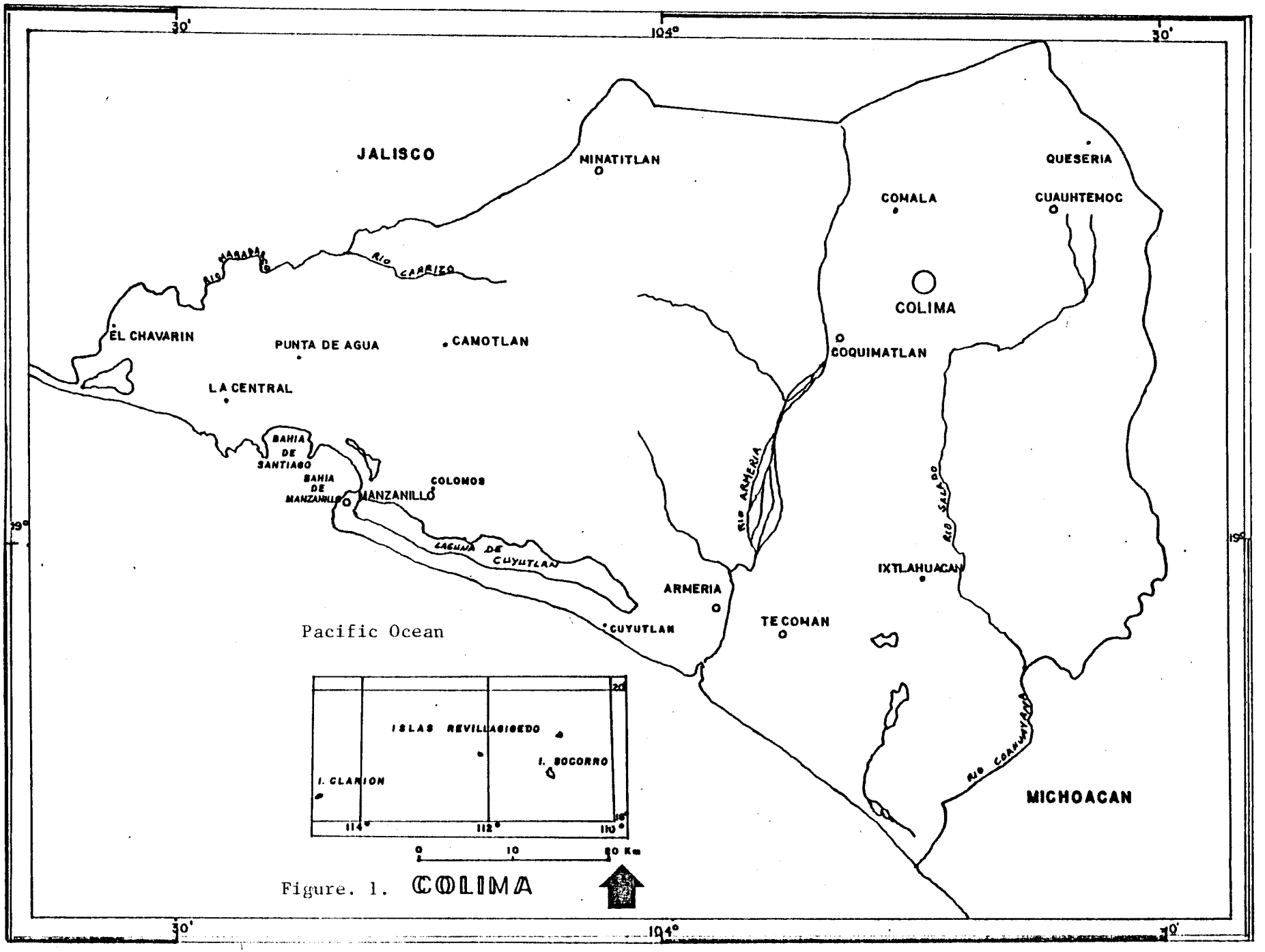


Figure. 1. COLIMA

The coastal zone of Colima is one of the most seismically active of Mexico, a fact which must be taken into account in planning and development of the coastal areas. The relative frequency of seismic activity is associated with an epicenter located to the west of Manzanillo, where the North American plate is in contact with the Pacific and Cocos plates, making the area unstable. The Clarion fracture zone running east-west near latitude 19° N also penetrates through Manzanillo as does the Pacific fracture zone (Fig. 2). Colima also has one of the most active volcanos of Mexico "Volcan de Colima". The most recent earthquake was in 1973 and affected a wide area (Fig. 3).

2.2 Climate

The climate of the region is by the Koppen classification semi-warm, sub-humid with high summer rainfall. The precipitation/temperature ratio (P/T) is 43.2 (Fig. 4)(Griffiths, 1976). The rainfall in summer is monzonic, because of the presence of cyclonic air masses in the months of July through October. During the period of 1952-1977 a total of 76 cyclones were generated in the region of which 16 affected the mainland. The localities that were affected most by hurricanes in Colima are Manzanillo, Tecoman and Armeria; all are located on the coast. Statistics indicate that every 10 years a hurricane hit the coast (Fig. 5) (COCOMABA, 1982).

The annual average temperature in Manzanillo is 26°C with a maximum of 33°C. The annual rainfall average is 1205.9 mm and winds range from 3.5 to 5.2 m/sec from a northwesterly direction from November to February, northeasterly from March to May, and

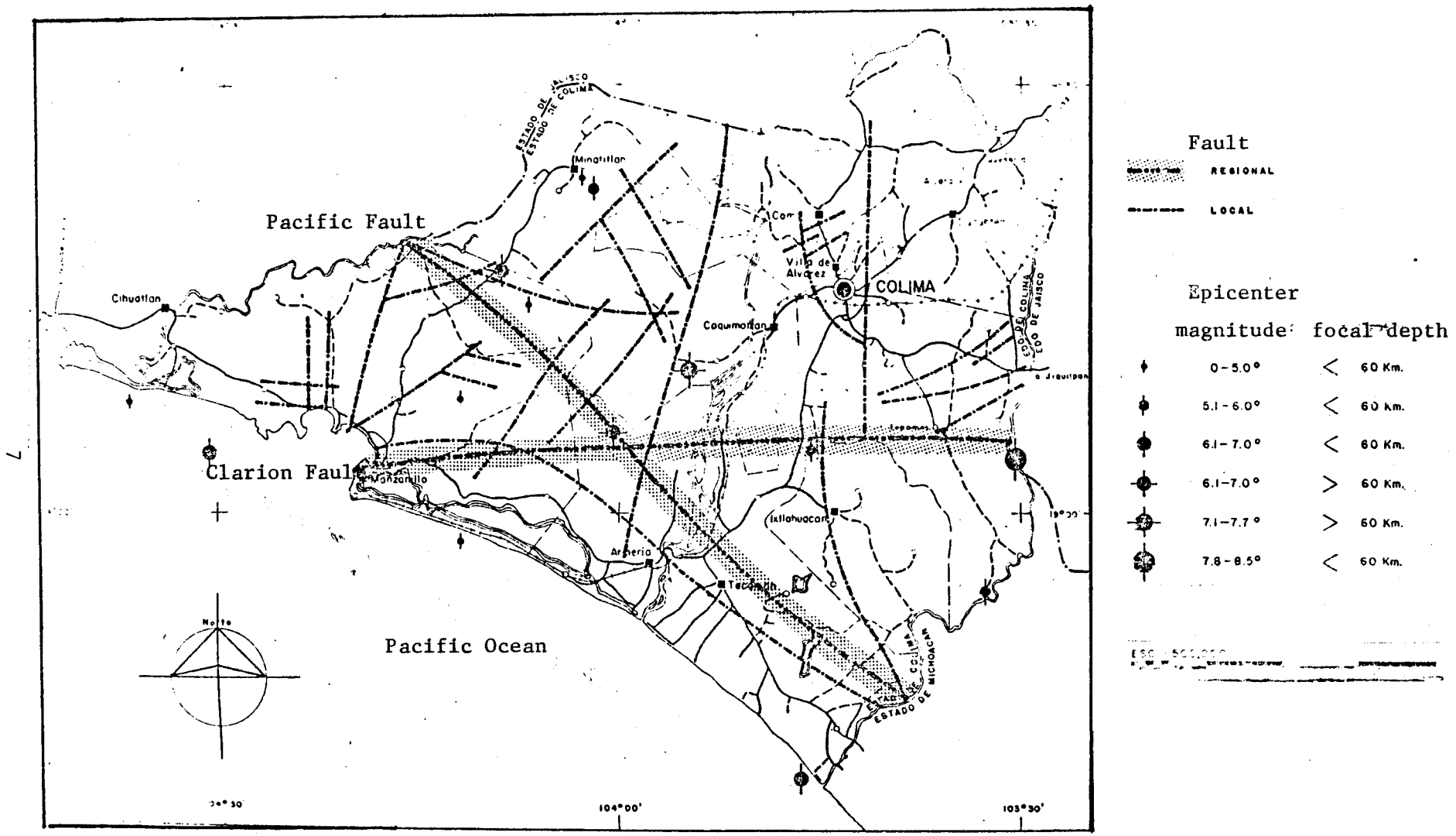
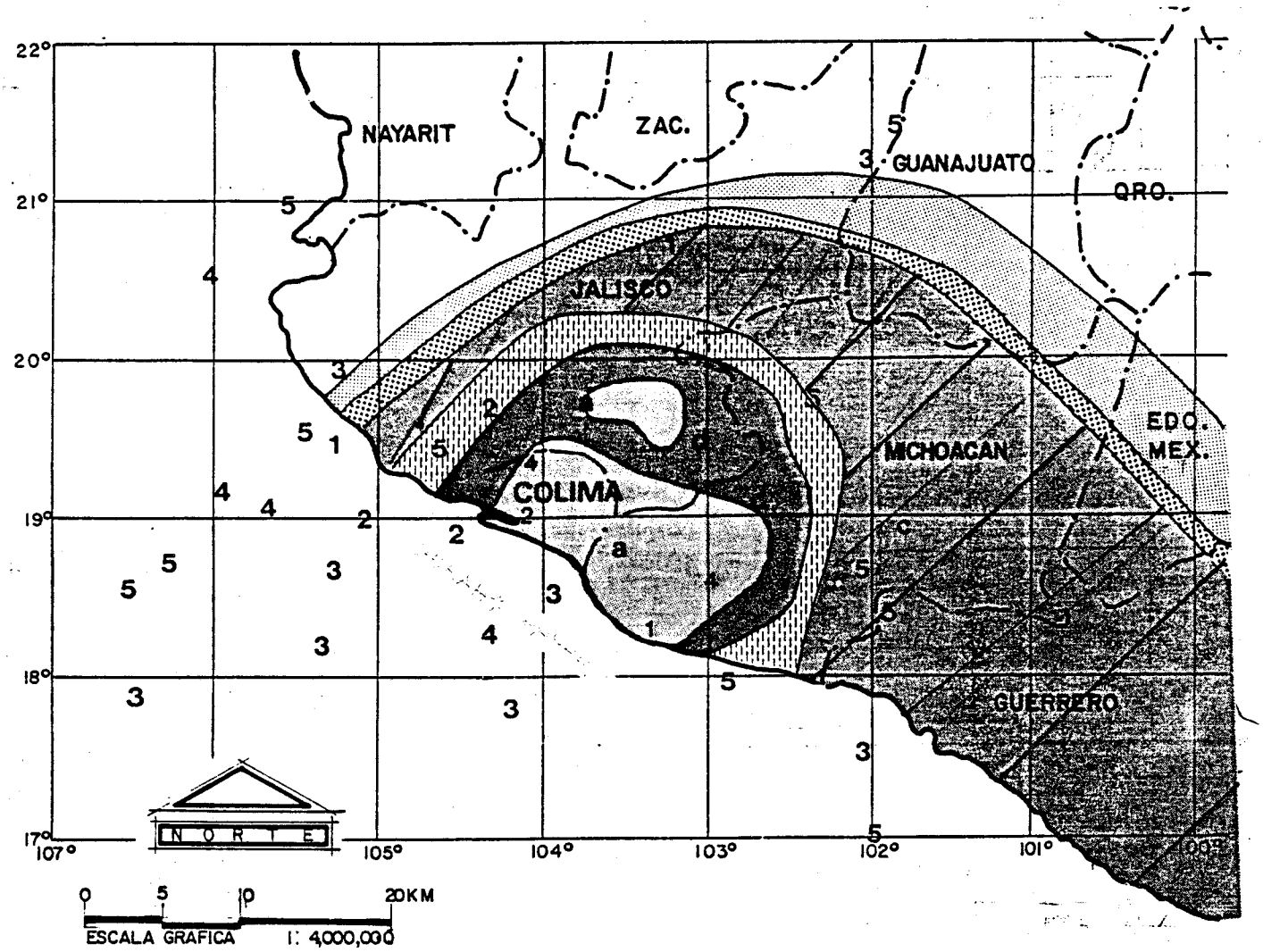


Figure. 2 . Fault lines and Earthquake within the State of Colima.
(from SAHOP, 1979)



focal depth		magnitude	intensity	key
high 60 KM.	less 60 KM.	Scale RICHTER	scale MERCALI 1931	
a	1	7.8 — 8.5	XI Y XII	V
b	2	7.0 — 7.7	IX Y X	VI
c	3	6.0 — 6.9	VIII	VII
d	4	5.3 — 5.9	VII	VIII
e	5	MAJOR 5.2	V Y VI	IX
				X

Figure. 3 . Distribution of maximum seismic intensity

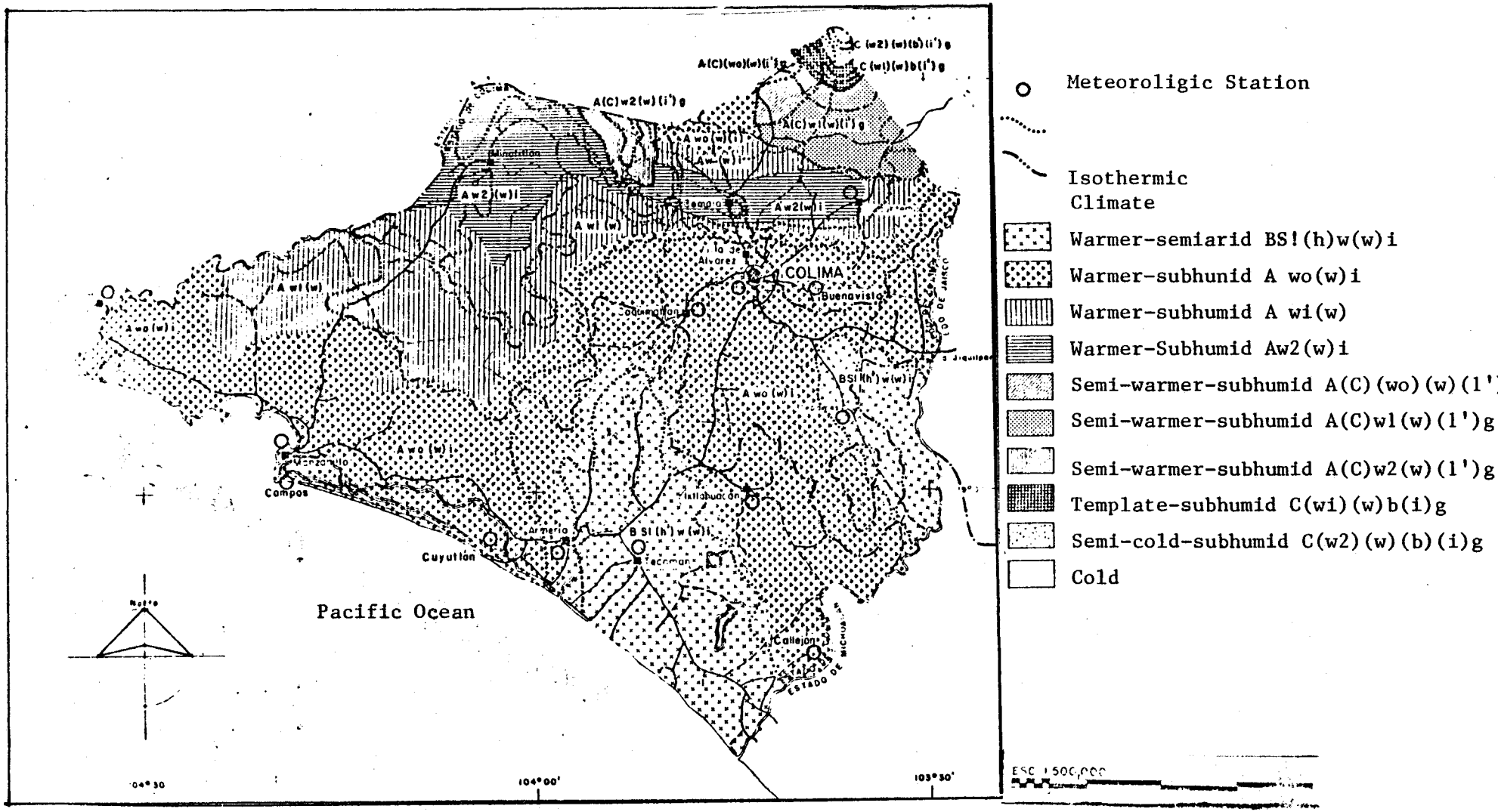
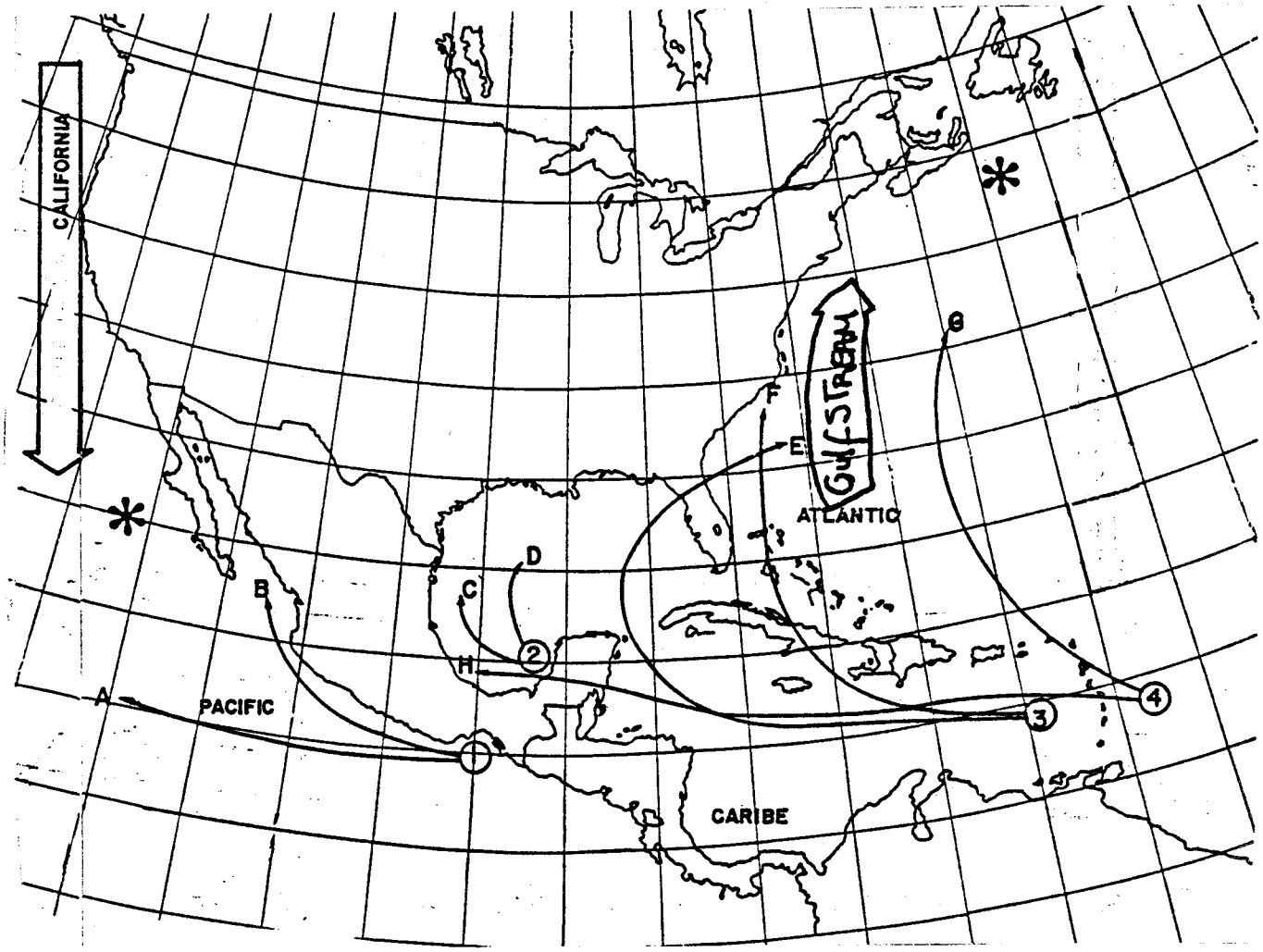


Figure. 4 . Climatic condition of the State of Colima.
(from SAHOP, 1979).



* Hurricane disintegration zone

1 Gulf of Tehuantepec
Hurricane began in the last week of May (A,B)

2 Campeche Sound
Hurricane began in the first week on June (C,D)

3 Caribbean
Hurricane began in July (E,F)

4 Atlantic Region
Hurricane began in the last week of July (G,H)

Figure. 5 . Common trajectory of hurricanes in North America

southerly and easterly from July to October (Benn, 1979).

2.3 Coastal Water Bodies.

Resources classification systems have often been developed as a convenient method for simplifying, generalizing, and categorizing information. Ecological classifications help to identify controlling factors in the natural environments. They also highlight similarities and differences among biological and physical resources and processes that may warrant similar or distinct management strategies. Classification systems that can be applied to specific geographical zones can be particularly useful to resource managers. Regulatory boundaries can be superimposed over those natural features that are most important to the management program.

There are several ecological classification of coastal systems; some only include estuaries and others only refer to high latitude water bodies. One of the most comprehensive classification systems is the USFWS, habitat classification system (Cowardin, et al. 1979). Their classification is hierarchical, ranging from broad categories to the most specific characteristics (Fig. 6).

In order to have some idea of what kind of water bodies the State of Colima has, this classification is applied in a broad sense, only mentioning the kinds of systems, their characteristics and their present conditions. The term SYSTEM refers to a complex of the water bodies that share the influence of similar hydrologic, geomorphologic, chemical or biological factors. For this purpose, five systems are used: coastal-lagoon,

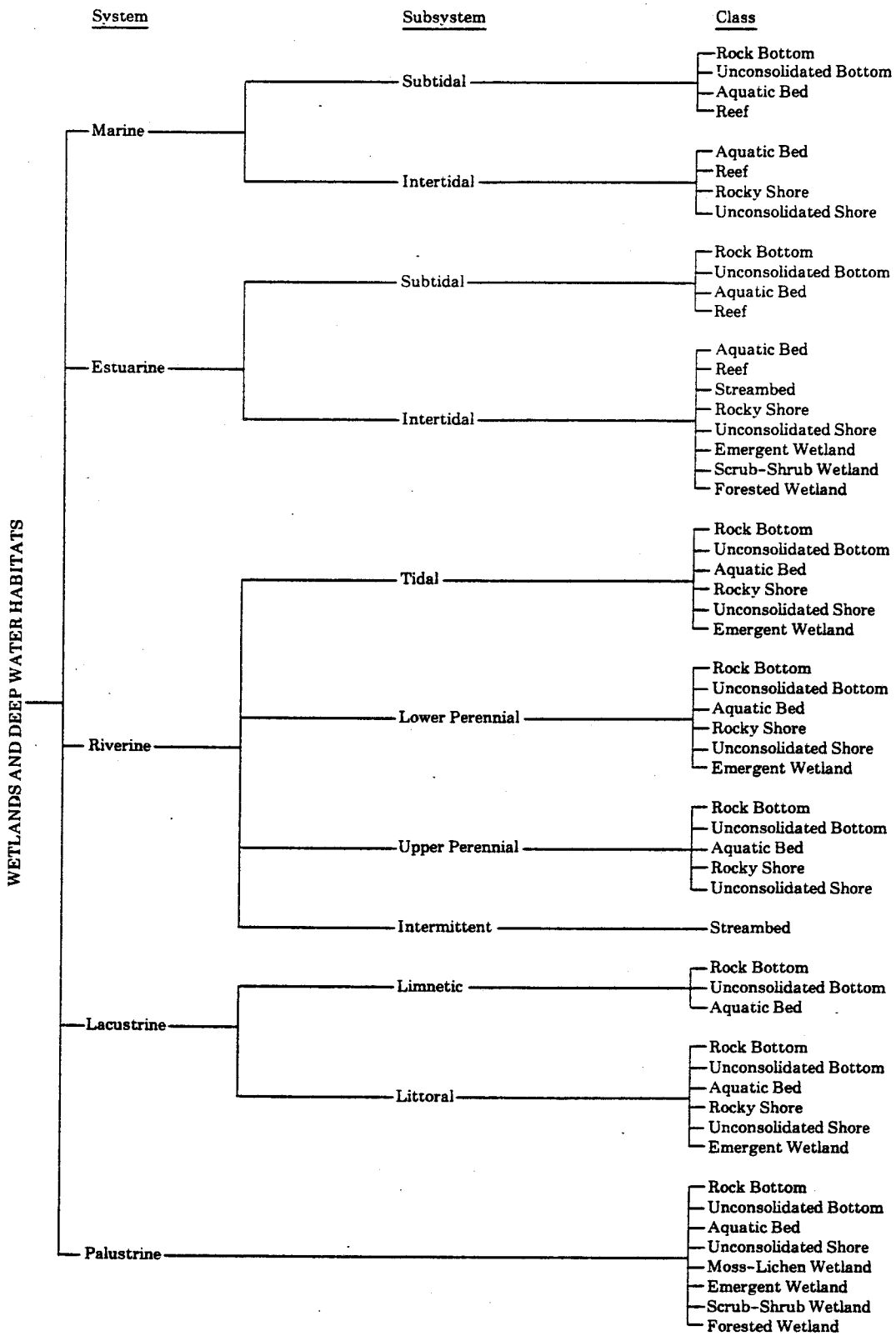


Fig. 6 Classification hierarchy of wetlands and deepwater habitats, showing systems, subsystems, and classes. The Palustrine System does not include deepwater habitats.

(from Cowardin et al., 1979)

estuarine, riverine, lacustrine and palustrine.

The coastal-lagoon and estuarine systems have some similarities with respect to flora and fauna but the chemical and physical processes are quite different. With respect to the flora in both systems, the mangrove is the dominant vegetation. Rhizophora mangle, Avicenia germinans and Laguncularia racemosa are the dominant species and principal primary producers. In fauna, both systems are characterized by great diversity of species. The great majority of fishes only spend part of their natural lives in those systems (the early stages) and the rest of their lives are spent at sea. The most abundant species of fishes are Mugil curema, Gerres cinerus, Diapterus peruvianus, Elops affinis, Centropomus robalito, Arius seemani, Citharichthys gilberti and Achirus mazatlanus. The most abundant crustaceans are Penaeus californiensis, Penaus vannamei and Calinectes sp. Birds, including both endemic and migratory species, are an important part of this ecosystem. There is a great diversity of species, both terrestrial and aquatic. Most of 200 species of birds in the coastal area are not fully identified (Mena, 1979 and Chavez, 1982).

The difference between these systems is that in the coastal-lagoon system its main axis is parallel to the coast, the marine influence is greater than the continental, and it tends to be hyperhaline. With the estuarine system, the main axis is in general perpendicular to the coast and the salinity gradient is the inverse of coastal-lagoon system.

2.3.1 Coastal-Lagoon System

There are four water bodies in Colima that can be classified as coastal-lagoon systems: Juluapan, San Pedrito, Cuyutlan and Chupadero.

Juluapan Lagoon.

The Juluapan Lagoon (also Miramar) covers an area of 176 hectares (Fig. 7), and can be divided into two areas. The first has an area of 44 ha (A) in which the marine influence is strong due to its direct communication with the Santiago Bay. The second area of 132 ha (B) is separated naturally with mangroves, has undergone several modifications during the last 25 years. At first the mouth of the lagoon was unstable. In the dry season there was no communication with Santiago Bay due to the natural littoral transport of sediment materials. In the wet season due to the amount of water held in the lagoon the communication was open only for a short time, before closing again. In 1973, a permanent and artificial opening between the lagoon and the bay was established. Since then, the lagoon has begun to fill with sand. Meanwhile, the margin of the lagoon was being filled for construction purposes. These modifications were done for specific individuals (Departamento de Pesca, 1981). Since 1973, there has been a bloom of jellyfish in the lagoon making most of the lagoon unusable for aquaculture (oyster, fish and shrimp), fisheries and recreation. In the present situation only a small portion of the lagoon is used for recreation and individual fisheries activities. It is no longer used for aquaculture. The lagoon still has serious sedimentation problems. A proposed

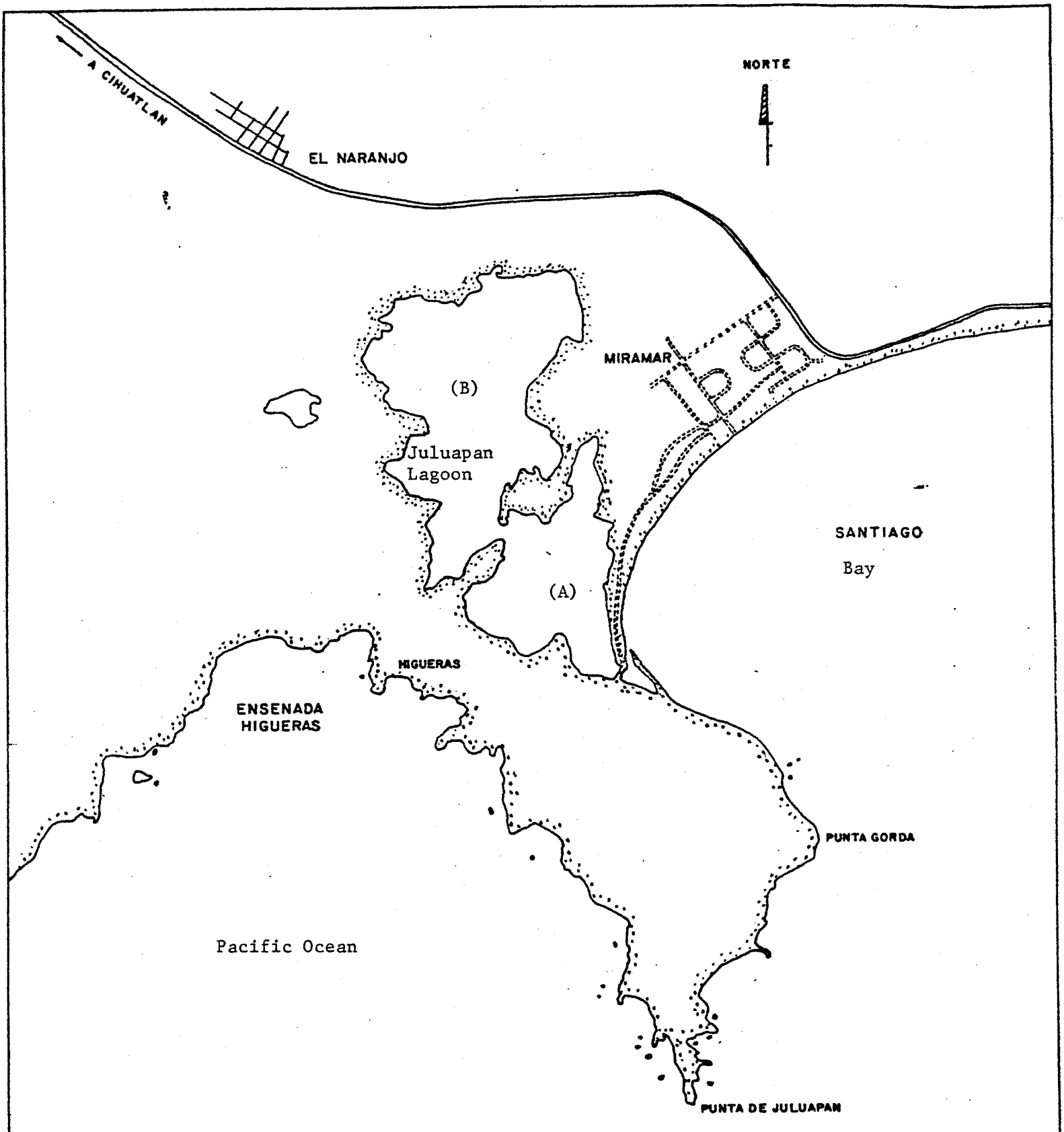


Figure. 7 . Juluapan Lagoon

marina construction project planned by a private company would involve dredging and filling additional portions of the lagoon.

San Pedrito Lagoon.

The San Pedrito Lagoon is the most modified water body in Colima, due to the construction of Manzanillo interior port facilities and modification of the circulation patterns (Fig. 8). It has an area of 135 ha. A large habitational development was began in 1959 in the the barrier of the lagoon. The federal government also began construction of the interior port dredging, and cutting the mangroves. The construction of the road separated the lagoon into three sections: the first section (A), where the interior port is located is known as Laguna San Pedrito; the second section (B) is known as Laguna Tapeixtles; the third section (C) is known as "Valle de las Garzas" . The lagoon was a tourist attraction because of the concentration of thousands of herons (Casmerodius albus) that use the area for reproduction and feeding activities.

In 1979, the federal government began the development of more marine terminals in the San Pedrito lagoon, dredging and cutting the remaining mangrove areas in both this and the Tapeixtles portions of the lagoon. This project also modified the hydraulic circulation in such a way that the Valle de las Garzas section was essentially cut off and the marine influence into that section was minimum. The heron colony is disappearing. Today the San Pedrito section is fully developed, the Tapeixtles section is disappearing, and the Valle de las Garzas section is being restored by international organization called DUMAC (DUCKS

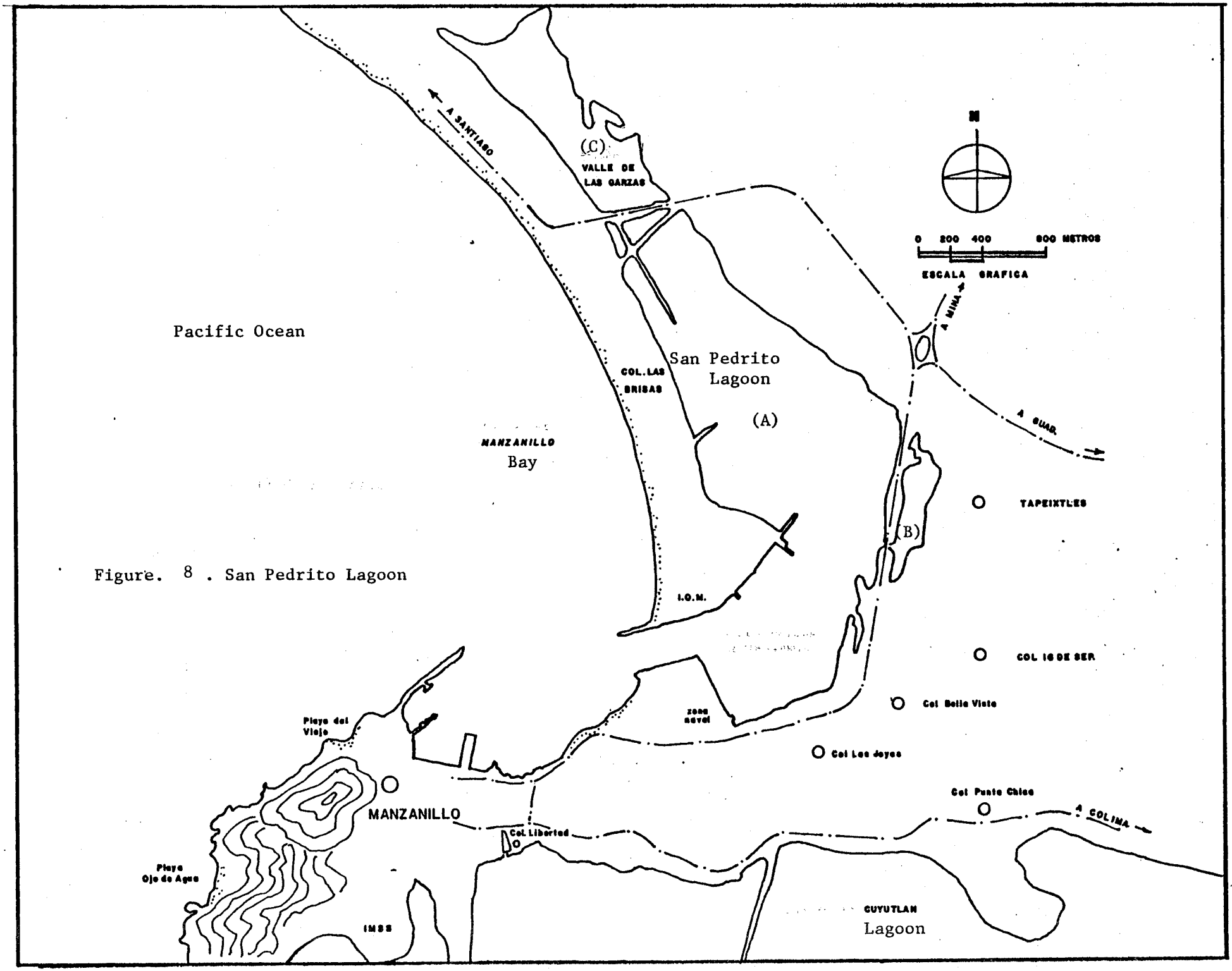


Figure. 8 . San Pedrito Lagoon

Unlimited Inc. of Mexico) for protection of migratory birds habitats.

Cuyutlan Lagoon.

The Cuyutlan lagoon is the largest water body in the state with 7200 ha (Fig. 9). It is 37 km long and its width varies from 130 meters to 3 km. It is separated from the ocean by a barrier composed mostly of sand dunes. There are two mouths for communication with Manzanillo Bay, both man made. The Cuyutlan lagoon has had several hydraulic modifications. The first was related to salt production, that area located in the south-east portion of the lagoon, and had dikes to hold the water. About the year 1889 a railroad was constructed that ran through the barrier of the lagoon to the port of Manzanillo, it crossed the lagoon perpendicular to the sand barrier. This work obstructed the circulation of water in the lagoon making some areas anoxic with high odor from hydrogen sulfide. In order to resolve this problem, the first artificial opening to the sea was constructed in 1932. In 1978 the federal electric company (Comision Federal de Electricidad) constructed a second opening to obtain water for the cooling system of a new thermoelectric power plant, constructed beside the lagoon. This opening increased water circulation and dramatically increased fisheries production, making it the major source of fish for the region. In 1981, due to the development of the interior port in San Pedrito and an environmental conflict with the dredged material disposal site (originally proposed in the Valle de las Garzas), the Governor of Colima decided that the waste had to be dumped into the sea.

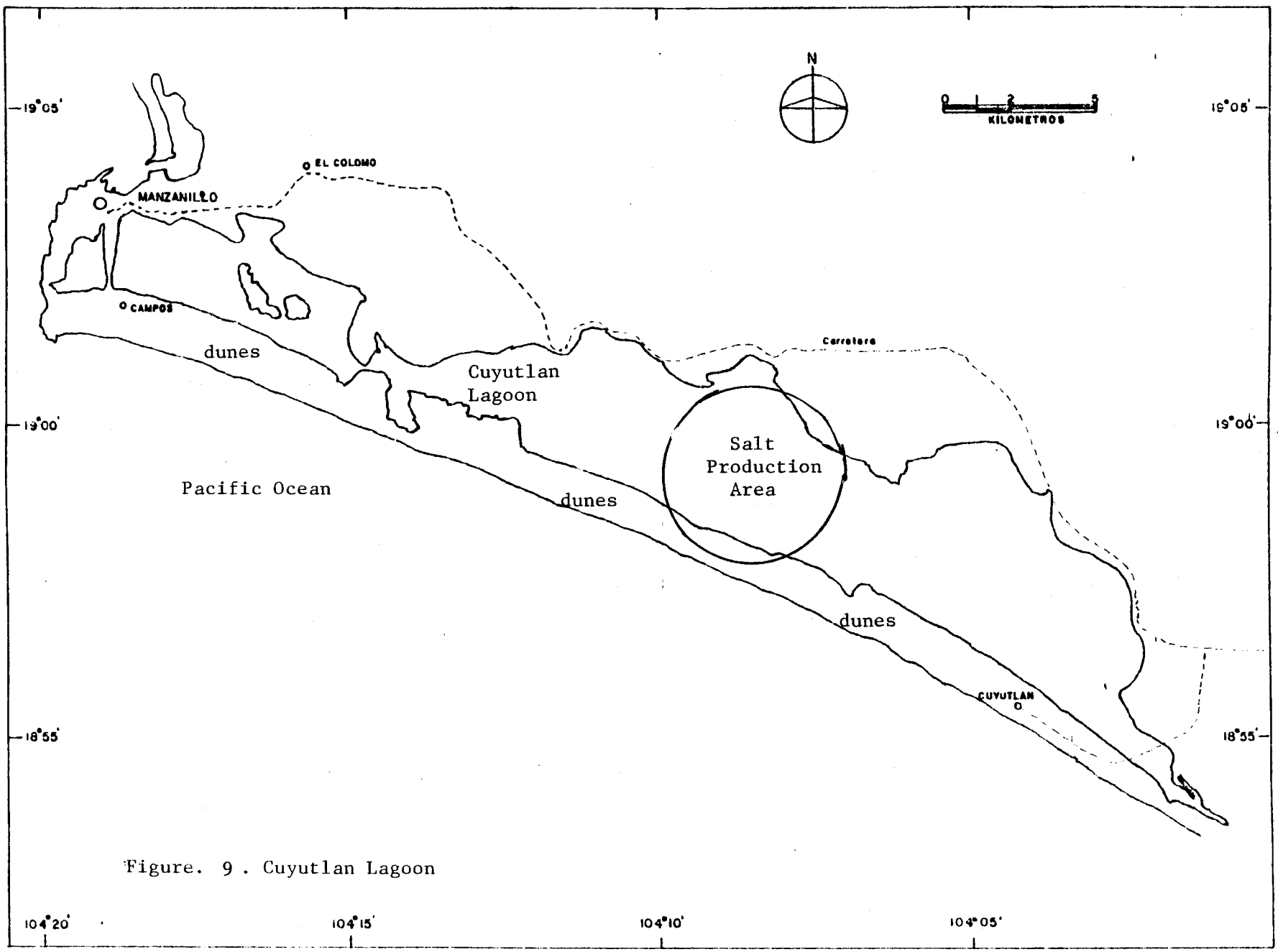


Figure. 9 . Cuyutlan Lagoon

Therefore a big line of dredging tubes was made across the San Pedrito Lagoon through the Cuyutlan Lagoon and into the sea. This line segmented the lagoon, causing the circulation problems. The installation of several electric line towers in the lagoon also caused an aesthetic problem. Finally because the power plant was unable to get enough water from the artificial mouth, another section into the lagoon was constructed (Fig. 10). This caused the decline of the fisheries production and also the increase of polluted water because of the lack of water circulation and the lack of treatment plant for the waste disposal of the city of Manzanillo (Chavez, 1982).

Chupadero Lagoon.

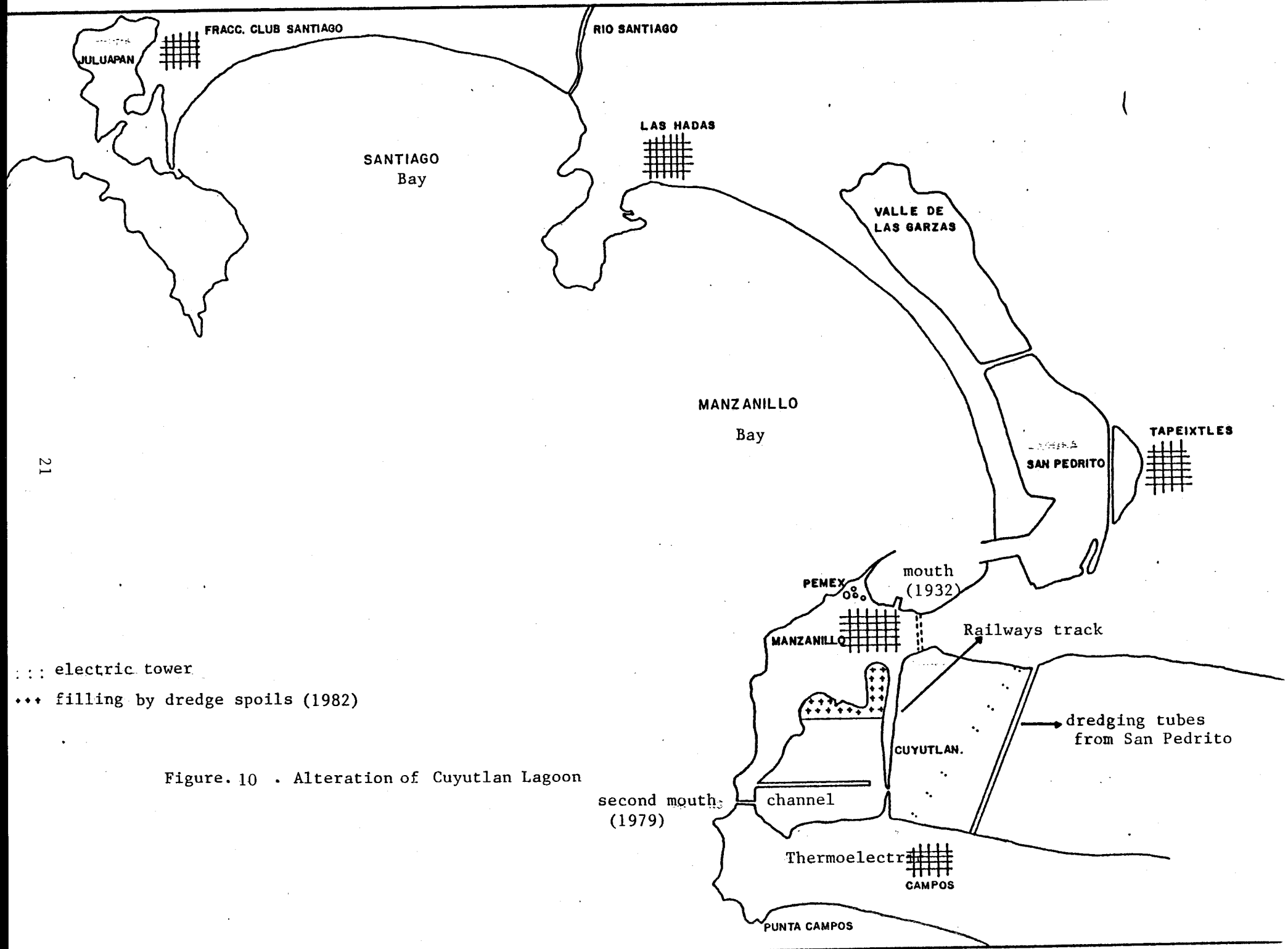
This lagoon is the southern coastal lagoon of the state (210 ha). This lagoon is still in its natural state and is principally used for fishing. In the wet season it receives fresh water from the Coahuayana River (Fig. 11).

2.3.2 Estuarine System.

The are seven estuaries in Colima: Potrero Grande, Paraiso, Boca Pascuales, El Real, Tecuanillo, San Rafael, and Boca de Apiza. These estuaries are blind estuaries; in other words, they have very low river flows during the dry winter season, often insufficient to maintain the opening at the mouth. The tide and waves from the ocean may build a sand bar across the mouth, temporarily closing the estuary to form a sill that retards tidal mixing of marine and river water.

Potrero Grande Estuary

The Potrero Grande estuary receives freshwater inflow from



::: electric tower

••• filling by dredge spoils (1982)

Figure. 10 . Alteration of Cuyutlan Lagoon

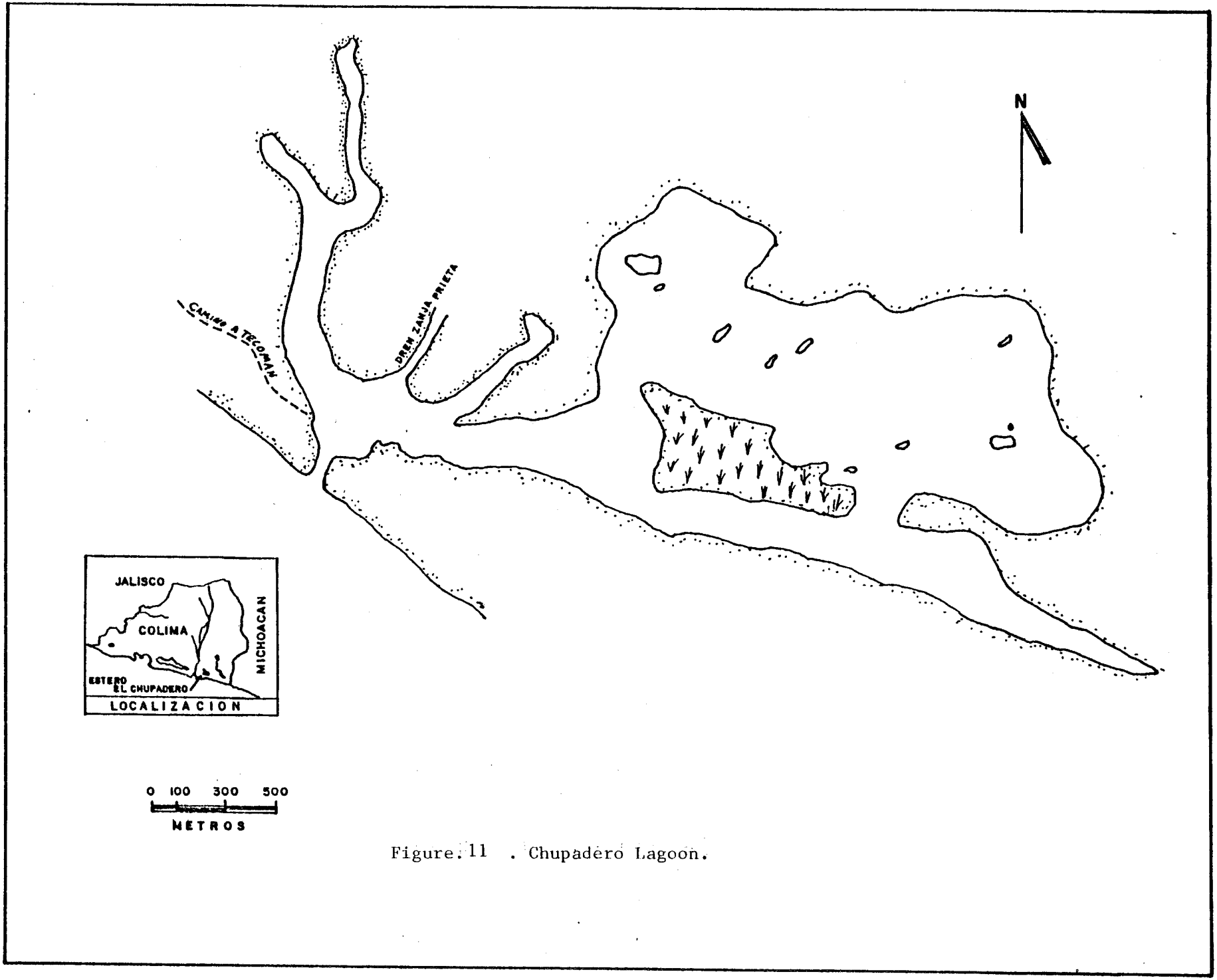


Figure 11 . Chupadero Lagoon.

the Marabasco River (Fig. 12). In the beginning of this century it had a large population of crocodiles but none are seen today. Around the estuary there are only agricultural fields (mainly coconut groves). This estuary is used for fishing. Close to the estuary there are aquaculture activities for production of Tilapia sp.. There is some problem with pollution, but it has not been fully evaluated. The local farmers claim that the mining complex upriver does not treat their wastewater properly, so that the water that comes downstream is contaminated with mud and toxic materials, causing unproductive crops and death of their animals.

The Paraiso estuary receives influents from the Armeria River and Boca de Apiza of the Cohuayana River. Paraiso, El Real Boca de Apiza, Boca Pascuales, San Rafael and Tecuanillo are all small estuaries and are used for small scale fisheries and recreational activities.

2.3.3 Riverine System

This system includes all the the water bodies contained within a channel with continuously flowing water. The salinity is less than 0.5 %o (see Fig. 1). The flora is mostly terrestrial and the fauna is low in fish, with some types of mollusks and crustaceans (Macrobrachium sp.). Aquatic insects and birds are abundant in this system.

The State of Colima has three main rivers: Marabasco, Armeria and Cohuayana. These rivers are in juvenile stages so their flow is higher in summer when the rainy season begins. These rivers are used for agricultural activities (irrigation) and some for

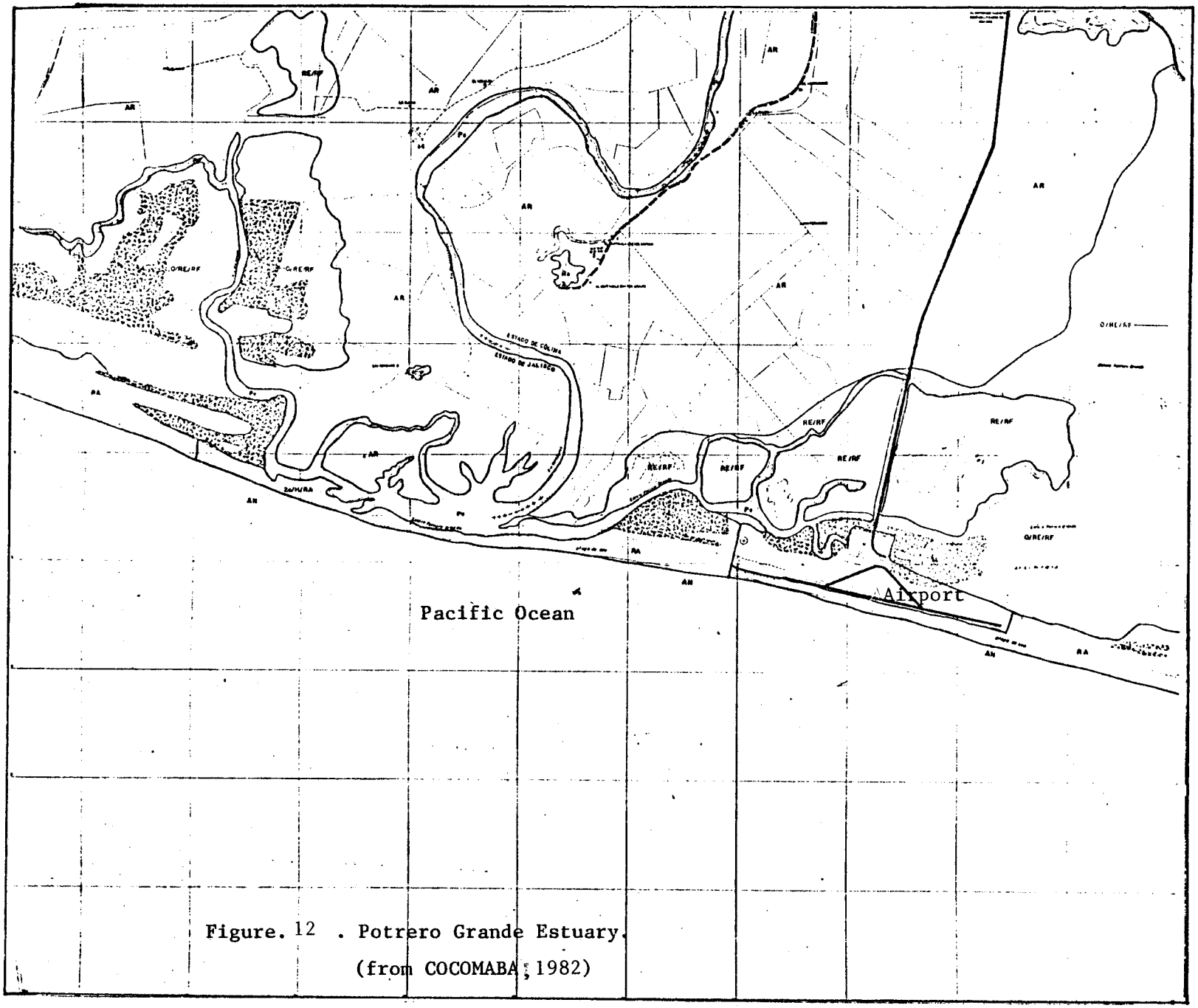


Figure. 12 . Potrero Grande Estuary.
(from COCOMABA, 1982)

industrial; the Marabasco for mining and the Armeria for pulp mill activities.

2.3.4 Lacustrine System.

The lacustrine system includes lakes situated in a topographic depression or a dammed river channel and have salinities less than 0.5%o . This type of of reservoir includes permanent water bodies bigger than 8 ha. The flora is mainly white water lily (Nymphaea sp.) that sometimes can cover 30% of the water area; The fisheries are poor, the fauna is mostly is terrestrial: birds, reptiles, amphibians, and some mammals.

In this category only one water body is found in the coastal area of Colima, it is named "Las Penitas" with an area of 12 ha. This water body was a small coastal lagoon but the opening to the sea was closed by a road so it became a lacustrine system. The rainfall and wastewater disposal for a tourist complex are the main sources of water. Every summer a bloom of frogs appears. It is only used for disposal of waste water.

2.3.5 Palustrine System.

The palustrine system includes those water bodies without tides, with salinity less than 0.5%o, with an area less than 8 ha and no waves, and a depth less than 2 meters. There are several water bodies that meet this classification.

III. COASTAL ZONE MANAGEMENT.

3.1 Definition.

A coastal zone has been defined as: "the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the water therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the coastal states including islands, transitional and intertidal areas, salt marshes, wetlands and beaches" (U.S. Coastal Zone Management Act, 1972). In the developing countries in the tropics, this definition could be expanded to include categories such as coral reefs, mangrove swamps, estuaries and seagrass beds (Kenneth and Manshard, 1981).

According to Ketchum (1972), coastal zone management is a process of:(1) developing an understanding of the coastal zone as a system; (2) using this knowledge to create a dynamic plan for its best use; and (3) implementing and enforcing that plan. the sequential steps in the total management process are:

- To determine man's desires in using the coastal zone, for example, values and priorities.
- To determine the capacity of the coastal zone in relationship to these desires.
- To determine what uses are compatible with these capacities and how the various uses impact the natural coastal zone system.
- To determine what the trade-offs must be if capacities and uses are not matched.
- To determine how the need for capacity-match can be communicated to the public.

- To determine what mechanisms are necessary to regulate and promote the compatible uses.

3.2 The U.S. Approach in the Coastal Zone Management.

Within the last decade, coastal planning and management efforts have begun in a number of countries including the United States, France, Great Britain, Japan, New Zealand and Australia. Efforts have began in only a few developing nations, e.g. Sri Lanka, Ecuador, Colombia and Brasil. There is no "model" coastal zone management program existing that could be adopted by developing countries. However, the experiences of some of these countries can be useful as a background to develop a program in any other country. A leader in the concern for the coastal zone has been the United States which in 1972 passed the National Coastal Zone Management Act. This act encourages individual states to exert a strong role in all matters affecting the coastal zone. As part of this program, a state may get planning grants to make baseline studies of its coastal resources, define problem areas, and develop the appropriate political mechanism for a management program. When a management program of the state is completed it must be approved by the Secretary of Commerce before the state receives implementation funding (Ross, 1978).

3.3 Background in Mexico.

Mexico is a country with 10,000 km of shoreline along the Pacific Ocean (including the Gulf of California), the Gulf of Mexico and the Caribbean Sea (Fig. 13). One third of its shoreline are coastal lagoons. The Mexican economy is based in part on the coastal oil industry and on tourism, especially as

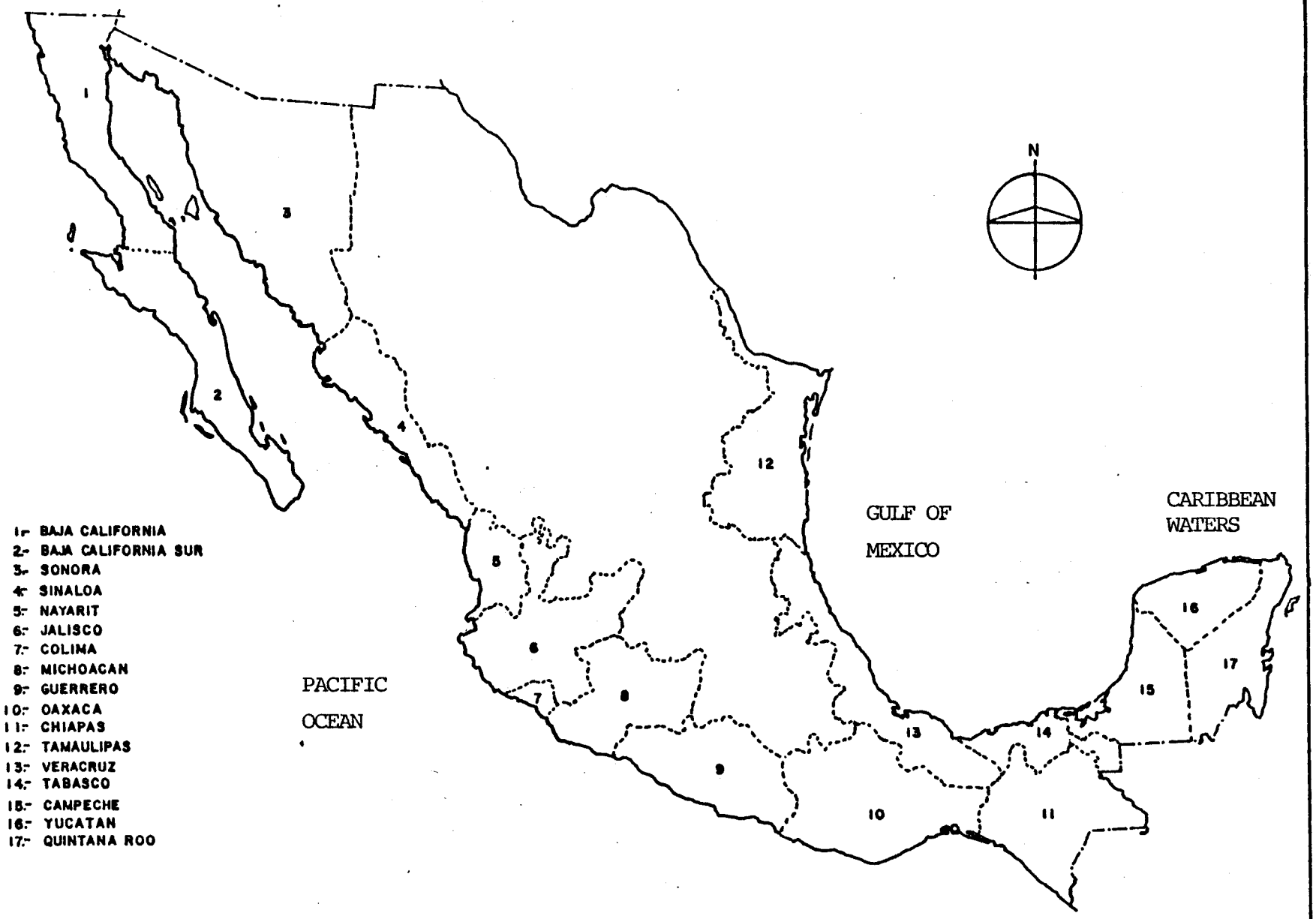


Fig.13. Coastal states of Mexico

generators of foreign exchange earnings, employment and regional development. More than 50% of oil extraction and foreign and domestic tourism is concentrated in the coastal areas.

Traditionally, Mexico has been oriented toward its interior. As in most Latin America nations, planning for the development of coastal and marine resources in Mexico is at an embryonic stage. Ocean and coastal areas under Mexican jurisdiction are extensive. With the establishment of its Exclusive Economic Zone in 1976, Mexico assumed jurisdiction over a marine area of almost 3 million square kilometers (Fig. 14). Few nations in the world have such an extensive coast line on three different seas (Pacific, Gulf of Mexico and Caribbean), with the potential development of different types of resources that such ocean access may ultimately entail.

According to Ayala Castanares (1983), the major problems of almost all developing countries with regard to ocean resources is that at the governmental level:

> " There generally exists a state of ignorance regarding the complexity and value of ocean resources and the need to view them through an integrated approach; marine science and technology have not given sufficient prominence nor funding; ocean development is not a priority in national development; ocean issues are approached in a fragmented way; and there is insufficient coordination among government agencies; and international cooperation is underutilized. At the scientific and technological level, there is a lack of trained personnel, particularly at the postgraduate level; marine facilities and equipment are inadequate, libraries have significant gaps and are ill organized; access to research vessels is difficult and ship maintenance budgets are low; basic oceanic services such as cartography, are inadequate; knowledge of marine resources in the Exclusive Economic Zone is very poor and most countries lack the capability to study these resources. At the socioeconomic level, moreover, there is a lack of scienti-

fictradition necessary to support large-scale investment in the marine science; in general scientists are undervalued and underpaid."

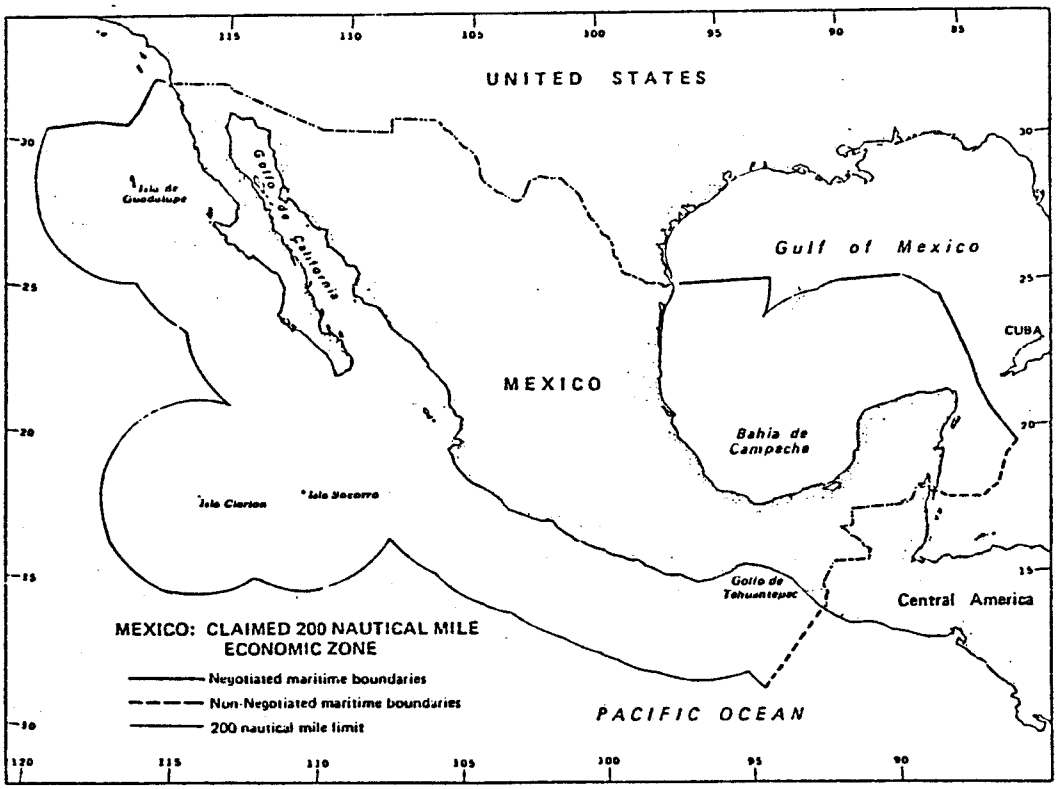


Figure. 14 . Exclusive Economic Zone of Mexico. (from Bowen and Hennessey, 1984)

3.4 Plan Colima.

In order to achieve development goals, the state government has developed the Plan Colima. This Plan is a set of priorities for cooperation with the federal government in the period 1983-1988. For the development of the coastal zone, the Plan Colima has emphasized the following objectives:

a) Communications and Transportation.

1. Improve and complete the works that have been started in the terminals in San Pedrito Lagoon in order to increase the efficiency of the port activities.
2. Studies for the construction of a coastal road from Manzanillo to the airport.
3. Complete a four-lane highway between Manzanillo and Guadalajara (in Jalisco to the north).

b) Fisheries

1. Construct tuna canning and fish freezing facilities.
2. Enhance of aquaculture activities.
3. Development of a program for research and evaluation of fisheries resources in the EEZ adjacent to the State of Colima

c) Tourism.

1. Improve and enhance the present resort areas.
2. Stimulate the development of new resort areas.

d) Energy.

1. Expansion and modernization of the oil storage and distribution facilities in the Port of Manzanillo.

2. Construction of a new terminal for storage and distribution of propane gas.
3. Studies to assess possible development mineral resources in Colima.

e) Ecology.

1. Control and prevention of pollution and ecologic deterioration of rivers, coastal-lagoons, estuaries, and bays of Colima.
2. Studies for filling and dredging a portion of the Cuyutlan Lagoon close to Manzanillo city and the opening of another mouth.
3. Development of a state protected area system with specifically in the coastal zone.

f) Navy

1. Construction of the principal naval base of the Pacific coast of Mexico at Manzanillo.
2. Evaluation of the degree of coastal pollution.

This Plan implicitly supports the idea of developing a CZM program. Such a program could be improve the effectiveness in achieving the many of the goals of the plan.

IV. TECHNICAL CONSIDERATION FOR PLANNING A COASTAL DEVELOPMENT

Planning is a continuous and incremental process which develops guidelines for urban and regional development. It is a continuous process of change in response to new social values, lifestyle patterns, technology, legislation, and the availability of resources. Gold (1979) also suggested that the planning process should be:

1. Evolutionary instead of revolutionary. Radical changes may be necessary in many instances, but they will have much greater chance of public acceptance if proposed in an incremental or demonstration program.
2. Pluralistic instead of authoritarian. The right choice is a matter of value, not fact, based on a consideration of several alternatives from individuals or groups with different objectives.
3. Objective instead of subjective. The criteria or methodology used to describe alternatives must minimize distortion of the fact even though the final decision may be based on subjective values.
4. Realistic instead of politically naive. Coastal zone management programs must develop a constituency to compete on their own merits in the decision-making or budgetary process.
5. Humanistic instead of bureaucratic. The approach to developing a plan, design, or service must to be serve people instead of the public agency responsible for providing development opportunities or preparing the plan.

The experience with domestic management of the coastal area

and resources in Latin America is rather limited. The challenge is to manage the multiple resources and use of the sea and shoreland for the long-term benefit to the people of the nation.

Integrated ocean and coastal resources planning, moreover, implies that an effort is made to weigh or optimize environmental protection, public use and economic development. Integration also assumes coordination between data gathering and analysis, planning, implementation and construction. Their management will always involve numerous agencies of government and numerous interest groups. Effective coordination of these agencies and groups thus will always be a major requisite for successful ocean and coastal management (Knecht et al., 1984).

There are several guidelines for implementation of a Coastal Zone Management program which can be useful for developing countries. These include the works of Odum (1976), Maragos et al. (1983), Clark (1974), Chacko (1973), United Nations (1982) and Knecht et al. (1984). I will refer to these materials in the discussion of the program.

4.1 Definition of Management Boundaries.

According to the United Nations report (1982), there are four criteria generally used for defining the coastal area:

- Physical. Examples of landward physical boundaries are a coastal mountain range, a watershed, or a major coastal road. On the seaward side a typical physical boundary is the edge of the continental platform and the adjacent waters. The problem with this criterion is the fact that there is no globally accepted determination of the continetal shelf or platform edge. The

advantage is that it is simple to describe and easy to understand. Such a definition may or may not respect existing political boundaries, and it may require special legislation to be enacted.

-Administrative boundaries. These are based on political and legal subdivisions. The advantages are that it is easy to understand, readily representable and legislatively viable. The drawback is that it may be too restrictive and it may not include valuable resources to be protected and managed.

-Arbitrary distances. The disadvantage to this method is that the area may bear no relationship to coastal topography, the location of critical natural systems and the pattern of economic activity.

-Selected environmental units. Examples include bays, nearshore gulf, inlets tidal deltas, estuaries, coastal lagoons, grassflats, channel areas, shorelands, marshes, mangroves, dunes.

In some countries , the coastal area has been defined by a combination of these criteria. Each criterion implies advantages and disadvantages and these must be weighed in the particular national context.

According to Knecht et al. (1984), there are three major steps in developing a Coastal Zone Management (CZM) program:

1) Identification of problems and opportunities;

2) Formulation of policies;

3) Development of implementation strategies.

4.2 Identification of Problems and Opportunities.

Obviously to be successful, a CZM program must address the

real problems and opportunities. Some of the coastal problems to be dealt with include erosion, coastal flooding, destruction of valuable natural resources such as coral reefs and mangrove forest, lack of recreational facilities and public access, non-existent or inadequate tourism facilities, low level of economic development, inadequate shore fisheries facilities, and lack of freshwater. Needs will include such factors as : conservation of natural resources, avoiding the siting of development in natural hazards zones, and promoting coastal-dependent industries. Opportunities to be promoted could include energy self-sufficiency, the orderly promotion of coastal tourism, the establishment of marine parks or refuges and the identification of unexploited resources (Knecht et al., 1984 and Maragos et al., 1983).

4.3 Policy Formulation.

This involves the development of a policy framework to guide private and public decisions with respect to the use and conservation of the coastal zone resources. The policy framework will address the problem and opportunities delineated above. Formulation of the policy framework will involve examination of the development potential of various resources, determining the impacts (environmental, social, economic) of such development, estimating the costs and benefit of development alternatives and ultimately setting priorities for the various development possibilities (Knecht et al., 1984 and Maragos et al. 1983).

The United Nations (1982), suggested that a fundamental requirement for a coastal management program is a national

policy for coastal environment protection and the exploitation of the resources. The policy for the coastal area may be subsumed into a large national policy covering environment and development in general. At the present time only a few countries have or are formulating explicit coastal development policy.

In 1983, the "Plan Nacional de Desarrollo 1983-1988" (National Plan of Development 1983-1988) gave the overall information and policies for the federal government of Mexico. This set of policies did not include the coastal zone per se, but it mentioned broad policies about ecology and marine resources. In 1984, the Secretariat of Urban Development and Ecology (SEDUE) announced the National Programs of Urban Development and Ecology 1984-1988. Again this was only a broad set of policies consistent with the National Plan, and did not mention the coastal zone per se, but in these policies are included all the critical ecological areas and encourage the preservation and arrangement of other ecologic entities, that many coastal areas fit into.

Sorensen et al. (1983), suggested that nationwide integrated coastal management may be inappropriate for non-coastal-oriented, continental nations such as Mexico. Regional coastal zone management, however may be well suited for areas (e.g. Colima), where, there is a concentration of coastal problems, such as estuaries with large ports and surrounding metropolitan development.

According to Knecht et al., (1984) most CZM plans contain three major types of policies:

- Policies related to the management of coastal development
- Policies related to marine resources development
- Policies related to the protection of natural systems in the coastal zone.

The kinds of individual policies and issues usually dealt with under each major policy area are suggested below.

Management of Coastal Development.

In Mexico, there is no federal or state level that deals with coastal zone management, instead we have several Secretariats that are deeply involved in different aspects of development and protection of the coastal zone. The major policies on coastal management of the federal government are:

- Natural hazard policies dealing with coastal flooding, erosion, tidal action and hurricanes. Secretariat of Navy (SM) and the the Secretariat of Urban Development and Ecology (SEDUE) are involved with the restriction of development in these hazard areas.
- Tourism policies dealing with hotel siting, public facilities and related aesthetic and environmental considerations. The Secretariat of Tourism (SECTUR) and SEDUE are involved.
- Port, harbor and navigation policies dealing with the operation and modernization of ports, the operation of harbors and improvement of navigation aids. The Secretariat of Communication and Transport (SCT) and SM are involved.
- Industrial siting policies dealing with water dependent industry, and such other projects that require a coastal location. The kind of industry determines which Secretariats

are involved. For example in aquaculture, SEPESCA is deeply involved.

Marine Resources Development Policies.

Since the declaration of Mexico's Exclusive Economic Zone in 1976, the federal government has been deeply concerned about marine resources development (mainly fisheries and oil). One step foward was the elevation the fisheries department to a Secretariat in 1980. The major marine resources development policies and the secretariats involved are:

- Fisheries development, SEPESCA;
- Offshore petroleum development, Petroleos Mexicanos (PEMEX);
- Hard mineral development, Energy and Mines Secretariat (SEMIP);
- Ocean energy sources (there is no interest at the present time)

Natural System Protection Policies.

Only recently, the Mexican government began to be concerned about the rapid degradation of several different ecosystems. For that reason, the ecology department was elevated to a Secretariat in 1982.

The major ecosystems in the coastal environment that should be protected are: wetlands and mangrove areas, coral reefs, lagoons, estuaries, shellfish beds, beaches and dunes.

4.4 Implementation Strategy.

A key element in CZM relates to the manner in which the coastal policies outlined above are implemented. In principle, a wide range of implementation approaches can be used separately, or in combination, to achieve the policies goals of protection

and rational development.

Implementation of Protection Policies.

There are several mechanisms of for implementation of policies including: permits, tax policies, guidelines and standards for coastal development, and protected area system.

Implementation of Coastal Development Policies.

These can be implemented by enforcement of laws and regulations regarding construction in hazardous areas, preservation of scenic views, aesthetics in the design of coastal structures, giving priorities to water dependent uses, siting of major facilities (concerning effluent discharges, public access ect.), and licensing and leasing schemes for shoreland and water areas used for resource extraction purposes (oil, sand, and gravel).

V. MANAGING THE COASTAL RESOURCES.

Many types of ecological systems are found throughout the coastal region of the world: marshes, seagrass beds, river deltas, estuaries, embayments, rocky coasts, islands, sand beaches, coral reefs, lagoons, mangrove swamps, and mudflats. In low latitudes, several different ecosystems may be in geographic proximity to one another.

The importance of an area to human beings depends on the nature of the ecosystem as well its size and often its location. Coastal ecosystems serve a number of important natural functions and typically are used by human beings for a variety of products and services. Marshes, estuaries, mangroves, seagrass beds, and coral reefs are among the most productive of all natural ecosystems, marine or terrestrial.

Because of the variety of ecosystems, I will concentrate the discussion on the most important coastal resources in the State of Colima, with greatest emphasis on the mangrove forests.

5.1 Mangrove Forests.

Mangrove swamps are complex ecological systems essentially characteristic of tropical and subtropical coasts subject to periodic tidal inundation. They are a predominant vegetation association on some 25% of the world's tropical coastlines (Johannes, 1972). Mangrove swamps function as ecotones between land and sea, and contain elements of each. The mangroves provide habitats for terrestrial and aquatic animals, including mammals, reptiles, birds, amphibians, insects, fish, crustaceans, and mollusks.

Mangroves are also one of the principal components of the coastal lagoons of Colima. The coastal lagoons represent a potential fisheries resource of considerable magnitude. For example, in Mexico one third of its shoreline (10,000 Km) has coastal lagoons and they constitute a substantial portion of all the fisheries catches (Yanez-Arancibia, 1977). Odum (1972), discusses that in the tropical coastal lagoons, the principal primary producer is the mangrove with 19 metric tons/ha/year. This organic matter is descomposed by bacterial activity and produces detritus that is the most assimilate form for herbivorous and omnivorous fishes. Odum (1971) remarks on the importance of detritus as a source of food for organisms in many ecosystems like estuaries, lakes, rivers, coastal lagoons and open ocean.

The mangrove association is a coastal ecosystem in which the role of detritic energy pathways is perhaps the most obvious. Heald (1971) noted that only 5% of mangrove leaves are consumed on the trees and that the rest are recycled by the detritic food chain. Only another 1-2% are lost to the sediment, mostly in the form of mangrove peat. The prevalence of detritic recycling is an overwhelmingly common characteristic of all types of mangroves. It is of similar importance in the neighboring marshlands and seagrass meadows. There is also little difference between the type of organisms which are agents at the different steps of this food chain in these three ecosystems (Dov, 1984). The essential difference of the mangrove ecosystem, as compared to other aquatic detritic ecosystems, is

the high efficiency of within ecosystem recycling. Although sizable amounts of the detritic food are lost to the open sea, the majority of the detritic mass is retained in the roots of the mangrove bottom and decompose in situ (Dov, 1984). Because some amounts of detritic organic matter are exported to the open ocean, the mangrove ecosystem is also an important source of food for the coastal fishes. Pillay (1967) emphasizes the close relationship between Indian Ocean coastal fisheries and the mangrove environment. In other words, the mangrove waters are perhaps the most important feeding grounds for shrimp and fish fauna of the tropics. For example, in Mexico the shrimp fishery is the most important fishery, contributing to foreign earnings, making the mangrove a valuable ecosystem to preserve in order to continue the shrimp harvest.

There is no doubt that mangroves are an important component of the tropical coastal ecosystem, but they are also important for human beings. The products taken form the mangrove ecosystem range from firewood, other fuels, and construction material to paper products.

The mangrove ecosystem is wide spread over all the protected coastal area of Colima. There are several local uses of the mangrove, mostly for construction activities and for firewood. In the coastal area of Colima the properties of the wood are well known for construction, so there is always a demand for mangrove wood. The impact of mangrove cutting activities is already noticeable in some areas. There doesn't seem to be any regulations imposed on such activities. I already described how

the mangrove forest was fully eradicated from the San Pedrito Lagoon due to dredging. There also are some important impacts in Juluapan and Cuyutlan by residential, industrial and agricultural development as well as reclamation for development in some important remaining areas.

Mangrove conservation and utilization depend wholly upon integrated planning that takes into consideration the habitat requirements of the mangrove ecosystem (i.e. hydroperiod, salinity regime, and physical-chemical properties of the substrate). For management purposes, Morton (1976) has summarized the values which make retention and wise management of the mangrove desirable: ecological, sedimentation and coastal protection, wildlife habitat, economic, coastal fisheries, aesthetic, scientific and educational.

Cruz (1984), categorized the mangrove resources for management purposes as follows:

- Reserved mangrove. These are the healthy forests that should be protected.
- Managed mangrove. These are mangrove forests under silvicultural production.
- Altered mangrove. These are permanently altered mangrove areas.

Snedaker and Getter (1984), and Odum (1976), outline and and summarize the management and planning provisions that should be required for any proposed development:

1. Maintain the topography and character of the forest substrate.
2. Perpetuate the natural patterns and cycles of tidal activity

and freshwater runoff.

3. Maintain the natural temporal and spatial patterns of surface and ground water salinity.
4. Maintain the natural equilibrium between accretion, erosion, and sedimentation.
5. Set maximum limits on all harvesting. Cutting schedules should be based on rigorous plans that ensure sustained yields and perpetuation of the ecosystem.
6. In areas subjected to potential oil spills, contingency plans should be developed to protect the mangrove from the damaging effect of oil (case of Cuyutlan).
7. Avoid all activities that may result in the impoundment of an area of mangrove. The cessation of surface circulation leads inevitably to the mortality of the trees.

5.2 Coral Reefs.

Coral reefs occur along shallow, tropical coastlines where the marine waters are oxygenated, clear and warm, and free of suspended sediments, excessive freshwater runoff, and pollutants. Most coral reefs are found in the tropics and at higher latitudes where there are warm ocean currents. Coral reefs are considered to be one of the most productive ecosystems of the world in terms of the support and maintenance of a large biomass. The most prominent role is the creation of a diverse habitat for perpetuation of large numbers of sessile and mobile organism. Coral reefs have a large variety of direct and indirect uses that benefit man and society. Among the dominant direct uses are the large yields from marine fisheries that are perpetuated by the

reef system. Some of the more valued uses, but lesser recognized, include the promotion and development of income earning tourist industries. (Odum, 1976). Coral harvesting takes place for species with precious or semi-precious jewel value and for species with an aesthetic appearence.

Odum, (1976), and Snedaker and Getter (1984), outline the major destructive actions affecting coral reefs throughout the world:

1. Destructive fishing practices including the use of explosives, poisons and non-selective traps.
2. Overexploitation of selected coral species for ornaments and semiprecious jewelry in tourist markets.
3. Siltation and sedimentation created by dredging, filling, and related construction activities.
4. Degraded water quality through changes in salinity and temperature and the introduction of pollutants.

The coast of Colima is not a zone having many coral reefs, but there are some coral patches that we may want to consider for protection. The distribution of this coral patchiness is not fully documented but there are some reefs close to Punta Juluapan and around the north side of this point.

There is a harvest of coral by fishermen and tourist divers that may threaten the low and remaining concentration of coral reef in the coastal area around Manzanillo. For the coastal zone of Colima, it is strongly recommended that planners should:

1. Determine what is the distribution and evaluate the

concentration of coral reefs and their local ecologic importance.

2. Prohibit any harvest of coral until this survey has been completed.

5.3 Beach and Dune Ecosystems

Beaches consist of unconsolidated sediments, ranging in size from rock fragments to fine-grained sands which are predominantly quartz in tropical areas. Beaches are not stable entities, but are dynamic landforms that are constantly subject to forces that cause erosion and/or accretion. Erosion tends to dominate depositional processes. Among the most commonly cited factors promoting beach erosion are: (1) river dams, and diversions that trap sedimentary materials, thus preventing their entry into the coastal littoral system; (2) poorly designed or placed coastal engineering works that alter longshore currents or wave forces; and (3) coastal dredging and dune mining projects that remove beach-building materials. It is very clear that the beach ecosystems are extremely sensitive to factors which alter their sand source, nearshore currents, and wave regime. Conservation of the ecosystem and its resources can be simply achieved by preventing any significant change from occurring.

Dune systems are a valuable, natural component of our coastal heritage. Dunes function as buffers to the erosive forces of waves and storm surges. Esthetically, they contribute visual relief to the beach and form a transition between land and water (Knutson, 1978). Dunes are naturally formed and maintained by

the action of beach grasses which trap and hold wind-blown sand, so vegetation is a critical factor for dune conservation (Culler and Bird, 1980).Though tolerant to the stresses of the shore environment, these plants form a community easily disturbed by human activities. Once disturbed, dunes may become an ocean of moving sand covering inland areas.

Nordstrom and Psuty (1983), summarized dune values as:

- Protection.
  - Barrier to overwash, flooding and inlet creation
  - Barrier to inland migration of beaches
  - Reservoir of sand
  - Windbreak
- Ecological
  - Habitat
  - Protection of inland vegetation from salt spray and flooding
  - Vegetational diversity not found on flat beach
- Esthetics
  - Topographic diversity
  - High ground for views of the sea
  - Unique environment

In the coastal zone of Colima there several important beach areas that are critical for the coastal tourist economy. The most important beaches are located in the area of Manzanillo where the major alteration of the coast is occuring . There are several engineering works like jetties and breakwaters, that may affect the coastline by erosion or accretion (Fig. 15).

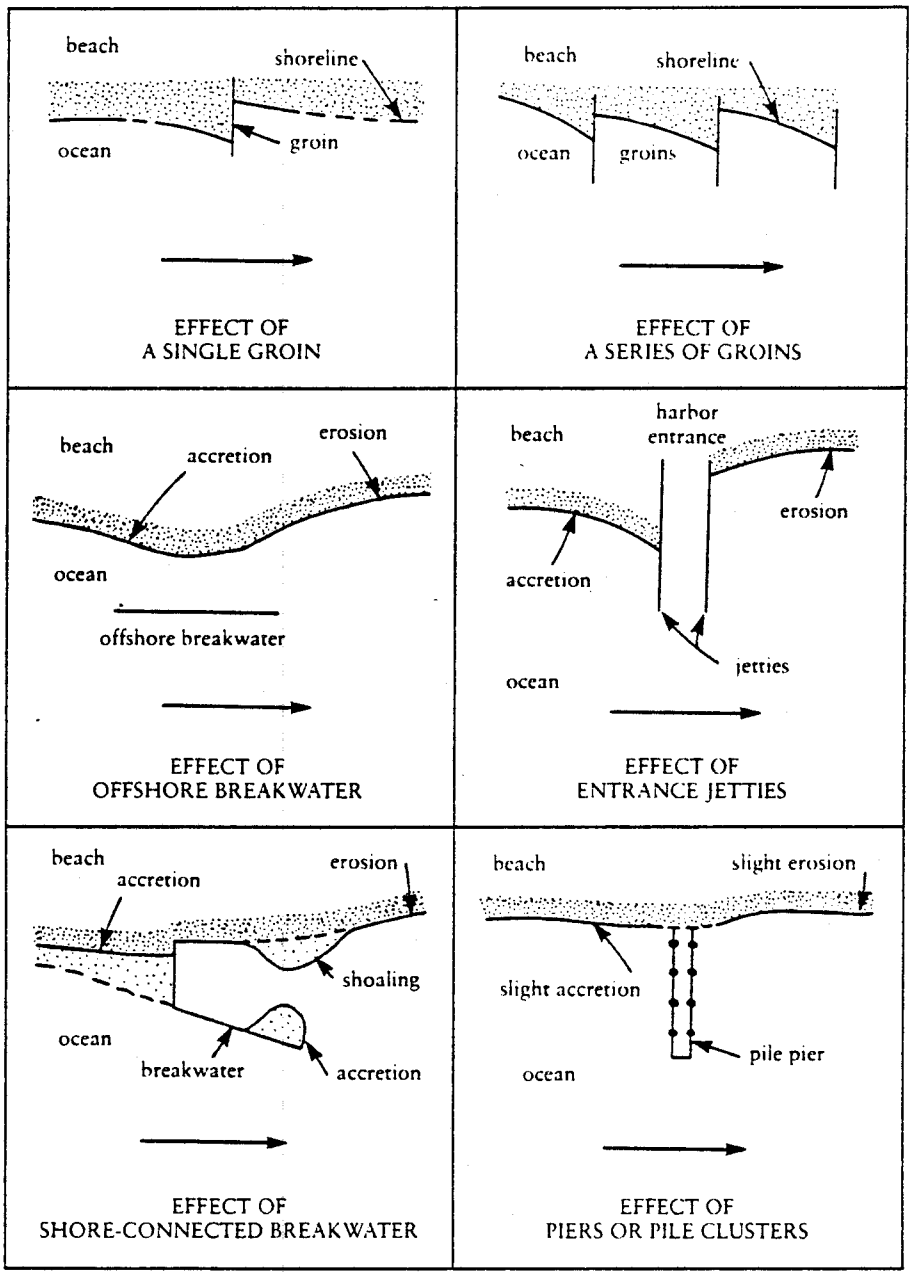


Figure. 15 *Various shoreline engineering structures. Groins, breakwaters, jetties, and even fishing piers trap sand and build up the beach at selected points. Although this may be good for recreation and storm protection, the sand that is trapped reduces the supply to the adjacent beach or island, which causes erosion.*

(from Pilkey and Evans, 1982)

The port and the channel constructed by the power plant still cause some problem with sedimentation so they need periodic dredging. The summer tropical storms dramatically change the profile of the beaches and often cause damage to property. Storms cause the most important erosion problems in the coastal zone of Colima. An example was the complete loss of sand on one kilometer of an important public beach, "Miramar", in Santiago Bay due to a tropical storm in July of 1983. Another important consideration is the loss of coastal dunes from Manzanillo to Cuyutlan area due to reclamation for agricultural, residential and recreational development. This may also affect erosion of the coast. Pollution on the beach is another problem mainly in the area of Manzanillo, where oil spills have occurred several times. Garbage on the beach (from tourist) causes aesthetic pollution, especially in the high season of tourism.

The guidelines below are those which are considered to be the minimal requirements for the maintenance and perpetuation of beaches and dunes (Nordstrom and Psuty, 1983; Culler and Bird, 1980):

1. Avoid the introduction of pollutants and excessive nutrients into the beach and dune environment.
2. Promote and control tourism on beaches.
3. Maintain the natural equilibrium between accretion and erosion. Coastal activities, including construction of structures, have the potential to alter the balance between accretion and erosion. Such activities should be evaluated for their potential impact on the beach environment.

4. Site-specific studies may be required at localities before development.
5. Decide what uses are permissible in the dunes.
6. Establish effective legislative controls.
7. Educate local communities about the values of dune systems.
8. All new structures should be located behind the dunes.

5.4 Estuaries and Coastal Lagoons.

I have already discussed estuaries and coastal lagoons for the coast of Colima, and some of the ecology in the mangrove forest that can be applied for estuaries and coastal lagoons. Here I will emphasize only the primary ecologic importance of these water bodies.

Estuaries and coastal lagoons are the richest of all coastal waters. They not only produce an abundance of fish and shellfish but also serve special needs of the migratory nearshore and oceanic species that require shallow protected habitat for breeding or as sanctuary for their young. Also they export energy in form of organic matter and provide nutrients to the adjacent coastal waters.

Because of their endemic productivity and utilization as natural ports and harbors, demands have resulted on these systems which have created a variety of environmental impacts and loss of these resources. The effects of improperly planned development of these resources create a variety of short and long-term effects which represent economic losses and opportunity cost. One of the important objectives should be to prevent pollution of the

coastal lagoons and estuaries in order to prevent decline of fisheries production, degradation of the environment and the decline of its carrying capacity. A second management objective should be to maintain the natural characteristic of basin configuration, circulation, and tidal flushing to achieve optimum carrying capacity of the ecosystem. A third management objective is to maintain the natural pattern of land drainage into lagoons and estuaries.

The estuaries and coastal lagoons of the coastal zone of Colima, have been drastically changed due to man's intervention, but we still have the opportunity to solve some of the environmental problems, by wise utilization, protection and management of the coastal zone. Sneaker and Getter (1984) summarize the guidelines which have to be considered requirements for the maintenance and perpetuation of coastal lagoons and estuarine systems:

1. Require the highest levels of waste treatment for industrial and municipal effluents released into estuarine and lagoon waters.
2. Locate industrial facilities inland if they have a high potential for disturbance of estuarine and lagoon ecosystems.
3. Avoid the use of structures that would adversely impede water circulation.
4. Select locations for removal and deposit of dredged material to avoid adverse effects on basin floors and critical areas such as mangroves and sea grass.

VI. MANAGEMENT OF COASTAL DEVELOPMENT.

6.1 Coastal Agriculture.

Snedaker and Getter (1984), identified two classes of problems associated with the agricultural use of the nearshore environment. The first is embodied in the term of reclamation of this coastal resource for arable land. The second class of problem concerns the low probability of success in actually converting nearshore sediments into agricultural soils suitable for production.

In the coastal zone of Colima coastal agriculture plays an important role in the economy. The main products that are cultivated on the coast are coconuts, bananas, and lemons, Colima is the major producer of coconuts and lemons in Mexico. The first class of problems described above is the main problem of the coastal zone associated with agricultural practice. There is continual reclamation and use of the coastal area for agricultural use that threatens some important coastal resources. This seems to be a complicated problem because of the necessity to provide arable land to the peasant and the political repercussions of not doing so.

It seems the coconut plantation is the best developed crop in the sandy environment of the coast, especially in the area of Manzanillo to Cuyutlan where the sand dunes are used and reclaimed for planting. There is also a problem to consider that is part of the second class of problem above that affects the coast of Colima; that is, the cyclones that can destroy open and non-protected crops.

It is recommended that in order to continually preserve high yield agricultural production and at the same time protect coastal resources:

1. In general, only areas above mean sea level should be considered for conversion to agriculture.
2. All the productive coastal agricultural area should be protected from change of the land use pattern.
3. Regulate use and reclamation of critical areas like margins of estuaries, lagoons, marshes, dunes.
4. Plan upland farm layouts to minimize the alteration of natural drainage pattern.
5. Apply and utilize fertilizers and pesticides in a manner that will minimize their loss and transport toward coastal areas.

6.2 Fisheries and Aquaculture.

The principal human factors affecting the abundance of living aquatic resources are overfishing, the drainage and development of coastal zone waters, especially estuaries and coastal lagoons, and international and national legal constraints that affect access. The living, renewable resources of the sea provide diverse and valuable raw products for human consumption, recreation, animal feed and industrial use.

Fisheries management has been described as "everything done to maintain or improve fisheries resources and their utilization" (Carlander, 1969). Management may include fisheries development, i.e exploratory fishing; gear, harbor, and fleet development; stock selection; environmental maintenance; processing and marketing; and establishment of aquatic reserves, and parks

(Alverson, 1973). The objectives of managing the fisheries resources vary from country to country, between ethnic groups, and by geographic areas, but we can classify objectives into three groups: (1) those concerned with the maintenance of resources; (2) those which are of a socioeconomic character; and (3) those reflecting national and international political interests.

The biological aim of fishery management is to attain the maximum continuing or sustainable yield, which may not be the same from the economic point of view which is to attain maximum profits. In developing countries the most common objectives of fisheries exploitation may be to generate goods and services that contribute to the Gross National Product, to produce a supply of protein foods, and to provide sources of foreign currency (Marr, 1972).

The objectives in Mexico's National Fisheries Development Plan 1977-1982, and today are: achievement of self-sufficiency in food for the nation; contributing to resolving the problem of unemployment; raising the standard living of the population; foreign currency earnings; and contributing to the development of other economic activities.

Mexico has more than ten thousand kilometers of coastline with an Economic Exclusive Zone of almost 3 million square kilometers with half a million square kilometers of continental shelf and 3 million hectares of interior water (including coastal lagoons and estuaries) and what are described as vast marine resources, especially fishery resources (Secretaria de

Programacion y Presupuesto, 1983). In 1956, the nation's catches were at the 100,000 metric ton mark. By the end of 1981, the production had surpassed 1.56 million tons, six times the 1970 level of 254,000 tons (Anonymous, 1984). With this production Mexico became the 13th ranking fishing country of the world.

In the ending of 1983, the production dropped 30% to 1.1 millions tons (Fig. 16). This decline was caused by the drop of anchovy and sardine catches. Also the tuna catches dropped from 72,588 tons in 1981, to 25,035 tons by the end of 1983 (Table I), partially because of the U.S. tuna embargo and lack of market. The most valuable fishery in Mexico is shrimp. This species is reserved for exploitation by Mexico's cooperative or "social sector", and constitutes one of the nation's most important exports; in 1983 shrimp exports of 84,000 tons were valued at 456 millon dollars. There are two other participating groups to consider in the Mexican fishing industry: the private sector and the parastate companies. The private sector plays the leading role at both the catch and processing levels of the industry; according to the most recent available figures, 60% of catches in 1982 and 79% of the fish processing activities in 1983 were carried out by private companies and individuals. Cooperatives were responsible for 27% of the total catch and 1% of the processing activities; the figures for the parastate sector were 13% and 20% respectively (Anonymous, 1984). Foreign direct participation in the fishing industry is minimal, but 21 joint venture companies (minimum 51% Mexican participation) do exist, aimed at sardines, anchovy, tuna and cod.

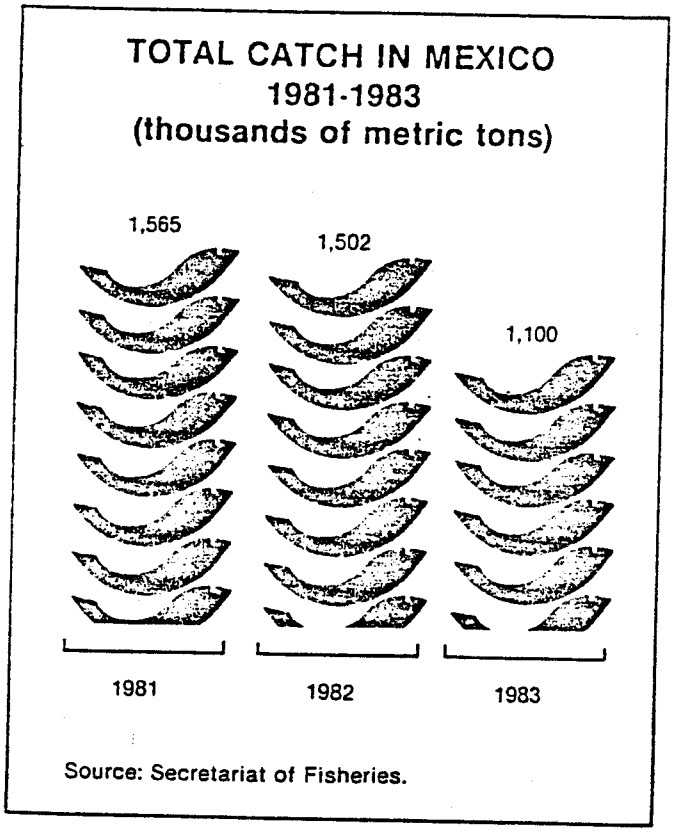


Figure. 16 .
(from Anonymous, 1984)

CATCH BY SPECIES IN MEXICO, 1981-1983
(metric tons)

	1981	1982	1983	Percentage change 82/81	83/82
Total	1,565,465	1,502,030	1,100,045	- 4.05	-26.77
Direct Human consumption	913,298	794,801	673,936	-12.98	-15.21
Shrimp	72,010	78,657	98,916	9.23	25.76
Sardine	116,851	109,561	80,869	- 6.24	-26.19
Mojarra	59,369	75,602	65,941	27.34	-12.78
Oysters	41,950	34,906	30,850	-16.80	-11.62
Tuna	72,558	41,225	25,035	-43.18	-39.27
Shark	20,646	21,610	19,691	4.66	- 8.88
Dogfish	14,683	13,120	11,079	-10.65	-15.56
Carp	11,134	8,747	10,960	-21.44	25.30
Mullet	14,602	13,087	10,722	-10.38	-18.07
Groupers	9,950	9,553	7,003	- 3.99	-26.69
Squid	9,816	409	353	-95.84	-13.70
Others	298,094	187,276	179,473	-37.18	- 4.17
Not officially registered[1]	171,635	201,048	133,044	17.13	-33.83
Indirect human consumption[2]	620,956	673,981	415,567	8.53	-38.34
Industrial use[3]	31,211	33,248	10,542	6.52	-68.29

1 An estimate by the Secretariat of Fisheries of the catch that is directly consumed by fisherman, and other non-reported catches.
2 Fish meal for animal feed, etc.
3 Used in production of inedible products, e.g. scientific research, cosmetics etc.
Source: Secretariat of Fisheries.

Table. I

(from Anonymous, 1984)

The participation of the State of Colima in the fisheries industry is minimal, mainly as artisanal and coastal fisheries. The Cuyutlan Lagoon traditionally supplied most of the state fisheries until recent years when coastal fisheries became more important. The main products are shrimp, red snapper, mullet, crabs, mojarra, shark and turtle. In 1979 the production was 4,639 tons: red snaper (guachinago) 276, mullet 188, mojarra 396, shark 472, turtle 311, and others 2,204 (Secretaria de Programacion y Presupuesto, 1981).

The most important problems of the fishing industry of the State of Colima face are:

1. Lack of data on the coastal fisheries resources.
2. Destruction and deterioration of spawning grounds (estuaries and coastal lagoons).
3. Lack of trained personnel.
4. Lack of physical infractructure (processing and refrigeration plants).
5. Lack of an enforcing mechanism for regulation of fisheries activities.

Marr, (1982) set a number of requirements for a successful fishery management system, that may be applied in Colima:

1. Explicit establishment of specific management goals. Frequently the goals are selected tacitly rather than explicitly and frequently conflicting or opposing goals are selected, i.e., to maximize biological yield and to maximize employment in the capture sector.
2. The establishment of appropriate institutional and physical

infractructures.

3. The recognition that the problems of coastal small-scale fishing communities are part of the broader problems of rural development.
4. Realistic planning, taking into account the finite, but renewable, nature of the resources.
5. Management on a logical basis that takes into account the nature of multispecies fisheries and the general lack of conventional data.
6. Management on a basis that is culturally acceptable, as well as physically possible.

There are some important steps to be taken to resolve some of the problems. For example, the federal government constructed marine fishery terminals in the interior port of San Pedrito in order to support coastal fisheries, but still no sea food processing industry exists because of a lack of refrigeration facilities, and a prospective market. There are a couple of institutional agencies to support fishery research like the National Institute of Fisheries (Instituto Nacional de Pesca), and the Navy Oceanographic Institute of Manzanillo (Instituto Oceanografico de Manzanillo de la Secretaria de Marina), both situated in Manzanillo, and capable of doing research and collecting data, but there is a lack of funding to support them. There are also several fisheries schools at the technical and professional level that can train personnel but there are not enough fisheries investment activities to hold them.

In the aquaculture area there are several attempts to

culture oyster, shrimp, and fishes in the Cuyutlan and Juluapan Lagoon by the fishery department but it seems that all the attempts have failed, without any specific explanation of the causes. Nevertheless an important culture of tilapia, exists in Potrero Grande, which may be hold a promise for future development. Also it is known that there is private culture of the prawn Macrobrachium rosembergii in the area of Tecuanillo (south of Tecoman), without any data available about its success at the present time.

6.3 Energy.

Energetics are instruments of support of economic growth of Mexico, providing the main source of foreign currency. The proven oil reserves in 1983 were 72,000 million barrels and the production of crude oil in 1982 reached 2.7 millions barrels daily with an exportation of 1.5 million barrels daily. The electric industry registered (1982) 18,000 megawatts of electric generation. Of this amount 65% was thermoelectric mainly oil based, and the 35% hydroelectric. 90% of primary energy depends on oil (Secretaria de Programacion y Presupuesto, 1983).

I will concentrate the discussion on oil operations and coastal power generation, because they are the only energy source in the State of Colima. Other sources of energy like ocean thermal energy conversion (OTEC), salinity gradient, wave energy and current energy, are not a feasibility at the present time.

6.3.1 Oil Operations.

The petroleum industry often creates conflicts with local

fisheries and the conservation of the coastal resources. Oil spillages from well blowouts, tanker spillages, pipeline breaks, and offloading activities have, in the past, resulted in long-term damages to coastal resources and also had economic and social consequences on tourism and fishing. Oil pollution represents one of the most serious problems in coastal management.

Embayments, ports and harbors like Manzanillo which handle petroleum products are likely to have detectable petroleum hydrocarborns, but although not as devastate as an acute spillage, the potential for bioconcentration and uptake by marine organisms is still there. In oil ports associated low-level pollution has led to changes in the species composition in several places of the world (Snedaker and Getter, 1984). Most of the oil entering Manzanillo and Santiago Bay, (mainly fuel oil) comes from general vessel operations (pumping of bilge water, spills during transfer operations, illegal tank washing, and ballast water), or accidents, e.g., grounding of ships. However, other potential sources may include pipelines from the PEMEX (Petroleos Mexicanos) pier to the storage tank, or from PEMEX to the power plant (Lau, 1984).

The key to reducing petroleum damage to coastal resources is the prevention of the release of petroleum products. There are several considerations in order to reduce the impacts of oil to coastal resources, proposed by Sneaker and Getter (1984) and Longley et al. (1978), that may applied to the coastal area of Colima:

1. All operations should avoid intentional discharge of oil and grease into the marine environment.
2. A detailed contingency plan should be developed for potential oil spills in Manzanillo, Santiago Bay and Cuyutlan Lagoon.
3. An evaluation made which includes a modeling of the fate and effects of a "worst-case" spill.
4. Cleanup of oil on oiled beaches and other coastal areas should commence after all oil has impacted the shore. Natural or manual cleanup should be emphasized.
5. Large fines should be charged to the owner of the ship spilling oil into the sea to cover cost of clean up damage.
6. Only trained personnel should be allowed in the operation of loading and unloading fuel in the port.

There have been some developments to prevent oil spills in the coastal environment since the blowout of the Ixtoc on the continental shelf of the State of Campeche, Mexico in 1979. There is a National Contingency Plan to reduce effects of oil spills on the marine environment, carried out by Secretaria de Marina (Secretariat of Navy). But the risk and probable size of a spill in Manzanillo should be reviewed in light of the following factors: (1) the amount of oil being transported into or out of the area; (2) the past record spills; (3) the size of the tankers which most commonly pass through the area; (4) likelihood of collision between tankers; and (5) the maximum rate of discharge from the terminal.

6.3.2 Coastal Power Generation.

Electric power generation plants are often located in the

coastal zone, because of the large volumes of cooling water required. In the coastal plan operation, seawater is used as the heat exchange vehicle, so the hot water from the plant is discharged back into the nearshore waters to an area distant from the intake in order to prevent recirculation.

Clark and Brownell (1973), classify the environmental impacts of the power plants into two categories: internal impacts are those involved with the water removed for the cooling purposes and the organism within that water; external impacts are those involved with the effects of the cooling water discharge on the source body of water and its biota.

Biota affected by internal impacts are those entrained or drawn involuntarily into a plant with the cooling water. Most of these are plankton which are unable to resist the water flow. Large entrained forms are stopped by a screen system. A high portion of such entrained organisms are usually killed as are the majority of those caught on the screens. Death of young stages of fish in the passage through the cooling system is a major problem. For many estuarine-sited plants, the inner-plant kill of fish is the most critical environmental issue, but this can hardly be seen because their bodies are so small and can easily float away with the current, unnoticed and unappreciated. For example the EPA (1972), reported that in Mount Hope Bay, 164.5 million menhaden larval were killed in a single day. The most valuable shellfish species have planktonic larval stages (meroplankton) that are vunerable to entrainment and to the harzard of passage through cooling systems. The major

unresolved question about the impact of inner-plant damage on plankton concerns the effect on food chain productivity and on the overall ecological balance of estuarine systems.

For many years the primary ecological concern about power plants, other than radioactivity, was thermal pollution. The heated discharge water frequently alters the biological balance of the marine system by eliminating those species whose temperature-tolerance limits are exceeded. It is a particularly severe problem in warm tropical waters where even a small increase in water temperature may exceed the tolerance limits for many organisms. Fish are killed by power plant discharges in a number of different ways: (1) thermal, from both high-temperature shock and cold shock; (2) chemical, from biocides used in cleaning the system, and ;(3) gaseous, mainly from nitrogen embolism (Clark and Brownell, 1974). The first one, I have already introduced. Chemicals are using to prevent fouling of the complex piping system within a plant, sodium hypochlorite is frequentely used as a control agent. Its subsequent disposal as a reactive chlorine in the cooling water also poses problems for marine life in the reciving area of the discharge water. Embolism kills occur in water that has been heated and thus becomes supersaturated with nitrogen. Excess of nitrogen taken into blood strea of a fish "boils out" into the tissue and organs causing death.

In 1978 the National Commission of Electricity (Comision Federal de Electricidad), began the construction of a thermoelectric plant in the coastal zone of Colima in the area of

Campos (close to Manzanillo) (Fig. 17). It is apparent that the principal site selection criteria in this case were: (1) cooling water availability, (2) fuel availability, (3) land availability, (4) engineering feasibility, (5) cost of land, and (6) transmission of power to the market areas. There was an environmental impact study that indicated no strong adverse effects at the site. However the construction affected the hydraulic condition of the Cuyutlan Lagoon with the opening of a mouth and dredging a channel to obtain cooling water from the lagoon. The construction caused the loss of mangrove areas of the lagoon together with the loss of sediments with disruption of bottom organisms and their habitats. However the opening of the mouth and changing of the hydraulic condition seems to have a good healthy effect on the lagoons due to the increase of fishery productivity (see Cuyutlan Lagoon). In 1982 the thermoelectric company realized that the amount of water for the cooling system was not enough, so the company built a system with more direct access to water. This construction caused obstruction by sand transported by the currents into the channel and fouling of the the screen and inner-plant fouling mostly by mollusks. Also there was a great development of a specie of polychaetes which formed reef habitats in the channel which obstructed the flow of water. In order to resolve the problem, the plant has to be shut down, chemicals are used, like hypochlorite sodium. It seems apparent that the thermal affluent does not have a strong impact in the surrounding area, due to the deeper water and the relative by strong currents of the area. But it could have a big impact in

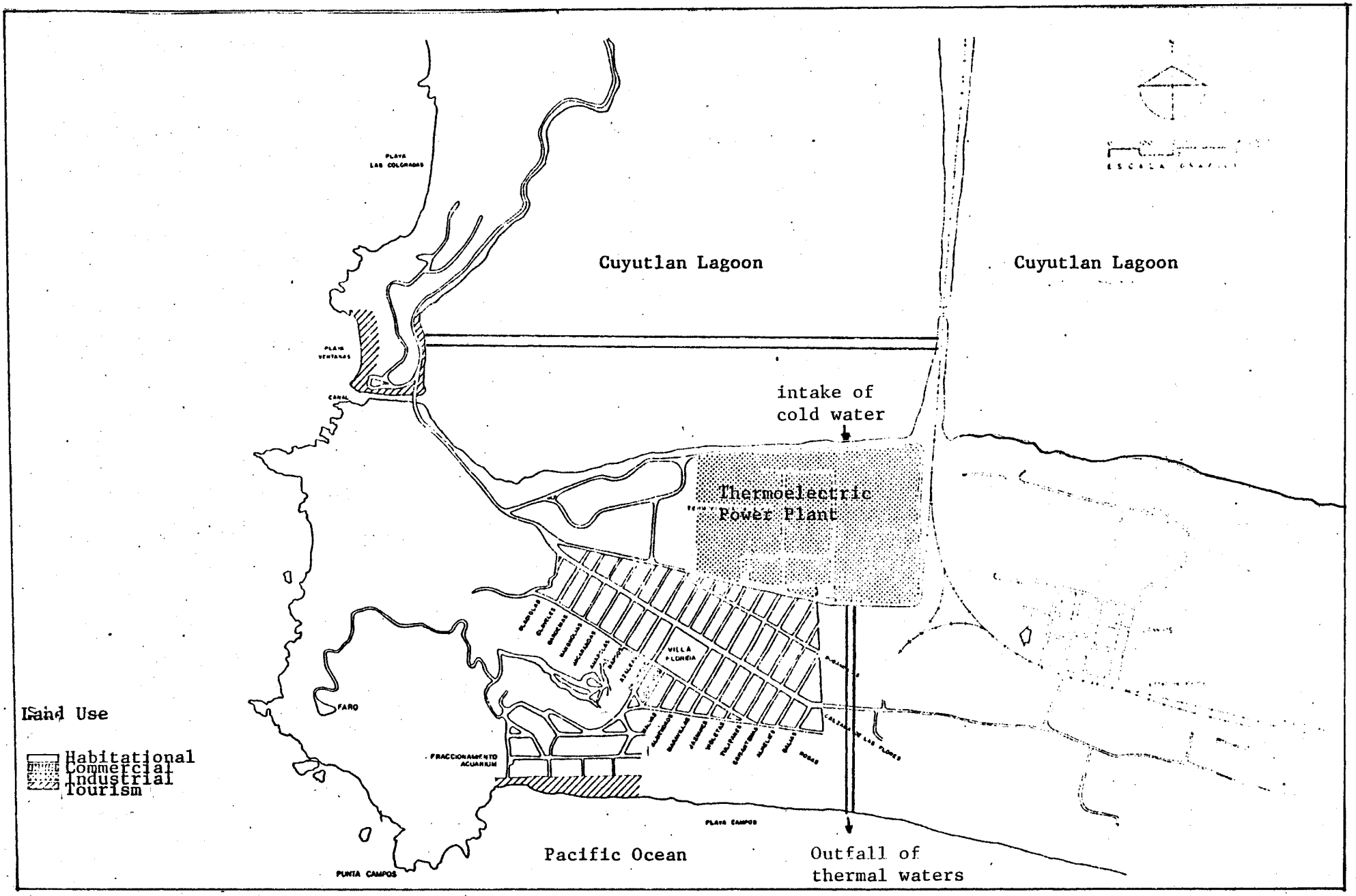


Figure. 17 . Location of the thermoelectric power plant (from COCOMABA, 1980)

entrainment and mortality of early stages of fishes, because a almost all the species of fishes spend a portion of their lives in the lagoon (Chavez, 1982). In 1983 there were several oil spills in the Cuyutlan Lagoon from the pipeline crossing the lagoon in the direction of the power plant, the effects were not fully evaluated.

Snedaker and Getter (1984), Clark and Brownell (1973) and Maragos et al. (1984), summarize the guidelines for minimization of the impact of power plants and their siting in a coastal environment.

1. Power plants should not be located in estuaries or coastal lagoons (case of Cuyutlan), unless they are designed for closed cycle cooling.
2. All operations should avoid the discharge of toxic substances associated with the operations of the plant into coastal waters (case of hypochlorite use in Cuyutlan).
3. Operation and construction activities that might lead to excessive sedimentation, erosion, or alteration in the chemical characteristics of coastal sediments should be avoided (case of the channel construction in Cuyutlan).
4. Power plant operations should perpetuate the natural patterns and cycles of tidal activity. Coastal structures like the ones that obstruct the open communication of the channel and the rest of the Cuyutlan change these natural patterns and should therefore be modified to ensure that those patterns are maintained.
5. Power plants in the coastal zone should have contingency

plans which provide response to spills of toxic materials (again the oil spills in Cuyutlan).

6. Power plant designs should emphasize technologies that reduce the incidence of marine life mortality through entrapment, screening, and entrainment.
7. The basic approach to site selection for power plants in coastal areas must be completely changed to meet environmental requirements.

6.4 Transportation.

6.4.1 Ports, Harbors and Marinas.

Ports and marinas are essential for waterborne traffic and as such have became gravitational points for industrial and manufacturing plants. A coastal zone plan should recognize the regional nature of port services and should not permit development activities which have not been carefully planned (United Nations, 1982).

Mexico's economy is highly dependent on maritime transport, about 80% of its export (around 120 million tons) in 1982. This maritime movement is highly dependent on foreign fleets (85% of all the transport), because of the small Mexican fleet. Also the ports and marine terminals have problems of inefficiency and congestion (Secretaria de Programacion y Presupuesto, 1983). The port system consists by 50 kilometers of terminals of which 19 kilometers belong of 25 commercial ports. The most important commercial ports of Mexico in which 85% of the movement is concentrated are: Tampico, Veracruz and Coatzacoalcos in the Gulf of Mexico; Guaymas, Mazatlan, Manzanillo, Lazaro Cardenas and Salina Cruz in the Pacific.

The State of Colima only has one port, Manzanillo, in which the main activities are commercial and military, but there are also some new fishery terminals. It is a natural harbor but is also protected by a breakwater 700 meters long from south to north. The main anchorage area is situated 600 m from the end of the breakwater and has a sandy bottom which is a good holding ground, with depths of 11/12 m (Fig. 18). The port of San Pedrito

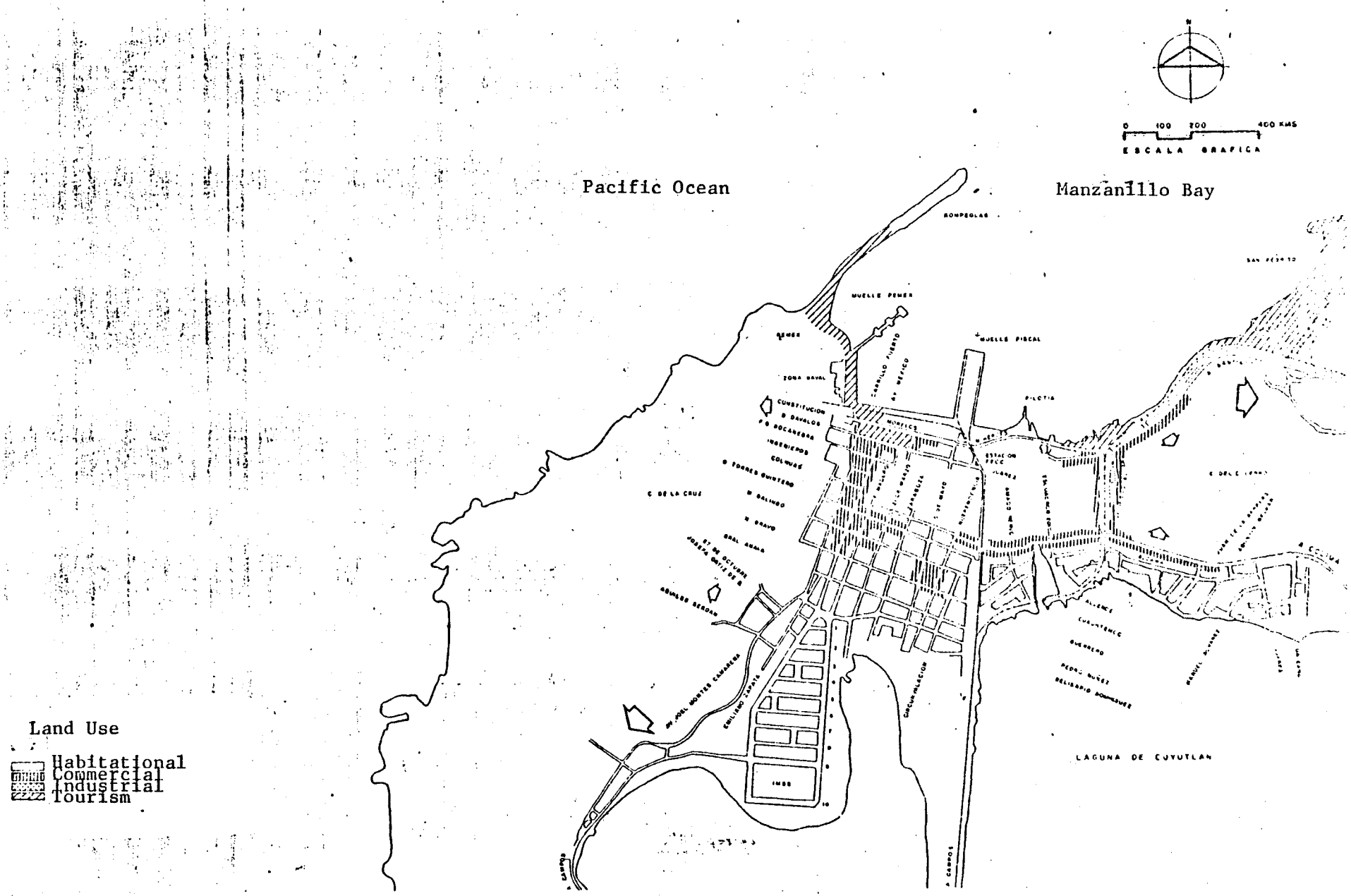


Figure. 18 Manzanillo Port Area.

is to the east of Manzanillo; it is an enclosed port whose entrance is protected by two jetties which have 150 m between their heads and form an access channel with a depth of about 12m (see Fig. 8).

Marine shipping has been the major economic activity of the city of Manzanillo, since 1825. Today it still plays an important role, together with tourism. Operation of the port, however, is inefficient because of complex administration, an infractructure with insufficient installations for the specialized handling of cargo, inadequate space for storage, and inadequate land transport connections. The port is surrounded by the city, which makes it difficult to expand, with the exception of the area of San Pedrito.

Marinas for smaller craft were developed in Manzanillo, since tourism became an important aspect of the economy. Today there are two of them, one situated in San Pedrito Lagoon and the other in the tourism complex "Las Hadas" in Manzanillo Bay. There is a plan to develop another one in Juluapan Lagoon.

Clark (1974), Snedaker and Getter (1984), United Nations (1982) and Maragos et al. (1982), offer guidelines and considerations to take into account in order to protect coastal resources (see applicable guidelines under oil operations):

1. Port operation should be conducted in a manner which maintains ambient-water relationships.
2. All port operations should avoid the discharge of oil and grease into the marine environment.
3. Ports and marinas should maintain the natural equilibrium

between accretion and erosion.

4. Ports, harbors, and marinas should be sited so as to avoid places having critical coastal resources.
5. Ports andmarinas should be placed in areas with the highest available tidal flushing rates, and the access channels should be designed to allow adequate circulation to prevent the creation of a stagnant water column.
6. Spoils from navigational dredging should not be placed in piles or ridges that will block water circulation and affect critical habitats. Excess dredge materials should be used for coastal habitat development and enhancement.
7. Pilings are to be used to elevate marina structures rather than solid fill.
8. Pump-out facilities for boat sewage must be provided.
9. Location and construction of offshore structures such as piers, jetties, groins, bulkheads or breakwaters should be regulated in view of their physical impacts.

6.4.2 Airport.

Urban airports often have been located at the water's edge, where large tracts of wetlands and tidelands are available at low prices and where an unobstructed overwater approach path is available (Clark, 1974). Both construction and operation activities of airport cause ecologic disturbance in noise and pollution.

The state of Colima has only one airport. It is located in the coastal area called "Playa de Oro", about 30 kilometers north of Manzanillo (see Fig. 12).

6.4.3 Roads and Railways

Industrial, commercial, and residential development in the coastal area necessarily requires overland transportation facilities such as roads and railways. Coastal roadways not only alter the land of the road but induce new forms of land use along the road corridor and, through pollution and physical disruption, reduce the quality of coastal ecosystems (Clark, 1974).

The State of Colima has a fair road system (Fig. 19 and 20). There are some problems in the location of roads and railways from the environmental point of view (see chapter, Cuyutlan Lagoon and San Pedrito Lagoon) that affect the hydraulic circulation of some lagoons.

The major guidelines for solving of the problems of the coastal zone of Colima are:

1. Road, railway, and bridge design requirements should include engineering provisions for the maintenance of natural surface water flow characteristics.
2. Planners, designers and engineers should have qualifications that not only demonstrate their professional knowledge of marine engineering but also of coastal ecology.

6.5 Coastal Recreation and Tourism.

Recreation is one of the largest and fastest growing uses of the coastal zone. Recreation has, in fact, become a major economic force in the coastal development. There is no question that the hotel, condominium and cottage rentals, and restaurant businesses associated with coastal recreation are by themselves multi-billion dollar businesses throughout the world.

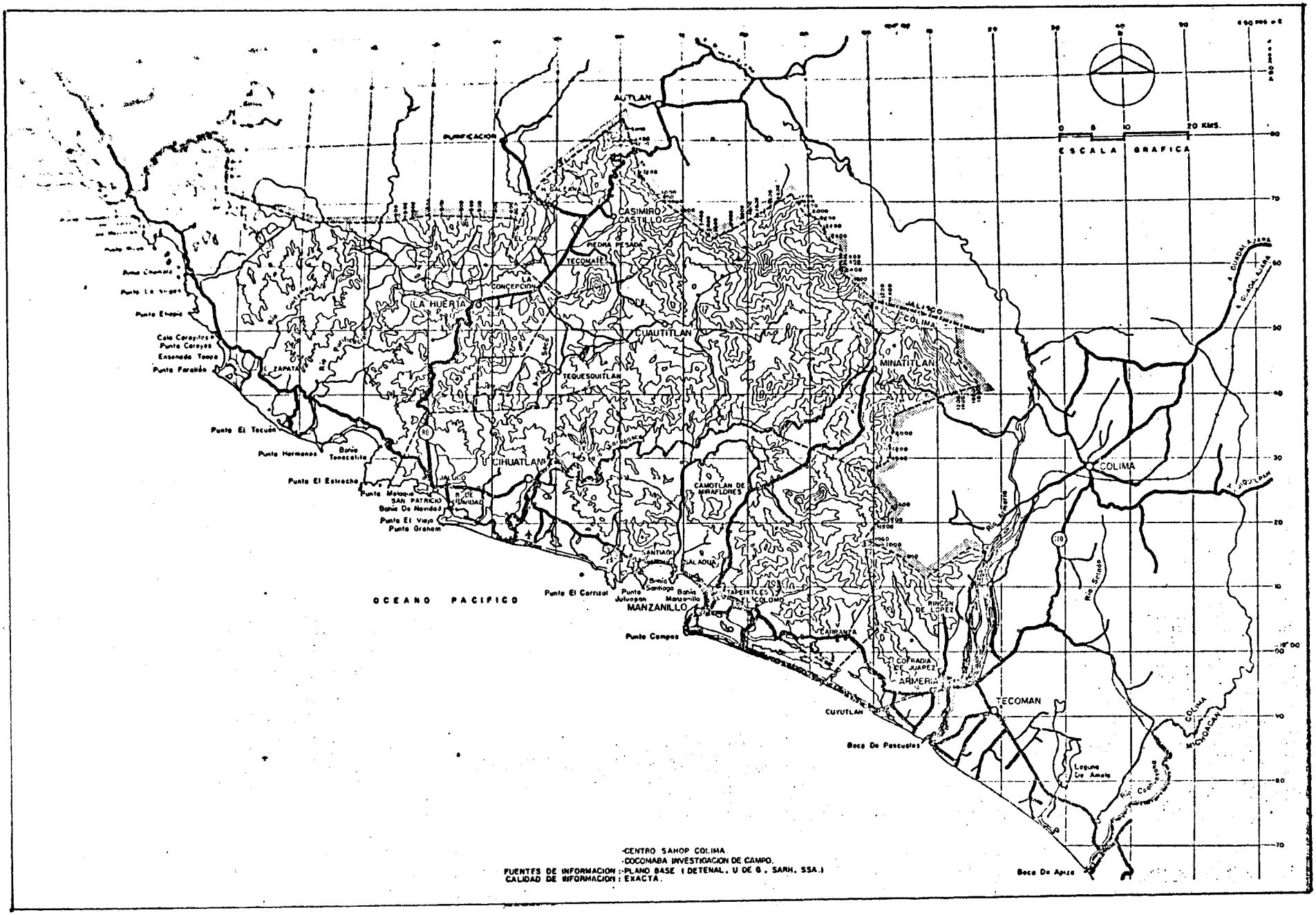


Figure. 19 . Road System of Colima.
(COCOMABA, 1980)

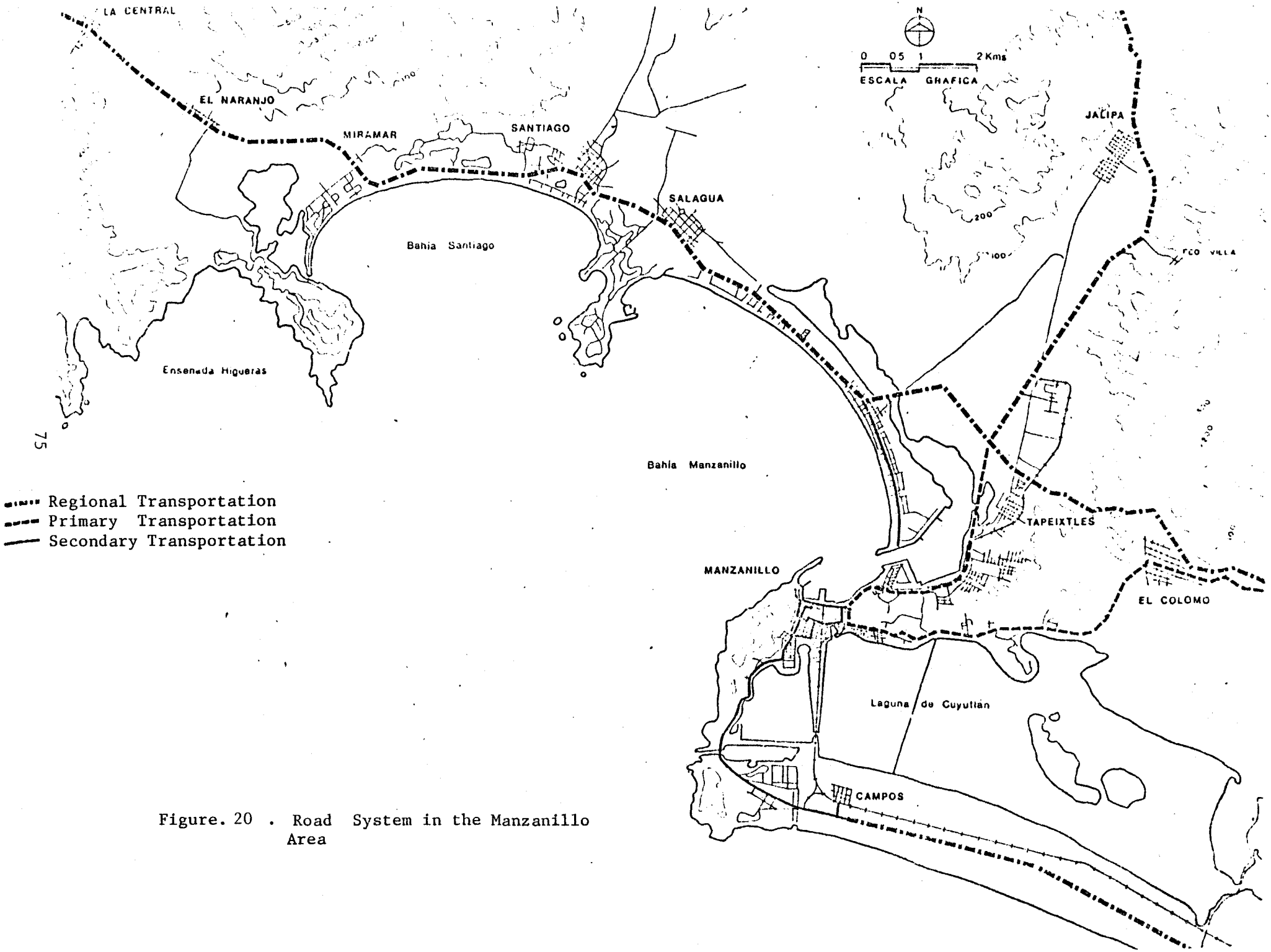


Figure. 20 . Road System in the Manzanillo Area

Coastal environments are been using by broad activities related to recreation like swimming, fishing, skin diving, surfing, boating or just relaxing by local, resident and foreign tourists. With regard for foreign tourism, coastal recreation attractions also stimulate local economic development and represent a significant source of foreign earnings for a national economy. Most coastal environments, in their natural state, offer various kinds of attractive recreational opportunities that only needs access. Other coastal recreational opportunities need development that involves visitor accommodations and other facilities.

In Mexico, the tourism sector in the economic and social development is crucial in to obtaining foreign currency, generating employment and the contributing to regional development. There is a concentration of tourism in the coastal zone of Mexico, because of the great variety in natural, economic, social and cultural attractions. Coastal zone management plans can provide a balanced development of tourism activities together with the utilization of other coastal resources.

In the State of Colima, tourism is an important part of the economy and coastal development. The coastal zone of Colima has beautiful beaches and climatic conditions that make for a major tourist attraction. The main area of local, national and international tourist and coastal recreation attraction is Manzanillo, also known as "the world capital of the sailfish" because of the annual international contest each November.

Manzanillo has six beaches: Playa Azul, Santiago, Miramar, Salahua San Pedrito and Audiencia (Fig. 21). North of Manzanillo there is a long beach called "Playa de Oro", without any development at all. The coastal zone of the municipality of Armeria offers two important coastal recreation areas, Cuyutlan and Paraiso. The coastal zone of municipality of Tecoman also offers four important coastal recreation areas: Boca de Pascuales, Tecuanillo, Boca Apiza and El Real (Fig. 22). The main season of tourism is in winter with the highest peak in March when the holy season begins.

The suitability of coastal areas for recreation depends on the type of shoreline involved, environmental carrying capacity, and the quality of the adjacent water (Ducsik, 1974). There are three basic shoreline units: beach, bluff and wetland. Of these sand beaches can support the widest variety of recreational uses.

The natural constraints on the use of coastal areas for recreation are primarily the limitations of space and access to that space to pursue a particular recreational activity. Climate is also a limiting natural factor. Another non-natural constraint is pollution from industry and from urban waste disposal, which seriously limits and precludes certain recreational activities.

One of the keys to coastal recreation is to offer access to the coast. Homes, business, and industries have often cut off existing access to the coastline, using up available road capacity and off-street parking, and have precluded use of the

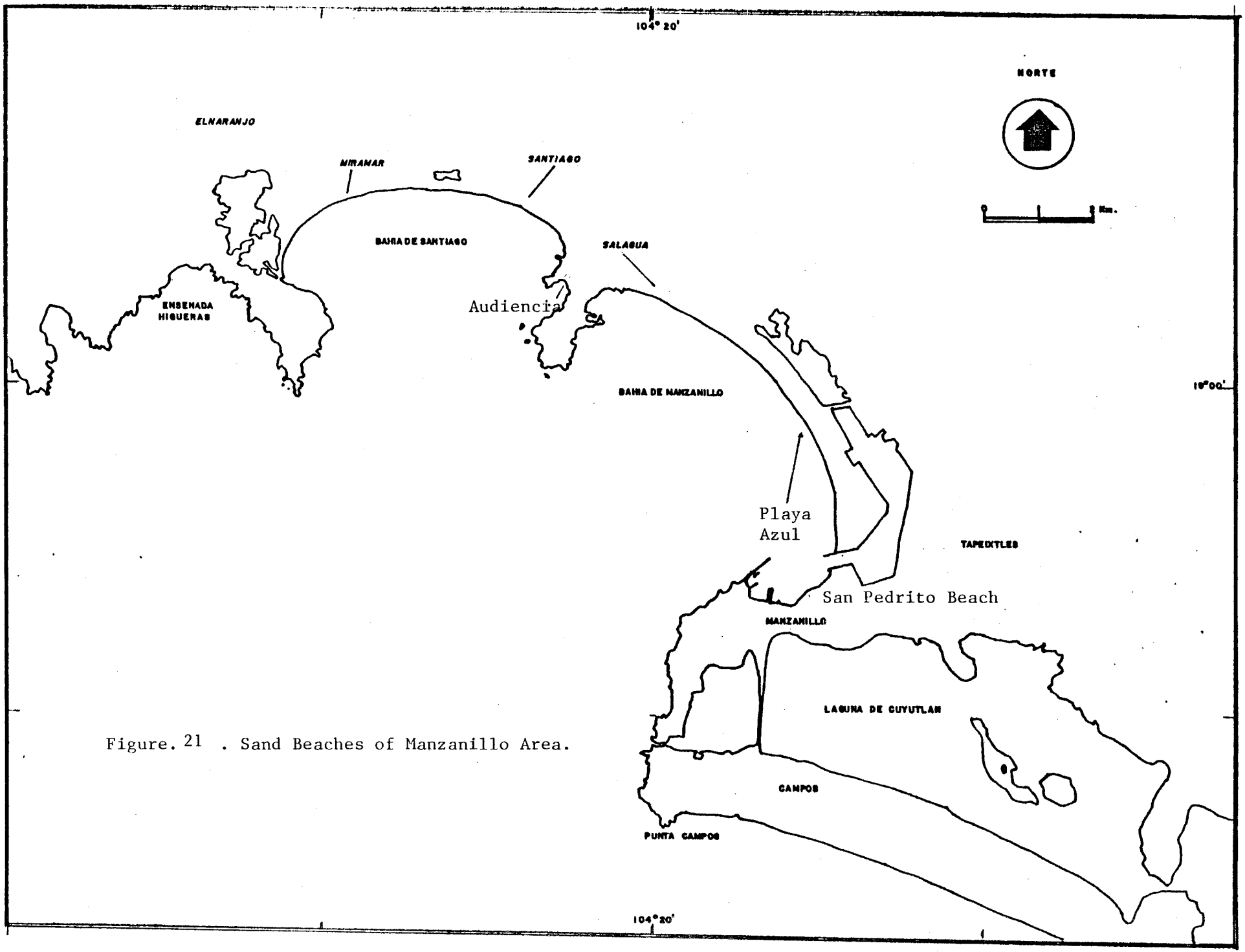


Figure. 21 . Sand Beaches of Manzanillo Area.

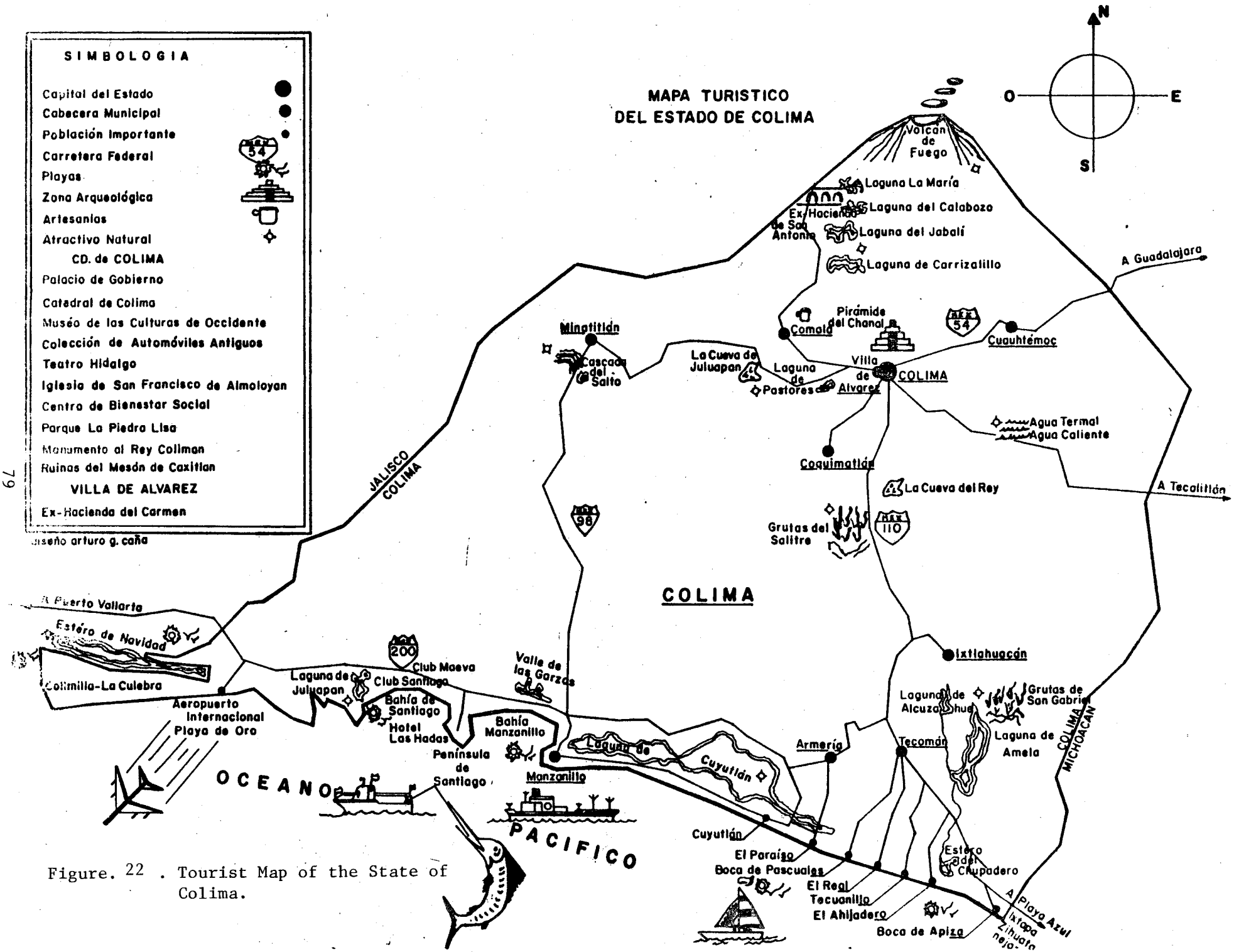


Figure. 22 . Tourist Map of the State of Colima.

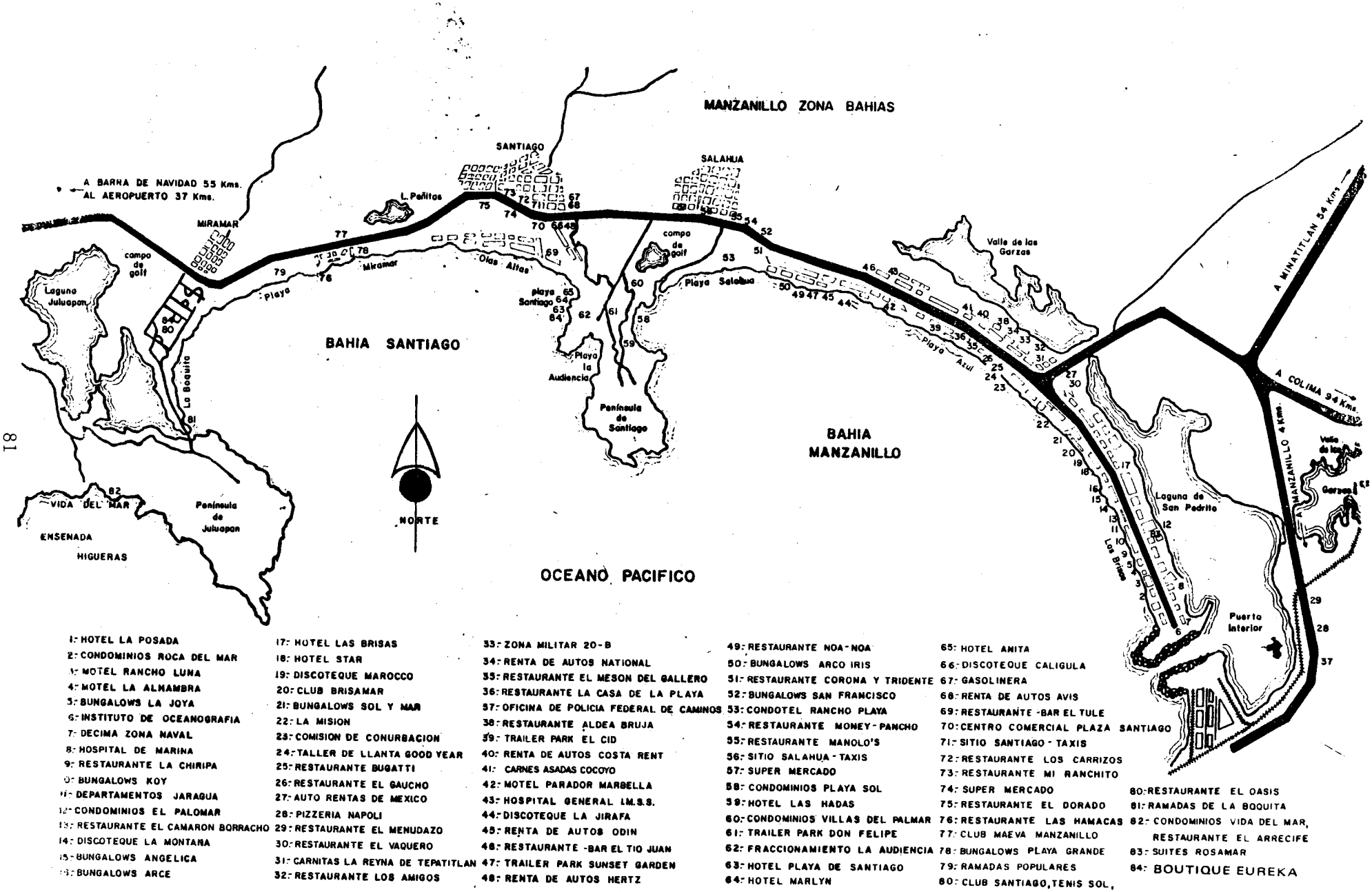
coastline area for recreation. A number of factors must be considered in locating and siting recreation access areas (Spharlar, 1979):

1. Natural character of the site.
2. Existing and proposed land use pattern.
3. User safety and health.
4. Population to be served.

The physical presence of access to the coast is insufficient unless the public also knows where it is located, how they can it, and what is there when they arrive. Coastal access maps are an important tool for informing the public on these three pieces of information (Goodwin, 1979) (Fig. 23).

Beach recreational planning can provide the governmental framework for implementing beach recreation management strategies. This kind of planning involves everything that impacts on the availability, quality and variety of recreation experiences available to the public. Beach recreational programs should be deal with a variety of issues, including:

1. Preservation of existing access.
2. Making better use of existing access.
3. Acquisition of new access.
4. Acquisition of parking areas near to accessways.
5. Improving transportation systems to make access more available to more people, such as those lacking automobile transportation



1: HOTEL LA POSADA
2: CONDOMINIOS ROCA DEL MAR
3: MOTEL RANCHO LUNA
4: MOTEL LA ALHAMBRA
5: BUNGALOWS LA JOYA
6: INSTITUTO DE OCEANOGRAFIA
7: DECIMA ZONA NAVAL
8: HOSPITAL DE MARINA
9: RESTAURANTE LA CHIRIPA
10: BUNGALOWS KOY
11: DEPARTAMENTOS JARAGUA
12: CONDOMINIOS EL PALOMAR
13: RESTAURANTE EL CAMARON BORRACHO
14: DISCOTEQUE LA MONTAÑA
15: BUNGALOWS ANGELICA
16: BUNGALOWS ARCE
17: HOTEL LAS BRISAS
18: HOTEL STAR
19: DISCOTEQUE MAROCCO
20: CLUB BRISAMAR
21: BUNGALOWS SOL Y MAR
22: LA MISION
23: COMISION DE CONURBACION
24: TALLER DE LLANTA GOOD YEAR
25: RESTAURANTE BUGATTI
26: RESTAURANTE EL GAUCHO
27: AUTO RENTAS DE MEXICO
28: PIZZERIA NAPOLI
29: RESTAURANTE EL MENUDAZO
30: RESTAURANTE EL VAQUERO
31: CARNITAS LA REYNA DE TEPATITLAN
32: RESTAURANTE LOS AMIGOS
33: ZONA MILITAR 20-B
34: RENTA DE AUTOS NATIONAL
35: RESTAURANTE EL MESON DEL GALLERO
36: RESTAURANTE LA CASA DE LA PLAYA
37: OFICINA DE POLICIA FEDERAL DE CAMINOS
38: RESTAURANTE ALDEA BRUJA
39: TRAILER PARK EL CID
40: RENTA DE AUTOS COSTA RENT
41: CARNES ASADAS COCOYO
42: MOTEL PARADOR MARBELLA
43: HOSPITAL GENERAL I.M.S.S.
44: DISCOTEQUE LA JIRAFA
45: RENTA DE AUTOS ODIN
46: RESTAURANTE -BAR EL TIO JUAN
47: TRAILER PARK SUNSET GARDEN
48: RENTA DE AUTOS HERTZ
49: RESTAURANTE NOA-NOA
50: BUNGALOWS ARCO IRIS
51: RESTAURANTE CORONA Y TRIDENTE
52: BUNGALOWS SAN FRANCISCO
53: CONDOTEL RANCHO PLAYA
54: RESTAURANTE MONEY-PANCHO
55: RESTAURANTE MANOLO'S
56: SITIO SALAHUA-TAXIS
57: SUPER MERCADO
58: CONDOMINIOS PLAYA SOL
59: HOTEL LAS HADAS
60: CONDOMINIOS VILLAS DEL PALMAR
61: TRAILER PARK DON FELIPE
62: FRACCIONAMIENTO LA AUDIENCIA
63: HOTEL PLAYA DE SANTIAGO
64: HOTEL MARLYN
65: HOTEL ANITA
66: DISCOTEQUE CALIGULA
67: GASOLINERA
68: RENTA DE AUTOS AVIS
69: RESTAURANTE -BAR EL TULE
70: CENTRO COMERCIAL PLAZA SANTIAGO
71: SITIO SANTIAGO-TAXIS
72: RESTAURANTE LOS CARRIZOS
73: RESTAURANTE MI RANCHITO
74: SUPER MERCADO
75: RESTAURANTE EL DORADO
76: RESTAURANTE LAS HAMACAS
77: CLUB MAEVA MANZANILLO
78: BUNGALOWS PLAYA GRANDE
79: RAMADAS POPULARES
80: CLUB SANTIAGO, TENIS SOL,
80: RESTAURANTE EL OASIS
81: RAMADAS DE LA BOQUITA
82: CONDOMINIOS VIDA DEL MAR, RESTAURANTE EL ARRECIFE
83: SUITES ROSAMAR
84: BOUTIQUE EUREKA

Figure. 23 . Tourist Map of Manzanillo Area.

6.6 Coastal Pollution.

Marshes, estuaries, mangroves, seagrass and coral reef ecosystems are among the most productive of all natural ecosystems, marine or terrestrial. Because many of these ecosystems are located on the tropical coast where human population densities are high they are heavily used or are highly exposed to human activities.

The demands on coastal space will continue to grow although the relative importance of the various demands will vary from country to country. In developed countries much of the demand will be for residential purposes, second homes and recreation areas, against a high background level of general exploitation of the coast. In the developing world, the needs of growing industries will receive greater emphasis.

Human activities frequently have a stronger impact on the coastal environment than on that of interior regions. This is partially because there are two fluid media through which harmful effects can spread from one place to another, air and water. Furthermore, the coastal area is in a state of dynamic equilibrium, so that the modification of any one natural process can cause a chain reaction upsetting other processes and finally disturbing the equilibrium of the whole system over a wide area. There are two types of environmental degradation: direct effects such as the destruction of living resources and creation of human health hazards through pollution; and indirect effects, such as the reduction of marine photosynthesis by residual hydrocarbons which remain even after gross pollution is eliminated (Maragos

et al., 1983).

In the coastal area economic activities can easily have adverse effects upon one another, partly because of limited space, but also because of diffusion of waste products and side effects through air and water and because of the fragility of the natural environment system upon which an industry may be based. Thus, production of one economic "good", say petroleum, may also involve the construction of platforms and terminals and inadvertent oil spills, which adversely affect the fishing and tourism industry.

Inland activities can have pronounced effects on the coast. Deforestation, farming and mining in drainage basins can result in increased erosion, increased sediment load in the river, and hence silting up of harbors and estuaries.

In the industrialized countries, the preservation of amenities and the environment is often the cause of concern; in developing nations the diversification of the coastal economy away from a dependence or traditional activities such as artisanal fishing is a common objective of national policy (Chacko, 1973).

The main route by which the principal pollutants enter the marine environment are (Ruddle, 1981):

1. The disposal of treated and untreated domestic seawage either by direct outfall into marine water or via rivers.
2. The disposal of manufactured or industrial products either by direct outfall or via rivers.
3. The disposal of effluents resulting from electricity genera-

tion either by direct outfall or via rivers.

4. The runoff from the land containing chemicals and their residues, used in forestry, agriculture or public health activities.
5. The exploitation of the seabed for petroleum or other minerals and deep sea trawling.
6. The operational discharge of polluting materials by ships and onshore installations during the course of their normal operations.
7. The deliberate dumping of materials from the ships.
8. The accidental release of materials through accidents to ships and submarine pipelines.
9. The transfer of pollutants to the ocean from the atmosphere.

In the coastal zone of Colima, the area of Manzanillo is where most pollution problems exist. We can detect four major sources of pollutants in the area:

1. The coastal thermoelectric plant power.
2. The ships and the port activities with the unloading and loading of fuels.
3. The disposal of domestic waste of Manzanillo.
4. The industrial waste of the mineral proccessing plant "Pena Colorada".

The coastal power plant and its impacts have already been discussed and include its thermal discharge, possible spills from oil pipeline and the discharge of chemicals used for biofouling control. The impact of the ships and port activities in the area have also been discussed and include oil spills and

discharges. The domestic wastes Manzanillo are mainly from three sources: kitchens, laundry rooms and bathrooms. There is no treatment of domestic waste and the problem has become worse due to population increase (Fig. 24). The mineral processing plant (iron pellet) "Peña Colorada" its waste is not fully evaluated, but there is primary treatment of its waste.

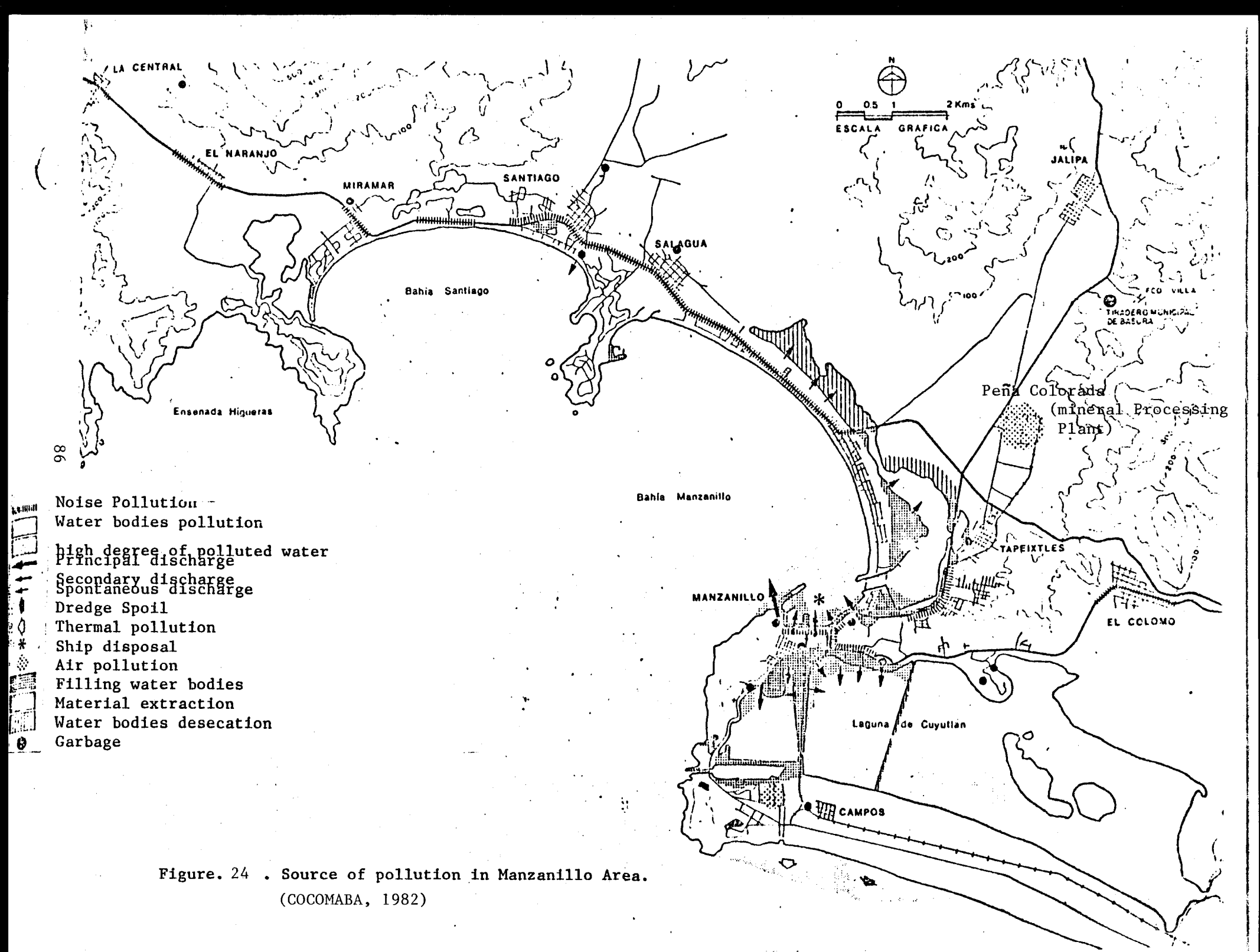


Figure. 24 . Source of pollution in Manzanillo Area.
(COCOMABA, 1982)

6.7 Coastal Mineral Resources.

The coastal and nearshore marine environment is a source of a variety of minerals of geological and biological origin that have been extracted, and utilized by man. The mineral resources of any giving coastal zone are directly related to its geological history and structure and to its hinterland. The existence of many mineral resources is also directly dependent on the inherent nature of the coastal zone as an area of interaction between land, air, and marine and freshwater (Kenneth and Manshard, 1981).

Ketchum (1972), divided in four types of mineral deposits found in the coastal zone:

1. Marine placers, those deposits that are accumulated by the winnowing of light minerals away from heavy metals-bearing minerals in response to waves and currents.
2. Lodes, those deposits that contain metal-bearing minerals in preexisting rocks and that are not related to present marine processes but do occur in the present coastal zone.
3. Chemically precipitated mineral deposits, like ferromanganese nodules.
4. Buried stream placers, which were formed during the last Ice Age in stream valleys when the sea level was lower but are now covered by the ocean in the present level; and minerals recovered from solution in sea water.

Among the more common minerals are building materials and construction aggregate (rocks, gravel, sand and coral), fertilizer components (limes and phosphates), jewelery (semi-

precious coral and shells), placer deposits metals (tin, chromium, manganese and titanium), and oil and gas.

Because they are at or near the surface, many of these minerals are extracted primarily by dredging. Dredging for surface or nearshore minerals disturbs the bottom and results in increased turbidity and siltation, which can adversely affect the natural bottom communities both at the mining site and nearby. Increased turbidity also reduces light penetration and thereby reduces photosynthesis and the biological productivity of the area. On other hand, it is possible that increased nutrients released by the dredging operations could have the opposite effect and stimulate plant growth (Ketchum, 1972). The mining of sand , gravel and placers in the immediate offshore area or on beaches, could lead to a disturbance in the nearshore equilibrium and the erosion of adjacent coastal areas to redress the balance. Alternatively, offshore sediment transport could be enhanced, possibly necessitating the making of new bathymetric charts in order to maintain safe navigation. Disturbance of fish breeding grounds is another possible effect of shallow water offshore mining (Cronan, 1980). The possible effect of nearshore mining on the recreational use of the beaches must also be considered. Sometimes these effects would probably be too high a price to pay for the minerals extracted.

Mexico has an ancient tradition in mineral activities but only in the last 40 years has offshore minerals extraction mainly oil and gas, begun. There are some other mineral extractions like magnesium, salt and water from sea water and

phosphates. In Colima, however, the only mineral extracted from the sea is sodium chloride (salt), with a production of 30,000 tons/year in the Cuyutlan Lagoon. There are no oil prospects at the present time but the possibility of finding oil still exists.

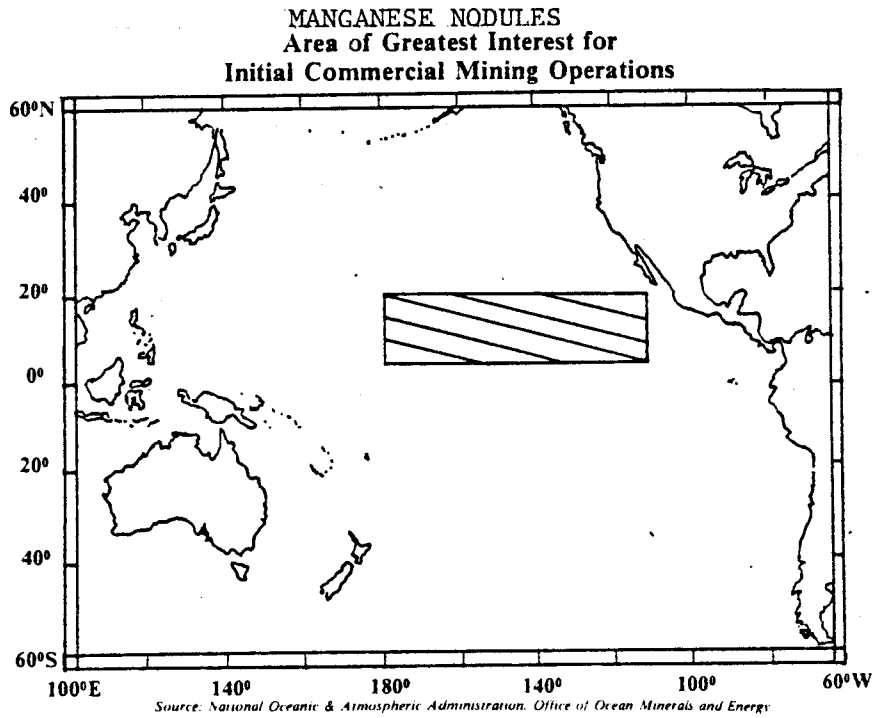
Another important issue we have to consider is the possibility of land-based minerals processing plants or operations to support offshore mining. Figure 25 shows the area of interest for commercial mining operations for manganese nodules. The area of Manzanillo is in a strategic position for land-based operations in support of such an effort.

Roels (1974) and DeBois and Towel (1984) have developed a series of guidelines for mineral activities at sea, also the same guidelines of pollution and oil operation activities can be applied here:

1. The establishment of baseline conditions in the potential mining area.
2. The environmetal monitoring of mining operation.
3. The documentation of changes induced in benthic and pelagic ecosystems by the mining and evaluation of their implications in relation to the current and potential marine resources.
4. If necessary, the recommendation of changes in mining methods and equipment use, based on the fact established in (2) and (3).
5. Mining of living coral reef should be prohibited.
6. Mining of beach sands should be discouraged.
7. Mining should be recommended to be sufficientely distant from the coast and in deep water.

8. The formulation of environmental criteria and regulations for future mining operations to minimize harmful environmental effects.

9. New salt production ponds and the expansion of existing ponds should be planned to minimize the overall impact on coastal habitats, mainly from interference with natural surface water flow patterns.



(from Robb, 1981)

Figure 25

VII. INSTITUTIONAL ASPECTS OF COASTAL MANAGEMENT

Jurisdictional authority in Mexico the coastal zone is divided along several important boundaries. On the land side of the coastal zone, state law and sovereignty dominate, with the associated police powers for the regulation of public health, safety and general welfare. The federal government typically exercises little authority on the land side of the coastal zone. The salient point is that the bulk of the decisions on the land side of the coastal zone are zoning and other regulatory decisions made at local levels of government.

Decisions concerning the use of the coastal zone are now made by a variety of governmental units. Many direct allocative decisions are made through market transactions in the private sector. The failure to give adequate weight to the ecological effects of human activity is usually attributed to the existence of many decision points which can influence how the coast is used. Some, such as local units of government, are seen as too small in scale. At the state and federal level, the belief is that there are too many agencies involved and that their responsibilities overlap and even conflict in some cases. This type of analysis is the basis of the frequently made recommendation that there should be new, fewer and larger public agencies and that they should have special and clear-cut authority to manage the coastal zone.

A major function of coastal zone management agencies will not be to administer an existing body of knowledge, but to facilitate and provide incentives for the generation of

substantially more information than now is available. Ketchum (1972) suggested that whatever their scale and formal characteristics, there are certain similar functions which agencies with a major responsibility for coastal areas will carry out. These include:

1. Regulating or prohibiting phenomena which are determined to have negative effects of an unacceptable degree.
2. Allocating or rationing coastal resources among potential users when the demand exceeds the supply.
3. Determining ways of increasing the carrying capacity of the coastal zone to increase the supply of socially preferred or necessary resources.

In general terms there must be a set of criteria for coastal zone decision processes to respond to and to allow a balance to be struck among various uses. The criteria should include economic, physical, biological, social and psychological values. Cost benefit measures in economic terms are by far the best developed and most accepted form of calculating values.

In terms of division of responsibility, the federal government should provide the leadership by developing a national coastal zone policy; designate a lead agency to coordinate the many relevant coastal functions of federal government; assist the states in carrying out coastal zone management; delegate most authority to states and set performance standards. This could be accomplish in Mexico by developing an agency that coordinates the policy of the different federal secretariats (SEDUE, SEPESCA, SCT, SM, SECTUR and SEMIP) that are involved in the coastal zone.

The state should be the focal point of coastal zone management. It must define its coastal zone. It must understand its coast socially, economically and environmentally. It must develop a plan that articulates objectives and ensure that the plan is implemented. To accomplish this, Colima has to develop an agency that coordinates the federal and state agencies (fisheries, tourism, urban development and ecology, and agriculture), and the university and municipalities (Manzanillo, Armeria, and Tecoman).

Local governments will make many management decisions, as long as they are in harmony with a state plan. Local government should in its planning process identify those areas that are primarly of local concern and, using the state and federal guidelines, participate with the higher level of government in the determination of those areas which are of state, regional or national significance. Manzanillo, Armeria and Tecoman must have an active role to ensure that all interested and affected sectors participate in the planning process.

It is not a purpose in this project to develop a program or to speculate what would be the final policy of the State of Colima under a CZM program, however, its is establish a tentative framework for a CZM program for Colima is presented in the figure 26. The state CZM agency should coordinate all the development in the coastal zone of Colima through the different federal and state agencies, giving the advice and approval to the local government for any development of its coastal jurisdiction. For example if there is an industrial development in the coastal

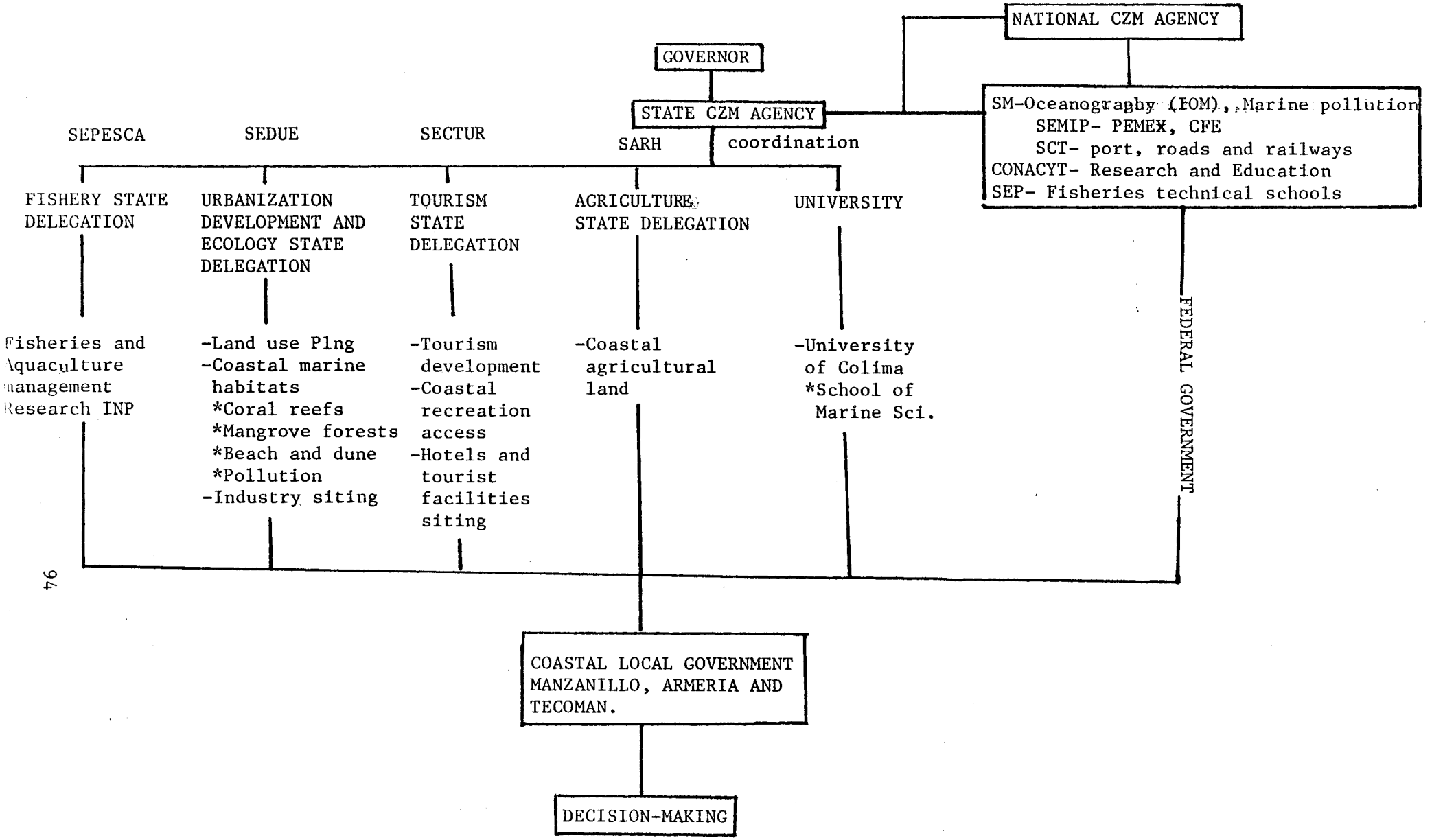


Figure 26. Coastal Zone Management for Colima: Tentative Organizational Framework

area of Manzanillo, the permits process should be through the urbanization development and ecology agency so this that agency could evaluate the application according to the state CZM program. If this application is in according with the CZM program, the urbanization development and ecology agency should summit the application to the CZM agency in order to give the approval and give to the local government of Manzanillo any specifications that they should implement. The local government of Manzanillo give the final approval. If the agency found any problems in the application with the state CZM program, the application should be rejected. The urbanization development and ecology agency and the state CZM agency should help the proposed project in meeting all the requirements.

According to Ketchum (1972) and United Nations (1982), coastal zone authorities should satisfy the following requirements:

1. No coastal zone management authority should exist without sufficient authority and financing to achieve its objective.
2. Management personnel must have a high level of understanding and compentence in the scientific, social and economic aspects of the coastal zone.
3. All coastal zone users must understand the multiple-use concept as a management principle for the coastal zone resources.
4. Atthe national level,a single specific agency should have responsibility and primary authority for the development and guidance of an integrated national program for coastal zone

management and use.

5. The appropriate federal coastal zone management authority should establish uniform standards for mapping, resource inventory and data collection.
6. Effective coastal zone management must begin in the uplands and continue into the sea. It must be flexible enough to cope with the multilevel and multidimensional problems. The coastal zone management authority must possess the jurisdiction and diversity of competence to handle the coastal zone problems as a single unit.
7. State administered coastal zone programs should have the authority to specify use classification within their coastal boundaries. The state's coastal zone management authorities should administer a permit system based on their comprehensive plans to regulate selected activities within use classifications.
8. The CZM authority should classify proposed coastal zone uses according to their dependence on coastal zone resources and it should give preference to those uses that are exclusively dependent on the coastal zone. The CZM authority should assure that all coastal zone users adhere to the principle of minimum use impact, regardless of what use policy the authority selects.
9. Each state coastal zone program should develop and maintain a resource classification and inventory system that describes the coastal zone spatially and temporally. Coastal zone management authorities will update the inventory system periodica-

lly. The inventory program should be sufficiently detailed to permit the authorities to evaluate impacts and changes due to man's activities in the coastal zone.

10. Each state's coastal zone management authority should develop a comprehensive long-range plan to guide the allocation of coastal resources. Plan implementation should include incentive policies as well as regulatory programs.
11. State authorities should place high priority and emphasis on the local government's and the general public's involvement and participation in evolving coastal zone plans and programs. States should use incentive grant programs to promote such involvement.
12. Each state coastal zone authority should function administratively independent of other agencies. It should utilize the information and expertise of other appropriate agencies to obtain relevant information and data to assist in the management process, to establish criteria for management, and to enforce the standards and regulation the authority establishes.
13. The coastal authority should determine standards and regulations that state and local agencies should use. The regulatory process should be at the lowest possible administrative level within the management structure.
14. The state coastal zone management authority should require that all proposed projects, publicly or privately sponsored, file an impact statement if the authority anticipates that the project could have a significant impact on social

economic or environmental coastal zone conditions.

This present project does not deal in detail with issues surrounding establishment of a national CZM program for Mexico. Even if a national program is not developed, the coastal states of Mexico should still be aware of the benefits of coastal zone management. States should develop and implement a mechanism for conservation of coastal resources. The State of Colima has the opportunity to be the first to develop and implement such a CZM program because of the present explicit support of the federal government in the Plan of Colima.

The federal government agencies can help the state in provide funding for acquire information and assist in the management process. In order to implement the program and the management authority, the state has to develop the appropriate legislation. The local government should promote public participation in all the planning process, and all the interested sectors should also an active role in let them know their interest.

There are all the ingredients at the present time to develop a CZM program to help achieve the goals of the Plan of Colima. There already exists a research and organizational infrastructure to accomplish the process. For example, vital coastal information and research could be done by IOM, INP, COCOMABA, and School of Marine Science.

VIII. CONCLUSIONS AND RECOMMENDATIONS.

In this report, I have reviewed some of the important issues of the coastal zone of Colima that should be taken into consideration in a coastal zone management program. Below I have summarized some important conclusions and recommendations that the authorities should evaluate in order to facilitate a better understanding of the management of the coastal areas.

1. Conclusion: Coastal zone management has proved to be a useful tool in many countries in order to resolve conflicts, preserve critical areas, and to increase the carrying capacity and uses of the coastal areas.

   Recommendation: A national CZM program should be considered for Mexico.

2. Conclusion: The State of Colima has experienced a great increase in coastal development over the last 10 years and it is expected to continue to experience further rapid development in all economic sectors. Environmental problems are already significant and can be expected to get worse if strong regulations and policies are not put in place to deal with the critical coastal issues.

   Recommendation: A coastal zone management program for the State of Colima should be developed in order to deal with coastal zone problems, development and preservation of coastal resources.

3. Conclusion: The State of Colima has important ecological systems within its coastal area that have potential value

for fisheries, recreation and science. They need protection. Recommendation: There is a need to establish a system of protected areas, including natural and critical habitat preserves all along the coast (e.g., mangrove forests, coral reefs, dunes).

4. Conclusion: There are also several natural hazards that should be taken into consideration when developing Colima's coastal areas, such as hurricanes, earthquakes, coastal erosion and tsunamis.

   Recommendation: A restricted development area system should be developed and implemented where the above hazards are the greatest.

5. Conclusion: There are traditional technical considerations and guidelines for CZM programs that may be useful for the State of Colima.

   Recommendation: Steps the State of Colima needs to take:

   1. Define the management boundaries of the coastal zone.
   2. Identify problems and opportunities in the coastal zone.
   3. State the goals, objectives (e.g., the maintenance, restoration, and enhancement of the overall quality of the coastal zone environment; the continued existence of optimum populations of all species; the orderly, balanced utilization and preservation of all living and non-living coastal zone resources), and policies of the proposed CZM program.

4. Specify the procedures to be followed to develop the CZM plan.
5. Inventory and map coastal resources and uses.
6. Identify sub-regions, on the basis of the relationships between ecosystems and potential and existing uses (e.g. Manzanillo area).
7. Specify which coastal policies will be implemented in each area or region.
8. Outline how the policies will be implemented.
9. Prepare a draft plan, coordinate with other agencies and obtain public input.

6. Conclusion: Insufficient data exist to adequately develop a CZM plan for Colima.

   Recommendation: A research plan and resource inventory should be developed and implemented, based on evaluation of the issues and problems of importance, some of which are discussed in this report. Research that should be done:

   1. A resource inventory should be developed and presented in maps or atlas for the use of planners. Remote sensing surveys, selected field surveys, interviews, and reviews of published information can be a valuable tool for such maps.
   2. Basic biological, chemical and physical research directed toward the following types of problems in the coastal zone:
      a. Transport, dispersion and cycling of nutrient and hazardous chemicals as they affect the functioning and stability of coastal zone ecosystems.
      b. Surveillance of input levels of contaminants, especially

domestic waste, chlorinated hydrocarbons, petroleum and heavy metals.

c. Effect of solid waste disposal.

d. Assimilative capacity of the coastal zone for all kinds of wastes.

e. Recovery processes for damaged ecosystems.

f. Factors affecting stability, diversity and productivity of coastal zone ecosystems.

3. Research in the legal, political, economic and social aspects of the coastal zone should be directed toward the following types of problems:

a. Study of laws that control, limit, and promote coastal zone implementation.

b. Exercise of property rights in wetlands and shore areas.

c. Interests and political pressures in the coastal zone.

d. The decision-making process for the coastal zone at local, state and federal levels.

e. Value systems that affect management practices in the coastal zone activities.

f. Cost-benefit analysis of ultimate uses of the coastal zone, including ecological effects.

7. Conclusion: Many mistakes have been made in the past by engineers, administrators and various decision-making authorities on development and planning of the coastal area of Colima.

Recommendation: Extension education programs are needed,

for both, oficials government and general public, including workshops, pamphlets, courses, on coast ecology, environmental impact assessment methods, coastal zone management to increase understanding and appreciation of coastal zone development decisions.

8. Conclusion: The Manzanillo area is where most of the coastal development and environmental problems have occurred in the past. More problems will occur here in the future.
   Recommendation: There is a need for Special Area Planning for the Manzanillo area with plan components:
   a. Land use and zoning.
   b. Pollution control.
   c. Critical habitat protection/restoration.
   d. Port/harbor development.

9. Conclusion. There are all the ingredients at the present time to develop a CZM program to help to achieve the goals of the Plan of Colima.
   Recommendation. A state CZM agency should be established as an independent agency, with its expertise and primary responsibility exercised in cooperation with other state and federal agencies involved in the coastal zone. Local governments should be strongly encouraged to participate in the planning process within the guidelines of the state coastal zone program.

In summary, the State of Colima could improve the utilization and management of its coastal resources if a CZM program is

implemented. Scientists, politicians, planners, decision-makers, environmental organizations and the public in general are important in applying pressure upon the authorities so that the appropriate legislation for developing a CZM program can be enacted. This report is a tentative effort in this direction.

IX. LITERATURE CITED

Alverson D., 1973. Objectives and problems of managing aquatic living resources. Jour. Fish. Res. Board Canada, Vol. 30, No 12 p. 1936-1947.

Anonymous, 1984. The dynamics of Mexico's fishing industry. Business Mexico, November, 1984, P. 88-97.

Ayala Castañares A., 1983. Problematica para el uso y el aprovechamiento de los recursos marinos en los paises de America Latina. Primer Curso Latino-Americano Sobre Planificacion de los Recursos Marinos. Mexico, D. F., Mayo 17-25, 1983.

Benn ed., 1979. Ports of the World. Benn Publications, 32 ed.

Bowen, R. E. and T. M. Hennessey, 1984. Adjacent state issues for the United States in establishing an Exclusive Economic Zone: The cases of Canada and Mexico. Oceans '84, Conference Marine Technology Soc. p. 444-448.

Carlander, K., 1969. An operational functional classification of fishery management techniques. Verh. Int. Verein. Limnol. 17: 636-640.

Chacko E., 1973. Planning coastal area development: a comprehensive framework. Proc. Tenth Annual Conference Marine Tech. Soc p 185-195.

Chavez, J. C., 1982. Consideraciones sobre habitos alimenticios de ocho especies de peces de la Laguna de Cuyutlan, Colima en verano de 1980. Tesis Profesional, Universidad Autonoma de Baja California, Escuela Superior de Ciencias Marinas, p. 78.

Clark J., 1974. Coastal Ecosystem. Ecological Consideration for Management of the Coastal Zone. The Conservation Foundation.

Clark J. and W. Brownell, 1973. Electric power plants in the coastal zone: environmental issues. American Littoral Society special publication No 7.

COCOMABA, 1980. Plan de ordenacion de la zona conurbada de Manzanillo-Barra de Navidad: 1-a bases. Comision de Conurbacion de Manzanillo-Barra de Navidad.

COCOMABA, 1982. Plan director urbano del centro de Manzanillo. Comision de Conurbacion de Manzanillo-Barra de Navidad.

COCOMABA, 1982. Aptitud territorial: franja costera municipios de Cihuatlan y la Huerta. Comision de Conurbacion de Manzanillo-Barra de Navidad.

Cowardin L, Carter V., Golet F., and E. LaRoe, 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31.

Cronan, D. S., 1980. Underwater Minerals. Academic Press.

Cruz A., 1984. A realistic approach to the use and management of mangrove areas in Southeast Asia. In H. Teas [ed.] Physiology and Management of Mangroves. Task Vegetation Sci. 9, Junk Publ.

Culler P. and C. Bird., 1980. Managing coastal dunes in South Australia. Coastal Zone '80, American Soc, of Civil Eng: 1253-1268.

Departamento de Pesca, 1981. Alteraciones naturales y artificiales en la Laguna Juluapan, Colima. Delegacion Federal de Pesca en el Estado de Colima, P. 10

Dov P. F., 1984. The ecosystem of the mangal: General considerations. In F. Dov [ed.] Hydrobiology of the Mangal. Development in Hydrology 20, Junk Publ.

DuBois, R. and E. W. Towle, 1984. Coral and sand mining. Case Study No 6 report to AID and NPS. Washington.

Ducsik, D. W., 1974. Shoreline for the Public. The MIT Press.

E.P.A., 1972. Proceedings in the matter of pollution of Mount Hope Bay and its tributaries. U.S. Environmental Protection Agency 2 vols: 643 p.

Gobierno Constitucional de los Estados Unidos Mexicanos y Gobierno Constitucional del Estado de Colima, 1983. Plan Colima.

Gold, S. M., 1979. Componentsof a recreational access plan. Proc. of a Forum on Recreational Access to the Coastal Zone: 115-123.

Goodwin R. F., 1979. Seattle shoreline access and viewpoints map. Proc. of a Forum on Recreational Access to the Coastal Zone: 24-27

Griffiths, J. F., 1976. Applied Climatology: An Introduction. Oxford University Press. Second ed. 136 p.

Heald E., 1971. The production of organic detritus in a South Florida estuary. University of Miami Sea Grant Tech Bull. 6.

Johannes R., 1972. Marine pollution in shallow tropical waters. FAO-SIDA, Training course on marine pollution in relation to proctection of living resources. FAO-SIDA Goterborg.

Kenneth R., and W. Manshard, 1981. Renewable Natural Resources and the Environment. Pressing problems in the developing world. United Nations University Publ. 396 pp.

Ketchum, B. H., 1972. The Water's Edge: Critical Problems of the Coastal Zone. Massachussetts Institute of Technology, Cambridge

Mass.

Knecht R., Cician B., Broadus J., Silva M., Bowen R., Marcus H. and S. Peterson, 1984. The Management of Ocean and Coastal Resources in Colombia: An assessment. Woods Hole Oceanographic Institution, Technical report WHOI-84-21.

Knutson P., 1978. Planting guidelines for dune creation and stabilization. Coastal Zone '78. American Soc. of Civil Eng: 763-779.

Lau Cham, S., 1984. Assessment and monitoring of marine pollution in Manzanillo and Santiago Bay. Master and Science Special Project Report, Oregon State University, p. 41

Longley W., Jackson R., B. Snyder, 1978. Managing oil and gas activities in the coastal environments. FWA/OBS-78/54.

Maragos J., Soegiarto A., Gomez E., and M. Dow, 1983. Development planning for a tropical coastal ecosystems. In R. A. Carpenter [ed.] Natural System for Development: What planner need to know Macmillan Publ. Co., 495 pp.

Marr J. C., 1972. Information for real-time decision and for understanding in fishery science. Progress in Fisheries and Food Science. Univ. of Wash. Publ. Fish. New. Ser. 5: 29.

Marr J. C., 1982. The realities of fisheries management in the Southeast Asian region, 299-307. In Pauly, D. and G. I. Murphy (Ed.) Theory and management of tropical fisheries. ICLARM Conference Proc. p. 360.

Mena, H. A., 1979. Contribucion al conocomiento de los factores que influyen en la productividad de la Laguna de Cuyutlan, Col. con enfasis en el camaron. Tesis profesional, Facultad de

Ciencias UNAM p. 46.

Morton J., 1976. Mangrove and reclamation. Information series No 13, 5pp Nature Conservation Council. Wellington. New Zealand.

Nordstrom K. and N. Psuty, 1983. The value of coastal dunes as a form of shore protection in California, USA. Coastal Zone'83 American Soc. of Civil Eng. p. 873-885.

Odum W. E., 1971. Pathways of energy flow in South of Florida estuary. Univ. of Miami, Sea Grant, Tech. Bull. 7: 1-162.

Odum W. E., 1972. Ecologia. Ed. Interamericana, 3ed. 639 pp.

Odum W. E., 1976. Ecological Guidelines for Tropical Coastal Development. World Wildlife Fund, IUCN Publ., News series 42.

Pilkey, O. and M. Evans, 1982. Rising seas shifting shores. Oceans, January 1982, p. 65-69.

Pillay T. V., 1967. Estuarine fisheries of the Indian Ocean coastal zone. In Lauff, G. H. [ed], Estuaries. American Ass. for the advancement of Science, Washington, D.C.

Robb, D., 1981. The politics and technology of deep ocean mining. Sea Technology, August, 1981, p. 25-31.

Roels, O., 1974. A suggested procedure to ensure the safe development of deep-sea mining. Tenth Annual Conf. Marine Tech. Soc. Proc., p163-170.

Ross D., 1978. Opportunities and Uses of the Ocean. Spring-Verlarg.

Ruddle, K., 1981. Pollution in the marine environment of ASEAN countries. In Frontiers for Development: The Southeast Asian seas. Chia, L. S. and McAndrews, C. [ed.]. McGraw-Hill.

SAHOP, 1979. Ecoplan de Estado de Colima. Secretaria de

Asentamientos Humanos y Obras Publicas.

Secretaria de Programacion y Presupuesto, 1981. Manual de estadistica del Estado de Colima. Coordinacion General de Servicios Nacionales de Estadistica Geografica e Informatica.

Secretaria de Programacion y Presupuesto, 1983. Plan Nacional de Desarrollo 1983-1988: Poder Ejecutivo Federal.

Snedaker, S. C. and C. D. Getter, 1984. Tropical Coastal Resources Management. A Guidebook for Coastal Resources Conservation and Development: Review Draft. AID/NPS Cooperative Program, International Affairs Programm, National Park Services RPI/SR/84-1

Sorensen, J., McCreary S., M. Hershman, 1983. Institutional Arragements for Coastal Resources Management: Review draft.

Spharlar, L., 1979. Design constraints on providing coastal accessways. Proc. of a Forum on Recreational Access to the Coastal Zone:53-56.

United Nations, 1973. Economic significance, in terms of sea-bed minerals resources, of the various limits proposed for national jurisdiction. A/AC.138?87, p. 34.

United Nations, 1982. Coastal Area Management and Development. Pergamon Press.

Yañez-Arancibia, A., 1977. Sobre los estudios de peces en las lagunas costeras: Nota cientifica. An. Centro Ciencias del Mar y Limnologia, UNAM, 2(2): 53-60.