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COASTAL FISHERIES MANAGEMENT

LESSONS LEARNED FROM THE CARIBBEAN

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SUMMARY

This study demonstrates the need for more comprehensive approaches to the management of coastal fish stocks. Caribbean fisheries for spiny lobster and conch, two highly-valued species occurring throughout the region and known to be under intense exploitive pressure, were selected for analysis. The approach taken documents (1) the history of the two fisheries leading up to present exploitation patterns, both locally and regionally; (2) the importance of conch and lobster resources to local economies; (3) the socio-economic effects resulting from their apparent over-exploitation; and (4) the major constraints on their effective management. Information was derived from existing literature, a questionnaire distributed to fishery officers throughout the region, and selected interviews and site visits to the U.S. Virgin Islands, Turks and Caicos, Antigua, and Belize which confirm the intense harvesting of both conch and lobster stocks, with possible over-exploitation evident in some cases. The structure and effectiveness of existing fisheries management programs are compared and analyzed.

Study findings suggest that:

(1) Long term sustainable utilization of coastal fish stocks requires comprehensive fishery management programs with well defined, practical objectives and financial, human, and technical resources appropriate to the task.

(2) Data collection and enforcement aspects of management program implementation can be enhanced through educational outreach activities and by restricting the number of production and/or processing centers in order to facilitate the monitoring of regulatory compliance.

(3) Continuing re-evaluation of objectives and criteria for fisheries management programs is essential and requires the systematic collection and interpretation of catch and effort data necessary for monitoring the status of fish stocks and harvesting practices.

(4) Management programs must be sufficiently flexible to accommodate external impacts of a local, national and regional character which threaten fish stocks, their habitat and the fishery itself.

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1. INTRODUCTION

The subject for the present case study is the management of the harvest of nearshore marine commercial fisheries. Coastal fishing may well represent the single most important extractive use of the oceans. Levy (1976) estimated that over 90 percent of the world's fish catch is derived from the continental shelf and from coastal upwelling areas. In terms of employment in the LDC's alone, there are an estimated 12 million fulltime fishermen and perhaps twice that amount fishing on a part-time basis (Sfier-Younis, 1980).

The economic significance of marine fisheries varies widely among developing areas, however. While Valencia (1978) has reported an average of 2.7 percent of GNP for South China Sea countries; it is less than 1 percent in the U.S. Virgin Islands, about 2 percent in Antigua and Belize, 6 percent in St. Lucia, 8 percent in Grenada and 15 percent in Turks and Caicos, where it is a very important source of export generated revenue (see Section 4). In some developing countries, especially islands, traditional village-based subsistence fishing activities or "artisanal fisheries", are extremely important to the local, non-market economy and nutritionally and socially significant. Artisanal fisheries are, however, often placed at risk by attempts at expanded commercial market oriented exploitation of fisheries resources. Therefore, the successful development and management of fishery resources requires an integrated approach which extends beyond the immediate coastal waters to encompass both the coastal zone proper and the adjacent ocean. This approach must attempt to reconcile such potentially competitive factors as the biological and ecological demands of a fish population, the socioeconomic demands for the stock's exploitation, and other human activities (for example, sand mining) which impose environmental demands on the habitat and may endanger the stock's current status. Reconciliation of these three types of demands can be facilitated through the establishment of a comprehensive management framework which documents and monitors the status of fish stocks and guides extractive uses and relevant coastal resource development activities with the goal of optimal utilization of the species. It is not an easy task, but an analysis of

successes and failures of previous approaches to the management of fish stocks provides lessons and guidelines to serve as a basis for the design of future management strategies.

The wider Caribbean region was chosen as the area most suitable for the case study. This was based partially on the author's familiarity with the region and the presumed availability of a relatively large data base needed to support the study.

Once the region was selected, the choice of fish stocks was relatively easy. Basically the species had to occur within proximity of the shore; be well described in the scientific literature; and have been both the subject of documentable intense exploitive pressures and management efforts. Based on these criteria the two species selected were the spiny lobster (Panulirus argus) and the queen conch (Strombus gigas).

The initial approach involved a literature review from which to develop the proper context for the study and a mailed survey questionnaire (see Appendix) circulated to the region's fishery officers soliciting their views on relevant fishery management issues and potential solutions. Sites were then selected primarily for their illustrative value for the purposes of the case study. These were: Antigua and Belize -- both independent countries, Turks and Caicos Islands -- a British Crown Colony, and the Virgin Islands -- a U.S. territory (Figure 1).

Some unanticipated difficulties were encountered. First, the desired documentation of trends in stock status proved to be elusive due to data scarcity, specifically the absence of significantly long time series of catch per unit effort (CPUE) and length/weight data. As a result, the study is based largely on total catch figures, extracted from export figures elicited by or derived from the interviews and survey questionnaire, as indicators of stock well being. A second problem concerned the lack of supporting documentation for such related management issues as the effects of habitat degradation on fish stocks. Finally, the depth and quality of the data varied significantly between sites. In cases where major data gaps occurred, the author attempted to integrate examples drawn from the literature into the case study.

The author wishes to acknowledge the many individuals who contri-

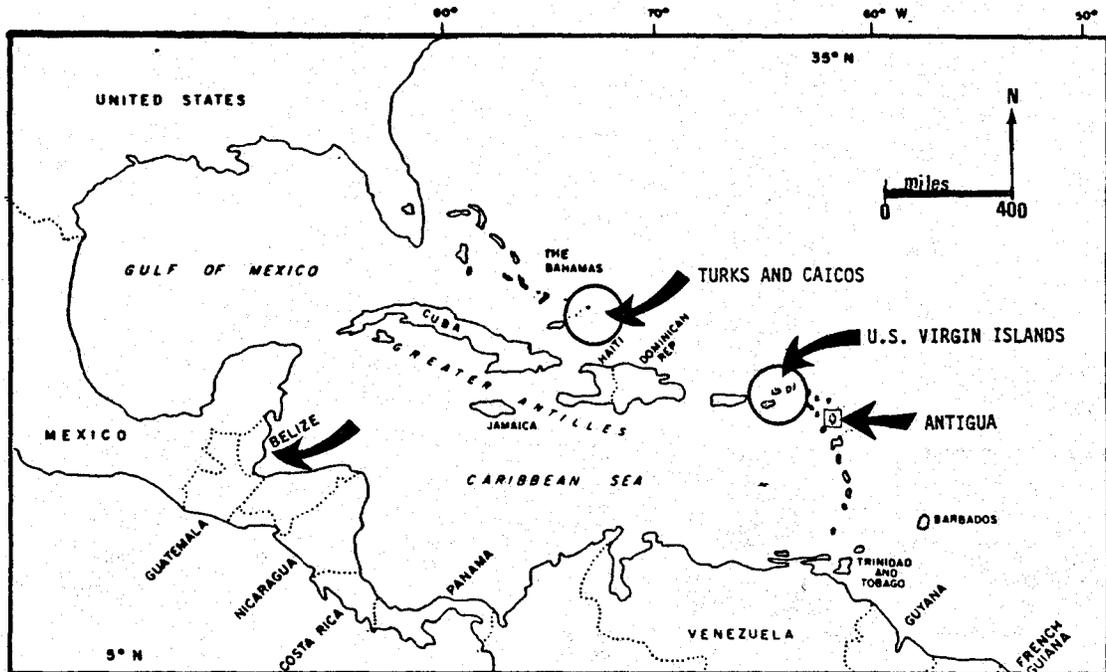


Figure 1. Location map of fisheries case study sites: Belize, Turks and Caicos, U.S. Virgin Islands, and Antigua.

buted to this endeavor. Those persons who provided special assistance were: Mr. Winston Miller and Ms. Janet Gibson (Belize Fisheries Management Unit); Mr. Christie Hall (Turks and Caicos Fisheries Office); Dr. Scott Siddall (State University of New York at Stony Brook); Dr. Arthur Dammann (of St. John, U.S. Virgin Islands and former chief scientist to the Caribbean Fisheries Management Council); Dr. Jerome McElroy (St. Mary's College of Notre Dame and formerly senior economist with the Virgin Islands Department of Commerce); Dr. Melvin Goodwin (Environmental Research Projects, Inc., Rhode Island); and Ms. Judith Towle (Island Resources Foundation, St. Thomas, U.S. Virgin Islands).

2. BASIC PRINCIPLES

2.1 Management Objectives

A management program must have clear objectives. These objectives, based on biological, social and economic considerations, are principally focused on regulating yields of particular species. The variations in desirable yield may be significant dependent on the choice of objective and the respective weight given the underlying variables. For our purposes there are three objectives commonly considered desirable in fisheries management: maximum sustainable yield (MSY); maximum economic yield (MEY); and optimum yield (OY).

Gulland (1977) has defined MSY as the greatest yield volume that a stock can produce year after year. It can be most easily conceptualized in terms of a total product curve used in traditional economic analysis (Figure 2.) In this example of a high-value species, fish yield increases with increasing effort until point E, or MSY, is reached. Beyond this point over-fishing occurs when added effort results in declining total product or yield. This is indicated by the negative marginal product curve (added output resulting from each added unit of effort).

If the desired management objective is to maximize the economic returns, defined as the greatest value of catch minus costs of capture, or MEY, total product yield would be reduced to the point of maximization of the marginal product curve (E_1).

In addition to MSY and MEY, a third objective, optimum yield (OY), has found increasingly common use in the U.S. Optimum yield attempts to incorporate both social and cultural considerations with their biological and economic counterparts characteristic of the previous models so as to obtain an "optimal" yield of the resource. Optimum yield is generally set below or equal to MSY and is consequently considered sustainable (OSY).

2.2 Management Tools

Once agreement on a management objective has been reached, its subsequent achievement depends on the efficacy of tools applied toward its implementation. The most common tools employed are (Armstrong and Ryner, 1978):

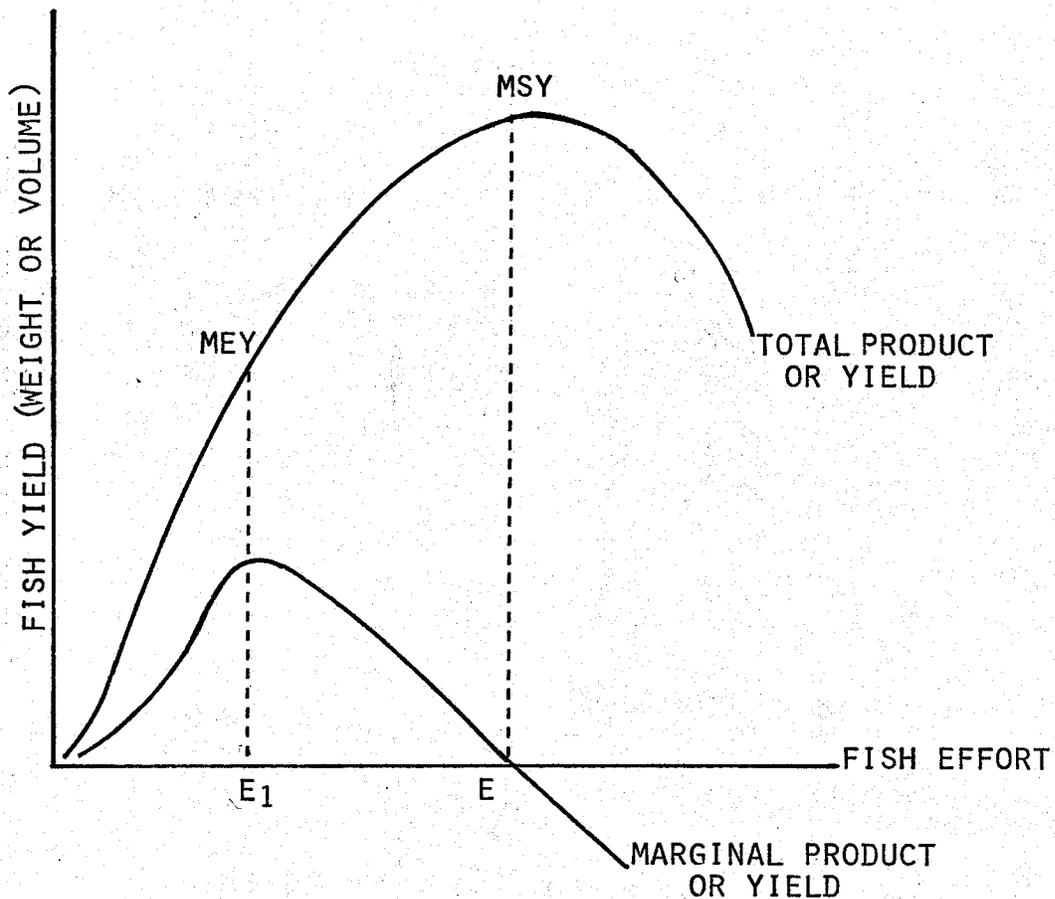


Figure 2. Total product curve for a hypothetical high-value fish stock. (Source: Adapted from Knight, 1977.)

1. Limited access - limitation of the fishery to a defined number of production units (boats, fishermen, gear type and number);
2. Closed areas - prohibition of fishing in spawning or other areas often considered critical to one or more stages of a species' lifecycle;
3. Closed season - closure of a fishery during specified periods of the year, usually correlated with peak breeding and/or spawning periods;
4. Selective harvest - restrictions on harvesting individuals of a population in critical life cycle stages (moulting, carrying eggs);
5. Size and/or weight restrictions - measures to protect pre-mature or maintain sustainable levels of harvest.
6. Gear restrictions - limitations on gear types to reduce efficiency of harvest.
7. Quotas - enforcing individual and/or total catch ceilings.

2.3 Management Constraints

The degree of effectiveness of these management tools is based on several assumptions.

First, both the monitoring of effectiveness and the measurement of achievement of management objective presumes on-going data collection. At a minimum, data should include catch and effort statistics for each species managed. Total annual catch compilation does not make allowance for yearly variations in effort, precluding calculation of effort-yield curves.

This leads to the second assumption that reported data are reliable estimates of actual fishing activity. For example, one report estimates that less than 10 percent of traditional artisanal fish catch is reported in the Caribbean region (Reintjes, 1979). Failure to account for this added exploitive pressure on fish stocks can render most management efforts ineffective.

Third, many of these tools require specific data characterizing a fish stock's population dynamics. In most developed countries this presents few problems where there are long time-series data sets for

coastal species inhabiting tropical waters.

Fourth, it must be recognized that these tools are tailored specifically for the biological management of the fish stock. They assume that other factors which might affect the "well-being" of target species are absent. No account is made for such real world externalities as pollution, illegal foreign fishing, or loss of distant parental stocks serving to replenish local populations. While these considerations may be ignored by the theoretician, they must be incorporated into the manager's program if it is to be a success.

The degree to which these tools prove effective will vary in direct proportion to the extent they are applied and accepted by the users. This may be the most complex element in the management process. Enforcement and acceptance of rules of conduct (in our case, fishery regulations) involve a host of variables which include resource user perceptions, education, economic need, and governmental enforcement capabilities.

Finally, while limited money and manpower may be important constraints, the real key to effective fisheries management programs lies in their design, appropriateness, and implementation.

3. HISTORY

3.1 The Region

The Caribbean basin covers an area of approximately 2.4 million km². Within the region there are 31 political entities which include independent and associated states, territories, and colonies, commonwealths and departments. States bordering the wider Caribbean range in type and size from small islands measuring 98 km² (Montserrat) to continental nations as large as 9.7 million km² (United States).

The region's political and physical variety is matched by a similar diversity in its economic, cultural and linguistic characteristics. Few areas of the world can demonstrate a disparity in economic well-being as extreme as that which exists between the United States and Haiti. In traveling through the region, one may overhear conversations in French, Patois, English, Dutch, and Spanish between descendents from West African slaves, English pirates, Spanish conquistadores, French colonists, and East and West Indians. This pronounced cultural and ethnic diversity concentrated in a relatively small area has stimulated development of resource utilization patterns which have potential applications to larger and more complex economic systems.

3.2 The Waters

Apart from the large continental shelf areas and localized zones of upwelling, the Caribbean region's tropical waters are characterized by low productivity in comparison to temperate waters. This is largely attributed to the presence of a permanent thermocline inhibiting nutrient exchange between water layers and the absence of large land bodies and shelf areas which serve as sources of nutrients and nutrient traps respectively (Sverdrup et.al., 1946). Despite these existing conditions, small insular shelf areas may be highly productive supporting such ecologically diverse communities as coral reefs and marine sea grass beds. These areas also provide sources of habitat for a diverse assemblage of fish species many of which represent a means of employment and income to the region's many fishermen. Two species in recent years have grown in market value to become the region's most economically important fisheries

exports and are the subjects of this case study.

3.3 The Resources

The two species chosen for this case study are the Caribbean spiny lobster (Panulirus argus) and the queen conch (Strombus gigas) (Figures 3 and 4). The continued high demand for these two species in both regional and extraregional markets has resulted in widespread over-fishing of stocks and, in a few instances, the development of successful management programs.

3.3.1 Caribbean spiny lobster

The spiny lobster industry began to develop at the end of World War II. Up until that period demand in the United States was low and satisfied by production from Florida. In the Caribbean, lobster was mostly caught in West Indian fish pots as incidental "by-catch" and often used as bait for fish. As America's taste for shell fish widened and demand began to increase, an export market developed (Table 1). Today, lobster imports from the Caribbean represent a sizeable component of total lobster imports into the United States, ranging between 12 and 26 thousand metric tons in the period 1960-1980 (Figure 5).

During the same period, however, an inter-regional trade pattern was also developing for lobster. Demand in the more affluent islands, fueled by foreign government assistance and rapidly growing tourist industries (Puerto Rico, U.S. Virgin Islands, French and Dutch West Indies), quickly exceeded local supply resulting in new alternative markets for spiny lobster. It has been the rapid development of these new markets, both in the U.S. and Caribbean, coupled with rapidly increasing value of lobster (Figure 6), that has provided the economic incentives resulting in the region's presently heavily exploited stocks.

3.3.2 Queen conch

Conch, in contrast to lobster, has been a traditional source of protein throughout the Caribbean. Its use for food has been most common in the coralline islands systems characterized by large shelf areas and limited

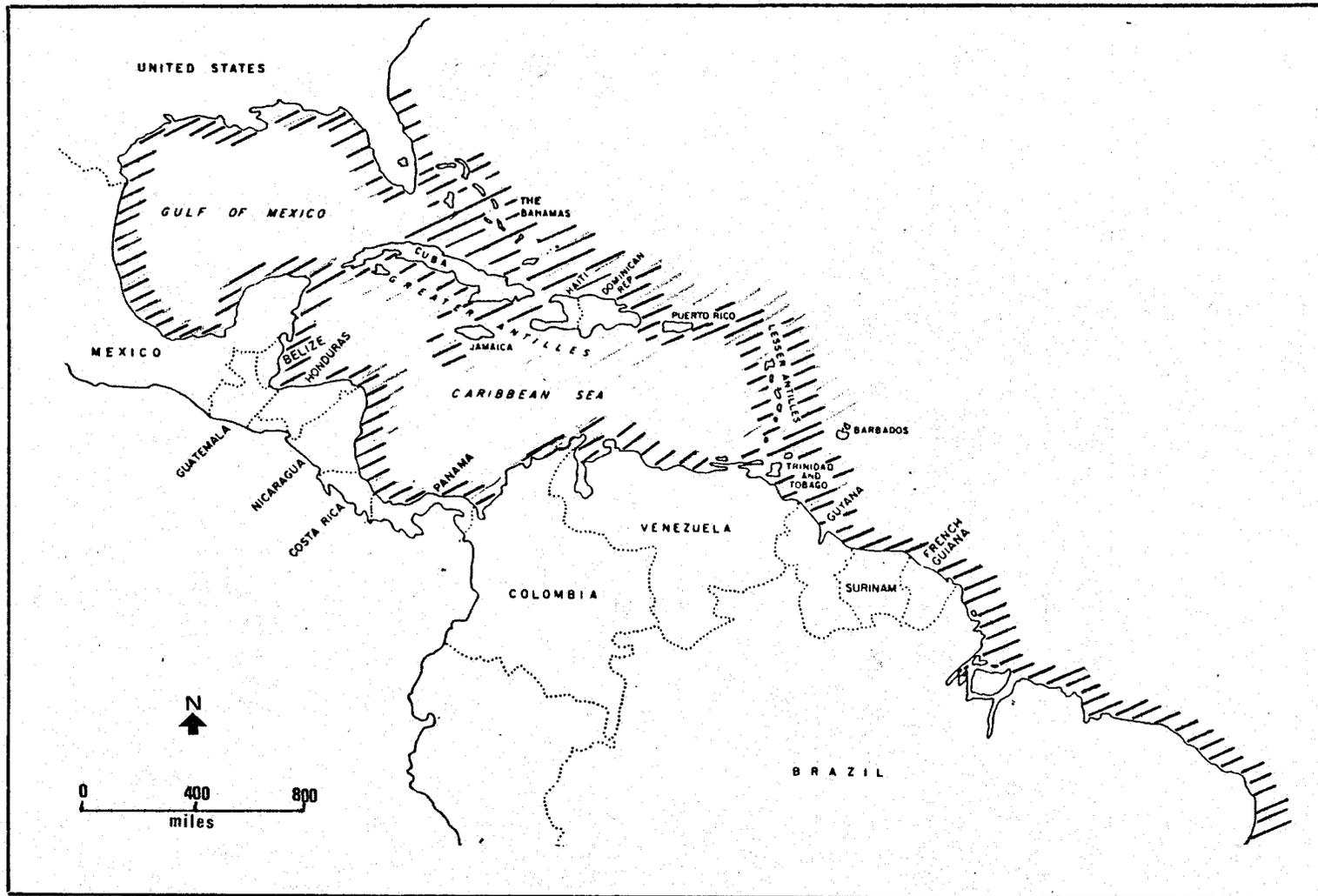


Figure 3. The area of distribution for Caribbean spiny lobster. (Source: Fischer, 1978.)

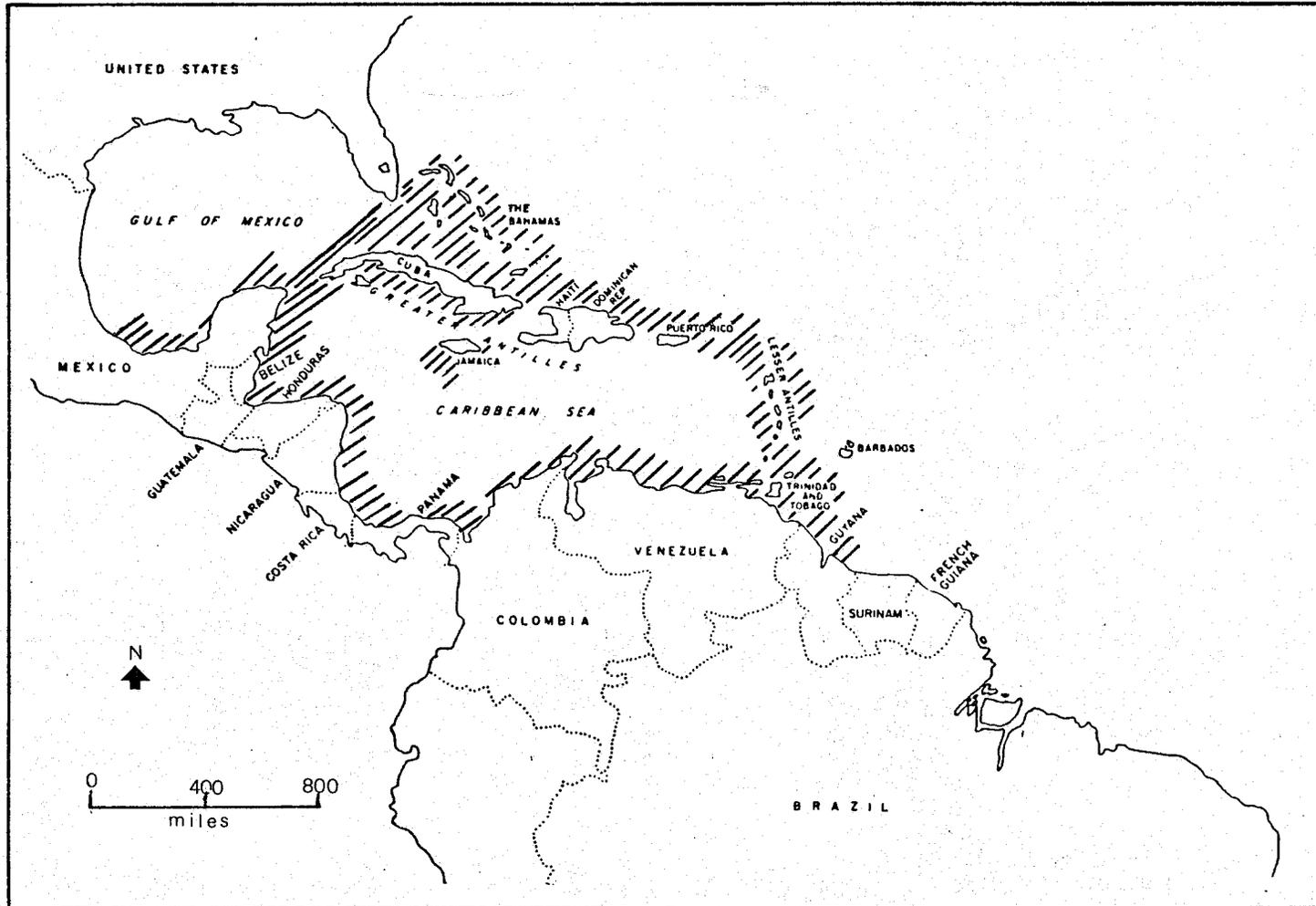


Figure 4. The area of distribution for queen conch. (Source: Fischer, 1978.)

Table 1. U.S. imports of spiny lobster by country, 1960 - 1980 in metric tons (converted to live weight).^a

Country	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Bahamas	2,050	2,300	1,830	1,086	1,150	1,350	760	750	1,010	960	1,090
Belize	550	390	400	466	400	470	480	310	600	610	370
Bermuda	0	3	0	0	0	0	0	0	1	0	1
Brazil	3,240	4,910	6,390	5,400	3,930	3,660	3,370	2,810	4,780	8,030	8,130
Cayman Is.	c	c	c	c	c	c	c	c	c	c	c
Colombia	0	10	0	0	10	40	40	10	70	40	100
Costa Rica	560	980	150	512	220	500	100	160	150	300	400
Cuba	3,900	1,960	130	0	0	0	0	0	0	0	0
Dom. Rep.	0	5	2	2	30	40	70	40	120	90	50
Fr. Guiana	0	0	0	0	0	0	0	0	80	0	80
Fr. W. Indies	0	0	10	0	0	1	0	0	0	40	40
Guatemala	0	10	20	14	40	60	20	10	10	5	10
Guyana	0	4	0	0	0	0	4	0	0	120	0
Haiti	80	100	100	115	170	330	290	330	410	430	300
Honduras	20	60	250	57	180	120	110	160	130	200	1,500
Jamaica	100	90	110	102	110	160	200	150	330	320	420
LWI ^b	40	4	10	2	1	0	50	40	20	10	10
Mexico	1,500	2,010	1,960	1,470	2,350	2,210	3,060	2,130	2,680	2,770	2,640
N. Antilles	0	5	70	56	0	0	0	0	0	0	0
Nicaragua	20	120	420	724	360	660	430	520	440	480	470
Panama	10	220	80	137	1	170	80	10	50	100	320
Surinam	0	20	0	0	0	0	0	0	0	10	30
Trin./Tobago	0	0	1	0	0	20	10	10	0	10	20
Turks/Caicos	c	c	c	c	c	c	c	c	c	c	c
Venezuela	0	0	30	30	3	70	20	20	90	180	110
Total	12,070	13,201	11,963	10,173	8,955	9,861	9,064	7,460	10,921	14,705	16,091

Table 1. Continued.

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Bahamas	1,420	1,940	1,680	1,255	1,204	1,827	1,324	745	1,290	1,763
Belize	540	510	410	415	262	281	338	283	456	446
Bermuda	0	0	0	0	0	0	0	77	0	0
Brazil	7,030	8,300	8,070	8,424	7,138	7,069	7,200	9,050	8,306	7,328
Cayman Is.	c	c	c	c	c	175	21	58	0	58
Colombia	110	320	70	163	315	122	90	49	35	0
Costa Rica	80	100	50	223	229	577	285	342	203	10
Cuba	0	0	0	0	0	0	0	0	0	0
Dom. Rep.	80	70	100	11	70	90	137	175	261	37
Fr. Guiana	0	0	0	0	0	0	0	0	0	0
F. W. Indies	70	0	0	0	0	0	0	0	0	0
Guatemala	20	20	40	10	0	0	0	0	0	69
Guyana	0	0	0	0	0	0	0	55	0	0
Haiti	300	340	210	235	253	334	193	398	355	315
Honduras	800	400	360	999	2,097	2,504	2,241	2,373	3,497	2,581
Jamaica	780	770	420	336	439	68	0	0	0	0
LWI ^b	50	100	90	59	82	144	548	253	84	27
Mexico	3,170	2,810	2,910	2,935	3,113	1,144	2,920	2,151	2,477	6,527
N. Antilles	4	0	0	0	0	0	0	0	0	0
Nicaragua	360	540	760	1,336	2,456	2,973	1,137	3,759	3,255	4,916
Panama	50	150	40	57	78	341	400	158	204	1,859
Surinam	0	0	0	0	0	0	0	0	0	0
Trin./Tobago	80	20	20	0	50	68	0	0	0	0
Turks/Caicos	c	c	c	c	0	233	423	389	477	806
Venezuela	70	20	80	12	0	0	0	0	0	0
Total	15,014	16,400	15,310	16,470	17,846	17,900	17,267	20,315	20,900	25,878

Source: Bureau of the Census, U.S. Department of Commerce. U.S. Imports for Consumption and General Imports; Streeter and Weidner, 1976.

^aConversion factors used: tails to live weight: 1:3; canned to live weight: 1:4.63; unspecified to live weight: 1:3.

^bLeeward and Windward Islands.

^cNot available.

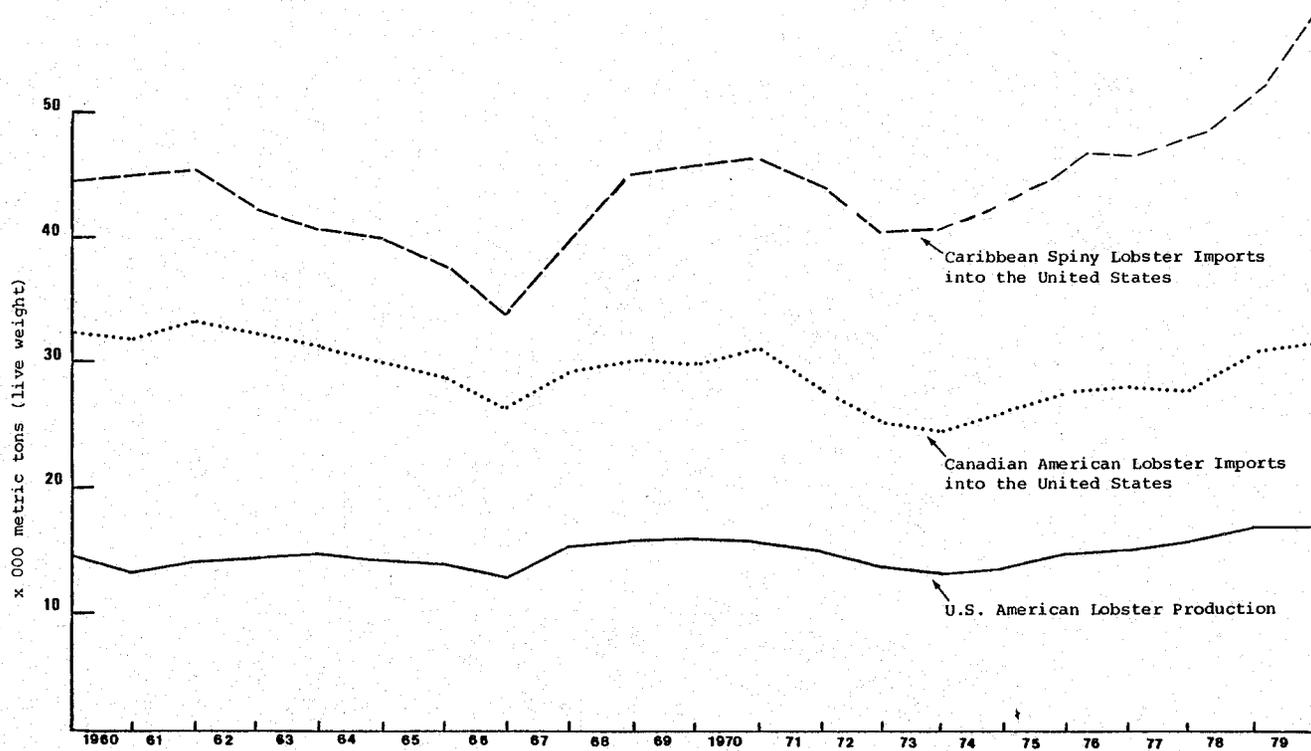


Figure 5. Cumulative totals and relative values of U.S. production and U.S. imports of Canadian American and Caribbean spiny lobster, in metric tons. (Source: U.S. Dept. of Commerce, 1981; Streeter and Weidner, 1976.)

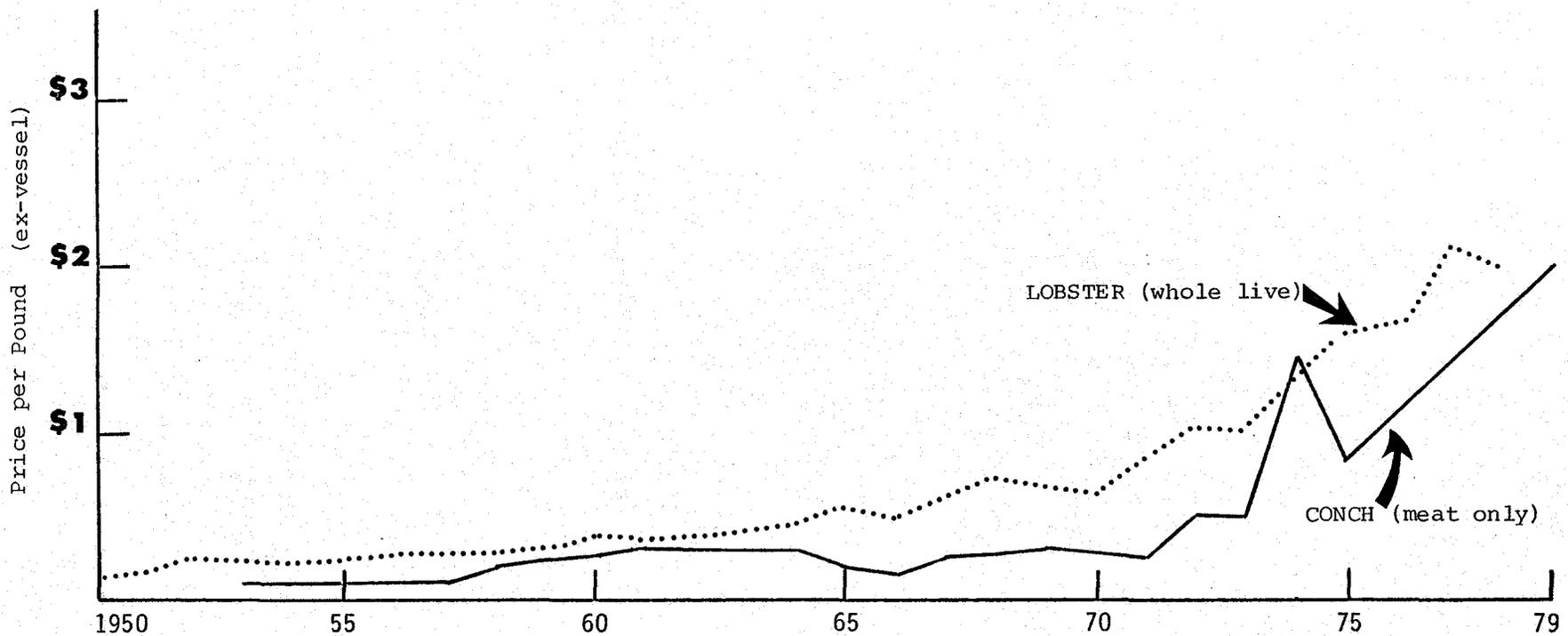


Figure 6. Price per pound of conch and lobster in Florida (1950-1979).
 (Source: Stevely and Warner, 1978; Labisky, *et.al.*, 1980.)

sources of protein (Bahamas, Turks and Caicos, the Grenadines). Conch, unlike lobster, has also been a traditional intra-regional trade commodity, often being exported in exchange for fruits and vegetables from neighboring islands. Demand for conch in the U.S. market began to climb in the early 1970's (Table 2). This has been attributed to three factors: increased restrictions on harvesting Florida's rapidly depleting stocks; a growing tourist industry in south Florida desiring to consume local seafood; and increasing Latin and West Indian populations in the state (most notably Cubans) with a tradition for eating the product (Stevely and Warner, 1978). As demand has increased in the United States and elsewhere in the region, so has the value of the product (Figure 6). The result is non-sustainable exploitation in many areas of the Caribbean similar to that for the lobster.

3.4 Regional Exploitation Patterns

Due to the region's long and varied history of political affiliations with several developed continental countries, many of the islands receive external subsidies and benefits from metropolitan capital and markets which fuel their development. Such examples include the U.S. Virgin Islands, the U.S. Commonwealth of Puerto Rico, the French Departments of Guadeloupe and Martinique, and the various islands which comprise the Netherlands Antilles. In still other cases, such as Barbados, a long and productive colonial legacy has provided the island with both expertise and economic links that continued after political ties with the United Kingdom were no longer deemed desirable or necessary.

As these islands became more developed, increased pressures were brought to bear on resident fish stocks. The sources of these pressures included the increased affluence of the local population, a growing cosmopolitan resident community, increased tourism and the development of alternative export markets for selected fish species. To meet demand, local catches, where they continued to exist, were supplemented by imports of conch and lobster from neighboring, less economically developed islands or occasionally from large mainland exporting markets. Barbados is one example of an increasingly cosmopolitan community where tourism

Table 2. Conch imported into the U.S. through Miami during the period 1970-82 in metric tons.

Place of Origin	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Belize	145.7	265.0	382.9	245.1	376.7	330.5	222.5	159.9	135.8	147.8	87.7	173.6	69.1
Colombia	0	0	39.8	107.7	122.5	50.3	13.5	11.2	62.3	2.5	0	0	23.3
Dominican Republic	0	0	0.5	24.4	10.1	0	2.1	0	0	6.4	0	79.5	33.9
Haiti	0	0	2.2	4.1	0	0.2	0.2	14.9	58.3	82.8	80.1	160.1	38.0
Honduras	58.0	32.4	88.2	83.4	5.7	36.3	57.7	3.7	21.4	0	7.5	7.2	18.4
Jamaica	0	0	1.5	4.1	28.5	40.7	0.8	0	0	0	0	0	0
Mexico	0.2	0	8.6	2.2	0	11.7	3.2	1.8	1.5	0	4.5	0	0
Turks and Caicos	2.0	2.3	0	0	0	65.9	150.9	221.7	262.8	141.5	256.8	256.3	179.8
West Indies	0	0	1.2	22.1	3.9	7.2	2.2	0	0	0	0	.2	
Other ^a	8.4	0.8	2.7	1.8	2.0	7.8	14.8	2.3	13.2	2.2	5.2	32.7	13.9
Total	214.3	300.5	527.6	494.9	549.4	550.6	467.9	415.5	555.3	383.2	436.9	704.6	376.4

Source: National Marine Fisheries Service, Fisheries Development Analysis Branch, New Orleans, Louisiana. Taken from Brownell and Stevely, 1981.

Note: Approximately 27,000 - 30,000kg of queen conch are imported to the United States each year directly through New York.

^aBahamas, Cayman Islands, Costa Rica, Guatemala, Nicaragua, Panama and Venezuela.

growth created a growing demand for imports which nearby Eastern Caribbean islands could not supply in the face of rising local demand (Table 3). In several islands, native stocks became so depleted that local consumption had to be met largely by imports. This was the situation in the U.S. Virgin Islands (see Section 4.1) and in St. Maarten (Netherlands Antilles) following the development of tourism in the 1960's (van Buurt, personal communication).

Table 3. Barbados imports of conch and lobster from the Eastern Caribbean for the period 1971-81 (lbs. x 000)¹.

	1971	72	73	74	75	76	77	78	79	80	81
St. Lucia	2.1	.1	0	0	0	1.0	0	0	0	0	0
Grenada	0	0	0	14.6	1.8	0	0	2.0	0	0	0
St. Vincent	0	0	0	2.9	1.4	15.4	7.0	3.2	.9	0	1.4
Antigua	0	0	0	0	.8	0	0	0	0	0	0
St. Kitts/ Nevis	0	0	0	0	0	0	0	.5	1.9	0	0
TOTAL	2.1	.1	0	17.5	4.0	16.4	7.0	5.7	2.8	0	1.4

Source: Barbados Govt. Statistical Services, 1981.

¹Data are summed for fresh, chilled, and frozen categories.

The regional trade patterns which have evolved for conch and lobster over the past 30 year period are depicted in Figure 7. These patterns identify both the region's present exporters and those areas where stock depletion and/or situations where demand has exceeded supply have forced countries to become importers of these shellfish. More importantly, when interpreted together with the previously cited literature, these patterns support a growing concern that over-fishing of conch and lobster may be rapidly shifting from being a local problem to one of regional proportions.

3.5 Management Responses

At the local level the response to over-fishing and depletion of fish

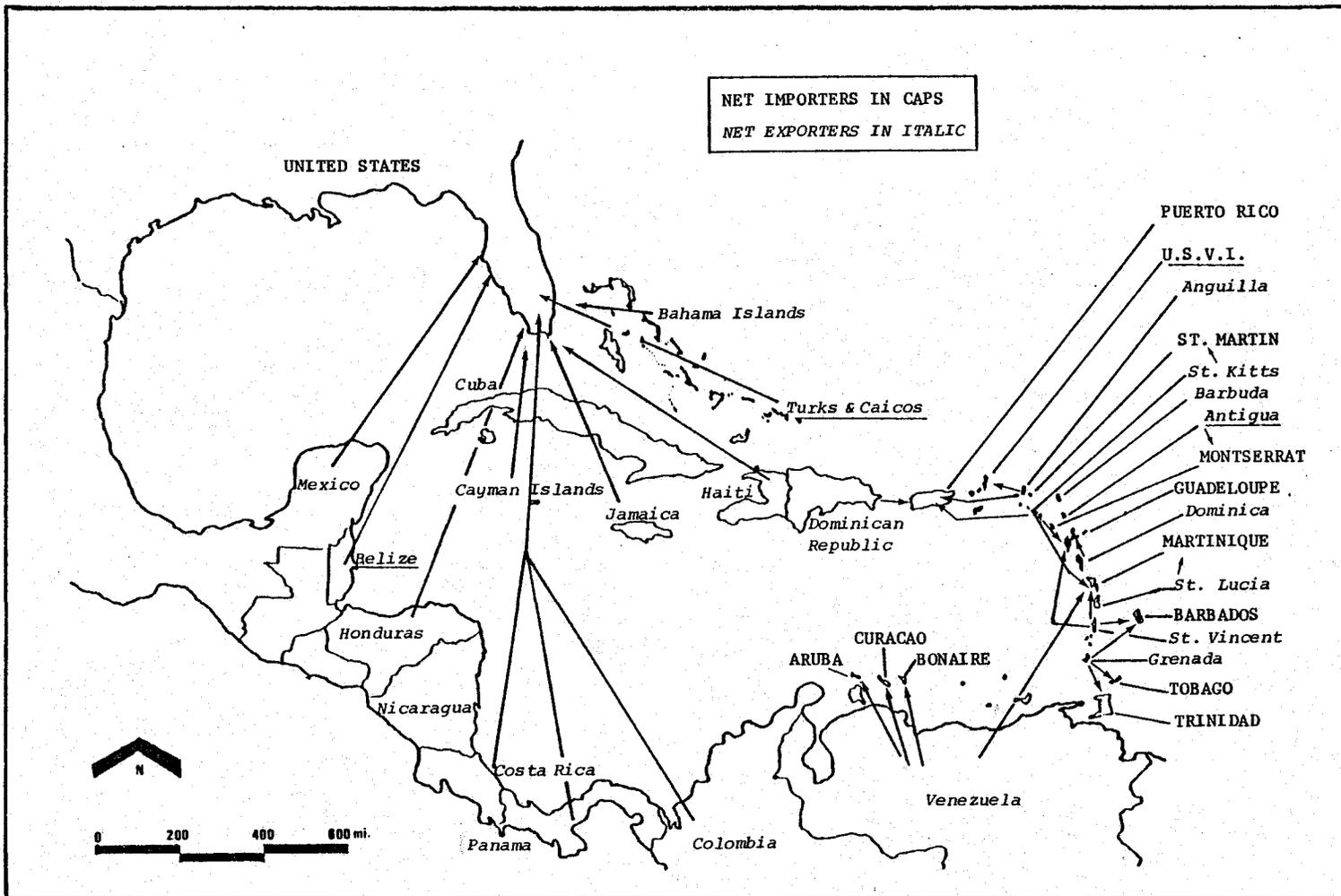


Figure 7. Trade patterns for conch and/or spiny lobster between countries in the wider Caribbean for period 1981 to 1983 (with case study sites underlined). (Source: Brownell and Stevely, 1981; Island Resources Foundation, 1983.)

stocks has been the development and implementation of management regulations. Results from the survey questionnaire initiated for this study (and other sources) indicate lobster regulations are both geographically more widespread and more restrictive than those for conch (Table 4). The development of lobster regulations also appears to have preceded their conch counterparts by at least a decade (the Bahamas is the only known country to have established a conch management program prior to 1970). In both cases regulations were implemented subsequent to the development of the fisheries and in many countries only after stocks began to demonstrate indications of over-fishing.

Despite the presence of regulations the management of conch and lobster stocks, with few notable exceptions, has proven to be largely ineffective (Appendix 1). This would indicate that regulation alone is insufficient to guarantee a stock's adequate management, supporting a principal theme of the case study. To be sure, regulations are considered a vital component of management especially when tailored to an individual species' population characteristics. But the regulatory component must be placed in a larger management framework which includes education, dissemination and enforcement elements. Finally, and perhaps most importantly for the purposes of this Casebook, design of a management program must take place within the larger context of the overall coastal and marine environment in which stocks are to be controlled.

Table 4. Existing regulations for conch and lobster in the Caribbean region.

	LOBSTER							CONCH								
	minimum size	minimum weight	closed season	closed area	berried females	gear restrictions	closed fishery	catch allocation	minimum size	minimum weight	closed season	closed area	gear restrictions	closed fishery	catch allocation	export restrict.
Anguilla	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Antigua/Barbuda	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Bahamas	x	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-
Barbados	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize	x	x	x	-	x	x	-	x	x	x	-	x	-	-	-	-
Bermuda	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Brazil	x	-	x	x	x	x	x	-	NA	-	-	-	-	-	-	-
Cayman Islands	x	-	x	-	-	x	-	x	-	-	-	-	-	-	-	-
Colombia	x	x	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Cuba	x	-	x	-	x	x	-	-	NA	-	-	-	-	-	-	-
Dominica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dominican Rep.	x	-	x	-	-	-	-	-	NA	-	-	-	-	-	-	-
Grenada	x	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Guatemala	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Guadeloupe	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haiti	-	x	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Honduras	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
Jamaica	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
Martinique	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexico	x	-	x	-	x	-	-	-	NA	-	-	-	-	-	-	-
Montserrat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. Antilles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nevis/St. Kitts	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Nicaragua	x	x	-	x	x	-	-	-	NA	-	-	-	-	-	-	-
Panama	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Puerto Rico	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
St. Lucia	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
St. Vincent	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Trinidad/Tobago	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turks/Caicos	x	x	x	-	x	x	-	-	x	-	-	x	-	-	-	-
US(Florida)	x	-	x	x	x	x	-	-	-	-	-	-	-	x	-	-
Venezuela	x	-	x	x	x	x	-	-	-	-	x	-	x	-	-	-
Virgin Islands(UK)	x	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-
Virgin Islands(US)	x	-	-	x	x	x	-	-	-	-	-	-	-	-	-	-

Sources: Adams, 1971; GCFI, 1980; IRF, 1980; IRF, 1983; Villegas, et.al., 1982.

NA: Not available.

4. SITE EXAMPLES

For a closer examination of events leading up to the adoption of a management program and its subsequent effectiveness four sites were visited and have been briefly described below.

4.1 U.S. Virgin Islands

Within the region, perhaps the U.S. Virgin Islands represents the most dramatic example of depletion of stocks due to excessive demand associated with growth and tourism development. As late as the early 1950's, the economy of the U.S. Virgin Islands was based on agriculture dominated by the production of sugar and its by-products, molasses and rum. The population was relatively stable at 25,000, actually dropping from 30,000 at the turn of the century. Fisheries, as in many other areas of the Caribbean, were exploited only for subsistence purposes. Fiedler and Jarvis (1932) in one of the earliest known written account of the islands' fisheries did not report conch and lobster as part of the landings.

Upon passage of the "Organic Act" by the U.S. Congress in 1954 (legislation which provided investment tax incentives for business), major changes in the islands' tax structure and expanding levels of federal assistance stimulated economic growth principally in the government, export manufacturing, and tourism sectors. In the latter, growth rates measured in terms of tourist arrivals and accommodations were exponential. In the 10 years between 1960 and 1970 alone, visitor arrivals increased tenfold, the employed labor force tripled, stock housing doubled, real per-capita income rose 10 percent annually and electric and water consumption rates increased on the average of 20 percent per year (McElroy, 1978).

The changing character of this burgeoning population and rising affluence also generated a rapid convergence of resident Virgin Islands consumption patterns with U.S. mainland standards (McElroy and Caines, 1980). These new tastes in combination with income elastic tourist patterns have visibly impacted the local fisheries. For example, as late as 1960 enough lobsters were caught in Virgin Islands waters to create a surplus for export to Puerto Rico (Caribo, 1961). However, by 1967 the

U.S. Virgin Islands had become a net importer of lobster and has remained so to this day (Table 5). Imports of lobster over this period have reached as high as 75 percent of total consumption, measured in both weight and value. Moreover this situation appears to be more than just a simple case of demand exceeding supply. Recent trends in the fishery including an increase in lobster pot thefts, a tripling in market value, and a decline in average size indicated that the species may be overfished (Dammann, et.al., 1976). This initial conclusion appears to be further substantiated by interviews conducted in the course of the present case study indicating that depletion of lobster stocks in nearshore areas has caused many fishermen to travel increasing distance from shore at additional cost and personal risk (Figures 8 and 9).

While CPUE data is being collected in the U.S. Virgin Islands, up until 1980 it had been reported solely on a voluntary basis. Comparisons of fishermen's reports with two years of port sampling indicated that less than 50 percent of all lobster are reported. This data gap prevents a more objective approach for determining the present status of stocks.

While few data exist concerning the status of conch populations, the results of interviews indicate that commercial quantities no longer exist in the Virgin Islands following a trend similar to that described for the lobster (Figures 10 and 11).

The Virgin Island resident fishing community is small, comprised of an estimated 420 full and part-time fishermen (Olsen, 1982). The impact of the apparent decline of these two fisheries on the community's economic well-being is difficult to ascertain due to the absence of accurate historical data. Per capita income for fishermen in 1981 was \$6,681 of which less than 20 per cent was represented by conch and lobster and the balance by fish (Olsen, 1982). The disproportionately small share representing such high-value species suggests a loss of income that is significant.

Distribution of catch in the Virgin Islands has always been diffuse and characterized by fishermen selling directly to the consumer and retailer or occasionally to the intermediary. An effort to bring more structure to the system through the establishment of cooperatives on

Table 5. Domestic landings and imports of lobster in the U.S. Virgin Islands (in U.S. dollars).

	Domestic Landings		Imports		Total Consumption		Total Consumption	
	lbs(x000)	\$(x000)	lbs(x000)	\$(x000)	lbs(x000)	\$(x000)	lbs(%)	\$(%)
1967	85.9	73	260.1	209	346	282	75	74
1970	NA	NA	34.6	24.8	NA	NA	NA	NA
1971	NA	NA	52.5	40.2	NA	NA	NA	NA
1972	NA	NA	68.0	53.5	NA	NA	NA	NA
1973	NA	NA	55.7	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA
1975	49.6 ^a	99 ^a	55.7	NA	105.3	NA	53	NA
1976	86.5 ^a	173 ^a	55.8	58	142.3	231	39	25
1977	129.8 ^a	260 ^a	77.5	60	207.3	320	37	19
1978	157.1 ^a	393 ^a	42.2	69.4	199.3	462.4	21	15
1979	162.7 ^a	NA	NA	NA	NA	NA	NA	NA
1980	109.1 ^a	NA	81.9	165.8	191	NA	43	NA
1981	97.7 ^a	415 ^a	NA	NA	NA	NA	NA	NA

Sources: U.S. Dept. of Commerce, 1980; Olsen, 1982.

NA: Not available.

^a Signifies estimates based on voluntary reported landings.

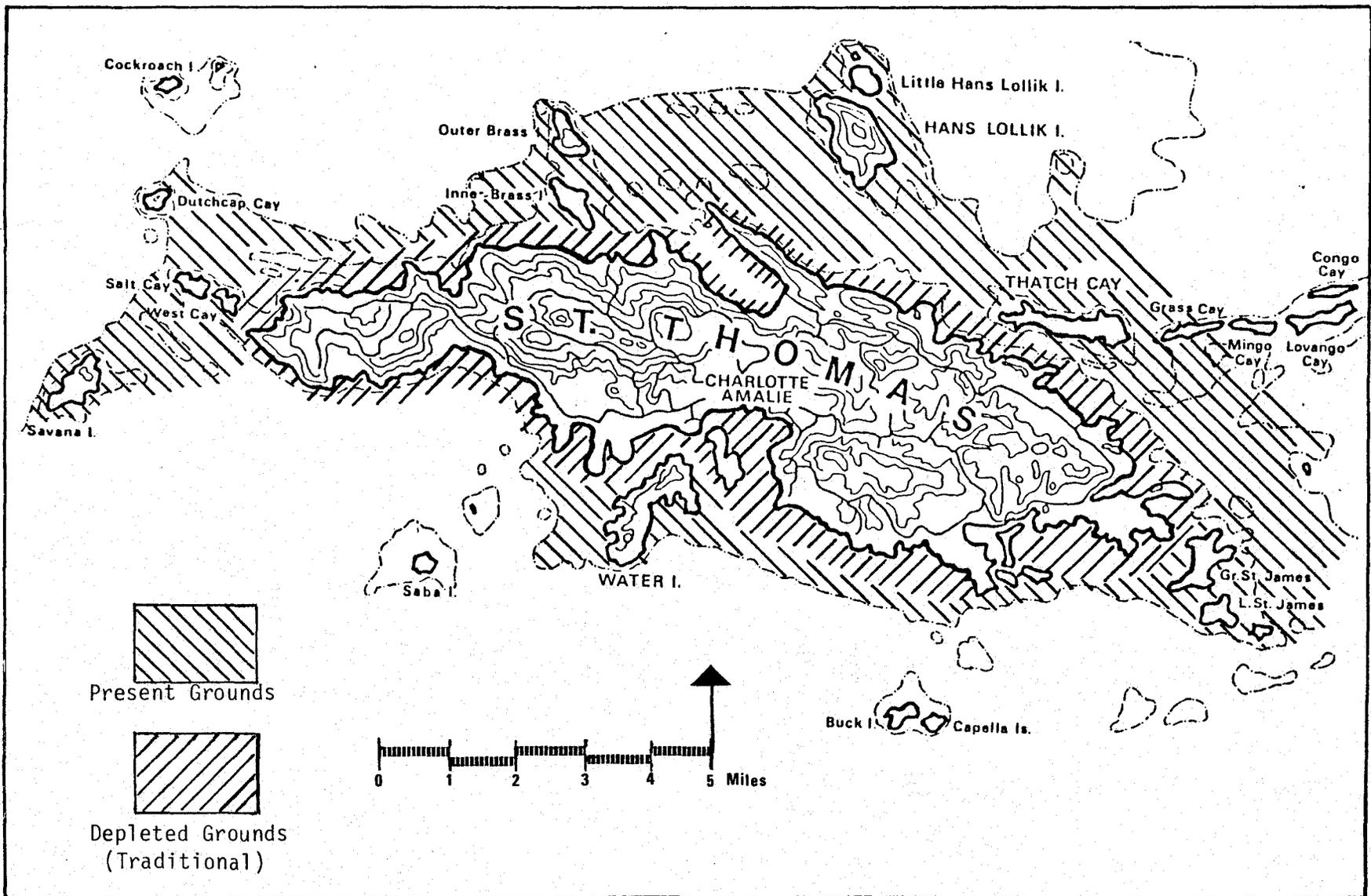


Figure 8. Traditional and present lobster fishing grounds of St. Thomas, U.S. Virgin Islands. (Source: LaPlace, personal communication, 1983.)

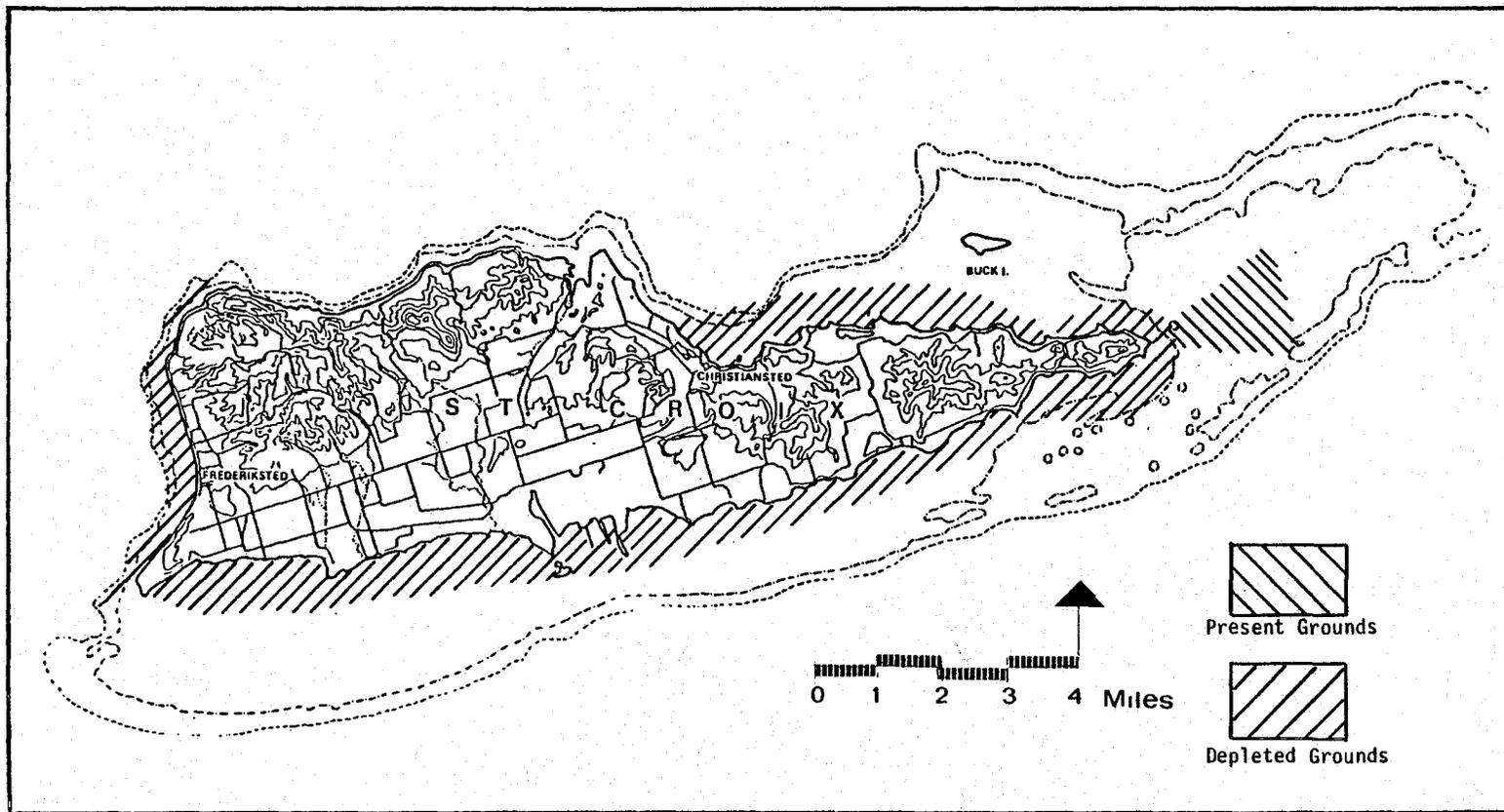


Figure 9. Traditional (depleted) and present lobster fishing grounds of St. Croix, U.S. Virgin Islands. (Source: Information furnished by Skov, personal communication, 1983.)

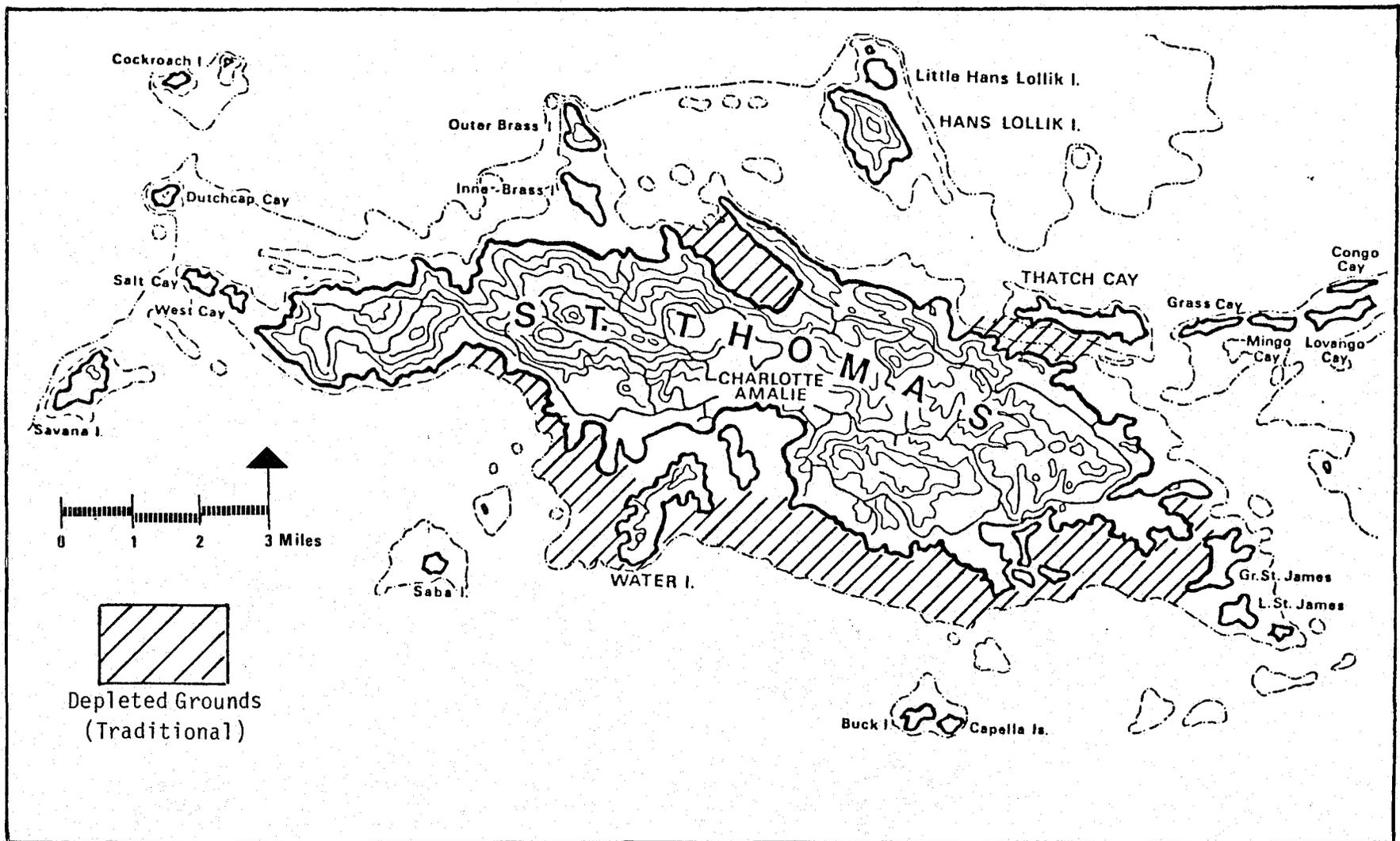


Figure 10. Traditional conch fishing grounds of St. Thomas, U.S. Virgin Islands. NB. No present grounds exist. (Source: LaPlace, personal communication, 1983.)

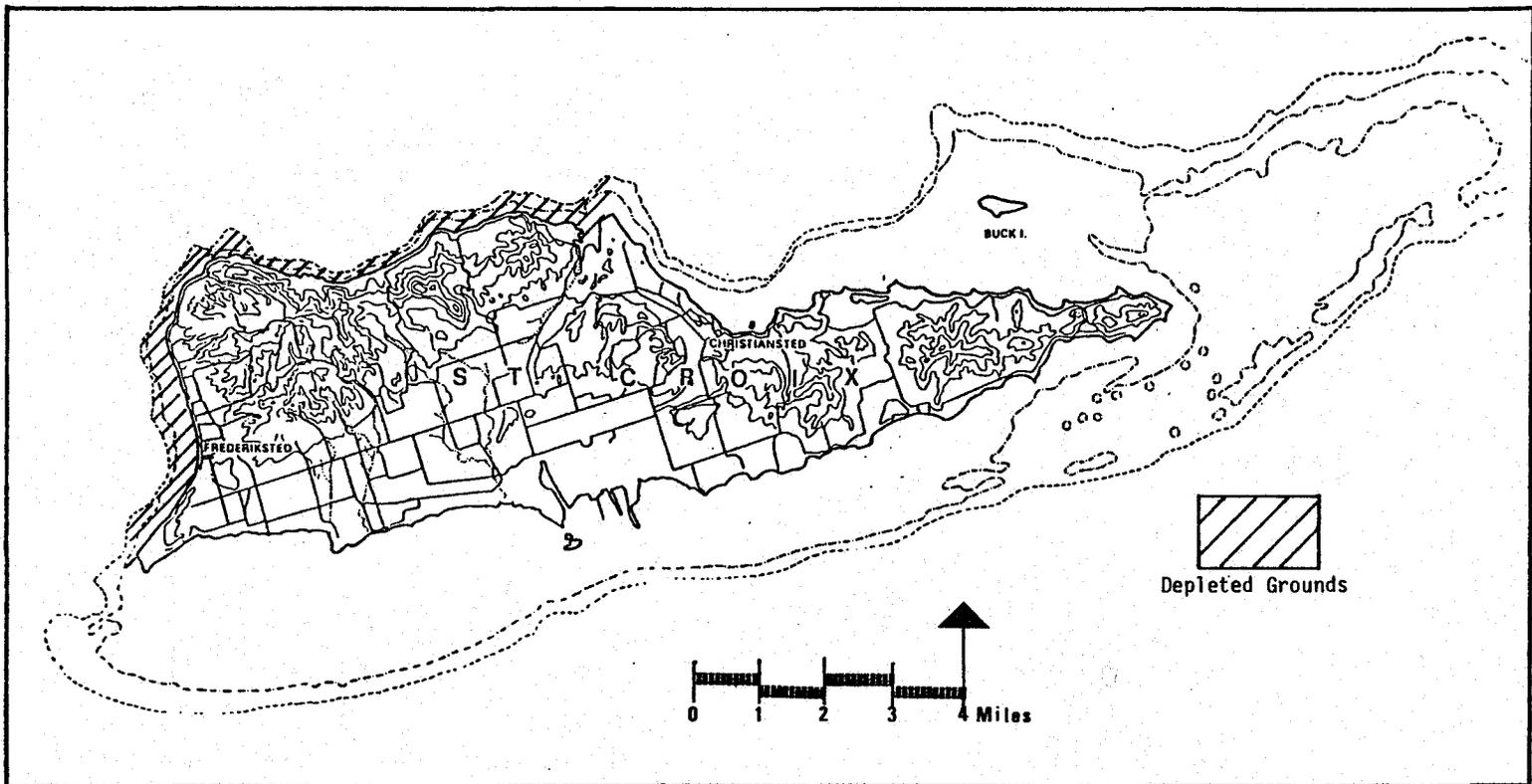


Figure 11. Traditional (depleted) conch fishing grounds of St. Croix, U.S. Virgin Islands. NB. No present grounds exist. (Source: Information furnished by Skov, personal communication, 1983.)

both St. Thomas and St. Croix ended in failure. This pattern of distribution has important implications for management and regulatory enforcement of the fisheries which will be discussed in more detail in Section 5.

In sum, with the example of the U.S. Virgin Islands, we have examined a developing area characterized by overfishing and an increased demand for lobster and conch. To explore how the circumstances of the Virgin Islands relates to the other parts of the region, we chose to examine the neighboring island of Antigua.

4.2 Antigua

Antigua together with its dependency, Barbuda, is fortunate to possess an extensive shallow water shelf area (2,500 km²) which is rich in demersal fish resources. Available trade statistics indicate that Antigua was exporting as much as 200 thousand pounds of lobster as early as 1957-58, before reaching a peak of 275 thousand pounds in 1978 (Figure 12). However, since that period, a decline in landings and subsequent exports began which has continued into 1982. Estimated landings have declined from 334 thousand pounds in 1978 to 95 thousand pounds in 1982 for an average of a 23.5 per cent negative annual change over that same period (Joseph, personal communication).

Although catch per unit effort (CPUE) data are rare in Antigua, for the four year period between 1970 and 1974 CPUE declined from 1.5 pound to one pound per trap, indicating the possible over-exploitation of the fishery (Peacock, 1974). Further evidence for this condition exists in records for total landings and the results from discussions with the Antiguan fisheries officer and local fishermen. One factor substantiated in these discussions was the necessity for fishermen to leave traditional fishing grounds as they became depleted for more distant areas elsewhere (Figure 13), a pattern reminiscent of the one described for the U.S. Virgin Islands.

There are an estimated 800 (full and part-time) fishermen in Antigua of whom approximately 640 depend, at least in part, on income derived

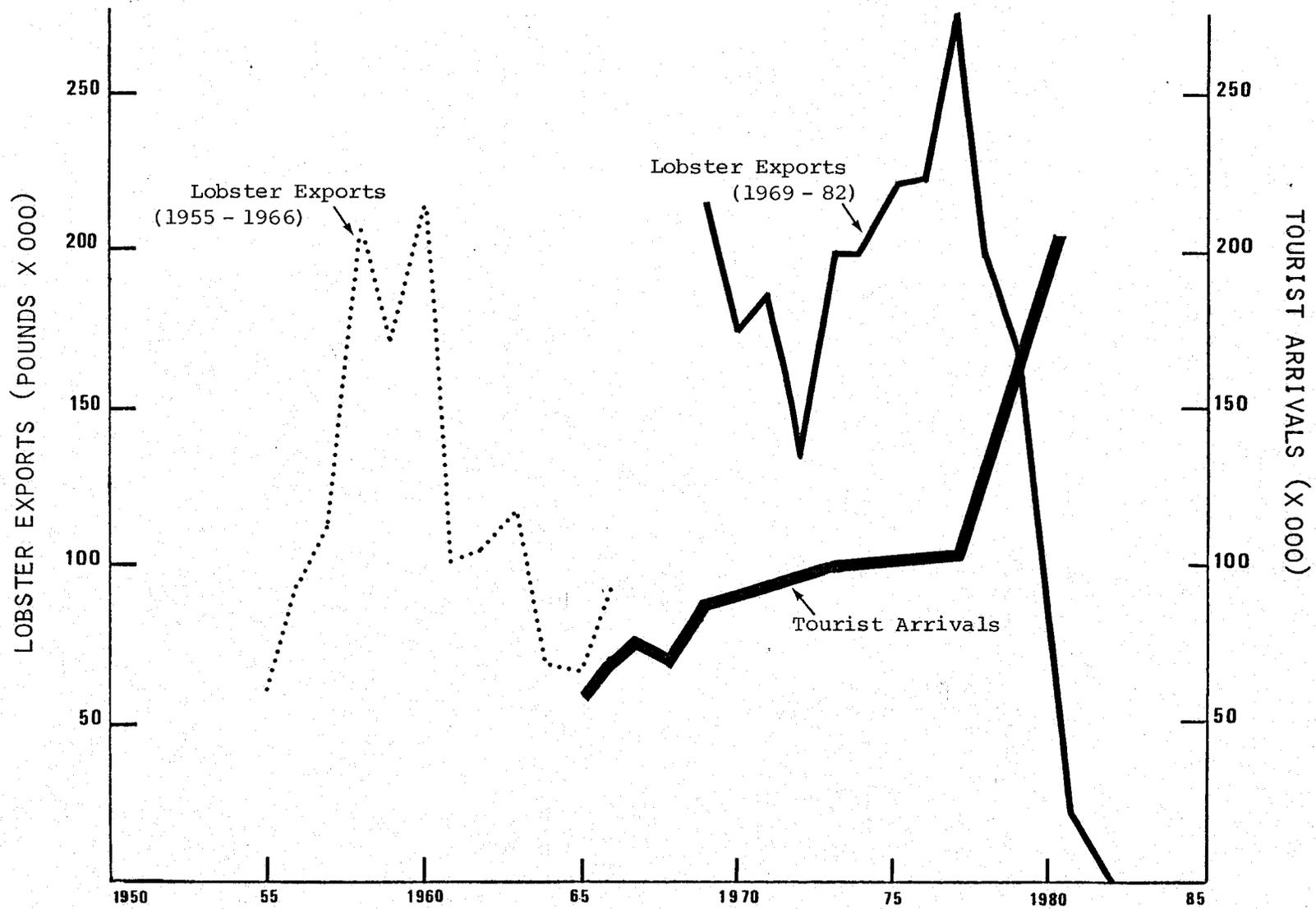


Figure 12. Lobster exports and tourist arrivals for Antigua. (Source: Information provided by Ministry of Agriculture, Lands and Fisheries.)

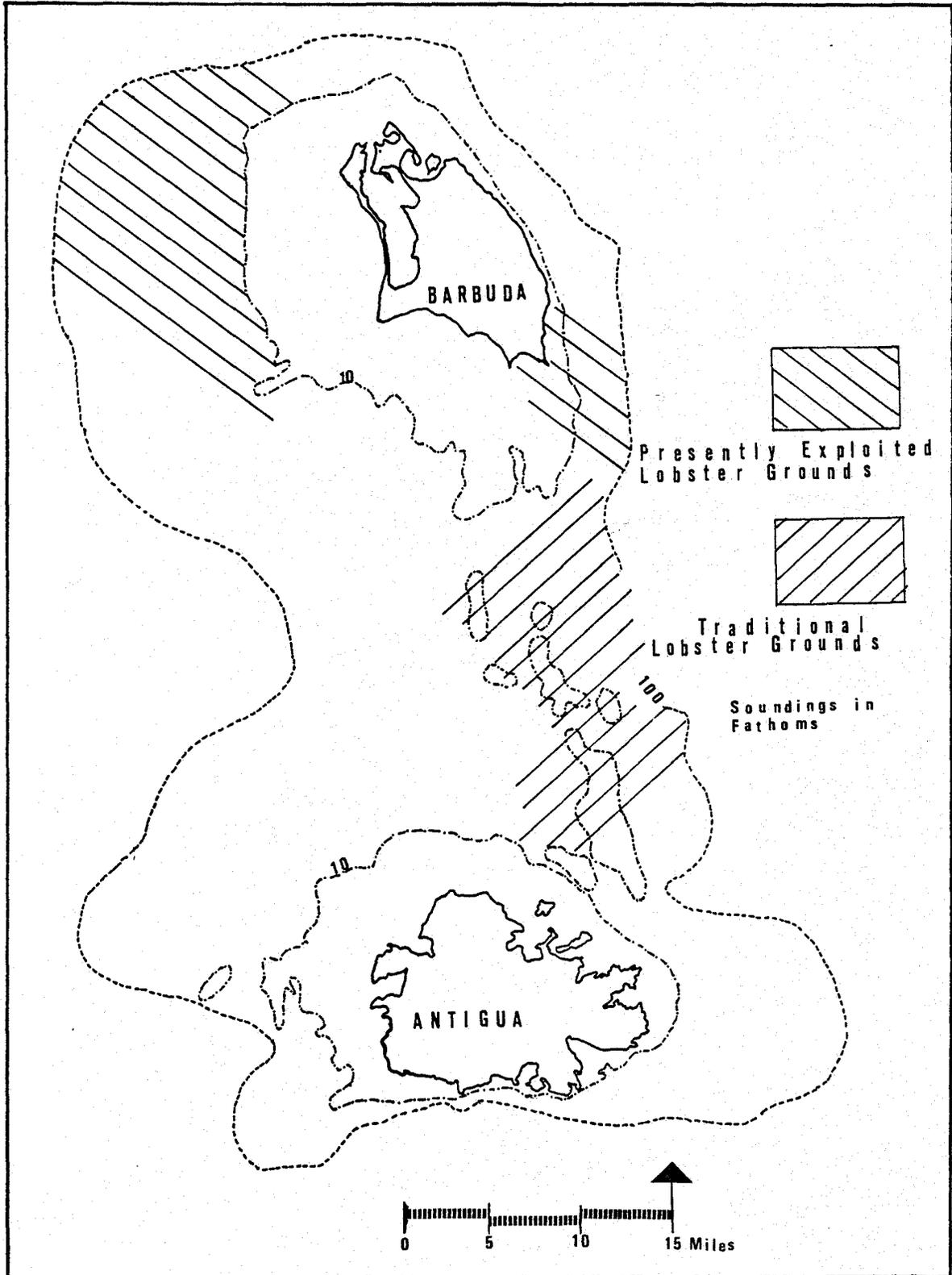


Figure 13. Traditional and present lobster fishing grounds of Antigua.
 (Source: Martin, personal communication, 1983.)

from conch and lobster. While there are no data available to assess the economic impact of a collapsed fishery on a per capita basis, gross loss of income to the community must be considered significant.

As a final note, as lobster catches have dropped and tourism has continued to grow, lobster is increasingly being diverted from export markets to local outlets (Figure 12). Despite this diversion, there continues to be a scarcity of the resource during the tourist season which has resulted in the species being dropped from the menus of several hotels and restaurants (Joseph, personal communication). If the U.S. Virgin Islands is a model with potential application to Antigua, the conversion of Antigua to a net importer of lobster is a real possibility. Unlike the Virgin Islands, which in an earlier period had alternative source areas to turn to, Antigua may not have the option as the region's stocks become increasingly scarce.

Unfortunately, Antigua seems to be representative of many of the small developing countries which are rapidly exploiting their natural resources as a means to obtain scarce foreign exchange. However, there are two countries which have been able to implement efficient and relatively successful management programs for their conch and lobster resources. These are Belize and the Turks and Caicos Islands.

4.3 Belize

The Belize fishery sector, dominated by the lobster and conch fisheries, has become one of the country's most important industries. As recently as the early 1950's fishery exports consisted of only small quantities of lobster destined for the United States. Now fishery exports are more significant, exceeding US\$6,000,000 in 1982 (Figure 14).

The lobster fishery began in 1921 with the introduction of the first lobster pot from Nova Scotia (Craig, 1966). Despite the success of the pot equipment, failures in the packaging plants led to the fishery's demise in 1935. The industry was revived with the introduction to the region of refrigerated cargo boats owned and operated by the U.S. import companies (Smith *et.al.*, 1948). Since that period the industry has grown (Figure 15) to become the country's most important export fishery.

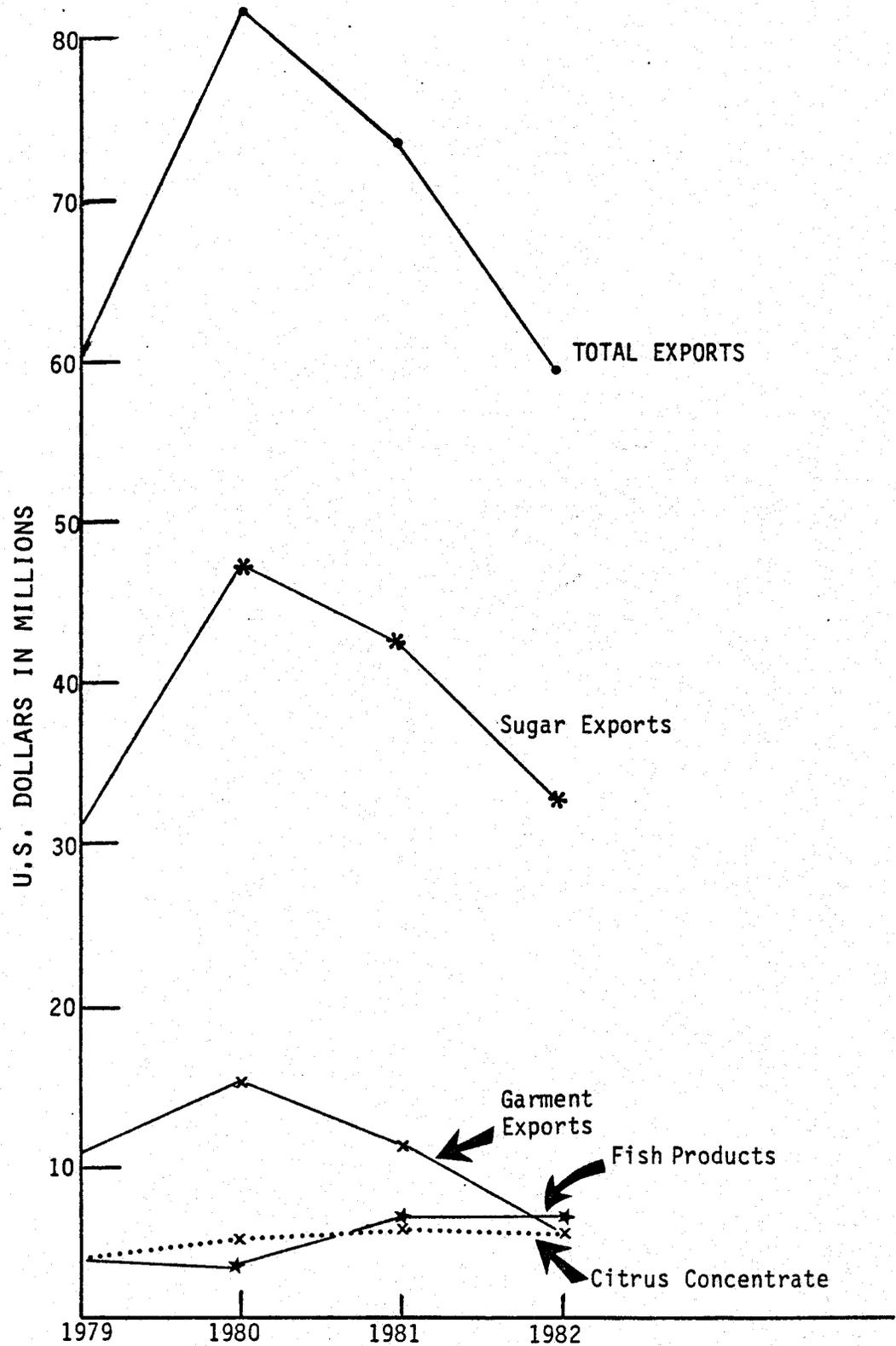


Figure 14. Value of Belize's major domestic exports in U.S. dollars. ¹⁾
 (Source: Belize Govt. Statistical Office, 1982.)

¹⁾ Data for 1982 are estimated.

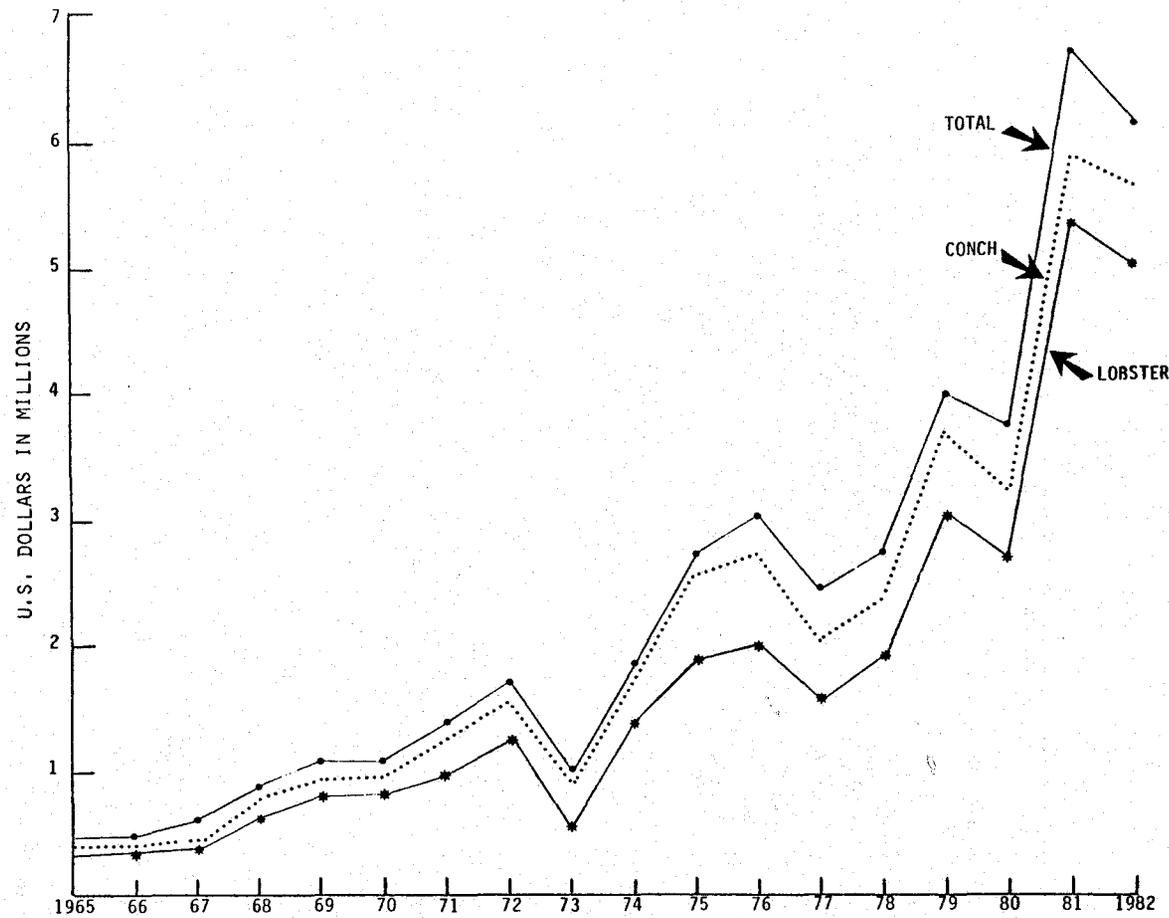


Figure 15. Cumulative totals and relative values of fishery exports in Belize, 1965-1982. (Source: Blakesley (1977) and information provided by Fisheries Management Unit, Ministry of Health, Housing and Cooperatives, Belize.)

In contrast to lobster, conch was a relatively unimportant fishery until the early 1960's. With increased demand in the U.S. market, however, exports grew from 100,000 pounds in 1965 to a peak of 1.25 million pounds in 1972 (Figure 16) and are currently the country's second most important source of "fish"-derived export revenue (Figure 15).

As the fisheries grew in Belize the economic necessity to provide finished products and negotiate competitively in external markets became readily apparent. In response the government encouraged the development of cooperatives whose function would be to "provide procedures and means for the efficient production, distribution, processing and sale of marine products through the united efforts and funds of its individual members" (Gibson, 1978). In fact, according to McElroy (1965), it was the establishment of the first indigenous lobster processing cooperative in the early 1960's that shifted the control of market from a U.S. buyer/processor monopsony to the local producers resulting in a dramatic rise in wholesale prices paid to fishermen that, in turn, was largely responsible for the rapid increases in lobster effort and catch after 1965. Based on a total of 800 full-time fishermen, gross per capita income was estimated to be \$4,130 in 1982.

Presently there are five cooperatives operating in Belize which represent over 700 fishermen and 450 boats. The cooperatives are the only legal means for exporting fish from Belize. They possess processing and packaging facilities, negotiate export markets annually, provide loans to their members and import equipment as needed.

The annual financial cycle of a cooperative consists of negotiating price and quantity contracts with foreign importers prior to the start of the fishing season. Once the season is underway, the cooperative's members receive initial payments for each landing they make. A second payment is made at the close of the fishing season based on the respective members' total landings and the external market price and quantities sold by the cooperative. A third payment is made at the end of the budget year, based on net profit of the cooperative, and distributed to its membership as determined by each member's respective number of shares. The breakdown of costs and revenues of one cooperative, illustrating the

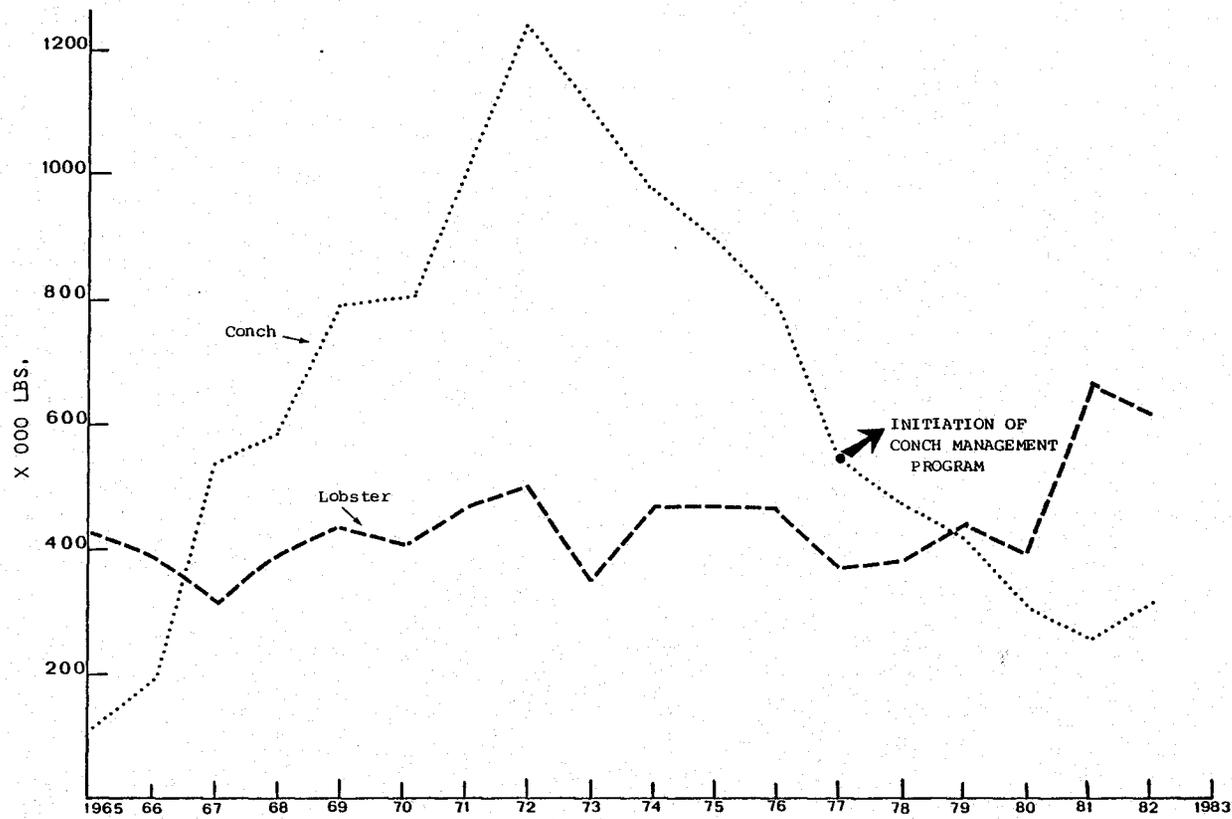


Figure 16. Conch and lobster exports from Belize. (Source: Information provided by Fisheries Management Unit, Ministry of Health, Housing and Cooperatives, Belize.)

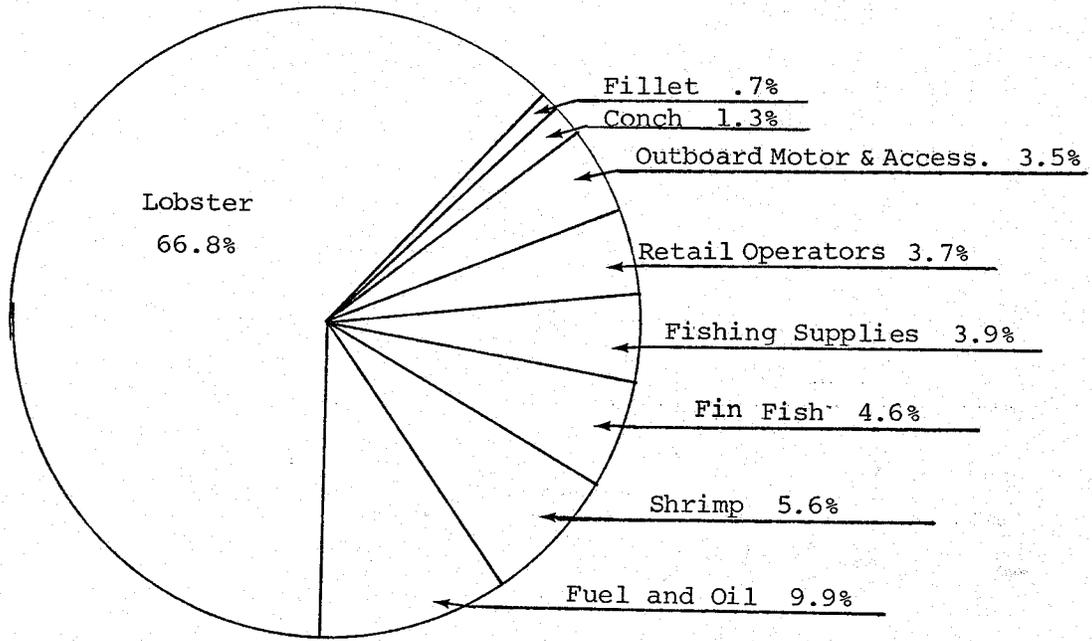
importance of lobster as a revenue earned, is displayed in Figure 17.

Catch per unit effort data collected for the lobster fishery over the previous five year period indicated that present catch levels are at or near MSY. While the data period was too short to confirm this trend, the use of alternative analytical techniques (yield per recruit) with growth parameters derived from Florida lobster populations supported this preliminary conclusion (Gibson, 1981). These indicators, together with the fluctuation of total catch figures in a range between 250 and 600 thousand pounds over the last 16 years (Figure 16), led the chief fisheries officer to conclude that lobsters were currently being harvested at MSY (Miller, 1981). In contrast, conch reached an export peak of 1.25 million pounds in 1972 and then fell into a rapid and steady decline continuing until 1981 before the trend was reversed and the first increase in catch was recorded (Figure 16).

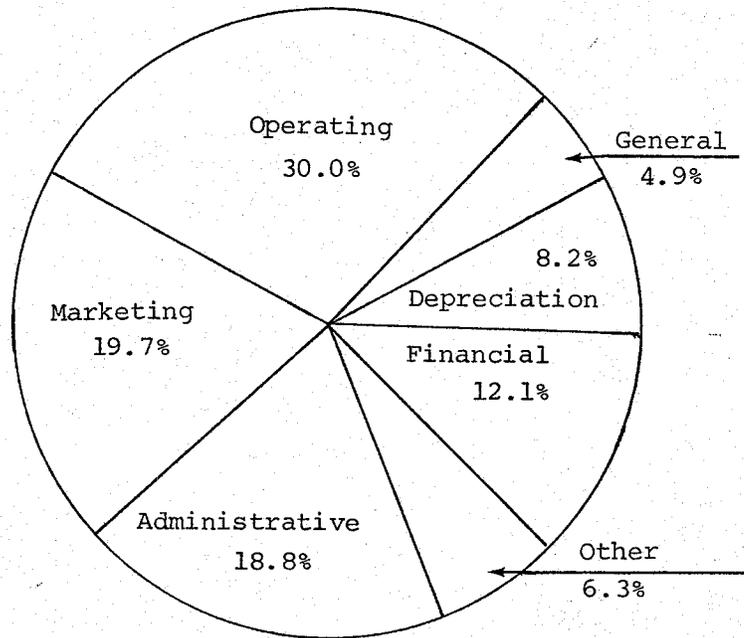
While the lobster history preceded the development of conch as an export commodity in Belize, the history of fishery development in the Turks and Caicos Islands was just the reverse.

4.4 Turks and Caicos Islands

The Turks and Caicos Island group, situated at the very southernmost end of the Bahamian chain, is typical of flat coralline islands found in many parts of the Caribbean (Caymans, Antigua), characterized by a sparse vegetative cover and few natural resources. Turks and Caicos is fortunate however, to possess an extensive shallow submarine bank fringed by reefs providing suitable habitat for conch and lobster. The island group is unique in its long export record for conch extending back to the early 1900's (Figure 18). Doran (1958) described the early years of the trade as a traditional export fishery to Haiti. The resource was fished by men working from dinghies operating from 30-40 foot sailing sloops. Using only a water glass and gig, conch were "hooked" to a depth of 20-25 feet from the surface. The animal was "cleaned" and dried on the sloop. The product was taken to Cap Haitian, Haiti, where in exchange for conch, the sloop bought back stores of fruit and vegetables to islands poor in such produce, before repeating the cycle anew.



THE INCOME DOLLAR SOURCE



THE EXPENSE DOLLAR BREAKDOWN

Figure 17. Percentage income and expenses of Caribena Cooperative for the operating year 1981-82. (Source: Caribena, 1982.)

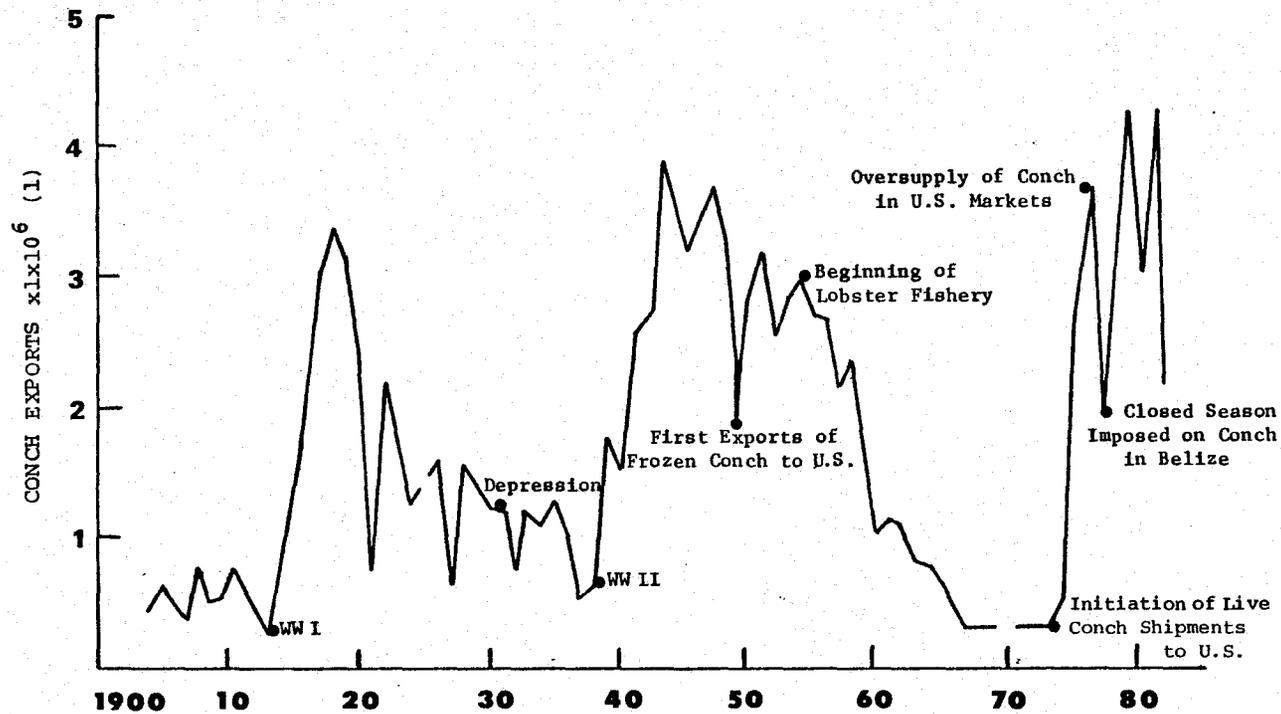


Figure 18. Conch exports from the Turks and Caicos Islands (1904-1982).
 (Source: Nardi, 1982; adapted from Doran, 1958.)

(1) Includes both dried and frozen meats.

Over the years until the late 1950s, Doran estimated an average of 1.7 million conch were exported annually with a maximum of 3.9 million reached in 1944. Doran attributed the increases in conch exports at the initiation of WW I and II to the diversion of cargo ships away from the region which had been importing alternative sources of protein that competed with conch. The decline in exports between the two world wars was attributed to the world-wide economic depression and decreased purchasing power. The increase in production from the late 1940s to the mid 1950s was attributed to the development of a frozen conch export market to the United States. Since that period a diverse range of factors, both local and external, have been identified as influencing the status of the fishery including the development of the more lucrative lobster fishery (Hesse and Hesse, 1977); passage of legislation in Florida affecting conch harvesting in 1965 and again in 1971 (Stevely and Warner, 1978); development of a growing market which began in in the United States in the late 1960's (Brownell and Stevely, 1981); and reduction of supply from competing exporting countries in the late 1970's (Brownell and Stevely, 1981). Despite fluctuations in exports of conch, the islands came to dominate the market during the period 1970-78 (Figure 19) and accounted for \$717,000 in export revenues in 1981.

The lobster fishery first developed in the late 1950's and has grown to a level averaging 620 thousand pounds per year for the period 1974-79, surpassing the conch fishery as the primary source of foreign revenue (Kucharski, 1980). Together these two fisheries constitute 95 per cent of all fish export revenues generated representing an estimated \$2.2 million in 1981.

The industry consists of five commercial processing facilities, four of which are located on South Caicos. While policies vary between plants, fishermen generally can work either as "independents" selling their daily catch directly to the company or on contract in exchange for use of the plant's boats and supplies. The industry dominates the island's private sector employing an estimated 300 fishermen and providing additional employment opportunities to as many as 2,000 individuals working in related support and service sectors (Hamaludin, 1982). Estimated per capita in-

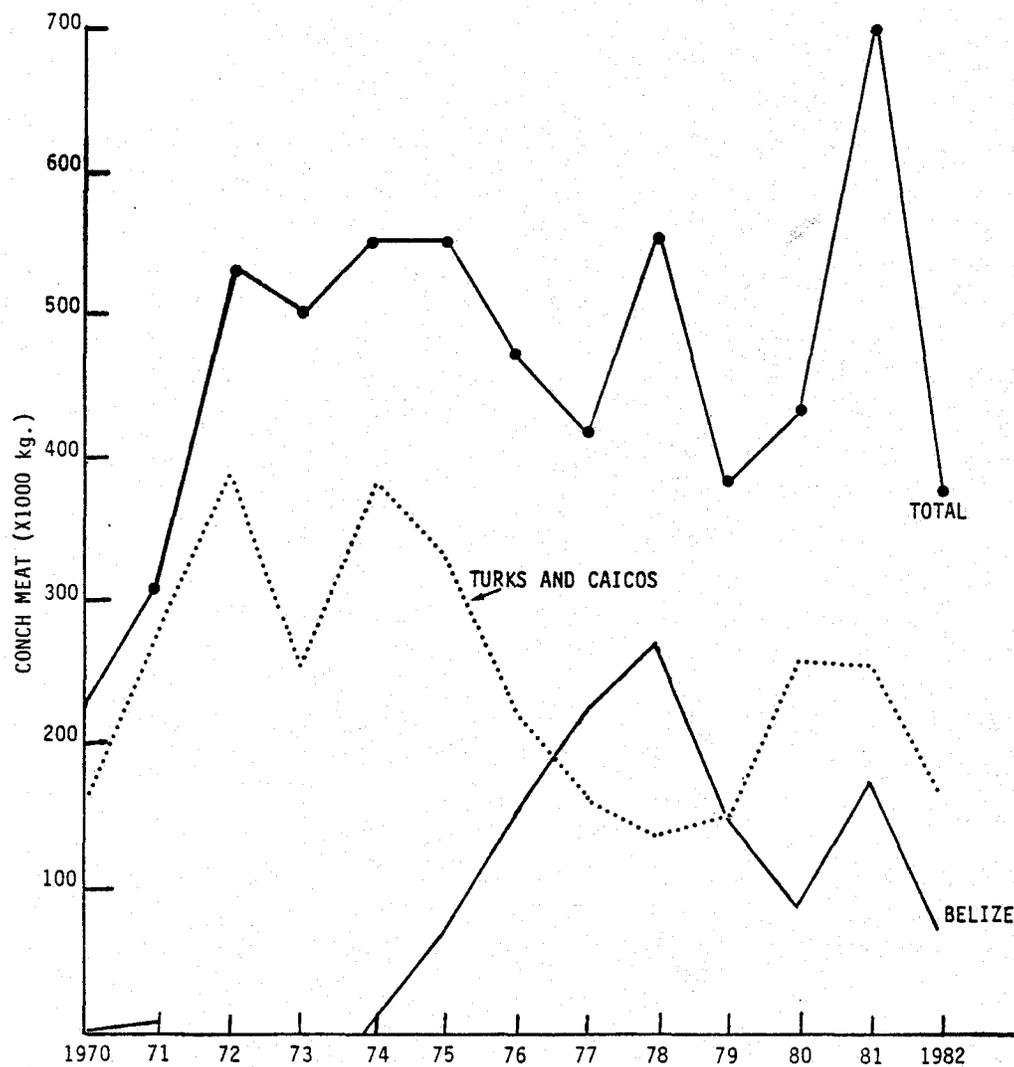


Figure 19. Conch meat imported through Miami, 1970-1982.
 (Source: Brownell and Stevely, 1981; and National Marine Fisheries Service, Fisheries Development Analysis Branch, New Orleans, Louisiana.)

come to fishermen from conch and lobster was \$5,246.

As in our previous site examples, accurate determination of the status of Turks and Caicos lobster and conch stocks is constrained by a poor data base. However, based on the results from interviews with the islands' chief fishery officer (Hall, personal communication), a plant owner (Gasgill, personal communication), and a review of the literature (Hesse and Hesse, 1977; Nardi, 1982), there appears to be a consensus that conch stocks are diminishing, although there is lack of consensus whether this is strictly a localized condition or occurs over the entire shelf area. Nardi (1982) provides data showing conch exports from the 1975 to 1981 averaging a relatively constant one million pounds per year, but it is difficult to ascertain if these levels are sustainable yields or represent the exploitation of the population's capital base. Fears of the latter have resulted in new regulations which will be described below.

There appears to be a higher degree of certainty in regards to the lobster population as CPUE data exist back to 1974. Based on an assessment of these data and landings dating back to 1959, Kucharski (1980) states all available evidence indicates the fishery is at or near its MSY.

5. COMPARING MANAGEMENT APPROACHES

In the previous examples, the development of the respective conch and lobster fisheries in four different Caribbean areas has been outlined, their economic significance described, and some of the issues associated with apparent over-exploitation identified. At this point, it would be productive to examine and compare the individual management regimes which have been put in place since the commercial development of the fisheries in each of the four study areas and then attempt to determine what factors played a role in successful management. However, having stated our objective, it would be prudent to avoid too rigorous a comparative analysis. This is due, in part, to the paucity of data on which to judge the "true" status of local fish stocks. Further, natural fluctuations in fish populations, as well as other factors beyond the scope of the present study, affect stocks and serve to complicate the evaluation of at least the short term effectiveness of a particular management approach. Finally, each of the four areas have a different development history and resist strict comparative analyses. Despite these caveats, drawing comparisons can still prove instructive and are therefore presented. In the discussion of management regulations, which follows, we make occasional reference to the management tools previously identified in Section 2.2 above but for brevity's sake, they are identified by number only in the discussion of the first study area.

5.1 Belize

As the example with possibly the most successful existing management program, Belize is a logical place to begin.

Regulation of lobster first began in 1963. In those regulations, which have been periodically updated, an annual total allocation was set to be divided among the cooperatives on the basis of number of members and past landings. This allocation (currently set at 600,000 pounds) had the affect of limiting overall catch which, in the case of Belize, is determined by a best estimate of MSY (tool no. 7). Other regulations presently include: a six ounce minimum tail weight or 3 1/4 inch minimum carapace length (tool no. 5); a four month closed season extending from

15 March to 16 July (tool and no. 3); prohibition on the capture of egg-bearing and soft-shelled moulting lobster (tool no. 4); and prohibition of use of SCUBA (tool no. 6).

Unlike lobster, conch remained unregulated until 1977 when the continuous decline in landings forced the formulation of management regulations. These are: a minimum seven inch shell length and three ounce (market clean) meat weight (tool no. 5); a three month closed season extending from 1 July to 30 September (tool no. 3); and prohibition of SCUBA use (tool no. 6). Whereas the lack of CPUE data makes it difficult to judge the effectiveness of these new regulations, the reversal of a downward trend in 1981 with the first annual increase in conch levels may in fact be partially attributable to their implementation. Siddall (1983) estimates queen conch reach average market size in 2 1/2 years. Based on this evidence and the assumption the regulations have been effectively enforced, the time period between regulation implementation and first observed increases in catch would have allowed for three year classes to enter the size range suitable for harvest.

The key to the effective enforcement of these regulations appears to lie with the cooperatives. Besides functioning as the principal means to process, package and export conch and lobster they also function as a vehicle for managing the country's fisheries. By requiring all fish exports to be channeled through the five cooperatives, the government has limited the production centers required to focus enforcement activities. Through periodic enforcement checks, adequate penalties for violating fishing laws, and a growing awareness by management of the need for a regulated fishery to preserve cooperative investments, Belize's fishery sector has become relatively efficient.

The current personnel support available to manage the Belize fishery consists of 12 staff members comprising the Fisheries Management Unit (FMU) with an operating budget of US\$86,535. The fishery more than pays for its management and development through a five per cent ad valorem duty which generated \$310,000 for the government in 1982 or 70 per cent more than was expended for government related fishery affairs that year (Table 6).

Table 6. Management costs, export values, and revenues for Belize's conch and lobster fishery in U.S. dollars. (Source: Caribena, 1982; Ministry of Health, Housing and Cooperatives, Belize.)

FISHERIES MANAGEMENT COSTS AND REVENUES

FISHERIES MANAGEMENT STAFF:

Fisheries Administrator	1	Technicians	2
Fisheries Officer	2	Clerical	2
Asst. Fisheries Officer	1	Boat Crew	1
Inspectors	1	Watchmen	2

TOTAL STAFF: 12

FISHERIES MANAGEMENT BUDGET AND REVENUES (1983 - 84):

<u>Fisheries Budget</u>	=	<u>\$ 86,535</u>	=	28%
Est'd Annual Govt. Revenue from Fisheries	=	<u>\$310,000</u>	=	

EXPORT VALUES AND REVENUES

EXPORT VALUE (1982):

Lobster	610,110 lbs.	@ \$8.25/lb. (approx.)	=	\$ 5,033,407
Conch	314,350 lbs.	@ \$2.12/lb. (approx.)	=	667,993
Other		@ \$0.89/lb. (approx.)	=	457,164
				<u>\$ 6,158,564</u>
<u>Fisheries Budget</u>		<u>\$ 86,535</u>	=	1.4%
Gross Export Value of Fishery	=	<u>\$6,158,564</u>	=	

(Conch and Lobster Total Fish Production, as percentage of total= 93%.)

ESTIMATED VALUE TO FISHERMEN

Lobster	610,110 lbs.	@ \$4.55/lb.	=	\$ 2,776,000.
Conch	314,350 lbs.	@ \$1.68/lb.	=	528,108.
				<u>\$ 3,304,108</u>

<u>Gross per capita income attributed to conch and lobster</u>	=	<u>\$ 3,304,108</u>	=	\$4,130.00/per
Direct Employment		800		employee

It is important to note the role educational activities have played in assisting the (FMU) to manage a fishery valued at more than \$6 million. Through both local and foreign assistance, a wide variety of programs have been funded which have been directed towards increasing the community's awareness on a variety of fishery-related issues including conservation. These have included short term training programs overseas, local workshops, and public information dissemination activities.

The wide public exposure and involvement in many such educational efforts can be partly attributed to the development of a relatively large and sophisticated institutional infrastructure concerned with fisheries development and management. These include the Belize Fishermen Cooperative Association and the Fishery Advisory Board. The Association is a thirteen-member body elected from the cooperative membership which serves to oversee cooperative activities and represent their interests to government (Gibson, 1978). The Advisory Board is composed of members from government and the fishery and business communities with responsibilities to advise the government on matters which could affect the industry.

Despite what appears to be a relatively effective national management program of an economically significant fishery, problems still remain. Chief among these are issues of an extra-national character. Due to lack of enforcement capabilities and disputed territorial waters, illegal fishing of high-value species occurs most notably in the south in disputed waters with Guatemala and Honduras. More complicated are illegal transactions involving Belizians selling lobster and conch to foreigners by-passing the cooperative system. Black markets such as these provide outlets for catches beyond the maximum national quota as well as for illegal lobster (shorts, out of season, egg-bearing). From a management perspective this represents a "leak" of a national resource outside of the existing management regime, the magnitude of which cannot be determined or controlled within the present management and enforcement structure. These extra-national issues are not unique to Belize and will surface again in the present study.

5.2 Turks and Caicos

In comparing the Belize experience with that of the Turks and Caicos Islands, one discovers more similarities than differences. Management regulations for lobster consist of a 3 1/4 inch carapace length and/or 5 ounce tail weight and a closed season from August 4 to March 31. Conch regulations consist of a minimum meat size of four inches and/or minimum shell diameter of seven inches. Scuba is also prohibited in the commercial fisheries.

However, due to the perceived over-fishing of conch stocks, the Fisheries Department is now reviewing all regulations. At present, that agency is considering the implementation of a closed season and annual maximum quota for conch as well as a proposal to require that all landings pass through a central landing site to facilitate enforcement efforts.

The fisheries department staff is relatively small (7) in contrast to the economic significance of the fishery it has been charged to manage. The department's present budget is US\$56,000, or less than 60 percent of the government revenue generated by the fisheries but proportionately more than the ratio calculated for Belize (Table 7).

Similar to the aforementioned Belize example, enforcement responsibilities are appreciably facilitated by centralization of the five processing plants in the islands (four are located on South Caicos).

Conservation education activities directed toward the community are minimal. Rather, there appears to be a reliance by the fishery officers on the plant owner's long-term self-interest to govern harvesting practices and facilitate the enforcement officers' duties. The validity of this assumption is open to question, at least in the case of Turks and Caicos. If maximization of profit is the sole objective of the company, one might be able to justify in economic terms a short term harvesting strategy characterized by low capital investment, high rates of extraction and possibly absentee or foreign ownership. In this light, a plant with little capital investment might accept the trade-off of losing the long-term sustainable exploitation of a species for the short-term maximization of profits. Enlightened self-interest cultivated by education

Table 7. Management costs, export values, and revenues for the conch and lobster fishery of Turks and Caicos in U.S. dollars.
(Source: Hall, 1982.)

FISHERIES MANAGEMENT COSTS AND REVENUES

FISHERIES MANAGEMENT STAFF:

Fisheries Officer	1	Clerical	1
Inspectors	4	Boat Crew	1

TOTAL STAFF: 7

FISHERIES OPERATING BUDGET: (1982) \$56,000

ESTIMATED ANNUAL GOVERNMENT REVENUE GENERATED FROM FISHERIES:

Commercial Fishing Licenses	300 @ \$20	\$ 6,000.
Boat Registration Fees	150 @ \$50 (ave.)	7,500.
Fishery Plant Registration Fees	5 @ \$5,000	25,000.
Excise Taxes:		
Lobster - 237,396 lbs. @ 17cents/lb. (approx.)		40,115.
Conch - 358,702 lbs. 5cents/lb. (approx.)		17,935.
		<u>\$96,550.</u>

Fisheries Budget	\$ 56,000	
Govt. Revenue Generated from Fisheries	<u>96,550</u>	= 58%

EXPORT VALUES AND REVENUES

EXPORT VALUE (1980-1981):

Lobster -		
Tails	142,810 lbs. @ \$8.00/lb.	\$1,142,480.
Whole cooked	73,640 lbs. @ \$3.00/lb.	220,920.
Cooked meat	20,946 lbs. @ \$2.00/lb.	41,892.
Conch	717,404 lbs. @ \$1.00/lb.	717,404.
Scale Fish	46,054 lbs. @ \$2.50/lb.	115,135.
		<u>\$2,237,831.</u>

ESTIMATED VALUE TO FISHERMAN:

Lobster (est'd.)	564,908 lbs. @ \$2.00/lb.	\$1,129,816.
Conch	888,318 lbs. @ .50/lb.	444,159.
		<u>\$1,573,975</u>

Gross per capita income attributed to conch and lobster	=	\$1,573,975	=	\$5,246/per
Direct Employment		300		employee

may succeed in Belize because the motives of the fishermen and owner are the same but fail in other areas where economic and conservation objectives differ. These differences must be taken into account by the individuals responsible for management.

In another parallel with Belize the most serious problem facing the industry, as perceived by the fishing community, is foreign poaching by fishermen from the Dominican Republic and Honduras. Lack of enforcement capabilities appear to be the principal constraint to preventing illegal fishing.

Whereas the two preceding site examples were relatively "structured" fisheries in that the control of production was held by only a few entities (cooperatives in Belize, centralized processing plants in Turks and Caicos), the Virgin Islands and Antigua are characterized by unstructured distribution networks. This, it is suggested, places an added burden on achievement of the effective application of management regulations.

5.3 U.S. Virgin Islands

Management of spiny lobster in the U.S. Virgin Islands was first provided for in Territorial Act 3330 in 1972. The principal regulations affecting lobster called for a minimum tail length of 5 1/2 inches, certain gear restrictions, and the voluntary submission of catch data. Prior to this date, lobster regulations were limited to a prohibition against the taking of gravid females and certain general fishery ordinances (e.g., prohibition against the use of poisons). Enforcement was confined to periodic spot checks of the islands' principal landing centers (Fiedler and Jarvis, 1932).

However in 1980, in response to the federally mandated requirement to develop fishery management plans, the Caribbean Fishery Management Council drafted a plan for lobster management. In this plan OY was defined as equivalent to MSY. The lobster population was treated as a unit sharing a common shelf of Puerto Rico and the U.S. Virgin Islands and thus subject to the same regulations. The specific regulations proposed were protection for gravid females and all animals with a carapace length (CL) of less than 3.5 inches and the submission of catch/effort data.

To date no management regulations have been developed for conch.

The agency responsible for the management of marine fisheries in the Virgin Islands is the Division of Fisheries and Wildlife. Within this agency 10 of the 17 staff members are assigned to fisheries duties. In contrast to the other examples, responsibility for enforcement lies in the Bureau for Environment and Enforcement, an agency outside of the Division but sharing the same parent agency (Department of Conservation and Cultural Affairs).

A relatively large budget and the ability to defray enforcement expenses through a sharing of resources with other government agencies gives the Fisheries Division a greater capability to monitor regulatory compliance than exists in the other three case study areas. The use of government patrol boats gives the Division a sea-going capability virtually non-existent in the other site examples. In addition, a large fisheries staff assures a higher frequency of spot checks at landing sites and retail outlets, while master fishermen are employed to work with local fishermen and to verify the accuracy of their CPUE data. All these activities come at a cost, for the Division's operating budget is more than four times the size of the next highest budget among the four sites (Belize), amounting to \$360,000 for the 1983/84 fiscal year excluding the aforementioned enforcement expenses.

5.4 Antigua

Antigua lobster regulations provide for a closed season extending from December 15 to May 1. There also are prohibitions on the taking of lobster smaller than 3 1/2 inches carapace length or 10 inches total length and of gravid females. These regulations, implemented in 1978, represent a significant increase in the degree of management constraint. Formerly, legal restrictions only applied to exported animals, including a minimum size of four inches total length and a prohibition against the export of gravid females (Peacock, 1974).

There are no restrictions on the harvesting of conch.

The export industry is largely in the hands of individuals who serve as "middle men" between the fishermen and importers. The primary role of

these individuals is to identify and negotiate agreements with importers from the external market, purchase and prepare conch and lobster from local fishermen, and, finally, arrange for shipment to fulfill their contractual commitments. Exporters are licensed biannually by government.

The Antiguan Fisheries Department is small, consisting of one fisheries officer and a small secretarial support staff. The government's primary responsibility has been to provide ice for the country's fishermen. Enforcement activities are confined to periodic spot checks at principal landing sites and hotels and restaurants.

In recognition of the "inefficiencies" in the present marketing system, several fishermen have joined together to form a burgeoning fisheries association with the intent of eventually developing into a cooperative.

5.5 Analysis

In light of these comparisons, we offer several observations. First, a principal constraint shared by all fisheries management units was lack of an adequate data base to determine the status of stocks with any degree of certainty. Secondly, in each unit the stated management objective for lobster was MSY. Common management tools shared by all were size and selective harvest (Table 4). However, in terms of number of tools employed to achieve the stated objective, Turks and Caicos and Belize appear to have more restrictive management programs plus a well defined harvest, processing and distribution system which facilitates monitoring activities, unlike the diffuse structure in the Virgin Islands and Antigua. Finally, of the four examples discussed, only Belize and Turks and Caicos currently have conch management programs.

At the risk of over simplification, Antigua appears to be following the development path previously taken by the U.S. Virgin Islands. Continuing growth of Antigua's tourism sector is creating shortages of local conch and lobster, causing cutbacks in the export market. Whether this trend will continue, resulting in the island's eventual conversion to a dependency on conch and lobster imports, remains to be seen.

On the assumption that we can accept the available evidence indicating continuing levels of exploitation of lobster stocks at or near MSY in Belize and Turks and Caicos and thus a measure of apparent success of their respective management programs, we can make a few tentative conclusions as follows. Management effectiveness of coastal fish stocks is related to the degree of restrictiveness and appropriateness of the tools applied, cannot be guaranteed by the presence of regulations alone, and appears to be closely linked to monitoring a few well-defined production centers rather than monitoring dispersed harvest and distribution networks. Savings in staff and budget derived from concentrated facilities is not applicable to Antigua with a sole fishery officer. This finding indicates that a certain "critical mass" of management staff is needed to carry out minimal management functions. Finally, Belize was the only country which had an extensive outreach and educational program associated with the fisheries management program, a critical element, in the author's opinion, in determining the program's success.

6. OVERCOMING MANAGEMENT CONSTRAINTS

In light of the four site examples and brief comparative analysis, we need to identify measures to overcome constraints which block the development of effective fishery management strategies in tropical developing coastal countries.

6.1 National Constraints

6.1.1 Data Base

One constraint is the absence of an adequate data base upon which to develop a management program. The traditional response to meeting this need has been to by-pass the data collecting phase and adopt regulations for the same or similar stocks which have been developed elsewhere. In the case of the spiny lobster, much of the early work on life cycles and population dynamics was done in Florida. Since the initiation of management programs based on this work, first by the State of Florida, then by the Southeast and Caribbean Fisheries Management Councils, many Caribbean countries have adopted similar regulations.

In another more recent approach, Munro (1983) describes a technique in which the status of fish stocks can be determined solely by the routine collection of length-frequency data. The significance of this technique is the facilitation and simplification of data collection procedures which would prove particularly relevant to understaffed fishery units. At present at least one such data collection program is underway in Nevis and St. Kitts (Goodwin, personal communication) and is being expanded to include several other Eastern Caribbean Islands.

6.1.2 Enforcement

Once a management data program has been developed, whether designed internally or adopted from other similar programs, the emphasis shifts to implementation. Here one meets a second major constraint, the need for adequate resources, both human and financial, to enforce the newly proposed management regulations.

In Belize, the government's partial response to this need has been to actively solicit the cooperation of the fishermen in support of the

achievement of the stated fishery management objectives. Cooperation is facilitated through several participatory programs which, in part, demonstrate that management and conservation of the country's fisheries is to everyone's own best interest. A similar approach is presently being pursued by Environmental Research Projects in Nevis and St. Kitts (Goodwin, personal communication). Both these approaches are in contrast to the more adversarial relationships which exist between harvesters and managers in many developed countries. While differences in effectiveness of regulation implementation may exist between these approaches, for our purposes the principal advantage of the former is the reduced enforcement costs implied by the active cooperation of the fishermen in the management program.

Enforcement costs can be further reduced when landing sites or production centers (cooperatives, processing plants, etc.) are few and concentrated. In both the examples of Belize and the Turks and Caicos Islands, the few sites in need of policing signified reduced manpower demands and more efficient application of available resources to assure regulatory compliance.

In countries where effective enforcement procedures already exist for fin fish stocks but are absent for conch and lobster (or other high value resources) due to their relative scarcity (such as in shelf-poor Barbados), the management of local production can often still be justified on a cost-effective basis. Continued local production of high-value species can reduce dependency on expensive imports as luxury items for the tourist market or domestic consumption. Where the capabilities already exist to monitor the catch of fish stocks, only a modest additional effort is required to enforce regulations for conch and lobster species (assuming landing sites or processing and marketing facilities are shared with the regulated fisheries). Where these facilities do not exist or in the absence of any organized fishery, benefits accruing from effective enforcement of management regulations for small conch and lobster stock sizes may not offset the associated costs.

6.1.3 Depleted Areas

Up to this point, we have been discussing solutions to management constraints where existing stock levels still justify traditional approaches. In severely depleted areas where management of the remaining stocks is largely an academic exercise "reseeding" is becoming increasingly popular as a management tool for conch. This approach takes advantage of established successful mariculture techniques presently capable of raising conch from egg to juvenile. Egg supply still remains dependent on collection from the wild, though research is continuing on hormone-induced spawning of captive females (Siddall, 1983).

While present economic and technical constraints may prevent raising juvenile conch to market size (Orr, 1983) the development of low-technology methods and equipment at the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) may make restocking strategies a viable venture.

In 1981, the Netherlands Antilles, with the assistance of RSMAS, initiated the Carco project in Bonaire. The project consisted of setting up a small laboratory, collecting conch egg masses, and hatching and rearing conch to the juvenile stage. The first batch was released in 1983, and the initial findings indicate survival rates are much higher than expected (van Buurt, personal communication). Other hatchery activities are currently underway at the University of Puerto Rico and Foundation for PRIDE in the Turks and Caicos Islands.

Advances in culturing spiny lobster have been slow. Its long and complicated larval phase has so far prevented artificial rearing efforts to complete its life cycle. Despite these problems initial experiments conducted by Environmental Research Projects in Grenada, employing settlement plates to collect recently metamorphosed lobster juveniles for pen rearing have proved promising.

These restocking tools would be unnecessary in an ideal world where effective natural stock management is commonplace. But in a real world characterized by rapidly diminishing conch and lobster populations, we are fortunate restocking strategies do exist and their continued development should be encouraged.

6.1.4 Habitat Modification

FAO has estimated that between 50 and 70 percent of the world's commercial fish catch comes from species which utilize coastal and estuarine areas (FAO, 1980). Uses vary among species and include one or more of the following: critical habitat for spawning or nursery grounds, feeding sites and protection. Coastal areas also provide the major source of nutrients to adjacent waters on which the food web is built and fish populations are dependent.

Coastal alterations without adequate planning can significantly affect these relationships often at the expense of many of the dependent coastal species. In the example of the Virgin Islands, due to the absence of baseline information, we will never know to what extent intensive coastal development during the 1960's and the subsequent loss of highly productive communities affected offshore conch and lobster populations.

In recognition of the growing problem of coastal degradation, Odum (1982) identified three basic approaches to incorporate coastal land use considerations into fishery management strategies. The first, and simplest, is to protect the fish populations during the stage of their life history when they use critical habitat. The second approach is to protect specific types of habitat such as in the designation of protective marine and estuarine reserves. Finally, the third, and most difficult, is to protect all habitat types which affect the coastal regime.

Recent legislation in Belize represents an example of an approach which falls between Odum's second and third options. In response to increasing deterioration of the coastal area due to pollution, tourism and urbanization (Miller, 1981) and the threat it posed to the country's fisheries, the government approved new regulations which gave the ministry responsible for fishery affairs the power to declare marine reserves to include adjacent lands. Reserve designation provides a protective status for the area and prohibits the destruction or disruption of its environmental quality. Attempts are underway to strengthen the existing regulations providing for power of review for any proposed coastal land use activity and to assess potential impact on the nation's fisheries.

The common thread shared by these approaches is the importance of acknowledging the linkages between the coastal area and its marine fisheries and the need to account for these relationships in both the management of fisheries per se as well as in the development of a comprehensive coastal area management strategy.

6.2 Regional Constraints

Despite evidence of the potential success of many of these innovative solutions to traditional management constraints they remain national approaches which are most effectively initiated at that level. In addition to these national approaches, several issues argue for a broader management approach than one based solely on physical or national boundaries. For our purposes, we will call these transboundary issues.

6.2.1 Foreign Fishing

One transboundary issue, foreign fishing, represented a major obstacle to effective management of stocks in both the Turks and Caicos Islands and Belize examples. This activity in effect circumvents national management efforts, making them less effective. Such illegal fishing not only places additional pressure on fish stocks but creates a potentially more serious problem among local fishermen. The typical reaction by locals to the realization that foreigners are flagrantly violating management regulations for fish stocks is to adopt the same behavior. This, in turn, makes a difficult situation worse and can eventually lead to the defeat of the proposed management program objectives.

One potential solution may exist in the example of the reciprocal fishery agreement signed between the United States and the United Kingdom which has permitted existing and historical patterns of fishing to continue between the waters of the U.S. and British Virgin Islands. A similar approach is being followed by Antigua and Guadeloupe to establish the right of mutual access for fishermen to their respective territorial waters. These agreements in turn provide the basis for the formulation of a common management program applicable to the signatory countries' respective fish stocks.

6.2.2 Biological Linkages

Transboundary issues can also be of a biological nature. Experiments by Ingle, et.al. (1963), indicating the occurrence of abnormally high densities of lobster larvae in Florida waters, suggested larvae could have been transported by ocean currents from distant spawning areas located to the south of the Yucatan Channel. Other researchers have suggested that lobster larvae are of local origin which have become trapped in gyres contributing to subsequent increased population counts (Johnson, 1974). While these explanations have yet to be satisfactorily resolved, the existence of possible relationships between two populations could have profound management implications. An example of a recent attempt to treat fishstocks separated by a political boundary as a single population unit is the lobster management plan developed by the Caribbean Fisheries Management Council. This plan recommended that uniform regulations and a common MSY be adopted by the respective governments of the U.S. Virgin Islands and Puerto Rico.

6.2.3 Economic Linkages

These political and biological transboundary examples share an economic counterpart. If a major producer country introduces a new technology, or older technologies previously prohibited due to their effectiveness in harvesting a resource to depletion, the short term effect is to lower international market prices. This, in turn, puts pressure on producers in other countries to adopt the same methodology to stay competitive. In the case of conch, many experts feel that a partial explanation for the success of the Belize and the Turks and Caicos management programs has been the prohibition of SCUBA which protects deeper water inhabitants which act as brood stocks to shallow water populations (Dammann, personal communication). However, recently increased levels of imports of conch into the Miami market taken by SCUBA in Colombia (estimated to be 103 thousand kg. from the period January to October, 1983, NMFS, New Orleans) have placed pressure on at least one Turks and Caicos producer to ask the government to reconsider conch management regulations in the islands (Gasgill, personal communication). While the expanded use of this tech-

nology would eventually result in the depletion of the resource causing both a shortage in Miami and higher prices, many producers prefer not to wait. Thus, economic pressure dictated by one country can have a deleterious effect on stocks regionally.

6.3 Regional Planning

International transboundary issues must be taken into account in planning for the management of living marine resources and require some form of regional strategy to supplement and coordinate existing national approaches. This is not a new concept, and there is evidence that some, albeit slow, progress is occurring toward achievement of that objective. In regards to fishery management, the Western Central Atlantic Fisheries Commission (WECAFC) in 1980 endorsed standardization of size limits on spiny lobsters within its area of jurisdiction. This recommendation was seconded in an informal joint workshop in Costa Rica involving fishery professionals from 23 countries in the west central Atlantic region (Villegas, et.al., 1982). In the area of enforcement transboundary issues are also being addressed. Three countries in the region (Barbados, St. Lucia and St. Vincent) are negotiating the development of a regional patrol boat capability to enforce newly declared exclusive economic zones on a shared cost basis. UNEP's Wider Caribbean Regional Seas Action Plan identified investigative studies of the role of coastal ecosystems in the life cycle of the region's commercially important species as a priority issue (UNEP, 1980). It is only through the continuation and support of these kinds of efforts leading toward a regional management approach of living marine resources that the long-term sustainable utilization of the common resource will ever be fully assured.

7. LESSONS LEARNED

7.1 Economic Significance

- Coastal fisheries are important to many tropical developing countries. Conch and lobster fisheries represent major sources of employment and income to many coastal peoples of the Caribbean. The two fisheries, in combination, provide Turks and Caicos' primary source of foreign exchange and account for significant portions of GNP in Belize and Antigua. Among the four areas studied as examples, an estimated 2,000 fishermen depend heavily on the income derived from these two fisheries resources, earning an average income ranging from US\$4,000 to \$7,000.

7.2 Market Considerations

- Harvest pressure on coastal fisheries is extremely sensitive to market demand. In most cases cited in the study, no commercial market existed for conch or lobster prior to 1950. Lobster was considered a nuisance fouling fish pots, and conch was harvested only for local consumption, Turks and Caicos' Haitian market being the exception. Rapid increases in demand attributed to increased consumer sophistication and the development of alternative markets led to increases in exploitive pressures on lobster. Similarly, in response to declines in Floridian conch populations and increased demands from the United States' Latin and West Indian populations augmented by tourism, market prices rose providing the incentive for conch exportation to the United States.

7.3 Over-fishing Risks

- Rapid increases in fishing pressure in the absence of management constraints can result in over-fishing and eventual stock depletion. In all sites described in the study, with the possible exception of Belize's and Turks and Caicos' lobster fisheries, increased pressure to export conch and lobster resulted in apparent rapid population declines. This pattern appears to accurately depict a larger regional phenomenon, based on the results from a survey questionnaire.

- Depletion of fish stocks may result in significant local social and economic costs. The U.S. Virgin Islands represents a good example of decreases in local stocks, coupled with increased demand, resulting in a reversal of the territory's traditional role, i.e., from lobster exporter to importer of both lobster and conch. There are indications that Antigua is following the same pattern. Other "costs" include the increased distances fishermen must travel to exploit new grounds, lost income from reduced catch, and secondary costs such as reductions in supplies of traditional protein sources in Haiti and Turks and Caicos as the regional market for conch developed.

7.4 Management Requirements

- The existence of fishery regulations alone do not assure a stock's successful management. In all site examples, with the possible exception of Belize, the apparent declines in lobster populations took place despite existing regulations. This implies that effective management requires a more comprehensive approach which includes, in addition to appropriate regulations, educational outreach programs to solicit active cooperation from the fishermen and community at large, adequate enforcement and data collection activities.
- Increased management efforts characterized by more stringent harvest regulations were developed only after over-fishing of conch and lobster become evident. Despite widespread indications of local stock depletion, present lobster regulations were implemented only recently in the U.S. Virgin Islands (1980); Belize (1963 and amended periodically since then); Antigua (1978); and Turks and Caicos (1973). Presently, conch remains unregulated in the U.S. Virgin Islands and Antigua. These results appear to be generally indicative of the situation in the wider Caribbean region based on information collected from the questionnaires.
- Successful management programs can be both efficient and economical. In terms of cost, both Belize and Turks and Caicos represent examples of areas where ad valorem taxes based on exports of conch and

lobster bring in income which far exceeds the costs of management. In addition, management effectiveness can be increased at reduced costs by encouraging active cooperation from the fishermen through outreach programs (Belize), and concentrating the number of landing sites and/or production facilities required to monitor for compliance.

- The absence of adequate data collection programs is a major constraint to the management of fish stocks. The case study adequately demonstrates the difficulties encountered in determining the status of fish stocks in the absence of sufficiently long time-series data collection. Gross catch statistics do not account for effort invested and thus are inappropriate to judge the effects of fishing pressure on stocks and the effectiveness of the management program. Methodologies have been developed which simplify data collection procedures and provide staff-short fishery units with the means to make rudimentary assessment of fish stocks.
- The increased incidence of fishery issues which are of an internationally transboundary nature argue for new integrative approaches to fishery management. These issues demonstrate the need for a more holistic approach to fishery management. On a national basis this may include the adoption of review measures for coastal development activities which threaten critical coastal habitats or species shared with adjacent states or territories. Regionally, the development of bi-lateral or multi-lateral management programs may be required.

8. GUIDELINES

- (1) Management objectives should be defined prior to the development of a fisheries management program. Management objectives will differ depending on whether the stated goal is maximization of catch, net revenue or an amalgam of socio-economic benefits. In most cases, levels of yield will change between goals. It is the desired yield level which will serve as a target of the fishery program and govern the selection of the appropriate management tools.
- (2) A comprehensive fisheries management program requires the systematic collection and analysis of data. The status of fish stocks and in turn the effectiveness of the management program cannot be determined without minimally collecting catch per unit effort (or length frequency) data over a sufficiently long period to identify trends in fish populations.
- (3) To increase the effectiveness and chances of success of a management program, the active cooperation of the producers/harvesters should be pursued. Sustainable yield management objectives are ultimately in the best interest of the producers as well as the consumers. An active effort to involve the users of the resource (the fishermen) in management program design is essential. This participatory approach should extend to the designing of management regulations. Mechanisms should be established to provide means for ongoing dialogue and education in both directions. Where possible, fishery management should be approached as a cooperative venture rather than an adversarial one especially in countries where artisanal (subsistence) fisheries survive side-by-side with commercial fisheries.
- (4) Facilities for commercial fishery landing and product processing should be concentrated to facilitate monitoring for regulatory compliance. Dispersed landing and distribution sites create excessive demands on enforcement staff. In countries where financial constraints dictate that government management and enforcement programs be highly efficient, marketing or processing "control points" can ease monitoring and enforcement procedures.

- (5) Research activities should be integrated in a comprehensive management program. Most existing fish population models have been developed in temperate latitudes and have little relevancy for tropical fish populations, suggesting the need for new models more appropriate to tropical systems. Research is also needed on the linkages between tropical coastal habitat modifications and fisheries activities.
- (6) In addition to monitoring and governing fish harvest activities, any framework for fisheries management needs to monitor other coastal resource harvesting and development activities which may adversely affect fish stocks. Increased losses of coastal fish production attributable to habitat degradation, from pollution, or other environmental modifications signify the need for a management mechanism which will evaluate the possible impact of proposed development on coastal fish stocks and provide means for mitigation. Options for such a mechanism include incorporating an environmental impact assessment requirement for coastal-related projects, empowering the existing fisheries management unit with a review function or the creation of a multi-agency body to resolve conflicts over coastal resource use.
- (7) Where coastal fisheries are significantly affected by forces of a regional nature, bi-lateral or multi-lateral organizations or agreements may be required to remedy the problem. The apparent increasing incidence of issues of a transboundary nature which affect coastal fish stocks demonstrate the inadequacies of national or local management approaches. New management approaches and mechanisms must be developed to address and resolve transboundary issues.

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Appendix 1

Summary, Sources and Methods of Data Acquisition

One phase of the data collection process consisted of mailing one survey questionnaire to each Caribbean country fishery officer (or equivalent where the position did not formally exist). The objectives of the survey were to obtain an additional perspective on the important issues related to conch and lobster management as well as to collect further information for the completion of the case study.

A master mailing list was compiled from a list previously developed by the author for an earlier survey, personal knowledge of particular individuals in the field and through information provided by the National Marine Fisheries Service.

Of the 34 countries (colonies, commonwealths etc.) identified within the geographic distribution of conch and lobster, surveys were mailed to 27 officers. The remaining seven countries, due either to recently completed or pending trips, were deleted from the list as the questionnaires were considered redundant to scheduled personal interviews in each of the countries.

The format (Attachment 1) consisted of six parts requesting general information and various data concerning the harvesting, marketing, importation, management and discernable trends in the status of both conch and lobster.

Of the 27 questionnaires mailed, 13 were filled out or responded to by letter for a 48 percent rate of return (Table 1). Together with the 9 countries visited, information was collected from 22 of the 34 countries equivalent to 65 percent of the total. Data from the remaining 12 countries were obtained through review of the literature, use of the results from previous surveys (IRF, 1980), and contact with other investigators in the field. In general, while the latter approach sufficed in collecting basic information relating to the two species, more detailed and/or current data concerning their status were scarce.

Three tables have been constructed summarizing the information ob-

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