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MEXICO'S CARIBBEAN FISHERY: RECENT CHANGE AND CURRENT ISSUES

The University of Wisconsin - Milwaukee PH.D. 1982

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Abstract

Mexico's Caribbean Fishery: Recent Change and Current Issues

By

David L. Miller, Ph.D.

The University of Wisconsin-Milwaukee, 1982

Under the Supervision of Professor Clinton Edwards

For some 400 years before Spanish occupation, coastal areas of Quintana Roo were virtually abandoned and marine resources were relatively undisturbed. Prior to this time, the Maya may have exploited extensively the area's marine fauna. Also, they may have overharvested, particularly turtles, conch and reef fish, even before the Late Classic (A.D. 600-888) when population was at its apparent zenith.

Effective resettlement of Quintana Roo did not begin until about the turn of the century, and population growth was slow until recently. It was not until the mid-1970's that the current inhabitants outnumbered estimates of the Maya population at the time of first European contact (1511-1519).

Recent historical accounts, production data, and information from fishermen's oral histories reveal that massive and wholesale exploitation of the marine resource did not begin until after the middle of this century. In this context, the evolution and present-day status of the fishery is documented. The organization and regulation of fishing effort are described, as are techniques, their distributions, rationale, and their relationship to the biological basis of the fishery. Changes in

production and product destination since the mid-1950's are detailed, tracing the fishery's evolution from small-scale enterprise to large-scale commercial industry focused on production of luxury species (e.g. conch, shrimp, spiny lobster) for export. Much of the capture is by cooperative members, who have exclusive rights to fish for luxury species. Access to lucrative reserved stocks is a principal motivation for cooperative membership.

The mobilization of effort to exploit the resource has obviously been quite sudden. Already, the formerly abundant and easily accessible stocks of turtle, conch, and some reef fish have declined drastically. Since all indications are that the rate of exploitation will increase, the danger that other stocks will also be overharvested is readily apparent.

Further dimunition of commerically important stocks may also result from the impacts of coastal development, manifested particularly in changes in the chemistry of nearshore waters which may diminish their biological carrying capacity. The impact on the fishery could be catastrophic, because it relies almost exclusively on species having all or some critical part of their life cycle in nearshore waters.

Current development programs have generated a momentum which has not been confronted sufficiently by concerns over environmental consequences or constraints. Planners have operated in a relative vacuum with respect to information on the historical evolution of the fishery, and the basic relations among the physical, chemical, and biotic phenomena which support it.

Clinton R. Edwards 17 May 1982

Major Professor Date

Mexico's Caribbean Fishery: Recent Change and Current Issues

By

David L. Miller

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

in Geography

at

The University of Wisconsin-Milwaukee

April 1982

Clinton P. Edwards 17 May 1982

Major Professor Date

George W. Kearley 7/9/82

Graduate School Approval Date

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We have not yet learned the difference between yield and loot.
We do not like to be economic realists.

- Carl Sauer

ACKNOWLEDGEMENTS

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I would like to acknowledge the cooperation, hospitality, and many courtesies of numerous government officials. Among those to whom I am especially indebted are: Enrique Azueta Orlayneta, Julio H. Arroyo Sánchez, Ma. Esther Ruiz de Espinosa, Daniel H. Amjona Vidal, Mario Alonzo Canto, Salvador Aranda Pedrero, Domingo Polanco, Luis Ravell M., Carlos Fuentes, Carlos Priego Ramos, and Leovigildo Ancona S. Special insight into the evolution of the fishery was provided by Luis F. Manzanilla, who allowed me to copy valuable historical documents, and answered many questions. He and his family were truly gracious hosts.

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I wish also to acknowledge the cooperation of Felipe Amaro Hernández,

head of the Escuela Technológica Pesquera in Puerto Morelos, and of Héctor Morales Malacara along with other members of the school's staff.

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CHAPTER I

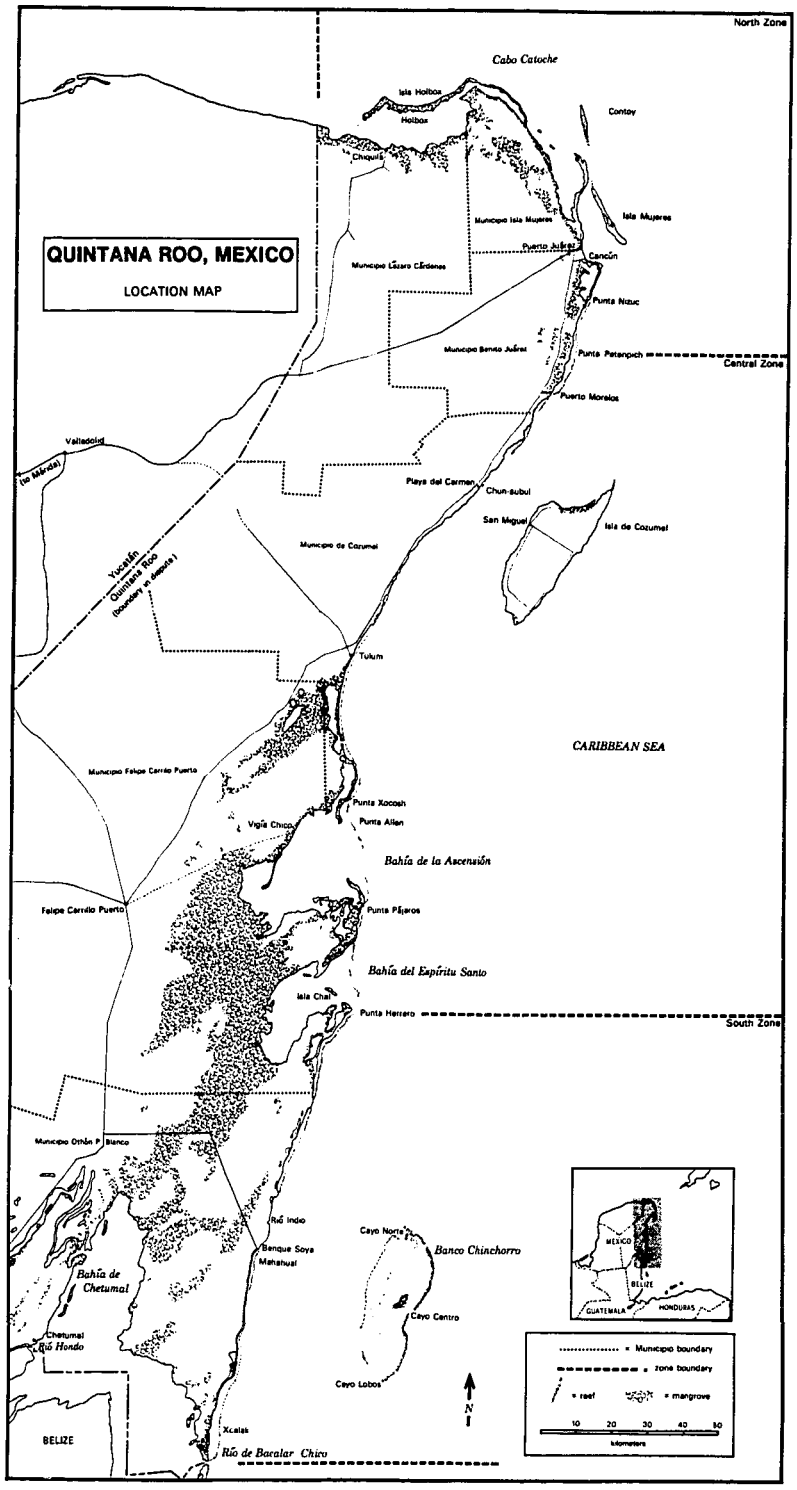
INTRODUCTION

Quintana Roo is located along the eastern side of the Yucatan Peninsula (Map 1.1), with Belize to the immediate south, and the Mexican states of Campeche and Yucatán on the west. The nearly 900 km of coastline includes all of Mexico's Caribbean shore, and a short stretch in the north that technically belongs to Gulf of Mexico shores.

Until recently, Quintana Roo was one of Mexico's least developed and sparsely populated areas. Since the late 1950's, the federal government has devoted increasing attention to its potential for absorbing surplus population and increasing agricultural production. Attention has also been directed toward commercialization of the fishery, and there have been significant changes in the pattern of exploitation, concomitant with increased government control.

Development programs were begun in the late 1950's in an effort to stimulate rapid and large-scale change from traditional to modern forms of marine resource exploitation. Fishing cooperatives were organized and their members given exclusive rights to fish lobster, shrimp and conch. Low interest loans were also made for purchase of vessels and gear. More recently, technical schools have been established at Holbox and Puerto Morelos, and shoreside processing facilities have been constructed at Holbox, Punta Allen and Xcalak. In addition, an attempt is being made to increase the advisory function of government representatives working with cooperatives and independent fishermen.

Since initiation of these programs, production has increased markedly. Between 1955 and 1970, production increased from about 93,400



Map 1.1. Location map.

kilos to over 700,000 kilos (landed weight). By 1979, production had reached nearly 1,330,000 kilos. Commensurate with these impressive increases in production are new spatial concentrations of demands on the marine resource. Current planning reflects a continuing commitment to expansion of the industry.

The effort to increase production in Quintana Roo's fishery represents one element of a national plan to increase food production in all sectors, necessary because Mexico has been unable to maintain self-sufficiency in food in the face of population growth. Recent estimates suggest that between 1981 and the year 2000, Mexico's population will increase from 73.3 million to 131 million. Thus, unless the country can increase food production, and sustain the increase over the long term, its deteriorating balance of payments will worsen, and dependence on foodstuffs from the world market will increase. Since world food supplies are already tightening as additional countries lose the capacity to feed themselves (Brown, 1981: 995, 997), funds generated by Mexico's sale of oil will have to be spent on maintenance of the population rather than on economic development.

Quintana Roo's contribution to the total national fishing effort is small. For example, in 1978, the state accounted for only .27 per cent of the nation's total capture by weight, and it ranked 17th in total production (Diagnóstico, 1979: 1). At the state level, revenues generated by the fishery were exceeded by those earned by agriculture, forestry and tourism. Nevertheless, the contribution of the fishery was not insignificant, as in that year it generated some 83 million pesos (about $3.6 million U.S., 1980[1]), the bulk earned by the export

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[1]Footnotes begin on page 209.

of lobster and shrimp to the United States.

The growing importance of fish as a source of protein in Mexico can be grasped even more readily by comparing the country's exports of fishery commodities to its imports (Fig. 1.1). In 1977, this ratio was about 3 to 1; by 1979, it was 1 to 1. While the quantities exported since 1977 have changed relatively little, imports have grown by some 34 per cent. Further, this has occurred even though production since 1977 has increased considerably.

Fig. 1.1 Mexico's imports, exports, and total production of fishery commodities by metric tons, 1977-1979.

Year	Total Production	Exports	Imports	Export/Import Ratio
1977	610,766	51,978	18,725	2.77 to 1.00
1978	702,629	55,050	32,946	1.67 to 1.00
1979	874,866	55,812	55,363	~1.00 to 1.00

Source: F.A.O. Catches and Landings, 1980; F.A.O. Fishery Commodities, 1981.

Objectives

The overall goal of this study is to contribute to a comprehensive view of the processes and consequences of rapid, large-scale development in a humid tropical context. More specifically, the study provides information and insight into factors which may determine success or failure of the development of the fishery in Quintana Roo. It also may provide Mexican federal and state officials with information useful for development programs which are consistent with environmental realities.

In order to achieve these objectives, I have undertaken an historical reconstruction of the pre-development "fisheries landscape," and documented some of the processes and consequences of the accelerating impact of development. The following questions are addressed:

- What is the extent and character of the contemporary fishery?
- How is the fishery organized?
- What determines the distribution of particular fishing methods?
- What are present and future problems of development?
- What are the prospects for sustaining or increasing yields?

Description of Fieldwork

From June 1978 to August 1979, and during the summer of 1980, I searched in Quintana Roo for archival materials on the exploitation of the marine resource, and gathered information on the dimensions, processes and effects of contemporary fishing technologies. In addition to collecting data in federal and state government agencies, I spent much time working with and observing subsistence and commercial fishermen in almost every settlement along the coast. I also worked closely with biologists of the Instituto Nacional de Pesca's "Centro de Investigaciones Pesqueras" in Isla Mujeres. These experiences provided me with first-hand knowledge of the marine resource base and its relation to the tools and technology of the fishery. Mapping was facilitated by use of ground checked remote sensing imagery. In this manner, I was able to locate sites precisely and estimate accurately the ranges of particular activities.

During fieldwork, I walked most of the state's coast, including a ten day trek from Xcalak to Punta Herrero, the latter in an effort to

gather data on the south coast immediately before the opening of an access road.

I compiled a list of species frequently caught, and recorded local names for fish and other marine fauna. Identifications of fish are based mainly on keys found in Hoese and Moore's Fishes of the Gulf of Mexico (1977).

Data Analysis

Thanks to the cooperation of fisheries officials, I obtained access to many of the monthly production summaries from 1955 to 1979. The documents list species captured, weight, state, and value of the product, whether captured by independent fishermen or cooperative members, and region of capture. The reports were very useful for developing a systematic description and explanation of the origin and development of the modern fishery. Using a computer, I transformed data on weights into "catch on a landed weight basis" and plotted this over time for the entire state and by zone. I was thus able to identify seasonal fluctuations, irregular changes in time, and long term trends. Combining this information with data obtained from oral histories of fishermen and previous studies (e.g., Carranza, 1962; Bassols, et al., 1976; Ramos, 1976) has allowed some commentary on the impacts of changes in vessels, gear, and processing technology.

It was my intention to correlate the information on production with data from gear registration forms in order to determine the catch per unit effort, gaining some insight on potential sustained yields. This had to be abandoned when close order analysis revealed that yearly

gear registrations were unreliable (this problem is discussed in detail in Chapter VII).

Significance

I know of no previous detailed study of Quintana Roo's fishing industry. However, it is mentioned in a number of sources dealing with other aspects of the state's economy, or that of the Yucatan Peninsula in general. Carranza's 1962 study of the fishery resources of the Peninsula provides some information on Quintana Roo in 1955, but focuses mainly on fleets working in the Gulf. Nevertheless, his work provides some of the best detail available on conditions prior to the beginnings of the modern fishery. In addition, his study contains a quite complete list of species of marine fauna common to Yucatán, Additional detail regarding marine exploitation in 1954 is provided by Edwards (1957).

Studies of the evolution of the fishery from the mid-1950's until the later 1970's are lacking. Sources such as Bassols, et al. (1976), Ramos (1976), Fuentes (1977), and the Departamento de Pesca's in-house paper, Diagnóstico (1979), all provide important information on the contemporary fishery, but little in the way of historical perspective.

In addition to Carranza, studies on fishing in nearby areas include Craig's 1966 work on the geography of fishing in Belize, and a study by Brannon (1979) focusing on federal policy and the development of fishing in the state of Yucatán. On balance, as Lange observed more than a decade ago, there remains

> ...an unfortunate lack of ethnographic information or ethnological data related to modern or historically recent fishing communities and to the general role of the fishing industry in [the Yucatan Peninsula] (1971: 634).

Obviously, the lack of sufficient information hinders successful management of Quintana Roo's marine resources. Mismanagement has serious social consequences, including underemployment, unemployment, and decreasing nutrition levels. Given the fragile nature of inshore tropical marine ecosystems, success of development strategies will be conditioned by the degree to which they accommodate environmental realities. This dissertation provides base-line data essential for forming policies to insure the renewability of the resource. Since one of Mexico's fundamental problems is increasing food production to keep pace with the rapidly growing population, I anticipate that this research will be of interest to local and federal officials involved in planning for further development in Quintana Roo.

From the scientific and academic point of view, this investigation is one facet of an on-going study which addresses the question, "are the pace and mode of development in the Latin American humid tropics consonant with environmental realities?" This question is important for understanding man-land interactions and the effects of human population pressures on available resources in the humid tropics. Before a general theory of development impact in such areas can emerge, historical baselines need to be established and subsequent landscape changes assessed (Edwards and Stewart, 1977).

The study examines Quintana Roo's fishery in a holistic manner, an approach whose benefits are just beginning to be appreciated. It examines many of the biological, cultural, and historical factors which underlie Quintana Roo's present day fishery. It provides a case study of change, and of the processes which initiate change. Recently, the need to take socio-economic aspects of fisheries into

consideration in developing management strategies has been widely acknowledged (Craib and Ketler, 1978; Robins, 1979; Pollnac and Sutinen, 1979; Poggie, 1980; Johannes, 1981). This study demonstrates the value of such an approach, but also underscores the need for viewing modern situations in their historical context.

Organization of the Study

Chapter II reviews elements of the physical landscape as they relate to aspects of the fishery. Chapter III focuses on exploitation of the marine resource prior to sixteenth century European contacts and includes speculation on the cumulative impacts of pre-contact human population growth on the resource. The chapter also considers reasons for the present-day lack of a truly indigenous fishing tradition. Chapter IV deals with the period from 1850 to 1950, and combines information largely from first-hand accounts to reconstruct the increasing levels of exploitation of Quintana Roo's marine resources after 400 years of virtual disuse. Chapter V deals with the organization and regulation of the present-day fishery, describes techniques, their distributions, and whenever possible, their rationale. Chapter VI records changes in production and product destination since the mid-1950's, and traces the fishery's evolution from small scale enterprise to large-scale commercial industry. Chapter VII focuses on problems and prospects of the fishery, and Chapter VIII concludes the study with a review of its findings.

CHAPTER II

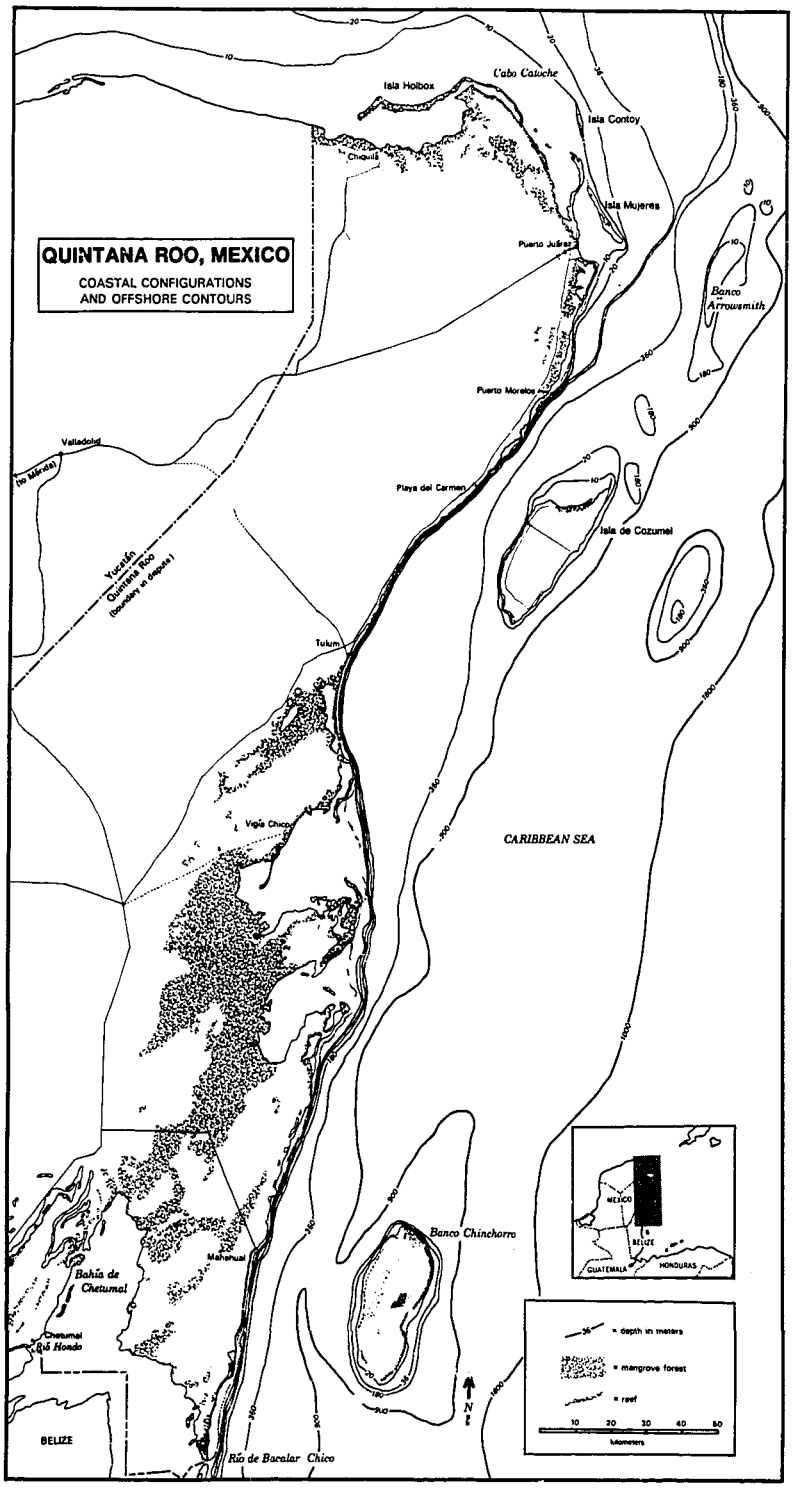
PHYSICAL ASPECTS OF THE STUDY AREA

Many aspects of Quintana Roo's physical landscape have been described elsewhere in the literature (Edwards, 1957; Murray, 1961; Murray and Weidie, 1962; Hoskin, 1963; Folk, 1967; Back and Hanshaw, 1970; Ward, 1970; Wilson, Ward and Brady, 1970; Brady, 1971; Doehring and Butler, 1974; Bassols, et al., 1976; Reid and Tomlinson-Reid, 1979). The following section reviews elements of the physical landscape as they relate to aspects of the fishery.

Coastal Configuration

Fishing activity at the northern end of the state is focused on the Yucatan Bank of the Campeche Shelf, an area richly endowed with marine resources. This broad and relatively shallow platform is the submarine extension of the limestone shelf underlying the peninsula, and there are numerous snapper banks and shrimping grounds located along the bottom. The north shore is fronted by a series of offshore bars and sand cays which extend around the northeast corner of the state. Most of the coastline behind these features is mangrove fringed lagoon, backed by rather extensive areas of mangrove flats and swampland.

In contrast to the shallow platform off the northeast coast, the shelf area of the eastern shore is relatively limited (Map 2.1). The bottom slopes away rather abruptly along virtually the entire coast, and depths of more than 50 fathoms (91.4 meters) are regularly encountered within 2 or 3 km of the strand. Farther offshore, the seafloor quickly drops away in a series of terraces to depths of 500 fathoms (900 meters).



Map 2.1. Coastal configuration and offshore contours.

Here, fishing activity seldom occurs out of sight of land, most of it taking place near or on the reef which fringes the shore.

The eastern coast is generally low lying, and consists mostly of stretches of white sandy beach, broken by low cliffed shorelines, rocky promotories, and an occasional sand and shingle or cobble beach. Lagoons and mangrove flats are often located immediately behind the beach ridge. Midway down the coast are two large shallow bays, Ascensión and Espíritu Santo, bordered with thick mangrove forests and backed by swamp or mangrove flats. Chetumal Bay lies at the far southern end of the state, and is also fringed by mangrove and surrounded by low swampy ground. As a general rule, the bottoms of these bays tend to become increasingly softer the farther one proceeds toward the interior. At their entrances, the floors are sandy, while towards the interior a sandy-mud bottom predominates. Turtle grass (Thalassia testudinum) meadows carpet much of the sandy floors of bays and areas along the coast protected by reefs.

A number of offshore features are important with respect to fishing activity. Most of the coast is fringed by barrier reef, and between it and the shore are long stretches of sheltered water. Farther offshore (about 25 km) lies Banco Chinchorro, a large atoll-like reef complex. Navigation inside the bank is generally restricted to craft of shallow draft (>2 meters), and considerable caution must be exercised while making passage as patch reef is scattered throughout the area. At the north and south ends are small sand cays which fishermen use as temporary base camps. A larger and somewhat more permanent camp is located at Cayo Centro, a relatively thickly wooded island in the center of the formation. Chinchorro is surrounded by

depths of well over 500 fathoms (900 meters).

Other offshore features include the island of Cozumel and a series of smaller shelf islands off the northeast corner of the state. Cozumel Island, consisting of a flat limestone block, lies about 19 km east of Playa del Carmen. It is described in considerable detail by Edwards (1957) and Davidson (1976). Like Chinchorro, it is surrounded by deep water, although soundings indicate that a somewhat shallower trench separates it from the mainland.

The offshore complex of barrier islands and spits at the northern end of the state has been studied in detail by Folk (1967), Ward (1970), and Brady (1971). With the exception of Isla Mujeres, whose southern end rises nearly 30 meters, these islands are low-lying. They are understood to rest on the seaward edges of terraces formed by deposition during the Pleistocene (Brady, 1971:8-10). Settlements on Isla Mujeres and Isla Holbox have long been centers of fishing activity. The rocky bottoms and reefs of the shallow platform lying under the waters of the northern end of the state have historically received the most intensive fishing pressure.

The Karst Landscape

As indicated earlier, with few exceptions the shore along the coast of Quintana Roo is only slightly above sea level and exhibits little relief. A nearly horizontal limestone platform underlies the state, and wherever rocks have been exposed to the elements, karstic features predominate. Sinkholes (*aguadas* and *cenotes*) are found throughout the state, and many along the coastal plain are connected by caverns which lead to the sea. Intricately fretted surfaces

(ironshore) often occur where baserock has been exposed to wave action, and numerous areas exhibit extensive undercutting. In some areas, it is possible for divers to work their way back under this shelf for considerable distances and underwater caves have been discovered which connect to cenotes near the coast. At various times throughout the year, considerable numbers of fish seek refuge under the underhanging rock. Species tolerant of reduced salinity levels frequently migrate to and from cenotes connected with the sea.

The sharp-edged, honeycombed ironshore surface is commonly found a few meters along either side of the shore where ironshore meets the water's margin. Walking on the jagged surface is quite difficult, and it is often necessary to seek a path farther inland. At one time it was thought that this feature was the result of chemical action, but recent work suggests that rock-boring and browsing organisms may contribute significantly to its formation (Multer, 1970: 17-21).

Hydrology

Salinity levels in near-shore waters fluctuate considerably, in part due to hydrology. Marine organisms which cannot adapt to or cannot flee sudden infusions of freshwater from the land may be killed.

At the surface of the karsted limestone, there are no streams; freshwater surfaces comprise cenotes, a few lakes and many aguadas, and temporary flowages. The only river in the state, the Río Hondo, forms the boundary with Belize and its course is apparently associated with faulting. The freshwater lens is only slightly above sea level (LeGrand, 1973: 833-834). The transmissibility of the bedrock is extremely high, as confirmed by pumpdown tests on aquifers. In

addition, surges of water produced by summer cloudbursts have been observed to move underground along the gradient toward the sea (Doehring and Butler, 1974: 592-593). While the precise directions and volumes of groundwater flow remain to be measured, Doehring and Butler have suggested a general pattern based on topography and distribution of precipitation (Map 2.2). They have also commented on seasonality, noting that during the dry season the freshwater flow toward the sea continues, and that the thickness of the freshwater lens is reduced (1974: 594).

Clearly, not all water flowing toward the sea reaches it; a considerable volume probably percolates to a great depth in the bedrock. There is also interception by vegetation, as well as increasing exploitation by man. However, there is evidence that considerable quantities are expelled along shore. Submarine springs (ojos de agua) have been found at many points along the coast and flows have been measured in some (Reid and Tomlinson-Reid, 1979: 10, 19). Although long-term recording of flow rates is yet to be done, my impression is that considerable volumes are expelled. Many springs are known to locals, and I have observed many large ones as well as extensive areas where freshwater floated in a thick lens just offshore. Marine flora and fauna at these sites, and for some distance downcurrent, are different from the assemblages in adjoining saltwater. The areal extent of some of these differences expands and contracts with seasonal variations in the supply of freshwater. The present distribution of sessile marine organisms (e.g., corals and sponges) in certain nearshore areas may reflect periods of salinity reduction to levels which severely traumatize or even kill creatures attempting to colonize.

Map. 2.2. Map of the Yucatan Peninsula showing isohyets of mean annual rainfall in meters and interpreted pattern of groundwater flow (after Doehring and Butler, 1974).

In addition to changes in salinity, other chemical alterations as well as temperature may affect faunal distributions. For example, large aggregations of single species of fish may result. I have observed such groupings shortly after heavy rains heralding the end of the dry season. Although I observed no spawning, the reproductive organs of fishes captured from these schools were highly developed, suggesting a connection between reproductive behavior and changes in water quality.

Climate

Temperatures in Quintana Roo vary minimally. Monthly averages range only from 24° C to 27° C. Maximum temperatures of from 35° - 40° C and minima of 5° - 15° have been recorded but such deviations are quite rare (Estudio de Cozumel, 1978: 16). Rainfall is distinctly seasonal, as reflected in the Aw or "tropical savanna" (Köppen) climate. Summers are hot and wet, whereas winters are mild and dry.

Winds are variable but generally out of the east from February to September. Wind velocities average 10 km/h (Ibid.: 20). A diurnal sea - land breeze system often attenuates windspeed during the night and early morning hours, and enhances it during the day. During February, and from April to June, winds frequently shift to the southeast, when they are called surestes. August is often the calmest month with respect to wind and weather, while September is considered the month of hurricanes.

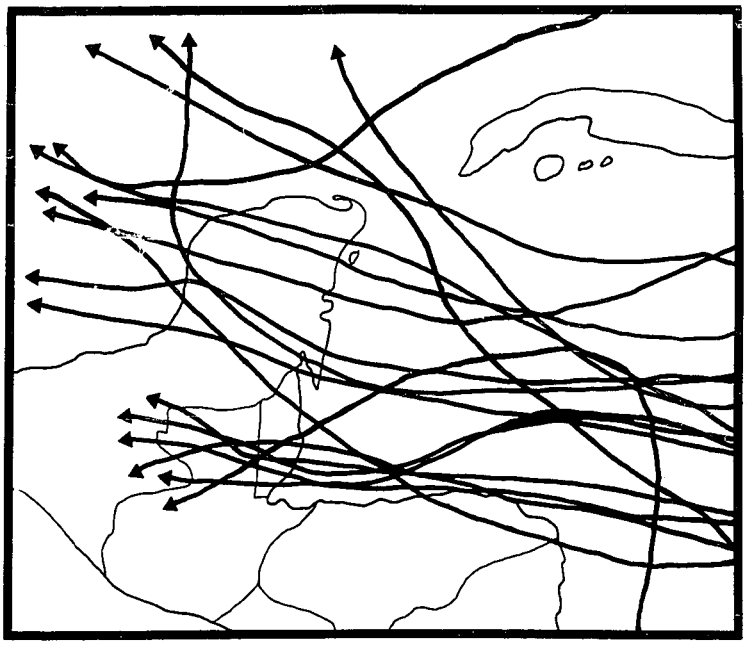
Occasionally, the wind shifts from the east to the northeast or west. The former occurs with some frequency in October and during the winter months, and is referred to as la brisa. Such wind shifts are

associated with movements of cold fronts or tropical disturbances. For example, while in Playa del Carmen in 1980, I witnessed a strong west wind associated with the offshore passage of hurricane Allen. Winds from the north (nortes) are common during October and November, and also occur occasionally in September and December as cold air masses descend from the north. Frontal storms often accompany these movements.

Storms and hurricanes

Tropical storms and hurricanes most often occur from August through October, but earlier and later storms have been recorded. Examination of the record since 1886 (Neumann, et al., 1978: Lawrence, 1979; Lawrence and Pelissier, 1981) reveals that 25 hurricanes have struck the coast and that another 47 have passed or struck nearby (within approximately 241 km or 150 miles, Map 2.3).

Although there are numerous recent settlers who have never experienced a full-blown hurricane, most locals over thirty vividly recall the destruction, havoc and aftermath of Janet in 1955. Since that time, only two hurricanes have struck, with only relatively mild consequences. During my fieldwork, I observed the impacts of two hurricanes which passed near Quintana Roo. In September of 1979, Greta landed near Stann Creek, Belize (some 160 km south of Chetumal). Greta was responsible for the deaths of six fishermen at Xcalak, a fishing village just north of the Belize border. During the same storm, I was on a boat which was driven aground near Playa del Carmen. In August 1980, Allen -- the strongest storm ever recorded in the Caribbean -- passed through the Yucatan Channel. While it caused no deaths in Quintana Roo, it was responsible for some loss of property



Map. 2.3. Tracks of hurricanes which have struck Quintana Roo or passed nearby, 1950-1980. Sources: Neuman, et al., 1978; Lawrence, 1979; Lawrence and Pelissier, 1981.

and considerable disruption.

Winds and storms impact on fishermen and fish in a variety of ways. In the past, when most fishermen worked from sailboats, it was of paramount importance to keep an eye on the weather. Older fishermen recount that some very hard lessons were learned as sudden squalls ripped sails, and dismasted or capsized boats. Nortes can blow up quite quickly, and sometimes last almost two weeks. During such times it was necessary for sailors to hole up at a safe anchorage, or run the risk of being driven aground. Most sailboats were hauled out of the water at the beginning of the hurricane season, and kept onshore until late October. During this period they were repaired, caulked and repainted. Today, a majority of fishermen work from outboard powered skiffs, and it is a relatively simple matter to haul them out whenever weather threatens. Local radio stations provide weather reports and detailed information on tropical disturbances.

Heavy rainfall from seasonal storms (particularly nortes) apparently triggers migrations of numerous important commercial species. Spectacular captures of lobster, snapper, grunts and mullet are regularly made immediately after passage of storms. Craig (1966: 10) observed a similar phenomenon in Belize. He notes that salting operations had to be suspended during rainy weather, and this is the case in Quintana Roo, although fewer and fewer fishermen today salt their catch.

In addition to stimulating movements of fish and lobsters, storms can cause considerable disturbance to their habitat. Investigation in Belize has revealed that sections of reef exposed to waves generated by hurricanes can be virtually destroyed (Stoddart, 1971:165-169). For

example, one investigator reports that hurricane Hattie was responsible for extensive damage of barrier and patch reefs, and that shortly after the passing of Hattie in 1961, "spurs with living coral were not seen within 25 miles of the storm track" (Ibid.: 165). Recent work in Jamaica by Woodley, et al. (1981: 749-755) in the aftermath of Allen, has also documented hurricane induced changes. The authors reported that violently moving water and dislodged solid objects (rolling corals, suspended fragments, and scouring sand) inflicted the damage.

Other elements of the reef community are also disrupted by hurricanes. Species observed to have been disturbed by Allen include sponges, urchins, damselfishes, parrotfish, yellowtail and other snappers. Reproductive behavior and feeding habits of some species were reportedly altered. At the micro-scale, sampling indicated changes in plankton distributions (Ibid.: 753-754). Thus, besides limiting fishing opportunity, storms can occasionally disrupt other elements of the patterns and processes upon which the fishery is based.

Hurricanes and severe storms can have considerable impact on other areas such as shallow bays and turtle grass flats. The effect of wave action and storm tides can result in immediate mass mortalities of marine animals. Turbulence, suffocation due to turbidity above muddy bottoms, oxygen depletion, and drastic lowering of salinity have been cited as factors contributing to fish kills (Tabb and Jones, 1962: 376-377). Damage to turtle grass beds as a result of mechanical storm action is apparently relatively limited. However, at least one source suggests that freshwater run-off can cause severe damage (Thomas, et al., 1961: 196).

Wind, waves and inundations generated by hurricanes have had con-

siderable effect on shoreline vegetation. Wholesale destruction and widespread disruption have been visited along many areas of the coast, resulting in shifts in the composition of plant communities. In some places, sections of strand vegetation have apparently been erased, although vines, creepers and grasses which make up the association often quickly recolonize these areas. Change of a more persistent nature occurs in vegetation commonly found along the beach crest (e.g., Suriana maritima, Tournefortia gnaphalodes, Coccoloba uvifera, Chrysobalanus icaco, Thrinax Wendlandiana) and in coconut plantations and thickets in degenerated plantations. Here, many plants display broken branches or lost crowns. The latter is particularly evident among the numerous abandoned plantations along the south coast where blowdowns occurred and no effort was made to replant groves. Lone-standing mature trees or crownless trunks are conspicuous above the thicket, which has grown up around the litter of uprooted or snapped trunks.

Mangrove forests (Rhizophora spp. and Conocarpus erecta), commonly found throughout the coastal swamplands which separate much of the shore from the interior, are also susceptible to disturbance. High winds have damaged tracts of mangrove forest. Major storms can also devastate sections of interior forest, as occurred in September of 1955 when hurricane Janet ravaged the southern part of the state.

Given enough time between severe storms, many submarine areas can be expected to recover from disturbances, although species and community compositions may be altered more or less permanently (Woodley, et al., 1981: 754). Since the effects of hurricanes often vary considerably throughout the full range of their impact, organisms at all levels are

affected unevenly. Thus the vagaries of wind, wave, and current will here and there spare a patch of reef, a few coconut trees, and a boat and its crew. Hurricanes remain the dominant force for recasting features of the mosaic of the near-shore land and seascape.

Tides and Currents

The tidal range in Quintana Roo is slight. There are no tide tables for the area, but all observations indicate that fluctuations are less than one-half meter (Craig, 1966: 11; Brady, 1971: 8). However, as Craig observed in Belize (1966: 11), onshore winds sometimes amplify incoming or diminish outgoing tides in shallow lagoons or bays. For the most part, the range of fluctuation poses little problem for fishermen, although heavily loaded sailboats traveling between Xcalak and Chetumal must often wait for high tide before they can pass through the Río de Bacalar Chico, the shortest passage between their destinations. Craft drawing more than 1.25 meters must proceed around the south point of Cayo Ambergris, through Belizian waters. Even at high tide, crews seeking to make the shorter passage in heavily loaded boats must shift their cargo to one side to careen their craft, and get into the water alongside to push, slide and bump the boat over numerous shallow spots outside the western entrance to the passage. As increasing numbers of fishermen switch to skiffs, concern about the state of the tide has become less important, at least in navigation.

Concern about the impact of tides on fish and fishing activity is shared by a few fishermen who station themselves along the shore where lagoon waters run out to the sea. In most instances, they time their net fishing or handlining to coincide with incoming or outgoing tides.

Spearfishermen who work along reef areas are little concerned with tides except in shallow areas where they affect water clarity and the normal current is increased.

Along the coast, surface currents run from south to north at an average velocity of 1.5 to 2 knots. Countercurrents frequently occur just outside and on the insides of barrier reefs. At the northeast tip of the state, the current accelerates to as much as 3 knots as it passes through the Yucatan Channel. From Cabo Catoche, the current sets to the west and northwest at somewhat reduced velocity.

In shallow areas (<10 meters) where currents are running particularly strong, water clarity is often diminished. This limits the opportunities of divers to locate their prey. Also, since swimming against a strong current is exhausting, range is limited. If the current is too strong, divers will quit for the day, or attempt to locate more sheltered areas. The waters off most beaches of Quintana Roo are crystal clear during the early morning, but become a bit turbid by late afternoon. During extended periods of strong winds, clarity often decreases to the point that diving becomes unproductive.

Net and trap fishermen must also reckon with the force of the currents. Heavy anchors are used to prevent gear from dragging and much scope is necessary to insure that currents will not tug buoys underwater. Handliners fishing in deeper waters must often use heavy weights to get their baits to the bottom. Strong currents also complicate the setting out and retrieval of gear.

The Biological Bases of the Fishery

On the whole, levels of productivity in tropical waters are

relatively low. With few exceptions, nutrient salts essential to productivity are lacking in surface waters, for reasons associated with the existence of a permanent thermocline (Russel-Hunter, 1970: 97-101). As one author notes:

> the total nitrate concentration in the surface waters for 20° latitude [which roughly bisects Quintana Roo] on either side of the equator is usually about 1/100 of the winter concentrations in the least fertile temperate seas. Phosphate levels in the same region often lie below the limits of detection (less than 1/100 the winter levels in temperate seas), and the only phosphate-rich waters within the tropics lie in depths below 150 meters, the richest concentrations being found in dense cold water at depths between 600 and 1000 meters (Ibid.: 97).

Exceptions to this low fertility are found in areas of upwelling water, coral reefs and shallow coastal waters. Reefs and shallows are found in Quintana Roo and fishing activity is focused on them. The relatively high productivity of these areas is due in large part to the presence of photosynthetic organisms close to or on the surface (e.g., coral symbionts, turtle grass, mangrove trees) and on the efficient recirculation of nutrients throughout reef ecosystems (Ibid.: 99-100). Although there is virtually no surface drainage from the interior of the state, nutrient-rich waters are apparently continually recruited as rainwater percolates to the shallow water table and emerges in springs along the coast.

An examination of historical data provides some preliminary indication of the productivity of Quintana Roo's inshore waters. For example, in 1978, a catch of nearly 1700 metric tons was registered at the state's fishery offices. The average yearly capture per fisherman was almost 2.5 metric tons. Since not all production was registered, the figure can be regarded as minimum; the actual average was probably

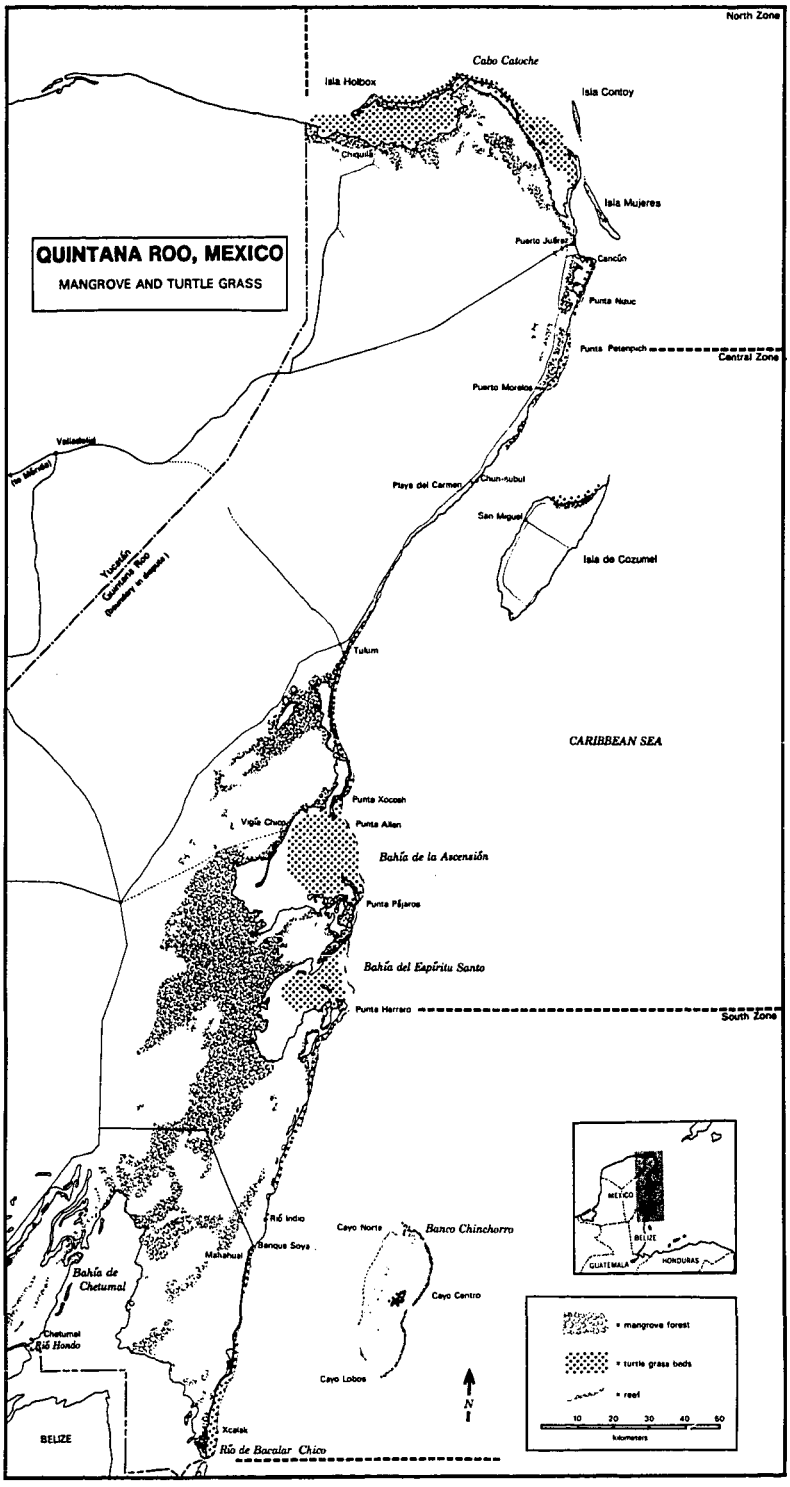
more than three metric tons. This amount becomes even more impressive considering that many fishermen fish only part-time.

What follows is a summary of pertinent characteristics of the principal fronts (locally significant areas of biological activity) where nutrients are incorporated into the food-webs which ultimately support fish populations.

Mangrove

Red mangrove (Rhizophora mangle) dominates coastal mangrove forests (Map 2.4). Farther inland, composition changes to include botoncillo (Conocarpus erecta) and black mangrove (Avencennia nitida). Specific distributions are to some degree associated with tolerance to salinity, red mangrove having the greatest. Mangrove stands (Manglares) are located in nutrient rich areas whose fertility depends on a high volume of discharge from the land (Faresworth and Golley, 1974: 97). Forests are quite often found behind shorelines protected from high wave action by coral reefs, and occur also in the three major embayments -- Bahía de Chetumal, Bahía del Espíritu Santo, and Bahía de la Ascensión. Mangrove forests cover about 5 per cent of the state, their area totaling more than 194,000 hectares (S.A.R.H. Cartografía Sinóptica, 1976).

Mangrove forests make a critical contribution to the stability and productivity of their appropriate environs. Because mangrove sets its roots in anerobic muds and brackish water, root systems trap sediments and provide a physical buffer to wave and storm surge. The roots also support a high density and diversity of marine animals. Manglares serve as important sources of refuge and food for juveniles of many important commercial species. Mangrove forests also provide a continuous source of organic



Map 2.4. Areas of mangrove forest and turtle grass beds.

material to bodies of water which surround them. Odum and Heald estimate that in the Florida everglades production is in excess of eight tons dry weight per hectare per year (1975: 266). Mangrove detritus is colonized by fungi and bacteria, creating a food source of high caloric and protien content. Odum observes that this food source provides "much of the basic food input to the food-webs of nearby coastal waters" (1976: 37).

Turtle grass beds

Turtle grass in the waters off Quintana Roo commonly occurs at depths of 1 to 10 meters, and is most commonly located between the shore and coral reef where it is protected from high-wave action (Map 2.4). Since the density of growth varies considerably, the area covered by turtle grass beds does not give a true measure of their biomass. The water area within reefs and bays where I have observed thick beds comprises about 40 km^2. Areas of particularly thick growth occur inside the reef along the southern coast, to the south of Xcalak and in front of Río Indio, in and around Espíritu Santo and Ascensión bays, and north of Puerto Morelos to Cancún.

The distribution of turtle grass beds is thought to be based on a series of interrelated factors including depth, waves, currents, substrate, turbidity, and light penetration (Thayer, et al., 1975: 290). The beds are high in organic productivity, with annual production values ranging from 200 gC (grama of Carbon) per m^2 to 3,000 gC/m^2. By comparison, the world average for cultivated maize and the U.S. average for hayfields are 412 gC/m^2 (Ibid.).

Turtle grass beds support larger populations of invertebrates and fishes than adjacent bare areas. They provide cover and are important

feeding areas for a number of species of considerable commercial importance such as mullet, snappers, turtles, and conch.

Coral reef

Barrier, fringe and patch reefs are found along the coast (Map 2.1). Common species include: Porites porites, Montastraea cavernosa, Acropora cervicornis, Acropora palmata, Diploria labyrinthiformis, Agaricia agaricites, Millepora complanata, Manicina areolata, and Isophyllastrea rigida. Barrier reef is the most predominant form, extending in interrupted stretches for a total length of 218 km.

Coral reefs are thought to be among the most productive and diverse of all ecosystems. They provide shelter and food for "an enormous variety and quantity of fishes and invertebrates" (Odum, 1976: 45). Reefs also provide protection to coasts by dissipating wave energy.

The high productivity of coral reef areas is based on efficient recirculation of nutrients among the producer and consumer components of the reef ecosystem (Russel-Hunter, 1970: 100). Productivity is dependent on stable temperatures, salinity levels near those of the open ocean, bright light, and moving water.

The Focus of Fishing Effort

Most of the fishing in Quintana Roo is done within sight of land and in shallow water. The fishermen know that fish are not evenly distributed along the bottom, and so they focus on areas where fish congregate. These include barrier reef, shoals, crevassed rocky bottoms, and shelves. Little effort is wasted on the vast areas of barren sandy bottom (blanquizales). Productive inshore areas often include sections of rocky shoreline, patch and fringe reefs, some areas of man-

grove-lined estuaries, turtle grass meadows, and the entrances to lagoons. Appendix I lists marine fishes and other creatures commonly fished, and provides information on areas of capture.

CHAPTER III

THE FISHERY BEFORE SPANISH CONTACT

It is useful to consider the nodern fishery as "born again," rather than just in its infancy or as a direct continuation of the pre-modern mode of exploitation. Although the scale and scope of the pre-historic industry remain subject to debate (Lange, 1971; Ball and Eaton, 1972), there is considerable evidence that abundant marine resources were harvested quite actively prior to the time of early European contacts (1511-1519). However, as the European conquest proceeded, the native population declined drastically due to disease and disruption. Coastal settlements were virtually abandoned as survivors moved inland for greater security.

At the time of first contacts, the population of the ancient provinces of Ecab, Uaymil, and Chetumal, which comprise most of the modern state of Quintana Roo, was about 300,000 according to Cook and Borah (1974: 34). There may have been an additional 9,000 on Cozumel (Edwards, 1957: 132). During the Maya classic period (A.D. 250-1000), the area probably supported even greater numbers. Yet the impacts of the conquest initiated a 400 year decline which has only recently been reversed. As late as 1910, the population was estimated to be fewer than 10,000, and growth until mid-century was relatively slow. The 1950 census recorded only about 26,900 inhabitants.[1]

In effect, most of Quintana Roo was abandoned. Populations along the coast were apparently the first to go. For example, by the early 1700's, Cozumel and Isla Mujeres were virtually depopulated and became bases for corsairs and smugglers who pursued their trade along

The eastern coast (Edwards, 1957: 149-157). Except for occasional visits by turtlers, fishing activity was limited to subsistence. Such was apparently also the case elsewhere, including Cancún, Contoy, and Holbox. Cozumel remained viritually depopulated through the mid nineteenth century, and permanent settlement of the coast did not resume until the turn of the twentieth century.

Although a few small fishing settlements were established on the islands around the mid-nineteenth century, large scale production did not occur until the mid-1950's. Thus, for about 400 years, the marine resources established a new equilibrium based on greatly reduced levels of exploitation by man. The historical record suggests that levels of production achieved by modern fishermen may have only recently surpassed those attained by aboriginal folk.

The Maya Fishery on the Eve of Spanish Contact

Judging from the archaeological record and early historical accounts, the native Maya fished in much the same way as the grandfathers of today's fishermen. Conch were gathered, fish were handlined and netted, and manatee, the larger sharks, and rays were harpooned. Turtles were turned on beaches, and harpooned and netted at sea. Although the Maya lacked modern hooks, leaders, weights, floats, lines and nets, indications are that their equivalents were entirely adequate. Bone and shell provided material for hooks, weights were of stone or fired clay, floats were carved from wood, and line was spun from plant fibers.

Maya canoes were seaworthy and well suited for a fishery which

exploited nearshore areas. On the whole, I suspect that a competent prehistoric net or handline fisherman would be at little disadvantage in competing with his modern counterpart. Indeed, the former's probable wealth of tradition and technique, based on the experience and critical observation of fish and fish habitats, over many generations might easily offset any advantage of modern gear.

That the Maya indeed possessed a rich body of practical knowledge is suggested by early descriptions of their fishery. For example, Landa writes that:

> ...the abundance of fish on the coast is such that the Indians almost do not bother about those of the lagoon, unless it is those who have no apparatus of nets, who are accustomed to kill great numbers of fish with the arrow as there is little water; the others pursue their fisheries on a very large scale, by which they eat and sell fish to all the country. They are accustomed to salt the fish, to roast it and to dry it in the sun without salt and they take into account which of these methods each kind of fish requires, and the roasted keeps for days, and is taken twenty or thirty leagues for sale, and for eating it they cook it again, and it is well flavored and sound. The fish which they kill and which are found on that coast are very excellent and very fat [mullet], trout equal (to ours?) in color, spots and flavor, and they are fatter and delicious to eat and are called in their language utz cai, [2] very good [snook], sardines and with them come soles, [mackerel, grouper, mojarras and an infinite variety of other small fish] (Tozzer, 1941; 189-190; Relaciones, 1900: 377).

In addition, he mentions that fishermen captured manatee, turtles, stingrays, manta, three or four kinds of cazón [3] and sharks (Tozzer, 1941: 189-190; Relaciones, 1900: 377-381).

Various Relaciones de Yucatán lend credence to Landa's description.[4] Sarmiento writes of a lagoon twenty leagues from Valladolid (Río Lagartos?) where "many species of fish grow, including grouper, snook, sea trout, and cazon" and notes that production from this area helps

to sustain Valladolid [and part of the city of] Mérida (Relaciones, 1900: 32). Urrutia states that Río Lagartos has "very good fisheries of very good fish" (Ibid.: 73). Other accounts mention that residents near the coast maintained salt pans (salinas) along the shore, and indicate that fishing was a collateral activity (Ibid.: 137; 196). Fish (presumably salted) are also mentioned as tribute items (Ibid.: 53). Further support for Landa's commentary on the scale of the fishery is found in Tamayo's description of a coastal area as having "large and very good salinas" where Indians capture "much fish with which they supply Merida" (Relaciones, 1898: 134), and in Reigosa's observation that the inhabitants of another coastal settlement maintain themselves by fishing, to the exclusion of farming (Relaciones, 1900: 197).

Archaeological evidence confirms that Maya fishermen captured some of the species mentioned in these early accounts (Lange, 1971: 629-634), and concentrations of net-sinkers, potsherds, other artifacts and shell mounds have been found in numerous areas along the east coast of the Yucatan peninsula (Gann, 1918: 55; Collier, 1964: 139; Andrews, 1965: 45; as cited by Lange, 1971: 632; also Sanders, 1960: 261; Craig, 1966: 17-31; Eaton, 1976: 232-238; observation, 1979). Marine fauna are also portrayed in Maya glyphs (Tozzer and Allen, 1910: 307; Lange, 1971: 629) and on murals (Ibid.: Covarrubias, 1957: fig. 127; Lothrop, 1924: 55). Linguistic evidence (Roys, 1931: 326-344) indicates that the Maya were familiar with a variety of marine life ranging from sardines to whales.

Although we have reasonably good information on what was caught, and on fishing techniques in general, specific technical details on the gear and how it was used are generally lacking. For example, although Landa describes in some detail how the harpoon was used to

take manatee, he merely mentions the use of bow and arrow, trammel nets, hooks, and other gear for fishing (Tozzer, 1941: 156, 190).[5] The modern fishery offers little in the way of clues.

While some of the methods of today's fishermen are similar to those of the ancient Maya, the direct links to ancient ways cannot be made. Although the Maya names for some species of fish are known, only a few are used interchangeably with their Spanish equivalents in everyday conversation. Thus, the cultural heritage transmitted to today's fishermen seems meager. Presumably, the fund of pre-Columbian knowledge decreased as the population diminished and coastal areas were abandoned. Much of what may have been a rich fund of knowledge about fish behavior, water conditions, and the timing and placing of gear has apparently been lost.

Pre-Columbian Levels of Marine Resource Exploitation

The archaeological record of the pre-Columbian Maya indicates that maize farming was the basis of village life in the Maya lowlands. However, as Willey (1982: 264) observes

> ...there are also indications that their outfield farming, whether swidden, raised field, or terraced, was supplemented with infield or kitchen-garden cropping of foods, such as breadnuts, avocados, palm-nuts, probably manioc, and various fruits. Site debris indicates that hunting of animals, such as deer and peccary, and fishing supplemented the agricultural diet.

The extent of dependence on marine resources has come under question. Lange (1971) reviews extensively the evidence and argues that

> ...the subsistence base of a large portion of the Yucatan Peninsula was the exploitation of marine resources... [which] would have freed both the government and the people from major concerns of crop failure and other agricultural menaces.

Others argue that Lange overstates the case. For example, Ball and Eaton (1972) present evidence that few coastal sites were occupied continuously, and that the function of some may have varied over time. Some sites apparently served as socio-political or religious centers, others as burial sites or centers associated with the salt trade. They assert that

> ...archeological data appears to suggest heavy subsistence utilization of marine products prior to the appearance of Classic Maya civilization [A.D. 250 to 1000] with decreased reliance upon this resource during the Classic and Early Post-classic [A.D. 1000 to 1200] periods...[Although] small seaside villages must have persisted through the Classic, reliant for their subsistence both upon the adjacent marine riches and upon trade with the inlanders, ...a diverse resource exploitative system replaced the heavily agricultural and marine reliant patterns of the Preclassic lowland Maya.

More recently, in an article reviewing recent findings and interpretations by Maya archaeologists, Willey (1982: 264) has concluded that

> ...by the Late Classic [A.D. 600 to 800] the Maya appear to have been using every available subsistence resource, suggesting population pressure on resources.

If this is correct, how can a decrease in reliance on the marine resource during the Classic and Early Postclassic be explained? One possibility is that the marine resource was over exploited. Even before the Late Classic population maximum, the demand for marine products may have outstripped supply. Mollusks, certain fish, and especially turtles and manatee may have been overfished. Stocks would also have been depressed further during periods of crop failure or times of foreign wars, revolt or trade failures, when levels of exploitation may have been excessive. The historical agricultural experience demonstrates that drought, insect plagues, and storms fre-

quently damaged crops. Presumably, this was also the case in earlier times. Just as some agricultural folk have had to eat their seed corn during times of famine, so may have fisherfolk been pressed to harvest the basis of several years' production, which later imposed severe penalties.

Some insight on this question derives from the analogy of modern fisheries, the dynamics of fish populations, and the ecology of individual species. For example, it is generally accepted that fish stocks can be harvested on a sustained yield basis (Russell, 1931; Schaefer, 1955). As Ricker observes:

> If a stock is not fished, all growth and recruitment is balanced by natural mortality. If fishing begins, it tips the balance toward greater removals, and occasionally fishing may steadily reduce the usuable stock until it is commercially extinct. Much more often a new balance is established, because the decreased abundance of the stock results in (1) a greater rate of recruitment, or (2) a greater rate of growth, or (3) a reduced rate of natural mortality (1975: 24).

Thus, as long as a stock's ability to regenerate itself is not compromised, a certain "surplus" can be harvested by fishermen.

Some stocks, however, are particularly vulnerable to overharvesting because of the pattern of their life history. Sea turtles and conch -- exploited heavily by the ancient Maya -- fall into this category. The slow moving conch are particularly vulnerable in shallow nearshore waters, as are female turtles while crawling laboriously up the beach to deposit their eggs. It is well documented that the turtles return to lay their eggs on the beaches where they were hatched, thus comprising a stock dependent on that beach for successive generations. In Quintana Roo, as elsewhere, their seasonably predictable spawning behavior is exploited by fishermen who station themselves along nesting

beaches to harvest turtles and eggs. As is the case with various species of fish (Iles and Sinclair, 1982: 627), this predictability accounts significantly for the vulnerability of turtle stocks to over exploitation.

Conch are also vulnerable because of seasonally predictable behavior. In Quintana Roo, as in other areas of the Caribbean, it is common knowledge that conch can be found in shallower water and closer to shore during the summer. Research carried out by Hesse (1979: 303-311) in the Turks and Caicos Islands has confirmed that conch migrate in the fall to deeper water or farther offshore where surface conditions are less apt to affect the sea bottom. Hesse also recorded that conch frequently bury themselves in the sand and remain dormant for up to six weeks during the winter. Their subsequent spring migration to shallow water makes them easier to harvest.

Conch stocks in many areas of the Caribbean have diminished considerably and observers of individual stocks have concluded that exploitation at current rates will result in commercial extinction (Adams, 1970; Hesse, 1975; Brownell, Berg and Haines, 1976; Blakesley, 1977; Brownell, 1978; Stevely and Warner, 1978; as cited by Goodwin, 1981). In Quintana Roo, numerous areas formerly abundant with conch are now barren. Stocks have declined at such an alarming rate that the government restricts gathering to members of cooperatives and has imposed quotas. Similar controls have been placed on the turtle harvest. Large scale exploitation of turtle did not begin until the mid-twentieth century. Production peaked in little more than a decade, and then diminished to such an extent that fishing was prohibited altogether in 1972 and 1976. As elsewhere, many beaches once swarming

with females during the nesting season are now relatively barren.

In addition to turtle and conch, the ancient Maya exploited near-shore reef fish stocks, also vulnerable to overharvesting. Huntsman's summary of the biological basis of reef fishery production suggests why sustained yields are difficult to maintain;

> Evolutionary impetus to retain and recycle energy and nutrients has fostered the development of extra-ordinarily complex reef fish communities with many trophic levels. Complex reef communities contain many species, but the biomass and potential catch of any single species are small. Most reef fish biomass is contained in small herbivores and primary carnivores but man's interest is principally in the scarce, large, high-order carnivores.
>
> Evolutionary adaptation to the low probability of larval encounter with reefs and survival to adulthood has resulted in four common characteristics of reef fish life histories that affect fisheries production. Low mobility of reef fishes allows their easy over-exploitation. Slow attainment of maximum size, low natural mortality rates and protogyny all suggest that fishing mortality [must] be kept low and recruitment age high to achieve maximum yields (1980: 131).

Again, it can be presumed reasonably that, during periods of drought or disruption, the inhabitants of coastal areas would have increased fishing pressure on reefs, and that fishing mortality during these times would have been high. Even under moderate fishing pressure, stocks would have been hard pressed to reestablish for reasons associated with their biology. Maya fishermen would also have been familiar with the locations where spawning occurred within the areas they fished. Species which form such aggregations are quite vulnerable to over-exploitation (Craig, 1969: 252-263; Johannes, 1981: 32-37; Iles and Sinclair, 1982: 627-633). In Quintana Roo these include snapper, grunts, and grouper -- all first-class foodfish that inhabit shallow water reef areas.

If the Maya overharvested an initially bountiful resource, their decreased reliance on it by Classic times could have been the result of scarcity rather than changes in the exploitative system. Over time, the cumulative impacts of human population growth may have included the depletion, perhaps even virtual extinction, of local stocks of marine fauna which in earlier times were important as food.

CHAPTER IV

ANTECEDENTS OF THE MODERN FISHERY

Until the later 1950's, Quintana Roo was very much a backwater area. On the whole, it had a rather unsavory reputation which in early times may not have been entirely undeserved. The offshore islands, once a haven for pirates, later became bases for smugglers, and the interior was controlled by hostile Maya Indians who violently resisted subjugation until well into the 20th century. As late as 1910, one American resident of Mérida was "told by intelligent Yucatecans that at that moment [it was] an excellent place to keep away from" (Villa, 1945: 29; as cited by Edwards, 1957: 166). Nearly a half century later, Edwards discovered that a considerable number of Yucatecans still regarded Quintana Roo as "a wild forest land, full of hostile, uncooperative Indians" (Ibid.: 167).

Historical background on the activities and actions of the Maya and Mexicans are found in Villa (1945) and in Edwards (1957). Edwards also provides an account of the economic and social development of the territory through the mid-1950's. The following account focuses chiefly on the resettlement of the islands and coast of Quintana Roo, and summarizes what little information exists related to the early development of the modern fishery. Most detail regarding the situation prior to the 20th century must be gleaned from the accounts of early explorers and tourists interested mainly in the area's ancient Maya ruins. On the whole, sources of information on the fishery become more frequent after the turn of the century, although much of the detail they offer is sketchy. A complete description of the fishery's

pre-modern evolution is outside the scope of this inquiry, and remains to be written.

The Nineteenth Century

During the mid-1800's, after long abandonment, settlements were reestablished on Holbox, Isla Mujeres, and Cozumel. The first permanent settlers were apparently refugees from the struggles for political power on the peninsula or Mexicans fleeing the mainland during the War of the Castes (1847-1853). Before this time, these islands were uninhabited except for turtle hunters and occasional fishermen (Edwards, 1957: 170-172).

Stephens' account, written in the early 1840's, provides some detail regarding the fishery and conditions on the islands. Of the Holbox Island area ("Yalahao") he writes:

> The fishing on this coast was for turtle; on one side of [a fisherman's] hut were jars of turtle oil, and outside, rather too near when the wind was in certain quarters, were the skeletons of turtles from which he had extracted it (1843: 242).

Stephens also relates that the pirate Lafitte then lived on Isla Mujeres, and describes the harpooning of a hawksbill turtle off the southern end:

> ...we came silently upon a large turtle, apparently asleep, which must have been somewhat surprised on waking up with three or four inches of cold steel in his back. The patron and sailors looked upon him as a bag of dollars snatched from the deep (Ibid.: 243).

Of the three species of turtle commonly found in northern Quintana Roo, Stephens writes that the loggerhead was taken only for its eggs or oil, the green turtle for its meat, eggs, and shell (the latter "worth two reales the pound... [but] the commonest kind, not worth killing for the sake of its shell") and the hawksbill for its shell ("worth ten dollars a pound...the rarest"). He adds that fishermen lucky

enough to capture a hawksbill cooked its meat and ate it "on the spot" (Ibid.: 243-244). Stephens also visited Cancún and Cozumel, which he found deserted. On the mainland across from Cozumel he observed a turtle crawl near a fisherman's hut (Ibid.: 261).

Within a few years after Stephens' visit, permanent settlements were established on Holbox Isla Mujeres and Cozumel. These grew very slowly, and their inhabitants apparently supported themselves by turtling, raising produce to sell to ships stopping in for water or a safe anchorage, and smuggling.

One of the earliest descriptions of these settlements is found in the report of the 1885 visit of the U. S. Fisheries Commission steamer Albatross to Cozumel. A village had been established at San Miguel but the report does not provide any additional detail other than to imply that it was not particularly impressive. The residents of a small inland Indian village ("about fifty huts occupied by thirty families") were "much neater in the general appearance and more intelligent than the Indians [sic] of San Miguel" (Tanner, 1887: 9).

Four years later, Alice Le Plongeon visited the island and observed:

> We found a few Americans from New Orleans and Key West living there. They said that they could make plenty of money if they had good laborers (1889: 31).

At that time, coconuts, sugar cane, garlic, ginger, and sago were grown on the island and sent mainly to British Honduras, Isla Mujeres and Cuba, with small amounts also to Campeche. Turtles, probably captured on the east side, were shipped to British Honduras. In addition to providing income, turtles apparently served as a "cover"

for smuggling cigars to Belize City.

Writing of the inhabitants of island villages, Le Plongeon notes that:

> ...the principal industry of the villages is fishing, and from the month of April to August, all their attention is given to turtle catching (Ibid.: 19-22).

She describes Holbox as:

> ...a picturesque Indian village whose inhabitants make a living by catching turtle to send to British Honduras, where demand is constant. Near the shore there were turtles in pens... (Ibid.: 2).

Off Isla Mujeres were schooners from Havana, and coasting sloops "that carry on considerable contraband between British Honduras and Yucatan" (Ibid.: 8-9).

Population estimates for the islands do not appear until almost the turn of the century. Holmes (1895: 57) records that Isla Mujeres supported a "humble fisher settlement of some 500 inhabitants" and Cancún had only an Indian hut on it. He reports that Cozumel is:

> ...sparsely inhabited, containing less than 2,000 people, who live in the simplist possible manner, content to fish and raise chickens and to cultivate small fields of corn and groves of bananas... [they are] assembled mainly in the village of San Miguel...Spanish fishermen of Cuba have dominated in the district for a long time, and the native Maya element is as a result quite degenerate, and retains fewer traces of the ancient language and customs than in other equally isolated portions of Yucatan (1895: 64).

The 1896 Pilot describes Cozumel as "settled by Indians from Yucatan and the population is about 1,500" and notes that:

> ...cattle are plentiful, poultry may be obtained; cotton is the chief product; tobacco and sugar cane are grown in small quantities, and dyewoods are exported (Pilot, 1896: 145).

The source reveals also that Contoy was uninhabited but visited by fishermen for water, that by this time several fishermen (probably turtlers) had huts on the northern arm of Cancún, and notes that "the

largest fishing establishment on this part of the coast [was located] about 3½ miles westward" of Point Allen (Ibid.: 142, 147). Another small "fishing establishment" was located 1½ miles south of Owen Island (Isla Chal) in Espíritu Santo Bay.[1] In this context, "establishment" probably refers to a fishermen's camp, rather than a regular settlement.

The Early Twentieth Century

Around the turn of the century, green turtle fishing increased in Quintana Roo as fishermen of British Honduras worked out the stock in their area. As Craig reports, the export of turtles from Belize was well established in the latter half of the nineteenth century, and:

> ...as the green turtle declined in numbers due to heavy fishing pressure in British Honduras waters, Mexican fishermen from Isla Mujeres, Cozumel, and Xcalak imported a considerable amount of these animals, together with bags of their eggs dug up from the famous nesting grounds along the coast of Quintana Roo. This trade flourished for a time until rising transportation costs and trade restrictions brought the business to a virtual standstill in the early 1920's (1966: 42-43).

Craig also relates that cargo ships sailing from New Orleans to Belize commonly stopped along the Quintana Roo coast to fish for kingfish[2], which were salted and barreled for sale in Belize, "whose chronic shortage of fish provided them with a ready market" (Ibid.: 44). This fishing took place off Arrowsmith Bank, the southern end of Cozumel, and Chinchorro Bank. There is no indication that fishermen of Quintana Roo participated, but it seems likely that some may have been involved in the regular production of salt fish for the Colony.

One of the few descriptions of fishermen's settlements is found in the account of a visit by Arnold and Frost, two British gentlemen

who visited the northern part of the coast in 1906 and 1907. From them we learn that Holbox was a village of "some three hundred " and that "there was not an Indian in the place. It was a community of Yucatecan fishermen, as indeed are most of the inhabited islands as far south as Ascension Bay" (1909: 133). Holbox is described as "a square of wood huts, painted bright blue and white, built round a plaza of sand" (Ibid.: 132)

From Holbox, the adventurers sailed in a "three ton dory" to Isla Mujeres and stayed at Delores, the island's only village, which consisted of a row of whitewashed huts fronting the anchorage (Ibid.: 133-146). Arnold and Frost also visited Puerto Morelos and San Miguel. The former they describe as being "half a dozen huts and a jetty where provisions are landed," and the latter a town of:

> ...a few palm thatched huts, a wooden store, an open space, a custom house with a flagstaff, a few small boat-shelters of palm trees to save boats from cracking in the sun, and a jetty, three feet wide, running out into the water waist deep (Ibid.: 156, 166).

They also provide some detail on the marine resources and their exploitation:

> ...the long stretches of sand are everywhere rich with perhaps the most beautiful shell in the world, that giant gasteroped technically called Strombus but commonly known as fountain-shell ... [On Cozumel] they are not numbered by twos or threes or half dozens, but are literally scattered in myriad profusion. The natives break up the shells with machetes and eat the fish. In the little coral coves it is nothing unusual to see the whole surface of the rocks littered with this wonderful rose-pink debris (Ibid.: 170).

While anchored near Cancún the authors joined their crew in fishing for "the giant picuda" [barracuda] ...15 or 20 lbs. full grown" using live smaller fish for bait on a "string quite ropelike in thickness" (Ibid.: 146). They relate correctly that this fish can be dangerous

when hauled aboard, and describe what remains common practice on landing a barracuda today: "the sailors kill him by hitting him over the head with a wooden mallet" or by pressing two fingers "into the creature's eye-sockets" (Ibid.). Off the southern end of the island ("Nisuc Point"), the two dyed-in-the-wool Englishmen note that there are:

> ...turtle in plenty: both the green turtle (Chelonia midas), beloved of aldermen, and the hawk-billed turtle, the caret (Eretmochelys impricata) which provides the commercial tortoise-shell. It is the latter which the Yucatecan fishermen chiefly hunt, for they can get as much as eight dollars a pound for the shell. For the flesh of the turtle they have no taste; an example of the truth of the saying that what we have we never value. The beaches of these Caribbean isles, around the fisher settlements, are often littered with the rotting carcases of turtle, spectacles of wilful waste sufficient to break the stoutest aldermanic heart (Ibid.: 152).

With respect to the turtle fishery, the authors observe that:

> ...a certain trade is done in the green reptilian with the captains of American trading schooners which come across the Gulf from Florida and the Eastern States. Thus a feature of the villages are the turtle "crawls," enclosures built some few yards out from the water edge, made of stakes driven in in the form of a small square bound together by lianas. Here the turtles swim about until they are wanted. At the "crawl" in Isla de Mujeres there were some two dozen, many of them monsters weighing four hundred pounds or more (Ibid.).

Additional insight on conditions and the status of the fishery are contained in Lloyd's 1915 report on Cozumel. He reports a population of some 1400, 900 in San Miguel, "a thriving, well-formed town. It has several wide clean streets; a plaza, [and] a very presentable little church" (Lloyd, 1915: 228). He writes that fish could be had "for the trouble of throwing a line" and that turtles were "for the taking, to say nothing of turtle's eggs" (Ibid.: 232). Judging from his report, an active turtle fishery was underway. Hawksbill turtles were scarce, and two of them were "equal to a month's

wages of ordinary catches" (Ibid.). Green turtles were sold in Belize, for shipment to the U.S. Turtling was apparently widespread, as Lloyd observes it was a favorite occupation of islanders.

Lloyd also tells of a sponge fishery, but notes that efforts by foreigners to exploit it on a large scale had failed due to insufficient quality and quantity. He adds that:

> ...where the sponges are found the divers have a 5-knot current to contend with; furthermore, they can only get the sponges which are on a ledge running along the coast, west and part of north, as all the remainder of it is too much exposed to heavy seas -- at a depth of 12 fathoms, which is, of course, too deep for divers to operate in. Most of the sponges obtained from the ledge are not dived for, but they are dragged off by means of long, hooked poles, which only experts at the work can handle (Ibid.: 234).

Lloyd states that "during the last 30 years, one French and two American companies have gone out of the sponge fishing business because of the difficult conditions." If this is accurate, sponging may have begun as early as 1885, making it, along with turtling, the oldest elements of the modern fishery. Although the foreign companies failed, the industry continued:

> At present some Greek divers -- left behind by the last of the foreign companies -- are exploiting the ledge in partnership with a Mexican fisherman who has a permit from the Government to take out sponges. They get a few hundredweight per month and sell them to local merchants who, in turn, dispose of them abroad, most of the product going to New York via Progreso. During an average year the quantity of sponges exported amounts to about five thousand pounds, gross weight (Ibid.: 236).

Increasing commercial activity

At the turn of the century, the Federal government made large land grants to private concerns for logging, chicle-tapping and commercial agriculture, and settlements were established on the mainland (Edwards, 1957: 174). Although the Maya continued to resist this infringement of

their territory, by the 1920's the chicle business was firmly established, and the influence of the Mexican government was increasing (Ibid.: 176-177).

Although some fishermen on the coast may have been involved in a salt fish industry to supply henequen plantations, and chicle and logging camps, the demand cannot have been very great. Between 1910 and 1930 the territory's population was only about 10,000 (Censo, 1930: 11). It was much more profitable to haul contraband between Belize and outposts such as Xcalak, San Miguel, and Puerto Morelos. During this time, Cozumel also became a center for merchandising all sorts of British manufactured goods, including arms, fine liquors and linens. Chicle gatherers were paid in gold coin or silver dollars and, as Villa observes, "even at the most exorbitant prices these articles found a ready market among the natives who spent money like water" (1945: 32).

Indications of increasing fishing activity along the coast after the turn of the century appear in the sailing directions. For example, the 1918 Coast Pilot notes that locations of small fishing villages to the south of Cabo Catoche, and relates that at Isla Mujeres:

> Beef and mutton are procurable, but not vegetables. The populations (about 400) is engaged in fishing, sponge collecting, and catching turtle. A customhouse was established in 1898 (Pilot, 1918: 281-282).

Cozumel had "probably about 1,000" inhabitants, and "the lagoons are said to abound with fish" (Ibid.: 277). The 1918 Pilot repeats the information in the 1896 edition that "the largest fishing establishment on this part of the coast" is in Ascensión Bay and notices again the small "fishing establishment" near Owen Island (Ibid.: 275-276). In addition, at Allen Point there is "good seining and sport."

Almost a decade later, during the boom days of the chicle industry, the sailing directions described Isla Mujeres as having

> ...a population of about 300 which is dwindling through lack of business. The only industry is fishing though some of the inhabitants have coconut plantations (Pilot, 1927: 313).

Cancún had "a small settlement of 25 Mexicans and Indians from Mugeres Island [and] coconut plantations which together with fishing form the principal industry" (Ibid.: 311). Puerto Morelos, formerly an important outpost for the chicle and timber trade, seems to have fallen on hard times:

> The village...has a population of about 20 and has decreased in importance. The wharf was formerly 100 yards long with a depth of 9 feet (2.7 m) at its end, but the middle of it was destroyed by a hurricane and only the section adjoining the land is in use (Ibid.: 311).

However, the description does go on to note that the village has "the only telegraph station on the east coast" and that "there is considerable travel through Puerto Morelos, in both directions, both to Cozumel from Merida and vise versa " (Ibid.). Henequen, coconuts, and turtle fishing were the chief industries of Cozumel, chicle was exported, and "its lagoons are said to abound with fish" (Ibid.: 309). The population was then estimated at 1,400, and San Miguel had a mayor, customs and health officers, a port captain, and a Federal forestry representative (Ibid.: 309-310). The 1931 supplement to this edition repeats essentially the same information, but observes that "the chief industry is the transshipment of chicle which is brought here from the mainland," and that radio stations are located at the village and at Puerto Morelos (Pilot, 1931: 9-10).

The begining of population increase

Although the chicle business slumped after the early 1930's, Quintana Roo's centuries long pattern of population decline was finally reversed, and a trend of slow population growth was established. As Edwards relates:

> The first sharp upswing in population occurred between 1930 and 1940, when the population increased from 10,620 to 18,752. Between 1940 and 1950 an increase at practically the same rate brought the 1950 population to about 26,900 (1957: 180-181).

Most of the increase prior to the mid-1950's was achieved by colonization of the interior by subsistence farmers from Yucatán, and by the return to Chetumal of families who had fled to British Honduras during the Maya hostilities (Ibid.: 181). Census data for the years 1930-1950 reveal that coastal settlements grew relatively slowly (Fig. 4.1). In 1954, Quintana Roo's population was about 32,000, with nearly a quarter living in Chetumal (Edwards, 1957: 78-79). By comparison, Cozumel, then "the most important settlement in the entire northern half of the territory," had 2,550 inhabitants (Ibid.).

Concurrent with the slow increase in population was a growth in the number of fishermen. Many had emigrated from coastal Yucatán. With few exceptions, the fishermen limited their activities to turtling and the salt fish trade. Their equipment was essentially the same as that of fishermen already working in Quintana Roo.

The waters off the northern end of the state were exploited heavily by handliners and shark fishermen from Cuba (Secretaría, 1942: 108; Sevilla, 1956: 3; Edwards, 1957; 92; Carranza, 1962: 19,21), Belize (Sevilla, 1956: 3), the U.S. (Ibid.), Holbox, and Isla Mujeres. Holbox fishermen sold shark-skins to the Cubans (Edwards, 1957: 92).

Fig. 4.1 Population change in Chetumal, selected coastal settlements, and the territory of Quintana Roo.

Location	1930	1940	1950	1960	1970
Chetumal	2,790	4,672	7,247	12,855	23,685
Xcalak	232	425	527	176	127
Vigía Chico	41	2	n.d.	n.d.	1
Punta Allen	8	9	41	n.d.	n.d.
Playa del Carmen	25	89	69	93	232
San Miguel (Cozumel)	1,599	2,085	2,332	2,915	5,858
Puerto Morelos	98	63	80	47	132
Dolores (Isla Mujeres)	399	557	657	1,071	2,663
Puerto Juárez	6	6	5	59	100
Holbox	299	286	291	519	581
Total State	10,620	18,752	26,967	50,169	88,150

Source: Censo, 1930-1970.

The antiquity of this trade is uncertain, but Holbox fishermen informed me that it was underway during the early 1900's. Virtually all of this production was not registered, being sold directly to Cuban boats anchored off the island. Fillets cut from sharks were salted, dried, and sold to a nearby agricultural operation or shipped to Progreso.

Sponge fishing in Quintana Roo continued, although the focus shifted from Cozumel to more northern waters. Here, sponges were of higher quality (Osorio and Cardenas, 1966: 3) and conditions were more suitable for extraction. Apparently, most of the sponges were harvested with a Cuban sponge hook called bichero (Quesada, n.d.: 81) or gancho (Carranza, 1962: 40). After 1939, production diminished markedly due to an epidemic that wiped out virtually all of the commercial sponges in Quintana Roo (Ibid.: 40; Osorio and Cardenas, 1966: 5). The devastation was apparently so complete that sponging was effectively ended (Fig. 4.2). Six years after the epidemic struck it was reported that the nurseries were beginning to show signs of slow recovery but that the industry was not yet reestablished (Osorio and Cardenas, 1945: 6). Edwards, who visited the area in 1954, observed that sponging was limited to "occasional gathering for local use" (1957: 93).

Beach weirs were probably introduced to southern Quintana Roo in the 1940's, a few years after Belize fishermen began to use them. However, their use may not have become widespread for more than a decade, since in 1955 Carranza only observed them in Chetumal Bay (1962: 105).

The Fishery at Mid-Century

Data on production prior to the mid-1950's are limited, but generally supportive of statements by older fishermen that, with the

Fig. 4.2 Sponge production in Quintana Roo for the years 1929-1941, as reported by Osorio and Cárdenas (1966: 2). The authors caution that these data are possibly inexact, and note that the weights probably refer to finished commercial product.

Year	Kilograms
1929	221
1930	3,576
1931	135
1932	1,822
1933	510
1934	1,157
1935	126
1936	198
1937	1,879
1938	25
1939	1,871
1940	35
1941	156

exception of turtle, production was low and exports were minimal. For example, Quintana Roo's total registered production in 1940 was 90 metric tons (Secretaría, 1942: 108). Although I have no breakdown on composition of the catch, the majority was probably turtle, since that industry boomed during the 1940's and peaked at the end of the decade (Carranza, 1962: 138). Additional evidence that finfish production was limited is found in the preface to the 1950 census:

> The quantities of fish taken along the coast of Quintana Roo have remained almost unchanged in the last few years, but production of "industrial species" e.g., sharks and turtles has increased importantly (Censo, 1950: 8).

Shark liver oil became an important source of vitamin A during World War II, and Holbox fishermen profited accordingly. Large numbers of

sharks were captured exclusively for their livers until vitamin A was synthesized, as a result of which the shark fishery collapsed (Carranza, 1962: 93). Finally, a review of Carranza's data regarding the principal scale-fish species captured between 1952 and 1959 (Fig. 4.3) suggests that even after 1950, production for national consumption was relatively limited, compared to captures during the 1960's.

Fig. 4.3 Production of key scale-fish species in Quintana Roo, 1952-1959, according to Carranza's (1962) study.

Year	Mojarras	Snappers	Pompano	Red Grouper	Total
1952	-0-	2,826	300	35,190	38,316
1953	-0-	2,025	-0-	62,532	64,557
1954	2,125	200	423	27,316	30,064
1955	1,700	785	200	16,403	19,088
1956	16,645	8,060	100	19,208	44,013
1957	17,575	11,412	-0-	11,307	40,357
1958	15,770	8,729	170	17,668	42,337
1959	14,210	5,715	-0-	4,226	24,151

With the exception of turtles, exports from the Quintana Roo fishery were minimal owing to isolation. Although fish traps were used in the south, fish captured in them were consumed locally. Most of the fishing was done at the north end of the state, in the shallow waters nearshore by fishermen from Holbox and Isla Mujeres.

The Holbox fishermen specialized in shark fishing, producing salted and dried fillet, oil, skins, and dried fins. Most of the fishing was done from May to September, after the last norte and before

the surestes began (Carranza, 1962: 93). As is still the case today, fishermen captured shark from sailboats by handlining. From November to February, Holbox fishermen also handlined for wahoo which they salted, dried and sold to Cuban fishbuyers along with the sharkskins (Ibid.: 19). In addition, they handlined for grouper and snapper, which they kept in live wells until returning to port where the bulk of the catch was salted.

Isla Mujeres fishermen continued mainly as turtlers. In this context, turtle "fishing" was in reality turtle gathering. Fishermen merely waited for females to come ashore during the egg-laying season (May to about mid-June), and then turned them. Although some fishermen used nets, these were usually stretched off nesting beaches or in narrow breaks in the nearshore reef where, for the most part, they intercepted females before they could crawl ashore.

Turtling was also done by fishermen of Cozumel who worked the sandy beaches of the east side. However, as Edwards observed, most of the production was consumed locally in the form of dried meat (1957: 92). Turtles were also turned on mainland beaches from Cancún to Playa del Carmen (Ibid.).

Green turtles were the most frequently captured, and the only species exported. They were kept in crawls just off the village of Isla Mujeres, awaiting export to the U.S. (Ibid.: 91; Parsons, 1962: 34-35). Hawksbill turtles were relatively rare, but were captured whenever the opportunity presented itself. Their shell was highly valued and their meat was eaten by locals. Loggerheads were only captured for their oil, which along with that of the green turtle and certain fish, was used for lighting and cooking in many villages (Edwards,

1957: 91).

Fishermen of Cozumel and small coastal settlements such as Playa del Carmen trolled from small sailboats for barracuda and other surface feeding fish. For the most part, these were salted and dried, then marketed locally. Amberjack fishing off Playa del Carmen had only recently begun after the resource was discovered by a Cozumel fisherman while handlining for snapper and grouper.

On the whole, Quintana Roo's fishing industry at mid-century remained small in scale, and not much changed from a decade or two earlier. Yet, as communication and transportation improved, and as the nature of the marine resource became more apparent, more capital and new technologies slowly changed the character of the fishery.

CHAPTER V

THE CONTEMPORARY FISHERY

The current fishing effort is focused on near-shore and shallow water stocks. Most fishermen work from skiffs or Belizean-style smacks powered by outboard motors, and over the course of the year use a variety of gear. This chapter deals with the organization and regulation of the fishery and the distribution of methods used by fishermen, with details of some of the less common systems.

General Organization and Regulation

Quintana Roo's fishery, like that of other Mexican states, is regulated by the federal government.[1] By law, fishermen must have identity cards and the licenses necessary to fish for various categories (especies) of marine life. Also all boats and gear must be registered. Fees are minimal, and the licenses function primarily to facilitate tax and data collection. Subsistence fishing, or production for domestic consumption (consumo doméstico), requires no permit.

Federal law also reserves certain species for exploitation by cooperatives. In Quintana Roo, independent fishermen (permisionarios libres) cannot legally capture lobster, shrimp, or conch, which are reserved for cooperative members. In effect, this restricts captures of non-cooperative fishermen to scale-fish or shark -- products of considerably less value.

Preferential treatment for collective and cooperative enterprises began during the presidency of Lázaro Cárdenas (1934-1940), as part of a series of revolutionary reforms. Between 1936 and 1950, new fisheries legislation gave cooperatives exclusive rights to fish for

certain species, which caused a rapid increase in the number of cooperatives (McGoodwin, 1980: 39-41; Petterson, 1980: 64-66).

Although Mexico's first fishing cooperatives were established in the 1930's, they were not begun in Quintana Roo until a quarter of a century later. This was due partly to the state's backwater location, the small scale character of the fishery, and the limited local market for the reserved species. Most fishermen concentrated on scale-fish, shark, and turtle. Fish and shark meat could be salted and preserved for the often lengthy time necessary to build sufficient inventories to justify voyages to Gulf ports. Likewise, turtles could be kept in crawls and shipped live whenever there were adequate numbers.

As lines of communication and transportation expanded, the character of the fishery began to change. It became obvious that the lobster resource was substantial, and that there was a considerable market. In the early days of the lobster fishery, independent fishermen were permitted to take any of the reserved species since the law allows this wherever cooperatives do not operate. Not surprisingly, as the first stirrings to organize a cooperative began, many fishermen decided to join in order to assure access to the resource. The state's first cooperatives ("Patria y Progreso" and "Caribe" on Isla Mujeres) began to register their catches in September, 1957. Also not surprisingly, their first permits were for the high-priced lobster. Examination of production and registration for the early years is revealing. As independent fishermen, they continued to capture scale-fish and shark. Many apparently continued their pre-existing arrangements with fish buyers who "sponsored" them with loans, gear, and even boats in exchange for a share of the capture and the exclusive right to purchase

the rest. As cooperative members, these same fishermen obtained permits to fish lobster, which allowed them to register captures. This was necessary for legal sales to their "sponsors". The relationship between fishermen and buyer was somewhat analogous to that of peón and patrón on a hacienda; in fact, buyers were referred to as patrón. Viewed in this context, capture and gear registration records suggest that, at least in the early years, the cooperatives existed in name only. Older fishermen of Isla Mujeres generally confirmed this, and more than one volunteered that the patrones were instrumental in organizing their own people into cooperatives. Thus, the buyers retained access to the high profits of the lobster market.

As lobster production increased to satisfy the steadily growing demand, fishermen elsewhere in the state organized to form cooperatives. In 1960, groups were established in Xcalak ("Andrés Quintana Roo") and ("Cozumel"), and in 1966, the Holbox group ("Pescadores de la Isla Holbox") began to function. In 1968, members of the Cozumel cooperatives split off to form another group ("Pescadores de Vigía Chico") which is presently based at Punta Allen. More recently, in 1976, graduates of the Puerto Morelos fishery school organized a special state-sponsored group ("Technológica de Puerto Morelos") chartered exclusively for shrimping. In the same year, black coral divers and artisans on Cozumel Island formed a cooperative in an effort to regulate their industry.

In 1980, there were 799 registered cooperative members. Of these, 643 were considered fishermen; the rest were employed in administrative capacities or the black coral trade. Details regarding the membership of each cooperative are presented in Fig. 5.1.

Fig. 5.1 . Personnel occupied in the fishery.

Cooperative or other Production Group	Location	Number of Members or Permit Holders	Salaried Employees	Total
SCPP Pescadores de la Isla Holbox	Isla Holbox	119	1	120
SCPP Patria y Progreso	Isla Mujeres	160	1	165
SCPP Caribe	Isla Mujeres	65	2	67
SCPP Technológica de Puerto Morelos	Puerto Morelos	22	1	23
SCPP Cozumel	Isla Cozumel	72	1	73
SCPP Buzos y Artesanos de Coral Negro de la isla y costas de Quintana Roo	Isla Cozumel	40	1	41
SCPP Pescadores de Vigía Chico	Punta Allen	80	2	82
SCPP Andrés Quintana Roo	Xcalak[1]	125	1	126
Permisionarios Libres[2]	North and Central Zone	104		104
Total		787	14	801

[1]The office of the Xcalak co-op is located in Chetumal

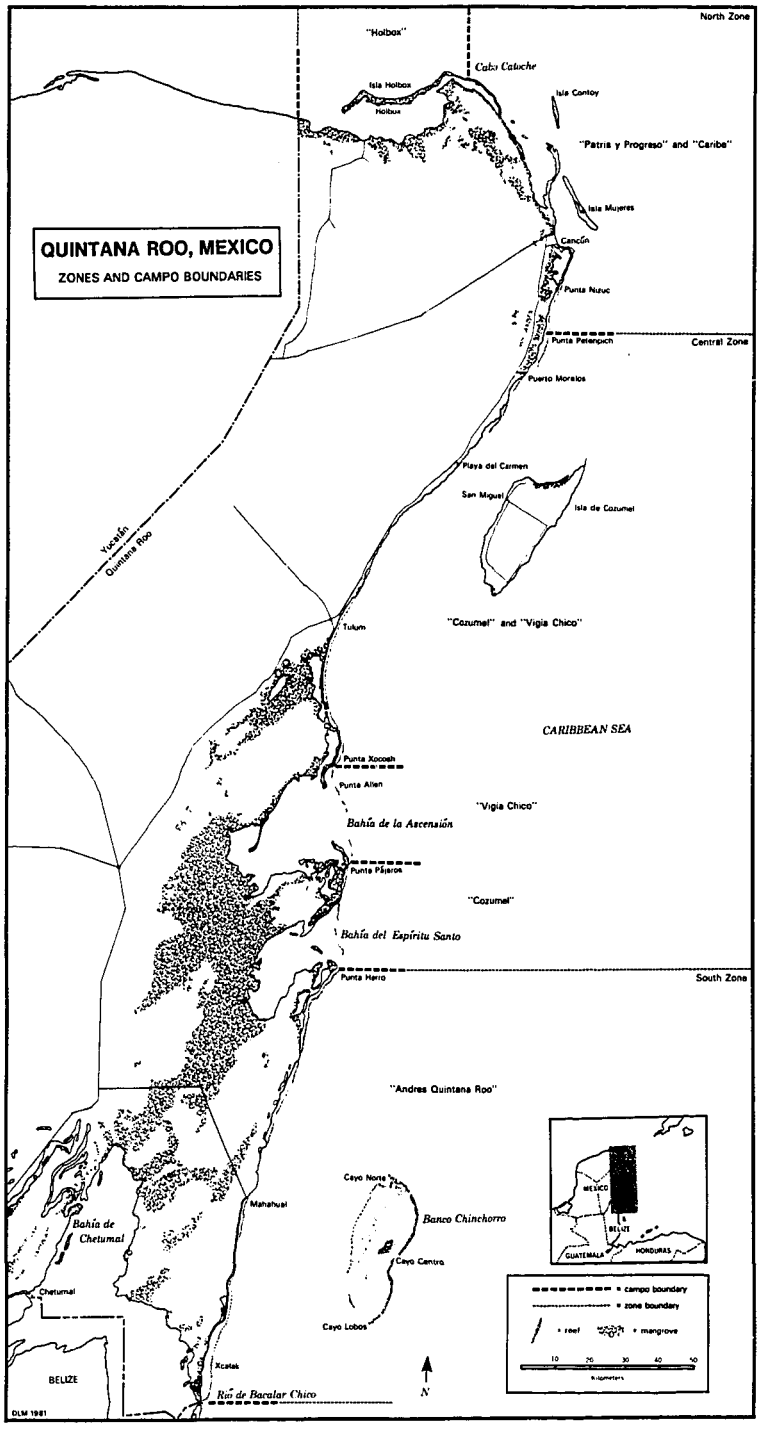
[2]Four of the registered indpendent fishermen (permisionarios libres) hold permits for large scale production, and are fish buyers. They sponsor some of the others who do not belong to a cooperative. In 1979, two patrons were based in Cancun, and two worked out of Playa del Carmen. As best I could determine, only one patron did any fishing.

Source: Diagnóstico, 1979.

Shortly after being chartered as the state's first cooperatives, the two Isla Mujeres groups obtained permits to exploit lobster and each was assigned a site (campo) where they could fish. "Patria y Progreso" received rights to fish off Contoy, while "Caribe" was awarded Cancún. Petitions by independent fishermen for lobster permits were denied, and fishermen in the north wishing to fish legally for lobster had to join a cooperative. In most cases this was not difficult, as any citizen has the right to join, as long as it can be established that he is of good moral character. Over the years, as the number of cooperatives grew, additional campos were awarded and boundaries had to be redrawn. Whereas the Isla Mujeres cooperatives technically enjoyed the exclusive right to fish for lobster on the whole coast, with the founding of the Xcalak and Cozumel groups, their field of operation was reduced substantially. Further reduction of the Isla Mujeres campos occurred in 1966 when the Holbox cooperative was granted its charter.

This division into exclusive zones for the exploitation of reserved species reflects a policy apparently established in the early days of Mexico's fishing cooperatives. They were structured like land-based agrarian collectives (ejidos) and given "title" to fixed areas for exploitation (McGoodwin, 1980: 40).

Today, the Isla Mujeres cooperatives share a campo from Cabo Catoche to Punta Petenpich (Map 5.1). The Holbox group's campo begins at Cabo Catoche and extends west to the Yucatán border. The central zone cooperatives ("Cozumel" and "Pescadores de Vigía Chico") share the area between Punta Petenpich and Punta Xocosh, but have divided the rest of their campo to the south. On paper, "Vigía Chico" has



Map 5.1. Fishing zones and campo boundaries.

exclusive rights to the Bahia de la Ascensión (Punta Xocosh to Punta Pájaros) while "Cozumel" fishes in Bahia Espíritu Santo, the area south from Punta Pájaros to Punta Herrero. In actual practice, there are exceptions, since each cooperative has a few members of the other working in its area. The campo of the Xcalak cooperative ("Andrés Quintana Roo") begins at Punta Herrero and extends south to the border with Belize.

Species presently reserved for exploitation by cooperative members include lobster, shrimp, conch and marine turtles. Although any fisherman can fish for scale and shark anywhere in the state, cooperative members generally limit this activity to their own campos. When questioned about this, they explain that their campo generally reflects the traditional limit of their fishery, and they add that by restricting their activity to their area they avoid engendering suspicion that they are "invading" another cooperative's campo. Invasions have occurred in the past, causing bitter disputes. In most instances, these invasions consisted of members of one cooperative poaching a skiff-load of conch or lobster from the territory of another.

Captures of conch and lobster are also subject to regulations that limit quantity or establish minimum size. State and federal officials have set quotas on conch because of concern about the rapid rate of exploitation. For example, in 1979 the Xcalak cooperative was allowed six tons of conch per month, while "Vigía Chico", "Cozumel", and "Holbox" were permitted two tons apiece. The two Isla Mujeres cooperatives were allowed a total of four tons. In contrast to the ceilings established for conch production, lobster production is limited only by a minimum tail size (13.5 cm.) and by a closed season (March 16 to

July 16) which coincides roughly with the lobster spawning season. Quotas, minimum size limits, and closed seasons have been established for other species; a complete list is provided in Appendix II.

Local representatives of the federal fisheries department (Departamento de Pesca) are charged with enforcing regulations, issuing permits and certifying legality of capture. The latter is necessary for transport of product to market. Offices are currently located in Chetumal, Cozumel, Puerto Morelos, Cancún, Isla Mujeres, and Holbox. As a general rule, the federal officials cooperate closely with state government personnel in the development and implementation of policy. The Instituto Nacional de Pesca, a federal agency charged with providing data to assist local and regional planning, regulation and management, maintains a research station on Isla Mujeres.

With few exceptions, schemes for the development and regulation of the state's fishery have been devised and implemented in three separate zones (Map 5.1) each of roughly equal area but distinct with regard to physical and biological conditions of the fishery. These zones form the basis for the following description and analysis.

General Characteristics of the Fishery

Subsistence fishing in Quintana Roo contributes relatively little to total food supply. Most of the activity occurs near coastal villages, and is done by hook and line. Cast nets are used occasionally where conditions are appropriate. Young men and boys often possess facemasks and second-hand or makeshift spearguns with which they stalk less wary shallow water fish including grunt, mojarra, snapper and parrotfish. Some families or groups of friends from the interior

regularly visit the beach on weekends or holidays, and many use the opportunity to fish. Although most people fish principally for sport, a few are quite proficient and often return home with considerable amounts of seafood which they sell for extra income.

On a commercial scale, both members and non-members of cooperatives (about 100 "independents") engage regularly in gillnetting and spearfishing. Gillnet fishermen use nylon twine and monofilament nets, most of which are purchased in Mérida. Length, depth, and line weight of nets generally depend on the area fished, the species sought, and the size of the boat. Mesh size varies considerably but usually ranges from 5 to 12 cm stretched. Almost all nets are fished to intercept surface and near surface runs of fish.

Spearfishing is done mostly by specialists who free-dive. Where compressors for refilling air tanks are available, many divers use SCUBA gear. They are virtually omnivorous in catching finned or shelled prey, and few species can elude an experienced diver. When conditions (i.e., water clarity and current) are right, many divers hunt in deeper water, often along the outside edge of the barrier reef. Whenever fishing pressure is heavy, stocks of lobster, conch, and finfish of any size are quickly cleaned out, and snapper, grouper, hogfish, parrotfish and barracuda also disappear rapidly. Not unexpectably, divers are finding it necessary to range farther from their bases to find fish.

Quintana Roo's fishermen also utilize a variety of other gear: a complete inventory is found in Figure 5.2. Information on the numbers and types of boats is presented in Figure 5.3.

Fig. 5.2. Inventory of fishing gear used in Quintana Roo, 1979.

Type of Gear	Number in Use
Nasas (Australian style lobster traps)	5,000
Redes langosteras (lobster nets)	130
Casitas (artificial habitats to attract lobster)	17,800 (est.)
Redes tortugueras (turtle nets)	100 panels
Redes camaroneras (shrimp nets)	56
Bicicletas (snapper reels)	15
Palangre tiburonero (shark longlines)	17
Redes (nets, including seines and gill nets)	207
Aletas, snorkel, y visor (fins, snorkel, and mask for skin diving)	665 sets (est.)
Ganchos langosteros (lobster gaffs)	665 (est.)
Pistolas (spearguns)	375 (est.)
Carretes de cordeles (handlines)	400

Source: Diagnóstico, 1979; information on gear registration forms at regional offices, and personal observations.

Fig. 5.3 . Numbers of boats used by the major groups participating in the Quintana Roo fishery, 1979.

Group	Lobster Boats	Shrimp Boats	Multi-purpose	Small Sailboats or Skiffs
Empacadora y Congeladora Romeo (Isla Mujeres)	20	6	4	
Industrial y Comercial de Puerto Morelos	-	-	5	15
Distribuidora de Alimentos del Caribe (Cancún)	-	-	7	19
Cooperative "Pescadores de Holbox"	-	-	2	43
Cooperative "Patria y Progreso"	-	0	-	35
Cooperative "Caribe"	-	-	-	15
Cooperative "Technológica de Puerto Morelos"	-	-	3	-
Cooperative "Cozumel"	-	-	1	22
Cooperative "Vigía Chico"	-	-	-	34
Cooperative "Andrés Quintana Roo"	-	-	1	24
Cooperative "Buzos y Artesanos de Coral Negro" (Cozumel)	-	-	-	6
Permisionario Libres	-	-	-	65 (est.)

Source: Diagnóstico, 1979; information on gear registration forms at regional offices and personal observation.

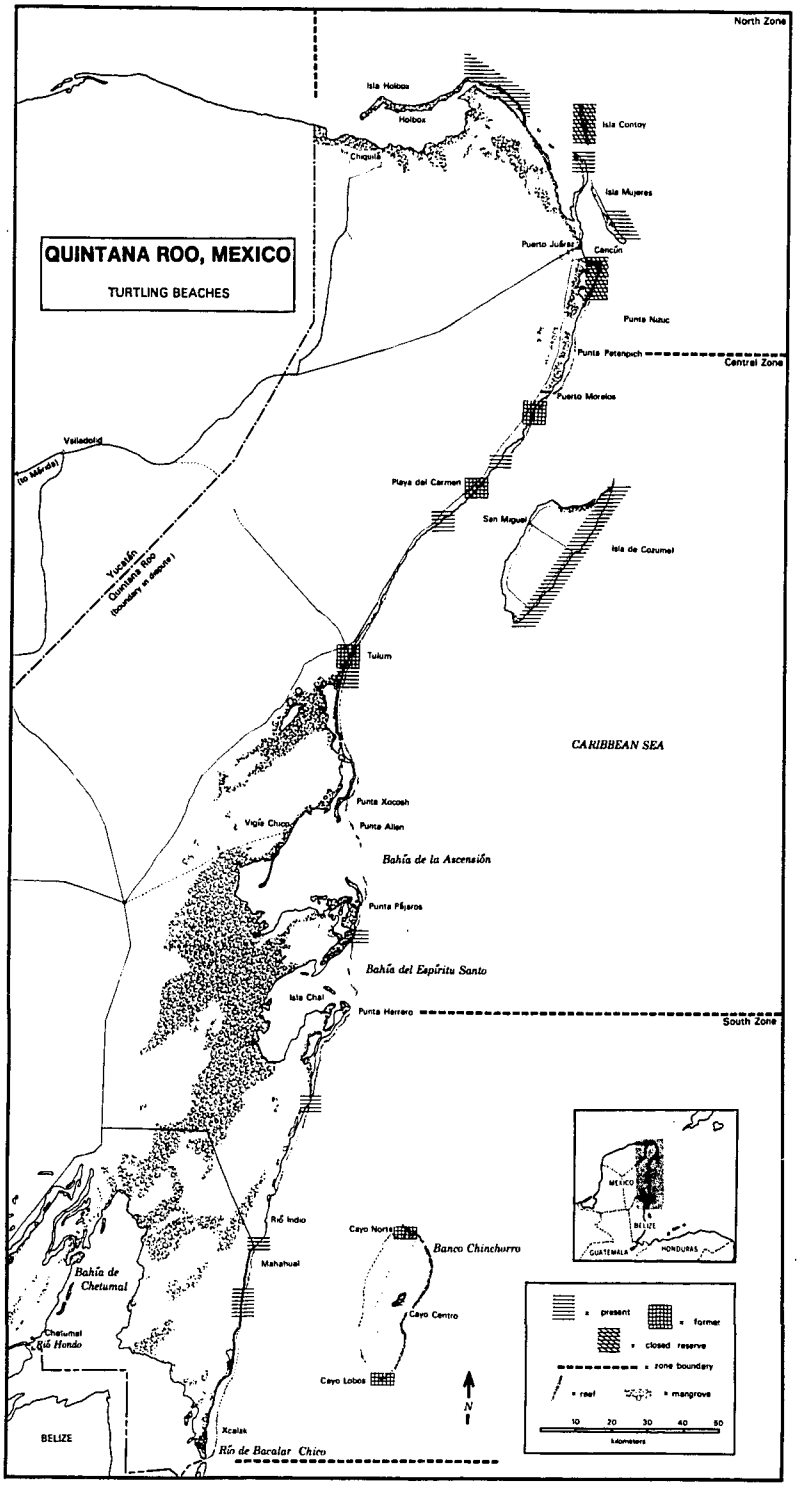
Major Characteristics of the Three Zones

Fishing pressures have historically been the most intense in the northern zone. Today, most of the state's production for export is shipped from here, processing facilities are best developed, and here the most sophisticated gear is found. For example, shrimp, lobster traps and long-line boats are equipped with modern navigational and depth finding instruments, seldom, if ever, found on the craft of fishermen in the central and southern zones.

Throughout the state, turtles are turned on the beach (Map 5.2) or taken at sea whenever the opportunity presents itself. The latter is accomplished with harpoons, or by merely chasing the creature to the point of exhaustion. They are then hauled aboard and their flippers are pinioned. However, only in the north zone is turtling organized on a commercial scale, and details of capture methods are described in that context.

Fishermen of the central zone work close to the shore. In contrast to the northern zone, the shelf is narrow, often ending abruptly a kilometer or two from shore. Also, production from this zone has been considerably less. In recent years, tourism has had a significant impact, draining the zone of manpower and capital. Most of the remaining fishermen have focused on the capture of "luxury" species (lobster and conch), destined for consumption by tourists or for export.

Communication and transportation in the central zone are facilitated by an all-weather road which parallels the coast as far south as Tulum. Here the road turns inland while an unpaved road continues along the shore, ending at Punta Allen. From this point



Map 5.2. Turtling beaches.

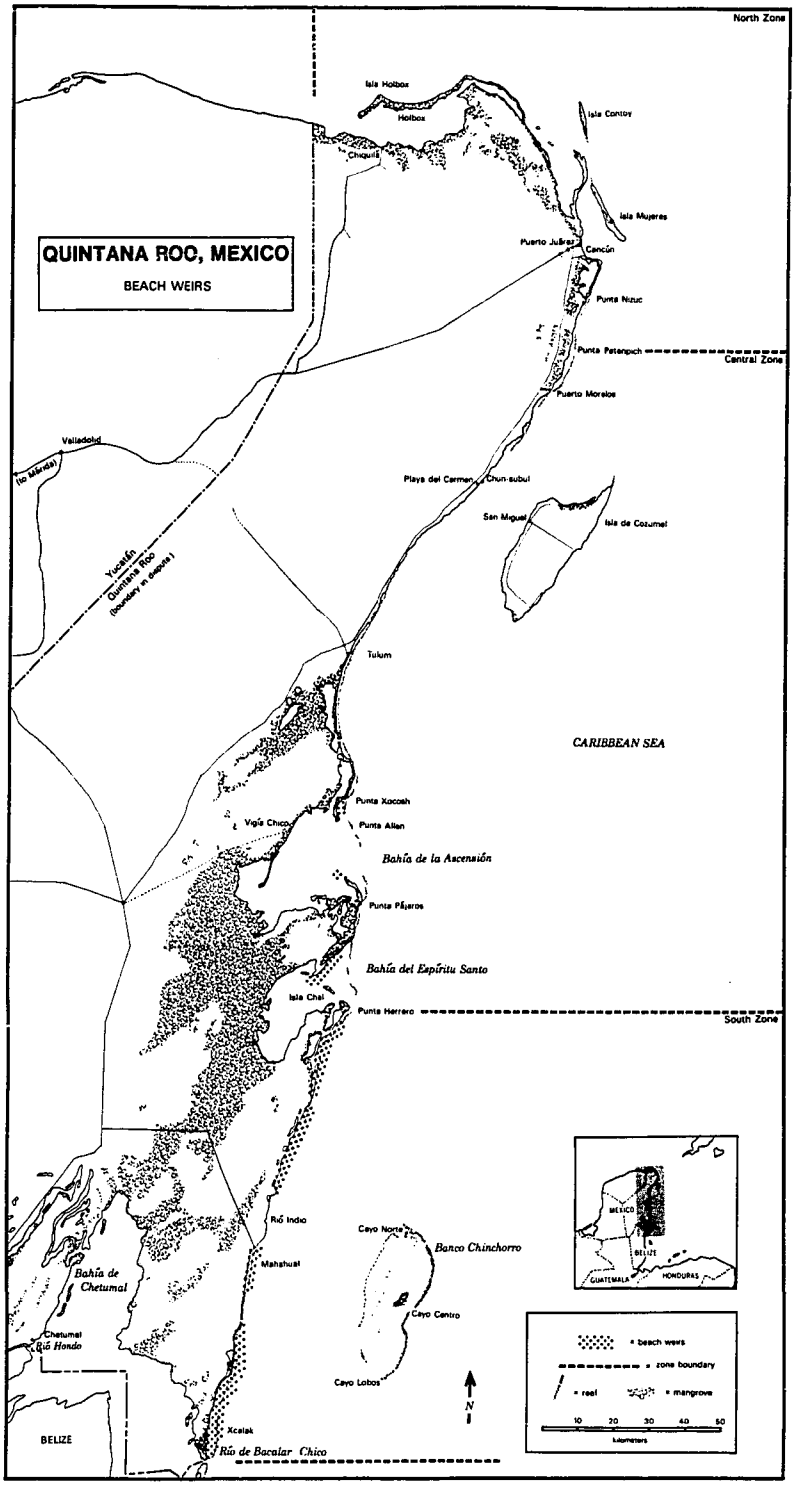
south, to Benque Soya, there is no access for vehicles, and products must be shipped out by boat; living conditions and subsistence styles here are more representative of how things were along the entire coast prior to opening of the paved road.

The south zone fishery begins at Punta Herrero, and extends south to the border with Belize. In late 1979, a road was completed along the coast from Xcalak to Benque Soya, where it turns inland to join the main highway. Prior to that time, the entire southern coast was accessible only by boat. Fishermen of this zone generally restrict their activity to lagoons, shallow backreef areas and to Banco Chincohorro. While luxury species make up the bulk of production, elements of a more traditional fishery persist. Beach weirs are used along the southern coast, and their captures contribute significantly to scale fish production for domestic consumption.

The Southern Zone

The beach weir fishery

Beach weirs, or "trampas de corazón y cola" (Fig. 5.4), have been used along the southern coast for at least thirty years. Presumably, this technique was learned from fishermen of northern Belize, where it was introduced by a Canadian in the mid-1930's (Craig, 1966: 80). Although handlining and spearfishing contribute to the total catch, these shallow water traps account for the bulk of production. In 1979, 35 traps were registered at the Chetumal fisheries office (Appendix III). Their principal distributions stretched from the Belize border to Punta Herrero (Map 5.3), although a few additional weirs were located near



Map 5.3 Beach Weirs.

Punta Allen. Fishermen observe that most locations have been in use for years, although a trap might be moved a short distance if the previous year's production was poor. By common accord, no one is allowed to construct a trap within 500 meters of an existing one.

Weirs are constructed of galvanized chicken wire tied to mangrove poles stuck in the bottom. While there are minor variations, most traps consist of a corral (corazón) about 20-25 meters in diameter, set in water 1.2 to 1.4 meters deep (Fig. 5.5). Two wings (piernas) lead away from a point along the side of the corral facing the shore. One wing, called the cola, leads in to the beach, extending nearly to the land and is often angled, or pointed slightly to the north. Fishermen explain that this is to prevent large schools of fish from colliding with it and breaking it, and it also herds them toward the entrance. The second wing (ceno) runs to the north, roughly parallel to the shore. A funnel-type entrance is situated where these wings converge, making entry to the carazon easy but exit difficult.

In 1979, the cost of a trap (including labor) ranged from 4,000 to 5,500 pesos, ($174 to $239 U.S.). Three men can set up a weir in half a day if all materials are at hand. With few exceptions, galvanized wire purchased in Belize is used since it lasts much longer than the Mexican product. However, even with the best wire, traps rarely last more than a season and a half. Normally, traps are operated from September to December, when the fish are running. Leaving the wire on the poles beyond this "season" is generally not justified. Most fishermen untie it from the stakes, roll it up, and take it ashore. A handful of fishermen trap year-round, but it is thought that if more did this, the capture would not justify the effort. In

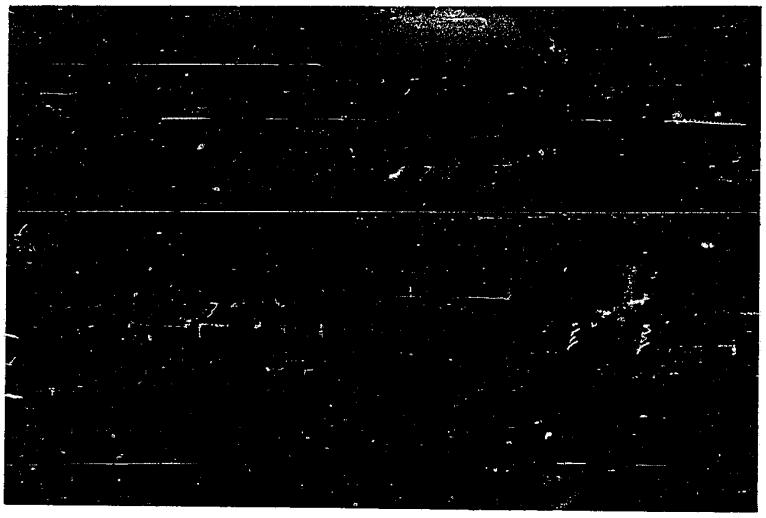


Fig. 5.4 Beach weir, or trampa de corazón y cola, located just north of Xcalak.

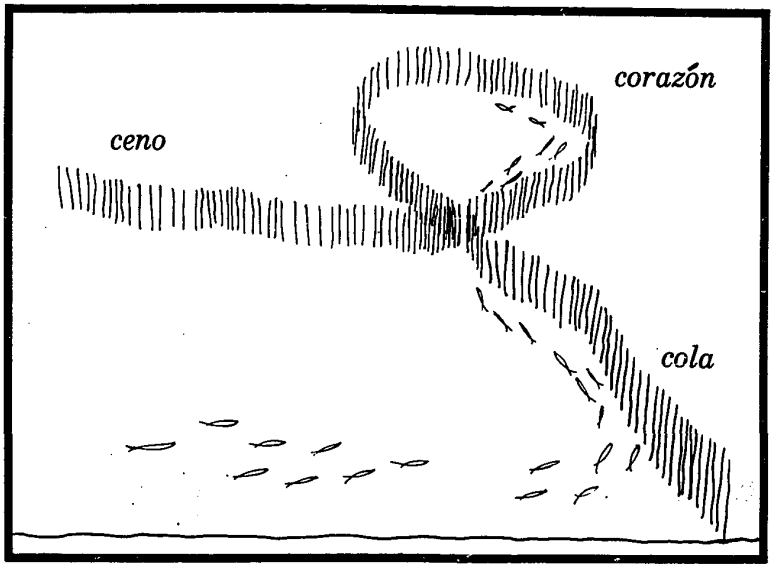


Fig. 5.5. Schematic drawing of the capture of a school of fish in a beach weir.

addition, some believe that year-round trapping does not allow the fish sufficient opportunity to breed.

Once the trap is constructed, maintenance is minimal, but daily inspection is necessary. Seaweed must be removed from the wire, since its accumulation would damage the trap, either by its weight, or by preventing the current from passing through the mesh. In addition, sharks (particularly the nurse shark or gato) and turtles frequently force their way into the corral, and need to be removed and the damage repaired.

To make the harvest, fishermen tie their skiff alongside the corral and hop into the trap. They scoop up the fish with a hoop net about .75 meter in diameter (Fig.5.6). The fish generally run along the side, making the catch easy once bottom sediment is stirred up to confuse them. Netted fish are dumped over the side into the skiff.

Before entering the trap, fishermen are careful to look for such potential dangers as sharks, morays, barracudas, rays and loggerhead turtles. These are removed either by capturing them with a noose, harpoon or speargun. Then any damage to the trap is repaired and the netting of fish can proceed.

Mullet and snapper are most frequently caught, but other species commonly found in the traps include grunts, jacks, bonefish and barracuda. Immediately before and during bad weather (particularly nortes), fish are said to run to the south, and spectacular catches can result. From October to January, record catches up to five tons per weir have occurred in 24 hours. Average catches are smaller, but captures of one or two tons are not uncommon.

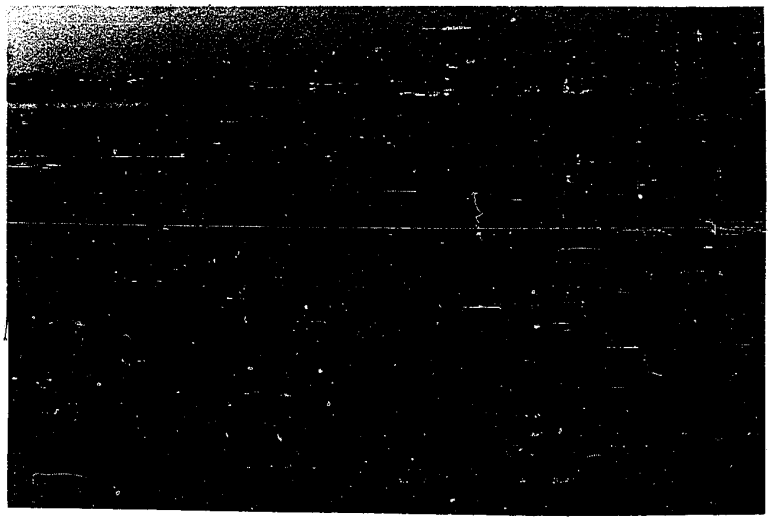


Fig. 5.6. Xcalak fishermen using hoop nets to harvest fish from beach weir.

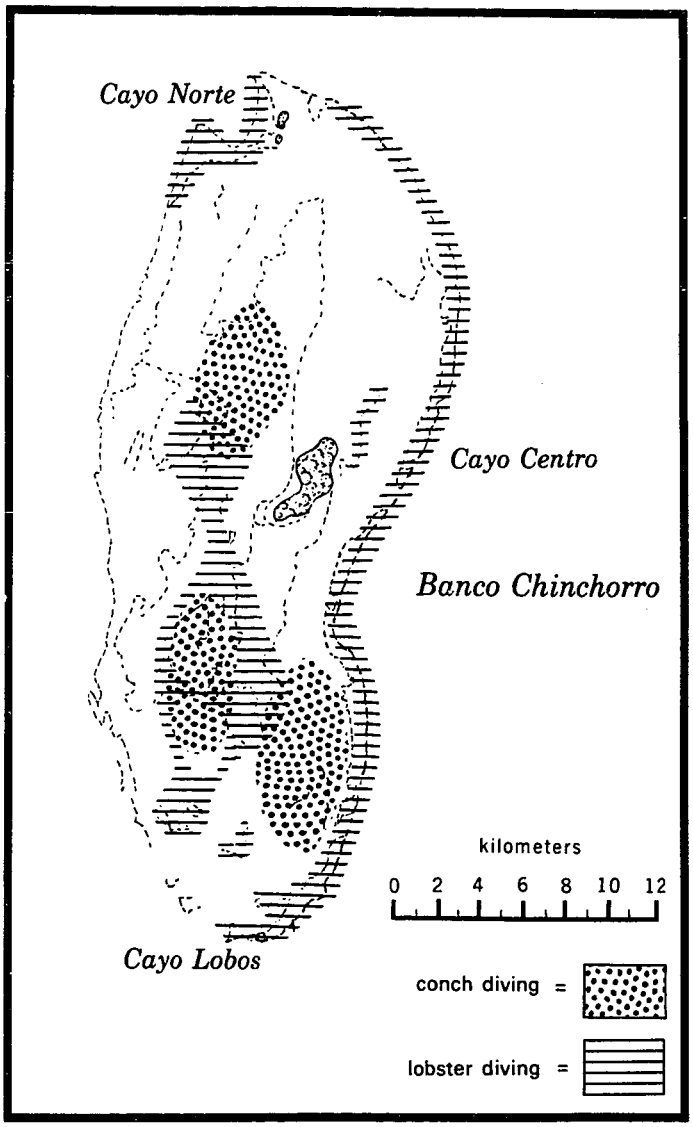
Fig. 5.7. Typical Xcalak smack, fitted with an ice box.

Until about ten years ago, most of the catch was carried to Chetumal in live-wells of small sailboats, which could carry 500 to 600 kilos. Although the fresh water of the Río Hondo eventually killed many of the fish, most arrived at Chetumal in satisfactory condition; however, since the fishermen relied on the wind, contrary or calm weather sometimes resulted in a spoiled catch. This apparently occurred frequently enough so that once a reliable supply of ice became available in Chetumal, the fishermen plugged the wells and installed ice boxes (Fig. 5.7). This began about 15 years ago, also allowing the boats to carry considerably more fish, expanding their capacity from one to three tons, since they could be packed in tightly. Today, virtually every sailboat seen at Chetumal has an ice chest, and older boats can be identified by the plugs in their hulls.

Fish traps offer unique advantages. They allow time for other activities since the weir works unattended and can be checked whenever convenient. Their tending is often left to older men and boys. The catch can be simply left in the corazón until the quantity is sufficient, and the weather is right for a trip to Chetumal. Finally, there are no storage costs, and fresh fish can always be taken out for local consumption.

The Chinchorro Bank lobster and conch fishery

Fishermen of the Xcalak-based fishing cooperative state that wholesale exploitation of lobster and conch at Chinchorro Bank (Map 5.4) has been underway for only seven to ten years. Previously, their visits to Chinchorro were less frequent. Earliest notice of lobstering is found in Solis-Ramirez's 1966 account, which indicates that in 1965 lobsters were being taken by divers, and implies that



Map 5.4. Lobster diving and conch gathering areas at Banco Chinchorro.

this had started three years earlier (1966: 10). In any event, prior to the later 1960's, trips to Chinchorro were sporadic, the primary attraction being hawksbill turtles and, on Cayo Centro, alligators.[2] Stocks of lobster and conch were plentiful enough along the coast.

Chinchorro Bank is within the campo of the "Andrés Quintana Roo" cooperative. Trips to Chinchorro are made in two stages, beginning at Chetumal where ice, fuel, and other supplies are obtained. Leaving early in the morning, the fishermen sail down the bay to Río de Bacalar Chico, motor through the mangrove lined channel, and sail north to Xcalak. This leg of the trip takes about seven hours. On the following morning, if conditions are favorable, the 58 km crossing to Cayo Centro is made. This takes from six to twelve hours, depending on the character of the boat as well as wind, current, and waves. On a calm day, fishermen can make the crossing in their outboard powered skiffs in less than three hours.

The number of fishermen at Chinchorro varies considerably over the course of a year, but the greatest numbers are present during the first one and one-half months of the lobster season (July 16 to early September). At this time, lobsters are particularly abundant, and the largest catches are made. Most fishermen live at fish camps for periods of up to two weeks, returning to Xcalak occasionally for no more than a day or two. Fishermen retire to the mainland during September, the height of the hurricane season. They return in October, but their stays are shorter and their trips less frequent, since the lobster are not so abundant, and conch quotas can be quickly filled.

During the last week of July, 1979, there were about 55 men at

the Cayo Centro main camp, and five to ten at Cayo Norte. At Cayo Lobos, there was a temporary camp, where fishermen from the main camp sometimes spent a few nights. During the early part of the season, at least one larger boat and several skiffs could usually be found anchored off the smaller cays.

At the Cayo Centro camp, nearly everyone lives in huts on pilings located 45 to 90 meters off the southwestern side of the island (Fig. 5.8) the minimum distance for relief from biting insects. At night, the whining of mosquitos is audible and fishermen jest half-seriously that it would be better to remain adrift and lost at sea than to be washed up at Cayo Centro to become insect food. The pilings are cut from trees growing on the island and the huts are framed with wood from the same source or washed up on the shore (Fig. 5.9). They are generally ramshackle affairs, crudely pieced together but serviceable in providing cooking, eating and sleeping space. Sanitary facilities are of the most elementary sort. They are roofed with sheets of corrugated tarboard purchased in Chetumal or, in some cases, tarpaulins or sails are stretched over the roof. Crude arrangements of pans, tubes, and barrels are set up for capturing rainwater to augment the supply brought from the mainland. The first shelters were built on the west side of the island, but it was soon discovered that they were too exposed to nortes.

In the early days of the Chinchorro lobster and conch fishery, as had been the custom on turtle expeditions, sailboats served as bases. The actual fishing was from dugout canoes, with two or three canoes to a boat. After anchoring the boat near a promising area, divers paddled or swam the canoes to a propitious spot. When they had fished

Fig. 5.8. Fishermen's huts at the Cayo Centro base camp at Chinchorro Reef.

Fig. 5.9. Fishermen's hut at Cayo Centro, Chinchorro Reef. Men underneath are adding pilings.

out the spot or filled the canoe, they returned to the sailboat. Apparently, it was not until outboard motors came into general use that exploitation of conch and lobster became more regular, that the permanent camps became popular.

Powered by outboards, the dugouts could reach and return from virtually any part of the reef on the same day. Initially, six hp. Johnson and Evinrude motors were used, but larger ones (20-25 hp.) soon replaced them as plywood skiffs (pangas) imported from San Pedro, Belize, become more popular (Fig. 5.10). These skiffs are faster, and also more stable than dugouts, a quality that can be appreciated readily by one who has tried to climb aboard a dugout after a morning of exhausting diving. In 1980, I observed only two dugouts still in use, both approximately four and one-half meters long and powered by six hp. outboards.

Although some fishermen still live on their sailboats while at Chinchorro, most live in huts, anchoring their boats nearby or tying up to huts. From this base, the skiffs can speed to any part of the reef in the morning and return by late afternoon, before the catch spoils. All in all, the huts are much more livable than the sailboats, providing space for cooking, washing, repairing gear and salting fish. They are more comfortable for sleeping since hammocks can be hung, and gear can be stored during a brief trip to the mainland.

The use of skiffs also has advantages. They can be pulled up into the mangroves during bad weather, and left there during the off season. If fishermen learn that a really bad storm is coming, they can cross quickly to the mainland. In calm weather, it is not uncommon to see the larger boats of the cooperative towing four to six skiffs

Fig. 5.10. Typical plywood skiff with 25 horsepower outboard used by Xcalak lobster and conch fishermen.

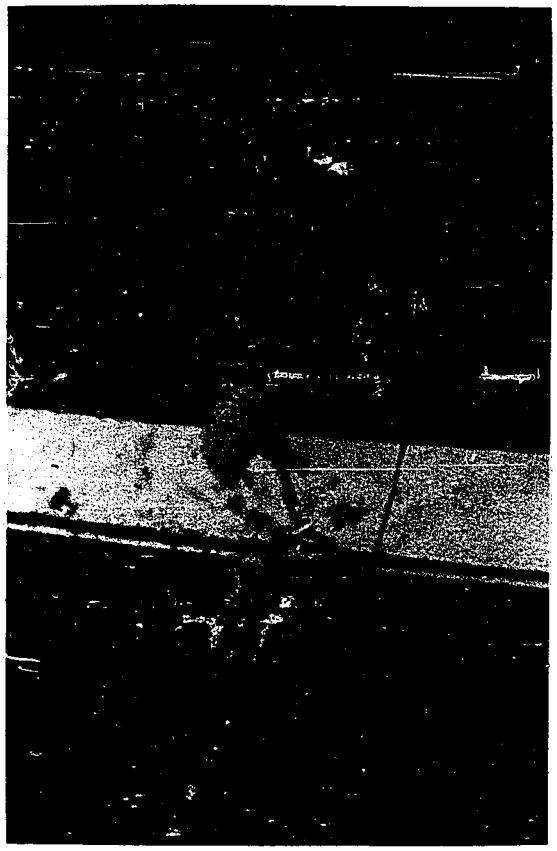


Fig. 5.11. Separating a lobster tail; the rest is discarded over the side.

and carrying another one or two on deck. Obviously, this "piggy-back" transport saves fuel and is safer than crossing alone.

The skiffs have built-in floorboards, which in addition to keeping the fishermen's feet dry, cover a space for stowing the catch or other items out of the sun and out of sight. In some skiffs, the double bottom space can hold as much as 600 kilos of conch.

Most larger sailboats have been fitted with inboard diesel engines and no longer carry functional sails. For example, the cooperative's mother ship Andrés, obtained in 1978, has a mast but no boom. Although most smaller sailboats still have sails, few rely on sails alone. Many have long-shaft 20 or 25 hp. outboards mounted at the stern as is common in Belize. Almost all sailboats currently in use were built at Cay Caulker in Belize about 60 km south of Xcalak. They usually have built-in ice boxes and thus are not dependent on the mother ships and can carry smaller catches more economically. Since most have sails in working order, they can be used if the wind is right. Smaller boats are also able to save fuel because they can make the shallow passage through Río Bacalar Chico. Boats drawing more than 1.25 meters must go around Ambergris Cay, through Belizian waters, and follow a narrow channel up the bay to Chetumal.

Although the sailboats are more costly and require more maintenance than skiffs, they do have advantages. They can be loaded heavily with supplies such as drums of gasoline, cases of lubricants for outboards, canned goods, vegetables, fruit, and ice. They are also more seaworthy, an advantage readily appreciated during foul weather. In the event of a hurricane, most are run up the Río Hondo, potentially offering fishermen and their families somewhat more security than

residents of Chetumal.

The daily routine at Cayo Centro begins at about 4:30 a.m. with the hum of a few late night mosquitos and the static of radios being tuned to the Chetumal station or Radio Belize for the weather report and the news. Cooking fires are started, coffee is put on, and a light breakfast is prepared. The plan of the day is discussed amid considerable banter and joking, gear is checked, gas tanks are filled, and by 7:00 or 8:00 a.m. almost everyone is on his way out.

During good weather, many fishermen dive for lobster outside the east reef. Here, as elsewhere, one of the men guides the skiff, keeping it near the divers who generally work close together. Lobster are taken with a one meter gaff (bichero) made from a branch of mul-che (Bumelia mayana), to which a large fishhook has been wired. The other end of the stick is sharpened to a point. The branches are cut green, which allows them to be straightened or shaped as desired. The wood is extremely flexible, allowing the diver to work into holes and caves where a stiffer handle would be useless, and when submerged, it has near neutral buoyancy. This device is worked with one hand, while the other is fitted with a heavy glove, necessary to protect the hand from the sharp spines, the wounds from which are often slow to heal.

To become proficient with a gaff takes considerable practice, but once learned it becomes a devastatingly efficient tool. The hook must be slipped point down under the lobster, disturbing it as little as possible. Then the handle is rotated to put the hook in position to snag the underside of the carapace, and the gaff is yanked back hard. The diver then swims to the surface with the impaled

lobster, signals the skiff over, and swings his catch over the gunwale, shaking it loose onto the floorboards.

When divers find more than one lobster in a hole, most can gaff two or even three in a single dive. The hooked lobsters are taken off the gaff with the gloved hand, and killed by a punch in the lower carapace, using the sharpened end of the gaff-stick.

Most divers have developed a trained eye for spotting suitable habitats. They conserve energy by limiting their dives to patches of certain species of coral, and to crevices or seams in the rocks along the bottom. Many work the same areas of reef year after year and are able to recall holes where they made prior captures. More often than not, new residents can be found in these spots.

When they arrive at the outer reef, divers, begin by diving in water from 9 to 14 meters deep. They allow the current to carry them along, and dive whenever they see a suitable area. As the day wears on, tasks are rotated so that some can rest while piloting the skiff. Since free diving is exhausting, most teams move to shallower areas by late morning or early afternoon, and by about 2:00 p.m. the diving is over for the day.

When a large grouper or hogfish is spotted, a diver will call the skiff over for a speargun. However, divers are looking primarily for lobster, and fish captures are incidental. Also, fish cannot be taken too early in the morning because they may spoil. Spearguns are not used to take lobster since time is wasted loading the shaft and cocking the rubber slings. Spearguns are also more expensive, shafts cannot always be retrieved, and slings break. In contrast, gaffs are cheap, and, more important, flexible for snatching lobsters from

deep crevices well under the coral or in the rocks. This is done with consumate skill by experienced divers.

Lobsters from the outer reef are generally larger than those captured inside. Many weigh over two kilos, their tails averaging about 550 grams, large by any standard. During my visit at the beginning of the 1979 season, experienced three-man crews averaged about 30 kilos of tails per day, and some crews brought in nearly 40 kilos. At that time of the year, it is not unusual for twenty skiffs to bring in as much as 550 kilos a day.

Most crews return to camp by mid afternoon to clean the catch. Tails are cut away and the rest is tossed over the side (Fig. 5.11) A short piece of the lobster's finely barbed antenna is inserted in the anus to snag the gut and pull it out cleanly. Cleaning is done around the camp or near the shore because of the belief that dumping the bodies where lobsters are caught would cause them to abandon the area. Around the huts there are vast piles of slowly decomposing offal. These provide food and habitat for many fish, including large schools of snapper and bonefish which move constantly through the shallow waters around the huts.

The tails are washed in salt water and dumped in a barrel containing 15 to 25 gallons salt water and three or four double handfulls of sodium bisulfite, a preservative. They are soaked for 15 to 20 minutes, and then taken to the mother-ship, where they are weighed (Fig. 5.12), and the divers are credited for the day's capture.

Conch fishing is much easier, more akin to mere collecting. Divers motor to areas of concentrations, locate a promising spot, and set the anchor (Fig. 5.13). They gather nearby conch, pile them close beneath the boat, and either swim them up, two in each hand, or fill burlap

Fig. 5.12. Lobster tails being taken aboard the cooperative's mother ship anchored near Cayo Centro.

Fig. 5.13. Conch fishermen with a good catch. The shells will be dumped away from the harvesting area.

sacks lowered on a line. When the surrounding area is picked clean, they move to another anchorage. In 1980, three specific parts of Chinchorro were being exploited (Map 5.4) at depths of 7 to 11 meters.

The divers usually work in pairs, and often take 200 to 500 kilos of conch meat a day, representing from 1,000 to 1,750 large adult conch. Although fishermen consider conch gathering to be harder than lobster "hunting," they prefer conch fishing because it is a "sure-thing" and because greater weight can be obtained in a shorter period of time.

Conch are removed from the shell by punching a hole near the apex (Fig. 5.14), sticking a knife point into the hole, levering the muscle away from the interior spiral, and pulling the creature out by the "foot." The edible part is trimmed and tossed under the front deck to protect it from the sun. As with lobster, cleaning is done away from the conch beds, in the belief that conch will desert areas where their own kind have been slaughtered.

By dusk, everyone has usually delivered his catch to the mother ship (Fig. 5.15) and the crews return to their huts for supper. The main course is invariably seafood -- stews of fish, lobster, turtle or conch -- along with rice and beans, tortillas, powdered fruit drink and strong coffee. The fare is hearty, high in protein and carbohydrates, necessary nourishment for the strenuous daily effort. By consensus and cooperative rule, no alcoholic beverages are tolerated at the camps. While some of the younger men stay up well into the night, playing cards or other games, most retire to their hammocks or bedrolls early in the evening.

Virtually everyone at the camp dives six days a week, weather

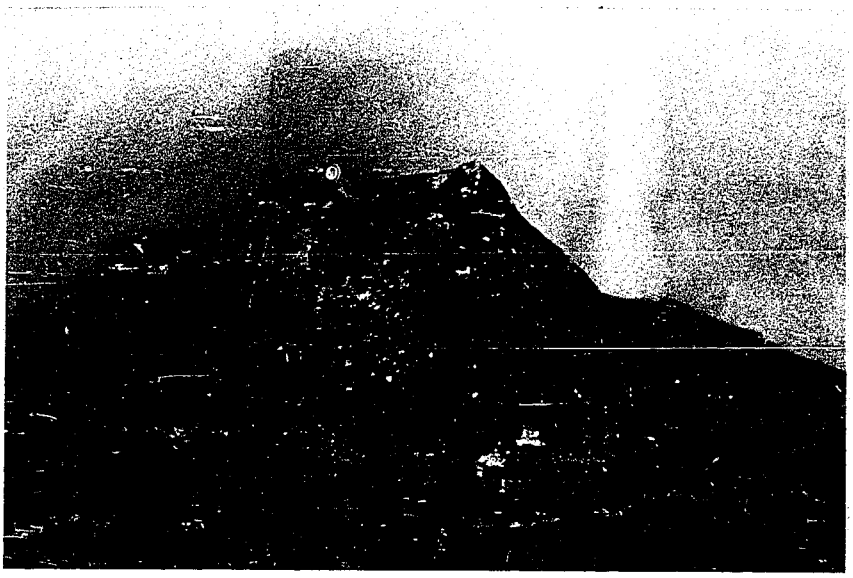


Fig. 5.14. Discarded conch shell, showing location where hole was punched through the shell to facilitate removal of the conch meat.

Fig. 5.15. Conch meat being weighed aboard the cooperative's mother ship at Cayo Centro.

permitting, and as long as there is a boat with ice to receive the catch of a quota remaining to be filled. On Saturdays or Sundays there is sometimes a soccer game on the narrow strip of land on the southwest side of the island, where the insects are not quite so troublesome if the wind is right.

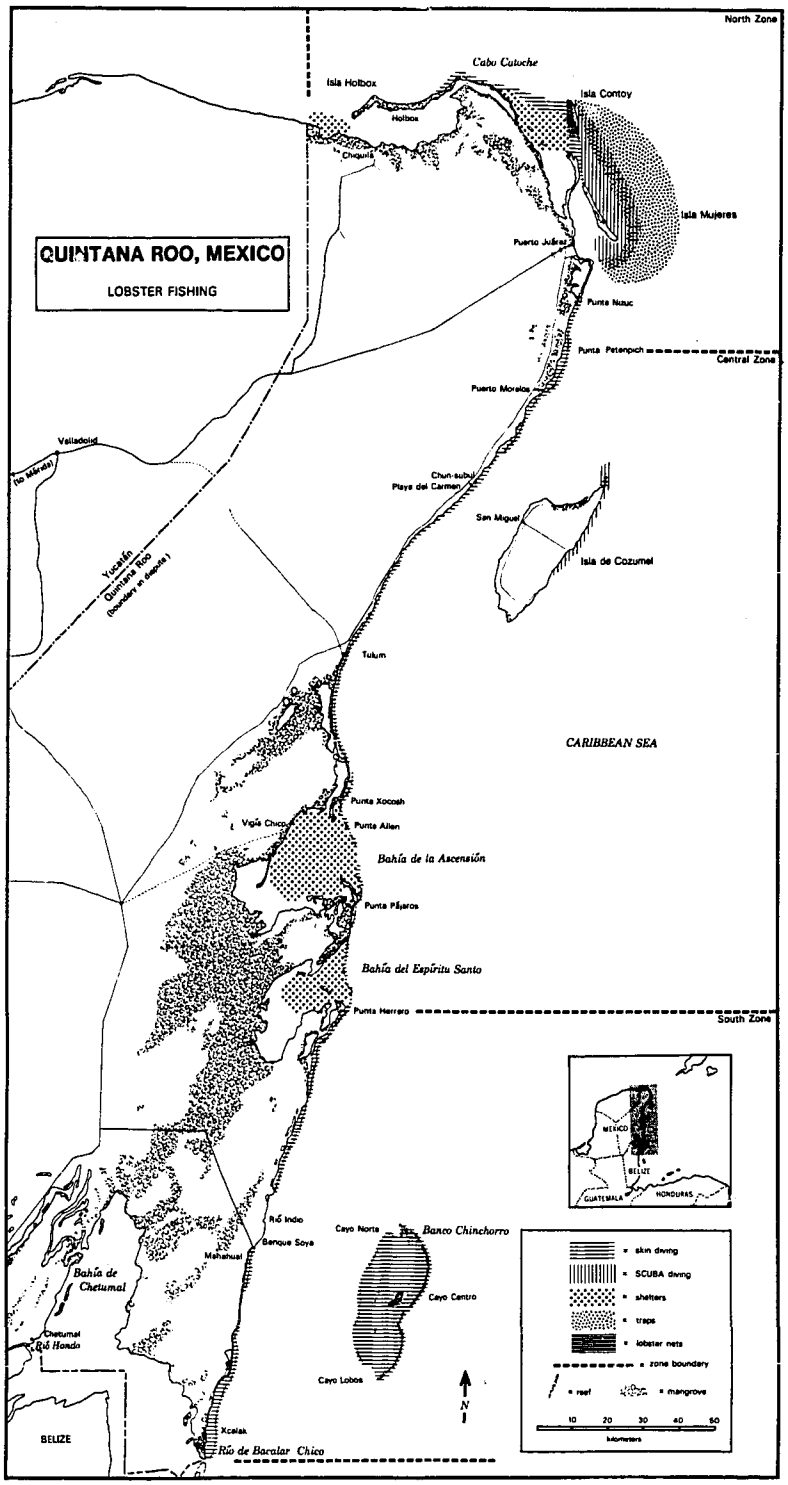
The Central Zone

The Ascensión Bay and Espíritu Santo Bay lobster shelter fishery

For more than a decade, many lobster fishermen in the central zone (Map 5.5) have utilized artificial habitats to increase the catch. Members of the Cozumel and Vigía Chico cooperatives have constructed small shelters designed to provide refuge for lobsters during their daytime period of relative inactivity. These shelters -- known by a variety of names including casitas, casas Cubanas, and sombras -- are assembled onshore and ferried out to areas of shallow water where they are sunk to the bottom. During the lobster season, fishermen periodically chech the shelters and harvest the lobsters.

Fishermen report that casitas were first introduced to Isla Mujeres in the latter 1960's by Cuban fishermen. Before casitas were adopted, lobsters were harvested from shallow water with bully nets.[3] However, by the time the use of casitas had spread to the central zone the common practice was to dive to the shelter and use a gaff. The use of casitas extended the depth at which lobsters could be harvested by no more than a couple meters, but greatly expanded the harvest area.

Shelters are built on a one and one half meter square frame of the trunks of a thatch palm (Thrinax Wendlandiana), known locally as chit. The wood is quite heavy, and sinks immediately. Although it decays rapidly when exposed to the air, it is said to last six to eight



Map 5.5. Lobster fishing.

years when kept submerged. Originally, a "roof" or solid covering was made also of chit logs, but newer styles incorporate a variety of roofing materials. In 1979, I observed roofs of plywood, flattened material cut from steel drums, drum lids and bottoms, corrugated roofing material and reinforced concrete. All styles seem to work equally well, although costs vary. Details of materials and costs for the various types of casitas are found in Fig. 5.16.

In making the original style of casita, the entumbado, a square foundation of four poles is assembled (Fig. 5.17); a solid row of poles is then nailed across the top to form a "roof" (Fig. 5.18); then two more poles are nailed across the roof (Fig. 5.19) to anchor the solid surface and strengthen the construction. These also serve to suspend the roof off the bottom when, as happens frequently, a shelter is overturned by an apparently playful dolphin.

Construction of an entumbado casita requires from 15 to 20 poles. With all materials at hand, three men can make 20 in a day, or two men can make 15. In 1979, groups of men with whom I worked were paid 50 pesos for each shelter they assembled. Fishermen estimate that it costs about 300 pesos ($13.04 U.S.) to put each entumbado casita in the water.

Compared to the other styles, the entumbado takes the most time to build and requires the most poles. It, and the casita de tambo -- roofed with flattened barrel sides or ends (Figs. 5.20-21) -- are the most expensive. However, as Fig. 5.16 indicates, these styles last longer than the casita de asbesto (Fig. 5.22), made from roofing material which does not stand the soaking as well.

In 1979, the first casita de cemento (reinforced concrete roof

Fig. 5.16 . Materials and costs of the four basic styles of shelter.

Style	Materials	Cost and Comments
"Entumbado" or "Casita de Chit" (Fig. 5.19)	basic frame (4 chit poles - see Fig. 5.17), 16 poles, nails	250-300 pesos ($10.86 - 13.04 U.S.); must be renailed after three years, poles last six to eight years.
"Casita de Tambo" (Fig. 5.20)	basic frame 4 chit poles; flattened side of a 55 gallon drum, 4 additional poles, nails	320 pesos ($13.91 U.S.); metal roof lasts one year, frames are then salvaged and re-roofed; heavy-duty oil drums last an additional season, but add 200 pesos ($8.69 U.S.) to basic cost; for every six constructed, a seventh can be assembled using barrel tops and bottoms (Fig. 5.21).
"Casita de Asbesto" (Fig. 5.22)	basic frame 4 chit poles; corrugated asbestos roofing, 2 additional poles, small squares of rubber cut from discarded auto tire, nails	150 pesos ($6.52 U.S.); roof lasts about eight months; rubber square serves as a washer which cushions the impact of nailing and increases the holding power of nails.
"Casita de Cemento" (Fig. 5.23)	basic frame 4 chit poles, 1 additional pole, reinforcing rods, cement, small squares of auto tires, nails	about 200 pesos ($8.69 U.S.); roof is cast about 3 cm thick; holes must be molded in for nails; fishermen began constructing this style shelter in 1979 -- its durability remains to be established.

Fig. 5.17. Members of the cooperative "Vigía Chico" assembling the foundation of an entumbado casita, or wooden lobster shelter.

Fig. 5.18. Fishermen nailing a solid row of poles across the top of the frame (Fig. 5.17) to form the roof of an entumbado casita.

Fig. 5.19. Completion of the entumbado casita. The uppermost poles strengthen the structure and serve to suspend the roof off the bottom in the event it is overturned.

Fig. 5.20. Construction of a casita de tambo, with a flattened barrel side for "roof."

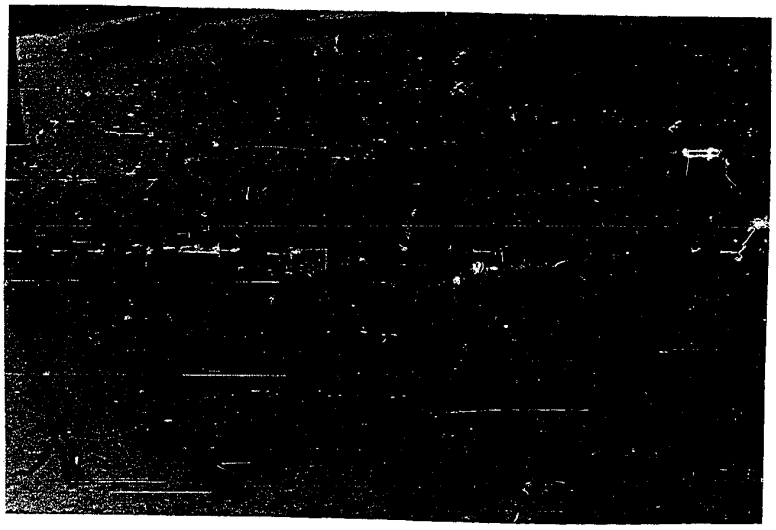


Fig. 5.21. Shelter with barrel lids and bottoms for "roof."

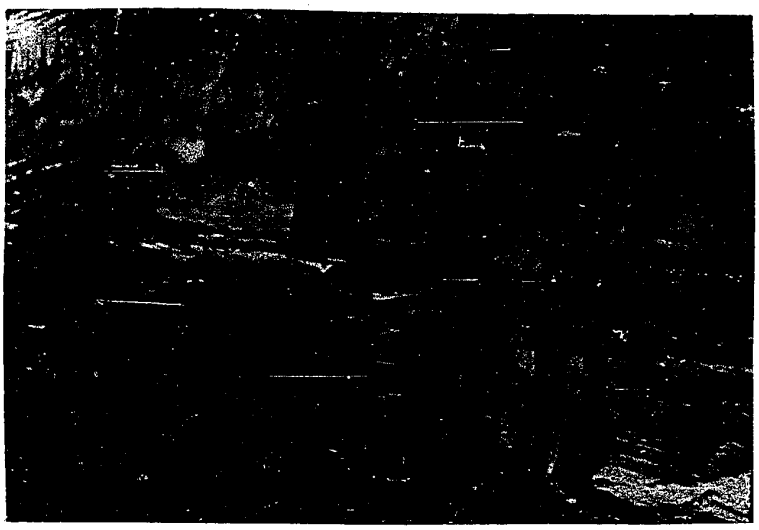


Fig. 5.22. A stack of casitas de asbesto ready for transport.

Fig. 5.23) was constructed. At that time material costs were somewhat less than the entumbado, although it required more preparation, effort, and time. The expectation was that the increased labor cost would be offset because the cement roof could be recycled indefinitely. Builders of these shelters argued that it would be necessary only to re-nail the roof to the frame every three years and to replace only the frame when it finally deteriorated after six to eight years, In the long run, this model would prove more economical.

Why a fisherman builds a particular style is not entirely clear, since it is generally believed that all styles function equally well. Some state that they prefer one style over another because of lower cost, while others cite lower weight, less construction time, or durability. In any event, large numbers of all styles are built and stacked on the beach, where they remain until shortly before the beginning of a new season (July 16). To place newly constructed shelters earlier would begin the process of decomposition sooner than necessary.

Although the cost of an individual shelter is relatively low, the average campo (a field of shelters belonging to an individual or family) represents a considerable investment. Many campos have more than 300 shelters. Three hundred of the least expensive styles would be an investment of 45,000 pesos (almost $2,000 U.S.). This becomes even more significant when the additional costs of a skiff, outboard motor and fuel are considered. Of course, each new casita quickly pays for itself, once the first few kilos are taken from it.

Completed casitas are ferried out to campos in skiffs which can carry three or four per trip (Fig. 5.24). If a site is distant, materials are often carried to a nearer shore where the shelters are

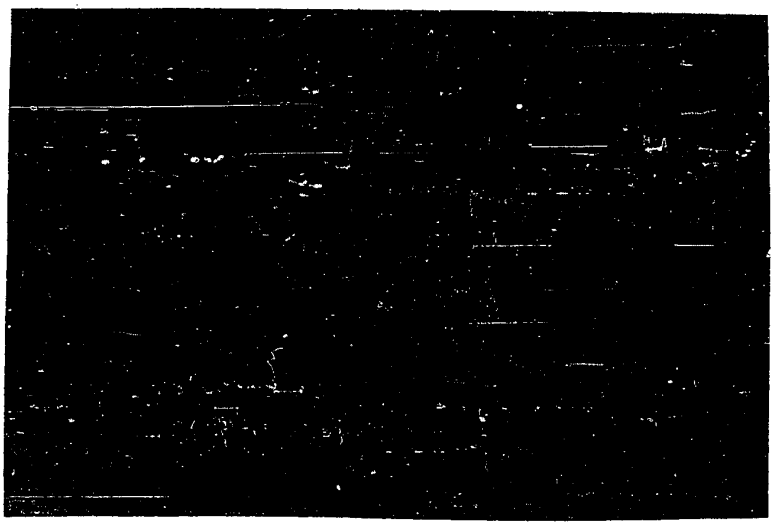


Fig. 5.23. A completed casita de cemento. Small squares of rubber cut from discarded auto tires serve as washers for nails which are hammered through pre-cast holes.

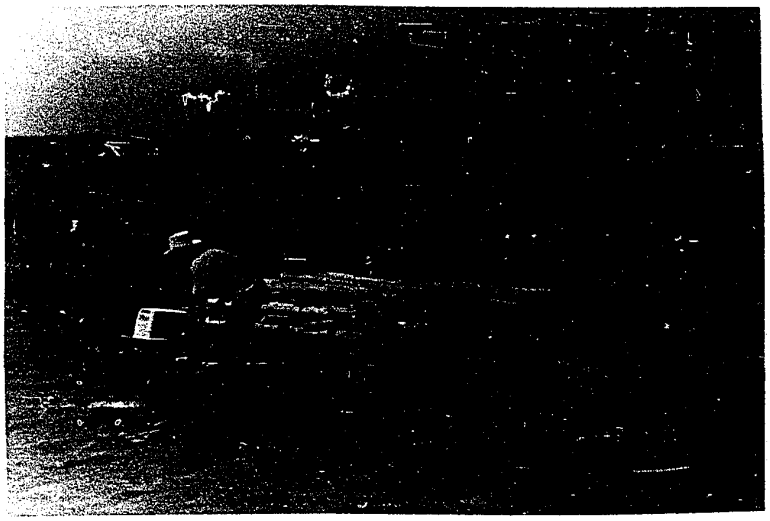


Fig. 5.24. Punta Allen fishermen ferrying out three casitas to their campo.

assembled and ferried out.

As a general rule, casitas are placed at depths of one and one half to six meters and on fairly solid bottom such as over patches of turtle grass or on rocky bottom. Nonvegetated sandy areas are avoided because loose sand fills the crawl space underneath. Muddy or otherwise soft bottoms are unsuitable because the shelters sink to their roofs. Distance between shelters varies, but averages about 40 meters, which seems to be the optimum. Areas where currents run over two or three knots, or where there is excessive wave action, are unsuitable.

Lobster are harvested from shelters by skin divers using a short gaff. They begin after about 8:30 a.m., when the sun is high enough to provide good visibility. Pairs of divers tow skiffs and work from shelter to shelter, looking for protruding antennae. The divers usually take two or three at a time, in a manner similar to that described for the Chinchorro divers. The fishermen leave their kill on the bottom nearby and continue the process until all lobsters are removed, interrupting the effort only to surface for air. I have observed the capture of as many as 15 lobsters from a shelter in this manner. When all have been taken, they are gathered by their antennae and carried to the surface in a mass resembling a bouquet of flowers held upside down.[4]

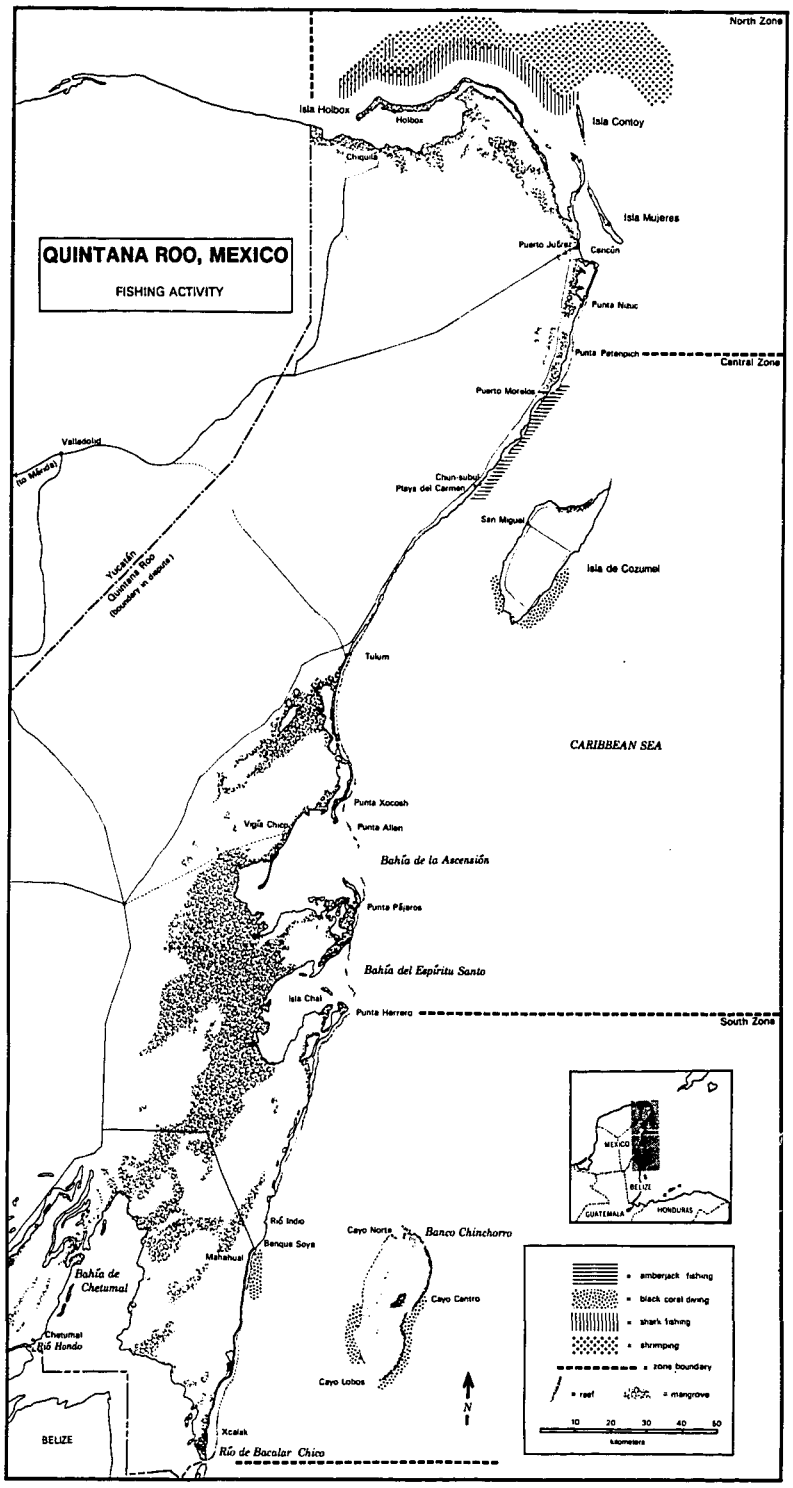
While the total catch may vary considerably from year to year, and while the condition of the shelters may influence the amount, a crew working a campo of 300 shelters can earn as much as 25,000 pesos a week ($1,087 U.S.). Helpers can earn 1,000 pesos a day ($23.00 U.S.) and sometimes as much as 10,000 pesos a week ($435.00 U.S.).

The Playa del Carmen amberjack fishery

Fishermen of the village of Playadel Carmen (Map 5.6) have hand-lined for amberjack (coronado ; Fig. 5.25) for at least 30 years. It is generally held that the resource was discovered by a fisherman from Cozumel, but there is no consensus on who made the discovery and precisely when it occurred. Although many elements of the fishery persisted for a considerable length of time, significant changes have occurred recently with respect to boats and gear.

By 1979, it was clear that traditional fishing craft -- Belizean smacks -- were being abandoned in favor of aluminum, fiberglass, or locally constructed wooden skiffs (lanchas) first introduced about two years earlier (Fig. 5.26). Powered by 20 or 25 h.p. outboards, these craft reduced travel time, and could be hauled up much more easily in case of threatening weather or for repairs. Furthermore, fishermen can now beach their boats near their homes after each day's fishing. This obviates the necessity of anchoring at the traditional anchorage, a small horseshoe-shaped reef (Chun-subul) about two km north. In addition to the convenience, worm damage and marine growth are eliminated, and all gear need only be carried a short distance.

Fishing begins early in the day with the search for bait. Sardines are preferred, and are captured with a cast net (atarraya) and kept alive in a bucket. In 1979, fishermen who still used sail-boats captured bait while walking to the anchorage. If unsuccessful, they handline in the shallows for small grunts which are also effective live baits. Once sufficient bait is obtained (about two



Map 5.6. Fishing activity.

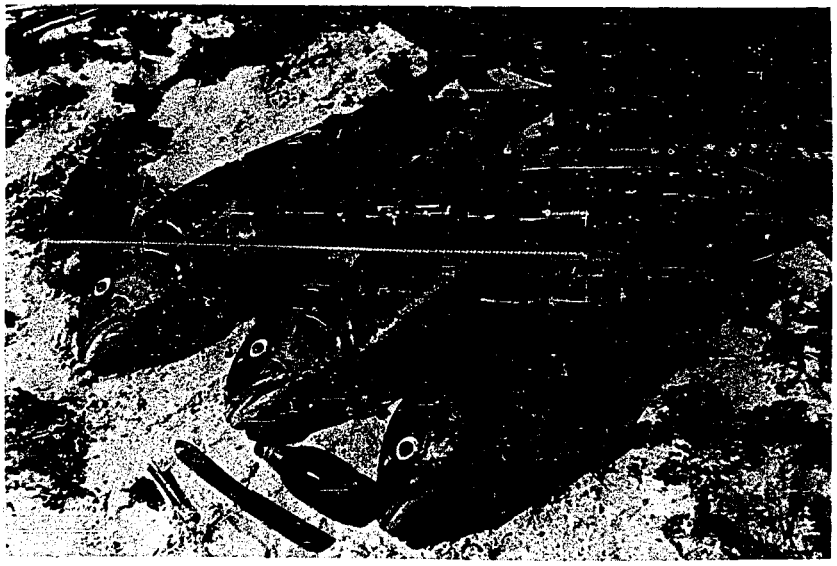


Fig. 5.25. Amberjack captured at Playa del Carmen. Fish at left and center are the greater amberjack (Seriola dumerili) while at right is the less frequently captured almaco jack (S. rivoliana).

Fig. 5.26. Aluminum and wooden skiffs, and a smack on the beach at Playa del Carmen.

dozen or a bucket full of sardines), they set out for the waters off Punta Piedra, about three km south of Playa del Carmen. Their course is roughly parallel to the bluewater line that marks El Cantil (the seaward drop-off) of the shelf. During this journey baits are trolled to catch barracuda, dolphin, or other surface feeding fish. Throughout the day, bait must be kept alive by adding seawater, a task specifically assigned to one of the crew.

Once off Punta Piedra, the boat is allowed to drift northward with the current in 100-120 meters of water, and baited lines are dropped over the side. For the last 10 years, glass bottles filled with sand have been used as sinkers, since they cost nothing, and are easily replaced when rigs snag on the bottom. Until recently, the handlining rig consisted of a short monofilament leader of 50-70 lb. test, connecting a sinker to the main line, and two huachinango (deep-water snapper style) hooks on stainless steel leaders attached to the main line by swivels just above the leader, and spaced about one meter apart. This assemblage was attached to approximately 150 meters of 150-200 lb. test monofilament. Because of the amberjack's well-deserved reputation as a tough fighter, most fishermen now use heavy monofilament for the lower 50 meters, the upper 100 meters consisting of polypropylene cord, which is thicker and allows a better grip. It also provides more control during the rocketing runs of the fish, which occur immediately after it is hooked, and the thicker cord is less apt to cause cuts than monofilament.

Batifish are hooked through the head or eyes, the line is fed out until the rig bumps the bottom, then the slack is taken up to

maintain it just off the bottom. When a school of coronado starts to hit with violent tugs on the lines, fishermen strike back hard to set the hook, and brace themselves for the first desperate runs. After yielding several meters of line, the fisherman manages to turn the fish and it is hauled in as quickly as possible, since sharks are often attracted by the commotion. Sometimes only the fish's head is brought aboard, but if a shark manages to snag itself while devouring a hooked fish, it often becomes part of the catch (Fig. 5.27).

Since amberjack travel in schools, it is not uncommon to hook two fish at once. In this case, the effort to land them is exhausting. Since many fishermen believe that a hooked fish will keep the rest of the school nearby, they will delay hauling in until their companions also hook fish, provided sharks do not appear. When brought to the side of the boat, amberjack are grabbed by the gill cover and pulled aboard.

Under ordinary conditions, fishermen complete four drifts before the morning's fishing ceases. Off Playa del Carmen, lines are pulled in and the boats return to either Punta Piedra or the place where schools were last encountered. If fish are biting particularly well, boats return to Playa del Carmen with the catch before returning to the starting point for another drift. Upon returning from the morning's fishing, the boats are anchored just outside the surf line, and the fishermen toss the catch into the water and float it to the beach. The fish are placed in the shade, and the fishermen eat lunch. Most will then make a second trip, from 2:00 to 4:00 p.m., and on returning they roll the skiff up

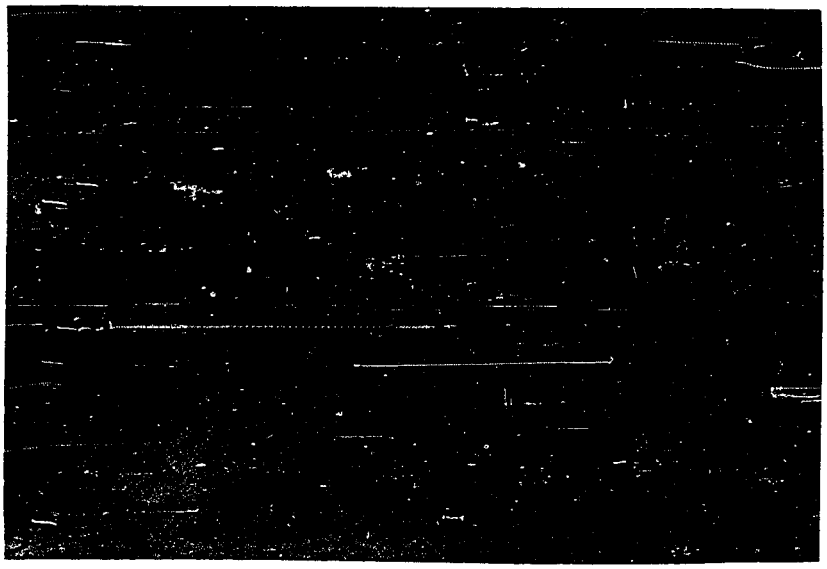


Fig. 5.27. Large shark (Carcharhinus sp.) caught by Playa del Carmen handliners.

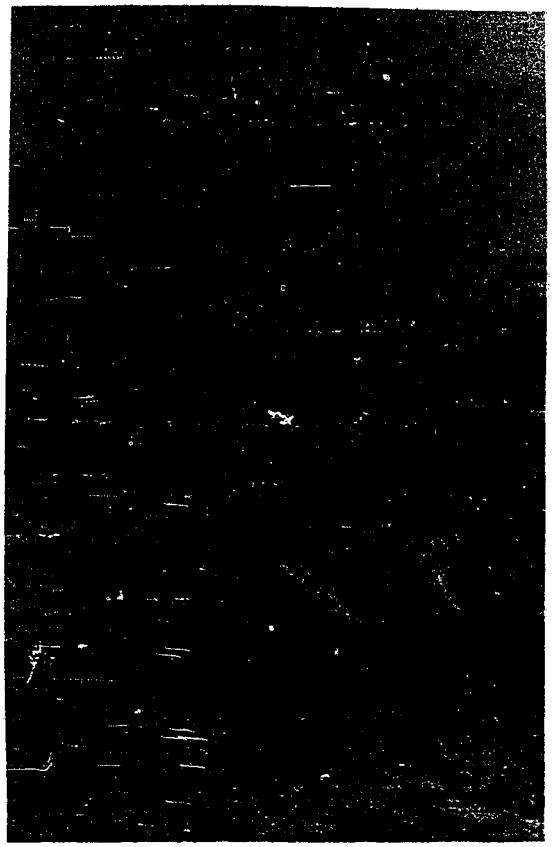


Fig. 5.28. Playa del Carmen amberjack fishermen preparing the catch for salting. Fish in foreground is a grouper, which is sometimes also captured by handliners.

the beach or return the sailboat to the anchorage. Part of the catch is sold on the beach to local residents, and the rest is butchered (Fig. 5.28) in preparation for salting, which is done on racks at the fishermen's homes. On the average, each amberjack requires two kilos of salt and three days of good sun to dry adequately.

Catches per boat vary considerably, depending on the skill or luck of the fisherman and the season. During May, and from October to December, 15 to 30 amberjack are caught every day. At other times, daily catches average only one or two fish. Amberjack caught in these waters are remarkably uniform in size (~12 kilos), but large specimens weigh 27 kilos or more. Coronado are present the year round, but a greater range of sizes occurs after December or January, when smaller sizes predominate. March can be a good month if strong winds are not too frequent, while fishermen state that the largest fish appear in April. Although gravid females are caught year-round, they are most frequently caught in December. Their egg sacks are heavily seasoned with salt and pepper and fried for lunch before the afternoon's fishing.

Other species caught frequently while handlining for coronado include snapper and grouper, which range from one to five kilos. During the months when amberjack fishing is slow, these species make up a larger percentage of the total catch. From February through March, fishermen often allow the current to carry them as far north as Puerto Morelos, and large grouper are captured on these northern drifts.

In 1979, equipment for one handliner -- line, leaders, and

hooks -- cost 300 pesos ($13.04 U.S.), while the cost of a skiff and 20 hp. outboard was 40,000 pesos ($1,739 U.S.). Used sailboats could be bought for 23,000 pesos ($1,000 U.S.) in 1978, but by 1980 their price had fallen to 5,000 to 10,000 pesos ($217-435 U.S.) depending on condition. During numerous visits to Playa del Carmen, I did not see more than two sailboats working at any one time, and these boats relied on outboards rather than sails. When I first visited in 1978, there were eight skiffs and three sailboats. In 1980, there were ten skiffs, and the sailboats were hauled up on the beach with no indication that they would be used again for fishing. The advantages of the skiffs had won out over the virtues of the more traditional and seaworthy craft.

The Cozumel Island black coral industry

Cozumel divers have harvested black coral (Anthipatarios spp.) since about 1966. Once dried, the branches can be cut, sanded, and polished to a glossy, almost onyx-like surface. The lustrous black jewelry fashioned from this material has become increasingly popular with tourists, and as tourism has grown, so has the demand. Initially, coral was taken by skin divers working at depths of 23 to 28 meters. However, with the introduction of SCUBA gear by 1968, the depth at which divers could work, and their bottom time, was greatly increased. Today, divers commonly work at 60 to 85 meters (Map 5.6).

Cozumel divers usually work in teams of four from a skiff or smack. Two work below, one floats on the surface above them, and the fourth pilots the boat. The task of the diver at the surface is to

track the bubbles of the pair below, in order to keep the boat as close as possible in case of trouble. At depths of over 45 meters it is easy for a person not in the water to lose track of divers.

At the more extreme depths, the diving is quite hazardous. Currents are strong, and sharks are occasionally encountered. Divers are limited to a few minutes of bottom time, during which they must locate a large branch (tronco or rama), saw it off with a hacksaw, attach it to an inflatable life vest, and send it to the surface. In 1978, the divers harvested an average of five kilos per week, valued at about 17,500 pesos ($760.00 U.S.) (De la Torre, 1979: 160).

When the industry began, divers concentrated their efforts on Palancar Reef, southwest of the island. However, the shallows were quickly worked out, and within a few years coral at deeper levels (~75 meters) was so diminished that other harvesting sites had to be sought. Additional concentrations were eventually located on the eastern side of the island at somewhat shallower depths, but in locations where strong currents make extraction difficult.

Another area recently opened is Chinchorro Bank. Here, as in Cozumel, concentrations of black coral were discovered at depths of less than 28 meters. According to fishermen, these stocks were first harvested in 1975, but by 1980, the shallow waters were "fished out". Little of this production was registered. Much of the harvest was made by skin divers, although SCUBA gear was used. Fishermen who participated in the harvest are unanimous in the opinion that nearly all coral occurring less than 45 meters has been removed. While this may be the case, one suspects an effort to guard whatever remains. In any event, very little harvesting now takes place, although divers

acknowledge that deeper stocks still exist.

Because of the high value of black coral, most divers are understandably evasive when discussing specifics of their activity. Harvesting locations are kept secret. Still, as De la Torre (1979: 159) observes, rumors relating to discoveries of black coral along other unspecified parts of the coast occasionally circulate. For example, in 1979, I was told a very convincing story of the discovery of a veritable "forest" of tall coral branches located "somewhere" along the southern coast.

Extraction of black coral in the central zone is currently restricted to members of the Cozumel-based cooperative "Buzos y Artesanos de Coral Negro en las Costas y Islas de Quintana Roo." There are currently about 40 members. Roughly one-third of which are divers, and the rest make and market jewelery. The cooperative's principal function is to regulate exploitation. Only cooperative divers can legally harvest coral, which they must sell to the cooperative. The cooperative, in turn, can only sell to artisan members. Most artisans employ young boys who manufacture the jewelery, copying sample pieces given to them by their patrón.

Regulations regarding minimum size have been established by the Departamento de Pesca in consultation with biologists at the Isla Mujeres research station and members of the cooperative. Currently, the trunk or main branch must be at least two and one half cm in diameter, and one and one-half meters long. In an attempt to provide for renewability, divers are supposed to make the cut no closer than ten cm from the base of the trunk, leaving a "stub" thought to be sufficient to allow for regrowth. A quota of 50 kilos per month

the entire state was in effect in 1979. This of course, is not consistent with a harvest of five kilos a week by each team of divers, but such inconsistencies are understandable in the context of such a valuable product.

In addition to earning a very good income, black coral divers enjoy a certain amount of prestige since theirs is a risky business. Numerous divers have died or been crippled and confined to wheelchairs as a result of accidents related to equipment failure or lack of judgment. Although most divers currently harvesting black coral have taken instruction and are certified, the depths continue to lure novices who want to make a killing. Few tourists are aware of this facet of the trade in black coral jewelery.

The Northern Zone

The fishery of the north is the state's oldest and thus the most developed and diversified. Shrimping, lobstering, and shark and scale-fishing are well established here, and account for a majority of the state's total catch by weight and value. Moreover, the zone's actual production is higher than that registered, since a considerable amount, particularly lobster, is sold on the black market. Also, an unrecorded but no doubt significant amount of shrimp and scale-fish are captured by fishermen from Progreso and Campeche who fish off Contoy and Cabo Catoche but register their catch in the fisheries offices of Yucatán or Campeche. Each year, some 400 to 600 "foreign" handliners and longliners fish in Quintana Roo's waters (Fig. 5.29) but this catch is not recorded in the state's production figures (Rivero, personal communication, 1979). Perhaps 40 shrimp boats also work the waters north of Isla Mujeres for about three months of the

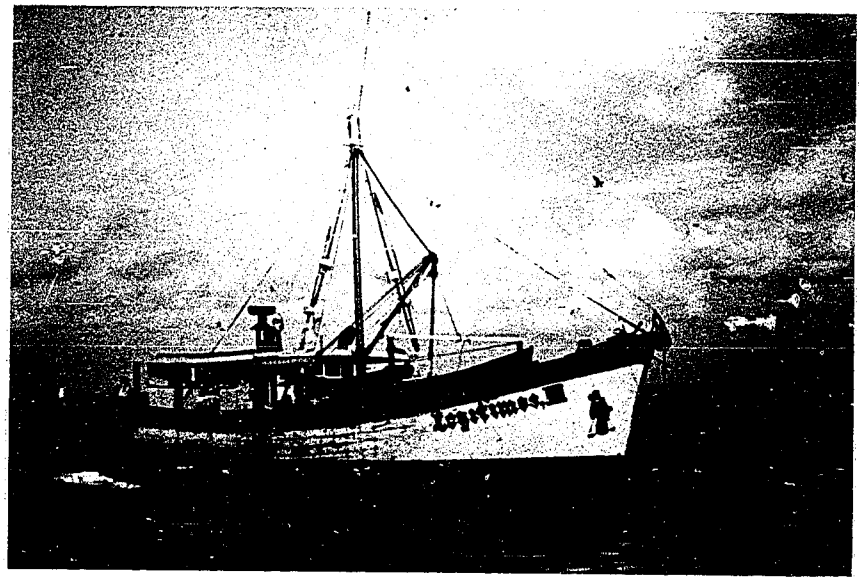


Fig. 5.29. Typical handlining boat from Yucatán anchored off Isla Mujeres. Fishermen work from small skiffs (alijos), and principally catch red grouper (Epinephelus morio).

Fig. 5.30. Lobster boat anchored at Isla Mujeres.

year, and capture three or four tons per boat each month (Manzanilla, personal communication, 1979).

The Isla Mujeres lobster trapping and shrimp fishing industry

Since the beginning of large-scale shrimping and lobster trapping about a decade ago, owners of packing plants have contracted with cooperatives for the exclusive rights to production of the reserved species. By accord, packers provide vessels, gear, and fuel, while cooperatives provide the crews. Vessels are leased to cooperatives for a token payment, and the catch is divided equally. Currently, the "Empacadora y Congeladora Romeo" has six shrimp boats (camaroneros) which are operated by members of Isla Mujeres cooperatives. Also, the packing plant owned 20 registered lobster boats (langosteros) and 5,000 Australian style traps (nasa tipo Australiana or nasa tipo colmena, beehive type trap; Figs. 5.30-31). Virtually all lobster traps used in this zone belong to the Isla Mujeres packing plant, and the majority are used by members of "Patria y Progreso." This group has acquired seven shrimp boats of its own funded through loans by federal agencies. However, in 1979, only two were in operation, the rest said to be undergoing repairs in Progreso.

Shrimping occurs about 20 to 29 km. offshore, from northeast of Contoy to Cabo Catoche and around to Holbox village where boats close in to five to eight kilometers offshore (Map 5.6). A wide, clear strip of sand is located in this stretch, and the water ranges from 5.5 to 13 meters deep. Vessels and gear are virtually identical to those found throughout the Gulf, and some vessels were purchased in the U.S. (Fig. 5.32). Most of the local shrimp boats are owned by the packing plants in Isla Mujeres and Puerto Juárez.

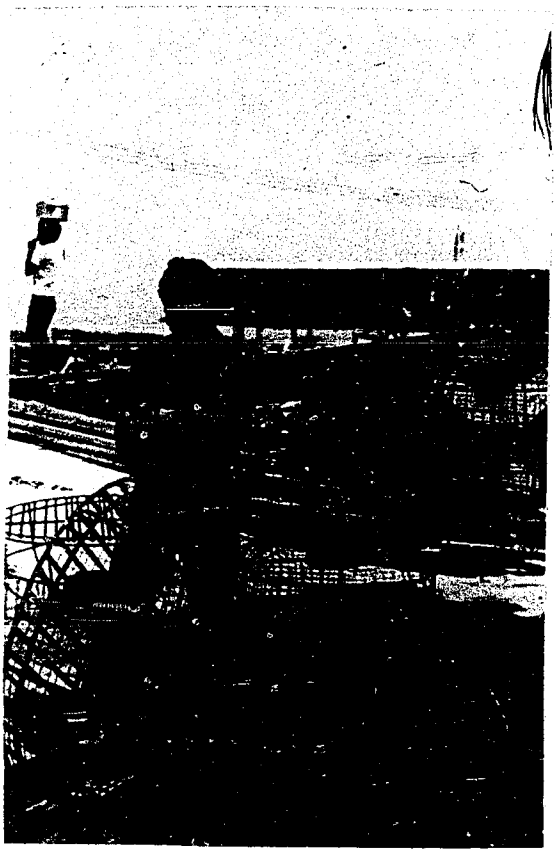


Fig. 5.31. Employee of the Isla Mujeres packing plant assembling an Australian style lobster trap.

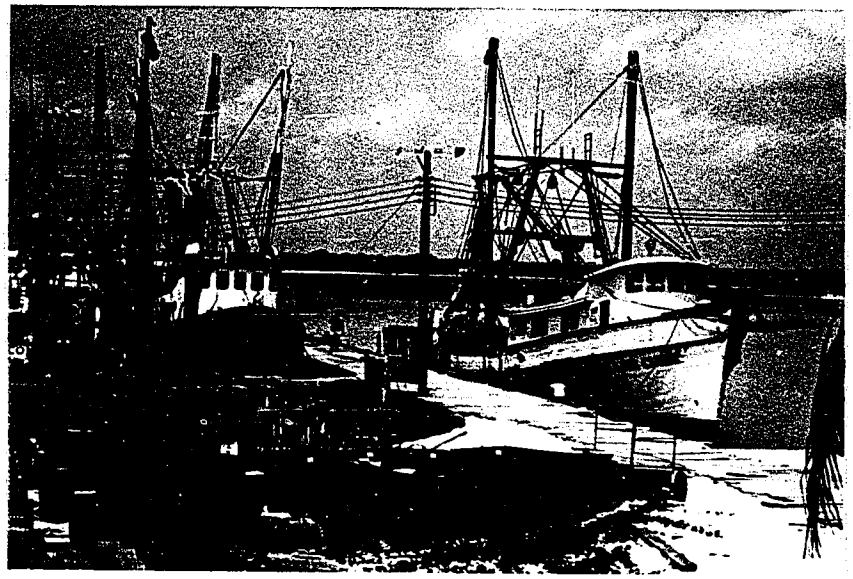


Fig. 5.32. Shrimp boats at the dock of the "Empacadora Romeo."

Lobster traps are generally set out 13 to 30 km off the eastern and southern sides of Isla Mujeres (Map 5.5). Fishermen set the traps in areas of rocky bottom, in depths of 25 to 33 meters. As a general rule, the traps are buoyed individually and each is baited with a piece of cowhide. The catch by a particular boat can vary considerably from year to year, reflecting variations in the lobster population and the ability of captains to locate prime areas. Fishermen estimate that perhaps 25 to 30 per cent of each month's capture is made by traps.

Most recently, the packing plant at Isla Mujeres ("Empacadora Romeo") has begun to reduce the numbers of boats it sponsers because, it is claimed, some crews have been off-loading much of their product to accomplices in small skiffs, thereby avoiding the necessity for splitting half of the catch with their sponser. On the other hand, the packing plant has increased the number of traps for crews who have been the most productive, apparently believing that these are more responsible.[5] Traps are said to be subject increasingly to "raids" by divers equipped with SCUBA gear. In some cases traps have disappeared altogether, and the suspicion is that they have been removed to another place or that their lines to bouys have been cut in order to insure that lobsters will not be harvested by their owners. Because of thefts, crews have been forced to venture farther out, beyond the range of divers in skiffs, and will no longer set their traps near Isla Mujeres.

Diving for lobster, conch and scale-fish

Diving has been the most popular and profitable method of capturing lobster and conch for about two decades. As the tourist industry has developed, skin divers at Isla Mujeres have also had opportunities

to learn the use of SCUBA gear. Gaffs (gancho) used in this zone differ from those elsewhere. Here, divers use a section of concrete reinforcing rod with a large hook welded or wired to the end. The heavier weight of this gaff is necessary since divers often work in areas of swift current, and it sinks to the bottom, instead of floating away when released.

Most diving is done from wooden skiffs five to five and one-half meters in length which are built on Isla Mujeres (Fig. 5.33). Their low freeboard facilitates getting in and out of the water. Although their seaworthiness is debatable, these boats provide a stable working platform and are capable of moving at a fast clip when powered by a 20 or 25 hp outboard. Some diving is also done from five and one-half to seven meter fiberglass boats which are built elsewhere in Mexico (Fig. 5.34). Although these craft require a minimum of maintenance and are virtually unsinkable, their higher freeboard makes them less suitable for diving.

Isla Mujeres using SCUBA gear normally carry a gaff, spear-gun, and woven plastic bag in which to stuff the catch. Although divers do work below in pairs, a partner in a skiff is necessary to follow the trace of bubbles, in case of difficulty. Also, most divers are rather cautious about carrying a number of speared fish, especially when sharks are known to be in the area. If a large shark, or more than one shark is spotted, divers surface and move to another area. If a large grouper or snapper is speared, most divers will take it right to the skiff, minimizing the amount of blood in the water around them. Divers generally work

Fig. 5.33. Typical wooden skiffs used by divers in the north zone.

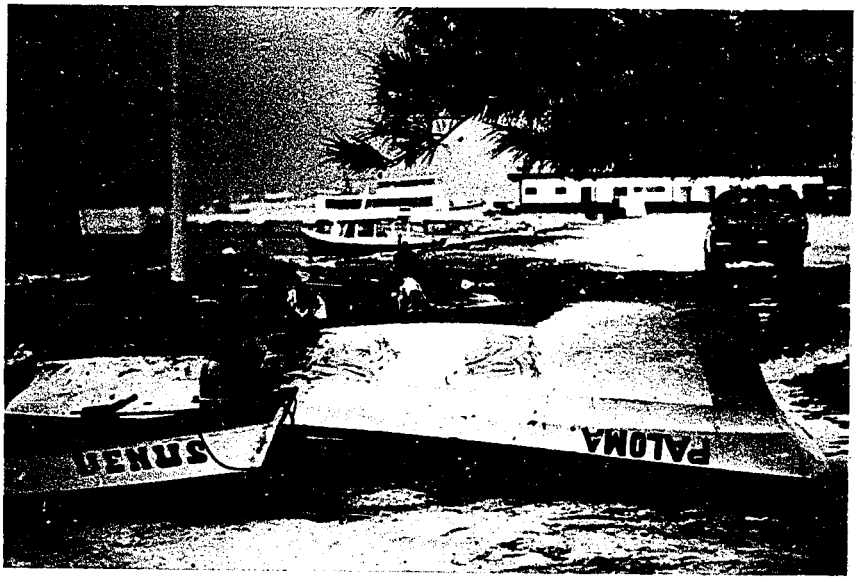


Fig. 5.34. Fishermen using coconut husks to clean the hull of his fiberglass boat.

in depths of 12 to 37 meters (Map 5.5). Although divers are aware that decompression stops are necessary after working beyond certain depths, few are familiar with the specifics, and most simply do not bother. Many average two tanks of air per trip, working for some time at depths ranging from 25 to 35 meters, and decompression is certainly advisable. The divers do not wear inflatable safety vests, and faced with an emergency (e.g. regulator malfunction), they simply jettison their gear and make for the surface.

With few exceptions, divers own their own regulators and rent tanks from a dive shop. There is no procedure for certifying individuals to use the equipment. Regulators are inexpensive single-stage models. Although divers customarily wash their gear in fresh water after use, only a handfull observe insturctions regarding periodic maintenance.

In discussing safety matters with divers, they point out that the depths at which they normally work are shallow enough so that they are "always" able to reach the surface in the event of trouble. While divers acknowledge occasional scares, I could confirm only one case of crippling injury. In any event, their style of operation may have detremental effects over the long term. Fishermen speak of young men becoming "burned-out" (quemado) from excessive diving, and some divers report troublesome arthritis-like symptoms.

Fishermen who skin dive limit themselves to depths of less than ten meters, although if suitable prey or promising habitat is sighted, some commonly dive as deep as 15 meters. Depending on their quarry, divers carry either a speargun or short gaff. Shafts for

spearguns are cut from concrete reinforcing rods, one end is ground to a point, and the other is notched to fit into the spear-release mechanism. Divers are quite proficient and few need a second shot to dispatch their quarry. For this reason, shafts are not connected to spearguns by a cord. If spears are bent, they can easily be straightened; if lost they are easily replaced. If the current is not too strong, divers will anchor their craft, and everyone in the boat will dive. Otherwise, one diver stays in the boat, and follows the others who swim with the current.

On Isla Mujeres, skin diving is quite popular during the first month or so after the opening of the lobster season, before the shallow water stocks have been cleaned out. So popular and profitable is lobstering during this period that some cooperative members fish only at this time. For the rest of the year, they ply the tourist trade, hauling loads of sightseers and snorkelers to and from the island's attractions. Also, some cooperative members invite friends and relatives to fish with them, thus "sharing" their exclusive right to fish for lobster and conch. So far, the authorities have not interfered; since the product is registered in the name of a cooperative member, at least the letter of the law is observed.

Virtually all of the Holbox lobster capture is by skin diving, primarily from wooden skiffs identical to those used in Isla Mujeres. Unlike divers elsewhere, they are towed by a line over lobstering grounds and release themselves whenever they spot a promising habitat.[6] As elsewhere, divers are very proficient at locating lobsters. Over the years, they have become familiar with a considerable expanse of sea floor and recall specific places where lobsters were found on previous

dives. Most Holbox divers even have their favorite "secret" crevasses which are virtually cartain to harbor lobsters.

Lobsters are extracted with gaffs like those used in Isla Mujeres. Most fishermen work through the morning to mid-day, when they return to Holbox, or to one of the cooperative's mother ships. Underwater visibility around the island is highly variable. The water is clearest from June to October, and much of the cooperative's production is registered within 60 days of the opening of the season. Periods of clear water also occur at other times and divers are quick to take advantage. Overall water quality, and the number of clear water days varies considerably from year to year and can have a significant impact on total production.

Contoy lobster-net fishing

In addition to diving and trap fishing, lobster are taken with nets stretched along the bottom of areas west of Contoy Island (Map 5.5). The source and timing of the introduction of this technique are not entirely clear, although some fishermen hold that a Japanese fisheries expert first demonstrated the successful use of lobster nets in the late 1960's. In any event, it found common acceptance by the early 1970's, when many members of Isla Mujeres cooperatives were tending lobster nets off Contoy from October to February.

The net is set along the bottom to intercept lines of migrating lobsters. Originally the nets of nylon twine were constructed of panels averaging 50 meters long by 6 meters deep. Lead sinkers were attached along the bottom and small floats were attached at the top. Lines one meter in length connected the sinker line to the float line

at two-fathom intervals. These served to gather in the net, creating pockets which help to enmesh the lobsters. Lines were run from each end of the net to anchors, and buoys were attached to mark the locations. Depending on where lobsters appeared to be migrating, nets were set at various depths, often between 5 and 30 meters. Since nets were shallow and set on the bottom, there was less chance for them to be snagged by passing boats.

More recently, some fishermen have begun to use a simpler net. They set out loosely hung nets without pockets. Evidently they have discovered that the simplified version is just as effective and easier to make. The new nets have panels from 30 to 50 meters long by one and one-half to two meters deep. They are anchored in the same manner as the older style, but are easier to transport and set.

Ramos (1974: 2) reports that lobster runs occur about four times a month for approximately four days at a time. Movement is from north to south, and mostly at night, although migrations have been observed during the day. The lobsters characteristically move in single file, and the nets are set from skiffs or small sailboats to intercept the march. Fishermen associate the migrations with changes in wind, current, and water temperatures. Sampling by biologists at the research station at Isla Mujeres suggests that movements may also be related to reproduction. Spawning is also associated with changes in temperature or other conditions. A few fishermen keep nets in the water continually in December and January, but the standard practice is to wait until receiving notice that a migration (<u>recalón</u>) has started. Locations are allocated on a "first-come-first-served" basis, and while some fishermen have favored spots, the paths of march vary to such an

extent that claiming any particular location has no apparent advantage. By consensus, and in order to avoid confrontations, fishermen do place their nets very close together.

Catches may very enormously, but daily captures for the area as a whole have been as high as nine tons of tails. Nets are hauled early in the morning, and a sizable capture requires hours of work to remove the lobsters. As elsewhere, the discarded parts are deposited onshore, or at a considerable distance from the netting area.

Lobster nets are used only by members of Caribe and Patria y Progreso, who claim that their campo includes the only sites where regular mass migrations have been observed. In 1980, there were approximately 130 lobster nets in use.

Turtling

Although turtle are commonly taken whenever encountered, the most intensive and well organized fishery occurs in the North zone. As indicated in the preceeding chapter, fishermen have exploited the area's breeding grounds of the green turtle (blanca or verde), the loggerhead (cahuamo), and the hawksbill (carey) for a long time. Until recently, most turtles harvested were females, caught when they crawled ashore at night to lay their eggs. Fishermen simply walked up and turned them over, rendering them helpless. If the eggs had been laid, they were added to the catch.

While turning turtles and sacking their nests are strictly forbidden, the practices continue, although at a somewhat reduced rate. Efforts to enforce the regulations are slowly becoming more effective as lines of communication and transportation are improved, and as surveillance

of nesting sites becomes more regular. Also, since the numbers of nesting turtles have declined drastically, the potential profit is no longer sufficient to outweight the risk of large-scale poaching.

As elsewhere, turtles are also chased down in fast skiffs. This system, called the corretada, became popular after the introduction of outboard motors around 1960, which allowed speeds sufficient for the chase. Previously, turtles were taken at sea with harpoons or nets. The latter are still in use, though declining. Turtles discovered asleep or resting on the surface must be approached with stealth. The harpoons have detachable points connected to a buoy by several meters of line. After striking a turtle, the fisherman merely follows the buoy until it can be retrieved and the catch pulled in. Today, few fishermen bother to harpoon turtles; most merely run them to the point of exhaustion, and take them aboard unharmed, to be kept alive until butchering is convenient.[7]

Use of turtle nets in the north had declined to only 17 or 18 by 1979. This was due in part to the decline in the turtle population, but also because many fishermen prefer to use the much simpler tactic of running the turtles down in powered skiffs. Fishermen who still use nets have long-standing claims to particularly productive sites for setting them. They persist in this technique despite the fact that it requires considerably more preparation and maintenance. The nets, of nylon twine, have panels 30 to 40 meters long by 6 to 10 meters deep. The mesh size is about 30 cm., stretched. The panels are tied together to form sets of one km. long. Occasionally, a fisherman will divide his set, using two or three panels of shallower netting close to shore, anchoring the remainder in deeper water. In so doing, he reduces

the risk that the entire net will be damaged if strong currents or storm waves wash it ashore.

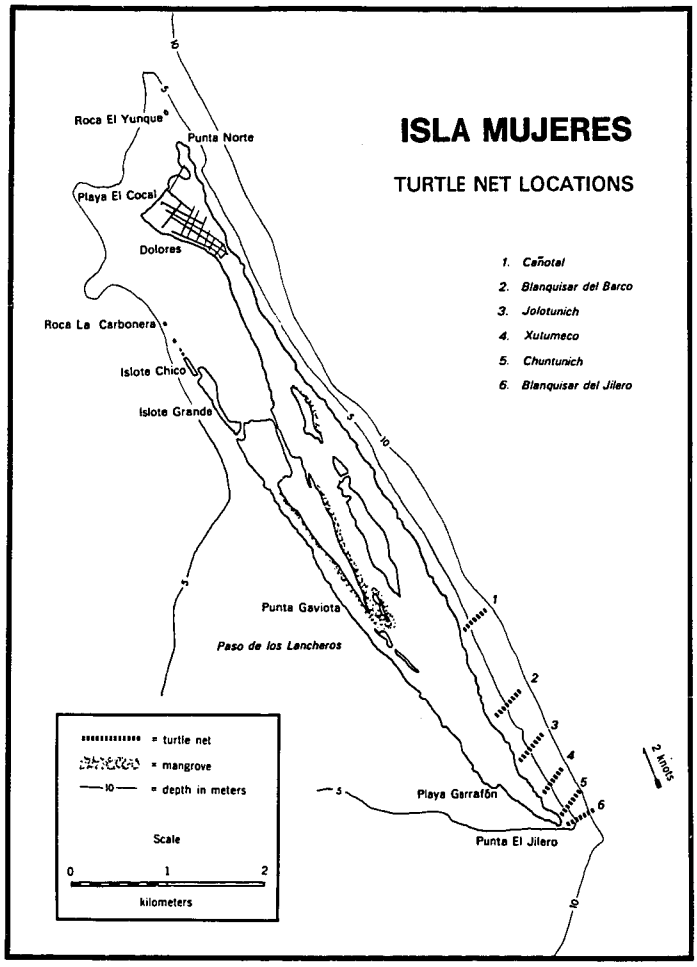
Nets are often damaged by the efforts of turtles to escape but more often they must be cut to remove turtles that are thoroughly enmeshed. Since damage may be considerable, and because repairs are difficult in the boat, most fishermen bring a spare panel along. This panel is spliced into the set, to take the place of one most deserving of repair. The panel removed is taken ashore, washed, and repaired, to become a spare as next needed. Thus the parts of the net are in continuous rotation (Fig.5.35).

Nets are anchored with large pieces of scrap iron or heavy rocks, and fist-sized stones with holes are used as net weights, spaced every few meters along the bottom. Buoys are attached at each panel juncture, and smaller floats serve to suspend the net. They are set roughly perpendicular to the shore, with a shorter net placed as close as possible to the breaker zone. Positioning is very important, and during calm weather nets are moved in as close to shore as possible. They are set loosely allowing captured turtles to float on the surface to breathe.

Until the mid-1970's, locations of nets had to be registered with the Captain of the port. Despite lack of enforcement, fishermen continue to register their locations, but rights to areas are more respected by custom than by regulation. Each set is marked with a buoy at each end and with at least one near the middle. In 1979, nets were set in six locations off the "otra playa" or southeast side of the island (Map 5.7). In the past, fishermen from Isla Mujeres tended nets along beaches to the west of Punta Cancún, along Playa Tortuga. After this area was taken over by tourism, it was closed to fishing.

Fig. 5.35. Isla Mujeres turtle fisherman mending his net.

Fig. 5.36. Caribe I, one of seven fiberglass boats originally owned by members of the cooperative "Caribe" but later converted to other use.



Map 5.7. Turtle net locations, Isla Mujeres.

The beaches near Punta Nizuc were also good for netting, as were the waters off the beaches of Isla Blanca. I did not observe any nets off these two areas, but was told that they were still set there occasionally. Upon the opening of the turtle season, the nets are set out and left, only individual panels being replaced as necessary. The fishermen begin their day at about 3:30 a.m.; they give a number of reasons for this early morning start: it is necessary to prevent others from robbing turtles caught in their net, there is less glare in the early hours, and it is cooler. The early start usually makes for an early return, thus allowing more time in the cooler morning for net-mending and other chores. If there are a number of well tangled turtles, it can take two or three hours to free them and re-set the nets.

Most fishermen reach the east side by going around El Jilero, the southernmost point of the island. This is the quickest route, although the passage is often tricky since even on a calm day the waves and currents can combine to produce steep and erratic waves dangerous to small boats.

The fishermen's boats are built of wood and range from 4.5 to 5.8 meters in length. Built mostly on the island, they are sturdily constructed (Fig. 5.33). Several years ago, some cooperative members obtained loans for diesel powered fiberglass launches, but these did not hold up well (Fig. 5.36). The hulls cracked when large turtles were dropped inside, and the freeboard was too high for hauling turtles aboard. The wooden crafts stand up much bettern under such punishment, and have lower freeboards.

Nets set along the "otra playa" are particularly effective from March through August. During this period, females swim close to shore,

scouting the beach and waiting for nightfall to come ashore to deposit their eggs. Technically, the turtle season is closed from the 15th of May to the 15th of August, but cooperative members can capture turtles out of season by special agreement with the Departamento de Pesca. This requires fishermen to bring all females to the research station at Isla Mujeres, where they are marked, held in a crawl and allowed to deposit their eggs in a guarded area. The eggs are hatched and the young turtles are kept in tanks, ultimately to be released into the sea. At the end of the closed season, turtles are released to the fishermen who brought them in. However, a small minority of fishermen have raised questions about the agreement, observing informally that not all cooperative members abide by its provisions and that it has opened the door for the illegal slaughter of many animals. Since few, if any, fishermen are willing to face the certain ostracism that attends making an official complaint, it is difficult to estimate the true extent of compliance.

In a relatively good year such as 1979, fishermen capture more turtles than the research station's crawl can hold. When this occurs, the biologists weigh and measure all of them, turn the excess over to the packing plant for slaughter (Figs. 5.37-41) and terminate the period of special harvest. Officials realize that some fishermen beat the system by delivering only a part of their catch to the station. Off the record, some acknowledge that deception is to be expected, but contend the trade-off is beneficial in the long run. The release from the research station of thousands of young turtles each year is thought to compensate for the sacrifice of a few hundred mature females for local consumption (Fig. 5.42).

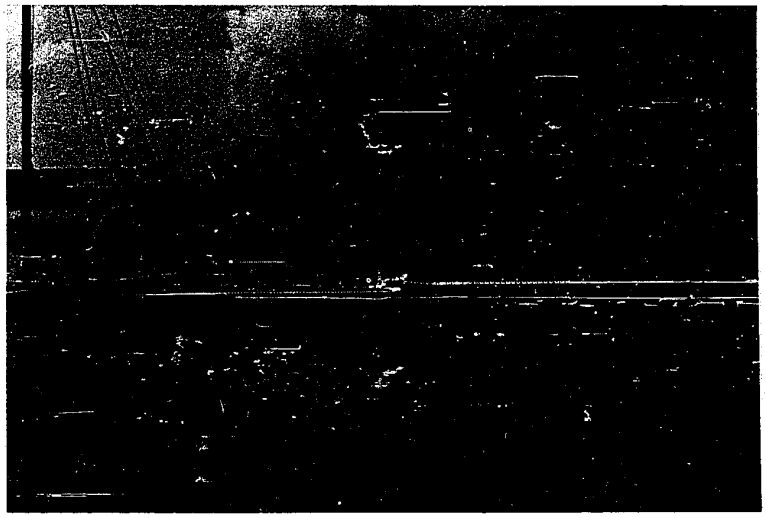


Fig. 5.37. Turtles awaiting butchering at the Isla Mujeres packing plant "Empacadora Romeo."

Fig. 5.38. Employee of the Isla Mujeres packing plant cutting fillet from a green turtle.

Fig. 5.39. Remains of a green turtle after butchering.

Fig. 5.40. Employee of the Isla Mujeres packing plant sacking eggs removed from a butchered green turtle. These are eaten after cooking and are considered a delicacy.

Fig. 5.41. Holbox fishermen unloading their green turtle catch at "Empacadora Romeo."

Fig. 5.42. Personnel of the Isla Mujeres marine biology research station releasing "head-started" baby green turtles.

On the remote east side of Isla Mujeres are beaches which once served as an important rookery for the green turtle. Some return each year but their ranks are continually thinned by poachers. Attempts have been made to patroll the area during the nesting season, but with limited success. Whenever the beaches are unpatrolled, poaching resumes in earnest. Poachers generally arrive around 10:00 p.m. and conceal themselves among the rocks. Many have favorite spots, but whoever arrives first has "rights" to that area for the night. Poachers stay turning any turtles that appear, until 3 or 4 a.m., when they and their catch are picked up by an accomplice in a car or truck.

The Isla Mujeres and Holbox lobster shelter fisheries

Shelters have been used in the North zone (Map 5.5) since the early 1970's, but in recent years little effort has been made to replace deteriorated ones, and their numbers have declined considerably. In 1977, members of the Isla Mujeres cooperatives registered 3,000 casitas, and the Holbox cooperative had perhaps 2,000 (Ancona, personal communication, 1978). In 1979, I estimate that there were only 1,800 in the entire zone.

There is no regulation of shelters in the zone, and no individually "owned" campos. Cooperatives provide materials to any member who wants to build shelters, and members are free to place them anywhere within the collective campo. Thus, for a time, only those who construct shelters know where they are located, which saves time and energy in the harvest. However, the shelters are in fact community property, and this initial advantage is lost as shelters are eventually found by others.

When one is discovered, it is sometimes moved to another location where it benefits only the discoverers. Fishermen generally explain the absence of individual campos by observing that the shelters are used between Holbox and Isla Mujeres where the coast is almost entirely uninhabited. Since there is constant small boat traffic in this area, the fishermen would find it difficult to guard a private campo.

Reasons given for the decline in shalter construction by the Isla Mujeres cooperatives generally focus on the fact that neither has been able to cooperate with the other on financing, construction, or placement. Since both cooperatives fish the same waters, there is no way for one to exclude the other from profiting by its investment. This state of affairs has caused a considerable amount of controversy, and has stymied efforts to increase production by using shelters.[8]

Fishermen of Holbox ceased construction of shelters because fishermen from Yucatán were helping themselves to the lobster. However, by 1980, this had been resolved sufficiently so that the Holbox cooperative members were once again building shelters to rejuvenate their network. At that time, there seemed to be a fair amount of enthusiasm, and most seemed convinced that lobsters would be "packed tight" under the new shelters after the first nortes of the season. The consensus was that nortes were essential; as one fisherman put it, "no nortes, no lobsters in the shelters."[9]

Holbox shark fishing

Most of the techniques and processes currently employed by Holbox shark fishermen were learned from Cubans who visited the area regularly until the early 1960's. Fishermen sold their sharkskins to

the Cubans, and marketed salted shark meat to buyers from Progreso and Veracruz. The main shark fishery is at Valencia Bajo, a shallow area northeast of the west end of the island (Map 5.6). Some fishing is also done along a five to seven km strip of sandy bottom which lies about eight km north. This runs more or less parallel to the shore toward Contoy, and is also frequented by shrimpers and longliners. On either side are rocks, and depths average from 11 to 13 meters.

In earlier times, shark were either harpooned or taken on handlines, but these methods have been replaced by longlining or by single baited hooks on to lines tied to 55 gallon drums which are allowed to drift and are checked from time to time to see if a shark has taken the bait. In both methods, the hooks are attached to lines by about a meter of wire or chain. Bait is cut from manta rays, which are speared in the shallow waters surrounding Holbox. Leatherback turtles, manatee, and dolphin were also used in the past, but their use has declined considerably. Leatherback turtle and manatee have become rare and are protected by law. Dolphins have traditionally been considered the best bait, but modern attitudes against killing dolphins seem to have made some inroads here. On the other hand, I suspect that one swimming too close to a fisherman's boat is still at considerable risk. The blood and liver of baits are used to make a chum slick to attract sharks.

Because of the heavy gear necessary for this fishing, the fishermen prefer to work from sailboats, since they provide a stable platform, are more seaworthy than skiffs, and can be sailed back to Holbox in case of engine failure (Fig. 5.43). Also, sailboats are sturdier and higher off the water, affording greater protection. Most sailboats are now

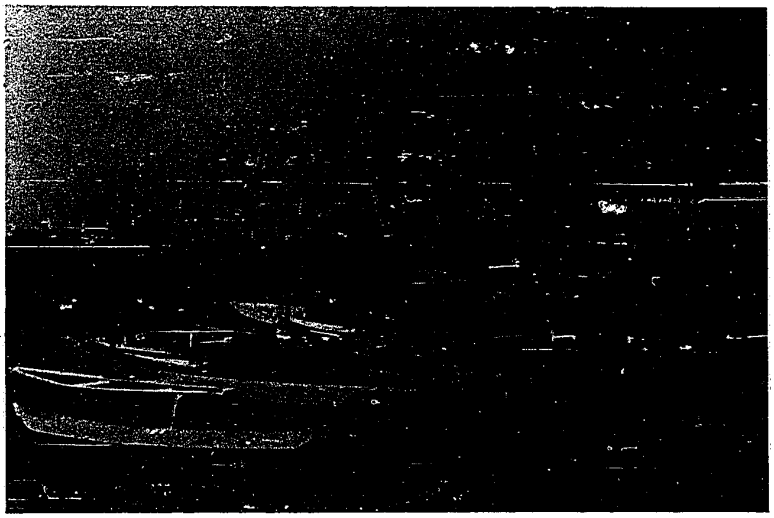


Fig. 5.43. Part of the Holbox fishing fleet. Most of the sailboats are used for shark fishing.

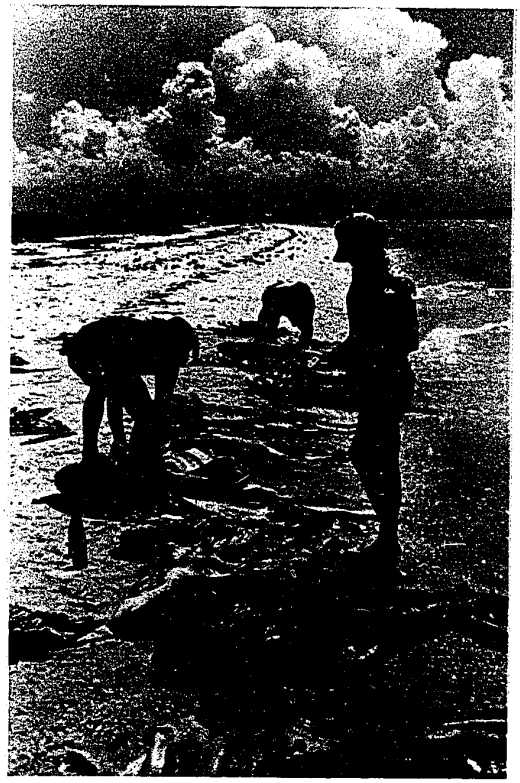


Fig. 5.44. Holbox fishermen butchering bull shark.

powered by small inboard diesels which have replaced the three to six hp gasoline engines used since the early 1960's.

Although shark fishing is done the year round, the largest catches are commonly made from March to May, when bull and tiger sharks about two meters long make up the bulk of the capture. Other sharks captured frequently include the mako, lemon, and hammerhead. Nurse sharks are sometimes taken by divers who spot them while searching for lobster. The sharks rest in caves or under coral formations with just the tail protruding, and some fishermen claim that they slip a noose around the tail, secure the line to their boat, and tow it until it drowns.

Nearly every part of the shark is utilized. One average size shark will yield 1.5 kilos of dried fins and 30 kilos of dried meat. The teeth or entire jaw will be cut out for sale to curio shops and the skin (if undamaged) will be salted and rolled up for sale to leather factories in Mérida or elsewhere. In 1979, fishermen were paid 12 pesos ($.52 U.S.) per linear foot (30.48 cm.) of whole sharkskin. If a large catch is made, the fishermen will also make shark liver oil. All told, a two meter shark yields about 1,200 pesos ($42.17 U.S.). Sharks are dragged onto the beach west of town for butchering, where their meat is cut into fillets and salted (Figs. 5.44-45). This product is dried in the sun for several days, and then is sacked for shipment.

The Holbox scale-fish industry

Holbox fishermen use gill nets, handlines and longlines for scale-fishing. By tradition, they do not use seines, nor will they permit fishermen from other areas to use them in their zone. In 1968 they

Fig. 5.45. Holbox fishermen carving fillets from shark meat. The decaying carapaces of turtles can be seen nearby.

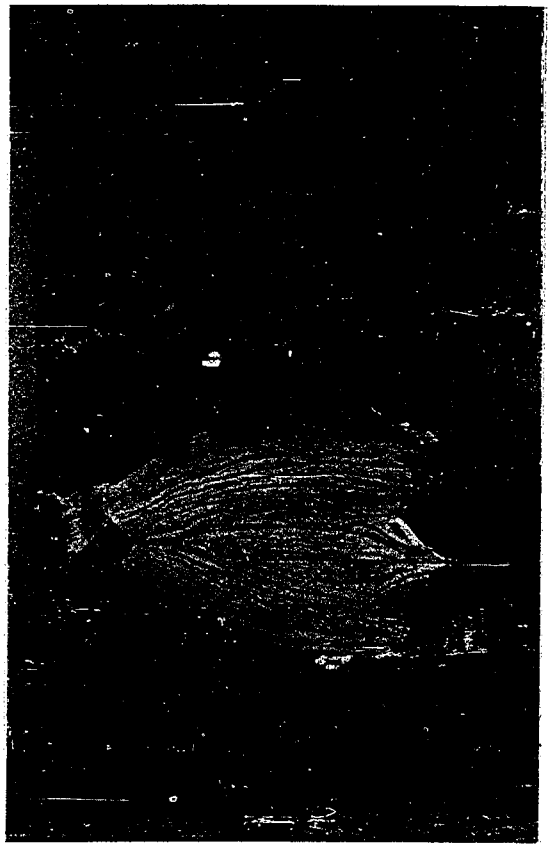


Fig. 5.46. Holbox fishermen with a typical product of his cooperative's salting station -- a salted and dried barracuda.

lobbied successfully to have their nearshore area declared a nursery (criadero), based on the common belief that excessive amounts of juvenile fish are being killed by seining.

Handlining and longlining are done at a shallow bank called Valencia Bajo, where some fishermen combine these techniques with shark fishing. Fishermen now use deepwater snapper hooks on stainless steel leaders. Sardines caught along the shore with cast nets are preferred for bait. Various species of grouper, rock hind, dog snapper and red snapper are caught most frequently. On the way out and on the return, fishermen troll for barracuda.

Gillnets are used throughout the zone in shallower waters. Most fishermen use nylon thread nets with panels 30 to 50 meters long and about 3 meters deep, with a mesh size of 6.35 to 8.89 cm., stretched. Some use nets of monofilament, but the majority prefer nylon because of its lower cost and because cazón and snook seem to tangle more readily in it. Species commonly captured in nets include sea trout, mullet, catfish, mangrove and grey snapper, pompano, grunt, mojarra, snook, jack, and mackerel. The runs of pompano, mullet, and mackerel are the most important; the pompano generally run during February and April, while the mullet run peaks in October and sometimes continues through December. Mackerel run between November to February.[10]

Fishermen prefer to use outboard powered skiffs for net fishing because they are more maneuverable than larger, inboard powered craft and nets are less apt to be snagged by outboard propellors, which can be tilted out of the way. Also, skiffs are faster, allowing the fishermen the opportunity to intercept schools of fish spotted in the distance.

Outboards use more fuel, but the fishermen observe that this is outweighed by the increased catch.

In 1979, most of the Holbox cooperative's catch was being salted and dried just west of the town (Fig. 5.46) First-class fish, including snapper, sea trout, and pompano, were often sent along with lobster to a freezing plant at Cancún. Also, large captures of mullet were iced down and sent by truck to Cancún or Cozumel. A government funded freezing plant was being constructed on the island, and once in operation it may end the area's long tradition of salt fish production.

At Chiquilá, on the mainland just across from Holbox, are several large iceboxes owned by a packing plant operating in Cancún. About a dozen fishermen from Campeche have moved into the area to begin gillnetting, and the boats they brought with them can be recognized easily since they contrast with local types (Fig. 5.47).

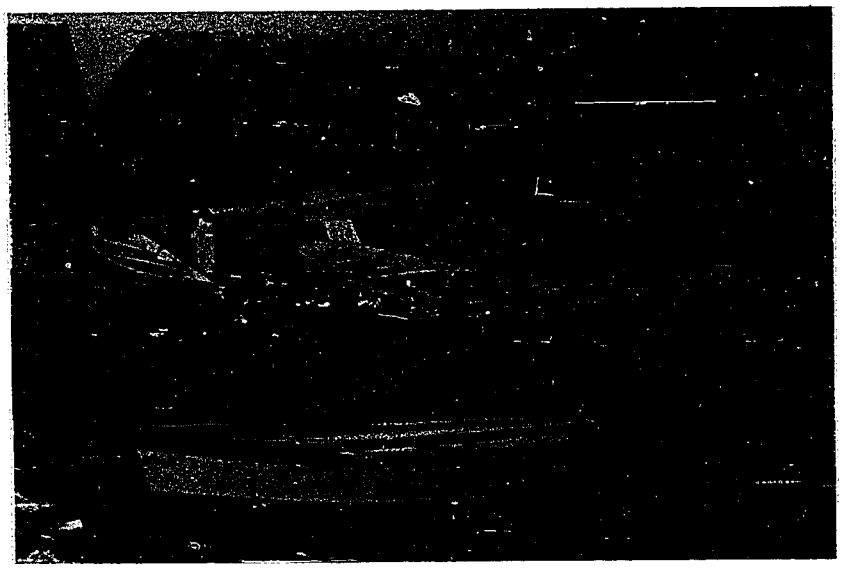


Fig. 5.47. At center, a boat from Campeche; in foreground, a typical skiff of northern Quintana Roo, at Chiquilá.

CHAPTER VI

PRODUCTION TRENDS AND PRODUCT DESTINATIONS

The current fishing effort focuses heavily on the production of "luxury" species such as conch, lobster, and shrimp. Conch is produced for the local and national market, while virtually all lobster tails of the appropriate size and all red shrimp are exported to the United States. The less valuable oversized lobster and other species of shrimp (principally rock shrimp) are utilized either locally or nationally, as is almost all of the area's scale-fish production. Turtle production is limited, and only for local consumption, whereas virtually all of the salted and dried fish (e.g., shark, amberjack, barracuda) is sent to Veracruz or Mexico City.

Detailed information on destination of production is limited to a 1977 Departamento de Pesca study, but my survey of shipping invoices in the local fisheries offices for the years 1978 and 1979 suggests that although quantities have varied, the relative percentages sent to various destinations have not changed greatly since 1977. Data from the 1977 study are presented in Figure 6.1. In that year, 34 per cent of the total production was exported to the United States, 49 per cent to other states in Mexico, and 17 per cent was consumed locally. This pattern of distribution was established during the later 1970's, in concert with the evolution of the local tourist industry which consumes a significant amount of the state's production. Given the fishery's preoccupation with the production of luxury species, there has been little shortage of lobster and shrimp. However, the demand for fillets of first-class fish (grouper and snapper)

Fig. 6.1 Summary of destination of production of the Quintana Roo fishery for the year 1977.

	Metric Tons	Percent to Destination	Percent to Total
Total State Production	1,352.2	---	100.0
Total Exported to Foreign Countries (98% to U.S.)	459.4	---	34.0
Total Exported to National Markets	663.8	100.0	49.1
Baja California Norte	2.5	0.4	0.2
Campeche	43.6	6.6	3.2
Colima	12.1	1.8	0.9
D. F. (Mexico City)	322.7	48.6	23.9
Guerrero	18.6	2.8	1.3
México	29.2	4.4	2.2
Nuevo León	4.9	0.7	0.4
Puebla	6.5	1.0	0.5
Sinaloa	9.1	1.4	0.7
Tabasco	4.0	0.6	0.3
Tamaulipas	0.2	---	---
Veracruz	37.1	5.6	2.7
Yucatán	173.4	36.1	12.8
Total Consumed Locally	229.0	100.0	16.9
Municipio Benito Juárez	109.9	48.0	8.1
Municipio Cozumel	7.1	3.0	0.5
Municipio Othón P. Blanco	54.4	24.0	4.0
Municipio Carrillo Puerto	27.1	12.0	2.0
Municipio Isla Mujeres	30.5	13.0	2.3

Source: Diagnóstico, 1979: 93.

during the tourist season has consistently exceeded local production and supplies are flown in from Yucatán.

Production for local consumption is sold directly to residents of coastal villages on the beach, or in town markets. Presently, there are 16 retail outlets, mostly booths in large public markets, which sell fresh fish to the public. Species most frequently sold include grunts, barracuda, parrotfish, jacks, and mullet. During my visits to these markets, I observed repeatedly that supplies were quickly sold out, and local residents complain about the inadequate supply.

Five privately owned processing plants are currently functioning in the state. Their locations, capacities, and details regarding their products are found in Figure 6.2. In addition, government funded Centros de Recepción ("Reception Centers") have been constructed recently in Xcalak, Punta Allen, and Holbox. These have yet to begin operation. It is currently planned that these plants will be managed by PROPEMEX (Productos Pesqueros Mexicanos), a semiautonomous government agency created to stimulate the development of the nation's fishing industry. PROPEMEX currently receives the lobster production of the Xcalak cooperative which is trucked to a processing plant in Yucatán. The Holbox cooperative has a salt-fish processing station consisting of a small cinderblock building and wooden drying racks located on the beach near Holbox village. Fish buyers from Mérida and other areas regularly visit the station to buy the products, which they ship via Chiquilá to the interior.

With the exception of the fishermen of Holbox and Playa del Carmen who salt their catch, most fishermen use ice. Access to a steady supply of block ice has become increasingly important as local stocks

Fig. 6.2. Processing plants in Quintana Roo, in 1979.

Business and Location	Products	Capacity for Production and Estimated Annual Use of Capacity
Empacadora y Congeladora Romeo, S.A., Isla Mujeres	frozen lobster and shrimp tails; scale-fish, conch, and turtle fillets, salt shark	11 tons per day, 125 tons storage capacity; operating at 35% capacity
Industrial y Comercial de Puerto Moreles, Puerto Morelos	frozen lobster and shrimp tails, scale-fish, and conch; fresh fish	8 tons per day, 60 tons storage capacity; operating at 20% capacity
Mariscos del Caribe, Puerto Juárez	frozen shrimp tails and fish fillets	25 tons per day, 227 tons storage capacity; production began in 1979
Empacadora y Congeladora Yoli, S.A.	canned conch, and octopus from Campeche	1.5 tons per day, 30 tons storage capacity; operating at 33% capacity
Distribuidora de Alimentos del Mar Caribe, Cancún	frozen fish and conch fillets	3 tons per day, 14 tons storage capacity, operating at 35% capacity
Pescadores de Isla de Holbox, Holbox	salted and dried shark and shark fins, salted shark skins	no estimate
PROPEMEX de Holbox	salted and dried shark and cazón, frozen shark, cazón, scale-fish and conch fillets	5 tons per day, 5 tons storage capacity; not yet operating
PROPEMEX de Vigía Chico	frozen cazón, scale-fish and conch	Ibid.
PROPEMEX de Xcalak	frozen shark, scale-fish, conch and lobster tails	Ibid.

Source: Diagnóstico, 1979: 73-74, combined with information gathered on visits.

of fish, conch, and lobster have diminished, causing fishermen to venture farther from their home ports. There are currently six privately owned-ice making plants that regularly supply block ice. Information on their locations and capacities is in Figure 6.3. Three of these operations are associated with processing plants while the others are strictly ice factories.

Fisheries production for export is sent by boat to Miami (Fig. 6.4) or by refrigerated truck to Brownsville, Texas. Production for national consumption is also shipped by truck or sent as cargo on passenger busses. Smaller anounts of luxury products are iced-down and flown to Mexico City. Local production is generally hauled in small trucks (camionetas) on which large ice boxes have been constructed.

Clearly the present day fishery contrasts sharply with the situation some three decades earlier. As detailed in Chapter IV, exports to the United States were then limited to turtle; lobster and conch were captured only for local consumption, and all scale-fish destined for the local market had to be salted since there were no refrigeration plants. The following section charts the evolution of the fishery to its present day form. The commentary is organized regionally, and follows the development chronologically, beginning in 1955. Data on total and regional production are found in Appendix IV and are shown in Figures 6.5, 6.6, and 6.7. Included with each year's data is a ratio of luxury products to finfish (scale-fish and shark). Yearly changes in this ratio (L/F), along with changes in the amounts of each major category, are sensitive indicators of change in the fishery. They reflect fishermen's judgements concerning availability and profitability of particular species, the introduction of new technology

Fig. 6.3. Ice plants regularly supplying fishermen with block ice in 1979.

Business and Location	Daily Production Capacity (tons)	Storage Capacity (tons)
Empacadora y Congeladora Romeo, S.A., (Isla Mujeres)	14	150
Industrial y Comercial de Puerto Morelos, (Puerto Morelos)	5	25
Mariscos del Caribe, (Puerto Juárez)	60	600
Fabrica de Hielo Chetumal (Chetumal)	35	n.d.
Eyden Villanueva (Chetumal)	3	n.d.
Productos Refrigerados de Cancún (Cancún)	36	n.d.

Source: Diagnóstico, 1979: 83, and information gathered on visits.

and capital, changing market conditions, and the impact of governmental regulation.

The Commercial Fishery: 1955-1959

South zone

During the latter 1950's, fishermen along the south coast generally limited their activity to beach weirs, although some fished occasionally at Chinchorro Bank during good weather. In June 1955, there were some 600 people living at Xcalak, and the fishing fleet comprised about twelve boats (Carranza, 1962: 32).

Yearly registrations indicate that some twenty or thirty weirs were stationed along the coast, and many were tended by people working

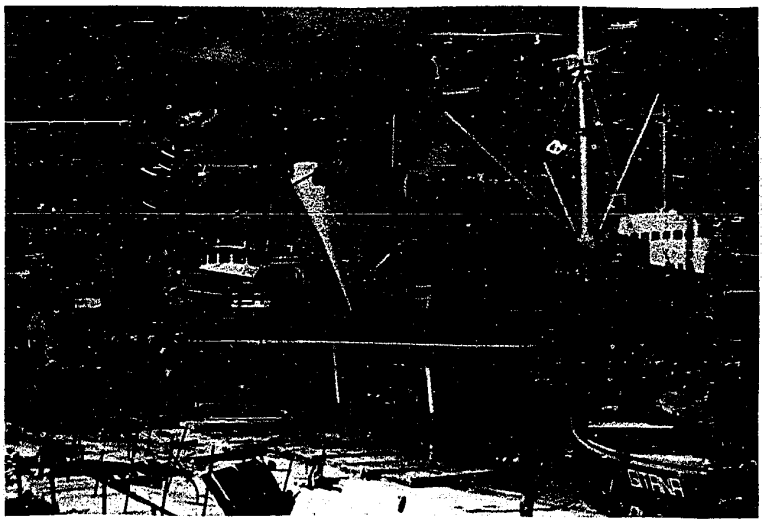


Fig. 6.4. The Ultra Freeze, a ship carrying luxury product (e.g. lobster and shrimp) to Miami from the packing plant at Isla Mujeres.

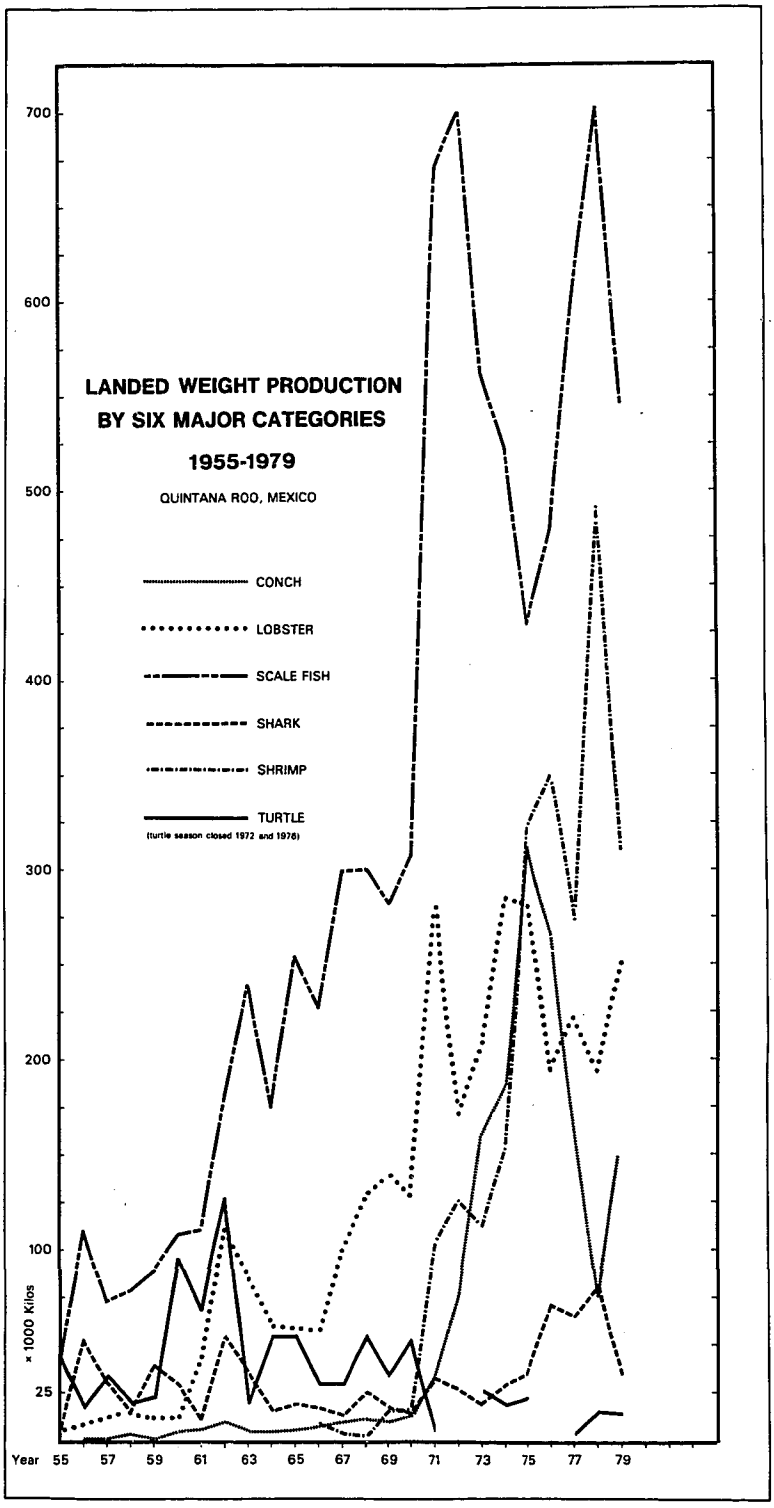


Fig. 6.5. Summary of production of the Quintana Roo fishery by six major categories for the years 1955-1979. Based on sources listed in Appendix IV.

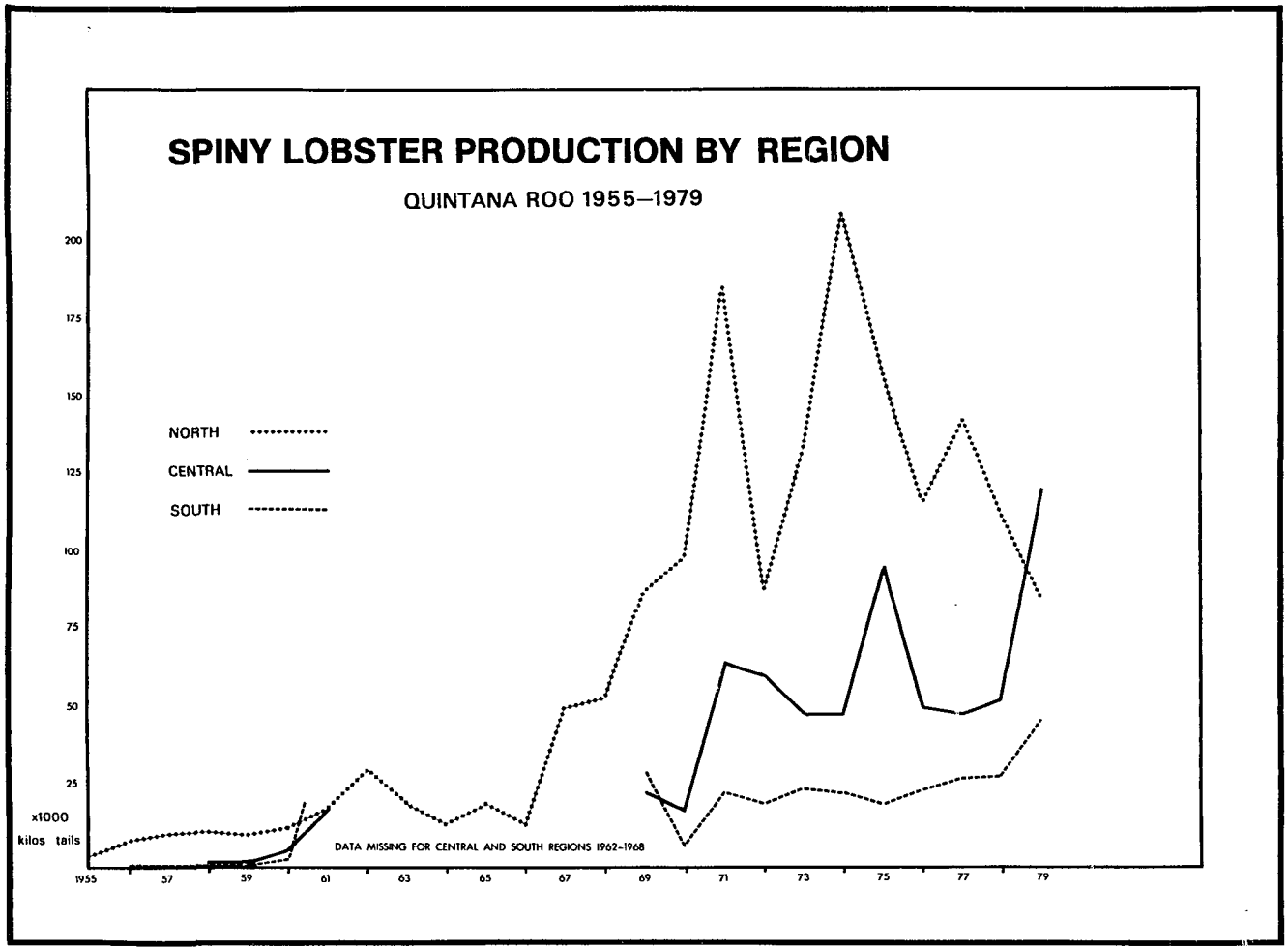


Fig. 6.6. Spiny lobster production by region, 1955-1979. Based on sources listed in Appendix IV.

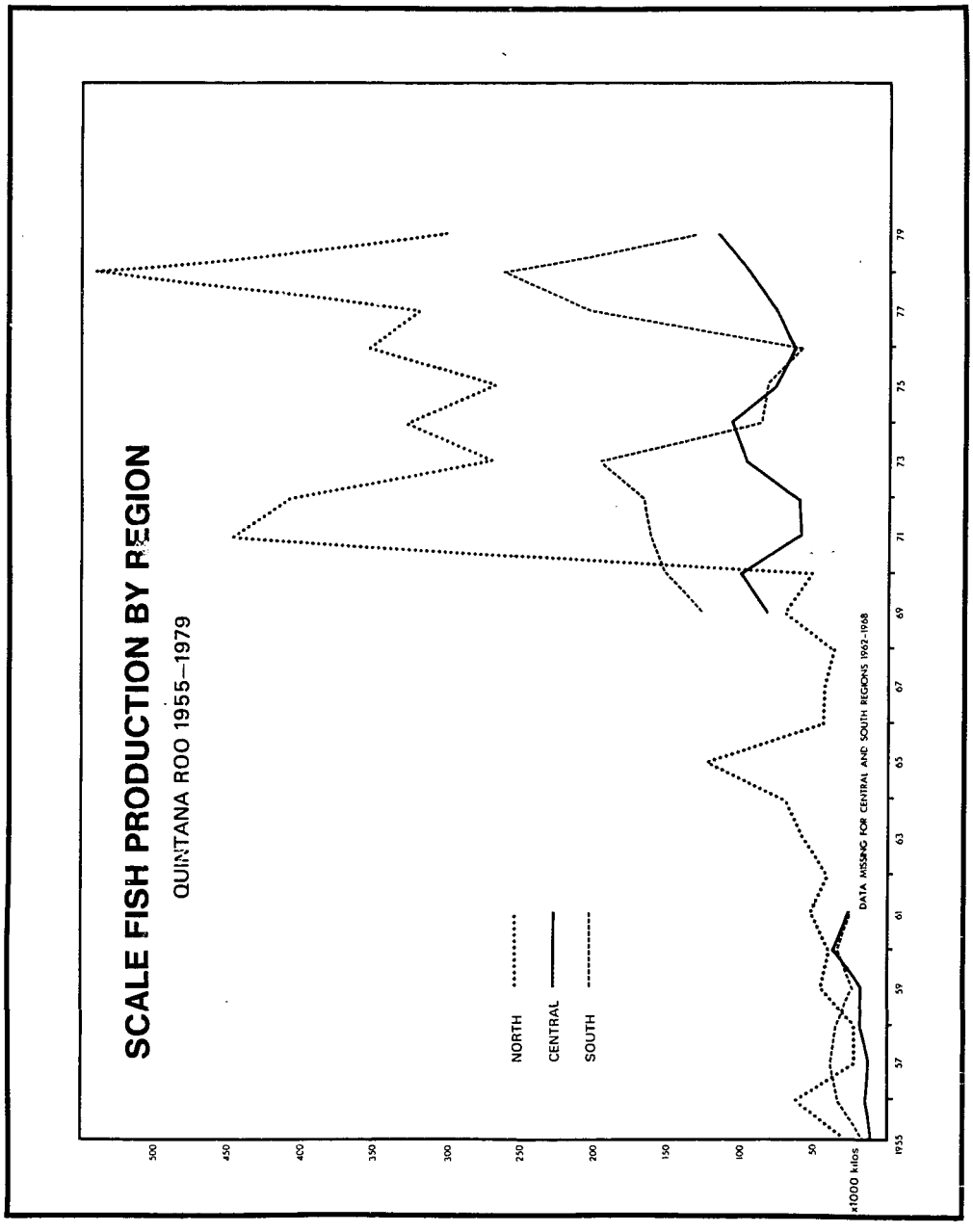


Fig. 6.7. Scale-fish production by region, 1955-1979. Based on sources listed in Appendix IV.

in the copra operations. With few exceptions, catches registered at Chetumal were of fresh fish, in amounts ranging from 100 to 200 kilos. The fish were brought in live wells of small smacks making regular trips for supplies and equipment for coconut plantations. Larger boats could not be used because of the shallow channel just west of Río Bacalar Chico, and grounding caused mud to enter the live wells and suffocate the fish (Ibid.: 32-33).

Turtles were occasionally caught in weirs, were carried live to Chetumal, on the decks of sailboats. Lobster were also taken in weirs whenever winter storms triggered near-shore migrations, and were sold also at Chetumal.

In September of 1955, hurricane Janet devastated Chetumal and destroyed many coastal coconut groves, reducing numerous planter-fishermen to fishing their weirs while reestablishing groves. Some were apparently so disheartened that they abandoned their property altogether. The beach weir fishery was important as a source of food for Chetumal as the city struggled to rebuild. Prices of fresh fish were frozen at 2.5 pesos per kilo by order of the territorial governor, and this was continued through most of the following year.

Janet virtually wiped out the settlement of Xcalak. Many who chose to remain were killed by the storm surge that inundated the coast. Most of today's fishermen lost family members or relatives, and still remember the tragic event vividly. As a matter of course, they maintain their families in Chetumal or send them there during the hurricane season. The remains of the old lighthouse at the northern end of town stands as mute testimony to the havoc wrought by the storm (Fig. 6.8).

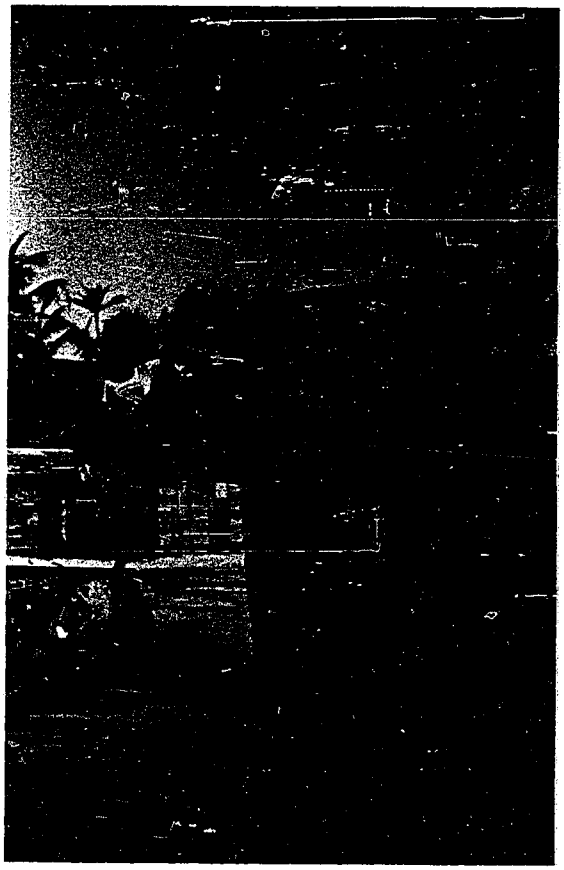


Fig. 6.8. The remains of a former lighthouse at Xcalak battered by hurricane Janet. The entire settlement was devastated by the 1955 storm.

Production records for September to November of 1955 are missing, perhaps because of the hurricane. In any event, it can be assumed that many weirs were destroyed since pre-Janet levels of production were not achieved until April of the following year. Fishermen relate that they had difficulty obtaining wire for traps just after the storm, but the following year most were operating again.

The first mention of a commercial lobster harvest in the south is found in the August 1956 production summary. Lobster was sold for three pesos per kilo, virtually the same as salt fish or conch. Fresh snapper sold for 2,5 pesos per kilo, while other species sold for 2.0 pesos per kilo. The commercial conch trade did not begin until April 1957, and registrations appear fairly consistently after this date. Production of salt fish was limited; generally occurring just before Easter week or Christmas.

According to fishermen, a grouper fishery, the antiquity of which is unknown, operated during December and January at Mahahual. Solís (1966: 8) reports that in 1965, fishermen told him that they took from 20 to 30 tons of grouper during this epoca de arribazón (roughly, "the season of the massing"), and that most of the catch was salted and sold to chicle camps or to buyers from British Honduras (Belize) who in turn sold it in Guatemala.[1] Only a small percentage of their production was sold fresh in Chetumal. Presumably a fishery of similar scale existed in the mid-1950's.

On balance, production records and information obtained from fishermen suggest that little change occurred through 1959. However, a conch trade was initiated at this time as small amounts began to be included with the fresh fish carried to Chetumal in live wells. Although

conch required more work to process than scale fish and were only worth one peso more per kilo, they were always abundant. Most fishermen began topping off their catch with 50 to 75 kilos of conch (roughly, the meat from 250 to 375 mature conch). This product, along with the rest of the southern zone's production, was consumed by residents of Chetumal and the surrounding area. With the exception of some limited commerce with Belize, exports were minimal.

Central zone

During the mid 1950's fishermen of the central zone concentrated on scale-fish. Barracuda were taken by trolling, and deepwater fish (amberjack and grouper) were taken by handlining. Catches were salted, dried, and shipped to Mérida via Progreso or to Veracruz. Other species included grunts, mojarra and mullet, captured in seines or beach weirs along the mainland coast. The catch was transported to Cozumel in the live wells of smacks.

The earliest production of scale-fish for export seems to have occurred on Cozumel. Records indicate that in January of 1955, 400 kilos of grouper fillets were flown to Tampa, Florida. The following month 1,200 kilos were shipped, and for the year a total of ɔ,486 kilos were flown out. Exactly when this began is uncertain, but according to islanders it was not before the early 1950's.

As an individual example, during the 1950's turtle were captured by Juan Delgado Alcocer, who obtained a permit in May of 1955. The following month he registered his boat Ramón, a 1.25 ton Belizean smack, and 300 kilos of turtle fillets. He registered another 1,624 kilos in August, and 954 in November. His total production for the year,

2,878 kilos, represents approximately 1,400 green and loggerhead turtles. His product was shipped by air to Belize, and then flown to St. Petersburgh, Florida.

By the late 1950's, increasing amounts of salted fish, shark, and shark parts (e. g., fins and skins) were shipped to Progreso on the Claudio Canto, a schooner then making regular trips from Cozumel. Playa del Carmen's salted amberjack production was sailed to Puerto Juárez, and transported by truck to Veracruz.

The first notice of commercial lobster production in the zone occurred in March of 1958, when Casimiro Choc Uch registered 110 kilos of cooked lobster. This product was flown to Mérida. Production records of the following November show that an association of fishermen who called themselves the "Perla del Caribe" cooperative began to function on Cozumel, focusing on lobster. While this group called itself a cooperative, it apparently had not received official sanction, since its production was registered along with that of independent fishermen. Assuming that this was an effort in good faith to organize a cooperative, it failed, since the last registration of production by this group occurred in February of the following year.

In any event, lobster continued to be registered by independent fishermen. In February of 1959, in what was probably an experiment, a small amount of uncooked whole lobster was iced down and air freighted to Mérida. This was evidently a success, since 200 kilos more were sent later in the year and afterwards such shipments occurred with increasing frequency.

The first commercial capture of conch was registered in August 1958, when Andomaro Angulo M. paid taxes on 40 kilos. An equal

amount was registered by another fisherman the following month. These two captures were the only ones registered that year. Although the destination was not listed, this product was probably shipped by air to Mérida. Conch are said to have been so abundant at this time that anyone could walk out to waist deep water right off San Miguel and harvest as many as they wanted.

As late as 1959, turtles were shipped live to Belize on the María Fedelia, another cargo schooner. Other boats were undoubtedly involved in this trade, which saw the exchange of green turtles for British products such as firearms, fishing gear, hardware, cosmetics and bottled goods. Older residents of Cozumel recount that their island had the reputation of being a free port long before Quintana Roo received its official status as a "duty-free" area.

The north zone

Compared to other zones, production in the north was clearly the most diversified, reflecting the traditional nature of its fishery. Fishermen used nets and handlines, and worked from sailboats. In 1955, the Holbox fleet consisted of fifteen sailboats, five of which had outboard motors of about 10 hp. (Carranza, 1962: 30). Nine of the thirty-five sailboats at Isla Mujeres had auxiliary outboards (Ibid.: 31). Outboards were introduced sometime in the early 1950's and their gradual acceptance increased the range of the fleet. However, this does not appear to have contributed to any significant increase in scale-fish production. Indeed, the volume of the relatively high 1956 capture was not exceeded until 1964, while shark production for the same year was not surpassed until 1977 (Fig. 6.7). To some degree,

the failure to maintain or significantly increase production may reflect the relative stagnation that characterized the fishery for a long time. Yet, it was at this time that commercial-scale experiments with lobster fishing were underway, and initial successes drained manpower and capital from other more traditional sectors of the fishery.

During the early days of the lobster fishery, prices per kilo were not much different than those for fish. Thus, there was no incentive for switching to lobster. However, lobster were abundant, and on the whole, the work was easier than capturing and salting fish. Lobster were captured with bully nets and kept in live wells until processing. In contrast to the work involved in processing fish (filleting, skinning, salting, and drying) lobsters were merely parboiled, iced down, and flown to Mérida.

Exports from the zone were limited, and generally consisted of the luxury species. For example, production records of 1954 indicate that some 850 green turtles were shipped to Tampa and Key West. In December of the same year, 425 kilos of cooked lobster and 655 kilos of grouper were shipped to Tampa on the motor-sailer Jewell. The latter is the only record of fresh fish production for the entire year. In 1955, perhaps 1,856 green turtles were shipped to the Granday Canning Company in Key West.

The organization of the fishery began to change slowly in the years immediately prior to 1960 as additional connections with overseas markets were established. By May 1957, after the road between Puerto Juárez and Mérida had been completed, 320 kilos of loggerhead turtle skins were shipped by bus to Mexico City. In the months that followed,

fish buyers began to make increasing use of this route. Cooperatives began to function on Isla Mujeres in September of the same year, and the following month "Patria y Progreso" registered 1,768 kilos of whole lobster, which was shipped to Mérida by bus. Lobster permit holders continued to register similar captures until their permits expired on March 15, 1958. For example, Francisco Martín Novelo registered his final production (70 kilos) on the 14th of March. After this he focused on production of salt shark, shark skins, turtles and turtle skins.

As a general rule, loggerhead turtles were captured only for their skins at this time. Consumers preferred the meat of the green turtle, and these were so abundant that there was no demand for loggerhead meat. Carcasses of skinned loggerheads were left on the beach for the vultures, crabs and insects. Limited quantities of sponge and hawksbill turtle shell were shipped by mail to Veracruz and Mexico City. In addition to the regular trade of green turtles to Key West, some were also shipped to Mérida and other interior cities including Mexico City.

Additional changes began to occur in the organization of the fishery. During the last three months of 1958, the cooperatives sent joint expeditions to fish for lobster in Bahía Ascensíon. Men and small skiffs or dugouts were transported on shrimp boats which came from Cuidad del Carmen. Apparently, a deal was struck whereby members of the Isla Mujeres cooperatives could use the shrimp boats as mother ships in exchange for the right to purchase the capture. These were generally successful voyages, and the total production of about 4,000 kilos was apparently split evenly between the two cooperatives and carried by the shrimp boats to a seafood exporting company in Progreso.

This continued until mid-November of the following year. By the second voyage of that month, both groups had apparently decided to keep whatever they captured, rather than splitting it. While the result of the first November voyage was 1,200 kilos divided equally between the cooperatives, in the second voyage, "Caribe" registered 629 kilos while "Patria y Progreso" registered 1,300. Good will had apparently diminished, since by the following month the cooperatives divided the Ascensión Bay area between them, "Caribe" receiving the southern half while "Patria y Progreso" worked the north.

By 1959, the northern zone had begun to develop production capabilities and market strategies for increasing amounts of lobster. Wood lath traps from Florida were introduced and first used by members of "Patria y Progreso." Also, younger men were learning to use skin-diving gear and gaffs. However, the main effort continued to focus on salt-fish and shark. The commercial market for conch developed only after 1959. There was apparently little in the way of a market for fresh fish; not one kilo was registered during the entire year. Most fishermen continued to fish in traditional ways, using the tools and techniques of their fathers.

Orientation to Production for Export: 1960-1969

In the early 1960's many elements of the fishery began to change as increasing effort and capital were invested to increase production for the export market. By the late 1960's, at least in the north zone, the small scale fishery with low-level technology was in transformation into a capital-intensive industry that focused on luxury species. Four new cooperatives were formed, and the waters off Quintana Roo were divided

into campos for the exploitation of lobster and conch. Also during this period, control over the distribution of production was consolidated. Processing plants were constructed on Cozumel and Isla Mujeres and their owners moved toward a virtual monopoly on exports to the United States.

South zone

Records of fishing during this period are sparse (see Appendix IV) and therefore have been supplemented by fishermen's oral histories, and with information from other parts of the state and Belize.

Scale-fishing continued as the main focus of fishing effort, and increasing numbers of beach weirs were constructed. Turtles became scarcer, until their capture ceased to be productive. The Xcalak cooperative ("Andrés Quintana Roo") was organized in 1960, and its members immediately began registering captures of lobster. Previously, lobsters had been captured in beach weirs, and skindiving had been only recently introduced. Nearly all lobster and conch were harvested along or inside the barrier reef, where they are said to have been quite abundant. Wholesale exploitation of Chinchorro stocks did not begin until after 1969.

Fishermen plugged their live wells and installed ice boxes so they could carry more lobster and conch. Block ice was purchased in Chetumal at a plant built by Apolonio Valencia, one of the principal fish buyers. Also, by this time Xcalak fishermen began purchasing plywood skiffs built in San Pedro, Belize. Their use became widespread, and most were powered by 6 hp. outboards also obtained in Belize.

Most of the scale-fish and conch brought to Chetumal were consumed

locally, although some fish were carried in live wells to Cozumel. Lobster was also taken to Cozumel and Isla Mujeres, destined for export to the United States. In the mid-1960's, some lobster captured by Xcalak fishermen were sold in Belize, so quantities registered at Chetumal probably understate the actual production. Knowledge of production capacities, and how they changed over time are also complicated by the fact that, during the early 1960's, Belizean fishermen began delivering fresh and salted fish to Chetumal. In many respects, this reflected the frontier position of southern Quintana Roo; the border was a meaningless abstraction to the fishermen.

During the later 1960's, inshore lobster and conch stocks declined, and fishermen began to organize regular expeditions to Chinchorro Bank. These forays ito near virgin territory were highly successful, and were repeated with increasing frequency.

Central zone

Records between 1960 and 1969 are also sparse for this zone, and details of fishing have been inferred. Perhaps the most significant event was the formation of the Cozumel cooperative ("Cozumel") in 1961, marking the beginning of large-scale lobster production in the zone. Concomitant with its founding were the first shipments by the Empacadora de Quintana Roo (the Quintana Roo Packing Co.) on Cozumel, which received the cooperative's lobster production, in addition to that of the Isla Mujeres cooperative "Caribe." The founding of the cooperative "Cozumel" at this time seems to have been no coincidence. As on Isla Mujeres, middlemen were instrumental in organizing the cooperative and, in effect, they seized the opportunity

to keep marketing in their own hands.

In addition to lobster, the packing plant shipped turtle fillet to the Brownsville Shrimp Exchange in Texas. Fresh fish from weirs in the south or from handliners in Playa del Carmen were consumed locally, while salted amberjack, grouper and shark were sent to Mérida and Mexico City via Puerto Juárez or Progreso. Throughout the period, scale-fish production generally increased, while turtle captures declined, presumably because of overexploitation. While the bulk of fish production came from Playa del Carmen, fishermen of the Cozumel cooperative who dived for lobster also speared fish, adding somewhat to the scale-fish capture. As elsewhere, skindiving equipment became generally available after 1959, and SCUBA came into use by the later 1960's. The introduction of the diving equipment and the increasingly widespread use of outboard motors probably account for the increases in production during this period.

Casitas were introduced shortly before the founding of the cooperative "Vigía Chico" in 1968. According to members, this group was formed by a disgruntled faction of the cooperative "Cozumel." The reasons for formation are even today hotly argued, and a clear understanding of what actually happened is lacking. However, at least part of the reason for the conflict may have been the effort to divide Ascensión and Espíritu Santo bays into "private" campos. This may have served as the catalyst for disputes which had simmered for a considerable time. Allegiances of former times were disintegrating and debts, grudges, jealousies, and suspicions surfaced as new alliances were formed.

North zone

Significant changes occurred in this zone as fishermen adopted new techniques, and as the industry grew in size and complexity. Production shifted to a clear emphasis on luxury species, and new marketing arrangements evolved. By 1969, a pattern of production trends and product destinations had been established which characterize the zone's current fishery.

In the early 1960's, turtling was the most important focus and production levels achieved between 1960 and 1962 have not been reached since. As in earlier times, fishermen turned turtles on the beaches and captured them in nets. Appendix V provides data on net registrations in the monthly reports of the Isla Mujeres fisheries office. Most turtles were shipped live to Key West, although some live turtles and turtle fillets were shipped by truck to Mérida and Progreso, and by boat to Cozumel. During the years 1960 through 1962, some 9,405 turtles were captured, with a production peak of over 4,000 in 1962.

Members of the Isla Mujeres cooperatives continued to make lobstering trips to Ascensión Bay until 1961, when the Cozumel cooperative took over. Subsequently, they were limited to lobstering within the north zone. Shrimp boats served as mother ships for lobstering by fishermen of Isla Mujeres in exchange for the right to purchase the entire production. The Xcalak cooperative had a similar arrangement, and for a time, registered lobster from Expíritu Santo Bay at Isla Mujeres. Production was registered as sin caparazón (without carapace, or tail only) and fresco (fresh), indicating that the mother ships carried ice. Local boats consistently registered their product as entero cocido (cooked whole), since local smacks did not carry ice, and

were obliged to boil the catch before shipping to prevent spoilage.

Boat registrations for this period indicate that fishing craft changed little. Most fishermen worked from sailboats, although by 1962 the majority of Isla Mujeres fishermen used small outboards as auxiliaries. The increased income from lobster fishing, combined with three good years of turtle production, probably facilitated the purchase of motors and defrayed the expense of running them.

During the early 1960's, shark and scale-fish production remained relatively stable. Most was shipped to Progreso by two fish buyers, F. Martín N. and J. A. Magaña R. Records show that Magaña was supplied regularly by fishermen who belonged to "Patria y Progreso," while Martín obtained much of his product from "Caribe" members and Holbox fishermen. Another entrepreneur, Hilario Scumperdis, seems to have bought most of the zone's turtles, and shipped them live to Key West. Scumperdis, a Greek, also sent occasional shipments of sponge to the United States.

As in the previous decade, members of "Patria y Progreso" and "Caribe" sold their production of scale-fish, sharks, and turtle to their former patrons. Cooperative membership was merely an expediency allowing fishermen to capture lobster. They worked from the same boats owned by the fish buyers, and were sponsored by them in a similar manner. Although "Caribe's" lobster production was sold to the Cozumel packing plant, and "Patria y Progreso's" to a plant in Progreso, Yucatán, the buyers were still very much in the business; their purses were large, and they were powerful and influential local forces.

After 1962, the fishery began to change rapidly. Scumperdis left Isla Mujeres, and Magaña absorbed much of his operation. The cooperatives

began selling small amounts of live lobster to tourist hotels near the ruins at Chitzén Itzá in Yucatán. Shipments of cooked whole lobster decreased, and then ended altogether in October, 1963. By this time, boats with live wells were all plugged and ice boxes were installed. The curio trade began to blossom in the summer of that year when Martín shipped 7 tons of conch shells to Miami, .5 tons to Veracruz, and 3 tons of assorted shells, 1,325 kilos of dried starfish, 725 kilos of sea fans, 27 kilos of clam shells and 100 kilos of coral to Acapulco. Previously, shipments were limited mostly to conch shells, and destined almost exclusively for Veracruz.

Scale-fish and shark fishing continued through the mid-1960's with little change. Most of the product still went by boat to Progreso, although there was some increases in amounts shipped overland by truck to Mérida, Veracruz, and Mexico City. The cooperatives occasionally registered shipments of salted fish, but the bulk of this product was handled by Martín or Magaña.

Shipments of fresh fish were relatively rare until early in 1965, when an American entrepreneur, Charles Hawkins of Palmetto, Florida, began buying from Martín and shipping directly to the United States. This arrangement marks the beginning of a slow but ever increasing trend toward fresh rather than salt fish production. Hawkins apparently picked up fish in Holbox, and registered it at Isla Mujeres. Also, Hawkins may have introduced small four-cycle gasoline inboard engine to Holbox. He may also have brought monofilament gillnets and other equipment from the United States, which resulted in increased captures of sea trout, snapper and pampano.

Magaña also began supplying Hawkins with some fresh fish in May 1965,

and with considerable amounts of sea trout and snapper by the following July. After this, Martín's registrations drop off sharply, and it appears that he virtually abandoned the fish buying business. There is no indication that he was somehow maneuvered or forced out of the business, as some fishermen contend today.

Production of the Isla Mujeres cooperatives was limited mostly to turtle and lobster. By early 1965, "Patria y Progreso" was selling the bulk of its production to Hawkins, while "Caribe" was selling to the packing plant in Progreso. Presumably, Magaña continued as silent partner of numerous members, and after 1965, appears to have been well on his way to establishing a virtual monopoly on the turtle, carey shell, shark skin, and fish trade. Martín's production registrations after this point indicate that he specialized exclusively in the curio trade. Magaña also appears to have branched out, as he registered the island's first sportfishing boat in April of the following year.

In May 1966, the first hauls of shrimp were registered at Isla Mujeres by members of the "Laguna de Términos" cooperative of Cuidad del Carmen. In that year, the local cooperatives produced, in addition to lobster, 50 kilos of squid, 400 kilos of shrimp, and only 400 kilos of turtle meat, a small amount compared to previous years.

Although neither cooperative at Isla Mujeres had a shrimp boat, shrimp and also squid caught in shrimp nets, began to be registered in the local fisheries office. The explanation probably lies in the federal program started at about this time to teach members of the local cooperatives how to run shrimp boats.

Presumably, as a part of the same federal program, in January of the same year, "Caribe" obtained seven diesel powered fiberglass boats

equipped to haul wooden lobster traps. Also, a small "demonstration" fish processing plant was set up in Puerto Juárez, which began handling the area's shrimp and fresh fish production. Hawkins and other Americans who had been exporting fresh fish from Isla Mujeres were squeezed out of the business. Production from the demonstration plant was sent to Progreso, and from there to the United States. From this time on, the amount of salted fish sent to the interior decreased substantially.

The demonstration plant apparently operated only until summer, by which time Magaña had built his own freezing plant on Isla Mujeres. In June, he shipped 2,270 kilos of turtle fillets in 5 lb. boxes, along with virtually all of "Patria y Progreso's" lobster catch (2,578 kilos) to Miami on the Super Freeze. By the end of the year, Magaña was handling the bulk of the state's "luxury" product, and shipping it to Jacksonville, Florida.

Other elements of the fishery also changed. Holbox fishermen formed their own cooperative and registered their first capture, 1,337 kilos of lobster tails, in August of 1967. In addition, a group of 23 on Isla Mujeres formed a cooperative of tour boat owners.

Early in 1968, when the cooperatives applied for credentials for their members,"Holbox" requested 75, "Patria y Progreso" 60, and "Caribe" 33. Holbox registered 400 lobster traps, "Patria y Progreso" 600, and "Caribe" 350. These registrations probably included some casitas, which had been introduced by Cuban immigrants by this time. As the island's lone patrón, Magaña registered only 13 fishermen, yet he marketed virtually all of the fist caught in the zone.

In 1968, the cooperatives focused almost exclusively on lobster.

"Caribe" also began supplying Magaña with lobster, and by the end of the year he was freezing all of the zone's lobster production and exported nearly all of it to the United States.

The Industrial Fishery: 1970-1979

The 1970's saw the development of a truly industrial fishery in the north zone, characterized by high technology and by increasing government and private investment. Although some elements of the fishery changed little, new technologies were introduced in all zones, resulting in significant increases in captures and changes in the composition of catch. Production of luxury species predominated. Production for export peaked in the later 1970's and then declined as the local tourist trade began to consume increasing amounts. Also, increasing numbers of immigrants from Yucatán settled along the coast, and domestic consumption of marine products increased.

Most production was registered by the members of cooperatives working their "reserves" for luxury species. Some cooperatives which had historically produced significant amounts of fresh fish virtually abandoned handlining and gillnetting, limiting themselves to gathering conch and capturing lobster. Other fishermen quit the business altogether, to ply the tourist trade, converting their boats to accomodate sightseers. Others retained their membership in a cooperative, but fished only when lobster were particularly abundant.

As part of a state and federal plan to develop the state's fishing industry, roads to remote parts of the coast were opened, processing plants were built, and the advisory function of government officials was increased. New fisheries offices were established in

Holbox, Cancún, and Puerto Morelos, reflecting the effort to increase control over the exploitation of marine resources. For the first time quotas were imposed on turtles and conch, whose abundance had already diminished drastically. Also, technical schools were established in Puerto Morelos and Holbox to teach young boys fishing and maintenance of gear, in an effort to encourage more of them to go into fishing. In addition, a multi-million peso aquaculture facility was constructed in Puerto Morelos.

South zone

The focus of production in the south zone changed dramatically early in the decade, after a packing plant and cannery ("Enlatadora Yoli") were established in Chetumal. This plant initially received fish, lobster and conch, but soon began to focus almost exclusively on conch. Accordingly, conch production became the prime focus of most members of the Xcalak cooperative. By 1973, the cooperative was registering over 100,000 kilos of conch per year, virtually all of it coming from Chinchorro Bank. It was canned and sent by truck to Mexico City, Monterrey, Guadalajara and Ensenada (Bassols, et al., 1976: 230-231).

Lobster production also increased somewhat during this period reflecting increased activity at Chinchorro, and the establishment of permanent base camps there. Scale-fish production was also augmented as divers searching for lobster began to spear larger fish at Chinchorro.

Rapid population growth in Chetumal also stimulated production by increasing the demand for fresh fish. By the middle of the decade, the city's population was over 42,000 (Ibid.: 57); however, fishermen were not able to satisfy the demand. Between 1973 and 1974, scale-fish production dropped from 195,455 kilos to 86,694. Levels of production

continued to be depressed until 1977. Two factors contributed to the inadequate supply. The demand for conch far exceeded the production fishermen were able to supply, and hurricane Carmen caused some destruction of beach weirs in early September 1974. Although price controls for fish production for domestic consumption do exist, they do not seem to be a disincentive.

To compensate for the scarcity of fish in Chetumal, conch quotas were set low (38,000 kilos in 1974) in an effort to induce fishermen to return to scale fishing. The difficulty was that scale-fishing brought the least returns for fishing effort. Also, although lobster brought more pesos per kilo, fishermen preferred to harvest conch, since it was easier. In addition, conch can be packed much more tightly in iceboxes, allowing greater amounts of weight to be transported per trip.

Efforts to enforce the quota proved only partly effective. While the cooperative's administration assigned its members monthly quotas, these were generally ignored, and the increasingly scandalous situation forced officials to put increasing pressure on the cooperatives to observe the quota. By 1977, registrations of conch had been reduced by half, but were still double what the quota permitted.

Although in 1977 some cooperative members once again began to diversify their fishing methods, and scale-fish production increased substantially, a trade in black market conch flourished as other members unloaded much of their production before arriving at the Chetumal dock. In 1978, at least on paper, compliance with the quota improved. The following year, based on a survey of conch stocks at Chinchorro, Xcalak's quota was increased to 72,000 kilos, to be harvested at a rate of 6,000 tons per month. However, during that year capture of

122,508 kilos so grossly exceeded the quota that early in 1980, officials declared a complete ban on production.

The effort to force members of the cooperative to diversify their catch met with short-lived success. In 1977 and 1978, scale-fish production increased substantially, as did lobster production, although not so significantly. However, in 1979, the cooperative's lobster production nearly doubled. In February and March and from August to October, lobster were unusually abundant. Nevertheless, a review of conch production figures for the year suggests that gathering remained very attractive to most fishermen since during the closed lobster season, March 16 to July 15, many fishermen did little else but gather conch. In fact, almost 31 per cent of that year's total conch production was gathered during May and June.

In 1979, scale-fish production by the cooperative fell of considerably; at 131,074 kilos, it was less than half the preceding year's total. Here, as elsewhere in the state, members of cooperatives were clearly preoccupied with luxury species. The demand for conch and lobster was such that scale-fish were considered merely incidental. Although production peaks of over 200 metric tons of scale-fish had been achieved in 1977 and 1978, production in 1979 dropped to less than that registered during any of the first four years of the decade.

Despite concerted efforts to diversify the zone's fishery, fishermen belonging to the cooperative resisted; conch gathering continued to be their primary activity. Much of Chetumal's demand for fresh fish went unsatisfied. By 1979, an increasing number of fishermen from Campeche and Yucatán were settling in the area as independent fishermen, who began to supply the local markets with more scale-fish.

Central zone

By the early 1970's, tourism had become Cozumel's most important industry. Numerous boats were converted to haul tourists rather than fish. Reefs near the island bacame a "Mecca" of sorts for SCUBA divers and many fishermen quit fishing to serve as pilots for dive boats, and as crew or guides for sport fishing or excursion craft. Because such work was highly seasonal at first, many returned to fishing after the winter season ended, However, as the tourist industry grew, increasing numbers of fishermen quit altogether, preferring to work as diving or fishing guides, or abandoning the water altogether to work as waiters. Such employment was easier, involved less risk, and was more lucrative.

For the most part, fishing by Cozumeleños centered on the luxury products, which were shipped to the United States by Empacadora Cozumel. The plant owned mother ships which it sent on a regular schedule to Espíritu Santo and Ascensión Bays where members of "Cozumel" and "Vigía Chico" had their lobster shelter campos.

Registration of lobster in the zone had diminished in the years prior to the separation of the "Vigía Chico" cooperative from "Cozumel" and continued at a low level for some time afterwards. New leadership eventually emerged and each group was able to demonstrate sufficient stability so that lines of credit could be reestablished, and new repayment schedules set for outstanding loans. The amounts of lobster registered during this period should be viewed with caution since the totals probably understate the actual volume of capture. Fishermen acknowledge that in Cozumel, as elsewhere, a thriving black market has developed. Most of the lobster captured in waters near the island

undoubtedly were not registered, as fishermen sold directly to restaurants. In contrast, most of the lobster captured by cooperative members along the mainland was registered, since it was carried to Cozumel in mother ships provided by the packing plant. This minimized the opportunity to bypass the middleman and sell directly to the restaurants.

As the island's population has grown, and as the tourist industry blossomed, the black market has increased. Nevertheless, there is some evidence that by 1980 the trade had peaked. This is perhaps because the opportunity for black-marketeers to operate in secret has diminished as communication has improved. Also, as lobster have become more valuable, and scarcer, cooperative members have become less tolerant of other fishermen trafficking in what is reserved for "members only."

In contrast to the luxury species focus of the zone's cooperative members, fishermen on the mainland continued to fish for scale-fish. The Playa del Carmen amberjack fishermen expanded their operations somewhat, and began to supply residents of Cozumel with fresh fish such as mojarra, jack, grunt and mullet. However, virtually all amberjack was salted, dried and sold to fish buyers who shipped it to Puerto Juarez where it was sent as cargo on a passenger bus to Veracruz or Puebla.

Product destinations and production for the zone as a whole began to change by the mid 1970's. Registrations indicate that increased amounts of lobster were sold to local restaurants and that additional amounts were shipped regularly to restaurants in Mérida and Mexico City. Both cooperatives began to exploit conch in earnest, and their production was purchased by the packing plant in Cozumel. Half of this was consumed locally, while the rest was shipped to Mérida.

Both cooperatives began to register increasing amounts of first-class fish (e.g., snapper and grouper), which they sold to the packing plant for export as fillets. In addition, the cooperatives registered occasional captures of cazon which they sold for local consumption, probably in the public market. Independent fishermen of the island began to register captures of grunt, grouper, mullet and snapper more frequently, and continued to gather conch at levels which often exceeded those of either cooperative. This continued until July 1975, after which only cooperatives were permitted to harvest conch. Presumably, the increasing scarcity moved cooperative members to insist on enforcement of the law reserving conch for their own exploitation.

Independent fishermen in other parts of the central zone also increased their production during this period, but details are scarce. For the most part, fishermen in places like Puerto Morelos began to supply residents of Cancún and restaurants with increasing amounts of fish. The bulk was captured by divers spearfishing along the barrier reef. Nearly all divers worked from small skiffs powered by outboards, and captured a wide variety of reef fish. Fish buyers from Cancún made daily visits to Puerto Morelos to buy from divers they sponsored. The volume of production and its variations remain uncertain. However, the amounts may have been considerable, since once abundant stocks of conch have all but vanished, and larger-sized groupers, snappers, parrotfish, and even grunts are notably diminished along the reef. Regular registration of this production did not begin until the Cozumel packing plant moved to Puerto Morelos in 1978. The following year a fisheries inspector was assigned to the plant, which is on the only road leading out to the main highway, and

known fish buyers were required to register their cargos.

Associated with the development of the tourist trade was the expansion of the curio trade. During the early 1970's, the black coral trade grew explosively, as did the shell trade. Most production was sold in local shops, although items such as conch shells and dried starfish were shipped regularly to other resort areas in Mexico. Hawksbill turtle shell jewelery and stuffed juvenile turtles continued to be sold, although both their capture and the marketing of the shell had been illegal for some time. Local merchants were given a grace period to merchandise their stock, which a naive observer would have to conclude were extraordinarily large.

Registrations of black coral appears throughout the records available to my inspection (1972 to 1979), but individuals associated with the industry acknowledge that these were mostly "token" registrations, and give only limited perspective on the amounts removed. When I discussed the records for 1977 with black coral divers, I was told that the amount produced was easily double the 90 kilos registered.

The export of saltwater aquarium fish was begun in Cozumel by R. Villanueva Martín in 1972. He built an aquarium on the waterfront which functioned as a tourist attraction and provided holding tanks for the export business. My information on his early dealings is incomplete, but by the mid-1970's he was shipping thousands of small tropical fish (peces ornamentales) to Florida by air. For example, in 1975 he exported 8,333 fish, while in 1976 and 1977, he sent 5,956 and 5,274 respectively. The available evidence suggests profits were substantial. However, in 1978 he exported only 207 fish, and shortly thereafter his export permit was cancelled. Individuals with whom I discussed this

claimed that there had been a protest raised, based on the belief that divers working for his operation were systematically looting the reef along Cozumel's southwest side, which had then been declared a national underwater park.

In recent years, neither of the zone's cooperatives has increased substantially in its capture of scale-fish. Members of "Vigía Chico" have dedicated themselves almost exclusively to lobster. Their total registered scale-fish production for 1979 was only 3,840 kilos, or an average of 53 kilos per member, the weight of 3 or 4 good-sized fish. "Cozumel's" average was considerably higher, 572 kilos per member, but does not begin to approach the 4,750 kilos per man that full-time independent fishermen of Playa del Carmen produced in the same year. The higher production registered by members of "Cozumel" is explained in part by their use of snapper reels, adopted around 1975, installed on mother ships which haul the lobster from Espíritu Santo Bay to the Puerto Morelos packing plant. "Vigía Chico," whose members reside mostly in Punta Allen, ships its production out by truck.

Clearly, the use of lobster shelters has proved very rewarding. Although some members of both cooperatives continued to harvest from natural habitat, there was a clear consensus that members who had campos had a significant advantage. When I visited Punta Allen in the summer of 1979, there was a tremendous effort underway to increase the number of shelters before the season's opening. A similar effort in Espíritu Santo Bay was being made by members of "Cozumel." This investment was lucrative; production for 1979 reached an all time high, and for the first time exceeded that of the north zone. As has been the case historically, most production was shipped to the United States.

North zone

Although production data for the year 1970 are not unlike those of the proceeding year, significant changes in the fishery were underway at that time, as a result of improved technology. Tangle nets to intercept winter lobster migrations off Contoy were introduced, and by the following year, 130 were in use. Fishermen also constructed increasing numbers of lobster shelters in the shallow areas to the north of Isla Mujeres. More and more divers learned to use SCUBA and began harvesting lobster and conch from greater depths. In addition, more divers began using spearguns to harvest scale-fish.

In the summer of 1970, Magaña concluded an agreement with the cooperatives on Isla Mujeres whereby he would provide boats, lobster traps and fuel in exchange for 50 per cent of the capture and the exclusive right to purchase the remainder. This official accord merely formalized the de facto situation. However, it apparently resulted in an increase in the number of traps which cooperatives began using that fall. "Patria y Progreso:registered 1,500, while "Caribe" registered 1,000. These traps were of a new and more durable style (tipo "Australiano", Fig. 5.31). Their frames were constructed of concrete reinforcing rod in Mérida, and the final product was assembled on the island.

The following year Magaña, now incorporated under the name "Empacadora y Congeladora Romeo," doubled the number of traps available to each cooperative. Also, "Patria y Progreso" obtained two additional shrimp boats, apparently through government loans, and shrimp production increased markedly. The packing plant purchased virtually all of the cooperative's shrimp production, and shipped it,

along with the lobster, to Miami on the Ultra Freeze. From there it was delivered to either the Beaver Street Fisheries Company in Jacksonville, or to the Ocean Garden Products Corporation in San Diego. Shipments were also made on the Red Diamond 4 to Booth Fisheries Products of Brownsville, Texas. The Empacadora Romeo also purchased rock shrimp of lower value and shipped most of it, along with some lobster, to Mérida on the truck line "Transportes Magaña."

The significant increases registered after 1970 are explained in great part by the introduction of new technologies and the development of a marketing network, but other factors were also involved. Production data indicate that increases in overall production were concomitant with the drastic decline in the turtle catch. By the later 1960's, it became clear that captures were decreasing and that this element of the fishery was in serious trouble. The effort necessary to capture turtles increased as the population declined. Despite this, many turtlers earned good incomes during the early period of the decade, and the numbers of fishermen involved in turtling increased. Later, captures per fisherman declined significantly, and lobstering and shrimping became increasingly attractive.

The spectacular rise in scale-fish production was also partly related to the decreased amount of time spent turtle fishing. Also important was the establishment of higher prices for first-class scale-fish associated with the development of a market in the United States.

Shipments of frozen fish began to be included with the lobster and shrimp, and soon the Isla Mujeres packing plant was shipping all the first-class fish that the area's fishermen could produce. Snapper

and grouper were frequently captured by shrimp boats, and this "by-catch" was added to the exports. Also, and possibly more importantly, monofilament gillnets were introduced and their use became widespread, resulting in significant increases in captures of pompano, sea trout, and mackerel. Spring runs of mackerel occur in the waters north of Isla Mujeres, and these nets were found to be extremely effective.

Diving with SCUBA became increasingly popular in the early 1970's, as dive shops were established on Isla Mujeres and air-tanks could be rented for a day's fishing for less than the value of one lobster. First notice of capture by diving is found in the island's production records for August 1972. At that time, as at present, divers worked out of small skiffs, powered by outboards. Essentially opportunists, they gathered, hooked or speared virtually anything of value, including conch, lobster, scale-fish, and even starfish to hawk to tourists. A few divers also began to harvest regularly from traps set out by other cooperative members.

Significant changes were also occurring on the Island of Holbox. The fishermen, long accustomed to using nylon twine gillnets, quickly learned to appreciate the effectiveness of the new monofilament nets for capturing pompano, sea trout, and mackerel. Records indicate that cooperative members began to sell increasing amounts of these species, along with grouper, bonefish, barracuda, mojarra and snook as fresh rather than salted to buyers from Mérida and Progreso. The cooperative also continued to produce a considerable amount of salted shark, cazón, and barracuda for buyers who trucked it to Mexico City.

Holbox's lobster production varied considerably. In 1972, the

cooperative produced only 9,993 kilos, but 46,066 kilos the next year. Such extreme variations are explained by water conditions. When the late summer and early fall months are windy, waters around Cape Catoche become quite turbid, and opportunities for diving are limited.

Other changes in the Holbox fishery included the introduction of lobster shelters, and the widespread adoption of outboard motors. The latter facilitated setting and hauling of larger gillnets, and generally increased the range of the fishermen. A freezing plant was built by private interests, and ice became routinely available. Thus, fish could be held fresh and fishermen were freed from the time-consuming necessity of salting the capture.

By 1973, hotels and restaurants on Isla Mujeres were purchasing small amounts of seafood from the packing plant, but nearly all production went to the United States. The only significant exception was a regular conch trade with Mérida, which was established that year. Some shipments exceeded 1,000 kilos registered by independent fishermen as well as cooperative members. In May 1973, the freezing plant on Holbox was closed, apparently because of administrative problems, and the Holbox fishermen began selling their lobster and first-class fish captures to the Isla Mujeres plant. Production sent there in 1973 totaled 15,445 kilos of fresh fish and 46,066 kilos of lobster tails. Shipping invoices for this period indicate that virtually all of this product was exported to the United States. These documents also suggest that Magaña's monopoly may have been quite lucrative. For example, his packing plant purchased grouper and mackerel at 3 pesos per kilos and sold it at 5 and 4.5 pesos per kilo, respectively. This same year, the Holbox cooperative obtained a shrimp boat through government loans, and

began selling its capture to the Isla Mujeres plant as well.

During the first half of the decade, virtually all of the zone's shrimp and lobster production was shipped to the United States. This changed gradually as the tourist industry developed. Magaña's plant began to supply Cozumel restaurants with shrimp and lobster which, in addition to fresh fish, were shipped by air. Other aspects of the industry also changed. The last shipment of turtles to the United States was made in April, 1975, when fillets from 122 green and 79 loggerhead turtles were sent to Miami. The following month, the Isla Mujeres fishery office received a directive ordering that turtle could only be harvested for domestic consumption.

During the later half of the 1970's, fewer and fewer fishermen bothered to salt their capture. Increased amounts of whole fish and fish fillets were shipped iced down or frozen. Monthly production reports at this time indicate that scale-fish production by cooperative members increased during the closed season for lobster, and also generally whenever opportunities for turtle production were limited. After the first two months of the open lobster season, scale-fish production again increased, presumably as lobster became scarce. The volume of scale-fish caught during the winter months varies considerably from year to year, but is probably related closely to the quantity of lobster migrating through the area in December and January. As a general rule, production of fish increased in the spring and early summer, since large runs of fish occur during this time. Although there are some exceptions to these generalities, most of the fishing in the north zone follows this pattern today.

Shrimp production increased considerably after 1974, when boats were

added to the fleet. As it had done with lobster boats and traps, the packing plant began supplying shrimp boats to both of the cooperatives in exchange for half of the production. Holbox's experiment with shrimping ended in December of 1976, when the cooperative apparently concluded that their operation was unprofitable, and the boat was returned to the creditors. Explanations vary, but often focus on the lack of adequate training to maintain such a vessel, an unrealistic loan repayment schedule, faulty equipment, and the oft-repeated explanation, "mala administration" (bad administration). It is uncertain why problems did not confront the zone's other cooperatives.

Further changes occurred in 1976 when Isla Mujeres and Holbox fishermen began supplying the new city of Cancún. As a general rule, restaurants and hotels received luxury species while local markets were supplied with increasing amounts of fresh fish, formerly shipped to Mérida or Mexico City. Although a handful of older fishermen of "Patria y Progreso" continued to salt some fish and shark, "Caribe's" salted fish production ended with 900 kilos of processed shark early in the year. At the end of the year, during the busy tourist season, Isla Mujeres supplied Cancún with 1,982 kilos of lobster, 3,620 kilos of barracuda. All of this production was shipped frozen.

As in other zones, a local black market in products reserved for exploitation by cooperatives also began to function. Some cooperative members began selling their product directly to hotels and restaurants, contrary to the provision in their contract with the packing plant, which guaranteed a minimum price. By avoiding the intermediary, fishermen received a higher price, and restaurants were able to purchase lobster and shrimp

for less than the packing plant's price. Some independent fishermen also began to supply the restaurants directly. Equipped with SCUBA and working off fast boats, they frequently removed lobsters from traps belonging to the cooperative. Other entrepreneurs merely rendezvoused with the cooperative's boats at sea and purchased lobster and shrimp from them.

In the later 1970's, rectangular traps for catching scale-fish were introduced by Empacadora Romeo, resulting in significant increases in captures, especially of grouper and snapper. Isla Mujeres fishermen, including cooperative members, began using the traps supplied by the plant on a share-of-the-catch basis. Also at this time the Holbox cooperative began to register captures of octopus and increasing amounts of conch. The cooperative also began to supply the Campeche public market with fresh fish in addition to the still considerable amounts of salt fish which it supplied to Mexico City. As in earlier times, Holbox's shipments consisted chiefly of shark, barracuda, and grouper, and the largest quantities were sent in May and early April for Easter Week. The island's fishermen also began supplying buyers and the public market in Cancún with increasing amounts of fresh fish, including mullet, mojarra, grouper, snook and pompano. The latter three species were formerly often reserved for export.

By the end of the decade, increased amounts of the zone's production of luxury species were being diverted to the local tourist industry. The relative amount of frozen fish sent to the United States declined considerably, although lobster and shrimp shipments remained large. Conch gathering was limited to cooperative members, and for a brief period, large quantities were exported to the United States, but stocks became so diminished that quotas were imposed. Turtle fishing

was reserved for local consumption, limited to cooperative members, controlled by quotas and size limits, and allowed only by fishermen who agreed to lend some of the females to the supervised hatching program run by the marine biological research station on Isla Mujeres.

By the end of the decade, members of both Isla Mujeres cooperatives virtually abandoned the practice of salting fish Instead, they sold whole fish to the packing plant. By 1978, they were registering little more than the species reserved for their exclusive exploitation. Thus, the island's cooperative revolution had come full circle, existing now as they had come into existence, as cooperatives in name only, membership being little more than a formality necessary to maintain control over valuable resources. Many have given up the pretense altogether, having found that fishing for tourists is easier and more profitable than working nets or shark lines. As one fisherman explained, "I can make more money, more regularly, by taking tourists out for sightseeing rides along the coast and on snorkeling trips." Another fisherman put it most economically by noting that "two tourists equal one shark; and tourists are easier to catch."

In contrast, Holbox fishermen continue to salt scale-fish and shark in considerable quantities. This is explained in part by their relatively isolated position, their longer tradition of fishing, the lack of a tourist industry, and the peculiar combination of current and coastal configuration which results in generally more turbid water conditions. Diving remains relatively restricted, at least compared to the east coast, where the waters are most often crystal clear.

CHAPTER VII

PROBLEMS AND PROSPECTS

The success of schemes to develop Quintana Roo's fishery will depend not only on decisions made locally, but also nationally. Mexico is experiencing explosive population growth, and is hard pressed to meet the increasing needs and rising expectations of its lower classes. Federal planners have targeted the state's fishery for increased production to provide more food and employment. Yet, little is known about the extent of the marine resource and its ability to sustain increased fishing pressure. Already, the stocks of two formerly abundant elements, conch and turtles, have been diminished in many areas to the point of commercial extinction. This raises questions about the ability of other stocks to sustain current and projected levels of production.

Long-range costs of development must be weighed against short-term benefits, or future generations may conclude that today's was not only shortsighted, but blinded by greed. This chapter provides insight into some problematical aspects of the evolving fishery, in an effort to assist the development of programs more consistent with cultural and environmental realities.

On the Lack of Adequate Historical Data

Future efforts to determine sustainable or optimum yields in Quintana Roo's fishery will be hindered by the lack of historical data. Ideally, population parameters should be estimated by comparing a chronological series of data on catch and effort, to establish the relation-

ship between effort and average fishing mortality (deaths in a fish stock caused by fishing). In situations where innovation has modified the fishing power of gear or vessels, data on effort would be standardized to determine if measurements of yearly differences in captures were caused by fluctuations in abundance of the stock or by changes in fishing power (Ricker, 1975: 18-22). Obviously, such an analysis would provide information vital to the management of the state's marine resources.

Unfortunately, the historical records with respect to gear and registrations of captures are unreliable. For a variety of reasons, the monthly summaries of production registered at the various regional fisheries offices understate the actual catch. For example, the production of many small-scale fishermen goes unregistered, as does an unknown quantity sold on the beach. As coastal populations have increased, so has the demand for fresh fish. Another source of error is related to the registration process, which requires that fishermen must register their product in order to obtain documentation (guia or transport permit) which certifies that the capture was made legally and that taxes were paid. Although taxes are often only a few pesos per kilo, they vary with the value of particular species. For example, taxes on luxury species such as lobster or conch are higher than those for scale-fish. As a result there is an incentive to understate production, especially for the more valuable species. In addition, since the regulations only allow those with permits to register captures, those without permits cannot make registrations, since their product is automatically contraband. It either goes unreported, or is entered as production of someone holding the correct permit. For example, fishermen belonging to cooperatives routinely register the production of friends or employees.

Registration serves further to regulate the fishery by controlling transportation of the product. Receipts for tax payment are necessary to obtain a permit for shipping. Since trucks are inspected at various points along the highway, a shipping permit is necessary, or a scheme for bypassing the requirement must be at hand. Ships must also have proper documentation before leaving port. According to fishermen the regulations are circumvented routinely, introducing another source of error in the official records. However, systems of communication and the regulatory machinery have been improved and the net is being drawn tighter around those who would avoid the legalities.

In the past, green turtles and hawksbill turtle shell were probably the products most commonly smuggled. They were transported to Belize by sailboat, and exchanged for British goods. More recently, with the development of the tourist industry, a brisk trade in black coral and hawksbill shell for jewelery has developed. A similar trade has grown for shrimp, conch, lobster, and turtle to supply the expanding number of restaurants. Although the capture of hawksbills and the possession of the shell are illegal, both fishing and the use of the shell continue with no estimate of the quantity. Production of the other items is limited technically to cooperative members, some of whom sell directly to restaurants, from which they receive substantially more than from the cooperative.

The figures for lobster and conch production in the last few years are particularly suspect. Fishermen and fishery officials alike concur that much of the actual production goes unreported. They estimate that as much as 40 to 60 per cent of the total capture is sold directly to restaurants and hotels. Although a potentially more accurate estimate

of present production might be obtained by including these amounts, it is unclear that this would be suitable for estimating past production. Nor is it clear that these estimates reflect the situation in all parts of the state. Based on discussions with fishermen, I suspect that the percentage marketed illegally has reached 40 to 60 per cent only in recent times, and in those places where tourist industry has developed.

Although some officials have tried to curb the contraband, it persists because of the lack of manpower for patrolling the state's long shoreline. For the forseeable future, the black market will continue to affect the accuracy of production reports.

Historical records listing gear, boats, and fishermen are also unreliable. For example, analysis of monthly reports reveals that not all of the permits issued were registered. This can be inferred with some confidence, since some individuals registered products without officially noted as having a permit to capture. A further complication is that the data contained in some registrations cannot be accepted at face value. Two examples should illustrate this point adequately.

Boat registrations in Isla Mujeres from 1955 to 1962 show that all boats were sailboats; the only boats which had auxillary engines were those over four tons. However, a brief note appended to the boat registration form for August, 1962, states that while all but one of the local boats are "registered with the Port Captain as sailboats, ... the majority of them have small outboard motors." Of course, an outboard, though used only as an auxillary, increased the range and decreased the travel time whenever wind or current were unfavorable, thus increasing the boat's fishing power.

A second example underscores further the difficulty. The membership

roll of "Vígia Chico" cooperative for August 9, 1974, lists 68 men. However, only 40 of these were listed among the 90 on the "official" roll, based on past records and kept by the "Direccion General de Capacitacion y Fomento Cooperativo Pesquero," the federal govenrment agency charged with overseeing fishing cooperatives. This came to light during an inspection visit held on August 12, 1975. After some discussion, the roll was re-worked. In early December, 21 "non-members" were dropped, four were added and the total was then settled at 73. Evidently, some additional changes were made, since by the end of the month a new roll listing 69 names was filed with the Pesca office in Chetumal. Since this is only one more than the original total, the revision would seem insignificant. However, the cover sheet for the packet of documents containing the new roll showed only 59 members. Presumably this was an error in transcription.

These errors and "adjustments" are significant since they predjudice seriously any attmept to determine how fishing effort has changed over the years. Efforts to estimate the population parameters of particular stocks through time, and to determine the impacts of particular fishing rates, must await additional sources of information.

The need for accurate information had become increasingly apparent to the local fishery officers, since fishermen and politicians must be convinced of the need for regulation. Accurate data must be marshalled in order to justify policies limiting fishing to a particular area or time. There has been a recent effort to upgrade the quality of information collected. For example, in July 1980, the lobster permit for the cooperative "Vígia Chico" was withheld for several days after the season was opened, until the membership roll was submitted and checked for accuracy. Other

cooperatives were threatened with similar treatment, as a "get tough" policy was communicated effectively. No longer would it be possible for cooperatives to ignore or delay the required yearly reports, or merely to copy data directly from last year's report. If this push for accuracy continues, better management decisions may result.

On the Federal Role in Regulation

With the exception of top officials in the main fisheries office in Chetumal, employees of Pesca are mostly civil servants and, for the most part, locals. They have known their area's fishermen for most of their lives, and are often related. Their familiarity with the local culture, and the remoteness of Quintana Roo from the rest of Mexico has resulted in a certain flexibility and reasonableness in interpreting and enforcing regulations and implementing policy. Until recently it was agreed tacitly that policies and favorite programs originating in Mexico City were less than permanent and not always appropriate. A certain system of mutual accommodation evolved by which the rules could be stretched to allow for the exigencies of wind, wave, and current, or in situations created by problems of documentation, communication and transport. In the past, it could be argued, there was a necessity and a certain logic to this approach. The civil servants, after all, had to deal with fishing and fishermen much more directly than the federal officials in Mexico City.

This pattern is being erroded by increasing federalization of the fisheries offices. Increasing numbers of "outsiders" are being put in charge, and lower-level functionaires are finding it harder to rationalize preferential treatment, or justify bending the rules in cases of exigency. Fishermen in day-to-day contact with the Chetumal

office have been slow to detect this change, but less frequent visitors have noticed the change in manner and approach and are often resentful. Also, a number of fishermen have been fined for some oversight or infraction which in the past was overlooked. Thus, some fishermen have become alienated, and are determined to cooperate as little as possible with the new regime. The civil servants are caught between two fires; the fishermen expect occasional relaxation of the rules, while the Pesca officers insist on their strict observance.

On Territoriality

Since 1957, exploitation of lobster and conch has been regulated by the assignment of campos to each cooperative. This represents the federal policy of structuring fishing cooperatives in a manner similar to agrarian collectives. The locations of assigned boundries comform to some extent to traditional boundaries. For the most part, these were defined by what was then the normal range of the fishermen from home port, and were mutually agreed upon.

Obviously, conditions have changed, and now virtually every fisherman has a motor, and most work from fast skiffs. Also, through the later 1960's, new cooperatives were formed, and the size of some campos has been reduced. More recently, as conch stocks in some campos have been depleted, there has been increased lobbying by the members of the cooperatives affected to have the limits of their campo expanded. Naturally, there is opposition by a cooperative whose campo is threatened by reduction. The only consensus between the existing cooperatives on this issue seemed to be a general agreement that no new cooperatives should be formed, since this would probably result in further reductions in

campos.

Although the campo system provides for management of discrete areas, and may encourage some fishermen to husband their resource, in the central zone it has become something of an administrative nightmare. When the cooperative "Vígia Chico" was formed by disaffected members of "Cozumel," the latter's campo was divided between them. Both agreed to share the area between Punta Xocosh and Punta Petenpich; "Vígia Chico" received the area between Punta Xocosh and Punta Pájaros; and "Cozumel" received the area between Punta Pájaros and Punta Herrero. However, some members of each cooperative had lobster shelters in the waters designated for the other. Fishery officers have attempted to untangle the situation by requiring that the few who had shelters in the area of the other cooperative join that one. It was hoped that this would facilitate regulation, and reduce the tensions which have existed historically between the two groups. To date, the fishermen have steadfastly ignored any directives "requesting" that they join the other group, and they apparently have no intention of doing so.

On Cooperatives, Development Policy, and Infrastructure

It could be argued convincingly that the development of fishing cooperatives in Quintana Roo has been compromised by economic decisions and operating constraints imposed by the federal development program and fish buyers, who have attained seemingly unchallenged control over their destinies. On the other hand, without the capital provided by private investors the industry might never have developed as it did in the late 1960's. In any event, my review of the history of the founding and development of cooperatives, combined with information and opinions gained in long discussions with cooperative members, has convinced me

that membership has meant, for the most part, only the opportunity to capture lobster and conch. Planners would do well to recognize this.

Currently, development policies have resulted in a fishery specializing in the production of luxury products for export. While this has brought employment, social mobility, and some degree of financial independence among fishermen, it seems not to have contributed significantly to the development of the infrastructure necessary to meet the country's ever-increasing need for protein. The consequences of such a narrow focus remain to be seen, but in 1978, the already low per-capita consumption of fish in the state was 1.6 per cent less than in 1976 (Diagnóstico, 1979: 90). This gains additional significance in view of the fact that scale-fish production in 1978 was the highest ever recorded, exceeding the 1976 production by some 225,000 kilos.

As part of the government's ambitious program to develop the fishery's infrastructure, processing plants have been built at Xcalak, Punta Allen, and Holbox. The plants are virtually identical, following a design drawn in Mexico City and used widely in other parts of the country. They are designed to produce ice for local fishermen and to serve as reception and processing centers. It is anticipated that these services will increase production, by allowing fishermen to spend more time fishing. But a seemingly frustrating combination of human and environmental factors have prevented the commencement of operations well beyond the projected starting dates in 1980. Some of these were apparently unforseen; others may have been forseen, but not resolved satisfactorily. Not the least of the problems seems to have been a lack of appreciation for the unique combinations of economic, social, biological, and general environmental characteristics of each site.

All the plants are in remote areas, and thus must be self-sustaining with respect to water and power. The plants are designed to produce five tons of ice per day, and thus require considerable amounts of fresh water. Freshwater supplies at Xcalak and Holbox were known to be inadequate. At Xcalak, a small desalinization plant was installed, while Holbox was to be supplied by a new pipeline to the mainland. This was scheduled for completion by early 1980, but in fact it never materialized. By July 1970, the Holbox plant was completed, but idle for lack of water. At the same time, the Xcalak facility was being readied for operation, but there was some concern about the ability of the desalinization plant to supply enough water because of its small capacity and because trained personnel to operate the machinery were not available.

All three plants are located some distance from the beach in recognition of the hurricane danger. However, it remains to be seen whether the standardized design is adequate to withstand the particular visissitudes of Quintana Roo's weather, with its torrential rains and hurricane force winds. The small desalinization plant at Xcalak is woefully exposed at an open site only 50 meters from the shore.

Since fish processed at these plants will be shipped by refrigerated truck, the roads leading to the settlements must be maintained. The roads leading in to Punta Allen and Xcalak are little more than bulldozed traces, and during the rainy season the low spots are often flooded. During the dry season trucks and cars are often seen buried up to their axles in loose sand. In many places, the roads pass very close to the beach, and in a hurricane would probably be breached.

Administrative problems have also appeared. Officials failed to

communicate with the cooperatives about the ownership and administration of the plants, and there was much resentment among the fishermen who felt that they had been given no real input in planning. In Holbox, many fishermen wondered aloud about the need for such a facility, especially since they had only recently invested their time and money in a salting station.

On Aquaculture

Another feature of the development program is an aquaculture station, begun at Puerto Morelos in 1978, and completed the next year. It was to begin commercial cultivation of reef fish, conch, and marine turtles, once preliminary studies were made. For a variety of reasons, very little progress has been made, and the whole facility was virtually idle in the summer of 1980.

Among the problems was the lack of adequately trained personnel. Apparently, there is a nationwide shortage, but also many may be reluctant to commit themselves to several years in Quintana Roo, which is viewed generally as a "hardship station." Although the federal government pays an extra allowance to technicians who come to the state, it is apparently insufficient to induce more than just a few.

The station's site has also hindered the beginning of operations. It is right on the beach, utterly exposed to the elements. To make matters worse, the beach vegetation in front has been chopped away, destabilizing a large dune and causing sand to drift into the compound, covering walkways and clogging drains. When a severe storm or hurricane eventually strikes, the ability of the station to withstand the high winds and storm surge will be tested severely. Already, hurricane Allen's

small surge flooded the pumping machinery, which had been installed in a small shed on the pier, incapacitating the entire facility. If this occurs during long-term experiments, or if the entire complex should be flooded by storm surge, research and production would obviously be dealt a serious blow.

The vulnerability of this location underscores the need for greater attention to detail by planners. In this instance, the prospects for success are handicapped severely as a result of planning by people who, albeit well motivated, did not devote sufficient attention to local conditions.

These problems associated with location may prove insurmountable. If so, the aquaculture station may be relegated ultimately to serving as a holding facility for small saltwater fish captured on nearby reefs and exported to the United States and Europe. This would be a sorry end for a project intended for scientific study of ways to increase the Mexican Caribbean's contribution to the country's effort to solve its food problem.

On Diving, Spearguns, and Gaffs

Some 60 to 70 per cent of all the lobster produced in Quintana Roo are captured using gaffs. Fishermen in the southern and central zones usually skin dive, most of the Isla Mujeres divers use SCUBA, and at Holbox they skin dive. The economics of skin diving make it attractive; credit is easily available at the beginning of the lobster season, and loans for the simple gear (mask, snorkel, and fins) can be repaid quickly with the proceeds from the first several lobsters.

Gaffs are inexpensive, and in experienced hands are very efficient.

However, they have a very important drawback; once a lobster is hooked, it is often wounded mortally. Should a diver discover that it is gravid, or undersized, it does little good to return it, and thus its potential contribution to the future catch is wasted. Spearguns share this drawback. In contrast, use of traps allows for closer inspection of the catch, and the opportunity to release unsuitable specimens unharmed.

There has been some controversy about the use of SCUBA to capture lobster, principally because some divers on Isla Mujeres have raided lobster traps. In 1968, the use of SCUBA for lobstering was prohibited, but by the early 1970's the rule was no longer being enforced. In 1975, fishermen were notified that the use of spearguns with SCUBA was forbidden, except as a means of protection against sharks. This regulation remains in effect but is widely ignored.

In 1979, there was some discussion among fishery officers about establishing separate areas for diving and trapping. At that time, trap fishermen were experiencing rather low returns, and were convinced that divers were picking their traps clean. Divers argued that neither the trappers or the packing plant which owned the equipment had any proof of this, that they were being singled out unfairly, and that some of the trap boat crews were selling on the black market, thus accounting for the decrease in captures. As of July 1980, no separation of areas had been made, and the owners of the packing plant had decided to reduce the number of boats they sponsered, accommodating only those fishermen who had been the most productive historically.

On Lobster Shelters

Lobster shelters have assumed an important role in exploitation of the resource. Since all indications are that the fishing effort will increase, it seems reasonable to conclude that the use of casitas will become more widespread. They are inexpensive to construct, and are paid for by the first captures. Their placement in nursery areas may be particularly appropriate if they contribute to a reduction in mortality rates, since where mortality rates and injury rates are low, juvenile lobsters grow rapidly (Waugh, 1981: 284; Davis, 1980: 58). Also, at least in the central zone where individuals have campos, their use has stimulated fishermen to become more concerned about illegal harvests.

However, shelters are not without their problematic aspects. In addition to problems of ownership and boundaries of campos, shelters compete with other technologies, draining capital and labor from other sectors of the fishery. For example, fishermen of the central zone acknowledge the potential of their area for a shark fishery, but have no plans to pursue this because any increase in sharks, attracted by the bait and chumming that traditionally accompany shark fishing, would obviously be dangerous to divers. Also, members of the Holbox cooperative have a long-standing feud with seiners from Yucatán who frequently snag shelters in their nets.

It seems clear that the use of shelters has hindered the diversification of the fishery in the central zone, where "Cozumel" and "Vígia Chico" specialize in lobster production. The main reason, of course, is the high price. While this specialization has proved quite profitable, it may not last. Shelters in shallow water are particularly vulnerable to hurricanes, and changes in water quality associated with inland

development may diminish the carrying capacity of nearshore nursery areas. If these areas are affected sufficiently, the lobster industry will collapse.

There are other potential biological problems. With respect to renewability of the resource, the long-term consequences of the use of shelters remain to be determined. Shelters may serve merely to concentrate existing stocks, facilitating overexploitation; or, their use may increase the carrying capacity of certain areas, thus increasing the number of lobsters which can be harvested. If the former is true, the number of shelters in nursery areas may have to be restricted to insure that enough lobsters survive to spawn.

Finally, the use of shelters in nursery areas has resulted in the increased capture of smaller lobsters and has led to reduction of the minimum tail size from 14.5 cm. to 13.5 cm. Fishermen of the central zone petitioned repeatedly for this reduction, which was eventually granted on a trial basis after a survey confirmed the predominance of smaller-sized lobsters in the area. In time, this became the legal limit for the entire state, owing to the absence of any apparent consequences, and in light of practical and political considerations.

Given the remarkable fecundity of the lobster, the size reduction may prove inconsequential. Nevertheless, the shelter system appears to be an extremely efficient capture strategy, particularly in nursery areas. Careful monitoring of stocks seems to be in order, regardless of whether recruitment of new stock is predominately local or from elsewhere. Patterns of recruitment may be altered as increasing numbers of shelters are deployed, and as harvesting pressure throughout the region is intensified.

On Hydrologic Constraints on Development

Along the coast, the dimunition of the aquifer during the dry season (November to April) may eventually present a serious obstacle to state and federal development programs. Shallow wells have historically produced adequate amounts of fresh water for domestic consumption during the wet season, but many are penetrated by salt water during the dry months. Lack of a reliable year-round source of fresh water remains a problem in many coastal areas, even those that are sparsely populated. In an effort to cope with periodic fresh water shortages, aguadas were lined with cement, and cisterns were constructed. Water was often transported from other areas. More recently, pipelines have been installed to bring water from inland sources, and desalinization plants have been set up at Cozumel and Xcalak.

It seems reasonable to conclude that as population densities increase, so will demands on the aquifer. Thus, the potential for water shortages will increase. In at least some areas, hydrogeological conditions apparently resemble those of karsted limestone areas in Bermuda, Puerto Rico, and Jamaica. These more densely populated islands have places which are chronically short of water due to infiltration and the discharge of large volumes of fresh groundwater to the sea (LeGrand, 1973: 861, 863).

All indications are that demand on the fresh water resources of Quintana Roo will increase. State and federal programs are underway for extensive development of coastal areas, particularly for tourism and fishing. Farther inland, schemes of massive forest clearance to open vast areas for large-scale mechanized and irrigated agriculture are underway. As a result of increasing demand for fresh water, the

pre-development hydrologic balance is being disrupted, the effects being both direct and indirect. For instance, high discharge pumping of wells has resulted in the contamination of low-discharge wells by pathogens and dissolved solids (Doehring and Butler, 1974: 592-595).

Consequently, interception of fresh water as it gets out to the sea would seem to make a good deal of sense. As LeGrand observes, writing of karst areas in general, fresh water represents "waste to the sea" and is "a serious problem because it deprives man and other life of the nourishment that water in the right place brings" (1973: 863). He further notes that "attempting to salvage this fresh water is not likely to have offsetting ecological problems" (Ibid.: 864).

At the first and most immediately pragmatic level of consideration, the feasibility of salvaging fresh water offshore depends on the quantity. Seasonal variation of flow may be a determining factor; it would be no small irony if during the dry season, the groundwater was so diminished as to render its use uneconomical.

Assuming that sufficient quantities of fresh water are expelled from the "ojos de agua" just offshore, the possibility of interception can be considered. LeGrand's assertion that interception of fresh water "is not likely to have offsetting ecological problems" deserves scrutiny, especially since he cautions that the natural hydrological balances in karst areas are easily disturbed, and that what is gained by changing the hydrology might have offsetting detremental consequences (Ibid.) On closer inspection, his statement that fresh water expelled to the sea is "waste" reveals a conspicuous land bias. He does not seem to have considered that a dimunition of fresh water expelled to the sea might upset seriously the marine ecology. Clearly, high stakes are

involved since the inshore waters are not only the most productive, but they are breeding grounds and refuge areas for the young of many species.

How might a gross disruption of the balance between hydrologic and ecologic conditions effect the marine resources of Quintana Roo? What would be the potential benefits or adverse consequences of altering the hydrology? Although there are no simple answers, some elements can be discerned. The most obvious result would be an increase of salinity in formerly brackish areas. Also, mineral nutrients, formerly brought to the shore and reef, would be lost.

Although we lack full understanding of how ecosystems would respond to such alterations, some basic principals are evident. We have learned that tropical marine ecosystems are fragile and easily disrupted (Moore, 1972: 218, 254-258). Based on this alone, it seems reasonable that interception has the potential to disrupt seriously the ecological balance of near-shore environments.

On the Vulnerability of Near-shore Areas

There is a fragile and intricate web of connections between organisms and their environments in near-shore areas. Maintenance of the fishery resource depends upon maintenance of each link of the ecologic chain. Experiences elsewhere demonstrate the propensity of development to disrupt coral reefs, mangrove forests and turtle grass beds.

Reefs are highly susceptible to changes in water quality associated with shoreside development. Activities known to have disrupted reef ecosystems include:

> increased dumping of sewage ... over fishing ... physical damage to the reef resulting from construction, dredging, dumping and landfills, [and] ... destruction of the reef on a large scale to provide tourists with souvenirs and coffee-

table curios (Goreau et al., 1979: 136).

Reefs in northern and central Quintana Roo have been subjected to the greatest pressure with regard to overfishing and souvenir hunting. There have been increases in turbidity which are obviously related to dredging and to microbial activity stimulated by sewer effluent. Clues to physical damage may already be apparent in the waters of Cancún, Puerto Morelos, and Cozumel. Efforts to intercept increasing amounts of fresh water at inland or shoreside sources for inland use would not seem to endanger reef ecosystems, but the long-term loss of mineral and organic nutrients would surely be detrimental. Increases in salinity or temperature caused by effluents of industrial or desalinization plants would clearly be traumatic (Farnworth and Golley, 1974: 97).

Destruction of mangrove forests lowers production in neighboring aquatic ecosystems, since the leaves, a major source of organic nutrients, are lost. In addition, habitat provided by the physical structure of the roots is removed. The mangrove forest in the northern end of the state is currently under the most pressure. A considerable amount of landfill has been made at Cancún, Puerto Juárez and Isla Mujeres, most of it associated with development for tourism. Around Puerto Morelos, former forest areas have been filled in to provide sites for homes and an industrial park. More land filling is underway in the Chetumal area. It remains to be seen whether forest clearance, agriculture, and industry will increase sedimentation to the point of coating root systems and killing trees. Mangroves are particularly susceptible since

> they possess aerial roots or pneumatophores which have air ducts leading to the deeper roots. When these ducts are clogged with sediment, the plants die within a few weeks (Farnworth and Golley, 1974: 195).

Oil spills can have a similar effect.

Since established mangrove depend on a high volume of runoff for decreased salinity, intercepting the flow would result in decreased productivity and biomass that contributes to food chains. It is possible of course, that the reduction of freshwater flow will stimulate mangrove growth farther inland; however, the gain in area by invasion of this new habitat may be compensated for by loss on its seaward margins. The long-term effects are difficult to predict. The Florida experience suggests that such a change might have negative consequences:

> When the fresh-water flow to the Everglades National Park was reduced, salinity increased in the estuary and the area covered by mangroves increased 70 percent in less than 20 years. At the same time, the shrimp fishery in Florida Bay was damaged because juvenile shrimp were not able to detect the greatly diminished streams of low-salinity water emanating from the lower estuary. The young shrimp were therefore unable to find their optimal nursery grounds (Farnworth and Golley, 1974: 192).

Turtle grass can be killed by disturbance of bottom sediments or alteration of sedimentation rates. While interception of fresh water might decrease harmful suspended sediments, mineral nutrients (e.g. nitrogen and phosphorus) would be diverted (Thayer et al., 1975: 293). The net effect would be a reduction of primary productivity and, as a consequence, a reduction in food available for higher trophic levels.

As new concentrations of human populations develop, there are new demands on the fresh water resources. Demand is also increased by agricultural and industrial development, as ever-increasing amounts of water are intercepted, Impacts of this are probably less readily detectable than those of direct interception at submarine outlets. Nevertheless, their long term effects may be as detremental as direct interception at submarine outlets.

The picture is clearly complicated, yet given what is known about

the karsted limestone platform, and what is known of the nearshore ecology, a worst-case hypothesis can be formulated. Domestic, industrial, and agricultural consumption of fresh water increase so that the resource is stretched to the ultimate. In irrigation, increasing amounts are lost by evaporation. Chemical and pathological contamination intensifies. The fresh water lens becomes more brackish due to high-discharge pumping from wells. Ultimately, diminished water quantity and quality render water from submarine outlets unusable. Widespread changes in the character of nearshore waters have catastrophic effects on the fishery.

This sequence, as well as its timing, are hypothetical, but some indicators are already visible. Personal observation and interviews with fishermen and other coastal folk indicate strongly that in areas nearest settlements, species distribution and community diversity have been altered. While these changes are often the result of selective predation by fishermen, more subtle effects can be discerned. For example, in many areas, coral appears to be generally unhealthy, populations of sea urchins have virtually exploded, and sampling has indicated that water quality has diminished (Doehring and Butler, 1974: 593; Estudio de Cancún e Isla Mujeres, 1978: 124; Estudio de Cozumel, 1978: 101, 127). Greater concentrations of nutrients, sediments, pathogens and toxins can be expected. Clearly, the ability of the ecosystem to support the marine resource will be tested severely.

Interception of fresh water at the shoreline may merely speed collapse of the fishery. If the relatively continuous flow of groundwater to the sea were reduced substantially, the first heavy rains would flush accumulated contaminants into offlying waters, resulting in a "super-shock" for shallow water organisms. Estuary and coral reef areas, those of highest

production, would be affected heavily. Food chains would be broken and life cycles disrupted. Areas nearest settlements would suffer earliest disruption, but eventually, few areas would escape. All this is in addition to impacts of over-use inland on the land-based economy.

On Conservation and the Alternative of Deepwater Fishing

Unless fishery officers are provided with more effective means to manage and regulate the state's marine resources, the overwhelming pressure of population increase will eventually severely diminish them. Stocks which are harvested routinely during their spawning aggregations are particularly vulnerable. As elsewhere (Craig, 1969: 252; Johannes, 1981: 81-84), the locations and timing of major spawning runs are well known to local fishermen. As Johannes suggests, surveillance of aggregations could provide important information on population size, and aid in determining whether regulation of the catch is necessary (Ibid.: 83). Also, since aggregations are limited to certain times of the year, and occur at specific locations, regulation of their exploitation may be accomplished easily (Ibid.: 82).

At some point, the focus of fishing effort may have to shift to deep water stocks, and to areas farther from shore, such as Arrowsmith Bank and the waters just north of Chinchorro Bank. Exploitation of these areas will require a considerable realignment of the fishery. Larger craft will be required, and additional harbors will have to be built, since from Punta Herrero south to Río Bacalar Chico there are no well sheltered anchorages. Also, fishermen feel little need to diversify their operations, since the vast majority are cooperative members and have exclusive access to lobster. Traditionally, they

have returned to shore after the day's fishing; few would care to stay at sea for at least several days at a time, as in deepwater fishing elsewhere.

CHAPTER VIII

SUMMARY

Examination of the historical record reveals that for some 400 years, coastal areas of Quintana Roo were virtually abandoned and the marine resources were relatively undisturbed. Prior to this time, the Maya may have exploited extensively the area's marine fauna. Also, they may have overharvested, particularly turtles, conch, and reef fish, even before the Late Classic (A.D. 600-888) when population was at its apparent zenith.

Effective resettlement of Quintana Roo did not begin until about the turn of the present century, and population growth was slow until recently. It was not until the mid-1970's that the current inhabitants outnumbered estimates of the Maya population at the time of first European contact (1511-1519).

Recent historical accounts, production data, and information from fishermen's oral histories reveal that massive and wholesale exploitation of the marine resources did not begin until after the middle of this century. Viewed in this perspective, the mobilization of effort to exploit the resource has been quite sudden. Already, the formerly abundant and easily accessible stocks of turtle, conch, and some reef-fish have declined drastically. Since all present indications are that the rate of exploitation will increase, the danger that other stocks will also be overharvested is readily apparent.

Further diminution of commercially important stocks may also result from the impacts of coastal development, manifested particularly in changes in the chemistry of nearshore waters which diminish their biological carry-

ing capacity. If sufficient, this impact on the fishery would be catastrophic, because it relies almost exclusively on species having all or some critical part of their life cycle in nearshore waters. For example, by value, lobster and shrimp accounted for some 75 per cent of the state's total capture in 1979. Shallow nursery areas are critical for these creatures. The abundance of these and other stocks is related clearly to relatively stable conditions which have allowed the physical, chemical, and biotic features of the current ecosystem to evolve.

Current development programs being implemented in Quintana Roo have generated a momentum which has not been confronted sufficiently by concerns over environmental consequences or constraints. Planners have operated in a relative vacuum with respect to information on the historical evolution of the fishery, and the basic relations among the physical, chemical, and biotic phenomena which support it. Lack of information has led not only to the expediency of short-term political and economic objectives; it has diminished long-term prospects for successful development and management of the fishery. It is already apparent that some unrealistic capital investments and project site selections have been made, and that unrealistic goals have been established. In the future, careful planning and management of the fishery's development will be necessary to avoid costly mistakes, and to assure that the ability of the fishery to sustain high annual yields will not be compromised. If yields were to fall significantly, the resulting unemployment and loss of an important source of protein would aggravate further Mexico's potentially explosive situation of high unemployment and population pressure, which are already stretching the country's food resources to the limit.

NOTES

CHAPTER I. INTRODUCTION

1. Based on 23 pesos to 1 United States dollar, the approximate exchange rate in 1980. This rate is used throughout the study.

CHAPTER II. THE FISHERY BEFORE SPANISH CONTACT

1. For a detailed commentary regarding population change in Quintana Roo since the time of first contacts through the mid-1950's see Edwards (1957), Part II, pp. 110-182.

2. Tozzer notes that "it is impossible to identify several of the fish that follow" and that "trout and bream are not found in Central America" (see note 996, p. 190). These statements are not entirely correct. For example, spotted seatrout (Cynoscion nebulosus; locally known as corvina) are abundant along the northeast coast, and might easily be mistaken for a freshwater trout, which Tozzer apparently thought Landa was referring to. I have found it necessary to substitute some of Tozzer's identifications with my own based on information provided in Relaciones (1898).

3. This identification is uncertain; Tozzer translates the text to read "pike" but notes (1001, p. 190) "there is a possibility it is tollos, "dogfish." Given the context, the latter seems a preferrable interpretation. Small sharks (cazón) are quite abundant in the shallow waters of the coast. The statement that some "are wonderfully wholesome and very different in their heads from the others, for they have round heads and very flat ones, enough to surprise one, and they have their mouth in the part inside and their eyes at the edge of the round part" (p. 190) probably refers to the bonnethead shark (Sphyrna tiburo).

4. Information contained in the Relaciones de Yucatán cannot be accepted uncritically; for commentary regarding their reliability see Edwards, 1975.

5. Landa also provides an account of the use of a gore to capture a crocodile, but from the context of the commentary (Tozzer, 1941: 192) it is not certain whether the Maya used the technique prior to their contact with Europeans.

CHAPTER IV. ANTECEDENTS OF THE MODERN FISHERY

1. The locations of these sites are depicted on the British Hydrographic Office Chart 1785 (West Indies, Yucatán: Spiritu and Ascension Bays). The "fishing establishment" in Ascensión

Bay is described as consisting of "fishing huts, large and conspicuous."

2. Although many of the fish captured were kingfish (Scomberomorus cavalla), it seems reasonable to assume that Spanish mackerel (S. maculatus) were also part of the catch. The latter are more common in the area, and when salted could be passed easily as kingfish.

CHAPTER V. THE CONTEMPORARY FISHERY

1. Mexico's inshore fisheries were declared to be under federal jurisdiction by the Ley Federal de Cooperativas, 1933 (McGoodwin, 1980: 41). However, federal control over the Quintana Roo fishery was assumed gradually because of its remote location and relatively inconsequential volumes of production. Prior to the 1933 law, and before the Revolution (1910-1924), the Diaz administration (1876-1911) granted liscenses for exploitation of marine products (Ibid.). Presumably, the sponge fishing companies which Lloyd notes worked from Cozumel (1915: 234-236) had such liscenses.

2. Solís (1966: 12) states that these were actually crocodiles, possibly Cocodrylus acutus (Cuvier).

3. Bully nets, or chapingorros, are small round nets on long poles. They are effective to a depth of about 3.6 meters.

4. As is the case elsewhere, lobsters are cleaned away from the lobster grounds. In 1974, Vigía Chico cooperative members passed a resolution calling for a fine of 1,000 pesos to be levied against anyone surprized throwing lobster heads into the sea.

5. It is reasonable to assume that cost factors helped to provoke the change.

6. This practice is not without risk because of sharks. The activity is limited mostly to areas where visibility is good.

7. Ramos (1974b) reports that in the mid-1970's, Holbox fishermen were using a short-point harpoon tip, called a pega, which would penetrate a turtle's shell, but not injure it seriously. This allowed it to be kept live until time for butchering or shipment. When talking with fishermen of the area in 1980, I was told that only a few still carried such harpoons.

8. This problem seemed to be coming to a head in 1980, after "Patria y Progreso" was notified that it had obtained a credit of 1.5 million pesos (≈65,000 U.S.) from the Bank of Mexico for shelter construction.

9. In October and November, lobsters removed from shelters are generally smaller and of a dark green color. Lobsters captured in December are usually large. The reasons for these differences are uncertain.

10. The timing of fish runs are not entirely predictable; peak periods suggested here conform to my observations, the experiences of fishermen, and a survey of available production records.

CHAPTER VI. PRODUCTION TRENDS AND PRODUCT DESTINATIONS

1. According to fishermen, the epoca de arribazón occurs after the last full moon of the year. I am currently gathering details regarding the exact timing of the event, and its association with a phase of the moon. In addition to the massing at Mahahual, other aggregations are said to occur at Banco Chinchorro, off a point near Playa del Carmen, and along a shoal off Holbox. Other concentrations probably occur, and some are closely guarded fishermen's secrets.

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APPENDIX I

SCIENTIFIC AND COMMON NAMES OF MARINE FAUNA CAPTURED COMMONLY, AND NOTES ON THE AREAS WHERE THEY ARE ENCOUNTERED FREQUENTLY.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Sharks and Rays (Chondrichthyes: Elasmobranchii)	
Carcharinus leucas (Valenciennes)	Bull shark; curro; probably the most frequently captured shark, all zones. Considerable numbers are caught off Holbox from March to May.
Carcharhinus limbatus (Valenciennes)	Blacktip shark; jaquetón; all zones.
Carcharhinus maculipinnis (Poey)	Spinner shark; jaquetón; north and central zones.
Carcharodon carcharias (Linnaeus)	Great white shark; tiburón blanco; said to be infrequently captured in offshore areas, north zone.
Ginglymostoma cirratum (Bonnaterre)	Nurse shark; gata; mis-cay? abundant in all zones, frequently encountered in shallow reef areas. A docile shark, but when disturbed it will often try to bite - capable of causing a severe wound. Fishermen treat even small gatas with care.
Galeocerdo cuvieri (Peron and Lesueur)	Tiger shark; tintorerra; tigre; considerable numbers are often captured in north zone during the spring.
Isurus oxyrinchus (Rafinesque)	Shortfin mako; tutzún?, jaquetón?, dentuzo, north and central zones.
Negaprion brevirostris (Poey)	Lemon shark; tiburón amarillo; kan-xoc (canxoc); all zones.
Sphyrna mokarran (Ruppell)	Great hammerhead; cornuda; divers consider this a very agressive shark, all zones.
Sphyrna tiburo (Linnaeus)	Bonnethead shark; chata; north and central zone.
Aeobatus narinari (Euphrasen)	Spotted eagle ray; raya pinta; often encountered in shallow waters of north zone.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Manta birostris (Walbaum)	Atlantic manta; manta lisa; manta raya; north zone.
Pristis pectinata (Latham)	Smalltooth sawfish; pez sierra; north zone.
Pristis perotteti (Müller and Henle)	Largetooth sawfish; pez sierra; pez blanco; said to be captured in the north zone.

Bony Fishes (Osteichthyes)

Elops sarus (Linnaeus)	Ladyfish; tzo-tzín; often captured in gillnets set in shallow waters of north zone. Used for bait.
Albula vulpes (Linnaeus)	Bonefish; macabí; often occurring in large schools on turtle grass flats, all zones.
Jenkinsia lamprotaenia (Gosse)	Dwarf herring; sak (saak?); all zones.
Sardinella anchovia (Valenciennes)	Spanish sardine; sardina; all zones.
Harengula pensacolae (Goode and Bean) or Harengula jaguana (Poey)	Scaled sardine; sardina; all zones.
Synodus intermedius (Spix)	Sand diver; bul-cay?; sometimes captured by handliners in central zone.
Arius felsi (Linnaeus)	Sea catfish; bagre; box-cay; north and south zones, particularly abundant in Chetumal Bay.
Holocentrus ascensionis (Osbeck)	Squirrelfish; Ojon; pez diablo; candil?; handliners fishing near reefs often land these - they handle them quite gingerly since wounds from their spines take a very long time to heal, all zones.
Centropomus undecimalis (Bloch)	Snook; robalo; abundant in lagoons of north zone, infrequently captured in south zone.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Epinephelus adscencionis (Osbeck)	Rock hind; calico grouper; cabrilla; common on offshore reefs and snapper banks, all zones.
Epinephelus cruetatus (Lacepede)	Grasby; cabrilla; payaso; common on shallow reefs, occasionally offshore, all zones.
Epinephelus guttatus (Linnaeus)	Red hind; cabrilla; offshore reefs, common in all zones.
Epinephelus itajara (Lichtenstein)	Jewfish; cherna; common near-shore reefs and near rock ledges, large specimens are frequently taken by SCUBA divers using spearguns.
Epinephelus morio (Valenciennes)	Red grouper; mero; abundant on snapper banks of north zone. Probably the msot frequently captured grouper of all zones.
Epinephelus striatus (Bloch)	Nassau grouper; mero criollo; common along shallow water reefs of all zones.
Mycteroperca bonaci (Poey)	Black grouper; negrillo; sometimes abadejo; shallow and offshore reefs of all zones.
Mycteroperca tigris (Valenciennes)	Tiger grouper; abadejo; monacin?; occastionally speared by skin-divers near shallow reefs, north and central zones.
Mycteroperca venenosa (Linnaeus)	Yellowfin grouper; abadejo; abundant near broken limestone bottom and shelves, all zones.
Malacanthus plumieri (Bloch)	Sand tilefish; corvinato; pez chile?; frequently captured over sandy bottoms in offshore areas, all zones.
Alectis crinitus (Mitchill)	African pompano; pampano de hebra; infrequently captured offshore of central zone.
Caranx fusus (Geoffroy Saint-Hilaire)	Blue runner; cojinuda, cojinuda blanca; frequently seen around shallow water reefs, all zones.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Caranx hippos (Linnaeus)	Crevalle; common jack; jurel; probably the most commonly captured jack, shallow waters, all zones.
Caranx latus (Agassiz)	Horse-eye jack; jurel; shallow waters central and north zones.
Caranx ruber (Bloch)	Bar jack; cojinuda; cojinuda rayada; occasionally seen near shallow reefs, all zones.
Selene vomer (Linnaeus)	Lookdown; papelillo; jorobado; inshore areas, north zone.
Seriola dumerili (Risso)	Greater amberjack; coronado; coronado blanco; sometimes esmedregal. The most frequently captured amberjack; north and central zones. Considerable numbers of juveniles are seen in Bahía Ascensión.
Seriola rivoliana (Valenciennes)	Almaco jack; coronado; coronado negro; occasionally captured in central zone.
Trachinotus carolinus (Linnaeus)	Florida pompano; pompano; inshore areas of north zone. Most abundant from February through April.
Trachinotus goodei (Jordon and Evermann)	Palometa; longfinned pompano; palometa; shallow areas of north zone.
Vomer setapinnis (Mitchell)	Atlantic moonfish; corcovado; shallow areas of the south zones.
Coryphanena hippurus (Linnaeus)	Dolphin; dorado; offshore areas of central and north zone. Particularly abundant between Cozumel and mainland.
Lutjanus analis (Cuvier)	Mutton snapper; pargo mulato; pargo colorado; occasionally seen near shallow reef of north zone.
Lutjanus apodus (Walbaum)	Schoolmaster; kán-xik; abundant in shallow nearshore waters, all zones.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Lutjanus campechanus (Poey)	Red snapper; huachinango (also guachinango); abundant on offshore reef of north zone, possibly also in central zone.
Lutjanus cyanopterus (Cuvier)	Cubera snapper; cubera; infrequently seen near areas of limestone shelf, north and central zone. A wary fish, difficult for divers to approach close enough to spear.
Lutjanus griseus (Linnaeus)	Gray snapper; mangrove snapper; black snapper; pargo mulato; possibly the most frequently captured shallow water snapper, in late September and October they form large schools and are easy targets for spearfishermen. All zones.
Lutjanus jocu (Bloch and Schneider)	Dog snapper; huachinango; frequently captured near shelves of rocky shoreline, all zones.
Lutjanus mahogoni	Mahogony snapper; pargo lunar?; often seen in small schools near rocky areas, all zones.
Lutjanus synagris (Linnaeus)	Lane snapper; candy snapper; biajaiba , frequently captured on offshore snapper banks, north and central zone.
Lutjanus vivanus (Jordan)	Silk snapper; huachinango amarillo; said to be captured occasionally by handliners in south zone.
Ocyurus chrysurus (Bloch)	Yellowtail snapper; rubia; canane; often seen individually near shallow reefs, frequently captured by handliners offshore, all zones but most abundant in north zone.
Rhomboplites aurorubens (Cuvier)	Vermilion snapper; bastard snapper; ?; occasionally on offshore reefs of north zone.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Diapterus plumieri (Cuvier and Valenciennes)	Irish pompano; mojarrita, chigua?; nearshore waters of south zone.
Gerres cinereus (Walbaum)	Yellowfin mojarra; mojarra; mopich; shallow nearshore waters, all zones.
Anisotremus surinamensis (Bloch)	Black margate; zapatero; candil; chonbo?; han-kay?; rocky bottom and shallow reef areas of central and south zone.
Anisotremus virginicus (Linnaeus)	Porkfish; margarita; xcampu?; inshore reef areas, central and south zone.
Haemulon aurolineatum (Cuvier)	Tomtate; chankay; dorado; reef areas of central and south zones.
Haemulon macrostomum (Gunther)	Spanish grunt; chac-chí rayado; dorado; shallow water reef areas of south and central zones.
Haemulon melanurum (Linnaeus)	Cottonwick; dorado; shallow water reef areas of central and south zones.
Haemulon sciurus (Shaw)	Bluestriped grunt; chac-chí; dorado; shallow water reef areas of all zones.
Cynoscion nebulosus (Cuvier)	Spotted seatrout; speckled trout; corvina; inshore areas of north zone, conspicuously absent from central and south zones.
Pogonias cromis (Linnaeus)	Black drum; tambor; shallow waters of north zone.
Mulloidichthys martinicus (Cuvier)	Yellow goatfish; barbaros; chihua?; reef areas of all zones.
Chaetodipterus faber (Broussonet)	Atlantic spadefish; chabela (chaveleta?); rocky shoreline of central zone. Occasionally speared by skindivers.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Lachnolaimus maximus (Walbaum)	Hogfish; boquinete; pez perro; abanderado; frequently taken by spearfishermen in all zones, near reefs and rocky bottom.
Scarus coeruleus (Bloch)	Blue parrotfish; pez loro; occasionally speared by divers near reefs or rocky shoreline, north and central zones.
Scarus guacamaia (Cuvier)	Rainbow parrotfish; pez loro; occasionally speared by divers near reefs or rocky shoreline, north and central zones.
Mugil cephalus (Linnaeus)	Striped mullet; lisa; taken by seine, gillnet and cast net fishermen in shallow waters of north and central zones. Large runs often occur in the fall, after the first heavy rains. Also captured in fishtraps of south zone.
Mugil curema (Valenciennes)	White mullet; liseta; less abundant than the striped mullet, but taken by similar means, all zones.
Sphyraena barracuda (Walbaum)	Great barracuda; picuda; barracuda; shallow reef areas and open waters, all zones.
Acanthocybium solanderi (Cuvier)	Wahoo; peto; carito.; offshore areas of north zone.
Scomberomorus maculatus (Mitchell)	Spanish mackerel; sierra; shallow waters and offshore areas of north and central zones.
Balistes capriscus (Gmelin)	Grey triggerfish; cochino blanco; escochin; sandy or hard bottom areas of all zones.
Balistes vetula (Linnaeus)	Queen triggerfish; cochino azul; escochin; sandy or hard bottom areas of all zones.
Melichthys niger (Bloch)	Black durgon, black triggerfish; escochin; sandy or hard bottom areas of central zone, possibly in other zones as well. Less frequently captured.

SCIENTIFIC NAME	COMMON NAMES AND NOTES
Mollusks	
Strombus gigas (Linnaeus)	Queen conch; caracol; nearshore sandy bottom areas, all zones.
Octopus sp.	Octopus; pulpo; nearshore areas of north and central zones. Often taken from empty conch shells.
Loligo sp.	Squid; calamar; frequently seen in small groups near shallow reefs of north and central zones.
Crustaceans	
Penaeus brasiliensis (Latreille)	Red shrimp; camarón rojo; offshore areas of north zone.
Sycyonia brevirostris (Stimpson)	Rock shrimp; camarón de roca; offshore areas of north zone. About 70% of the commercial capture (Arreguín-Sánchez, 1981).
Panulirus argus (Latreille)	Spiny lobster; langosta; nearshore and offshore reefs and rocky areas, all zones.
Sea Turtles	
Caretta caretta (Linnaeus)	Loggerhead turtle, cahuamo; tortuga cahuamo; nearshore areas, all zones.
Chelonia mydas (Linnaeus)	Green turtle; tortuga; tortuga blanca; tortuga verde; nearshore areas, all zones.
Eretmochelys imbricata (Linnaeus)	Hawksbill turtle; tortuga de carey; nearshore areas, all zones.
Dermochelys coriacea (Boulenger)	Leatherback turtle; chalupa; ting-lao?; offhsore areas, north zone. Infrequently encountered.

APPENDIX II

1979 SEASONS, SIZE LIMITS AND QUOTAS

Seasons

Specie	Closed season
Lobster	16th March to 16th July
Green turtle	16th May to 15th August
Loggerhead turtle	16th May to 15th August
Hawksbill turtle	No open season; capture prohibited

Size Limits

Specie	Minimum size
Lobster	13.5 cm tail length
Green turtle	.75 meters carapace length
Loggerhead turtle	.60 meters carapace length
Black coral	2.5 cm in diameter at base of branch; 1.5 meter branch length

Quotas

Conch	Amount
"Xcalak"	6 tons per month
"Vigía Chico"	2 tons per month
"Cozumel"	2 tons per month
"Patria y Progreso" and "Caribe"	4 tons per month
"Holbox"	2 tons per month
Black coral	50 kilos per month

Source: Diagnóstico, 1979.

APPENDIX III

BEACH WEIR LOCATIONS IN 1978 ACCORDING TO PERMIT APPLICATIONS FILED IN THE CHETUMAL FISHERIES OFFICE

	Petitioner	Description and Location
1.	David Villanueva Catzin	"one 'red de alambre de corazón y cola' of 115 meters, which will be installed 400 meters from Punta Kulche"
2.	Melchor Villanueva Catzin	"[one 'trampa de alambre de corazón y cola' of 115 meters] which is installed at Punta Rompe Olas"
3.	_____	"another 200 meters to the north of Tampalam"
4.	Victor Salazar	"one 'trampa de corazón y cola' of 115 meters which is installed at the ranch named San Andres, north of Tampalam"
5.	Melchor Villanueva Catzin	"one 'trampa de alambre de corazón y cola' of 115 meters which is installed south of Tampalam"
6.	Leonídez Águilar Villanueva	"one 115 meter long wire trap which is installed 16 kilometers from Punta Guesa [Gruesa?] "
7.	_____	"another to the north of Xcalak, 200 meters long at the Ensenada de Punta Gruesa"
8.	Eloy Salazar Young	"one ['trampa de corazón y cola'] of 115 meters of wire which is installed 200 meters from the one installed by Nemesio Salazar Y."
9.	Nemesio Salazar Young	" one ['trampa de corazón y cola'] of 115 meters which is installed at Rancho Punta Guesa"
10.	Jorge Pérez Vásquez	" one ['trampa de corazón y cola'] which is installed at Punta Ubero"
11.	Nemesio Salazar Young	"one 'trampa corazón y cola' of 115 meters which is installed at the southern end of Punta Ubero"

12.	[Ramiro Gonzales]	[see mention of this trap in subsequent description]
13.	Ubaldo Cárdenaz	"one 'trampa de corazón y cola' of 115 meters which is installed in Placer, 300 meters south of the one which Sr. Ramiro Gonzales owns"
14.	Joaquín Fernández Vivas	"[one 'trampa de corazón y cola' of 115 meters] which is installed near Rancho San Antonio, 'sin perjudicar ningun companero'[without damage to any other fisherman]"
15.	Laureano Águilar T.	"one trap, 200 meters long, in front of 'el Rancho del St. Augusto Aguilar' [?]"
16.	Joaquín Fernández Vivas	"one 'trampa de corazón y cola' of 115 meters which is installed to the north of Río Indio"
17.	Augustín Balun Cusheb	"one 'trampa de corazón y cola' of 115 meters of wire which is installed at Rancho Majagual [Mahahual]"
18.	_____	" another which is installed at the point named 'dos de Abril'"
19.	Mateo Mindez Dzul	"one 'trampa de corazón y cola' which is installed at San Isidro, 20 kilometers to the north of Xcalak" [see note in following description]
20.	_____	"another to be installed in Shawaxola Punta Xhuaxhol , 30 kilometers to the north of Xcalak" [Punta Xhuaxol is 29 kilometers north of Xcalak; San Isidro, about 30. The 20 kilometer distance given in the preceeding location statement is an error which may have occurred during transcription of the data]
21.	Eiplén Rivero Pérez	"one 'trampa de corazón y cola' of 115 meters of wire which is placed at Rancho Tankela (Ensenada Tan-quila)"
22.	_____	"another, 200 meters from the first"
23.	Nadir León Rosado	"one 'trampa de corazón y cola' of 115 meters of wire, which is installed north of Punta de Río Huach"

24.	Carlos Molina Ucan	"one trap installed at Punta Piten Pich [Petenpich], 1,000 meters in length, situated in front of Rancho Santa Rosa" [if the 1,000 meter figure is accurate, then this is the largest weir along the coast. However, caution is in order, since the figure may be the result of an error in transcription, or merely a bad estimate]
25.	_____	"another which is installed at the point named 'las cruces al Norte de Xcalak' one kilometer in distance from the Rancho Santa Rose, which is my property"
26.	Juan Rivero Pérez	"one 'trampa de corazón y cola' which is installed 16 kilometers to the north of Xcalak, between Rancho Hogna Hom nah and Excayal [Xcayal]"
27.	Leonídez Águilar Villanueva	"one trap or 115 meters of wire which is installed south of the 'Region de Hogna [Hom nah]"
28.	Teófilo Herrera Vivas	"[one 'trampa de corazón y cola'] of 200 meters which is installed at the 'Punta de Hogna'"
29.	_____	" another of 115 meters which is installed at a place called 'Subida de Hogna [south of Hom nah]
30., 31.	Jorge Pérez Vásquez	"two 'trampas de corazón y cola' which will be installed, one at Punta Gavilan, and the other at Hogna, 'sin molestar a ningun companero'"
32.	Telesforo Ortia Kuc	"one 'trampa de corazón y cola' which is installed at a place named 'subida del blanquisar' [north of Siete Cocos]"
33.	_____	"(another) at Rancho Siete Cocos"
34.	Luis F. Rivero Pacheco	"two 'trampas de corazón y cola', one at the point named 'Norte de Xcalak', 200 meters in distance from Rancho Santa Anita"
35.	_____	"the other trap installed at Rancho Santa Anita"

36.	Fortunato Herrera Muñoz	"one 'trampa de corazón y cola' of 115 meters which is installed at the Punta de Chelen, 2,400 meters south of Xcalak"

APPENDIX IV

TOTAL AND REGIONAL PRODUCTION, 1955 - 1979, WITH NOTES ON SOURCES

Note:

The following production data are based principally on monthly production reports from Quintana Roo fisheries offices. Individual product registrations have been converted to "landed weight" status when necessary according to the following formulas:

Whole lobster wt. x .67 = tail ("sin cabeza" or headless) wt.

Whole shrimp wt. x .67 = tail ("sin cabeza") wt.

Whole turtle wt. x .25 = fillet wt.

Fish fillet wt. x 3 = whole ("entero" or gutted) wt.

Salted and dried fish wt. x 1.67 = whole ("entero") wt.

These conversion "factors" have been used by Pesca offices since the mid-1960's to compute the taxes to be paid on registered catches.

Monthly production records for Isla Mujeres from 1955 to 1979 are located at that island's fisheries office. In addition, at the same office are located Cozumel records from 1955 to 1961, and Chetumal records from 1955 to 1960. Cozumel's records from 1962 to 1971 have been apparently lost, as have Chetumal's records from 1961 to 1976. Cozumel records from 1972 to 1979 are located at that island's fisheries office. Chetumal records from 1977 to 1979 are located at that city's fisheries office. Holbox production records for the years 1972 (when that island's office began functioning) to 1979 are at the Isla Mujeres fisheries office. A Cancún office was opened in 1977, and production records beginning with that year are located in that city's office.

1955

	North	Central	South[1]	Total
Lobster	3,268.85	.00	.00	3,268.85
Turtles	37,350.00	5,616.00	.00	43,066.00
Scale fish	29,718.35	10,091.70	1,825.00	41,635.05
Shark	6,062.70	.00	.00	6,062.70
Total	76,399.90	15,707.70	1,825.00	93,932.60
L/F Ratio	1.13	.50	.00	.97

1956

	North	Central	South	Total
Lobster	7,118.14	.00	164.50	7,282.64
Conch	.00	.00	270.00	270.00
Turtles	15,760.00	31.25	100.00	15,891.25
Scale fish	63,765.88	12,204.20	34,165.65	110,135.73
Shark	52,234.55	.00	.00	52,534.55
Total	138,878.57	12,235.45	34,700.15	185,814.17
L/F Ratio	.19	.00	.01	.14

1957

	North	Central	South	Total
Lobster	10,390.19	.00	217.75	10,607.94
Conch	23.00	.00	930.00	953.00
Turtles	26,996.40	3,643.75	925.00	31,565.65
Scale fish	23,604.02	11,832.00	38,097.00	73,533.02
Shark	31,355.77	201.00	.00	31,556.77
Total	92,369.88	15,676.75	40,169.75	148.216.38
L/F Ratio	.68	.30	.05	.41

1958

	North	Central[2]	South[3]	Total
Lobster	11,883.69	589.43	432.50	13,008.62
Conch	.00	80.00	2,070.00	2,150.00
Turtles	17,539.10	550.00	.00	18,089.10
Scale fish	24,000.62	19,996.50	35,144.00	79,141.12
Shark	14,606.90	1,603.20	.00	16,210.10
Total	68,030.31	22,919.13	37.649.50	128,598.94
L/F Ratio	.76	.06	.07	.34

1959

	North	Central	South	Total
Lobster	10,264.20	666.82	80.40	11,011.47
Conch	.00	.00	1,195.00	1,195.00
Turtles	19,950.00	2,720.00	175.00	22,845.00
Scale fish	45,296.08	19,726.44	24,648.75	89,671.27
Shark	32,145.30	7,646.00	.00	39,791.30
Total	107,655.58	30,759.31	26,099.15	164,514.04
L/F Ratio	.39	.01	.05	.27

1960

	North	Central[4]	South[5]	Total
Lobster	12,486.79	5,125.00	2,684.00	20,295.79
Conch	196.00	1,123.00	4,853.00	6,172.00
Turtle	76,165.00	16,280.00	1,531.25	93,976.25
Scale fish	40,810.30	36,227.90	32,758.10	109,796.30
Shark	23,542.04	6,865.96	.00	30,408.00
Total	153,200.13	65,621.86	41,826.35	260,648.34
L/F Ratio	1.38	.52	.270	.85

1961

	North	Central[6]	South[7]	Total
Lobster	18,648.69	18,638.00	18,232.10	55,518.79
Conch	95.00	3,538.00	3,080.00	6,713.00
Turtles	56,970.00	10,937.96	.00	67,907.96
Scale fish	52,407.06	27,568.00	25,549.74	105,524.80
Shark	12,627.72	9,507.05	.00	22,134.77
Total	140,748.47	70,189.01	46,861.84	257,799.32
L/F Ratio	1.16	.89	.83	1.01

1962

	North	Central and South[8]	Total[9]
Lobster	30,260.99	78,751.87 [10]	109,012.86
Conch	488.00	9,529.00 [11]	10,017.00
Turtle	100,805.00	26,180.50	126,985.50
Scale fish	41,795.00	140,338.90	182,133.90
Shark	14,326.00	38,014.15	52,340.15
Total	187,674.99	292,814.41	480,489.41
L/F Ratio	2.34	.64	1.04

1963

	North	Central and South[8]	Total[9]
Lobster	19,772.83	63,553.88 [12]	83,326.71
Conch	221.00	5,796.00 [13]	6,017.00
Turtle	14,995.00	2,662.50	17,657.50
Scale fish	58,869.77	181,237.67	240,107.44
Shark	23,277.62	13,336.43	36,614.05
Total	117,136.22	266,586.48	383,722.70
L/F Ratio	.42	.37	.38

1964

	North	Central and South[8]	Total[9]
Lobster	17,609.46	52,076.56 [14]	69,686.02
Conch	27.00	5,545.00 [15]	5,572.00
Turtle	38,782.50	15,400.50	54,183.00
Scale fish	69,024.36	106,558.64	175,583.00
Shark	8,539.36	7,748.15	16,287.51
Total	133,982.68	187,328.55	321,311.53
L/F Ratio	.72	.63	.67

1965

	North	Central and South[8]	Total[9]
Lobster	19,930.00	38,359.00	58,289.00
Conch	.00	5,818.00	5,818.00
Turtle	54,055.00	465.75	54,520.75
Scale fish	124,755.24	129,820.93	254,576.17
Shark	18,369.05	1,726.06	20,095.11
Total	217,109.29	176,189.74	393,299.03
L/F Ratio	.51	.33	.43

1966

	North	Central and South[8]	Total[9]
Lobster	13,305.00	43,168.00	56,473.00
Shrimp	8,873.10	64.00 [16]	8,937.10
Conch	286.00	8,255.00	8,541.00
Turtle	29,500.50	.00	29,500.50
Scale fish	43,645.40	183,650.99	227,296.39
Shark	17,611.37	695.17	18,306.54
Total	113,221.37	235,833.16	349,054.53
L/F Ratio	.84	.27	.42

1967

	North	Central and South[8]	Total[9]
Lobster	51,617.11	48,677.46	100,294.57
Shrimp	4,832.00	.00	4,832.00
Conch	227.00	10,182.00	10,409.00
Turtle	28,624.00	.00	28,624.00
Scale fish	42,152.63	254,813.47	296,966.10
Shark	13,463.67	525.52	13,989.19
Total	140,916.41	314,198.45	455,114.86
L/F Ratio	1.53	.23	.46

1968

	North	Central and South[8]	Total[9]
Lobster	54,957.04	74,211.93	129,168.97
Shrimp	2,640.00	.00	2,640.00 [17]
Conch	.00	11,246.00	11,246.00
Turtle	54,230.87	.00	54,230.87
Scale fish	36,184.17	263,861.76	300,045.93
Shark	24,792.80	167.00	24,959.80
Total	172,804.88	349,486.69	522,291.57
L/F Ratio	1.83	.32	.60

1969

	North	Central	South	Total
Lobster	86,487.26	24,775.93 [18]	30,047.50	141,310.69 [20]
Shrimp	16,015.00	.00	.00	16,015.00 [20]
Conch	100.00	.00	9,855.00	9,955.00
Turtle	31,807.96	.00	1,200.00	33,007.96 [20]
Scale fish	70,987.70	83,838.02 [19]	127,329.50	282,155.22
Shark	16,977.36	100.00 [19]	.00	17,077.36
Total	222,375.28	108,713.95	168,432.00	499,521.23
L/F Ratio	1.52	.29	.32	.66

1970

	North	Central	South	Total
Lobster	106,189,34	17,858.00 [21]	12,042.80	136,095.14 [23]
Shrimp	16,066.72	.00	.00	16,066.72 [23]
Conch	.00	4,116.00 [22]	9,617.00	13,733.00
Turtle	52,698.59	.00	.00	52,698.59 [23]
Scale fish	54,317.59	100,447.32 [22]	154,298.75	309,063.66
Shark	15,076.38	.00	.00	15,076.38
Total	244,348.62	122,421.32	175,963.55	542,733.48
L/F Ratio	2.52	.21	.14	.67

1971

	North[24]	Central[26]	South[26]	Total
Lobster	191,247.00	65,000.00	24,000.00	280,247.00
Shrimp	104,213.40 [25]	.00	.00	104,213.40
Conch	11,561.00	3,100.00	18,427.00	33,088.00
Turtle	4,231.25	.00	50.00	4,281.25
Scale fish	445,832.43	60,410.92	163,146.05	669.389.40
Shark	34,021.36	.00	.00	34,021.36
Total	791.106.44	128,510.92	205,623.05	1,125,240.41
L/F Ratio	.64	1.12	.26	.59

1972

	North	Central	South[28]	Total
Lobster	91,177.36	61,496.62	20,994.08	173,668.06
Shrimp	117,994.42	.00	.00	117,994.42
Conch	3,740.00	6,637.00	66,559.00	76,936.00
Turtle[27]	.00	.00	.00	.00
Scale fish	470,201.15	62,974.50	166,831.64	700,007.28
Shark	27,445.92	.00	.00	27,445.92
Total	210,558.84	131,108.12	254,384.72	1,096,051.67
L/F Ratio	.42	1.08	.52	.50

1973

	North[29]	Central	South[28]	Total
Lobster	134,650.09	48,976.00	25,786.81	209,412.90
Shrimp	112,648.13	.00	.00	112,648.13
Conch	23,066.00	15,589.00	122,920.00	161,575.00
Turtles	25,278.00	.00	.00	25,278.00
Scale fish	271,148.20	95,874.00	195,455.54	562,477.73
Shark	19,072.54	30.00	.00	19,102.54
Total	585,862.95	160,469.00	344,162.35	1,090,494.30
L/F Ratio	1.01	.67	.76	.87

1974

	North	Central	South[28]	Total
Lobster	210,419.62 [29]	49,457.61	23,833.26	283,710.49
Shrimp	144,509.60	.00	.00	144,509.60
Conch	8,121.00	10,458.00	168,198.00	186,777.00
Turtle	18,855.00	.00	.00	18,855.00
Scale fish	328,709.24 [29]	106,595.19	86,663.31	521,967.73
Shark	30,254.11 [29]	50.00	.00	30,304.11
Total	740,868.56	166,560.80	278,694.57	1,186,123.92
L/F Ratio	1.06	.56	2.21	1.14

1975

	North	Central	South[32]	Total
Lobster	159,816.68 [30]	96,575.00 [30]	21,034.00	277,607.68
Shrimp	323,420,00 [30]	.00	.00	323,420.00
Conch	13,416.00 [30]	18,205.50	280,661.00	312,282.50
Turtles	21,500.00	.00	.00	21,500.00
Scale fish	271,805.67 [30]	75,471.76 [30]	82,573.50	429.850.93
Shark	36,890.60 [30]	.00	.00	36,890.60
Total	826,848.95	190,434.26	384,268.50	1,401,551.70
L/F Ratio	1.67	1.52	3.65	2.00

1976

	North	Central	South[32]	Total
Lobster	118,579.96	51,358.27 [29]	24,968.00	194,906.23
Shrimp	362,309.61	.00	.00	362,309.61
Conch	3,535.00 [29]	7,964.50 [29]	252,406.00	263,905.50
Turtles[33]	352,908.11 [29]	64,963.00	60,512.00	478,383.11
Shark	71,351.54 [29]	.00	.00	71,351.54
Total	908,684.21	124,285.77	337,886.00	1,370,855.98
L/F Ratio	1.14	.91	4.58	1.49

1977

	North[29]	Central	South[34,29]	Total
Lobster[35]	143,796.32	49,452.01	28,203.00	221,451.33
Shrimp	271,488.73	.00	.00	271,488.73
Conch	54,209.00	630.00 [32]	112,145.00	166,984.00
Turtle	2,500.00	.00	.00	2,500.00
Scale fish	324,444.97	77,075.80	203,427.83	604,948.59
Shark	65,591.32	.00	.00	65,491.32
Total	862,030.33	127,157.81	343,775.83	1,332,963.97
L/F Ratio	1.21	.64	.68	.98

1978

	North	Central	South[36]	Total
Lobster	112,303.22	53,225.75	28,578.40	194,107.37
Shrimp	456,977.02	.00	.00	456,877.02
Conch	20,450.00	1,102.00	54,349.00	75,901.00
Turtle	12,575.00	.00	.00	12,575.00
Scale fish	543,801.61	93,988.64	264,166.00	901.956.25
Shark	80,566.26	.00	.00	80,566.26
Total	1,226,573.09	148,316.39	347,093.41	1,723,632.89
L/F Ratio	.96	.57	.32	.73

1979

	North	Central	South	Total
Lobster	84,077.00	119,640.40	46,477.00	250,194.40
Shrimp	311,218.14 [38]	.00	.00	311,218.14
Conch	25,590.00 [39]	11,744.00	131,068.00 [39]	168,402.00
Turtle	12,525.00	.00	125.00 [39]	12,650.00
Scale fish[40]	301,134.49	116,749.93	131,074.50	548.958.92
Shark[40]	32,138.50	3,700.00 [39]	.00	35,838.50
Total	766,683.13	251,834.33	308.744.50	1,327,261.90
L/F Ratio	1.3	1.09	1.35	1.26

Notes

The following abbreviations are used in this section of the appendix:

"a" = monthly production records
"b" = Estadisticas Pesqueras, 1964
"c" = Estadisticas, 1979
"d" = Solis, 1966
"e" = Arroyo, 1971a
"f" = Arroyo, 1971b
"g" = Arroyo, 1971c
"h" = Fuentes, 1977
"i" = Juanes, 1976
"j" = Arroyo, 1979

1. Source "a" data are incomplete: missing September to November
2. Source "a" missing October; lobster = source "b"; scale = source "b"; shark = source "b".
3. Source "a" missing May; conch = source "b" - source "a".
4. Source "a" missing December; conch = source "b" - source "a".
5. Source "a" missing January; conch = source "b"; turtles = source "b"; scale = source "b"
6. Source "a" missing September; lobster = source "b"; conch = source "b"
7. Source "a" missing April to December; lobster = source "b"; conch = source "b"; scale = source "b".
8. Source "a" data missing for central and south zone. Combined central and south zone total = source "c" - north zone source "a" data.
9. Total production based on source "c".
10. Source "d" indicates south zone produced 25,300 kilos of lobster; if accurate, the central zone's catch was 53,451.77 kilos (source "c" - source "d").
11. Source "d" indicates south zone produced 4,369 kilos of conch; if accurate, the central zone's catch was 5,160 kilos (source "c" - "d").
12. Source "d" indicates south zone produced 6,134 kilos of lobster; if accurate, the central zone's lobster catch was 57,419.88 kilos (source "c" - source "d").
13. Source "d" indicates south zone produced 3,020 kilos of conch; if accurate, the central zone's catch was 2,776 kilos (source "c" - source "d").
14. Source "d" indicates south zone produced 5,117 kilos of lobster; if accurate, the central zone's catch was 46,959.56 kilos (source "c" - source "d").
15. Source "d" indicates south zone produced 2,475 kilos of conch; if accurate, the central zone's catch was 3,070 kilos (source "c" - source "d").

16. Assuming total shrimp production (8,937.10) is correct, then source "c" - source "a" = 64. The origin of this production was obviously in the north zone, and it is unclear how it came to be registered elsewhere.

17. Source "c" indicates the total was 2,587 kilos, 53 kilos less than source "a" documents.

18. Data are incomplete, and this figure is based on Cozumel office total (11,920.93 kilos, source "a") + Vigía Chico lobster production listed on source "e" (12,855 kilos).

19. Based on source "c" - source "a".

20. Source "c" indicates a somewhat different total, but sources "a" and "e" are more reliable since they are directly from offices where catches were registered.

21. Data are incomplete, and this figure is based on Cozumel office total (9,561.50 kilos, source "a") + Vigía Chico lobster production listed on source "f" (8296.5 kilos).

22. Based on source "c" - (sources "a" + "f").

23. Source "c" indicates a somewhat total, but sources "a" and "f" are more reliable since they are directly from offices where catches were registered.

24. Based on source "a" + Holbox data from source "g".

25. Source "g" indicates a somewhat different total, but source "a" is more reliable since it is directly from the Isla Mujeres office.

26. Based on source "g".

27. Turtle season closed.

28. Based on source "c" - (Isla Mujeres office source "a" + Cozumel office source "a").

29. Source "h" indicates a somewhat different total, but source "a" is more reliable since it is directly from the Isla Mujeres Office.

30. Source "i" indicates a different total, but source "a" is more reliable since it is directly from the regional office.

31. Based on source "i".

32. Based on source "h".

33. Turtle season closed

34. Source "a" missing January to November; data are based on source "h".

35. Lobster season extended 30 days (closed season began on 16 April rather than 16 March).

36. Source "a" missing May and July.

37. My source "a" data are incomplete; ending in July. Except where noted catches are based on source "j".

38. This figure does not include 26,820.69 kilos of shrimp caught by "Escuela Técnica Pesquera de Puerto Morelos" off Campeche.

39. Based on source "a", since source "j" indicates a lesser amount than recorded during the first six months of 1979 according to source "a" data. Ths discrepancy remains to be explained.

40. Source "j" data does not allow for a regional breakdown of catch by independent fishermen. Thus, I have estimated the zone breakdown of catch by assigning each zone a figure based on the percent of total captured in that zone for the first six months of the year according to source "a".

APPENDIX V

TURTLE NET REGISTRATIONS, ISLA MUJERES

Turtle nets registered by patrons and cooperatives on Isla Mujeres, 1960-1969, according to monthly reports of the fisheries office.

Year	JAM	FMN	HS	P & P	C	HBX
1960	-	50	50	100	-	-
1961	40	50	-	50	-	-
1962	50	50	20	100	-	-
1963	80	50	-	120	100	-
1964	-	-	-	-	-	-
1965	-	-	-	-	-	-
1966	-	-	-	-	-	-
1967	100	-	-	50	50	-
1968	50[a]	-	-	-	20	20
1969	50	-	-	80[b]	50[c]	60

Notes

Unless otherwise indicated, each net is 60 m^2

[a] these nets were noted as having 200 m^2

[b] these nets were noted as having 387 m^2

[c] these nets were noted as having 240 m^2

- = none indicated on registration forms

JAM = José A. Magaña R.
FMN = Francisco Martín Novelo
HS = Hilario Scumpurdis
P&P = "Patria y Progreso"
C = "Caribe"
HBX = "Holbox"

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