

C. Rogers

PROGRESS REPORT ON DEVELOPMENT OF A MANAGEMENT PLAN FOR THE

ST. KITTS/NEVIS SPINY LOBSTER FISHERY

prepared by

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I. Summary

A. The general biology and ecology of the spiny lobster P. argus are reviewed. Coral reefs and seagrass beds are important habitats for juvenile and adult spiny lobsters. First-year juveniles are probably limited by the availability of suitable habitat. This suggests that it may be possible to increase the size of lobster populations through the use of artificial shelters. Preliminary studies by the Fisheries Division indicate that this technique has promise for St. Kitts.

B. During the past three years, the Fisheries Division has obtained measurements on more than 2500 lobsters in local landings and in the wild. This information has been used to provide estimates of growth rate, as well as indications of minimum reproductive size and reproductive potential of various size classes. Spiny lobsters in St. Kitts/Nevis reach minimum legal size (95 mm carapace length) about 34 months after the end of the larval stage. The average carapace length of reproductively active female lobsters is 106 mm. Lobsters with carapace lengths ranging from 105 to 120 mm make the greatest contribution to the population in terms of reproductive potential.

C. Information on local catches does not permit accurate prediction of sustainable yield at this time. Provisional analyses of growth data have been completed.

D. Purchases of spiny lobster by four local consumers during 1985 were more than half the total exports from St. Kitts/Nevis during the peak year of 1976. The annual value of the spiny lobster fishery is conservatively estimated to be at least half a million dollars.

E. Both local and export demand for spiny lobster are expected to continue to increase. Measures are urgently needed which will stabilize the current harvest at a sustainable level, provide the maximum yield from the spiny lobster stock, and establish the optimum exploitation strategy for St. Kitts/Nevis spiny lobster resources.

F. Recommended actions are:

1. Implementation of fishery regulations now in draft
2. A moratorium on activities which would increase the present harvest of spiny lobster, particularly commercial ventures involving spiny lobster export
3. Improved export and fishing licensing procedures to provide better information to the Fisheries Division
4. Prohibition of any activity which would damage shallow coral areas or seagrass beds

G. Proposed Fisheries Division activities related to the spiny lobster fishery are described.

II. Introduction

Living marine resources are among the major natural assets of Eastern Caribbean nations. At the same time, evidence from other Caribbean and neo-tropical areas makes it clear that depletion of these resources is virtually inevitable if exploitation is uncontrolled. Recognizing the potential of these resources as well as their vulnerability, the Fisheries Division of the Government of St. Christopher/Nevis has undertaken the preparation of management plans for major indigenous living marine resources.

The purpose of these plans is to identify workable means through which maximum benefits can be secured for the people of St. Christopher/Nevis on a sustainable basis. Technical information upon which these plans are based is obtained through literature review and applied research by the Fisheries Division. This research is not intended to provide an exhaustive picture of the biology of each species, but is targeted toward key management concerns and toward establishing the applicability of work done elsewhere to marine resources of St. Kitts/Nevis.

It is expected that fishery management plans will be reviewed by a Fisheries Advisory Committee representing public and private interests to insure that all concerns are considered in each plan. Because critical issues and concerns may change with time and because continuing investigations will improve the marine resource information base, periodic review of the plans after implementation will provide opportunity for necessary modification and improvement.

The following outline is proposed for fishery management plans (based upon similar plans developed by Fishery Management Councils in the United States):

1. SUMMARY

- 1.1 Fishery
- 1.2 Management Unit
- 1.3 Maximum Sustainable Yield
- 1.4 Optimum Yield
- 1.5 Issues in the Fishery
- 1.6 Management Objectives
- 1.7 Proposed Management Measures
- 1.8 Management Measures Considered but not Proposed
- 1.9 Recommendations

2. DESCRIPTION OF THE STOCK

- 2.1 Description of the species
 - 2.1.1 Identity
 - 2.1.2 Incidental Species
 - 2.1.3 Morphology
 - 2.1.4 Distribution and Larval Recruitment

- 2.1.5 Biological Description (life history)
- 2.2 Abundance and Present Conditions
- 2.3 Ecological Relationships
- 2.4 Estimates of Maximum Sustainable Yield
- 2.5 Probable Future Condition
3. DESCRIPTION OF HABITAT OF THE STOCK
 - 3.1 Condition of the Habitat
 - 3.2 Habitat Areas of Particular Concern
 - 3.3 Habitat Protection Programmes
4. DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK
5. SOCIAL AND ECONOMIC CHARACTERISTICS OF THE FISHERY
6. DETERMINATION OF OPTIMUM YIELD
 - 7.1 Objectives
 - 7.2 Alternative Optimum Yields
 - 7.3 Analysis of Impacts of Management Options
 - 7.4 Specification of Optimum Yield
 - 7.5 Special Recommendations
7. REQUIREMENTS TO OBTAIN MANAGEMENT OBJECTIVES
8. SPECIFICATION OF PERTINENT FISHERY DATA
9. RELATIONSHIP OF RECOMMENDATIONS TO EXISTING LAWS & POLICIES
10. REVIEW & MONITORING OF THE PLAN
11. REFERENCES

This report summarizes progress toward development of a management plan for spiny lobster fisheries in St. Kitts/Nevis. The purpose of this report is to present available information, describe progress to date, and identify current needs and priorities toward obtaining the additional information needed to prepare a useful management plan.

III. Description of the Stock

A. Description of the Species

1. Identity -- Commercially important spiny lobsters in the waters of St. Kitts/Nevis belong to the species Panulirus argus, distinguished by having pale yellow spots scattered over the dorsal surface of the abdomen ("tail"), and shallow grooves running part way across the dorsal abdominal segments.

2. Incidental Species --

a. Spotted lobster (Panulirus guttatus): dark body with many light-colored spots covering the abdomen and legs, and grooves which run all the way across the abdominal segments

b. Smooth lobster (Panulirus laevicauda): similar to P. argus, but with spots only on the sides of abdomen, and without grooves on the segments

c. Slipper lobster (Scyllarus aequinoctialis): paddle-like legs at the front, much less spiny than Panulirus species

d. Deepwater lobster (Justicia sp.): reddish color, with long slender claws, resembling freshwater crayfish

3. Distribution and Larval Recruitment -- Spiny lobsters belonging to the genus Panulirus are distributed in relatively shallow tropical waters throughout the world. P. argus is found throughout the Caribbean, as well as on the neotropical Atlantic coasts of North and South America.

Spiny lobster have a long larval stage (4 - 22 months; Phillips and Sastry, 1980; probably 6 - 12 months for P. argus; Sims and Ingle, 1966). The larvae (known as phyllosoma) are adapted for a floating existence in the open ocean, and are characterized by a flat, transparent body with protruding eyes and long legs covered with bristles. The first phyllosome stage is less than 2 mm long, while the last is about 35 mm (1.4 in) in length. P. argus pass through 11 phyllosome stages (Lewis, 1951). After the last phyllosome stage, larvae enter a puerulus stage which resembles a miniature adult lobster. During their larval life, spiny lobsters feed upon plankton (microscopic floating plants and animals). Lobster larvae themselves face heavy predation from other plankton feeders including many species of fish and whales.

The long larval life of spiny lobsters offers a high potential for dispersal from the parent population, but this tendency may be moderated by several factors. Studies of larval dispersal in Pacific spiny lobsters (P. interruptus and P. cygnus) have shown that early larval stages tend to be transported far offshore by wind-driven surface currents, and many are carried into areas unfavorable for survival. Later larval stages migrate vertically in the water column, and are less affected by surface currents. At this stage larvae in the vicinity of California and western Australia are carried back toward shore by deeper ocean currents (Johnson, 1971, 1974; Phillips et al., 1979). Similar studies have not been reported for the Eastern Caribbean, but preliminary genetic studies (Menzies and Kerrigan, 1978) suggest that analogous mechanisms operate to return Caribbean spiny lobster larvae to the vicinity of their parent populations.

The long and complex larval stages of spiny lobsters have prevented successful culture of most species, including P. argus.

4. Biological Description

Spiny lobsters are encased in a hard shell or exoskeleton. The body is composed of two sections, the cephalothorax (back) to which the legs and antennae are attached, and the abdomen (tail). All of the internal organs are enclosed in the cephalothorax. The abdomen accounts for about one-third of the total body weight, and is divided into ring-like segments with four pairs of swimming paddles on the ventral surface and five uropods (tail fan) at the end. Lobsters normally walk on the five pairs of jointed legs, but when threatened can swim rapidly backward by flexing the abdomen.

The exoskeleton cannot increase in size, so that lobsters must periodically shed their shell in order to grow. This process is known as molting, and the shell of newly molted lobsters is quite soft for several days after the old shell is discarded.

Sexes are readily distinguished. Female lobsters have a small opening at the base of the third pair of walking legs (counting from the head), while males have flat paddle-like structures at the base of the last pair of walking legs. In addition, females have claws on the last pair of walking legs, while males do not.

During mating, male lobsters produce a sticky fluid containing sperm which is deposited onto the underside of the cephalothorax. The fluid hardens to form a "tar spot" often seen on reproductively active female lobsters. After mating, the female extrudes eggs from the opening at the base of the third pair of walking legs, and scratches the tar spot to fertilize the eggs. The eggs are deposited on the underside of the abdomen, where they are carried until they hatch after about four weeks. On the average, female lobsters lay about 500,000 eggs at one time. Larger lobsters are capable of carrying more eggs; female P. argus produce about 800 eggs per gram of body weight (Munro, 1974; Chitty, 1973).

Research by Donald Reid, a Canadian student working with the Fisheries Division in 1985, indicates that female lobsters may produce at least three separate sets of eggs in a single year. In the past three years, the smallest egg-bearing lobster from St. Kitts/Nevis waters had a carapace length of 82 mm. The smallest lobster bearing a tar spot had a carapace length of 78 mm. The average carapace length of reproductively active lobsters in St. Kitts/Nevis waters is 106 mm. Sex ratio in lobsters having a carapace length of less than 90 mm is approximately 1:1, but the ratio of male to female lobsters is consistently higher among lobsters whose carapace length is greater than 90 mm, ranging from 1.07:1 to 1.5:1. This may indicate increased mortality among reproductively active females. Available data indicate that reproductive activity is high from

March through August. A secondary peak may also occur in December (Figure 1).

Spiny lobsters are principally carnivorous, though they have been observed to occasionally feed upon marine plants as well. Food species are varied and include sponges, starfish, sea urchins, shelled molluscs (e.g., clams and conchs), crabs, and fish. Cannibalism is rare or absent.

Primary predators of spiny lobster include sharks, rays, octopus, loggerhead sea turtles, and large fish (snapper, grouper, and triggerfish). Spiny lobsters are particularly vulnerable to predation immediately after molting, and tend to remain under shelter until the new shell has hardened.

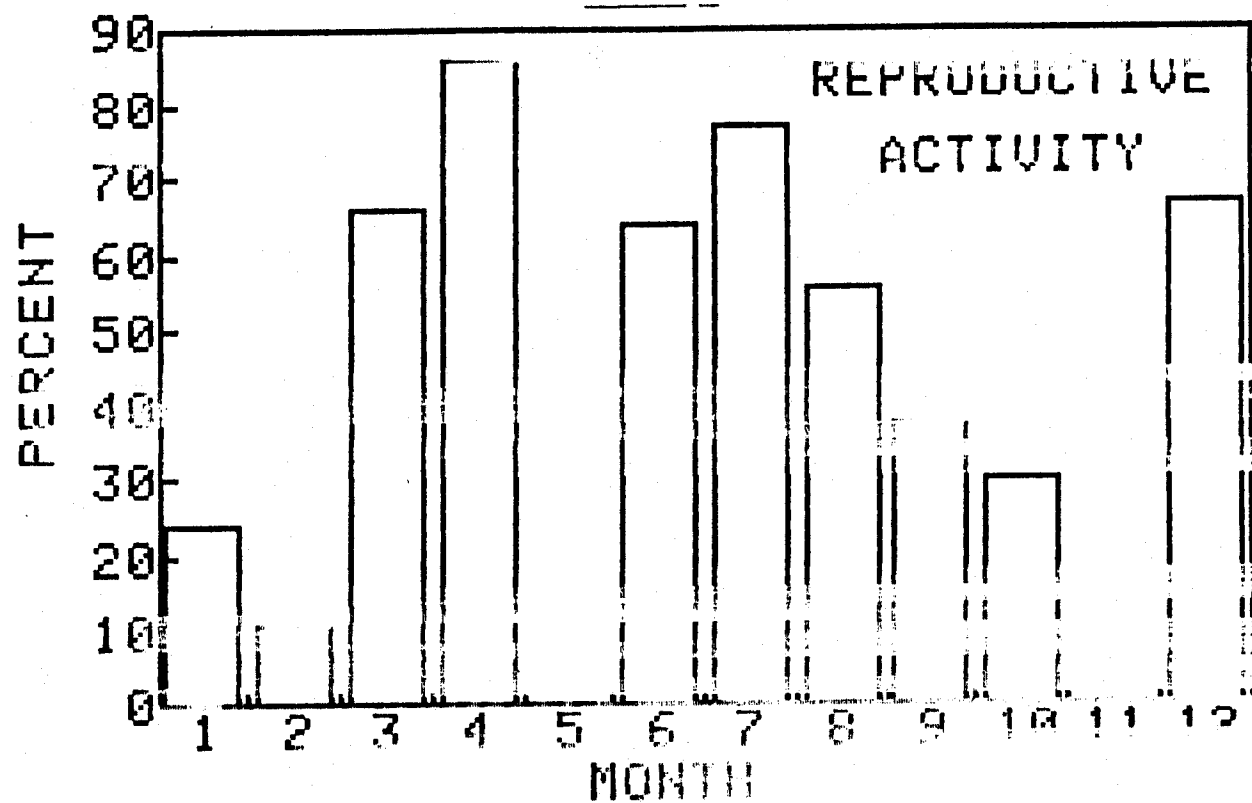
B. Ecological Relationships

Pueruli and post-larval lobsters are frequently found on algae-fouled objects such as anchor lines, boat bottoms, or fish pots. Natural habitats include sponges, mangrove roots, and spaces between the spines of black sea urchins. Post-larvae are often seen in shallow water or close to the surface, but numerous post-larval lobsters have been observed on artificial surfaces installed at depths of 40 - 50 ft in St. Kitts waters. Older juveniles are typically found in large numbers in shallow seagrass beds or coral rubble. Kanciruk (1980) states that juveniles between 1 and 2 years of age are infrequently found in groups while older juveniles are gregarious, but investigations of natural and artificial structures in St. Kitts have found large numbers of juveniles of all ages in both types of habitat. Older lobsters are less gregarious than juveniles. In St. Kitts/Nevis, highest densities of mature spiny lobsters have been found on healthy coral reefs, usually in depths of 50 ft or more.

As juvenile lobsters grow, they tend to move from shallow seagrass beds and reef rubble habitats to reefs in deeper waters. Both seagrass and coral reef areas are critical to maintaining spiny lobster populations, and it is clearly important that suitable deepwater habitats be adjacent to shallow-water areas suitable for juveniles. Spiny lobster populations appear to be habitat-limited in St. Kitts/Nevis, at least during the juvenile stages. Studies of related species in Australia have shown that natural mortality of juveniles increases as the density of the animals increases, so that an increase in larval recruitment does not produce an equivalent increase in the harvestable stock.

Manipulations which increase shelter for juveniles have the potential to partially overcome the habitat limitation. In 1985, the Fisheries Division conducted preliminary studies with simple shelters (Figure 2) installed in Major's Bay. These shelters were readily colonized by juvenile lobsters, and on several

FIGURE 1



occasions more than 50 juveniles were found in a single shelter. Local fishermen have used derelict vehicles to construct artificial reefs for older juveniles, and the use of artificial shelters as a fishing device is common in Mexico, Cuba, and the Bahamas.

C. Estimates of Maximum Sustainable Yield

Maximum sustainable yield (MSY) estimates for fishery species are usually based upon mathematical models which describe the reproduction and growth in the stock of interest. An alternative approach has been widely used by various consultants in the Caribbean to provide rough estimates of probable yield. This approach relates the quantity of available habitat to potential yield, based upon yields calculated for stocks in other areas of known size. Using this approach, Olsen (1984) estimated the potential annual yield of spiny lobster stocks in St. Kitts/Nevis to be 66,268 lb. This provides a rough idea of the potential for expanding the present catch, but must be improved upon before a management strategy can be defined. A major problem with this estimate is that detailed habitat surveys are not available for St. Kitts/Nevis, nor is it certain how population dynamics of spiny lobsters in St. Kitts/Nevis waters differ from those in other areas.

Two types of mathematical models are in general use for estimating MSY. Our concern here is not to describe these models in detail, but to identify the information needed to estimate MSY for the St. Kitts/Nevis spiny lobster fishery.

Surplus yield models require information on catch and associated fishing effort over a period when the effort has varied significantly. These models obviously cannot be applied to an unexploited stock (unless the data are generated specifically for this purpose through exploratory fishing). Virtually no information on catch and effort is available for the St. Kitts/Nevis spiny lobster fishery, eliminating the possibility of using surplus yield models at the present time.

Dynamic pool models require information on growth rate and natural mortality of the species concerned, and express maximum sustainable yield as a function of mortality due to fishing, number of animals annually entering the fishery, and minimum legal size. For the past three years, the Fisheries Division has undertaken investigations to obtain information on growth and natural mortality in St. Kitts/Nevis spiny lobster population. These investigations are primarily directed toward sampling landed lobsters from hotels and restaurants, as well as juvenile lobsters in the wild. More than 2500 such measurements have been used to construct length-frequency diagrams as illustrated in Figures 2 -- 8.

FIGURE 2

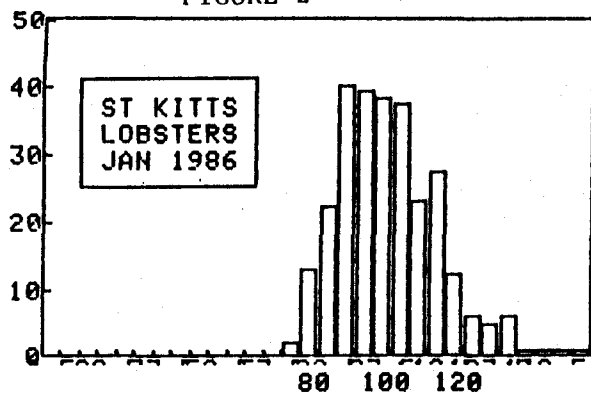


FIGURE 3

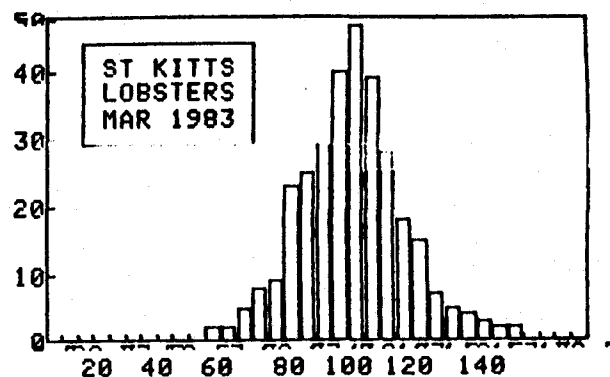


FIGURE 4

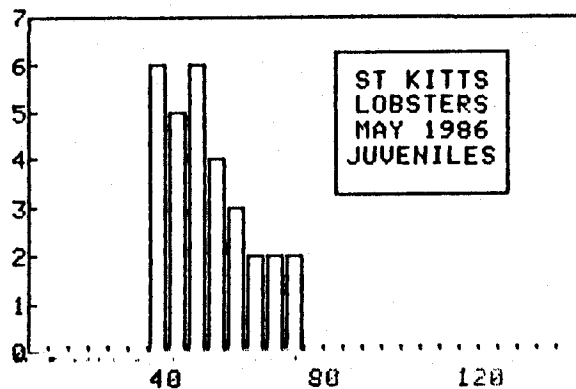


FIGURE 5

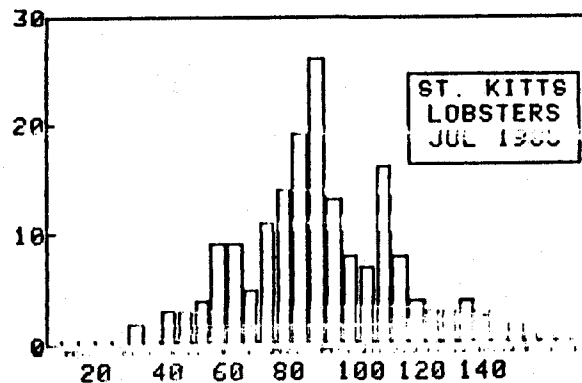


FIGURE 6

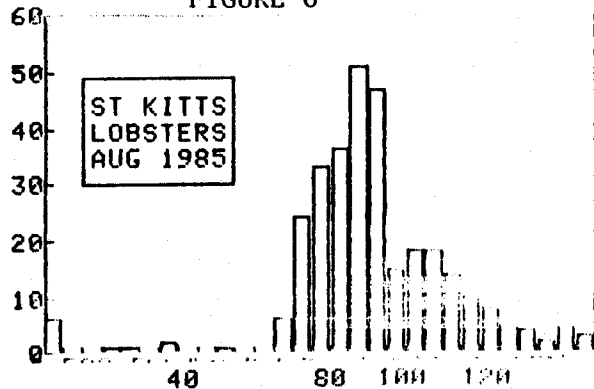


FIGURE 7

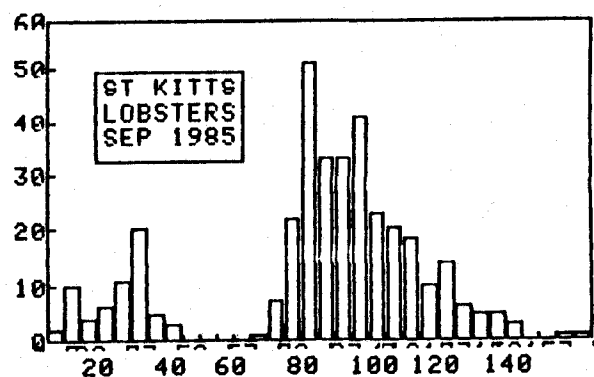
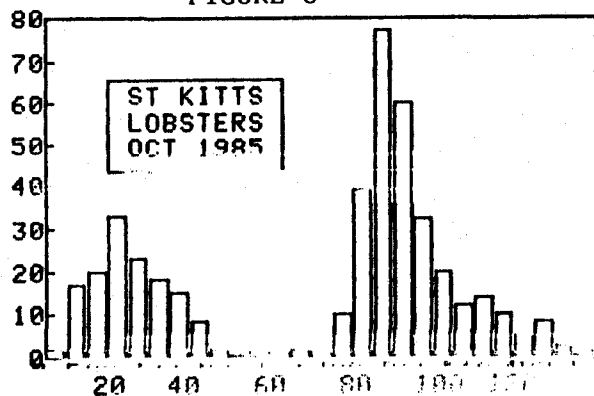


FIGURE 8



Growth rates have been estimated from these diagrams as follows. Data for single months have been analyzed by probit techniques (Sokal and Rohlf, 1981) using computer programs developed by the Fisheries Division. Individual size classes (representing different years) have been identified within the overall frequency distribution, and the mean of each class determined. In July 1985, for example, four classes were distinguished having means of 60, 85.5, 107.5, and 132.5 mm. These data suggest that the growth rate is approximately 25 mm per year, since roughly 25 mm separate each size class. Comparison of juveniles measured in Major's Bay during October 1985 with measurements from the same area in May 1986 indicates that the mean size of this cohort increased by 25 mm in six months. Thus, the growth rate during the first year is estimated to be 50 mm/yr.

Growth is often described by the von Bertalanffy equation:

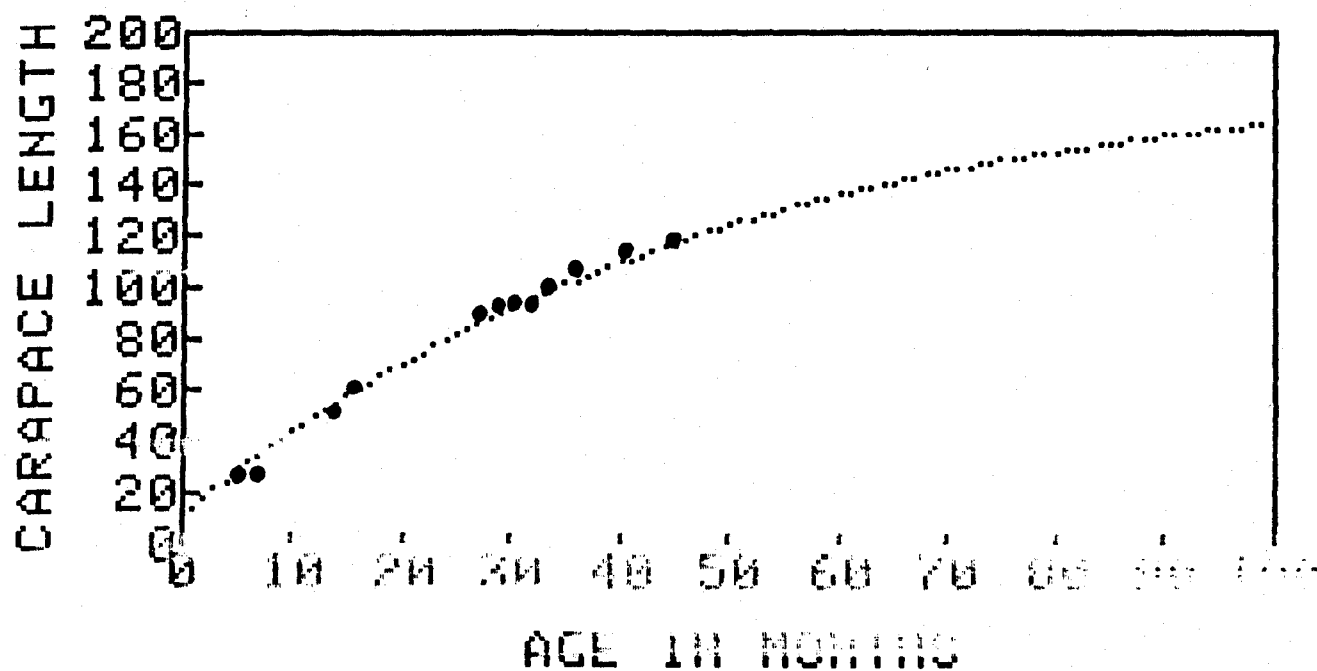
$$l_t = L_{\max} (1 - e^{-K(t-t_0)})$$

where l_t = the length at time t ; $L_{\max}$ = maximum length attained in the stock; e = the base of natural logarithms; K = the Brody growth coefficient; and t_0 is the theoretical age at which length is zero

A curve fitting routine has been used to fit a von Bertalanffy growth curve to St. Kitts/Nevis lobster data (Figure 9). Estimates obtained for the growth coefficient, maximum length, and theoretical age at zero length are similar to those reported from other areas (cited in Gulf of Mexico and South Atlantic Fishery Management Councils, 1982). The instantaneous rate of total mortality estimated by the method of Beverton and Holt (1956) is 1.09, which is equivalent to an annual mortality of 66.4%.

It is not possible to separate mortality due to fishing from natural mortality with available information. Because this separation must be made to apply production models and adequately evaluate the fishery, high priority is being given to obtaining catch statistics needed for this purpose. A preliminary analysis has been prepared of maximum yield at various levels of fishing and natural mortality using the YPER computer program developed by Dr. Jerald Ault at the Cooperative Institute for Marine and Atmospheric Studies at the University of Miami. This analysis indicates that the optimum minimum size at reasonable rates of fishing mortality is greater than the present minimum size of 95 mm, and that the yields might be improved by about 10% with an increased minimum size. Until it is confirmed that the range of mortalities considered includes the actual natural mortality and

FIGURE 9



Theoretical von Bertalanffy growth curve (dotted line)

fitted to monthly size class means (solid dots)

$L_{\max} = 188$; $K = 0.0205$ (monthly), 0.246 (yearly);

$T_0 = -3.16$ (monthly), -0.26 (annually)

RMS error of fitted curve = 0.619

mortality due to fishing, these predictions cannot be used for policy decisions.

IV. DESCRIPTION OF HABITAT OF THE STOCK

Critical habitat areas for spiny lobster include shallow seagrass beds and adjacent deepwater reef habitats. At present, these habitats are generally in good condition in St. Kitts/Nevis, despite periodic disruptions due to storms. Of particular importance are seagrass and coral areas adjacent to the southern and western portions of the St. Kitts southeast peninsula, reef areas between Conaree and Dieppe Bay, and habitats in Nevis between Charlestown and Newcastle. Exploratory information is not available on possible deepwater habitats, but these may be of major significance as the proportion of egg-bearing lobsters has been found to increase with depth in some areas (Kanciruk, 1976). If this is true in St. Kitts/Nevis, deepwater lobsters might constitute a major breeding reserve for the spiny lobster fishery, as these animals are not heavily harvested at present.

Shallow-water habitats are vulnerable to damage from land-based activity, particularly sedimentation. The most common sources of increased sediment load are erosion through poor land management, construction, and dredging. Sedimentation from all these sources can be controlled, and such control should be required to protect valuable resources associated with nearshore habitats.

V. DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK

Olsen (1984) estimated annual landings of spiny lobster in St. Kitts/Nevis to be 65,227 lb (which exceeds his estimate of sustainable yield). Records of current landings and exports are not complete, but available records indicate a steady decline in exports over the past ten years (Table 1). This trend is dominated by export activity in Nevis, which is reported to have been affected by individual marketing problems, rather than drastic decline in actual lobster production. There are no records of exports from St. Kitts since 1983, though fishermen in Dieppe Bay are known to have exported lobsters at irregular intervals during this time.

Hotels and restaurants in St. Kitts have been regularly surveyed to determine monthly purchases of spiny lobster. Information from four of the major consumers is summarized in Table 2. These four institutions alone purchased 23,065 lb in 1985, or more than half the total exports from St. Kitts/Nevis during the peak year of 1976. It is also noteworthy that purchases by these consumers during the first three months of 1986 were 60% higher than during the same period in 1985.

Table 1

Summary of Spiny Lobster Exports (lb) from St Kitts/Nevis

<u>Year</u>	<u>St. Kitts</u>	<u>Nevis</u>
1976	3,710	38,828
1977	10,345	31,358
1978	4,460	36,224
1979	8,542	7,865
1980	1,254	21,200
1981	--	12,532
1982	50	102
1983	2,802	--
1984	--	--

Table 2

Summary of Spiny Lobster Purchases by Four Hotels, 1985-86
(Fishermen's Wharf, Ft. Thomas, Golden Lemon, Ocean Terrace Inn)

<u>Month</u>	<u>Total Purchases (lb)</u>
Jan 85	2096
Feb 85	1929
Mar 85	2289
Apr 85	1821
May 85	1389
Jun 85	1663
Jul 85	2410
Aug 85	1822
Sep 85	1462
Oct 85	941
Nov 85	2844
Dec 85	2402
Jan 86	3318
Feb 86	3782
Mar 86	3260

The percentage of egg-bearing lobsters in landings samples ranged from 0.4% to 9%. The percentage of lobsters having a carapace length less than 90 mm in the same samples ranged from 23% to 46%. Fishing pressure on juveniles is clearly significant.

Because the egg-carrying capability of lobsters increases with increasing size, larger females may make a greater overall contribution to maintenance of the stock even though they are less abundant than smaller individuals. Indices of reproductive potential have been computed for lobsters in 1985 St. Kitts/Nevis landings (Table 3) which show that animals in the 105 - 120 mm size range are the most valuable sources of egg production. Lobsters in this size class are not directly protected by current or proposed minimum size regulations.

VI. SOCIAL AND ECONOMIC CHARACTERISTICS OF THE FISHERY

Spiny lobsters purchased by four institutional consumers reported above were valued at EC\$184,520. Considering that these figures do not include purchases by other consumers or any exports, the value of the spiny lobster fishery to St. Kitts/Nevis is almost certainly at least half a million dollars annually. These figures also make it clear that the local market could consume most if not all of the annual sustainable yield. Indeed, at least one major consumer (Jack Tar, whose spiny lobster purchases are estimated at 500 lb/wk) has requested assistance in improving local supply of spiny lobster.

Spiny lobsters are harvested by a relatively small number of fishermen using simple techniques, and at present this may well be the most individually profitable component of the entire fishery sector. The increase in purchases during the first quarter of 1986 illustrates the ready response of local suppliers to demand. Local demand is expected to increase steadily with the growth of the St. Kitts/Nevis tourist industry.

VII. DETERMINATION OF OPTIMUM YIELD

Optimum yield (OY) is the total annual catch size which produces maximum benefit to society. In practice, estimates of maximum sustainable yield are the starting point from which OY is defined after considering economic, social, and ecological factors.

Aside from estimates of MSY, the primary information needed to establish optimum yield is:

- number of fishermen currently employed (wholly or partially) in the spiny lobster fishery

- potential for expanded local production of spiny lobsters (e.g., through habitat enhancement with artificial shelters)
- the current fishing effort expended in the St. Kitts/Nevis spiny lobster fishery
- the local economic impact of increased or decreased availability of spiny lobster
- availability and price paid in alternative markets

VIII. CURRENT PRIORITIES / INTERIM RECOMMENDATIONS

A. Available estimates indicate that current landings are close to or exceed maximum sustainable yield. Considering the current and projected local demand, as well as steadily growing export demand, there is absolutely no doubt that St. Kitts/Nevis spiny lobster stocks face serious overexploitation. Measures are urgently needed which will:

1. Implement fishery regulations now in draft
2. Place a moratorium on activities which would increase the present harvest of spiny lobster, particularly commercial ventures involving spiny lobster export
3. Improve export and fishing licensing procedures to provide better information to the Fisheries Division
4. Prohibit any activity which would damage shallow coral areas or seagrass beds

B. The Fisheries Division proposes to undertake activities during the next 12 months to:

1. Continue monthly sampling of hotel and restaurant purchases to monitor characteristics of locally marketed lobsters (particularly average size and proportion of juveniles)
2. Obtain more accurate information on exports of spiny lobster from St. Kitts
3. Investigate the potential for increased spiny lobster production through the use of artificial shelters
4. Obtain an accurate estimate of the numbers of fishermen involved in spiny lobster harvest in St. Kitts/Nevis, and the relationship between catch and effort
5. Obtain information on the economic characteristics of the St. Kitts/Nevis spiny lobster fishery

6. Obtain information on alternative markets for spiny lobsters
7. Identify critical spiny lobster habitat areas on the coasts of St. Kitts/Nevis

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Table 3

Index of Reproductive Potential for Various Size Classes

Size Class	Percent in Class Bearing Eggs	Percent of Landings	Index of Reproductive Potential
85 - 89.9	2	20	100
90 - 94.9	3	19	163
95 - 99.9	18	11	666
100 - 104.9	17	8	513
105 - 109.9	24	11	1143
110 - 114.9	38	9	1667
115 - 119.9	28	6	915
120 - 124.9	13	5	397
125 - 129.9	22	3	452
130 - 134.9	20	3	458
135 - 139.9	15	4	549