AMENDMENT 2

to the

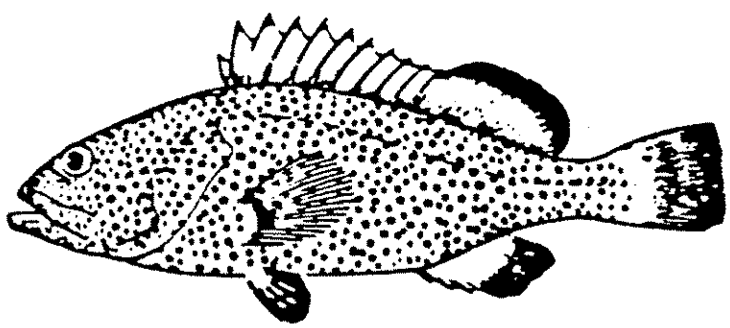
FISHERY MANAGEMENT PLAN

for the

SHALLOW-WATER REEF FISH FISHERY

OF

PUERTO RICO AND THE U.S. VIRGIN ISLANDS



MAY 1993

Caribbean Fishery Management Council
Suite 1108 Banco Popular
Hato Rey, Puerto Rico 00918
(809) 766-5926

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I. INTRODUCTION AND HISTORY OF MANAGEMENT

The Fishery Management Plan for the Shallow-Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (FMP), prepared by the Caribbean Fishery Management Council (Council) under the authority of the Magnuson Act, became effective in September 1985. The FMP established a management program for shallow-water reef fish resources within the exclusive economic zone (EEZ) of the Council's area of jurisdiction. Because the preponderance of fishery resources occur in waters under the authority of the Commonwealth of Puerto Rico and the Territory of the U.S. Virgin Islands, the management program was extended to the shoreline with agreement that the island governments would adopt compatible regulations. Some regulations are yet to be fully implemented.

The initial regulations, designed to rebuild declining reef fishes, established: (1) a minimum mesh size of 1.25 inches for fish traps; (2) requirements for degradable panels and door fasteners on traps; (3) a prohibition against hauling or tampering with another person's traps without written permission of the owner; (4) a vessel and gear identification system; (5) a prohibition on using poisons, drugs, other chemicals or explosives for taking fish in the management unit; (6) incremental size limits for Nassau grouper (Epinephelus striatus) and yellowtail snapper (Ocyurus chrysurus); and (7) a spawning season closure for Nassau grouper.

In November 1990, Amendment 1 to the FMP: (1) prohibited the harvest or possession of Nassau grouper; (2) provided for the annual closure to all fishing at a red hind (Epinephelus guttatus) spawning aggregation area in the EEZ southwest of St. Thomas; (3) defined overfishing for reef fish; (4) revised the Habitat section of the FMP; (5) increased the minimum allowable mesh size for fish traps to 2.0 inches effective September 1991; and (6) provided for the collection of socio-economic information under existing state/federal agreements. These measures were designed to guard against continued declines of Nassau grouper and red hind resources and to increase escapement of juveniles and smaller reef fishes from traps. The mesh size increase proposed for fish traps was later reduced to 1.5 inches to minimize economic impacts on the industry, while studies were conducted within the management area to more thoroughly evaluate the effectiveness of various mesh sizes and shapes. This adjustment, made under a framework provision in the FMP, provides additional protection to the resource over the previous 1.25-inch mesh size requirement. At the same time, escape panel requirements also were specified for the various allowable mesh sizes, and jute twine, no greater than 1/8 inch in diameter, was prescribed as the only acceptable fastening material for panels. Also, provisions for utilizing the access door as one of the required panels were described. The escape panels are designed to prevent continued fishing and subsequent mortality of fishes by traps that are lost (ghost traps).

II. PROBLEMS REQUIRING PLAN AMENDMENT AND MANAGEMENT OBJECTIVES

PROBLEMS:

The actions proposed in Amendment 2 address continuing and growing concerns by the Council over scarce resources, the need to protect important species when they aggregate for spawning, and the need to extend protection to other reef-associated species not presently in the management unit. Of some 350 species of shallow-water reef fish in the Caribbean, about 180 are landed throughout the region and collectively comprise the most important fishery in the islands. The management unit currently includes the 64 most commonly landed species that dominate the catch from the shoreline to the edge of the insular platform. At greater depths at the edge of the platform, another fishery occurs -- the deep-water reef fish fishery.

Initially, the Council anticipated developing a separate FMP for the deep-water reef fish complex; however, the Council decided that it would be more practicable and economical to incorporate those species into a single management unit for all reef fish. Distribution of some of the species overlaps with the shallow-water reef fishes, although they are more abundant as adults in deeper waters. Restrictive measures are not envisioned initially for deep-water species due to lack of data on the status of their populations; however, including them in the management unit permits regulatory action if necessary.

A large number of juvenile reef fishes and other small reef-associated species are taken by the marine aquarium trade industry. A decline in abundance has been noted for some of the more desirable species in certain localities. The ecological effects of their removal are unknown, and some of the most widely used collecting methods employ chemicals that damage the reef habitat and inflict mortality upon associated fishes and invertebrates. Expanding the management unit to include marine aquarium species would obviate the need for another separate FMP and provide a mechanism to initially manage this select group of fishes under the existing drug and chemical harvest restriction. Harvest of certain species either could be regulated or prohibited as necessary. These adjustments would require changing the title of the FMP, expanding the management unit, and updating the FMP to describe the fisheries incorporated. Marine aquarium invertebrate species will be included in the Coral FMP, which currently is under development.

Following collapse of the Nassau grouper resource, the red hind became an important species in the fishery; however, statistics show a decrease in the number of young fish in the population as concluded by the Stock Assessment Group (Appeldoorn, et al., 1992). A copy of the Reef Fish Stock Assessment Report is contained in Appendix II. Whenever possible, the Council relies upon closing aggregation sites during spawning seasons to enhance reproductive capacity. Most species that aggregate during the spawning season are highly vulnerable to capture at that time. Allowing mature individuals the opportunity to spawn is important to reverse declines in abundance. Even some fishermen have requested closure of spawning aggregation areas for red hind. A spawning aggregation area off St. Thomas, described and closed during the 1989-90 spawning season (December-February) by emergency action, has been closed during each successive spawning season under Amendment 1. Two additional red hind spawning areas are being considered for closure under Amendment 2.

A pronounced decline in the abundance of jewfish (Epinephelus itajara) has been noted throughout the management area and may extend throughout the Caribbean Basin. Similar declines in the Gulf of Mexico and off the south Atlantic coast of the U.S. led to a total prohibition on jewfish harvest in those areas. The Council believes that the jewfish should be protected throughout its range. The species appears to be scarce wherever it occurs and has unique biological characteristics that make it highly susceptible to overfishing. The U.S. Virgin Islands government has listed jewfish as a protected species, and prohibits its take in Territorial waters.

OBJECTIVES:

The basic objectives of the FMP are unchanged by this amendment, except they are extended to maintain deep-water reef fishes and marine aquarium fishes at levels that sustain adequate recruitment to replenish the populations. The states are requested to institute mandatory permitting and reporting requirements for fishing in both state and federal waters to obtain data on catch/effort relationships of species in the management unit. These data would be used to assess stocks, monitor population trends, and to restore and maintain stocks at optimum levels. Permits also would provide a sampling universe in the event some type of limited access program is considered for the future. Information collection on the marine aquarium trade should be expanded through the Puerto Rico Department of Natural Resources to obtain data on exports from Aquadilla and Ponce airports.

III. MANAGEMENT MEASURES

(A) Management Unit.

Deep-Water Reef Fish: The deep-water fishery, primarily for reef fish, ranges from the outer reaches of the shallow-water fishery (ca. 40 fathoms) seaward to depths up to about 300 fathoms. Fishes inhabiting the deep-water reef areas and slopes characterized by rocks, ledges, and corals generally are prosecuted with heavy duty traps and by electrically powered reels; bottom longlines are deployed to a limited extent. Appeldoorn, et al. (1992) reported that landings of all demersal fishes in Puerto Rico declined from a peak of 2,402 metric tons (mt) in 1979 to 519 mt in 1990. During that same period, deep-water snappers, in aggregate, declined from 340 to 80 mt.

Thirteen species currently not listed in the shallow-water reef fish management unit are major components of the deep-water landings and should be added to the management unit (Erdman, 1979). One other species (tiger grouper) is added at the suggestion of the Scientific and Statistical Committee (SSC) and Advisory Panel (AP) to the Council. Six species of snapper (Lutjanidae), black snapper (Apsilus dentatus), queen snapper (Etelis oculatus), blackfin snapper (Lutjanus buccanella), silk snapper (Lutjanus vivanus), wenchman (Pristipomoides aquilonaris), and vermilion snapper (Rhomboplites aurorubens); four species of grouper (Serranidae), yellowedge grouper (Epinephelus flavolimbatus), red grouper (Epinephelus morio), misty grouper (Epinephelus mystacinus), and tiger grouper (Mycteroperca tigris); two jacks (Carangidae), greater amberjack (Seriola dumerili), and almaco jack (Seriola rivoliana); and two tilefishes (Malacanthidae), blackline tilefish (Caulolatilus cyanops), and sand tilefish (Malacanthus plumieri) are taken predominantly in deep waters and should be included in the management unit. Including these species in the management unit will allow the Council to take appropriate management action as necessary to conserve or restore important components of the reef fish fishery. Other species in the deep-water fishery also are taken in the shallow-water fishery and are included in the management unit already. The most important of these are: dog snapper, mutton snapper, lane snapper, yellowfin grouper, Nassau grouper, coney, red hind, black jack, and squirrelfish. Table 1A (Appendix I) provides a complete listing of the revised management unit depicting the overlap of deep-water and shallow-water species.

Marine Aquarium Trade Fishes: A preliminary description of the marine aquarium trade was compiled by the Puerto Rico Department of Natural Resources, Fisheries Research Laboratory, for the Caribbean Fishery Management Council (Sadovy, 1991, unpublished manuscript). That report provides a description of the marine aquarium organism trade in Puerto Rico, the U.S. Virgin Islands, and other areas, including harvest methods, collection areas, handling and shipping, as well as a description and list of the most commonly collected species. The report, used as a source document for the management options considered, is appended (Appendix II). A list of the important finfishes has been extracted from that report for inclusion in the management unit (Table 2A, Appendix I).

Export of marine organisms for the aquarium trade began ca. 1970 in Puerto Rico, and 49 species appeared on the export availability list in the early 1970's. The United States is the chief importer. Until recently the trade was small, but over the last two to three years collection and export activity has increased. The trade and shipping lists for 1990/91 indicate that over 150 species of fish and invertebrates were exported from Puerto Rico. Increased export activity is attributed to a combination of increased demand for marine aquarium organisms, improved air transport facilities, and increased restrictions on Florida-based collectors. Since the aquarium trade fishery is not specifically regulated and since the number of individuals of certain species harvested in the marine aquarium trade fishery appears to be declining, unrestricted harvest has become a growing concern of the Council. Many of the species collected are young of those that are valued as adults in other fisheries, some of which are regulated. Appropriate restrictions for other species would have to be addressed as necessary following data collection and analysis.

About 100 people are engaged in the marine aquarium trade in Puerto Rico and a much smaller number in the U.S. Virgin Islands. Most collectors are exporters; however, some collectors sell to exporters or to local pet shops. Currently, there are about six export businesses in Puerto Rico with a similar number involved in intra-island trade.

Major collectors have their own equipment, and collect from 3-4 days to 7 days a week depending on weather and demand. Collectors visit specific areas and generally rotate collecting sites to avoid overfishing an area. Collection is commonly by SCUBA down to 20 meters but occasionally to 40 m for certain species; mask and snorkel are commonly used in shallow waters. The most frequent collecting gears are nets (barrier, gill, drop or cast nets, and dip nets), small mesh (1/4 - 1/2 inch) fish traps, slurp guns, and chemicals, such as "Quinaldine" (2-methyl-quinoline), chlorine, formaldehyde, and gasoline.

A total of 105 species or species groups of fishes appeared on trade lists and shipping lists from Puerto Rico in 1990/91 (Table 2A, Appendix I). Eighty-three species of fishes were noted as exported, while seven species, or families, accounted for over 70% of the total fish export. In order of decreasing numbers these were: royal gramma, Gramma loreto; yellowhead jawfish, Opisthognathus aurifrons; assorted wrasses, Labridae; rock beauty, Holacanthus tricolor; assorted blennies, Blenniidae; queen triggerfish, Balistes vetula; and French angelfish, Pomacanthus paru. Other species, such as queen angelfish (Pomacanthus ciliaris), blue chromis (Chromis cyanea), and pygmy angelfish (Centropyge argi), are less numerous but in high demand. At least 20 to 30 species taken in the marine aquarium trade also are valued as food fish. Some of these are highly prized as aquarium fish, notably rock beauty, French angelfish, and queen triggerfish; while others are being protected from overfishing as adults, such as red hind and possibly other serranids. A wide variety of invertebrates, including corals, also are exported. The aquarium fish trade is not specifically regulated and, in Puerto Rico, exporters are not required to be licensed and collectors are not treated as commercial fishermen. No information is available on the volume of intra-island trade.

For shipping, animals are packed in plastic bags filled with oxygenated seawater and placed in heavy duty cartons. In Puerto Rico the majority are air freighted from San Juan, Aquadilla, and possibly Ponce, however, occasional export reportedly occurs through the postal system (Federal Express) and United Parcel Service. Air shipments are inspected by personnel of the Puerto Rico Department of Natural Resources and the U.S. Division of Fish and Wildlife Services at the Luis Muñoz Marin airport in San Juan. On average, nine shipments a week leave Puerto Rico or 5,184 boxes per year containing an estimated 160,704 organisms. This translates roughly to the reported number of grouper (the predominant fish) landed annually by the commercial fishery in Puerto Rico. These estimates do not include shipments from Aquadilla or Ponce airports, the postal service, or intra-island trade.

Management Measures Adopted and Those Considered but Rejected by the Council.

Adopted Measure 1. Expand the management unit to include the most important components of the deep-water reef fish fishery.

Discussion:

Incorporating the major components of the deep-water reef fish fishery into a single reef fish management unit with the shallow-water fishery is appealing from a cost standpoint and because of the interrelationship between the two fisheries. Although the deep-water fishery is of less importance than the shallow-water fishery in terms of effort and landings, it includes one of the most economically valuable species, the silk snapper, Lutjanus vivanus (Matos and Sadovy, 1990); there is concern over silk snapper because more than 90 percent of the individuals harvested are less than minimum size of sexual maturation (Matos, 1992). However, the relative importance of the two fisheries makes justification of a separate FMP for deep-water reef fish difficult. The cost of preparing a separate FMP would likely approach the cost of the present FMP (ca. $200,000); whereas, added costs of consolidating the two complexes would be minor. Expanding the management unit to include the major components of the deep-water fishery also will extend the management area; and future costs would be commensurate with additional management measures that may be required eventually.

Rejected Measure 1A. Do not incorporate deep-water reef fishes into the management unit (status quo).

Discussion:

Species that are not included in an FMP cannot be managed under the Magnuson Act. Therefore, in the event that problems develop with species in the deep-water reef fish complex, substantial biomass decline and losses to fishermen could accrue before management action would be possible. It could take two years or more to develop a separate FMP, or a year or more to prepare and process an amendment to incorporate the appropriate species into the shallow-water reef fish FMP. Time lost in management translates into monetary losses to fishermen in the long term, and such delays could add years to the amount of time required for resource recovery.

Rejected Measure 1B. Develop a separate plan for managing the deep-water reef fish fishery.

Discussion: (Reference discussion under Preferred Measure 1.)

Adopted Measure 2. Expand the management unit to include marine aquarium fishes (invertebrates would be managed under the Coral FMP).

Discussion:

Placing marine aquarium fishes under the protection of the reef fish rules should result in benefits to the species involved, their habitat, and collectors. Disallowing the use of chemical substances and other destructive collecting devices would reduce cryptic mortality of target and associated species while reducing a source of habitat degradation -- both results eventually would benefit the resource and collectors. The long-term stability of the fishery also would be advantaged through implementation of a permitting and reporting system and the designation of marine reserves as recommended in this amendment.

Rejected Measure 2A. Develop a separate FMP for marine aquarium organisms.

Discussion:

The basic problem with separate FMPs for reef fish and marine aquarium organisms is that many of the species overlap both fisheries as adults and juveniles, and thus could fall under contradictory management programs. Since many species desirable in the aquarium trade are juveniles of reef fishes that are utilized for other purposes as adults, allowable harvest in one fishery may contravene selected management measures, e.g., spawning aggregation area closures, designed to rebuild resources in another fishery. Amendment of one FMP may require amendment of the other as well to avoid incompatible management measures, thereby increasing associated costs substantially. The likelihood of this is reduced under a single FMP. Costs associated with public hearings would at least double if an FMP were developed solely for marine aquarium organisms.

Rejected Measure 2B. Do not incorporate marine aquarium fishes into the management unit (status quo.)

Discussion:

This alternative would not be responsive to the needs of the marine aquarium fishery because it would allow indiscriminate harvest of limited resources and continued damage to the habitat. Irresponsibility to the needs of a resource similarly contravenes the needs of the resource users. Allowing indiscriminate harvest and habitat damage ultimately impacts those who rely upon the resource to sustain their livelihood. If resources are not protected, competitive harvest will continue until it is no longer economically feasible and the collectors have driven themselves out of business. Other users, such as tourist dive-boat operations, also could be impacted by overexploitation and habitat damage.

Adopted Measure 3. Retitle FMP to encompass the reef fish management unit.

Discussion:

Since the management unit has been enlarged to include fishes other than shallow-water reef fish, the Council suggests the document be retitled, "Fishery Management Plan for Reef Fishes of Puerto Rico and the U.S. Virgin Islands." This title accurately describes the fisheries for shallow-water reef fish, deep-water reef fish, and marine aquarium fishes.

There are no direct economic benefits or impacts associated with changing the title of the FMP; however, avoiding the confusion that might accompany the misnomer, could have distinct sociological implications.

Rejected Measure 3A. No action. Retain current title of FMP.

Discussion:

Retaining an inaccurate title for an FMP could result in confusion to managers and, more importantly, to the fishermen responsible for conforming to the regulatory program tailored to conserve reef resources.

(B) Gear Restrictions.

The marine aquarium trade initially will be regulated by gear restrictions designed to reduce fishing mortality and habitat damage. Of the gears currently deployed in the harvest of aquarium fishes, two will be prohibited by existing regulations for the shallow-water reef fish fishery; i.e., the use of chemicals and small-mesh fish traps. Nets, other than hand-held dip nets, also will be prohibited by this amendment because of their potential for damaging the reef habitat and as a source of inadvertent mortality.

The commercial fishery for shallow-water (and deep-water through this amendment) reef fish basically is regulated by requiring certain construction features of fish traps -- the predominant gear in the fishery. Escape openings (covered by panels fastened with degradable material) are required to prevent continued fishing and subsequent mortality by lost or abandoned traps. Trap mesh also is being manipulated in quest of an optimum size that will allow young and immature fish to escape and grow sufficiently to maximize yield from the fishery. However, in a fishery that contains such a large number of species and wide array of body forms, there is no such thing as an optimum mesh size, especially when some of the larger species appear to be overfished.

Although gear restrictions may perform a useful function, as indicated, effort limitations eventually are necessary to reduce fishing mortality in most fisheries. Unregulated expansion of the marine aquarium trade is a growing concern of the Council and of the people involved in that industry. Trap fishermen are equally concerned that overly restrictive mesh-size measures will eventually reduce catches to the extent that it is no longer economically feasible to fish with traps. Limitations to stabilize and reduce effort are desperately needed in both the fish trap fishery and the marine aquarium fishery. Restrictions on the number (per vessel) and size (volume) of traps are needed to control fishing capacity, coupled with the implementation of a permit (licensing) and reporting system and a moratorium on additional entry into both fisheries. Entry into the marine aquarium fishery can only be expected to increase as fishermen are displaced from other fisheries (both local and abroad), product demand increases, and export facilities improve.

Adopted Measure 4. Restrict the collection of marine aquarium fishes to hand-held dip nets and slurp guns.

Discussion:

Of the traditional gear employed in the harvest of marine aquarium fishes, the Council recommended that only hand-held dip nets and slurp guns be allowed. Other gears, notably cast nets (drop nets), barrier nets (gill nets), small mesh fish traps, and chemicals, have the potential of causing damage to the resource or its habitat, or both. Chemicals and small mesh fish traps are prohibited by existing regulations.

Rejected Measure 4A. Allow the collection of marine aquarium fishes by all gear types currently deployed in the fishery (status quo).

Discussion:

Some of the gears currently or traditionally used for collecting marine aquarium fishes have been shown to damage either the resource, its habitat, or both. Perhaps the most popular method of collection is by the use of chemical substances, the most common of which is quinaldine -- a coal tar derivative used in the manufacture of dyes and explosives. Although the long- and short-term effects on reefs and associated organisms of using quinaldine to stun fish are inconclusive, many dealers are reluctant to purchase fish taken by this method because mortality rates appear higher than with those collected using other methods. The use of other chemical agents, such as bleach, formalin, and gasoline for collecting marine aquarium fishes, has been reported from various areas, and all are prohibited because of their toxic effects on marine organisms, including corals. The use of chemical substances and explosives is currently prohibited by the shallow-water reef fish regulations that likewise apply to this fishery by amendment.

Cast nets (drop nets), barrier nets (gill nets), and specialized small mesh fish traps are other gears traditionally used to harvest marine aquarium fishes. These gears all have a potential for damaging reefs or reef resources. Small mesh fish traps are already prohibited under existing minimum mesh-size regulations.

Adopted Measure 5. Require that fish traps be constructed as follows: (a) at a minimum, basic construction material must be of 1.5-inch hexagonal mesh wire or 2.0-inch square mesh wire; (b) escape openings of at least 8 x 8 inches must be located on any two sides (except top, bottom, or side containing the funnel); (c) the access door may serve as an escape opening provided it meets all requirements for size and location, and is fastened in such a manner that the door will fall open when the fasteners degrade; (d) panels covering the escape openings must be of a mesh at least as large as the mesh used in constructing the trap, and fastened with untreated jute twine 1/8-inch or less in diameter when traps are fitted with zinc anodes; or (e) fastened with 18-gauge ungalvanized wire or 1/8-inch untreated jute twine (maximum diameter) if anodes are not used.

Discussion:

The Shallow-Water Reef Fish rule now in effect provides for a conversion from 1.5-inch square mesh wire to a minimum size of 2.0-inch square mesh wire in fish traps by September 13, 1993. Hexagonal mesh wire of 1.5 inches may continue to be used in trap construction after this date. Studies conducted off Puerto Rico during the phase-out period for the 1.5-inch square mesh wire were not substantively different from those conducted elsewhere (principally the Florida Straits) by other researchers (Appeldoorn and Posada, 1992). Statistical tests showed that the 1.5-inch square mesh caught significantly more individuals and smaller fish than the 1.5-inch hexagonal and 2.0-inch square mesh traps. A comparison of frequency distributions of fishes by weight, length, and circumference also showed that 1.5-inch square mesh caught significantly smaller fish than the 1.5-inch hexagonal mesh traps. Therefore, the Council concluded that the conversion to 2.0-inch square mesh would reduce resource waste through excessive mortality to small or juvenile reef fishes as compared to the use of 1.5-inch square mesh wire for traps.

Fishermen have testified that locating escape openings on two opposing sides of a trap (as presently required) can cause premature release of the catch from the weight of fish on the panel opposite the bridle during trap retrieval. Locating the escape openings on adjacent sides of a trap eliminates this problem. The minimum size of the escape openings (8 x 8 inches) and the use of untreated jute twine 1/8-inch or less in diameter as a fastening material are identical to present requirements. The use of 18 gauge ungalvanized wire on traps without anodes, however, was an improvisation of the Council to accommodate fishermen that contended jute twine is overly burdensome because of the amount of time required to retie the fastenings each time a trap is hauled. No data are available on the degradation time for 18 gauge ungalvanized wire.

Rejected Measure 5A. Require only one escape panel, which should be the access door, made of 2-inch square mesh wire fastened with 18 gauge ungalvanized iron wire and located on one side of the trap. The door should be hinged at the bottom and cover an opening of no less than 8 x 8 inches.

Discussion:

This option is supported by the fishermen and the Council AP over current measures that they believe are overly restrictive. The major departures from current requirements are the single escape panel and the use of wire fasteners. Objection to using traps with a single escape panel was addressed in response to comments received during review of the rulemaking for existing measures. The objection was that a lost trap might be positioned so that a single panel would be obstructed or incapacitated in such a way that it would not allow fish to escape. Two escape panels (one of which may be the access door) provide more assurance against this possibility.

The use of ungalvanized iron wire as a fastening material for access doors and escape panels is problematical for the following reasons. The Council spent approximately three years and a substantial amount of funds conducting studies to determine the most suitable material for fasteners on fish traps. The principal criterion for selection of a material was degradation time so that ghost fishing by lost or abandoned traps could be avoided. The key was to use a material that would degrade over a brief period so that fishermen would be compelled to replace the fasteners each time the trap was hauled. Based upon these studies, the Council selected 1/8-inch untreated jute twine as the most acceptable material for meeting this criterion; wires of various gauges and compositions were not tested. Also, many of the traps deployed in the management area are outfitted with zinc anodes to prevent electrolysis or oxidation of the trap. The use of anodes would similarly increase the life expectancy of the wire fasteners in sea water, thereby negating its utility as a fastening material.

Rejected Measure 5B. Retain current restrictions for fish traps (status quo).

Discussion:

Current regulations require that: (1) fish traps be constructed of a minimum mesh size of 1.5-inch square or 1.5-inch hexagonal wire; (2) fish traps contain an escape port on each of two opposite sides and be covered by a panel of a mesh size no smaller than that of which the trap is constructed and fastened with untreated jute twine 1/8-inch or less in diameter; (3) the access door may serve as one of the escape panels, provided it is on an appropriate side, it is hinged only at the bottom, and is fastened at the top by untreated jute twine 1/8-inch or less in diameter so that the door will fall open when the twine degrades; and (4) the escape ports on traps constructed of rectangular mesh measure a minimum of 9 x 9 inches and, for hexagonal mesh, 8 x 8 inches. These measures will remain in effect until September 13, 1993, when they will be re-evaluated in light of current studies on the size and species composition of fishes taken with various mesh size traps.

Current fish trap restrictions address most of the concerns associated with continued fishing mortality being inflicted by lost traps. However, legitimate concerns have surfaced regarding placement of the escape openings on opposite sides of a trap, and the continued use of 1.5-inch square mesh wire (see discussion under Preferred Measure 5). Basically, the location of escape openings on opposite sides of a trap can trigger the release of fish prematurely by pressure from the weight against a panel during hauling. Also, additional studies to evaluate size composition of species in the catch by various mesh-sized traps generally supported the efforts of other researchers, and indicated that 2.0-inch square mesh would result in the release of substantially greater numbers of small or juvenile fishes as contrasted to 1.5-inch square mesh (Appeldoorn and Posada, 1992).

(C) Harvest Prohibitions.

Presently, there is a prohibition on the harvest and possession of Nassau grouper, and one other is proposed for jewfish in this amendment. The harvest of Nassau grouper (once the dominant species in the reef fish fishery) was not prohibited until a collapse of that resource was experienced. A prohibition against harvesting jewfish is recommended as that species now appears as only a relict of its former abundance. Generally, organisms are most common near the geographical center of their range; however, population declines have led to the closure of the jewfish fishery along peninsular Florida -- the center of abundance. A similar prohibition in the Caribbean management area is recommended under this amendment.

Options for limiting the harvest of red grouper, tiger grouper, and certain marine aquarium fishes also were examined by the Council. The Council, taking SSC and AP recommendations into account, agreed that insufficient evidence was available to prohibit the harvest of most aquarium fishes, but that the young of species under a rebuilding program should be protected until those resources recover. The Council also decided that insufficient information existed to establish a harvest prohibition on tiger grouper, but recommended monitoring removal from a spawning aggregation area near Vieques, Puerto Rico. If necessary, the aggregation area could be closed to all fishing from February 1 - April 30 of each year to protect the resource (see recommendation 4). Insofar as red grouper is concerned, the status of the resource is uncertain in the management area. According to literature (Brownell and Rainey, 1971; Erdman, 1979; FAO, 1978), the species is abundant to the north (eastern Gulf of Mexico) and is common in Venzuelan markets to the south, but does not appear to be common in the management area. Whether this is a function of distribution, localized overexploitation, or other resource-related problems has not been determined. Because of the uncertainty of the status of red grouper, the Council preferred to delay any harvest restrictions until more information is collected.

Adopted Measure 6. Prohibit the harvest or possession of jewfish (*Epinephelus itajara*) in waters around Puerto Rico and the U.S. Virgin Islands.

Discussion:

Jewfish occur off both coasts of Florida, throughout the Gulf of Mexico and the Greater Antilles, and along the southwestern Caribbean coast (FAO, 1978). A disjunct population also occurs along the Pacific coast from Costa Rica to Peru. The center of abundance is off peninsular Florida, but the species appears to be no longer abundant anywhere within its range. Of about 150,000 records of measurements from biostatistical samples from Puerto Rico since 1983, only about 30 are of jewfish, and all of those were sexually immature. According to Bullock et al. (1992), the minimum size of sexually mature females is ca. 1,225 mm total length, and for males ca. 1,155 mm total length. All specimens in the biostatistical samples from Puerto Rico were less than 875 mm total length. Juveniles occur primarily inshore in mangrove and seagrass areas; adults generally are taken on reefs in deeper waters.

Life history characteristics of jewfish make it extremely susceptible to overfishing and recovery from overfishing, in all likelihood, would be very slow. Jewfish grow to a large size, upwards of seven feet and 700 pounds, which makes them prime targets for spearfishing, the chief method of harvest. The species is unique and, because of its unusual size, is esteemed by spearfishermen and by underwater photographers and divers for its aesthetic appeal. These features all combine to make jewfish a prime candidate for total protection.

Rejected Measure 6A. Allow the unrestricted harvest of jewfish (status quo).

Discussion:

Although data are inadequate for a stock assessment, the species is so scarce that it is likely that sufficient data will never be available. Allowing continued harvest could result in the reduction of the jewfish population to a level that would require an unusually extensive time period for recovery, or result in displacement of the species altogether. This approach certainly would not be responsive to the needs of this unique resource.

Adopted Measure 7. Prohibit the harvest and possession of certain species used in the marine aquarium trade.

Discussion:

The status of many species of marine aquarium fishes has not been determined, but some are uncommon while others are heavily exploited without restriction. All marine aquarium fishes will benefit from the gear restrictions contained in this amendment. Because of the intensifying and uncontrolled harvest of marine aquarium fishes in Puerto Rico, and based on experiences elsewhere, there is a need to regulate this fishery. By adding marine aquarium fishes to the Shallow-Water Reef Fish FMP, the harvest and possession of the young of species that presently are in a rebuilding mode would be subject to prohibition until those resources have recovered. This group currently includes red hind (Epinephelus guttatus) and mutton snapper (Lutjanus analis).

A number of criteria were examined in selecting species to be precluded from harvest in the marine aquarium trade. In compiling a list of prohibited species for the management area the following were considered:

1. Species that are locally rare are potentially vulnerable to harvest for the aquarium trade because the scarcity and the higher value associated with rare species often result in greater effort expended for their harvest (Randall, 1987). Of the species listed by Sadovy (1991), two genera of fishes that may be considered rare or uncommon in the management area are the seahorses (Hippocampus spp.) and basslets of the genus Liopropoma. Since the latter are collected mainly by chemicals, such as quinaldine, and harvest by chemicals is prohibited, basslets already receive protection. Only 30 of 25,276 (0.001%) fishes recorded in Sadovy 1991 were either Hippocampus or Liopropoma; therefore, a prohibition will not impact collectors economically.

2. Species that are harvested either recreationally or commercially as food fish in other fisheries must be carefully evaluated for stock condition to avoid overharvest or user conflicts. Species in the aquarium trade in this category are the red hind, which is definitely growth overfished (Sadovy and Figuerola, 1992), and possibly recruitment overfished (Sadovy, 1992), the coney, Epinephelus fulvus (stock status uncertain), and the queen triggerfish, Balistes vetula. Substantial numbers of juvenile queen triggerfish are reportedly taken in the marine aquarium trade; however, like the coney, the status of this species is uncertain although average size in landings has declined (Appeldoorn, et al., 1992). Both are important species in the commercial landings of Puerto Rico. Other species that are important as food fishes and that may be in a state of decline are goatfishes (Mullidae), parrotfishes (Scaridae) in the U.S.V.I., and some of the trunkfishes.

3. Some species are considered unsuited for the aquarium trade because they do not survive well in captivity. According to Wood (1992), a number of butterflyfishes do not feed well in captivity and consequently experience high mortality (e.g.,- Chaetodon capistratus, C. striatus, and C. aculeatus). Permitting harvest of these species for the aquarium trade would constitute inefficient and wasteful use of these resources under the Magnuson Act. Also, small individuals of a number of other species of value to the marine aquarium trade, especially the angelfishes, do not survive well in captivity.

4. Certain species may be of more value to the habitat than if harvested, as their removal may be detrimental to the reef ecosystem. Cleaner fishes, such as juveniles of some of the wrasses, basslets and angelfishes -- notably Thalassoma bifasciatum, Bodianus rufus, Gramma loreto, and Pomacanthus paru -- are known to remove parasites and mucous from a wide range of fishes. Their importance to the health of the reef or its components is unknown but should be evaluated.

Finally, a number of species that are targeted heavily for the aquarium trade should be assessed in terms of stock condition. These species include royal gramma, Gramma loreto, rock beauty, Holacanthus tricolor, yellowhead jawfish, Opistognathus aurifrons, french angelfish, Pomacanthus paru, queen angelfish, Holacanthus ciliaris, pygmy angelfish, Centropyge argi, bluehead wrasse, Thalassoma bifasciatum, puddingwife wrasse, Halichoeres radiatus, blue chromis, Chromis cyanea, and red-lipped blenny, Ophioblennius atlanticus.

Accordingly, prohibiting harvest of the following species is proposed for the marine aquarium trade.

seahorses - Hippocampus spp.
red hind - Epinephelus guttatus
mutton snapper - Lutjanus analis
foureye butterflyfish - Chaetodon capistratus
banded butterflyfish - C. striatus
longsnout butterflyfish - C. aculeatus

Other species may be added as vital information is gathered from stock assessments generated by research and the reporting system recommended as part of this amendment.

Rejected Measure 7A. Only harvest and possession prohibitions on food species and those protected by ancillary restrictions would apply to marine aquarium trade (status quo).

Discussion:

While some species of marine aquarium fishes are abundant, certain species are uncommon and may be highly susceptible to overharvest. This alternative would not provide the protection this latter group deserves. It is possible that some species are already overfished while others may provide greater benefits as components of the reef ecosystem rather than being harvested. Often species in short supply are in great demand; therefore, conservation measures are needed to guard against further decline and to protect the interests of collectors/exporters dependent upon these resources for their livelihood. As currently expressed, the no-action alternative would protect only the young of prohibited species (i.e., Nassau grouper and jewfish), and to a large degree basslets (genus Liopropoma) that appear to be most susceptible to harvest by chemicals that are illegal collection devices under this FMP.

(D) Spawning Aggregation Area Closures.

Since a red hind spawning area in the EEZ southwest of St. Thomas was first closed on December 1, 1989, through the duration of the spawning season (February 28, 1990), the Council has attempted to identify additional spawning aggregation areas to further protect declining reef fish resources. During the spawning season, some species of reef fishes are aggressive and extremely vulnerable to capture. Protecting spawning aggregations is a sound management practice and the Council prefers spawning area closures to other approaches, such as size limits and quota management, that are more labor intensive to monitor and inflict high rates of mortality on undersized fish. Because aggregating fish are highly susceptible to capture by a wide range of gears (hook and line, trap, spears, etc.), a total ban on use of gear capable of taking fish is necessary to protect spawning aggregations. Other spawning aggregations may be added, if necessary, when identified.

Adopted Measure 8. Closure of additional red hind aggregation areas during the December through February spawning season.

Discussion:

A spawning aggregation area has been identified in the EEZ off the west end of Puerto Rico. The area lies to the west of Tourmaline buoy, west of Mayaguez, Puerto Rico. The best known location, based on historic productivity, covers an area of approximately 3 x 5 miles. The area is bounded by rhumb lines connecting the following points (see Fig. 1, Appendix I):

Point	Latitude N.	Longitude W.
A	18°11.0'	67°25.5'
B	18°11.0'	67°20.4'
C	18°08.0'	67°20.4'
D	18°08.0'	67°25.5'
A	18°11.0'	67°25.5'

Another red hind spawning aggregation area has been identified in the EEZ east of St. Croix, U.S. Virgin Islands, at the extreme eastern end of Lang Bank. Based on comments received from members of the St. Croix Fisheries Advisory Committee, this area is now delimited to waters less than 50 fathoms (300 feet) in depth. The area formerly extended to the 100 fm. contour but was reduced because of impacts on fisheries for large pelagics (tuna, dolphin, wahoo, and marlin) and deepwater snapper. The harvest or possession of red hind during the spawning season (December through February 28) would be prohibited within the area bounded by rhumb lines connecting the following points (see Fig. 2, Appendix I):

Point	Latitude N.	Longitude W.
A	17°50.2'	64°27.9'
B	17°50.1'	64°26.1'
C	17°49.2'	64°25.8'
D	17°48.6'	64°25.8'
E	17°48.1'	64°26.1'
F	17°47.5'	64°26.9'
A	17°50.2'	64°27.9'

Rejected Measure 8A. Status quo.

Discussion:

Leaving the identified areas unprotected from intensive fishing effort could lead to the demise of the spawning aggregations and declines in local abundance, at least to the extent that local populations of red hind are dependent on these aggregations. No action definitely would contribute to a continued decline of the red hind resource.

Adopted Measure 9. Prohibit the harvest of mutton snapper (*Lutjanus analis*) in a spawning aggregation area off St. Croix from March through June of each year.

Discussion:

A mutton snapper spawning aggregation area has been identified in the EEZ off the southwest coast of St. Croix. In keeping with the Council's management preferences, the U.S. Virgin Islands, Division of Fish and Wildlife, has recommended that the area be closed to all fishing from March through June of each year to protect the species. The spawning area is bounded by rhumb lines connecting the following points (Fig. 3, Appendix I):

Point	Latitude N.	Longitude W.
A	17°37.9'	64°52.6'
B	17°38.2'	64°52.1'
C	17°38.3'	64°51.8'
D	17°38.1'	64°51.4'
A	17°37.9'	64°52.6'

Based on information obtained from commercial fishermen and the Division of Fish and Wildlife, U.S.V.I. records from 1981, mutton snapper have been harvested for more than 20 years from the spawning aggregation. The aggregation area is located between 2.1 and 3.2 nautical miles southwest of Long Point in 10 to 27 fathoms of water. Most commercial fishing occurs at night by handline fishermen in outboard-powered vessels less than 6m in length; however, fish traps and most recently gill nets have been used to harvest mutton snapper in this area. Weather permitting, more than 30 fishing vessels can be seen nightly for one week after the full moon during the months of March through June. Fishing effort is most heavily concentrated at depths of 10 to 15 fathoms. Commercial landings indicate that mutton snapper have been fished to the extent that production from the aggregation is declining; catches have been reduced from >500 pounds per boat to <100 pounds per boat for the highliners. Average individual weights have decreased from over 10 pounds to 5 pounds during the period reported.

Several attempts have been made to locate the spawning aggregation by Division divers/researchers during daylight; however, no significant numbers of mutton snapper have been observed above 15 fathoms. It is believed that actual spawning occurs in the deeper waters of the EEZ immediately off the insular shelf at depths of up to 27 fathoms. The steepness of the outer shelf slope and short linear distance between the 10 and 100 fathom contour, requires that the entire area included by these contours be enclosed (Tobias, 1986; 1992).

Rejected Measure 9A. Status quo.

Discussion:

Mutton snapper appear to be especially vulnerable to harvest when aggregated for spawning. This has prompted the curtailment of fishing activity during the spawning season in waters under the jurisdiction of the South Atlantic Council and similar action soon will be contemplated by the Gulf of Mexico Council. To allow spawning populations to be overexploited during periods of unusual vulnerability is not a biologically sound practice.

IV. RECOMMENDATIONS TO LOCAL GOVERNMENTS AND OTHER AGENCIES ON ACTIONS APPROVED BY THE COUNCIL

(A) Mandatory Permitting and Reporting.

The necessity of limiting entry into the marine aquarium fish trade was expressed by both the SSC and AP. Prior to establishing a limited access program, however, it is necessary to determine present participation at different levels within the fishery. A mandatory permitting and reporting system would accomplish this. In the marine aquarium trade there are collectors, exporters, and dealers. An individual may function in one or more of these capacities; most collectors are exporters, although some collectors also sell their catches to an exporter, or directly to local pet shops (Sadovy, 1991).

A permit and reporting system also is recommended for fishermen and dealers involved in the shallow- and deep-water reef fish fisheries. This system would be designed to identify the universe of participants and facilitate introduction of a limited access program in the event that one is warranted in the future. From the universe of permittees, a number will be selected to report catch/effort information and other data that are considered necessary for managing the fishery, including socio-economic data. Information also will be collected from the marine aquarium trade through existing procedures employed at export centers (airports), supplemented by other reporting requirements as deemed appropriate.

Recommendation 1. Require an annual permit for the sale of reef fish, including marine aquarium fish.

Discussion:

An annual permit issued by the local governments would be required to sell reef fish from the management area described in the FMP (including state and federal waters). The permit system would be operated by the local governments, while NMFS would assist by screening and recommending approval or disapproval of any applicants from the U.S. mainland. A permit would be denied anyone with an outstanding violation in any fishery. Local governments could charge an appropriate fee to recover costs of administering the program.

As long as administrative costs are not exceeded, NMFS could adopt the permits as federal permits and have the flexibility to sanction them as an enforcement mechanism.

Aquarium fish collectors and exporters are not licensed in Puerto Rico and their activities are not regulated. Although there is a licensing system for commercial reef fish fishermen in Puerto Rico, the system is not mandatory. The U.S. Virgin

Islands requires permits for both fisheries; however, the vast majority of activity occurs in waters around Puerto Rico. A permit system for the entire management area is requisite to establishing a moratorium on additional entry and limited access programs for the marine aquarium trade and the commercial reef fish fishery. In the absence of an operational permitting system, new entry into either fishery could not be prevented.

Recommendation 2. Require periodic reports from those engaged in the sale of reef fish, including marine aquarium fishes.

Discussion:

Reports would be required by the local agencies administering the permit program to more accurately determine actual participation as well as the catch and the amount of effort expended in the reef fish fishery. The data collected would allow fishery scientists and managers to better assess the status of resources in the management area and make informed judgments for conserving those resources. The data also would serve as the foundation for developing limited access programs for the reef fish fisheries. Reporting intervals and other requirements should be patterned after systems already tested and proven successful in other fisheries.

A number of management actions and recommendations have been deferred by the Council, SSC, and AP because of insufficient data. Indecision on proper management actions would be expected to continue in the absence of current information on reef fish harvest. Information on the number of participants, amount of effort and catch is too incomplete to develop limited access programs that are desperately needed in some segments of the reef fish fishery.

(B) Other Harvest Prohibitions. (Reference Discussion pp. 22-23)

Recommendation 3. Closely monitor the condition of red grouper (*Epinephelus morio*) resources from expanded data collection efforts to determine appropriate management needs.

Discussion:

The Council has received information from resource users that the status of red grouper in the Council's area of jurisdiction may be stressed. Both the SSC and the AP indicated that existing landings and biostatistical data are insufficient to accurately assess the condition of the resource and have advised that management actions be delayed until sufficient data are available. The Council has thus concluded that any action to restrict the harvest of red grouper at this time is not warranted and that fishery data collecting agencies must increase the collection of information needed to make management decisions concerning the resource.

As with jewfish and Nassau grouper, however, red grouper are so scarce that it is unlikely sufficient data will become available to accurately assess the condition of the resource in a timely manner. However, unlike jewfish and Nassau grouper, which are primarily targeted by spearfishermen, red grouper generally are taken by hook and line or in traps. Release mortality of fish taken from deep water could offset potential benefits that may be gained from a harvest prohibition.

(C) Other Spawning Aggregation Area Closures. (Reference Discussion p. 29)

Recommendation 4. Recommend that the local government monitor the spawning aggregation area for tiger grouper (*Mycteroperca tigris*) in waters near Vieques Island to obtain biological and socioeconomic information over a two-year period through a comprehensive permitting and reporting program implemented by Puerto Rico.

Discussion:

The tiger grouper occurs from Florida and Campeche Bank southward through the West Indies to the northern coast of South America in coral reef areas from the shoreline to depths of at least 30 meters. Although reports (FAO, 1978) indicate a general distribution throughout the range and that the species "commonly" reaches a length of 40 cm. (16 inches), there is little information on local abundance around Puerto Rico and the U.S. Virgin Islands. Information on abundance within the management area, as indicated by both the SSC and AP, is requisite to formulating a position on harvest limitations.

In July 1991 the Council recommended that the government of Puerto Rico take appropriate action to protect a spawning aggregation of tiger grouper in waters near Vieques. The National Marine Fisheries Service added its support to the proposed closure, recognizing that protection of spawning aggregations is an effective management tool and is preferred by the Council over measures that induce high rates of mortality (size limits) or that are difficult and costly to monitor (size limits and quotas).

Placing tiger grouper in the management unit paves the way for cooperative management to protect this species in waters under federal jurisdiction. Should Puerto Rico decide upon closing the spawning aggregation area off Vieques, the Council may close adjoining areas or other spawning aggregation areas as deemed necessary to protect the resource.

Based on observations off Vieques by Sadovy, Colin, and Domeier (ms. 1992), the species aggregates for spawning at about 120 feet and is targeted primarily by spearfishermen and by hook and line. The species reportedly is reluctant to enter traps and is taken infrequently outside the aggregation season. Up to 18 boats have been observed on the highly circumscribed spawning grounds at the same time. Estimated annual harvest from the aggregation is about 24,000 pounds or 4,900 fish. Spawning activity outside the area has not been observed and aggregation spawning may represent the total reproductive output for tiger grouper. Therefore, the estimated total number of fish removed (4,900) could constitute a significant portion of the adults using this spawning site each year, and eventually lead to the demise of the aggregation as has occurred in other grouper species.

Because of the heavy fishing pressure on the Vieques aggregation, and the apparent vulnerability of grouper spawning aggregations to exploitation in general, Sadovy, et al. (loc. cit.) recommended that tiger grouper aggregation landings be closely monitored over the next few years, and that fishing activity at the aggregation site be limited to hook and line. If marked declines in numbers of fish, catch per unit of effort, and average size are noted, the aggregation should be protected to avoid long-term damage to local tiger grouper stocks.

(D) Marine Reserves and Other Recommendations.

Tropical coral reefs are the basic component of several important fisheries in the management area of the Caribbean Council and establishing a number of them as marine reserves is a worthy concept. The most important coral reef resources are: shallow-water reef fish, spiny lobster, marine aquarium organisms (including corals and other invertebrates), and deep-water reef fishes. Except for spiny lobster and coral, these resources would be managed under the Reef Fish FMP. Balancing the traditional consumptive fisheries for these species with alternate uses of reef resources, such as ecotourism, sport diving, and aesthetics, is one of the most difficult challenges facing fishery managers. The potential of marine fishery reserves was addressed by the Reef Fish Plan Development Team of the South Atlantic Fishery Management Council (1990).

Coral reefs are highly complex ecosystems and support a diversity of species. The ecology and life history characteristics of many reef fishes make them particularly vulnerable to overfishing, such as slow growth rates, long life, late maturity, spawning aggregation behavior, and sex reversal. Larger individuals generally are targeted and are aggressive and disposed to high fishing mortality. The basic habitat itself is composed of living organisms, some of which are highly prized by collectors and others that are highly susceptible to sedimentation or other forms of degradation. The development and maintenance of marine coral reef reserves will require coordinated efforts by state and federal managers. Establishing reserves could benefit the resources and fishery managers in numerous ways.

Recommendation 5. Recommend that local governments work in cooperation with other agencies as necessary to establish marine coral reef reserves in strategic locations throughout the management area.

Discussion:

Although the coral reef per se is the basic unit of the proposed marine reserves, the concept of marine coral reef reserves cross-cuts the objectives of different FMPs and should be included as a measure in each FMP affected along with supporting rationale. In their review of proposed management options for Amendment 2, both the SSC and the AP encouraged pursuing the development of marine reserves, recognizing that the number and extent of such areas and designation of their use would require cooperation by local and federal governments.

The benefits that may be derived from marine coral reef reserves under Amendment 2 would be distributed among shallow- and deep-water reef fish resources, marine aquarium fishes, and their habitats. Marine reserves would: (1) serve as a gene pool or spawning stock reservoir to prevent depletion of fisheries by ensuring recruitment to surrounding areas; (2) strengthen the success of the reef fish management program; (3) decrease the urgency of utilizing other management actions; (4) establish a baseline for evaluating management actions in nearby areas; and (5) provide natural reef communities for educational and research sites. Marine reserves could contribute substantially to rebuilding overfished reef fish resources and guard against overfishing of others.

Recommendation 6. Recommend that the unauthorized introduction of exotic species into marine waters be prohibited.

Discussion:

According to Courtenay, et al. (1991), 47 exotic species of finfishes are listed as established in the continental United States. These species became established accidentally or with human assistance through escape or release from aquaculture facilities, introduction for biological control or sport fishing, and release of aquarium fish. Although most of these species are confined to freshwater, others are euryhaline and adapt readily to the oceanic environment. Some marine species, such as *Lutjanus kasmira*, also have been transplanted successfully (Oda and Parrish, 1981). Unauthorized introductions of exotics, whether deliberate or accidental, could result in biological catastrophes such as the displacement of more desirable species from their niches, or adverse modification of the genetic composition of the desirable species.

Most states, including Puerto Rico and the U.S. Virgin Islands, regulate the introduction of exotic species. Extending the prohibition into federal waters would serve to support and strengthen state regulation; however, the Magnuson Act cannot be used to control species outside the management unit of an FMP. For species not related to reef fishes, the Council must defer to local and other existing federal law to control their introduction.

V. OVERFISHING AND REBUILDING SCHEDULE

By definition, a reef fish stock or stock complex is overfished when it is below the level of 20% of the spawning stock biomass per recruit (SSBR) that would occur in the absence of fishing (see Regulatory Amendment to this FMP, dated July 1991).

The Nassau grouper and jewfish are currently considered overfished. Although a quantifiable SSBR cannot be determined because of the paucity of available data, total landings have declined to the point where these once abundant species rarely occur in the landings. The harvest of Nassau grouper was prohibited under Amendment 1 to the Shallow-Water Reef Fish FMP, and will remain so until the species has recovered to a level of 20% SSBR. Amendment 2 prohibits all further harvest of jewfish. This is the most restrictive action possible to restore these drastically impoverished stocks.

Red hind (now one of the most prevalent species in the landings) are being harvested at less than optimum size. The average size and production of mutton snapper also appears to be declining. These conditions are contrary to objective 2b of the FMP: "Prevent the harvest of individuals of species of high value (e.g., snappers, grouper, and others) which are less than the optimum size."

Many species of reef fish, including those mentioned above, aggregate in geographically limited areas for spawning. Instead of employing quotas and size restrictions that are labor intensive, difficult to monitor, and cause excessive mortality of juveniles, the Council prefers spawning area closures as a management tool. Protection of spawning aggregations is a practical way to reduce fishing mortality at a time when fishing effort is the most intensive and catch per unit of effort is the highest. Protection in these areas will also increase the likelihood of spawning success. The benefits of the closure of spawning areas could depend, however, on the extent that fishing effort and catch are increased during the remainder of the year.

Because of the vagaries of the condition of reef resources and the uncertainties associated with the available data, it is difficult to specify a definitive time frame for the recovery of overfished species. The many divergent characteristics of reef fish, especially those associated with age, growth, and size at maturity, make it difficult to establish rebuilding time frames with any degree of precision. The rebuilding plan also must ensure that sufficient numbers of males are produced in protogynous species, thereby increasing the likelihood of spawning success. It takes several years (more than ten in many cases) for females to become males.

The red hind, is growth overfished in both Puerto Rico and the U.S.V.I (Sadovy and Figuerola, 1992). A recently completed SSB/R analysis indicates that under current conditions of fishing mortality, SPR for red hind in Puerto Rico falls within the range of 30-40% (depending on parameters used in the analyses) (Sadovy, 1992). Since this level of SPR is higher than the current level of SPR determined to represent a state of recruitment overfishing in the management unit (i.e., 20%), the red hind is not, by definition, recruitment overfished.

However, the results of the SSB/R analyses strongly suggest that this level (20%) is too low and that for the red hind the overfishing definition should be higher than 20%. This recommendation is predicated on the finding that recruitment failure may already have occurred in this stock, as determined by analyses of length-frequency distributions (Appeldoorn et al., 1992). If so, this would indicate that recruitment overfishing occurs at a higher SPR than 20% and that the critical level of SPR for management of this stock should be higher.

For rebuilding of the red hind resources, the generation time, which is based on 1.5 x the reproductive life span of the female, is estimated at 7-8 years (Sadovy, Figuerola, and Roman, 1992). Therefore, an optimistic rebuilding schedule would be about 12 years.

Generally, little has been published on mutton snapper; however, some work has been done in Cuba and in the U.S. The Cuban study (R. Claro, 1981) indicated that females mature sexually at 4 years. The study was conducted in a heavily fished area where fish were found up to a maximum of 8 years; whereas, the U.S. study indicated a maximum age of 14 years. Although the Cuban study likely more closely reflects the biology of mutton snapper in Puerto Rico and the U.S.V.I., combining findings from the two studies may produce the most appropriate estimate of generation time. Individuals from the heavily fished population off Cuba are likely to attain a less advanced age, on average, than a population under more lightly fished or unfished conditions. Therefore, combining the results of these studies would provide an estimate of 10 reproductive years for females (14 - 4 = 10). Based upon the assumption that a realistic rebuilding schedule for mutton snapper may be estimated by the same criteria employed for red hind (i.e., 1.5 x the reproductive life span of the females in the population) yields a time frame of 15 years for rebuilding the resource.

Tiger grouper and red grouper may never have been abundant in the management area. Although overfishing may not be a factor influencing their limited population size, the Council has a responsibility to protect those resources from overfishing. The Council favors a conservative approach in managing these species, and their harvest will be monitored to determine the need for regulatory action. The Puerto Rico Department of Natural Resources has agreed to protect the spawning aggregation area for tiger grouper that has been identified in territorial waters, if such a need is supported by data collection efforts.

References

American Fisheries Society, 1991. Common and scientific names of fishes from the United States and Canada, Fifth ed., Spec. Publ. No. 20, 183 pp.

Appeldoorn, R.S. and J.M. Posada, 1992. The effects of mesh size in Antillean fish traps on the catch of coral reef fish. Final Rept. to the Caribbean Fishery Management Council, December 1992.

Appeldoorn, R., J. Beets, J. Bohnsack, S. Bolden, D. Matos, S. Meyers, A. Rosario, Y. Sadovy and W. Tobias. 1992. Shallow water reef fish stock assessment for the U.S. Caribbean. NOAA Technical Memorandum NMFS-SEFSC-304, 70 p.

Brownell, W.N. and W.E. Rainey, 1971. Research and development of deep water commercial and sport fisheries around the Virgin Islands Plateau. Carib. Res. Inst. pp. 51-52.

Bullock, L.H., Murphy, M.D., Godcharles, M.F., and M.E. Mitchell, Age, growth, and reproduction of jewfish Epinephelus itajara in the eastern Gulf of Mexico. Fish. Bull., U.S. 90:243-249.

Claro, R., 1981. Ecologia y ciclo de vida del pargo criollo, Lutjanus analis (Cuvier), en la plataforma cubana. Informe Cientifico-Tecnico, Academia de Ciencias de Cuba-No. 186.

Courtenay, W.R., Jr., Jennings, D.P., and J.D. Williams, 1991. Exotic fishes, Appendix 2. In: Common and scientific names of fishes from the United States and Canada, Fifth ed., Amer. Fish. Soc. Spec. Publ. No. 20, pp. 97-107.

Erdman, D.S. 1979. Proposed management data for deepwater reef fishes (Fishery Management Plan, FMP) for the Caribbean Fishery Management Council. Report of Scientific and Statistical Committee, Sep. 20, 1977.

Food and Agriculture Organization of the United Nations (FAO), 1978. FAO species identification sheets for fishery purposes; Western Central Atlantic Fishing Area 31; Vol. 5.

Mason, D.L. and C.S. Manooch III, 1985. Age and growth of mutton snapper along the east coast of Florida. Fish. Res. 3: 93-104.

Matos, D. 1992. Annual report to the National Marine Fisheries Service Interjurisdictional Fisheries Program. P.R. Dept. Nat. Res. Fish. Res. Lab., 55pp.

Matos, D. and Y. Sadovy, 1990. Overview of Puerto Rico's small-scale fisheries statistics 1988-1989. P.R. Dept. Nat. Res., Tech. Rep. Vol. 1, No. 4, 17 pp.

Oda, D. and F. Parrish, 1981. Ecology of commercial snappers and groupers introduced to Hawaiian reefs. Proceedings IV, Int. Coral Reefs Symp. Manila, Vol 1, pp. 59-67.

Randall, J.E. 1987. Collecting reef fishes for aquaria. Human impacts on coral reefs: facts and recommendations. B. Salvat et., Antenne Museum EPHE, French Polynesia:29-39.

Reef Fish Plan Development Team, South Atlantic Fishery Management Council, 1990. The potential of marine fishery reserves for reef fish management in the U.S. southern

Atlantic. J.A. Bohnsack, Chairman. Southeast Fisheries Center, Natl. Mar. Fish. Serv., NOAA, 41 p. plus appendices.

Sadovy, Y. 1991. A preliminary assessment of the export trade in marine aquarium organisms in Puerto Rico. Report to the Caribbean Fishery Management Council. Manuscript 43 pp.

Sadovy, Y. 1992. Spawning stock biomass per recruit: Epinephalus guttatus (Puerto Rico). Report to the Caribbean Fishery Management Council, October 1992.

Sadovy, Y., Colin, P.L., and M.L. Domeier, 1992. Aggregation and spawning in the tiger grouper, Mycteroperca tigris (Pisces: Serranidae). Manuscript 13 pp. plus figs.

Sadovy, Y. and M. Figuerola. 1992. The status of the red hind fishery in Puerto Rico and St. Thomas, as determined by yield-per-recruit analysis. Proc. Gulf. Carib. Fish. Inst. 42:23-38.

Sadovy, Y., M. Figuerola, and A. Roman. 1992. Age and growth of red hind, Epinephelus guttatus, in Puerto Rico and St. Thomas. Fish. Bull. U.S. 90:516-528.

Tobias, W. 1986. Assessment of the population dynamics of snapper/grouper spawning aggregations. Dept. of Comm. Ann. Rept. PL 88-309, 6 pp.

Tobias, W. 1992. Letter to the Caribbean Fishery Management Council in support of the mutton snapper spawning area closure. Division of Fish and Wildlife, U.S.V.I. 3 pp.; 30 December 1992.

Wood, E. 1992. Trade in tropical marine fish and invertebrates for aquaria. Proposed guidelines and labelling scheme. A report for the Marine Conservation Society 36 pp.

APPENDIX I

Table 1A. Species in the Expanded Management Unit for Shallow-Water and Deep-Water Components of the Reef Fish Fishery. (Species with asterisk occur in both fisheries; double asterisk = predominantly deep water.)

Scientific Name[1]	Common Name[1]	Spanish Name(s)[2]
Holocentridae	Squirrelfishes	
*Holocentrus ascensionis	Squirrelfish	Gallo, candil
*H. rufus	Longspine squirrelfish	Candilero
Serranidae	Sea basses	
Epinephelus adscensionis	Rock hind	Cabra mora
E. cruentatus	Graysby	Mantequilla
**E. flavolimbatus	Yellowedge grouper	Mero aleta amarilla
*E. fulvus	Coney	Mantequilla
*E. guttatus	Red hind	Mero cherna
E. itajara	Jewfish	Mero grande
*E. morio	Red grouper	Mero guasa
**E. mystacinus	Misty grouper	Guasa
*E. striatus	Nassau grouper	Cherna
*Mycteroperca venenosa	Yellowfin grouper	Moro pinto, Guajil
*M. tigris	Tiger grouper	Dientes de sable
Malacanthidae	Tilefishes	
**Caulolatilus cyanops	Blackline Tilefish	Domingo
**Malacanthus plumieri	Sand tilefish	Jolocho
Carangidae	Jacks	
Caranx bartholomaei	Yellow jack	Guaymen amarillo
C. crysos	Blue runner	Cojinua
C. latus	Horse-eye jack	Jurel ojon
*C. lugubris	Black jack	Jurel negron
C. ruber	Bar jack	Cojinua

[1] Names are from the American Fisheries Society List of Fishes, 1991.

[2] From Erdman, 1983, and FAO, 1978.

Table 1A (Continued)

**Seriola dumerili	Greater amberjack	Medregal
**S. rivoliana	Almaco jack	Escolar, Medregal
Lutjanidae	Snappers	
**Apsilus dentatus	Black snapper	Chopa negra
**Etelis oculatus	Queen snapper	Cartucho
*Lutjanus analis	Mutton snapper	Sama
L. apodus	Schoolmaster	Pargo amarillo
**L. buccanella	Blackfin snapper	Negra
L. griseus	Gray snapper	Pargo prieto
*L. jocu	Dog snapper	Pargo colorado
L. mahogani	Mahogany snapper	Rayado de yerba
*L. synagris	Lane snapper	Rayado
**L. vivanus	Silk snapper	Chillo
Ocyurus chrysurus	Yellowtail snapper	Colirrubia
**Pristipomoides aquilonaris	Wenchman	Muniama de afuera
*Rhomboplites aurorubens	Vermilion snapper	Besugo
Haemulidae	Grunts	
*Haemulon album	Margate	Viuda
*H. aurolineatum	Tomtate	Mulita, mula
H. flavolineatum	French grunt	Condenado
*H. plumieri	White grunt	Cachicata
H. sciurus	Bluestriped grunt	Ronco amarillo
Sparidae	Porgies	
Archosargus rhomboidalis	Sea bream	Chopa
Calamus bajonado	Jolthead porgy	Bajonado
C. penna	Sheepshead porgy	Pluma
+C. pennatula	Pluma	Pluma
Mullidae	Goatfishes	
Mulloidichthys martinicus	Yellow goatfish	Salmonete amarillo
*Pseudupeneus maculatus	Spotted goatfish	Salmonete colorado

Table 1A (Continued)

Chaetodontidae	Butterflyfishes	
Chaetodon capistratus	Foureye butterflyfish	Mariposa
C. ocellatus	Spotfin butterflyfish	Mariposa
C. striatus	Banded butterflyfish	Mariposa
Pomacanthidae	Angelfishes	
Holacanthus ciliaris	Queen angelfish	Isabelita
H. tricolor	Rock beauty	Isabelita medioluto
Pomacanthus arcuatus	Gray angelfish	Cachama blanca
P. paru	French angelfish	Cachama negra
Labridae	Wrasses	
Bodianus rufus	Spanish hogfish	Loro capitán
Halichoeres radiatus	Puddingwife	Capitán de piedras
Hemipteronotus novacula	Pearly razorfish	Doncella cuchilla
Lachnolaimus maximus	Hogfish	Capitán
Scaridae	Parrotfishes	
Scarus coelestinus	Midnight parrotfish	Judio
S. coeruleus	Blue parrotfish	Brindao
S. croicensis	Striped parrotfish	Loro
S. guacamaia	Rainbow parrotfish	Guacamayo
S. taeniopterus	Princess parrotfish	Loro
S. vetula	Queen parrotfish	Loro
Sparisoma aurofrenatum	Redband parrotfish	Loro
S. chrysopterum	Redtail parrotfish	Loro
S. rubripinne	Redfin parrotfish	Loro
S. viride	Stoplight parrotfish	Chaporra
Acanthuridae	Surgeonfishes	
Acanthurus bahianus	Ocean surgeon	Medico
A. chirurgus	Doctorfish	Medico
A. coeruleus	Blue tang	Medico

Table 1A (Continued)

Balistidae	Leatherjackets	
Balistes vetula	Queen triggerfish	Puerco
Canthidermis sufflamen	Ocean triggerfish	Turco
Melichthys niger	Black durgon	Japonesa
Xanthichthys ringens	Sargassum triggerfish	Puerquito
Ostraciidae	Boxfishes	
Lactophrys bicaudalis	Spotted trunkfish	Chapin
L. polygonia	Honeycomb cowfish	Chapin
L. quadricornis	Scrawled cowfish	Chapin
L. trigonus	Trunkfish	Chapin
**L. triqueter*	Smooth trunkfish	Chapin

†Not listed by AFS.

Table 2A. Species or species groups of aquarium fishes on trade lists and shipping lists for export from Puerto Rico 1990/91. (Species noted by an asterisk are taken at larger sizes as food fish.) Modified from Sadovy, 1991.

Scientific Name	Common Name	Number
Elasmobranchs	Sharks, skates, rays	-
Gymnothorax miliaris	Goldentail moray	44
Gymnothorax funebris	Green moray	-
Myrichthys oculatus	Goldspotted snake eel	4
Echidna catenata	Chain moray	-
Muraenids	Moray "eels"	8
Plectrypops retrospinis	Cardinal soldier	183
*Holocentrus ascensionis	Longjaw squirrelfish	5
Myripristis jacobus	Blackbar soldierfish	242
Holocentrids	Squirrelfish	3
Apogon maculatus	Flame/cardinalfish	98
Astrapogon stellatus	Conchfish	1
Priacanthus arenatus	Bigeye	24
Priacanthus cruentatus	Glasseye	26
Chromis cyanea	Blue chromis	439
Chromis insolatus	Sunshine Damselfish	20
Abudefduf saxatilis	Sergeant major	12
Stegastes partitus	Bicolor damselfish	-
Stegastes leucostictus	Beaugregory	49
Stegastes planifrons	Yellow damselfish	20
Stegastes dorsopunicans	Dusky damselfish	-
Microspathodon chrysurus	Yellowtail/jewel	299
Pomacentrids	Damselfish	8
Thalassoma bifasciatum	Bluehead wrasse	612
Clepticus parrae	Creole wrasse	43
Halichoeres cyanocephalus	Lightning wrasse	20
*Halichoeres radiatus	Puddingwife	587
Halichoeres maculipinna	Clown wrasse	34
Halichoeres garnoti	Yellowhead/neon wrasse	122
Xyrichtys splendens	Razorfish/green wrasse	26
*Bodianus rufus	Spanish hogfish	462
Labrids	Wrasses	-
*Sparisoma chrysopterum	Redtail parrotfish	-
*Scarus taeniopterus	Princess parrotfish	-
*Scarids	Parrotfish	20
Centropyge argi	Pygmy angelfish	345
*Pomacanthus paru	French angelfish	882
*Pomacanthus arcuatus	Gray angelfish	7
*Holacanthus ciliaris	Queen angelfish	114
*Holacanthus tricolor	Rock beauty	1552
*Pomacanthids	Angelfish	7
*Chaetodon capistratus	4-eye butterflyfish	133
*Chaetodon ocellatus	Spotfish butterflyfish	-
*Chaetodon striatus	Banded butterflyfish	338
Caetodon aculeatus	Longsnout/nose butterfly	111
*Chaetodontids	Butterflyfish	98
Gramma loreto	Royal gramma	11124
Serranus tabacarius	Tobacco fish	57
Serranus tigrinus	Harlequin bass	76
Serranus annularis	Orangeback bass	1
Serranus baldwini	Latern bass	13
Serranus tortugarum	Chalk bass	54
*Serranids	Basses	14
Liopropoma rubre	Swissguard basslet	6
Hypoplectrus nigricans	Black hamlet	-

Table 2A (Continued)

Hypoplectrus indigo	Indigo hamlet	-
Hypoplectrus unicolor	Butter hamlet	-
Hypoplectrus puella	Barred hamlet	-
Hypoplectrus guttavarius	Shy hamlet	1
Hypoplectrus gummigutta	Golden hamlet	-
Hypoplectrus aberrans	Yellowbellied hamlet	-
Serranids	Hamlets	12
Paranthias furcifer	Creole fish/anthias	135
*Epinephelus fulvus	Coney/gold coney	53
*Epinephelus guttatus	Red hind	12
*Serranids	Grouper	47
Rypticus saponaceus	Soapfish	1
Equetus punctatus	Spotted drum	21
Equetus lanceolatus	Jackknife fish	22
Pareques acuminatus	Cubbyu/high-hat	205
Chaetodipterus faber	Spadefish	6
Amblycirrhitus pinos	Redspotted hawkfish	31
Anisotremus virginicus	Porkfish	17
Ophioblennius atlanticus	Redlip blenny	451
Blenniids	Blennies	948
Gobiosoma spp.	Neon goby	-
Quisquilius hipoliti	Rusty goby	-
Gobiids	Gobies	-
Opistognathus aurifrons	Yellowhead jawfish	2631
Opistognathus whitehurstii	Dusky jawfish	126
Scorpaenids	Scorpionfish (Stonefish)	8
Bothus lunatus	Peacock flounder/flounder	-
Symphurus arawak	Caribbean tonguefish	-
Dactylopterus volitans	Flying gurnard/sea robin	437
Hippocampus spp.	Sea horse	24
Sygnathids	Pipefish	3
*Acanthurus coeruleus	Blue/yellow tang	367
*Acanthurus chirurgus	Surgeon tang/doctorfish	50
*Balistes vetula	Queen triggerfish	920
*Xanthichthys ringens	Sargassum/redtail/triggerfish	74
*Canthidermes sufflamen	Ocean triggerfish	1
*Melichthys niger	Black triggerfish	76
Aluterus scriptus	Scrawled filefish	-
Cantherhines macrocerus	Whitespotted filefish	22
Monacanthids	Filefish	28
*Lactophrys, Acanthostracion	Trunkfish, cowfish	-
Canthigaster rostrata	Sharpnose puffer	36
Diodon hystrix	Porcupinefish	2
Antennarius spp.	Frogfish	70
Ogcocephalus spp.	Batfish	6
Synodus intermedius	Lizardfish	1
*Mullids	Goatfish	9
Aulostomids	Trumpetfish	60

FIGURE 1. PROPOSED RED HIND AREA CLOSURE -- TOURMALINE BANK

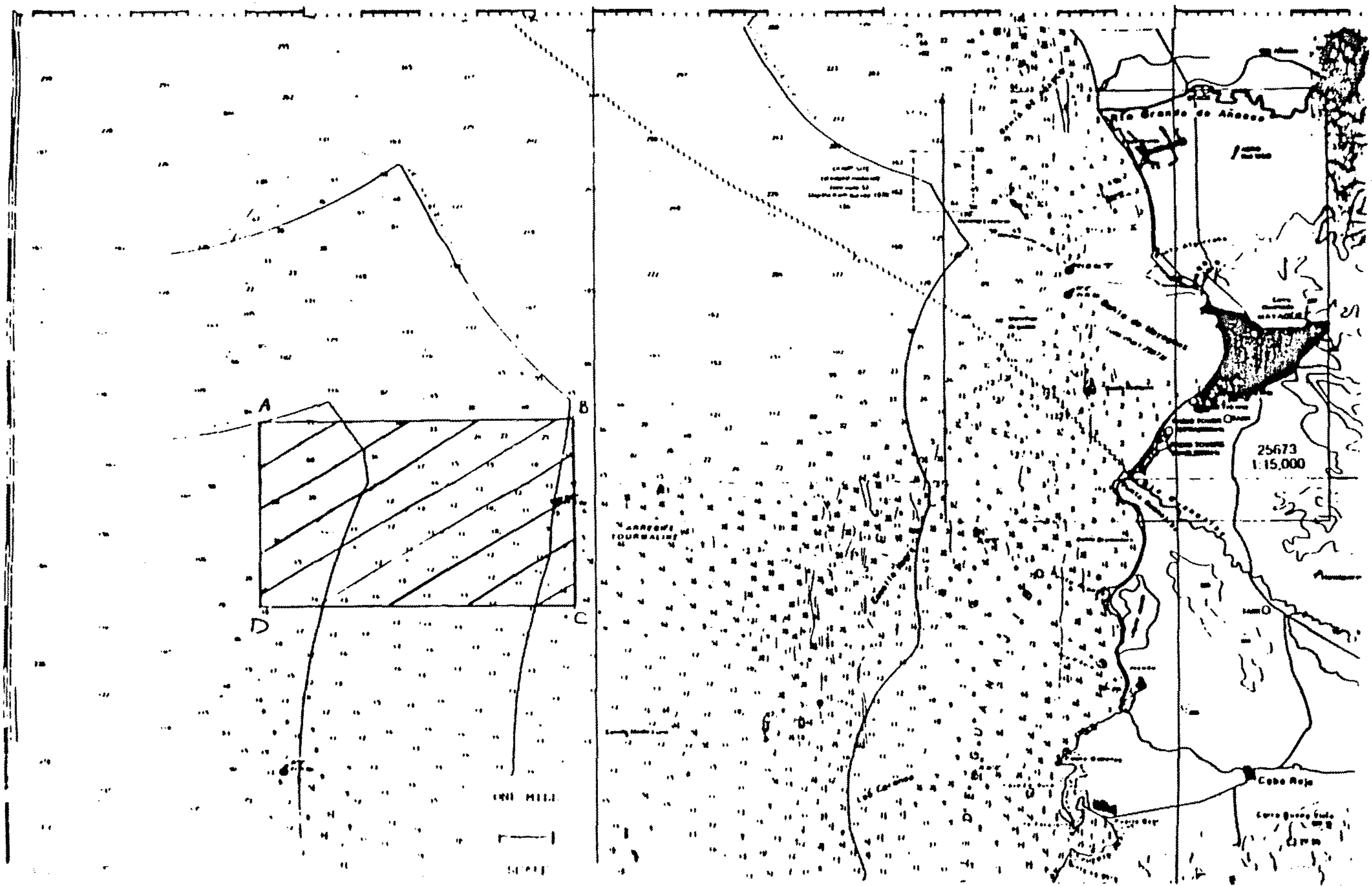


FIGURE 2. PROPOSED RED HIND AREA CLOSURE -- LANG BANK

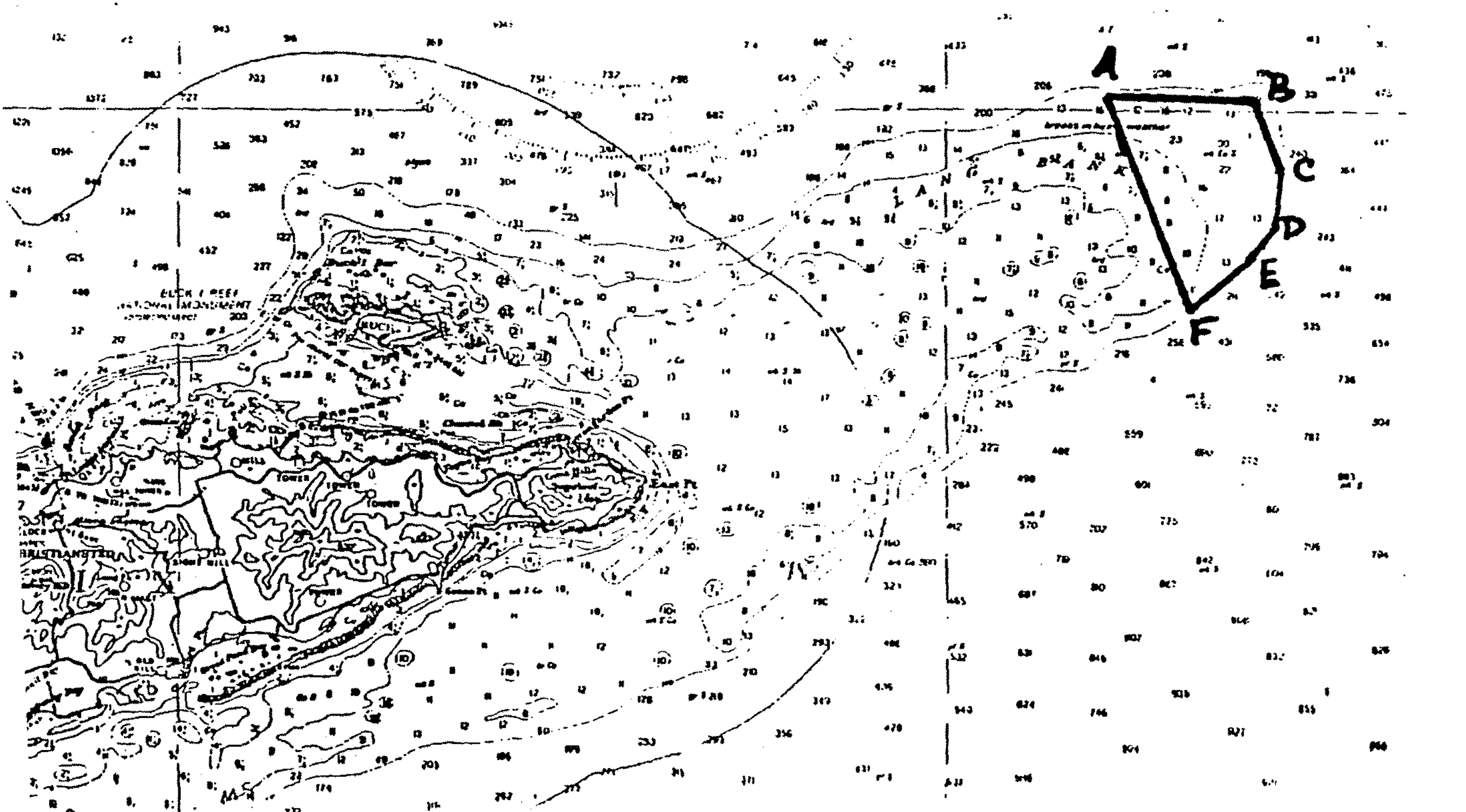
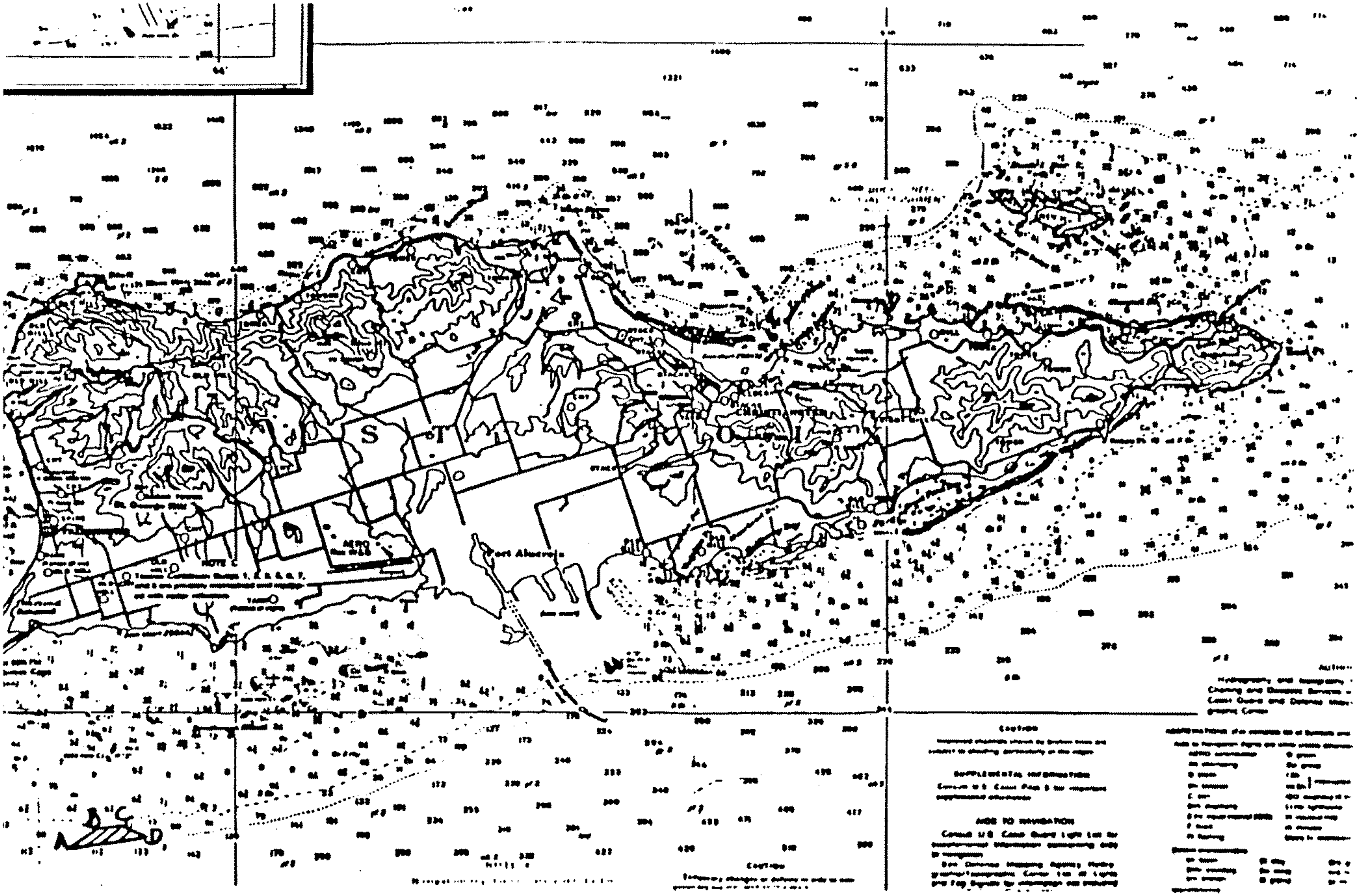


FIGURE 3. PROPOSED MUTTON SNAPPPER AREA CLOSURE -- ST. CROIX



APPENDIX II-A

NOAA Technical Memorandum
NMFS-SEFSC-304

Shallow Water Reef Fish Stock Assessment for the U.S. Caribbean

Report from a Workshop Held in San Juan, Puerto Rico, November 18-20, 1991

Prepared by:
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March, 1992

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U.S. DEPARTMENT OF COMMERCE
Barbara Hackman Franklin, Secretary

NATIONAL OCEANIC AND ATMOSHPERIC ADMINISTRATION
John A. Knauss, Administrator

NATIONAL MARINE FISHERIES SERVICE
William W. Fox, Jr., Assistant Administrator for Fisheries

March, 1992

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Cover Photo. Paradise lost? A spearfisherman with reef fish catch at Water Island, St. Thomas Harbor, St Thomas, U.S.V.I. (Modified from a photo published in the February 1956 National Geographic Magazine, p. 221 titled "Spearfisherman lands a rainbow catch at Water Rock in St. Thomas Harbor.") Fishes displayed include two large Nassau grouper, a large unidentified grouper, a mutton snapper, a large rock hind (on spear), a princess parrotfish, two unidentified parrotfishes, a triggerfish, a rock beauty queen angelfish, blue runner and an unidentified fish.

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EXECUTIVE SUMMARY

A stock assessment workshop examined fishery trends for shallow water reef fishes in the U.S. Caribbean based on available fishery landings and biostatistical data. Puerto Rico, St. Croix, and the combined St. Thomas/St. John areas were chosen as appropriate geographical units for analysis. The workshop focused on comparing 1985 with 1990 because the data for these years were nearly complete. Trends in catch-per-unit effort were examined using data from other years when sufficient data were available. Deep water reef fishes, although technically not included in the Shallow-Water Reef Fish Fishery Management Plan, were also examined because of their importance to the reef fish fishery.

Significant improvements were noted in data collection, management, and coverage since 1987, particularly in Puerto Rico. Continued improvements are possible and were encouraged.

Insufficient data were available to calculate spawning potential ratios to measure overfishing, although there was reasonable direct and anecdotal evidence to suggest that many species continue to be overexploited.

Overall, using these indices,the reef fish fishery in Puerto Rico has declined from previous levels. In 1931, 1403 fishermen using 711 vessels (only 9 with motors) landed 3,080,100 lbs (Jarvis, 1932). In 1989, 1822 fishermen with 1107 vessels landed 2,305,004 lbs (Matos and Sadovy, 1990). Over the past 16 years landings have averaged 3.15 million pounds, but after reaching a high of 5.36 million lbs in 1979, they declined to a low of 1.67 million lbs in 1988 and then only slightly increased in 1989 and 1990. Composition of snapper have shifted from mostly shallow water to deeper water species and several families comprise a smaller proportion of the total demersal catch.

A similar long term database was not available from the USVI although total projected finfish landings appeared reasonably stable between 1975 and 1989, averaging 0.93 million pounds for St. Thomas/St. John and 0.44 million pounds for St. Croix.

Catch per unit effort based on fish traps has declined in both the USVI and Puerto Rico. Landings of larger individuals of groupers such as coney and red hind have decreased; and Nassau grouper in particular continue to be very scarce.

Biostatistical data were used to examine size-frequency trends by area and gear type. Growth overfishing appears to be a major problem based on the large number of small fishes being landed and the recent declines in total landings. A yield-per-recruit analysis would help quantify this situation, however, the review team was unable to conduct an analysis because of the lack of essential biological data specifically tuned to Puerto Rico and the USVI.

Although simple evaluations were made to note changes in mean capture length over time, too few data existed to

interpret the causes of changes for most species. Recruitment variability was shown for red hind and coney in Puerto Rico and St. Croix. Relatively poor recruitment for red hind in recent years in both the USVI and Puerto Rico should be a particular source of management concern although whether this variability was due to natural events or as the result of fishery exploitation cannot be determined from available data. Fishing appears to be the cause for the recent decline of large coney in St. Croix because recruitment appears consistent. The workshop showed that long-term data sets are necessary for analyses to determine recruitment effects and allow proper interpretation. Recruitment variation and the effect of this variation on length-frequency distribution indicate that pair-wise comparisons of annual length-frequency distributions may give misleading results.

Recommendations were made concerning management and methodological issues. The most noteworthy management recommendation was to improve compliance and secure compatible regulations between the Caribbean Fishery Management Council and the Commonwealth and Territorial governments. Without compatible regulations and cooperation to increase compliance, particularly by the Commonwealth of Puerto Rico, no improvements for the fishery can be anticipated because so little reef habitat is under direct Council control.

The most obvious management recommendation was to reduce fishing effort, particularly on small fishes, in order to increase the productivity of the reef fish fishery. Increasing the minimum mesh size of fish traps to at least 2" would be a step in the right direction but probably will not be sufficient to obtain significant increases in yield, especially for species that are being recruitment overfished. Establishment of no harvest zones and protection of known spawning aggregations were recommended as a means to improve the spawning stock size. It was also recommended that deeper water reef fishes be included in the Fishery Management Plan.

Methodological recommendations include continued efforts to standardize and improve data collection, entry, and storage. Historical length-frequency and catch-per-unit-effort data should continue to be entered into the database. Local studies are needed on reef fish growth and fecundity to produce yield-per-recruit models and calculate spawning potential ratios. Better information on where and how fish are captured would be extremely helpful for future analyses.

INTRODUCTION

The Caribbean Fishery Management Council's (CFMC) Fishery Management Plan (FMP) for the Shallow-Water Reef Fish (SWRF) Fishery of Puerto Rico and the U.S. Virgin Islands in the Exclusive Economic Zone (EEZ) of the U.S. Caribbean became effective on September 22, 1985. The FMP identified a number of activities that require the attention of the National Marine Fisheries Service (NMFS) and the Caribbean Fishery Management Council (CFMC), in cooperation with the Commonwealth of Puerto Rico, and the Territory of the U.S. Virgin Islands (USVI) through their pertinent agencies: Puerto Rico Department of Natural Resources (PRDNR) and the Fisheries Research Laboratory, and the USVI Department of Planning and Natural Resources, Division of Fish and Wildlife.

The management unit includes 64 of the most commonly landed species (14 families) that compose the reef fish catch from PR and the USVI. The FMP established regulations to rebuild declining reef fish stocks in the fishery and reduce conflicts among fishermen. It established criteria for the construction of fish traps; required owner identification and marking of gear and boats; prohibited the hauling of or tampering with another person's traps without the owner's written consent; prohibited the use of poisons, drugs, other chemicals, and explosives for the taking of reef fish; established a minimum size limit on the harvest of yellowtail snapper and Nassau grouper; and established a closed season for the taking of Nassau grouper.

Amendment 1, May 1990, established an area closure during the red hind spawning season in the EEZ southwest of St. Thomas; included a provision for the collection of socio-economic data; and modified two management measures: (1) increase the minimum mesh size requirement for fish traps to 2 inches by September 1991, and (2) prohibit the harvest of Nassau grouper. In September, 1991, provisions were approved that (1) defined overfishing at 20% of the spawning stock biomass per recruit that would occur in the absence of fishing; (2) delayed the 2 inch mesh requirement until September 14, 1993; (3) allowed the use of 1.5 inch square mesh wire until September 14, 1993; and (4) made specific requirements for fish traps that included two required degradable escape panels on opposite sides of fish traps attached by 1/8 inch diameter, untreated, jute twine.

To meet FMP requirements for continual monitoring and subsequent action as data become available, a SWRF stock assessment workshop was conducted at the CFMC offices in San Juan, Puerto Rico on November 18-20, 1991. This is the resulting report for the SWRF resource in the U.S. Caribbean.

METHODS

This workshop focused on comparing data from fiscal year 1985 (October 1984 through September 1985), the baseline year, with calendar year 1990 (January through December 1990) because data from other years were incomplete, or had not been computerized and edited in time for this report. Trends in CPUE were examined for other years when sufficient data were available. Species considered "deep water" reef fish, although not part of the Shallow-water Reef Fish FMP, were examined as part of this assessment because some evidence indicates that the reef fish fishery has shifted to deeper water species over recent years.

In preparation for the assessment, data from approximately 450 St. Croix trip interviews gathered from 1985 through 1990 were assembled by the CFMC staff and submitted to Miami Laboratory NMFS for data entry in the Trip Interview Program (TIP) format. Many historical landings and biostatistical data were entered from raw data sheets by CFMC and NMFS staff as part of a data archaeology project administered by the SEFSC, NMFS. Biostatistical data representing over 52,000 measured fish were pooled for length-frequency analysis. Participants examined data and conducted analyses where appropriate. The 1985 Caribbean Analysis (Bohnsack et al., 1986) was used as a database and a baseline for this report. The assessment team chose to use Puerto Rico, St. Croix, and the combined St. Thomas and St. John area as appropriate units for analysis. St. Croix was separated from the other Virgin Islands because it is located on a separate geological platform. The assessment team also agreed that a minimum of thirty observations for a given species or gear type were necessary in order for the data to be included in statistical analyses for this report. Tables 4-7 report all available data.

Fish traps and fish pots are considered synonymous for this report.

Biostatistical Data

The biostatistical data were made available in various forms from each island: data base files (DBF) files from Puerto Rico, LOTUS files from St. Thomas/St. John, and raw data sheets from St. Croix. Once the St. Croix data were edited and entered into the NMFS Trip Interview Program (TIP), all files (DBF, LOTUS and TIP) were converted to ASCII and then downloaded onto the VAX computer at NMFS/SEFC in order to undergo statistical analyses. Because each island has its own database format with unique requirements and species codes, data could not be rapidly coalesced into a single database. The 1985 Caribbean data were uploaded from the mainframe and converted into ASCII to have all data available.

Biostatistical analyses concentrated on the 64 species listed in the 1985 shallow-water reef fish fishery management plan. Also included in this report are 33 other categories which included congeneric species, species grouped by family (e.g. Lutjanidae), and fishery market classifications (e.g., first class fishes, second class, etc.). All data were sorted and analyzed separately by island, with metric conversions being performed as necessary to create uniform measurements. At times the analysis of species by weight or length was impossible due to the lumping of species into categories, especially in the 1985 data. Gear comparisons were also sometimes difficult because of the different gear type used over time. The 1985 data were previously formatted with 4 gear types. Gear types in the 1990 database were expanded to 10 types, but for the purpose of this report were consolidated to 7 with "all other" including troll lines, skin diving and other unclassified gear.

Catch per unit effort (CPUE) Analysis

The CFMC provided CPUE by year calculated in terms of average landings per trip and average weight per species per trip where sufficient data were available (Appendix B). The use of CPUE as an indicator parameter for this report was complicated by several factors, including an insufficient number of samples for certain years and combined catches representing several fishing gears. Catch per unit effort estimates are influenced by the type of fishery, the area fished, and on the activity patterns of the fishermen. Fisherman in the U.S. Caribbean commonly troll for pelagic fishes while moving towards the area where fish pots have been set. After pulling traps, fishermen troll again to lobster or conch fishing sites, fish for these organisms, and then continue trolling to the landing site. Often these catches are combined in the data, regardless of the gear used to catch specific species. The fishermen of Puerto Rico participate in a voluntary trip ticket reporting system, in which the fishermen record their catch and effort information on a trip ticket which is collected by a port agent. To be effective, this system depends on the memory of the fisherman to accurately record their catches in a timely manner. Interpreting the trip ticket data however was sometimes difficult because several trips were, at times, summarized on one trip ticket. Occasionally only one gear type was recorded for the many species landed, even when it was known that the identified gear could not harvest the species indicated (e.g., conch harvested with bottom lines). Generally, however, the number of these questionable records was small. To compensate for these factors, we analyzed only those Puerto Rico trip tickets which identified one trip per ticket. The data are presented as pounds per trip for a given gear by species (Appendix B). Puerto Rico biostatistical data that did not indicate if the data represented a complete or partial harvest were not used in CPUE calculations.

The St. Croix biostatistical data represented complete landings and thus could be used as an indicator of CPUE. The data are presented as the average weight in grams for each species by trip. Only those samples which contained at least three years of data with thirty or more observations per year were included in this analysis. The St. Croix data are preliminary, however, as additional raw data were discovered after the analysis was completed and could not be included in this report. The additional data are not expected to significantly change the trends established within this report. No detailed St. Thomas or St. John landings data were available for CPUE analysis.

RESULTS AND DISCUSSION

Data Collection, Entry, and Management

Available Data

Results of this workshop emphasize the continued need for standardized data collection, entry, and storage. In a review of 1985 Caribbean data (Bohnsack, et al., 1986), recommendations were made for improved data collection and management. Since then, significant improvements have occurred in terms of collection procedures, data management, and degree of coverage, especially for data from Puerto Rico. Still several problems were noted with much of the historical data that limited the types of possible analyses. One problem was the definition and classification of some reef fishes; species listed in the FMP were not necessarily the same species cataloged in landings reporting categories. Some reef fish classifications have changed which makes interpreting historical data problematic (e.g. primary reef fish). Deeper water reef fish were not recognized in the FMP but are routinely reported in recent landings data, especially among snapper. Terms and definitions used in the reef fish plan should be standardized as much as possible.

The variability of computer formats used from island to island was a problem. Each island had their own database format, including their own codes and programs, which made merging all data difficult, if not impossible. Statistical analyses were therefore restricted and some comparisons between islands and years were impossible.

Participants of the workshop recommended standardization of data collection and data bases, particularly for future data collection efforts. The present NMFS TIP program may provide a suitable format. In preparation for this workshop considerable effort was directed at entering historical data on an ad hoc basis. Still, some data exist that has been collected but have never been entered into a database. A need was recognized for formal standardization of data entry, editing, and routine data management. The workshop recommends that the SWRF management plan include reef fish caught routinely in deeper water such as Lutjanus buccanella, L. vivanus, Etelis oculatus, and Rhomboplites aurorubens.

Statistical Bias

The Puerto Rico biostatistical data were the most randomly collected. Port samplers routinely went out to ports and sampled catches as they were offloaded from boats. Some statistical bias probably existed in that fishermen who cooperated were approached more frequently than those who did not. Also, it is probable that some bias existed in some interviews by interviewers preferentially sampling larger and more unusual fish. The USVI biostatistical data is very biased, but precise, in that all data from St. Thomas/St. John were collected from one trap fisherman. In addition, all St. Croix data were collected from one fish house, usually from the same fish pot fisherman, although on rare occasion the fish house would buy from other trap fishermen. Some snappers reported from St. Croix (e.g., Etelis oculatus, Apsilis dentatus, Lutjanus vivanus) were obviously not caught in fish traps and were actually a result of particular deep water reef fish sampling as these species are caught by vertical set lines. It is extremely important to note that the St. Croix trap fisherman who supplied nearly all biostatistical data began altering his traps from 1 1/2" to 2" mesh in 1987, completing the conversion in 1988.

Therefore shifts to larger fish indicated by the 1985-1990 St. Croix length-frequency comparison are most probably a result of mesh change rather than an increase in fish length at capture.

Puerto Rico Fishery Trends

Total Landings

In Puerto Rico total annual SWRF landings averaged 3.15 million pounds over 16 years, but have declined greatly since 1979 (Table 1, Figure 1). Total reported annual landings increased to a high of 5.36 million lbs in 1979, and then declined to a low of 1.67 million lbs in 1988. Landings in 1989 and 1990 increased slightly but were, only 36% and 35% respectively of the maximum reported landings in 1979 and well below the 16 year average. Despite uncertainty about the accuracy of calculated values for some years (see Matos and Sadovy, 1990a), the review team concluded that the data probably reflected general landings trends.

Two trends were noted in catch composition: (1) snapper (Lutjanidae) have shifted from mostly shallow water species to increased importance of deep water snapper (Table 2); (2) several families comprise a declining proportion of the total demersal catch: grunt (Haemulidae) declined from a maximum of 28% in 1977 to 8% of the catch in 1989; grouper (Serranidae) have declined from 19% in 1972 to 13% in 1989 while snapper (Lutjanidae) increased from 23% in 1974 to a high of 51% in 1989 (Appeldoorn and Meyers, in press, Table 2).

Fishing Effort

A workshop consensus was that fishing effort has probably increased slowly in Puerto Rico over recent years. Although some data are available on the total number of fishermen (Table 1), effort data specifically targeting reef fish by gear were generally unavailable although a shift in appears to have occurred in gear from fish traps to nets.

Direct comparisons of specific fishery gears is difficult to ascertain because of different gear classifications used. In 1985 total landings (n = 2,518,687 lbs) were accounted for by fish traps (53%), hook and line (31%), other traps and hooks (5%), and other gears (11%). Fish traps remained the major fishing gear accounting for 40% of total landings in 1990 (down from 53% in 1985). In 1990, traps were followed by bottom lines (26%), gill nets (14%), SCUBA (6%), beach seines (3%), longlines (2%), and other gears (10%) in terms of contribution to total landings (n = 1,520,596 lbs).

Matos (in review) compared fishes landed from fish traps, gill nets, and trammel nets and showed that fish traps tended to catch smaller fishes.

Catch-per-unit effort (CPUE)

The reported CPUE of reef fishes landed by fish traps in PR reached a maximum of around 325 lbs/trap-yr in 1978 and then declined to approximately 45 lbs/trap-yr in 1989 (Figure 1c). Appeldoorn and Meyers (in press) analyzed fisheries independent data and showed higher

CPUE with distance from shore. Presumably greater fishing effort closer to shore reduces stock size and CPUE.

Although CPUE is an important parameter used to indicate the condition of a fishery, our ability to use CPUE was limited for a variety of reasons. One problem was the fact that most reef fish were caught by a variety of techniques (Matos and Sadovy, 1990a). Other problems, as discussed before, were our inability to distinguish one trip from many in the voluntary trip ticket system, the inability to distinguish a total from a partial catch in several years, the pooling together of species, the absence of effort data, and insufficient data for certain years. Only 14 species had sufficient data (as described in the introduction) to calculate CPUE by gear type. Simple linear trend lines were fit to the data and plotted courtesy of the CFMC (Appendix B). Trends are described in Table 3, although too few years of data were available to test statistical significance of the trends. It is readily apparent that a longer time series of data is necessary to make meaningful conclusions. For the last few years the intensity of sampling in Puerto Rico has increased, but these data cannot be used to look at trends in this assessment as they either span only two years or do not have sufficient (more than 30) observations per species with a given gear.

U.S. Virgin Islands Fishery Trends

Total Landings

Total projected finfish landings in the USVI appeared reasonably stable, averaging 1.35 million lbs between 1975 and 1989 (0.93 for St. Thomas/St. John, and 0.44 for St. Croix; Figure 1, Table 1). Total annual landings were higher from St. Thomas/St. John than from St. Croix presumably because of fewer fishermen and a smaller island platform around St. Croix.

Fishing Effort and Catch-per-unit effort (CPUE)

The workshop consensus was that fishing effort had probably increased slowly in the Virgin Islands over recent years. Although some data were available on the total number of fishermen (Table 1), effort data specifically targeting reef fish by gear were generally unavailable. However, based on 1985 data, fish pots accounted for 73% of the recorded weight landed in St. Thomas/St. John, and 71% of the landings in St. Croix. The number of fish traps, the prevalent fishing gear, were estimated to have increased since 1978 (Figure 1b) while annual catch per trap has decreased from about 350 lbs/yr in 1979 to 100 lbs/yr in 1987 (Figure 1c).

Concern was expressed that the number of actively fished traps may be a poor indication of total fishing effort because an unknown number of traps are lost and still actively fish. Surveys by USVI Division of Fish and Wildlife have found numerous lost traps without escape panels that were still catching fish. These traps were classified as lost because buoy lines were cut, traps were heavily fouled, or floats had been fouled and submerged.

Biostatistical Summaries

Biostatistical data were used to prepare size-frequency graphs for species with greater than 30 observations (Appendix A). The mean length and weight were then noted by area (Tables 4 & 5) and gear type (Tables 6 & 7). By relating tables and graphs, a simple evaluation was made for the most frequent species to note if the mean capture length by area was generally increasing, decreasing or staying relatively stable. Discussion is made at the family level for the purpose of this report. Data for individual species can be examined in Tables 4-7 and Appendix A.

1. Scaridae (Parrotfish). Parrotfishes are generally caught in fish traps. All 4 species (Sparisoma chrysopterum, S. viride, Scarus vetula and S. taeniopterus) which met the statistical restrictions (>30 observations) displayed a decrease in mean capture size over time for USVI. It is important to note that all reported scarids decreased in mean capture size even though the St. Croix data included a increase in fish trap mesh size from 1 1/2" to 2". It was not possible to determine size trends for parrotfishes for Puerto Rico because the 1985 data were not species specific as most parrotfishes were categorized in general classes (e.g., first class, second class, etc.).

2. Haemulidae (Grunts). Overall, haemulids captured in fish traps tended to decrease in mean size over time. Four haemulids (Haemulon)were traditionally reported from the U.S. Caribbean fishery, however a recent addition of Pomadasys crocro was noted (St. Croix 1990). Two species (H. flavolineatum and H. sciurus) did not appear in the 1990 St. Croix biostatistical data, presumably because they were successfully escaping through the larger meshed fish pots. H. carbonarium and H. plumieri appeared to be maintaining mean size of capture in St. Croix, possibly because of the change to larger trap mesh. H. plumieri from St. Thomas/St. John decreased in size. In Puerto Rico H. flavolineatum decreased in size over time.

3. Lutjanidae (Snappers). The mean size of Ocyurus chrysurus decreased over time in Puerto Rico. In St. Croix mean size increased from 1985 to 1990 most likely due to the larger trap mesh size. Etelis oculatus, a deep water reef snapper, had a relatively stable mean capture size in St. Croix. The other lutjanids (all Lutjanus) also appear to be maintaining a relatively stable mean capture size over time.

4. Acanthuridae (Surgeonfishes). Surgeonfishes were much more important in the USVI fishery than for that of Puerto Rico due to consumer preference. None of the three reported USVI surgeonfish were influential in the Puerto Rico biostatistical database, perhaps because they were listed by market category or are not in demand. However, in both St. Croix and St. Thomas/St. John the mean capture size of all three species (Acanthurus coerulerus, A. bahianus and A. chirurgus) decreased over time. The mean capture size of St. Croix surgeonfishes did not have as much of a decline as that reported from St. Thomas/St. John, presumably due to the switch to a larger trap mesh size by the St. Croix fisherman.

5. Serranidae (Groupers). Only two groupers, coney (Epinephelus fulvus) and red hind (E. guttatus) were present in more than thirty interviews for both years from one location. The two groupers were reported only from St. Croix and both showed an increase in mean capture size over time. However, very few large individuals were reported in the biostatistical data. It should be noted that the 1990 data for coney had significantly fewer observations (n = 30) than 1985 (n = 1642). Potential reasons for these increases in capture size are discussed later.

6. Mullidae (Goatfish). Goatfishes appeared in the database for Puerto Rico and St. Croix in 1985, but only from Puerto Rico in 1990. Most likely the larger mesh size used in St. Croix allowed them to escape. In Puerto Rico the mean capture size of both Mulloidichthys martinicus and Pseudupeneus maculatus decreased over time.

7. Sparidae (Porgy), Balistidae (Triggerfish), Ostraciidae (Trunkfish) and Labridae (Wrasses). The porgies (Calamus bajonado, C. pennatula), triggerfish (Balistes vetula), and one trunkfish (Lactophrys polygonia), decreased in mean size over time for Puerto Rico. Mean size of capture for L. quadricornis remained stable. Data from St. Croix showed an absence of porgies and a decrease in the mean capture size of B. vetula and L. polygonia over time. The mean size of hogfish (Lachnolaimus maximus) increased over time for Puerto Rico.

Insufficient data existed to examine size differences for Carangids (Jacks), Holocentrids (Squirrelfish), and Pomacanthids (Angelfish).

Length-frequency Analyses

Further analyses were conducted at the workshop on the sources of variation in length-frequency distributions. Because of the relative abundance of data, primary emphasis was given to the red hind, with distributions available from St. Croix, St. Thomas/St. John and Puerto Rico (Figures 2 and 3). Growth curves from Sadovy et al. (in review) for Puerto Rico and St. Thomas were used to convert lengths to ages; the St. Thomas/ St. John curve was applied to the St. Croix data. In addition, Sadovy and Figuerola (in press) presented catch curves for Puerto Rico and St. Thomas. Distinct variations were evident between years in length-frequency distributions.

Our analyses showed that variations in red hind recruitment largely explain the above differences. Data from St. Croix (Figure 4) showed low recruitment for the last three years (1987-90). Good year classes that were spawned in 1980 (located at 350 mm in 1988) and 1983 probably have been supporting the fishery over the past few years. Mean size of the red hind has been increasing steadily from 292 mm in 1987 to 342 mm in 1990. This increase resulted primarily from poor recruitment and the absence of small individuals, coupled with the relative abundance of now large individuals from the earlier dominant year classes. The data also show that these older fish are disappearing (due to fishing and natural mortality). The switch to larger trap mesh size does not account for this pattern as smaller size classes continued to diminish after the switch was completed. Because the larger individuals will not be replaced due to poor recruitment in recent years, catches are predicted to decline; a trend already evident in the last 2 years.

In St. Thomas, the red hind fishery in 1984 was dominated by the 1974 year class (observed at 374-400 mm in 1984) (Figure 5). Poor recruitment occurred in 1985-86, resulting in a shift in the size distribution to larger fishes. A large recruiting year class spawned in 1985 was evident in 1986 (located at 200 mm); recruitment of this class over the next 2 years shifted the length-frequency distribution to the left. The 1974 year class was still present in 1988, representing what few large fish that remained. A previous comparison of the 1984 and 1988 data (Beets and Friedlander, in press) attributed the decline in large fish to overfishing. This can now be seen to be due to variations in recruitment and specifically the decline of the dominant 1974 year class.

Puerto Rico data show a prominent newly recruited red hind year class in 1984 (Figure 6). A lesser peak (located at 375 mm) probably represents the 1974 year class. Recruitment to the fishery in 1986 (data not available) was likely sufficient to cause a shift to the left (smaller) in the size-frequency distribution in 1987. This probably was due to recruitment of the 1982 year class. Recruitment to the fishery for the last 3 years has been relatively poor. Mean length has steadily increas- ed from 250 mm in 1984 to 303 mm in 1990. As in the Virgin Islands, this result is primarily due to recruitment declines and aging of dominant year classes. By 1990 the frequency distri- bution has flattened out as the 1974 and 1982 year classes, in particular, have aged, and no large recruitment events have taken their place.

The catch curves presented by Sadovy and Figuerola (in press) clearly show coherence in recruitment between St. Thomas/ St. John and Puerto Rico (Figures 5 and 6). Poor recruitment in the last 3 years in all three areas indicate that the spatial scale of recruitment covers all of the U.S. Caribbean, although local stochastic variations are expected.

The recruitment variation observed in red hind and the effects of this variation on the shapes of length-frequency distributions indicate that pair-wise comparisons of annual length-frequency distributions may give misleading results. One hypothesis is that increased mean size of red hind could indicate recovery of the fishery; an alternative hypothesis is that this has resulted from successive recruitment failure and may indicate just the opposite. Also, long term variations in the environ- mental and physical factors controlling recruitment may explain these patterns in addition to fishing effects. As an example, length distributions for the goatfish <u>Pseudupeneus maculatus</u>, for 1985 and 1990 (Appendix A, pg 63) might indicate overfishing. However, comparison to distributions in 1974 (Stevenson, 1974) show that size increased from 1974 to 1985. Again, too few data exist to separate fishing effects from recruitment effects.

Long-term data sets are thus necessary for analyses and proper interpretation. One example of an apparent fishing effect is illustrated by 6 years of consecutive data for coney, Epinephelus fulvus, from St. Croix (Figure 7). The decline in large fish has occurred simultaneous with stability in small fish and thus probable stability in recruitment.

Compliance with minimum size limits

Size-frequency data can be used to evaluate the compliance with minimum size limits. However, these data did not distinguish between fishes caught in the EEZ or territorial waters, thereby making it impossible to examine the effectiveness of size limits placed on yellowtail snapper (12") and Nassau grouper (variable between years). It was noted that the majority of measured individuals for yellowtail (Ocyurus chrysurus) were below FMP size limits (Appendix A, pg 60). The workshop concluded that the lack of compatibility with territorial regulations made size limits ineffective.

Nassau grouper (Epinephelus striatus) is currently protected from fishing by the CFMC in the EEZ. There were no data available to evaluate the effectiveness of this regulation although considerable skepticism was expressed about compliance.

Yield-per-recruit

Yield-per-recruit analyses have been conducted for yellowtail snapper (Dennis, in press, a), the white, bluestriped, and French grunts (Dennis, in press, b) based on data from 1984-85, and for lane snapper (Acosta and Appeldoorn, in press) and red hind (Sadovy and Figuerola, in press) based on 1988 data. These analyses were specific to Puerto Rico except for red hind which included St. Thomas data.

Yellowtail snapper in 1984-85 were found to be fully exploited or slightly over-exploited, based on a value of F/Z at or greater than 0.5. A similar situation was found for the white and French grunts for 1985, while bluestriped grunts were not exploited. For white grunt this represented a change from 1974, when the species was considered to be not exploited. Dennis (in press, b) thought that although the grunt species differed in size, a single trap-mesh could be used in the fishery. This was primarily based on the fact that the trap fishery was concentrated along the outer shelf where small white grunts were scarce; thus the smaller mesh needed to maximize the YPR for the smaller species would not adversely affect white grunt. However, Stevenson (1974) found a specific mesh-size to capture white grunt. Since 1985 effort on grunts has declined slightly, while that for yellowtail snapper has remained relatively constant (Dennis et al., in press). The proportion of grunts in the PR demersal landings has declined steadily from a high of 28% in 1977 to 14% by 1985 and 8% in 1989 (Appeldoorn and Meyers, in press), although this may reflect as much a change in fishing areas and gear-types as a decline in abundance.

Lane snapper in 1988 was fully exploited with 91% of maximum YPR being taken (Acosta and Appeldoorn, in press). It was felt that further increases in YPR would not be possible without increasing F to levels were spawning stock would be adversely affected. Estimates of F/Z indicate that in 1988 red hind were overfished in both Puerto Rico and St. Thomas. To maximize YPR, at $F_{0.1}$, F would have to be reduced by 35% and 20% respectively (Sadovy and Figuerola, in press). Changing size at first capture was not predicted to increase YPR.

Biological Parameters

The assessment team concluded that insufficient data existed to properly characterize biological parameters for most SWRF in Puerto Rico and the Virgin Islands. Important biological parameters for management purposes include growth rate, natural mortality, and fecundity. Sex ratios are also important especially for species that change sex. Puerto Rico DNR has work in progress examining fecundity of red hind and trunkfish. The workshop recommends increased research to measure biological parameters from the U.S. Caribbean reef fish fishery.

CONCLUSIONS

Status of Stocks

The SWRF FMP that became effective in 1985 assumed that the reef fish fishery in the U.S. Caribbean was overfished. Overfishing is occurring, as defined in the SWRF FMP, when a reef fish stock or stock complex is below the level of 20 percent of the spawning stock biomass per recruit that would naturally occur (e.g., without fishing). Although there are insufficient data available from the U.S. Caribbean to calculate these ratios, there is reasonable evidence to suggest that many species continue to be overexploited.

Overall, the reef fish fishery in Puerto Rico has declined from previous levels. In 1931 the fishery had 1403 fishermen and 711 vessels with total landings of 3,080,100 lbs (Jarvis, 1932). In 1989 the fishery had 1822 fishermen and 1107 vessels with total landings of 2,305,004 lbs (Matos and Sadovy, 1990). Although the decline in total landings is disturbing, the most surprising difference is that in 1931 only 9 boats had motors (240 had sails and 462 were rowboats)! We assume that most landings in 1931 were reef organisms because most vessels were unable to fish far from shore. The SWRF assessment workshop panel found particularly alarming the continued decline in total reef fish landings and CPUE from Puerto Rico since the FMP was implemented in 1985.

Although no similar long-term comparison of landings exist for the USVI, we assume that similar changes have occurred. Anecdotal evidence of a decline is provided by the photo used on the cover of a spearfishing catch at Water Island in St. Thomas harbor (published in the February, 1956 issue of National Geographic, pg 221). Currently it would be virtually impossible to make a similar catch by spearfishing at that location. Nassau grouper in particular have become very scarce. The most encouraging observation for the USVI is that total landings have remained stable in recent years despite increased effort. With some exceptions, the SWRF fishery in the Virgin Islands in general appears stable at present levels of fishing effort and under current fishing practices based on available data. An exception is the decline of larger individuals of grouper such as coney and red hind.

Growth overfishing appears to be a major problem in Puerto Rico, based on the large number of small fishes being landed and the recent declines in total landings. Growth overfishing is occurring when a fishery if removing the spawners and is characterized by smaller (in number and pounds) catches over the years. Recruitment overfishing, on the other hand, is when the fishery is removing recruits (a cohort). A yield-per-recruit analysis would help quantify this situation. The review team was unable, however, to conduct an analysis because of the lack of growth and other essential biological data specifically tuned to Puerto Rico and the Virgin Islands.

Poor recruitment in recent years in both the Virgin Islands and Puerto Rico for red hind should be a particular source of management concern. Data show definite evidence of recruitment variability for red hind and coney in Puerto Rico and St. Croix. Whether this variability is due to natural events, fishery exploitation, or a combination of both cannot be determined from available data. Long-term data sets are necessary for analyses to account for recruitment effects.

Recommendations

The assessment team concluded that most obvious management action to increase the productivity of the SWRF fishery would be to reduce fishing effort. Increasing the minimum mesh size of fish traps to at least 2" is a progressive step but probably will not be sufficient to obtain significant increases in yield, especially if recruitment overfishing is occurring. Rosario and Sadovy (1991) provided experimental evidence supporting the fact that increased mesh size will increase the average size of fish caught. Also direct evidence of increased fish size is provided from St. Croix where a fisherman voluntarily switched to larger meshed traps. Unfortunately, the benefits of switching to larger meshed traps cannot be fully realized with only one or a few fishermen switching.

Establishment of no harvest zones was also recommended as a means to improve the spawning stock size although there was considerable uncertainty concerning whether increased spawning stock in reserves would necessarily benefit local populations.

The review panel recommends increased effort to secure compatible regulations between the CFMC and Commonwealth and Territorial governments. Cooperation and compliance are essential. The workshop noted that even if the CFMC closed entirely the reef fish fishery in the EEZ, that there will be little impact on most reef fishes (especially around Puerto Rico) because so little reef habitat is under direct Council control. Without compatible regulations and cooperation to increase compliance, particularly by the Commonwealth of Puerto Rico, no improvements for the fishery can be anticipated.

Growth and fecundity studies are needed for SWRF in Puerto Rico and the

Virgin Islands to produce yield-per-recruit analyses and calculate spawning potential ratios for representative species. Some effort should be directed at describing the expanding diver-based SWRF fishery and the trammel net and beach seine fisheries particularly in Puerto Rico.

Better information on where fish are captured would be extremely helpful. Although the original FMP discussed differences in landings between territorial and EEZ waters, these could not be examined at the workshop because data that distinguished catch by location within or outside of the EEZ were unavailable.

The workshop recommends that continued efforts be made to standardize and improve data collection, entry, and storage. NMFS data collection programs should be expanded and data files routinely updated to include new Caribbean data, especially state-federal landings data for USVI. All raw data for landings and bioprofile form the USVI should be entered into the database for future analyses.

The inability of managers and researchers to locate and keep up with available literature was noted as a major problem for most of the U.S. Caribbean due to spatial and temporal problems. A suggestion was made that a core collection for Caribbean fishery information be established in the Miami Laboratory, SEFSC and in the Caribbean, which would serve as a resource base for future stock assessments.

SUMMARY OF MAJOR RECOMMENDATIONS

Management Recommendations

1. Establish compatible regulations between the EEZ and the territorial waters.

2. Reduce fishing effort, particularly on small fishes.

3. Protect spawning aggregations.

4. Improve compliance with minimum sizes and other regulations.

5. Increase minimum fish trap mesh size to at least 2" as soon as possible.

6. Include deep water reef fish in the FMP.

7. Initiate marine reserve projects. Identify potential reserve areas, begin baseline studies of flora and fauna.

8. Collect more biological information by species particularly concerning fecundity, growth, and mortality.

Methodological Recommendations

9. Continue to standardize data collection, entry, and storage as much as possible. Document and initiate universal procedures for data collection and entry in the U.S. Caribbean. Expand NMFS data collection programs and data files to routinely update and include new Caribbean data, especially state-federal landings data for USVI and Puerto Rico.

10. Continue to enter the backlog of raw historical fisheries data.

11. Provide precise information on site (e.g., depth, distance from shore) and method of capture by trip.

12. Assist the PRDNR and the USVI in organizing workshops and training programs for port agents and statistics personnel.

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LITERATURE CITED

Acosta, A., R.S. Appeldoorn. Estimation of growth, mortality and yield per recruit for Lutjanus synagris (Linnaeus) in Puerto Rico. Bull. Mar. Sci., In press.

Appeldoorn, R.S. and S. Meyers. Fisheries resources of Puerto Rico and Hispaniola. In: J.F. Cadday, ed. The fisheries resources of Greater Antilles. FAO Fish. Rept., in press.

Beets, J.P., and A. Friedlander. Stock analysis and management strategies for red hind, Epinephelus guttatus. Proc. Gulf. Carib. Fish. Inst. 42: in press.

Beets, J.P., A. Friedlander and W. Tobias. Stock analysis of coney, Epinephelus fulvus, in St. Croix, U.S. Virgin Islands. Proc. Gulf. Carib. Fish. Inst. 42: in press.

Bohnsack, J.A., D.L. Sutherland, A. Brown, Jr., D.E. Harper, and D.B. McClellan. 1986. An analysis of the Caribbean biostatistical database for 1985. A report to the Caribbean Fishery Management Council from the Coastal Resources Division, Miami Laboratory, SEFC, NMFS, NOAA. CRD-86/87-10.

Caribbean Fishery Management Council. 1985. Fishery management plan, Final environmental impact review, for the shallow-water reeffish fishery of Puerto Rico and the U.S. Virgin Islands. 69 p.

Dennis, G.D. The validity of length-frequency derived growth parameters from commercial catch data and their stock assessment of the yellowtail snapper (Ocyurus chrysurus). Proc. Gulf Carib. Fish. Inst. 40: in press.

Dennis, G.D. Commercial catch length-frequency data as a tool for fisheries management with an application to the Puerto Rico trap fishery. Mem. Soc. Cien. La Salle, In press.

Dennis, G.D., Y. Sadovy, and D. Matos Carabello. Seasonal and annual trends in commercial fisheries landings from Puerto Rico. Proc. Gulf. Carib. Fish. Inst. 42: in press.

Jarvis, N.D. 1932. The fisheries of Puerto Rico. U.S. Department of Commerce, Bureau of Fisheries, Investigational Report No. 13: 1-41.

Matos, D. (in review) Comparison of size of capture using hook and line, fish traps, and gill nets of five species of commercial fish in Puerto Rico during 1988-90. Proc. Gulf. Carib. Fish. Inst.

Matos, D. and Y. Sadovy. 1990a. Overview of Puerto Rico's small-scale fisheries statistics (Perspectivas de las Estadisticas de la Pesca en Pequena Escala de Puerto Rico) 1988-1989. Technical Report CODREMAR 1(4): 1-17.

Matos, D. and Y. Sadovy. 1990b. CODREMAR/NMFS Cooperative Statistics Program for 1989-1990. Annual Report to the National Marine Fisheries Service. Project SF-33. June 1990. 44 p.

Matos, D. and Y. Sadovy. 1991. Commercial Fisheries Statistics: Puerto Rico State/Federal Cooperative Fisheries Statistics Program. Department of Natural Resources Annual Report to the National Marine Fisheries Service. Project report no 2-IJ-12-3. 53 p.

Rosario, A. and Y. Sadovy. 1991. Trap mesh selectivity off the west coast of Puerto Rico. Completion Report. Puerto Rico Department of Natural Resources. 60 pp.

Sadovy, Y., and M. Figuerola. The status of the red hind fishery in Puerto Rico and St. Thomas, as determined by yield-per-recruit analysis. Proc. Gulf. Carib. Fish. Inst. 42: in press.

Sadovy, Y., M. Figuerola and A. Román. Age and growth of the red hind, Epinephelus guttatus, in Puerto Rico and St. Thomas. Fish. Bull. U.S. in press.

Stevenson, D.K. 1976. Determination of maximum yield conditions from length frequency data for a tropical fish pot fishery. Ph.D. Dissertation. University of Rhode Island, Kingston, RI. 150 pp.

Weiler, D. and J. Suárez-Caabro. 1980. Overview of Puerto Rico's small-scale fisheries statistics (Perspectivas de las Estadisticas de la Pesca en Pequena Escala de Puerto Rico) 1972-1978. Informe Tecnico, CODREMAR 1(1): 1-17.

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Table 1. Total Reef Fish Landings and Effort Summary

Puerto Rico Year	Total Landings (lbs)	Total Traps	CPUE[e] (lbs/trap)	Total Fishermen	Total Vessels	USVI[d] Year	Projected Finfish Landings (lbs)	Total Traps	CPUE (lbs/trap)	Licensed Fishermen	St Croix Projected Finfish Landings (lbs)	Licensed Fishermen	St Thomas St John Projected Finfish Landings	Licensed Fishermen
1931 a	3,020,100	4239	na	1403	711									
1951				223										
1964														
1969														
1970														
1971														
1972				970										
1973				930										
1974				1120										
1975 b	3,251,000	8191	294	1230	865	74-75	1,072,000	5337	195	457	181,000	227	891,000	230
1976 b	3,932,000	8967	321	1230	901	75-76	1,015,977	8858	169	509	152,040	197	863,937	312
1977 b	4,395,000	9743	316	1368	1036	76-77	1,196,703	8067	233	846	510,658	225	686,045	621
1978 b	4,728,000	12586	241	1442	1073	77-78	924,472	4182	265	265	289,896	103	634,576	162
1979 b	5,359,000	15252	219	1442	1073	78-79	1,043,849	4482	347	282	251,994	121	791,855	161
1980 b	4,147,000	19165	138	1447	1087	79-80	1,288,215	6418	302	356	449,882	144	838,333	212
1981 b	3,674,000	21368				80-81	1,252,626	7133	256	406	279,119	163	973,507	243
1982 b	3,275,000	23571		1872	1449	81-82	1,822,304	10176	254	578	863,048	322	959,256	256
1983 c	3,067,347	15045	104	1415	1125	82-83	1,276,680			454	386,858	195	889,822	259
1984 c	2,457,087					83-84	1,348,432			437	453,726	182	894,706	255
1985 c	2,599,720	9650	117	1766		84-85	1,209,411	19240	63	437	404,761	182	804,650	255
1986 c	2,296,207	12450	78	1135	865	85-86	1,892,464			536	554,628	206	1,333,836	330
1987 c	1,768,917			1731		86-87	1,866,947	18366	102	529	610,586	200	1,256,361	329
1988 c	1,666,716	11710	45			87-88	1,382,358			523	328,592	217	1,053,766	306
1989 c	1,933,047			1822	1107	88-89	1,583,613			425	587,353	188	996,260	237
1990 c	1,879,606	13555	45											
Mean	3,151,853	13,943	174	1395	1058		1,345,070	9,226	219	469	437,653	189	926,922	281

NOTES:

a Jarvis, 1932.

b Caribbean Council Shallow Water FMP, Table 9.

c Data from Laboratorio de Investigaciones Pesqueras, Departamento de Recursos Naturales de Puerto Rico.

d Data from Division of Fish and Wildlife, USVI.

e The CPUE estimate is only for fish caught with traps.

Table 2. Estimated annual landings of demersal fishes from Puerto Rico in metric tons. From Appeldoorn and Meyers (in press)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Grunts			382.7	318.8	420.0	480.5	482.7	458.4	329.8	78.0	200.5	183.8	185.5	143.2	88.8	78.8	42.3	35.9	53.8
Hogfish			18.4	18.8	25.0	34.1	34.1	35.5	34.5	13.8	32.3	37.3	34.1	21.4		21.8	15.0	11.8	9.9
Trunkfish	19.1	18.1	9.1	10.5	13.8	28.2	35.9	35.9	32.3	22.7	21.8	19.1	20.0	18.1	15.5	18.2	17.3	22.7	21.8
Squirrelfish	34.5	38.4	11.8	9.1	30.0	49.5	50.9	32.7	22.7	8.8	12.3	10.0	5.0	7.7	5.5	1.8	2.3	5.9	2.9
Parrotfish	84.1	118.2	157.3	142.3	137.7	108.5	124.5	173.8	120.0	35.9	127.7	105.5	110.9	108.8	48.4	33.8	5.5	1.8	16.7
Grouper	172.3	151.8	140.8	193.8	241.4	292.3	382.3	447.7	337.3	197.7	211.4	160.9	157.7	160.5	88.8	84.5	42.3	59.5	47.3
Mojarra	0.5	0.0	3.2	7.7	7.7	10.9	12.7	10.0	14.5	10.5	9.5	5.9	5.5	5.0	4.5	3.8	8.2	5.5	7.0
Lane Snapper	51.8	47.7	48.2	50.5	55.9	68.8	187.7	175.9	130.9	80.9	129.1	86.8	76.8	60.9	37.3	27.7	37.3	49.5	51.3
Yellowtail Snapper	45.5	44.1	48.2	65.9	58.2	73.8	100.5	138.5	98.8	51.8	89.5	81.8	66.4	77.3	44.1	45.9	35.5	41.8	48.7
Silk Snapper*	178.4	115.9	120.9	217.3	180.5	187.7	248.2	340.5	388.5	318.4	310.9	190.9	171.4	189.5	148.8	85.5	80.0	112.3	80.2
Mutton Snapper	28.4	28.4	30.8	28.4	38.0	31.4	42.7	53.2	47.7	28.9	31.8	31.8	27.7	23.2	13.2	8.2	10.0	14.5	11.4
Other Snapper	20.9	25.9	30.9	20.0	30.9	36.0	32.3	47.7	44.1	31.8	32.3	30.9	18.2	16.9		9.5	17.3	18.8	21.1
Total Snapper	330.9	300.8	288.1	380.0	370.5	378.4	611.4	738.8	709.1	518.2	583.8	422.3	380.5	387.7	243.2	189.8	180.0	238.8	212.8
Triggerfish	84.5	80.5	66.5	34.1	38.8	45.0	40.5	88.8	75.0	28.4	58.4	44.1	23.8	28.0	12.7	17.3	12.7	15.0	12.9
Porgy	38.8	21.8	24.5	21.4	29.5	28.8	28.1	68.5	58.8	14.1	63.2	37.7	31.8	12.3	8.2	5.0	4.1	4.5	4.1
Goatfish	198.5	151.4	133.8	121.4	131.8	134.1	134.5	183.2	182.7	11.4	71.4	73.9	80.9	27.7	9.8	4.5	3.2	4.5	6.1
Classified First																			82.7
Second																			88.6
Third																			23.2
Trash																			3.5
Other Fish	8.6	53.8	93.8	82.7	72.3	85.5	135.5	123.8	151.4	807.7	148.2	91.4	76.4	107.7	121.4	85.9	61.4	58.6	48.8
Total Demersal Harvest (mt)	921.8	892.8	1,185.4	1,336.5	1,515.3	1,654.5	2,063.1	2,401.7	2,047.5	1,738.6	1,548.3	1,301.6	1,051.9	1,005.9	640.5	529.5	394.4	462.4	619.4
Total Demersal Harvest (lbs x 10³)	2,033	1,968	2,614	2,947	3,341	3,648	4,549	5,296	4,515	3,834	3,414	[illegible]	[illegible]	[illegible]	1,412	1,168	870	1,020	1,366

*Includes all deepwater snappers

Table 3. Trends in catch per unit effort by species and gear type for Puerto Rico (PR) and St. Croix (SX) based on data plotted in Appendix B. Too few years of data were available to justify the testing of statistical significance of the trends.

Species Location	Units	Gear Type	Trend Direction	Years	
Balistes vetula (Queen Triggerfish)					
	lbs/trip	Bottom line	up	3	PR
	lbs/trip	Fish pots	up	5	PR
Bodianus rufus (Spanish Hogfish)					
	lbs/trip	Gill net	down	3	PR
	lbs/trip	Fish pots	down	3	PR
Epinephelus guttatus (Red Hind)					
	lbs/trip	Bottom line	down	3	PR
	lbs/trip	Fish pots	up	3	PR
	gm/trip	Fish pots	up	4	SX
Etelis oculatus (Queen Snapper)					
	gm/trip	Fish pots	stable	4	SX
Haemulon plumieri (White Grunt)					
	lbs/trip	Bottom line	down	4	PR
	lbs/trip	Fish pots	down	4	PR
	lbs/trip	Gill net	up	4	PR
Holocentrus ascensionis (Squirrelfish)					
	lbs/trip	Fish pots	down	3	PR
Lachnolaimus maximus (Hogfish)					
	lbs/trip	Fish pots	up	4	PR
	lbs/trip	Spear	down	4	PR
Lactophrys trigonus (Trunkfish)					
	lbs/trip	Fish pots	down	3	PR
	lbs/trip	Gill net	down	3	PR
Lutjanus analis (Mutton Snapper)					
	lbs/trip	Bottom line	stable	4	PR
	lbs/trip	Fish pots	up	4	PR
	lbs/trip	Gill net	down	4	PR
Lutjanus buccanella (Blackfin Snapper)					
	gm/trip	Fish pots	up	3	SX
Lutjanus apodus (Schoolmaster Snapper)					
	gm/trip	Fish pots	down	4	SX
Lutjanus synagris (Lane Snapper)					
	lbs/trip	Bottom line	stable	4	PR
	lbs/trip	Fish pots	up	4	PR
	lbs/trip	Gill net	up	4	PR
	lbs/trip	Trotline	down	4	PR
Lutjanus vivanus (Silk Snapper)					
	gm/trip	Fish pots	down	3	SX
Ocyurus chrysurus (Yellowtail Snapper)					
	gm/trip	Fish pots	up	3	SX
	lbs/trip	Bottom line	up	4	PR
	lbs/trip	Fish pots	up	4	PR
	lbs/trip	Gill net	up	4	PR
	lbs/trip	Troll line	down	3	PR

TABLE 4. Comparison of fish length between 1985 and 1990

FAMILY — Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
HOLOCENTRIDAE — Squirrelfishes												
Holocentrus ascensionis	PR	NORTH						7	221.4	15.1	6.8	220.0
(Squirrelfish)	PR	SOUTH						2	207.5	9.2	4.4	207.5
	PR	WEST						1	205.0			205.0
	SC	--	187	204.9	13.8	6.7	205.0	4	227.0			230.0
	SIT/SU	--	89	218.0	28.6	13.1	220.0	2	252.5	3.5	1.4	252.0
Holocentrus rufus	PR	NORTH						1	219.0			219.0
(Longspine squirrelfish)	SC	--						6	225.2			230.0
	SIT/SU	--						86	195.0	15.1	7.6	195.0
Holocentrus spp.	PR	EAST						9	171.2	21.8	12.7	170.0
(Unidentified squirrelfish)	SIT/SU	--	30	225.5	22.4	9.9	227.5					
SERRANIDAE — Sea basses												
Epinephelus adscensionis	PR	EAST	5	246.4	20.3	8.2	250.0					
(Rock hind)	PR	NORTH						1	678.0			678.0
	PR	SOUTH	8	234.5	59.8	25.5	216.5	44	260.3	145.4	55.9	294.5
	PR	WEST						3	420.0	156.9	37.4	380.0
	SC	--	1	337.0			337.0	2	374.5			374.5
	SIT/SU	--	5	420.0	61.8	14.7	455.0	4	372.5	81.8	21.9	410.0
Epinephelus afer	PR	EAST	8	251.1	24.6	9.8	247.5					
(Mutton hamlet)	PR	NORTH	1	282.0			282.0	1	280.0			280.0
	SIT/SU	--						1	225.0			225.0
Epinephelus cruentatus	PR	EAST	2	408.5	96.3	24.1	408.5	221	238.8	30.5	12.8	238.7
(Graysby)	PR	SOUTH						3	243.0	2.7	1.1	244.0
	PR	WEST						3	201.7	23.1	11.5	215.0
	SC	--	8	222.5	20.8	9.3	224.0					
	SIT/SU	--	3	269.3	19.0	7.1	270.0					
Epinephelus flavolimbatus	SIT/SU	--	2	822.5	152.0	18.5	822.5					
(Yellowedge grouper)												
Epinephelus fulvus	PR	EAST	208	247.6	49.1	19.8	240.0	111	239.1	31.3	13.1	235.0
(Coney)	PR	NORTH	14	230.7	30.5	13.2	225.0	118	223.9	31.8	14.2	228.0
	PR	SOUTH	179	224.7	29.7	13.2	225.0					
	PR	WEST	191	222.0	23.8	10.7	220.0					
	SC	--	1644	230.3	20.4	8.9	245.0	20	243.7			251.0
	SIT/SU	--	189	243.7	23.3	9.6	230.0	21	218.8	26.3	12.0	220.0
Epinephelus guttatus	PR	EAST	456	270.4	45.6	16.9	261.0	445	293.7	67.1	22.9	282.0
(Red hind)	PR	NORTH	2	268.0	53.7	20.1	268.0	1	263.0			263.0
	PR	SOUTH	138	282.8	47.3	16.7	284.5	242	334.1	72.6	21.7	330.0
	PR	WEST	136	289.6	44.0	15.2	285.0	89	264.5	30.9	11.7	260.0
	SC	--	567	307.3	54.5	17.7	296.0	469	339.0			342.0
	SIT/SU	--	448	334.8	62.7	18.7	325.0	21	262.4	50.7	19.3	250.0
Epinephelus itajara	PR	EAST	3	331.0	102.2	30.9	313.0	5	437.6	200.5	45.8	346.0
(Jewfish)	PR	SOUTH						4	382.3	284.3	74.4	399.5
Epinephelus morio	PR	EAST	3	451.0	123.8	27.5	406.0	1	256.0			256.0
(Red grouper)	PR	SOUTH						1	465.0			465.0
	SIT/SU	--	10	549.5	101.3	18.4	582.5					
Epinephelus mystacinus	PR	EAST						6	331.7	80.3	24.2	320.5
(Misty grouper)	PR	NORTH						1	238.0			238.0
	PR	WEST						1	130.0			130.0
	SC	--	6	566.2	197.5	34.9	547.5	4	485.0			451.5
	SIT/SU	--	4	946.8	104.5	11.0	990.0					
Epinephelus striatus	PR	EAST	45	381.2	92.2	24.2	377.0	1	352.0			352.0
(Nassau grouper)	PR	NORTH						1	244.0			244.0
	PR	SOUTH	12	262.8	50.6	19.3	247.5	34	430.9	70.2	16.3	440.0
	PR	WEST	7	432.0	126.2	29.2	415.0					
	SC	--	4	390.0	67.8	17.4	385.0	6	400.5			386.0
	SIT/SU	--	73	559.2	90.7	16.2	550.0	1	360.0			360.0
Mycteroperca bonaci	PR	SOUTH						37	560.9	158.4	28.3	550.0
(Black grouper)												
Mycteroperca interstitialis	PR	SOUTH						1	393.0			393.0
(Yellowmouth grouper)	SIT/SU	--	10	422.0	73.2	17.3	417.5					
Mycteroperca tigris	PR	EAST						1	260.0			260.0
(Tiger grouper)	SC	--	2	485.0	226.3	46.7	485.0					
	SIT/SU	--	24	486.3	103.2	21.2	472.5					

TABLE 4. Comparison of fish length between 1985 and 1990 (con't)

FAMILY – Family common name Species name (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
Mycteroperca venenosa	PR	EAST	17	437.8	97.8	22.3	449.0	7	618.4	107.8	17.4	640.0
(Yellowfin grouper)	PR	SOUTH	2	347.0	87.7	25.3	347.0	1	400.0			400.0
	PR	WEST	1	235.0								
	SC	--	11	402.6	124.4	30.9	380.0	3	366.0			350.0
	SIT/SU	--	103	554.7	140.4	25.3	570.0	10	348.5	83.7	24.0	340.0
CARANGIDAE – Jacks												
Caranx bartholomaei	PR	EAST						18	275.9	30.2	11.0	282.0
(Yellow jack)	PR	SOUTH						2	310.5	143.5	46.2	310.5
	PR	WEST						81	453.7	127.2	28.0	470.0
	SC	--	10	382.7	49.6	13.0	376.0					
	SIT/SU	--	5	263.0	18.9	7.2	265.0					
Caranx crysos	PR	EAST	21	216.1	41.7	19.3	210.0	95	361.2	67.3	18.6	370.0
(Blue runner)	PR	NORTH						5	355.2	51.0	14.4	346.0
	PR	WEST						1	257.0			257.0
	SC	--	19	281.8	65.5	23.2	265.0	1	475.0			475.0
	SIT/SU	--	15	386.0	51.8	13.4	370.0					
Caranx hippos	PR	NORTH						22	232.1	154.1	66.4	214.0
(Crevalle jack)	PR	WEST						1	585.0			585.0
Caranx latus	PR	EAST						3	489.7	94.0	19.2	450.0
(Horse-eye jack)	PR	NORTH						42	194.9	68.2	35.0	174.0
	PR	WEST						100	310.2	132.2	42.6	311.0
	SC	--	6	477.8	68.6	14.4	492.5					
	SIT/SU	--	6	414.2	41.4	10.0	402.5					
Caranx lugubris	PR	WEST						34	446.4	57.5	12.9	431.5
(Black jack)	SC	--	5	422.4	76.4	18.1	396.0	8	401.5			394.5
	SIT/SU	--	1	480.0			480.0					
Caranx ruber	PR	EAST						43	288.9	44.8	15.5	290.0
(Bar jack)	PR	NORTH						4	279.5	68.1	24.4	281.5
	PR	SOUTH						50	261.6	33.6	12.8	260.0
	PR	WEST						176	266.3	71.3	26.8	285.5
	SC	--	96	236.3	43.6	18.5	227.0	9	289.8			275.0
	SIT/SU	--	32	301.7	96.9	32.1	292.5	2	227.5	3.5	1.6	227.5
Caranx spp	SIT/SU	--	3	333.3	135.8	40.7						
(Unidentified jack)												
LUTJANIDAE – Snappers												
Apsilus dentatus	PR	NORTH	1	470.0			470.0					
(Black snapper)								61	337.5			325.0
Etelis oculatus	PR	NORTH						12	609.3	162.9	26.7	612.5
(Queen snapper)	PR	SOUTH	1	190.0			190.0					
	PR	WEST						340	393.2	131.9	33.5	355.5
	SC	--	48	377.5	96.5	25.6	380.0	231	380.7			360.0
	SIT/SU	--	21	602.4	129.5	21.5	595.0					
Lutjanus analis	PR	EAST	30	399.2	135.4	33.9	330.0	81	378.1	157.7	41.7	300.0
(Mutton snapper)	PR	NORTH	7	607.0	95.5	15.7	601.0	9	483.4	139.6	28.9	505.0
	PR	SOUTH	10	389.0	120.9	31.1	367.0	35	306.9	98.1	32.0	290.0
	PR	WEST	6	491.7	101.1	20.6	470.0	200	264.1	115.0	43.5	223.0
	SC	--	17	400.0	105.2	26.3	380.0	7	539.9			590.0
	SIT/SU	--	27	410.0	128.1	31.3	375.0	1	450.0			450.0
Lutjanus apodus	PR	EAST	19	289.9	74.9	25.8	274.0	60	342.1	94.4	27.6	332.5
(Schoolmaster)	PR	NORTH	19	349.3	73.4	21.0	374.0	2	300.5	171.8	57.2	300.5
	PR	SOUTH	26	260.8	32.9	12.6	255.0	51	276.1	74.2	26.9	250.0
	PR	WEST	8	236.1	39.4	16.7	229.5	83	281.3	43.6	15.5	269.0
	SC	--	101	283.0	42.3	14.9	280.0	102	278.5			270.0
	SIT/SU	--	39	312.6	51.3	16.4	300.0	20	240.8	38.8	16.1	232.5
Lutjanus buccanella	PR	EAST	18	233.7	42.2	18.1	226.0	44	278.6	77.2	27.7	273.5
(Blackfin snapper)	PR	NORTH	2	188.0	21.2	11.3	188.0	94	232.8	34.7	14.9	230.0
	PR	WEST						19	354.7	75.0	21.1	350.0
	SC	--	85	277.6	41.7	15.0	275.0	392	284.7			276.0
	SIT/SU	--	180	302.9	47.0	15.5	305.0					
Lutjanus campechanus	PR	NORTH	1	270.0			270.0					
(Red snapper)	SIT/SU	--	1	380.0			380.0					
Lutjanus cyanopterus	PR	EAST						3	529.0	128.8	24.4	550.0

TABLE 4. Comparison of fish length between 1985 and 1990 (con't)

FAMILY – Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
(Cubera snapper)	PR	WEST						6	642.2	205.1	31.9	642.5
	SIC	--	4	260.0	10.8	4.2	257.5			-		
Lutjanus griseus	PR	EAST	4	219.0	23.8	10.9	217.0	6	353.3	131.6	37.2	320.0
(Gray snapper)	PR	NORTH	4	237.5	27.1	11.4	232.0					
	PR	SOUTH						2	300.0	28.3	9.4	300.0
	PR	WEST						2	325.5	34.7	10.6	325.5
	SIT/SU	--	1	780.0			780.0					
Lutjanus jocu	PR	EAST	4	402.5	171.8	34.9	475.5					
(Dog snapper)	PR	NORTH	9	329.1	67.2	20.4	321.0	3	331.7	132.6	40.0	276.0
	PR	SOUTH	6	238.5	31.4	13.2	255.0	34	391.9	106.5	27.2	386.5
	PR	WEST						1	322.0			322.0
	SIC	--	3	323.7	62.7	19.4	290.0	4	308.3			265.0
	SIT/SU	--	16	497.2	121.8	24.5	540.0	1	385.0			385.0
Lutjanus mahogoni	PR	EAST	10	327.6	51.9	15.9	327.0	2	330.0	77.8	23.6	330.0
(Mahogany snapper)	PR	NORTH	7	318.3	30.0	9.4	303.0	2	262.5	74.3	28.3	262.5
	PR	SOUTH	9	230.7	22.4	9.7	218.0					
	PR	WEST	1	200.0			200.0	8	316.5	17.7	5.6	312.0
	SIC	--	12	222.8	20.6	9.2	223.5	16	244.2			241.0
	SIT/SU	--	12	263.8	26.0	9.9	252.5	2	285.0	56.6	19.9	285.0
Lutjanus spp.	PR	NORTH						1	210.0			210.0
(Unidentified snapper)	PR	WEST						2	447.5	24.8	5.5	447.5
Lutjanus synagris	PR	EAST	208	226.3	36.6	16.2	218.0	309	239.9	39.8	16.6	235.0
(Lane snapper)	PR	NORTH	10	262.5	45.8	17.5	246.5	122	245.7	35.3	14.4	240.0
	PR	SOUTH	102	206.7	26.3	12.7	201.5	238	209.6	36.3	17.3	202.5
	PR	WEST	109	219.9	29.3	13.3	216.0	1,503	234.0	36.9	15.8	230.0
	SIC	--	4	220.8	24.5	11.1	255.0	8	238.3			236.5
	SIT/SU	--	103	259.8	61.1	23.5	230.0	8	210.0	22.0	10.5	212.5
Lutjanus vivanus	PR	EAST	18	310.6	55.0	17.7	300.0	223	276.5	56.1	20.3	266.0
(Silk snapper)	PR	NORTH	159	229.6	45.7	19.9	220.0	403	261.6	51.7	19.8	254.0
	PR	SOUTH	3	262.7	56.2	21.4	247.0					
	PR	WEST	1	155.0			155.0	22	339.4	106.2	31.3	327.5
	SIC	--	165	378.3	68.0	18.0	375.0	603	326.8			310.0
	SIT/SU	--	36	296.4	141.5	47.7	225.0	4	213.8	8.5	4.0	212.5
Ocyurus chrysurus	PR	EAST	521	294.9	57.4	19.5	290.0	854	271.9	51.8	19.1	263.0
(Yellowtail snapper)	PR	NORTH	402	284.7	37.5	13.2	284.0	115	318.8	45.6	14.3	314.0
	PR	SOUTH	43	248.1	38.0	15.3	255.0	277	246.0	43.6	17.7	242.0
	PR	WEST	30	241.9	39.7	16.4	237.0	873	262.5	53.7	20.4	255.0
	SIC	--	610	275.5	63.6	23.1	257.0	69	283.0			277.0
	SIT/SU	--	456	341.5	61.5	18.0	325.0	12	268.8	82.1	30.5	245.0
Rhomboplites aurorubens	PR	EAST	58	206.7	16.1	7.8	206.0	443	217.3	35.2	16.2	212.0
(Vermilion snapper)	PR	NORTH	104	197.2	27.7	14.0	194.0	307	201.3	25.6	12.7	198.0
	PR	WEST						86	201.9	56.9	28.2	183.0
	SIC	--	14	357.2	32.8	9.2	357.5	110	284.6			275.5
	SIT/SU	--	8	202.5	35.0	17.3	210.0					
HAEMULIDAE – Grunts												
Anisotremus surinamensis	PR	EAST						20	265.3	41.3	15.6	251.0
(Black margate)	PR	WEST						1	260.0			260.0
	SIT/SU	--	2	335.0	35.4	10.6	335.0					
Anisotremus virginicus	PR	EAST						32	230.1	70.6	30.7	223.5
(Porkfish)	PR	SOUTH	2	247.0	94.8	38.4	247.0	27	201.6	20.7	10.3	198.0
	PR	WEST						38	227.5	24.8	10.9	223.5
	SIC	--	13	217.1	26.6	12.3	210.0	7	229.3			225.0
	SIT/SU	--	8	303.1	65.0	21.4	292.5					
Conodon nobilis	PR	EAST						53	263.2	32.3	12.3	267.0
(Barred grunt)												
Haemulon album	PR	EAST	19	290.0	97.7	33.7	245.0	8	289.1	80.0	27.7	280.0
(Margate)	PR	SOUTH	2	217.5	10.6	4.9	217.5					
	SIC	--	3	445.3	144.8	32.5	435.0					

TABLE 4. Comparison of fish length between 1985 and 1990 (con't)

FAMILY — Family common name *Species name* (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
	SIT/SU	--	21	506.3	92.4	18.2	525.0					
Haemulon aurolineatum	PR	EAST	12	220.7	26.5	12.0	216.0	6	156.0	10.8	6.9	154.0
(Tomtate)	PR	NORTH						23	158.8	22.6	14.2	153.0
	PR	SOUTH	5	233.8	14.2	6.1	243.0					
	PR	WEST						1	182.0			182.0
	SIT/SU	--	20	226.8	22.5	9.9	227.5					
Haemulon bonariense	PR	EAST	1	220.0			220.0					
(Black grunt)	PR	SOUTH						1	193.0			193.0
	PR	WEST						2	287.0	43.8	15.3	287.0
Haemulon carbonarium	PR	EAST						14	241.8	40.3	16.7	222.5
(Caesar grunt)	PR	WEST						4	208.3	12.6	6.1	203.0
	SC	--	31	206.7	14.8	7.1	209.0	116	209.9			210.0
Haemulon chrysargyreum	PR	WEST						3	159.0	5.2	3.3	162.0
(Smallmouth grunt)												
Haemulon flavolineatum	PR	EAST	82	219.5	27.6	12.6	220.5	9	196.8	32.9	16.7	182.0
(French grunt)	PR	SOUTH	57	167.9	16.0	9.5	170.0	16	180.5	7.1	3.9	181.5
	PR	WEST	69	178.8	15.4	8.6	175.0	21	173.7	26.5	15.3	172.0
	SC	--	232	190.4	14.9	7.8	190.0	14	184.8			181.0
	SIT/SU	--	12	196.3	13.0	6.6	200.0	27	171.5	16.4	9.6	170.0
Haemulon macrostomum	PR	EAST	15	220.1	28.4	12.9	217.0	47	215.0	30.5	14.2	210.0
(Spanish grunt)	PR	NORTH	4	206.8	13.4	6.5	206.5					
	PR	SOUTH	28	201.9	42.9	21.2						
	PR	SOUTH	15	188.5	26.2	13.9	189.0					
	PR	WEST						2	302.5	38.9	12.9	302.5
	SC	--						1	310.0			310.0
	SIT/SU	--	6	347.5	22.1	6.4	365.0					
Haemulon melanurum	PR	EAST	1	210.0			210.0					
(Cottonwick)	PR	SOUTH	1	235.0			235.0					
	SC	--	1	206.0			206.0	2	236.0			236.0
	SIT/SU	--	12	232.5	14.7	6.3	230.0	15	191.7	19.1	10.0	195.0
Haemulon parrai	PR	EAST	7	252.1	11.1	4.4	256.0	65	235.3	28.9	12.3	240.0
(Sailor's choice)	SIT/SU	--						2	242.5	31.8	13.1	242.5
Haemulon plumieri	PR	EAST	530	213.8	24.5	11.5	210.5	996	229.1	29.5	12.9	230.0
(White grunt)	PR	NORTH	57	252.2	35.5	14.1	251.0	15	260.0	42.3	16.3	246.0
	PR	SOUTH	320	205.7	29.0	14.1	205.5	636	209.1	38.6	18.4	208.0
	PR	WEST	186	213.5	38.7	18.1	210.0	1,001	211.9	34.0	16.0	214.0
	SC	--	1588	217.9	20.5	9.4	215.0	803	218.7			215.0
	SIT/SU	--	39	289.9	81.3	28.0	285.0	75	209.5	125.8	12.3	205.0
Haemulon sciurus	PR	EAST	36	221.8	31.0	14.0	211.5	173	231.3	31.6	13.7	230.0
(Bluestriped grunt)	PR	NORTH						1	274.0			274.0
	PR	SOUTH	86	217.6	29.2	13.4	221.0	68	204.9	27.6	13.5	205.5
	PR	WEST	17	228.1	30.8	13.5	215.0	94	217.5	31.9	14.7	212.5
	SC	--	136	234.1	19.3	8.3	231.0					
	SIT/SU	--	23	249.4	29.3	11.7	240.0	55	215.1	28.2	13.1	210.0
Haemulon sp.	PR	NORTH	1	282.0			282.0					
(Unidentified grunt)	PR	SOUTH						1	232.0			232.0
Pomadasys crocro	PR	NORTH						1	240.0			240.0
(Burro grunt)								45	236.6			235.0
SPARIDAE — Porgies												
Archosargus rhomboidalis	PR	EAST						1	172.0			172.0
(Sea bream)	PR	SOUTH						4	192.3	18.7	9.7	184.5
	PR	WEST						2	182.5	10.6	5.8	182.5
	SIT/SU	--	7	234.3	11.0	4.7	235.0					
Calamus bajonado	PR	EAST	89	211.1	26.3	12.5	200.0	5	235.8	52.3	22.2	209.0
(Jolthead porgy)	PR	SOUTH	15	220.3	40.4	18.3	212.0	281	195.0	29.6	15.2	190.0
	PR	WEST						232	190.7	39.5	20.7	181.0
	SC	--						5	282.8			295.0
	SIT/SU	--						188	199.8	36.7	18.4	190.0
Calamus penna	PR	EAST	480	209.4	38.2	18.2	204.0		196.1	21.3	10.9	191.0
(Sheepshead porgy)	PR	NORTH						2	187.0	11.3	6.1	187.0
	PR	SOUTH	82	197.3	32.9	16.7	193.0	23	197.3	29.9	15.2	188.0
	PR	WEST	65	182.3	29.8	16.3	180.0	74	184.0	31.6	17.2	175.0

TABLE 4. Comparison of fish length between 1985 and 1990 (con't)

FAMILY.– Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
MULLIDAE – Goatfishes												
Mulloidichthys martinicus	PR	EAST	10	229.0	29.0	12.7	222.0	8	159.1	18.7	11.7	151.5
(Yellow goatfish)	PR	NORTH						3	199.3	8.1	4.1	203.0
	PR	SOUTH	49	211.1	26.1	12.4	212.0	36	206.1	21.7	10.4	205.5
	PR	WEST	31	216.2	23.8	11.0	210.0	84	180.0	28.8	16.0	187.5
	SC	--	547	206.0	15.1	7.3	206.0	2	250.0			250.0
	SIT/SU	--	22	260.2	29.9	11.5	250.0	36	248.8	32.4	13.0	245.0
Pseudupeneus maculatus	PR	EAST	871	188.5	18.9	10.0	189.0	106	191.5	24.9	13.0	190.0
(Spotted goatfish)	PR	SOUTH	180	194.4	20.6	10.6	196.0	23	199.2	27.3	13.7	207.0
	PR	WEST	204	193.8	21.9	11.3	196.0	339	175.0	28.9	16.5	174.0
	SC	--	125	207.0	18.2	8.8	203.0					
	SIT/SU	--	3	236.7	38.2	16.1	245.0	8	232.5	19.3	8.3	242.5
EPHIPPIDAE – Spadefishes												
Chaetodipterus faber	PR	WEST						1	271.0			271.0
(Atlantic spadefish)	SC	--	1	295.0			295.0					
CHAETODONTIDAE – Butterflyfishes												
Chaetodon ocellatus	SIT/SU	--	2	125.0	0.0	0.0	125.0					
(Spotfin butterflyfish)												
POMACANTHIDAE – Angelfishes												
Holacanthus ciliaris	SC	--	9	276.1	50.3	18.2	280.0	67	359.5			250.0
(Queen angelfish)	SIT/SU	--	14	294.3	41.6	14.1	285.0	7	206.4	135.4	17.2	200.0
Holacanthus tricolor	SC	--	31	208.5	12.9	6.2	207.0	66	212.7			213.0
(Rock beauty)	SIT/SU	--	6	202.5	13.3	6.6	200.0	1	180.0			180.0
Pomacanthus arcuatus	PR	WEST						1	305.0			305.0
(Gray angelfish)	SC	--	17	303.1	68.9	22.7	300.0	15	295.9			297.0
	SIT/SU	--	82	310.9	64.8	20.8	313.0	5	181.0	36.1	20.0	170.0
Pomacanthus paru	SC	--	13	269.5	54.3	20.1	247.0	18	262.4			260.0
(French angelfish)	SIT/SU	--	17	297.9	80.2	26.9	315.0	6	166.0	19.5	11.8	165.0
LABRIDAE – Wrasses												
Bodianus rufus	PR	SOUTH						6	285.8	14.0	4.9	290.5
(Spanish hogfish)	PR	WEST						2	283.5	26.2	9.2	283.5
	SC	--	15	244.7	28.4	11.6	232.0	5	256.4			256.0
	SIT/SU	--	12	272.5	20.6	7.6	270.0					
Halichoeres radiatus	PR	EAST	1	229.0			229.0	1	283.0			283.0
(Puddingwife)	PR	SOUTH	1	273.0			273.0					
	SC	--	5	292.0	48.7	16.7	315.0	1	242.0			242.0
	SIT/SU	--	3	296.7	33.3	11.2	280.0					
Lachnolaimus maximus	PR	EAST	17	318.9	68.6	21.5	299.0	7	474.9	105.1	22.1	455.0
(Hogfish)	PR	SOUTH	19	348.7	110.3	31.6	301.0	176	397.3	106.6	26.8	393.5
	PR	WEST	17	372.7	123.6	33.2	315.0	21	282.3	60.9	21.6	268.0
	SC	--	3	329.7	29.3	8.9	318.0	1	292.0			292.0
	SIT/SU	--	27	504.2	116.1	23.0	530.0	8	248.1	29.4	11.9	247.5
SCARIDAE – Parrotfishes												
Scarus coelisthus	PR	SOUTH						2	610.0	77.8	12.8	610.0
(Midnight parrotfish)												
Scarus coeruleus	PR	NORTH						24	197.8	13.7	6.9	195.0
(Blue parrotfish)												
Scarus guacamaia	PR	SOUTH						6	579.7	103.5	17.9	582.5
(Rainbow parrotfish)	SIT/SU	--	3	615.0	62.7	10.2	610.0					
Scarus spp.	PR	EAST						2	270.0	28.3	10.5	270.0
(Unidentified parrotfish)	SIT/SU	--	1	240.0			240.0					
Scarus taeniopterus	PR	EAST						1	250.0			250.0
(Princess parrotfish)	PR	SOUTH						50	247.9	24.9	10.1	244.0
	PR	WEST						13	269.9	32.3	12.0	258.0
	SC	--	167	257.6	19.9	7.7	256.0	49	244.5			243.0
	SIT/SU	--	29	245.0	23.6	9.6	235.0	8	192.5	22.2	11.5	195.0

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FAMILY – Family common name / *Species name* (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
Scarus vetula	PR	EAST						5	304.0	11.4	3.8	300.0
(Queen parrotfish)	PR	SOUTH						16	270.4	72.8	26.8	283.5
	PR	WEST						63	303.9	30.7	10.1	306.0
	SIC	--	10	330.7	38.0	11.5	328.5	36	308.9			307.0
	SIT/SU	--	1	365.0			365.0	2	280.0	14.1	5.1	280.0
Sparisoma aurofrenatum	PR	SOUTH						15	236.3	11.9	5.0	235.0
(Redband parrotfish)	PR	WEST						37	233.2	30.7	13.2	222.0
	SIC	--	217	216.7	9.4	4.3	217.0	18	240.9			247.5
	SIT/SU	--	25	223.2	35.9	16.1	220.0	15	223.0	10.8	4.9	220.0
Sparisoma chrysopterum	PR	EAST						189	257.7	41.7	16.2	260.0
(Redtail parrotfish)	PR	SOUTH						193	248.2	23.6	9.5	250.0
	PR	WEST						348	266.5	27.7	10.4	270.0
	SIC	--	1862	262.4	20.1	7.7	263.0	1,253	253.9			250.0
	SIT/SU	--	93	284.1	33.9	11.9	285.0	51	249.0	25.4	10.2	245.0
Scarus rubripinne	PR	EAST						13	254.9	27.6	10.8	255.0
(Redfin parrotfish)	PR	WEST						1	315.0			315.0
	SIC	--						4	246.3			246.5
	SIT/SU	--						9	243.9	44.1	18.1	260.0
Sparisoma spp.	PR	EAST						256	220.9	38.5	17.4	220.0
(Unidentified parrotfish)	PR	SOUTH						3	215.0	45.1	21.0	191.0
	PR	WEST						39	202.3	44.2	21.9	185.0
	SIC	--	3	229.3	12.9	5.6	233.0					
	SIT/SU	--	190	250.7	47.0	18.7	241.0					
Sparisoma viride	PR	EAST						107	280.9	30.6	11.7	255.0
(Stoplight parrotfish)	PR	SOUTH	1	180.0			180.0	154	260.2	31.8	12.2	257.5
	PR	WEST						518	285.0	33.3	11.7	285.5
	SIC	--	1693	283.3	31.1	11.0	305.0	1,257	269.1			267.0
	SIT/SU	--	53	315.0	51.9	16.5	285.0	37	243.5	38.7	15.9	250.0
ACANTHURIDAE – Surgeonfishes												
Acanthurus bahianus	SIC	--	355	190.0	11.1	5.8	180.0	136	188.8			189.0
(Ocean surgeon)								189	166.9	27.6	16.5	165.0
Acanthurus chirurgus	SIC	--	227	233.2	25.6	11.0	235.0	575	218.4			216.0
(Doctorfish)	SIT/SU	--	139	249.0	33.8	13.6	250.0	23	188.9	21.1	11.2	190.0
Acanthurus coeruleus	SIC	--	2063	184.8	17.2	9.3	182.0	1,162	171.2			170.0
(Blue tang)	SIT/SU	--	410	200.1	29.3	14.6	200.0	199	160.3	25.6	16.0	160.0
Acanthurus spp.	SIC	--	192	192.0	10.2	5.3	192.0					
(Unidentified Acanthurid)												
BALISTIDAE – Leatherjackets												
Balistes spp.	PR	EAST						1	240.0			240.0
(Unidentified triggerfish)												
Balistes vetula	PR	EAST	86	301.2	47.8	15.9	297.0	37	292.7	34.8	11.9	290.0
(Queen triggerfish)	PR	NORTH	3	305.3	26.8	8.8	301.0	1	322.0			322.0
	PR	SOUTH	165	250.3	46.8	18.7	246.0	32	256.3	47.7	18.6	255.0
	PR	WEST	86	295.9	51.4	17.4	290.0	56	260.5	51.5	19.8	248.5
	SIC	--	815	282.4	48.3	17.1	320.0	180	265.0			260.0
	SIT/SU	--	509	316.4	51.7	16.3	275.0	44	288.8	50.6	22.1	227.5
Canthidermis sufflamen	SIC	--	13	369.7	33.5	9.1	365.0	1	415.0			415.0
(Ocean triggerfish)	SIT/SU	--	3	340.0	10.0	2.9	340.0					
Melichthys niger	SIC	--	1	260.0			260.0					
(Black durgon)												
OSTRACIIDAE – Boxfishes												
Lactophrys bicaudalis	PR	EAST	15	170.4	30.6	17.9	166.0	1	221.0			221.0
(Spotted trunkfish)	PR	SOUTH	53	182.9	41.2	22.5	175.0	9	193.6	19.9	10.3	194.0
	PR	WEST	11	217.1	50.1	23.1	206.0	9	256.3	140.1	54.6	192.0
	SIC	--	12	180.1	17.9	9.9	175.0	20	200.9			182.5
	SIT/SU	--	1	175.0			175.0	7	197.1	26.6	13.5	195.0
Lactophrys polygonia	PR	EAST	90	223.2	37.5	16.8	219.0	56	229.9	38.2	16.6	223.5
(Honeycomb cowfish)	PR	SOUTH	77	219.2	43.2	19.7	213.0	47	227.0	38.8	17.1	225.0
	PR	WEST	36	275.4	41.3	15.0	270.0	19	190.0	21.5	11.3	190.0
	SIC	--	190	246.8	37.6	15.3	248.0	622	241.8			240.0
	SIT/SU	--						86	185.0	34.9	18.9	175.0

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FAMILY – Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN
Lactophrys quadricornis	PR	EAST	73	201.6	29.1	14.4	197.0	27	189.1	46.1	24.2	200.0
(Scrawled cowfish)	PR	SOUTH	97	207.7	42.9	20.7	200.0	13	246.2	33.7	13.7	240.0
	PR	WEST	49	207.4	39.2	18.9	215.0	8	242.3	41.4	17.1	250.0
	SC	--	9	281.2	30.1	10.7	280.0	28	266.9			268.0
	SIT/SU	--						5	231.0	45.3	19.6	220.0
Lactophrys trigonus	PR	EAST	12	283.8	70.9	25.0	306.0	3	360.3	21.5	6.0	350.0
(Trunkfish)	PR	SOUTH	5	317.2	23.6	7.6	309.0	3	217.3	82.6	38.0	180.0
	PR	WEST						18	268.8	90.2	33.5	273.5
	SC	--	2	235.0	120.2	51.2	235.0					
Lactophrys triqueter	PR	EAST	18	161.6	33.2	20.6	151.0	13	186.8	20.2	12.1	170.0
(Smooth trunkfish)	PR	SOUTH	22	174.0	34.7	19.9	167.5	7	165.3	18.4	11.1	167.0
	PR	WEST	9	181.7	36.1	19.9	175.0	5	333.4	117.4	35.2	350.0
	SC	--	19	160.4	15.1	8.9	188.0	80	162.3			160.0
	SIT/SU	--						33	180.8	23.6	12.4	195.0
UNKNOWN – UNKNOWN												
Uncategorized fish	PR	EAST	213	206.2	60.9	29.6						
(Multiple species)	SC	--	9	111.0	333.0	300.0						
	SIT/SU	--	4	252.5	168.6	66.8						
	SIT/SU	--	1	730.0								
Unidentified sp.	PR	EAST	1	0.0								
(Unidentified species)	PR	EAST	1	145.0								
	PR	SOUTH	3	0.0	0.0							
	SC	--	20	723.9	77.8	10.7						
	TOTAL =		26,294					28,054				

* ISLAND CODES

TABLE 5. Comparison of fish weight between 1985 and 1990

FAMILY – Family common name / *Species name* (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
HOLOCENTRIDAE – Squirrelfishes												
Holocentrus ascensionis	PR	NORTH						7	205.0	56.6	36.4	210.0
(Squirrelfish)	PR	SOUTH						2	160.0			160.0
	PR	WEST						1	160.0			160.0
	STC	--	187	182.6	40.3	22.1	175.0	4	250.0			250.0
	StT/SU	--	99	301.7	631.9	209.4	225.0					
Holocentrus rufus	PR	NORTH						1	165.0			165.0
(Longspine squirrelfish)	StT/SU	--						84	198.2	42.7	21.5	
	PR	EAST						9	125.0	44.2	35.4	122.0
	STC	--						1	150.0			150.0
Holocentrus spp.	StT/SU	--	30	221.0	57.9	26.2	200.0					
(Unidentified squirrelfish)												
SERRANIDAE – Sea basses												
Epinephelus adscensionis	PR	EAST	5	253.2	66.5	26.3	272.0					
(Rock hind)	PR	NORTH						1	5,102.0			5,102.0
	PR	SOUTH	8	165.5	189.9	114.8	120.0	44	702.3	376.6	53.6	597.5
	PR	WEST						3	931.7	631.4	67.8	810.0
	STC	--	1	800.0			800.0					
	StT/SU	--	5	1,345.0	512.5	38.1	1,525.0	1	600.0			600.0
Epinephelus afer	PR	EAST	8	251.8	90.3	35.9	237.5					
(Mutton hamlet)	PR	NORTH	1	346.0			346.0	1	370.0			370.0
Epinephelus cruentatus	PR	EAST	2	1,238.0	937.[illegible]	75.7	1,238.0	221	245.1	101.3	41.3	225.0
(Graysby)	PR	SOUTH						3	323.3	218.3	67.5	210.0
	PR	WEST						1	150.0			150.0
	STC	--	8	162.3	49.8	30.7	175.0					
	StT/SU	--	3	350.0	109.0	31.1	400.0					
Epinephelus flavolimbatus	StT/SU	--	2	7,549.5	3,464.1	45.9	7,549.5					
(Yellowedge grouper)												
Epinephelus fulvus	PR	EAST	206	289.1	438.5	151.7	222.0	111	244.8	115.0	47.0	220.0
(Coney)	PR	NORTH	14	208.7	90.5	43.4	184.5	6	162.3	36.9	22.7	160.0
	PR	SOUTH	179	182.2	71.4	39.2	178.0	114	191.3	68.3	35.7	182.5
	PR	WEST	191	165.3	49.6	30.0	163.0	29	198.5	67.1	33.8	205.0
	STC	--	1,844	208.2	57.9	27.8	200.0	20	280.0			250.0
	StT/SU	--	189	255.9	75.4	29.5	250.0	21	315.5	97.3	30.8	200.0
Epinephelus guttatus	PR	EAST	456	325.0	217.4	66.9	265.0	444	433.9	284.0	65.4	330.0
(Red hind)	PR	NORTH	2	275.5	146.4	53.1	275.5	1	205.0			205.0
	PR	SOUTH	136	336.6	183.9	54.6	308.0	233	590.9	368.5	62.4	520.0
	PR	WEST	136	362.1	208.5	57.6	297.0	85	236.9	98.8	41.7	215.0
	STC	--	567	510.2	339.5	66.6	397.0	436	759.1			725.0
	StT/SU	--	448	641.9	406.4	63.3	525.0	15	376.7	141.6	37.6	475.0
Epinephelus itajara	PR	EAST	3	751.0	742.9	98.9	472.0	5	1,970.0	3,464.1	175.8	460.0
(Jewfish)	PR	SOUTH						4	19,630.3	14,504.6	73.9	17,241.5
Epinephelus morio	PR	EAST	3	1,578.7	1,259.0	79.8	1,036.0	1	225.0			225.0
(Red grouper)	PR	SOUTH						0				
	StT/SU	--	10	2,870.0	1,576.6	54.9	2,775.0					
Epinephelus mystacinus	PR	EAST						6	716.2	465.1	64.9	527.5
(Misty grouper)	PR	NORTH						1	11,907.0			11,907.0
	PR	WEST						1	24,947.0			24,947.0
	STC	--	6	3,803.3	3,622.9	95.3	2,875.0					
	StT/SU	--	4	9,999.0	0.0	0.0	9,999.0					
Epinephelus striatus	PR	EAST	45	1,025.5	850.5	82.9	770.0	1	630.0			630.0
(Nassau grouper)	PR	SOUTH	12	383.3	401.3	104.7	206.5	1	190.0			190.0
	PR	SOUTH						33	1,098.8	516.0	47.0	1,140.0
	PR	WEST	7	1,602.1	1,462.3	91.3	1,024.0					
	STC	--	4	1,087.5	572.[illegible]	52.6	1,100.0	6	1,437.5			1,075.0
	StT/SU	--	73	3,251.0	1,933.8	59.5	2,900.0					
Mycteroperca bonaci	PR	SOUTH						36	3,383.1	2,927.1	86.5	1,882.5
(Black grouper)												
Mycteroperca interstitialis	PR	SOUTH						1	790.0			790.0
(Yellowmouth grouper)	StT/SU	--	10	1,241.5	637.0	51.3	1,122.5					
Mycteroperca tigris	PR	EAST						1	230.0			230.0
(Tiger grouper)	STC	--	2	2,600.0	2,969.9	114.2	2,600.0					
	StT/SU	--	24	2,062.7	1,486.3	72.1	1,762.5					

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY – Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
Mycteroperca venenosa	PR	EAST	17	1,725.9	1,166.8	67.6	1,355.0	7	4,940.9	2,596.8	52.5	4,536.0
(Yellowfin grouper)	PR	SOUTH	2	703.5	521.1	74.1	703.5	1	790.0	.		790.0
	STC	--	11	1,096.0	1,247.6	113.6	780.0	3	808.3			675.0
	SIT/SU	--	103	3,491.2	2,426.3	69.5	3,100.0					
CARANGIDAE – Jacks												
Caranx lugubris	PR	WEST										
(Black jack)	STC	--	5	1,641.4	943.0	57.5	1,250.0	4	1,400.0			1,075.0
	SIT/SU	--	1	825.0	.	.	825.0					
Caranx bartholomaei	PR	EAST						18	400.6	134.9	33.7	397.5
(Yellow jack)	PR	SOUTH						1	1,340.0	.		1,340.0
	PR	WEST						20	2,000.1	3,932.8	196.6	635.0
	STC	--	10	1,016.5	234.9	23.1	1,017.0					
	SIT/SU	--	5	325.0	82.9	25.5	350.0					
Caranx crysos	PR	EAST	21	234.9	114.7	48.8	198.0	95	936.2	488.8	52.1	900.0
(Blue runner)	PR	NORTH						5	786.0	335.4	42.7	735.0
	PR	WEST						0	.	.		
	STC	--	19	525.5	321.3	61.1	365.0					
	SIT/SU	--	15	1,131.0	467.6	41.3	910.0					
Caranx hippos	PR	NORTH						22	853.7	1,629.7	190.9	280.0
(Crevalle jack)	PR	WEST						1	3,515.0	.		3,515.0
Caranx latus	PR	EAST						3	2,834.7	907.5	32.0	2,835.0
(Horse-eye jack)	PR	NORTH						39	212.7	224.9	105.7	114.0
	PR	WEST						69	547.9	641.1	117.0	410.0
	STC	--	6	2,192.0	816.7	37.3	2,212.0					
	SIT/SU	--	6	1,437.5	454.4	31.6	1,300.0					
Caranx ruber	PR	EAST						43	445.0	200.8	45.1	375.0
(Bar jack)	PR	NORTH						4	381.3	221.1	58.0	355.0
	PR	SOUTH						50	282.7	97.6	34.5	252.5
	PR	WEST						129	328.8	230.8	70.2	305.0
	STC	--	96	238.7	159.8	67.0	198.0	6	564.0			487.5
	SIT/SU	--	32	625.0	1,084.2	173.5	400.0	1	400.0	.	.	400.0
Caranx spp. (Unidentified jack)	SIT/SU	--	3	975.0	1,064.5	109.2						
LUTJANIDAE – Snappers												
Apsilus dentatus	PR	NORTH	1	1,975.0	.	.	1,975.0					
(Black snapper)								49	868.4			700.0
Etelis oculatus	PR	NORTH						7	1,577.0	1,219.5	77.3	1,406.0
(Queen snapper)	PR	SOUTH	1	119.0		.	119.0					
	PR	WEST						108	696.6	6,117.6	293.9	382.5
	STC	--	48	878.0	752.2	85.7	690.0	150	1,068.4			762.5
	SIT/SU	--	21	3,191.6	2,057.3	64.5	2,840.0					
Lutjanus analis	PR	EAST	30	1,444.3	1,461.6	101.2	581.0	81	2,081.4	1,426.8	65.3	420.0
(Mutton snapper)	PR	NORTH	7	4,177.7	2,812.4	67.3	4,352.0	8	2,185.4	975.6	157.3	2,159.5
	PR	SOUTH	10	1,220.0	1,090.7	89.4	960.5	34	620.1	797.1	214.8	370.0
	PR	WEST	6	2,221.7	1,484.3	66.8	1,857.0	146	371.1	1,002.0	101.3	135.0
	STC	--	17	1,431.4	1,338.5	93.5	936.0	5	2,860.0			2,800.0
	SIT/SU	--	27	1,483.7	1,343.4	90.5	850.0					
Lutjanus apodus	PR	EAST	19	594.9	517.7	87.0	387.0	60	989.2	769.3	121.0	694.0
(Schoolmaster)	PR	NORTH	19	977.1	574.3	58.8	1,048.0	2	636.0	264.9	73.0	636.0
	PR	SOUTH	26	337.9	128.8	38.1	300.0	50	390.4	251.4	59.6	262.5
	PR	WEST	8	248.0	120.4	48.5	206.0	82	421.7	300.5	61.7	350.0
	STC	--	101	477.7	277.0	58.0	425.0	47	508.0			450.0
	SIT/SU	--	39	607.7	384.2	63.2	500.0	2	487.5	317.0	71.0	487.5
Lutjanus buccanella	PR	EAST	18	247.1	153.8	62.2	209.0	44	446.5	245.2	107.0	351.5
(Blackfin snapper)	PR	NORTH	2	126.5	43.1	34.1	126.5	44	229.1	198.3	45.3	177.5
	PR	WEST						8	437.5	2,022.9	63.0	407.5
	STC	--	65	421.3	222.1	52.7	369.0	223	566.3			500.0
	SIT/SU	--	180	486.2	214.8	44.2	450.0					
Lutjanus campechanus	PR	NORTH	1	330.0		.	330.0					
(Red snapper)	SIT/SU	--	1	910.0		.	910.0					
Lutjanus cyanopterus	PR	EAST						3	3,209.7	7,805.8	134.1	3,629.0
(Cubera snapper)	PR	WEST						2	5,819.5	1,314.8	116.4	5,819.0
	STC	--	4	243.8	12.5	5.1	250.0					
Lutjanus griseus	PR	EAST	4	174.3	51.7	29.7	162.0	6	1,129.8			515.0

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY – Family common name / *Species name* / (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
(Gray snapper)	PR	NORTH	4	249.5	87.8	35.2	242.5					
	PR	SOUTH						2	306.0	36.4	11.8	306 0
	PR	WEST						0	.	.		
	SIT/SU	--	1	8,050.0		.	8,050.0					
Lutjanus jocu	PR	EAST	4	2,674.5	2,766.7	103.5	2,386.5					
(Dog snapper)	PR	NORTH	8	644.8	364.0	56.5	572.0	3	758.3	756.6	99 6	250 0
	PR	SOUTH	6	249 8	90.3	36.1	275.0	34	1,114.8	1,056.1	94.7	827 5
	PR	WEST						1	415.0	.		415 0
	STC	--	3	669.7	402.3	60.1	450.0					
	SIT/SU	--	16	2,554.7	1,493.8	58.5	2,525.0	1	525.0	.		525 0
Lutjanus mahogoni	PR	EAST	10	623.2	271 1	43.5	575 5					
(Mahogany snapper)	PR	NORTH	7	482.3	91.7	19.0	448.0	2	280.0	212.1	75 8	280 0
	PR	SOUTH	8	198.1	56.8	28.7	170.0					
	STC	--	12	190.8	56.8	29.8	175.0	7	280.7			250 0
	SIT/SU	--	12	275.0	75.4	27.4	275.0					
Lutjanus spp.	PR	NORTH						1	150.0	.		150 0
(Unidentified snapper)	PR	WEST										
Lutjanus synagris	PR	EAST	208	183.8	139.9	76.1	180.5	309	241.4	103.5	42 9	225 0
(Lane snapper)	PR	NORTH	10	298.9	175.1	58.6	252.5	120	240.0	105 4	43.9	212 5
	PR	SOUTH	102	160.3	89 1	55.6	143.0	237	144.2	90.0	62 4	116 0
	PR	WEST	109	179.2	77.4	43.2	168.0	1326	208.1	97.9	47 0	190 0
	STC	--	4	212.5	62.9	29.6	200.0	8	281.3			300 0
	SIT/SU	--	103	329.4	198 4	60.2	300.0	7	267.9	68.8	25.7	
Lutjanus vivanus	PR	EAST	18	536.3	309.7	57.7	420.5	223	456.5	916.5	200 8	330 0
(Silk snapper)	PR	NORTH	159	223.6	172.0	77.0	178.0	334	290.7	204.4	70.3	230 0
	PR	SOUTH	3	279.0	176.9	63.4	204.0					
	PR	WEST	1	39.0		.	39.0	13	382.3	262.2	68 6	420 0
	STC	--	165	994.3	589 6	59.3	879.0	378	770.9			600 0
	SIT/SU	--	36	711.5	1,094.2	153.8	200.0	4	275.0	35.4	12.9	
Ocyurus chrysurus	PR	EAST	521	442.7	279.3	63.1	369.0	864	415.0	1,802.1	434.3	292 5
(Yellowtail snapper)	PR	NORTH	402	392.9	142.2	36.2	370.0	115	496.9	200.9	40.4	430 0
	PR	SOUTH	43	253.6	126.1	49.7	280.0	270	238 9	131.0	54 8	210 0
	PR	WEST	30	223.1	105.9	47.5	193.0	370	254.3	129 8	51 0	225 0
	STC	--	610	384.8	342.1	88.9	284.0	32	432.0			425 0
	SIT/SU	--	456	705.1	384.9	54.6	565.0	1	300.0	.		300 0
Rhomboplites aurorubens	PR	EAST	58	153.5	33.9	22.1	148.5	443	191.5	112.6	58 8	170 0
(Vermilion snapper)	PR	NORTH	104	133.2	62.8	47.2	117.0	280	130.6	52.2	40 0	120 0
	PR	SOUTH						40	154.6	103.2	66.8	124 0
	STC	--	14	751.3	178.9	23.8	737.0	76	422.7			400 0
	SIT/SU	--	6	143.3	82.0	57.2	125.0					
HAEMULIDAE – Grunts												
Anisotremus surinamensis	PR	EAST						20	431.9	253.1	58.6	352.5
(Black margate)	PR	WEST						1	350.0	.		350 0
	SIT/SU	--	2	775.0	247.5	31.9	775.0					
Anisotremus virginicus	PR	EAST						32	273.0	94 9	34 8	275 0
(Porkfish)	PR	SOUTH	2	326.5	186.0	57.0	326.5	27	215.3	73.2	34.0	210 0
	PR	WEST						38	305.0	92.7	30 4	290 0
	STC	--	13	315.0	114.0	36.2	300.0					
	SIT/SU	--	8	743.8	362.7	48.8	737.5					
Conodon nobilis	PR	EAST						53	287.6	63.5	22.1	285 0
(Barred grunt)												
Haemulon album	PR	EAST	19	643.0	749.3	116.5	287.0	8	553.8	582.5	105 2	340.0
(Margate)	PR	SOUTH	2	211.0	93.3	44.2	211.0					
	STC	--	3	2,291.7	2,041.2	89.1	1,550.0					
	SIT/SU	--	21	2,580.2	986.1	38.2	2,636.0					
Haemulon aurolineatum	PR	EAST	12	216.4	62.3	28.8	204.5	6	76.3	15.3	20.0	73.0
(Tomtate)	PR	NORTH						23	78.7	36.1	45.8	66.0
	PR	SOUTH	8	215.0	35 9	16.7	226.0					
	PR	WEST						1	90.0	.		90 0
	SIT/SU	--	20	218.8	71 1	32.5	200.0					
Haemulon bonariense	PR	EAST	1	201.0			201.0					
(Black grunt)	PR	SOUTH						1	150.0	.		150 0
	PR	WEST						2	530.0	141.4	26.7	530 0

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY – Family common name / Species name (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
Haemulon carbonarium	PR	EAST						14	268.6	110.7	41.2	223.0
(Caesar grunt)	PR	WEST						4	198.8	41.1	20.7	180.0
	STC	--	31	193.1	36.3	18.3	198.0	78	231.7			225.0
Haemulon chrysargyreum	PR	WEST						3	67.3	8.3	12.4	70.0
(Smallmouth grunt)												
Haemulon flavolineatum	PR	EAST	82	215.0	115.0	53.5	212.0	9	152.9	38.2	25.0	150.0
(French grunt)	PR	SOUTH	57	128.0	98.3	76.8	115.0	16	126.3	16.2	12.9	130.0
	PR	WEST	89	125.4	35.9	28.6	121.0	21	115.6	69.7	60.3	104.0
	STC	--	232	158.8	47.2	29.7	150.0	8	182.5			150.0
	SIT/SU	--	12	179.2	33.4	18.7	200.0	23	179.4	59.7	33.3	150.0
Haemulon macrostomum	PR	EAST	15	248.7	118.0	47.4	214.0	46	230.5	114.2	49.6	199.0
(Spanish grunt)	PR	NORTH	4	196.0	36.9	18.8	196.0					
	PR	SOUTH	26	244.9	131.8	53.8						
	PR	SOUTH	15	156.5	57.3	36.6	135.0					
	PR	WEST						2	550.0	332.3	60.4	550.0
	SIT/SU	--	6	783.3	113.7	14.5	750.0	15	198.3	41.7	21.0	550.0
Haemulon melanurum	PR	EAST	1	185.0		.	185.0					
(Cottonwick)	PR	SOUTH	1	241.0		.	241.0					
	STC	--	1	170.0		.	170.0					
	SIT/SU	--	12	250.0	63.1	25.2	170.0					
Haemulon parrai	PR	EAST	7	317.1	55.5	17.5	225.0	65	236.2	70.3	29.8	231.0
(Sailor's choice)	SIT/SU	--						2	350.0	70.7	20.2	550.0
Haemulon plumieri	PR	EAST	530	206.5	84.4	40.9	197.5	996	254.2	91.3	35.9	245.0
(White grunt)	PR	NORTH	57	329.6	81.7	24.8	326.0	15	257.0	47.9	18.6	240.0
	PR	SOUTH	320	188.4	75.6	40.1	181.5	613	180.8	71.3	39.4	175.0
	PR	WEST	186	203.6	111.4	54.7	177.0	970	201.0	91.3	45.4	195.0
	STC	--	1,588	236.7	62.2	26.3	225.0	309	272.2			250.0
	SIT/SU	--	39	633.7	1,042.9	164.6	475.0	85	308.2	99.2	32.2	250.0
Haemulon sciurus	PR	EAST	36	222.3	81.5	36.7	187.5	172	246.9	98.1	39.7	235.0
(Bluestriped grunt)	PR	NORTH						1	390.0	.		390.0
	PR	SOUTH	88	215.4	84.8	39.4	212.5	71	170.8	73.6	30.2	180.0
	PR	WEST	17	235.8	101.8	43.2	177.0	83	231.6	82.8	27.7	190.0
	STC	--	136	269.6	75.5	28.1	300.0					
	SIT/SU	--	23	331.5	123.2	37.2	300.0	48	299.0	78.8	29.7	
Haemulon sp.	PR	NORTH	1	384.0	.	.	384.0					
(Unidentified grunt)	PR	SOUTH						1	230.0	.		230.0
Pomadasys crocro	PR	NORTH						1	170.0	.		170.0
(Burro grunt)								6	665.0			725.0
SPARIDAE – Porgies												
Archosargus rhomboidalis	PR	EAST						1	110.0	.		110.0
(Sea bream)	PR	SOUTH						4	148.3	44.6	30.1	120.0
	PR	WEST										
	SIT/SU	--	7	232.1	31.3	13.5	250.0					
Calamus bajonado	PR	EAST	89	255.6	94.3	36.9	216.0	5	343.6	315.6	91.9	190.0
(Jolthead porgy)	PR	SOUTH	15	287.5	155.5	54.1	222.0	271	193.2	101.6	52.6	165.0
	PR	WEST						228	175.7	97.8	55.6	152.5
	SIT/SU	--						122	294.3	117.4	39.9	
Calamus penna	PR	EAST	480	224.0	139.5	62.3	204.0	19	189.6	57.1	30.1	165.0
(Sheepshead porgy)	PR	NORTH						2	157.5	10.6	6.7	157.5
	PR	SOUTH	82	215.4	108.4	50.3	170.5	23	192.9	98.8	51.2	165.0
	PR	WEST	85	148.7	69.6	46.8	124.0	69	167.9	100.3	59.8	130.0
MULLIDAE – Goatfishes												
Mulloidichthys martinicus	PR	EAST	10	243.5	114.1	46.9	194.0	6	84.0	22.1	135.0	83.0
(Yellow goatfish)	PR	NORTH						3	126.7	14.4	11.4	135.0
	PR	SOUTH	48	177.6	74.4	41.9	163.0	33	171.2	71.3	41.7	150.0
	PR	WEST	31	186.6	65.3	35.0	158.0	64	117.4	61.9	52.8	94.0
	STC	--	547	184.9	44.3	23.9	175.0					
	SIT/SU	--	22	307.1	95.8	31.2	287.5	26	339.4	66.4	19.6	350.0
	SIT/SU	--	2	650.0	70.7	10.9	650.0					
Pseudupeneus maculatus	PR	EAST	871	134.8	66.0	49.0	141.0	108	118.0	45.9	39.6	108.0
(Spotted goatfish)	PR	SOUTH	190	131.4	42.6	32.4	123.5	21	157.1	54.2	51.8	170.0
	PR	WEST	204	134.1	50.5	37.6	131.0	339	104.7	28.9	12.4	100.0
	STC	--	125	181.0	47.8	26.4	170.0					

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY – Family common name *Species name* (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
	ST/SU	--	3	230	121.2	52.7	250.0	3	233.3	815.0	83.5	
EPHIPPIDAE – Spadefishes												
Chaetodipterus faber	PR	WEST						1	690.0	.		690.0
(Atlantic spadefish)	STC	--	1	875.0	.	.	875.0					
CHAETODONTIDAE – Butterflyfishes												
Chaetodon ocellatus	ST/SU	--	2	75.0	0.0	0.0	75.0					
(Spotfin butterflyfish)												
POMACANTHIDAE – Angelfishes												
Holacanthus ciliaris	STC	--	9	697.2	310.6	44.6		35	535.0			500.0
(Queen angelfish)	ST/SU	--	14	698.2	308.1	44.1		3	616.7			550.0
Holacanthus tricolor	STC	--	31	296.4	63.0	21.3	300.0					
(Rock beauty)	ST/SU	--	6	245.8	29.2	11.9	250.0	1	200.0	.		200.0
Pomacanthus arcuatus	PR	WEST						1	1,370.0	.		1,370.0
(Gray angelfish)	STC	--	17	1,123.5	641.4	57.1	900.0					
	ST/SU	--	82	1,064.0	514.9	48.4	930.0	3	258.3	80.4	31.1	263.0
Pomacanthus paru	STC	--	13	757.5	450.3	59.4	500.0	9	841.7			500.0
(French angelfish)	ST/SU	--	17	979.4	679.0	69.3	1,025.0	2	237.5	17.7	7.4	237.5
LABRIDAE – Wrasses												
Bodianus rufus	PR	SOUTH						6	345.0	44.3	12.8	340.0
(Spanish hogfish)	PR	WEST						2	397.5	109.6	27.6	397.5
	STC	--	15	291.7	96.9	33.2	255.0	3	375.0			375.0
	ST/SU	--	12	348.3	90.4	26.0	355.0					
Halichoeres radiatus	PR	EAST	1	201.0	.	.	201.0	1	300.0	.		300.0
(Puddingwife)	PR	SOUTH	1	382.0	.	.	382.0					
	STC	--	5	494.0	217.9	44.1	500.0					
	ST/SU	--	3	426.7	219.4	51.4	300.0					
Lachnolaimus maximus	PR	EAST	17	794.2	501.1	63.1	547.0	7	2,196.9	1,633.4	74.4	1,070.0
(Hogfish)	PR	SOUTH	19	966.7	955.3	98.8	502.0	174	1,236.8	1,223.6	99.0	1,057.5
	PR	WEST	17	1,227.0	1,119.6	91.2	530.0	21	480.5	370.7	77.2	405.0
	STC	--	3	816.7	246.6	30.2	700.0					
	ST/SU	--	27	2,806.7	1,697.9	60.5	2,490.0	2	775.0	530.3	68.4	530.3
SCARIDAE – Parrotfishes												
Scarus coelestinus	PR	SOUTH						2	3,616.5	2,583.1	71.4	3,616.5
(Midnight parrotfish)												
Scarus coeruleus	PR	NORTH						24	204.0	41.0	20.1	190.0
(Blue parrotfish)												
Scarus guacamaia	PR	SOUTH						5	2,715.2	1,468.8	54.1	1,725.0
(Rainbow parrotfish)	ST/SU	--	3	5,006.7	1,058.0	21.1	4,475.0					
Scarus spp.	PR	EAST						2	367.5	201.5	54.8	367.5
(Unidentified parrotfish)	ST/SU	--	1	250.0			250.0					
Scarus taeniopterus	PR	EAST						1	345.0	.		345.0
(Princess parrotfish)	PR	SOUTH						50	282.1	116.1	41.2	260.0
	PR	WEST						13	320.8	124.5	38.8	265.0
	STC	--	167	330.5	75.3	22.8	312.0	36	339.6			350.0
	ST/SU	--	29	302.8	80.1	26.5	275.0	7	182.1	102.8	56.4	375.0
Scarus vetula	PR	EAST						5	378.0	51.3	13.6	370.0
(Queen parrotfish)	PR	SOUTH						16	451.9	163.8	36.3	380.0
	PR	WEST						63	512.5	197.2	38.5	505.0
	STC	--	10	762.9	186.7	24.5	750.0	32	699.2			637.5
	ST/SU	--	1	1,175.0			1,175.0					
Sparisoma aurofrenatum	PR	SOUTH						15	193.7	23.5	12.1	195.0
(Redband parrotfish)	PR	WEST						37	253.0	104.0	41.1	210.0
	ST/SU	--						1	225.0	.		225.0
	STC	--	217	217.4	42.9	19.7	200.0	6	300.0			225.0
	ST/SU	--	25	251.0	122.4	48.8	200.0					
Sparisoma chrysopterum	PR	EAST						189	362.4	95.0	32.4	350.0
(Redtail parrotfish)	PR	SOUTH						182	292.7	104.0	30.0	292.5
	PR	WEST						345	346.9	106.9	40.1	360.0
	STC	--	1,862	367.2	85.5	23.3	369.0	718	373.9			375.0
	ST/SU	--	93	437.7	147.5	33.7	450.0	9	266.7	90.7	38.7	275.0

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY — Family common name / *Species name* (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
Sparisoma rubripinne	PR	EAST						13	312.0	125.4	40.2	245.0
(Redfin parrotfish)	PR	WEST						1	245.0	.		245.0
	SIT/SU	--						2	500.0	141.4	28.3	500.0
Sparisoma spp.	PR	EAST						258	293.5	139.0	47.4	255.0
(Unidentified parrotfish)	PR	SOUTH						3	281.7	186.0	65.7	185.0
	PR	WEST						15	322.7	103.2	32.0	330.0
	STC	--	3	340.7	49.1	14.4	360.0					
	SIT/SU	--	180	422.9	263.4	62.3	367.5					
Sparisoma viride	PR	EAST						107	473.3	175.8	37.1	454.0
(Stoplight parrotfish)	PR	SOUTH	1	113.0	182.1	40.0	113.0	154	362.1	149.4	41.3	330.0
	PR	WEST						518	455.3	164.8	36.2	425.0
	STC	--	1,893	513.6	174.2	33.9	500.0	819	460.1			425.0
	SIT/SU	--	53	677.0	366.6	54.2	575.0	18	412.5	217.4	52.7	550.0
ACANTHURIDAE — Surgeonfishes												
Acanthurus bahianus	STC	--	355	187.8	37.4	19.9	196.0	112	188.6			200.0
(Ocean surgeon)	SIT/SU	--	56	191.3	101.3	53.0	180.0					
Acanthurus chirurgus	STC	--	227	316.3	78.5	24.8	325.0	605	168.6			150.0
(Doctorfish)	SIT/SU	--	139	364.5	128.6	35.3	350.0	13	265.4	59.1	22.3	325.0
Acanthurus coeruleus	STC	--	2,063	206.2	56.6	27.5	200.0					
(Blue tang)	SIT/SU	--	410	248.9	103.5	41.6	225.0	65	191.5	80.8	42.2	225.0
Acanthurus spp.	STC	--	192	177.9	36.4	20.5	175.0					
(Unidentified Acanthurid)												
BALISTIDAE — Leatherjackets												
Balistes spp.	PR	EAST						1	425.0	.		425.0
(Unidentified triggerfish)												
Balistes vetula	PR	EAST	88	769.6	405.0	52.6	677.0	37	668.7	288.1	43.1	620.0
(Queen triggerfish)	PR	NORTH	3	689.3	148.8	21.6	646.0	0	.	.		
	PR	SOUTH	165	416.4	246.6	59.2	363.0	32	451.3	260.9	57.8	395.0
	PR	WEST	86	704.4	378.0	53.7	611.0	56	454.6	267.3	58.8	397.5
	STC	--	815	632.3	327.1	51.7	525.0	105	544.1			525.0
	SIT/SU	--	509	844.8	372.3	44.1	800.0	43	529.7	326.3	61.6	550.0
Canthidermis sufflamen	STC	--	13	1,199.8	258.5	21.6	1,200.0					
(Ocean triggerfish)	STC	--	1	525.0	.	.	525.0					
	SIT/SU	--	3	858.3	144.3	16.8	775.0					
OSTRACIIDAE — Boxfishes												
Lactophrys bicaudalis	PR	EAST	15	157.6	61.5	39.0	144.0	1	290.0	.		290.0
(Spotted trunkfish)	PR	EAST	14	1,135.4	1,002.6	88.3						
	PR	SOUTH	53	208.0	177.4	85.3	162.0	9	180.3	50.8	28.2	170.0
	PR	WEST	11	254.8	159.1	62.5	211.0	9	264.1	238.3	90.2	205.0
	STC	--	12	175.7	35.0	19.9	172.5	10	255.0			175.0
	SIT/SU	--	1	115.0	.	.	115.0	5	345.0	106.7	30.9	1,137.0
Lactophrys polygonia	PR	EAST	90	219.8	110.6	50.3	191.0	56	258.9	184.8	71.4	210.0
(Honeycomb cowfish)	PR	SOUTH	77	219.8	130.8	59.5	191.0	47	223.2	139.4	62.5	205.0
	PR	WEST	36	433.0	182.0	42.0	399.5	19	148.6	47.4	31.9	140.0
	STC	--	199	309.4	120.4	38.9	300.0	394	330.1			325.0
	SIT/SU	--						82	251.5	157.8	62.7	350.0
Lactophrys quadricornis	PR	EAST	73	143.7	64.4	44.8	130.0	27	173.6	182.8	105.3	125.0
(Scrawled cowfish)	PR	SOUTH	97	187.4	119.4	63.7	180.0	13	208.0	78.5	37.7	195.0
	PR	WEST	49	172.2	64.6	37.5	167.0	6	256.8	111.3	43.4	255.0
	STC	--	9	339.8	147.6	43.5	340.0	15	376.7			400.0
	SIT/SU	--						1	225.0	.	.	225.0
Lactophrys trigonus	PR	EAST	12	502.0	324.7	64.7	607.5	3	836.7	170.1	20.3	830.0
(Trunkfish)	PR	SOUTH	5	595.2	144.7	24.3	537.0	3	265.0	225.2	85.0	135.0
	PR	WEST						18	554.2	369.3	66.6	675.0
	STC	--	2	362.5	371.2	102.4	362.5					
Lactophrys triqueter	PR	EAST	18	143.2	86.2	60.2	110.0	13	157.1	33.7	21.5	165.0
(Smooth trunkfish)	PR	SOUTH	22	171.6	87.6	51.1	149.0	7	161.6	45.7	28.3	185.0
	PR	WEST	9	161.7	91.8	56.8	137.0	5	721.2	566.8	78.6	610.0
	STC	--	19	177.5	39.3	22.1	175.0	59	181.0			175.0
	SIT/SU	--						9	225.0	75.0	33.3	175.0

TABLE 5. Comparison of fish weight between 1985 and 1990 (con't)

FAMILY – Family common name *Species name* (Species common name)	ISLAND*	COAST	1985 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN	1990 WEIGHT IN GRAMS N	MEAN	STD	CV	MEDIAN
MISCELLANEOUS – Multiple species												
Uncategorized fish (Multiple species)	PR	EAST	213	177.6	485.3	273.2						
	STC	--	9	2,981.9	3,769.0	126.4						
	SIT/SU	--	4	1,475.0	1,090.5	73.9						
	SIT/SU	--	1	7,450.0								
	TOTAL =		26,336					20,197				

* ISLAND CODES
PR – Puerto Rico
SC – St. Croix
SIT/SU – St. Thomas and St. John

TABLE 8. Summary of fish length and weight by gear type for 1985 data

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1985 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
HOLOCENTRIDAE – Squirrelfishes											
Holocentrus ascensionis	HOOK & LINE	24	200.5	13.7	6.8	205.0	24	141.3	39.0	27.6	125.0
(Squirrelfish)	TRAPS	252	209.6	21.2	10.1	210.0	252	231.6	399.6	172.6	200.0
	TRAPS & HOOKS	10	226.5	22.9	10.1	225.0	10	227.5	76.8	33.8	212.5
Holocentrus spp.	TRAPS	30	225.5	22.4	9.9	227.5	30	221.0	57.9	26.2	200.0
(Unidentified squirrelfish)											
SERRANIDAE – Sea basses											
Epinephelus adscensionis	HOOK & LINE	2	397.5	102.5	25.8	397.0	2	1,037.5	689.4	66.5	1,037.5
(Rock hind)	TRAPS	15	268.2	88.6	33.0	250.0	15	406.0	565.8	139.4	188.0
	TRAPS & HOOKS	2	363.5	37.5	10.3	363.5	2	975.0	247.5	25.4	975.0
Epinephelus afer	HOOK & LINE	1	282.0	.	.	282.0	1	346.0	.		346.0
(Mutton hamlet)	TRAPS	6	250.8	28.0	11.1	247.5	6	246.8	103.8	42.1	224.5
	UNKNOWN	2	252.0	18.4	7.3	252.0	2	266.5	51.6	19.4	266.5
Epinephelus cruentatus	HOOK & LINE	6	216.0	17.3	8.0	221.0	6	145.8	45.9	31.5	150.0
(Graysby)	TRAPS	5	312.6	101.6	32.5	270.0	5	664.8	708.0	106.5	425.0
	TRAPS & HOOKS	2	273.0	21.2	7.8	273.0	2	312.5	123.7	39.6	312.5
Epinephelus flavolimbatus	OTHER GEAR	1	715.0	.	.	715.0	1	5,100.0	.	.	5,100.0
Epinephelus flavolimbatus	TRAPS & HOOKS	1	930.0		.	930.0	1	9,999.0	.		9,999.0
(Yellowedge grouper)											
Epinephelus fulvus	HOOK & LINE	243	223.2	21.1	9.5	221.0	243	187.2	59.2	31.6	175.0
(Coney)	OTHER GEAR	2	249.0	9.9	4.0	249.0	2	302.5	54.5	18.0	302.5
	TRAPS	2,034	232.4	26.8	11.5	230.0	2,034	215.6	152.7	70.9	200.0
	TRAPS & HOOKS	73	231.9	19.3	8.3	230.0	73	214.1	72.8	34.0	200.0
	UNKNOWN	73	241.8	27.6	11.4	238.0	73	243.2	126.6	52.1	207.0
Epinephelus guttatus	HOOK & LINE	495	307.1	54.6	17.8	299.0	495	505.2	338.4	67.0	397.0
(Red hind)	OTHER GEAR	29	315.9	47.1	14.9	268.0	29	516.8	299.3	57.9	446.0
	TRAPS	1,041	298.8	61.0	20.4	285.0	1,041	453.6	337.0	74.3	330.0
	TRAPS & HOOKS	71	330.3	57.1	17.3	330.0	71	623.6	391.1	62.7	500.0
	UNKNOWN	111	277.1	42.4	15.3	310.0	111	358.7	252.9	70.5	283.0
Epinephelus itajara	TRAPS	3	331.0	102.2	30.9	313.0	3	751.0	742.9	98.9	472.0
(Jewfish)											
Epinephelus morio	TRAPS	9	526.9	106.7	20.6	550.0	9	2,444.9	1,455.2	59.5	2,750.0
(Red grouper)	TRAPS & HOOKS	3	583.3	77.8	13.3	575.0	3	3,583.3	1,682.5	47.0	34,000.0
	UNKNOWN	1	356.0	.	.	356.0	1	682.0	.	.	682.0
Epinephelus mystacinus	HOOK & LINE	7	626.0	243.4	38.8	665.0	7	4,688.4	4,052.3	86.4	4,500.0
(Misty grouper)	OTHER GEAR	2	894.5	147.8	16.5	894.5	2	9,999.0	0.0	0.0	9,999.0
	TRAPS & HOOKS	1	999.0	.	.	999.0	1	9,999.0	.		9,999.0
	HOOK & LINE	11	277.7	87.3	31.5	250.0	11	543.1	1,020.7	187.9	193.0
Epinephelus striatus	OTHER GEAR	1	400.0	.	.	400.0	1	961.0	.	.	961.0
(Nassau grouper)	TRAPS	116	474.6	128.3	27.0	475.0	116	2,171.2	1,875.0	86.4	1,700.0
	TRAPS & HOOKS	11	573.6	93.1	16.2	560.0	11	3,622.3	1,860.2	51.4	3,200.0
	UNKNOWN	2	446.5	26.2	5.9	446.5	2	2,501.5	1,690.7	67.6	2,501.5
Mycteroperca interstitialis	HOOK & LINE	1	312.0	.	.	312.0	1	438.0	.	.	438.0
(Yellowmouth grouper)	TRAPS	6	434.2	69.9	16.1	420.0	6	1,300.0	661.8	50.9	112.5
	TRAPS & HOOKS	4	403.8	84.7	21.0	392.5	4	1,153.8	685.7	59.4	1,162.5
Mycteroperca tigris	TRAPS	24	496.5	106.4	21.4	480.0	24	2,212.7	1,564.5	70.7	1,850.0
(Tiger grouper)	TRAPS & HOOKS	2	362.5	53.0	14.6	362.5	2	800.0	424.3	53.0	800.0
Mycteroperca venenosa	HOOK & LINE	3	216.7	11.6	5.3		3	141.7	14.4	10.2	
(Yellowfin grouper)	HOOK & LINE	27	624.4	104.1	16.7	635.0	27	4,787.0	2,118.0	44.2	4,475.0
	TRAPS	99	492.5	135.5	27.5	480.0	99	2,463.4	2,098.4	85.2	1,626.0
	TRAPS & HOOKS	5	869.0	178.7	26.7	710.0	5	5,299.8	3,313.4	62.5	5,700.0
	UNKNOWN	2	370.0	205.1	55.4	370.0	2	1,393.0	1,568.4	112.6	1,393.0
CARANGIDAE – Jacks											
Caranx lugubris	HOOK & LINE	3	454.7	84.7	18.6	426.0	3	2,036.7	1,073.8	52.7	1,600.0
(Black jack)	TRAPS & HOOKS	2	374.0	33.9	9.1	374.0	2	1,048.5	280.7	26.8	1,048.5
	UNKNOWN	1	480.0		.	480.0	1	825.0	.	.	825.0
Caranx bartholomaei	TRAPS	11	331.0	79.4	24.0	330.0	11	687.1	382.9	55.7	680.0
(Yellow jack)	TRAPS & HOOKS	4	375.3	28.8	7.7	376.0	4	1,058.0	287.6	27.2	1,025.0
Caranx crysos	HOOK & LINE	12	366.7	61.4	16.8	373.5	12	1,029.6	367.8	35.7	1,012.5
(Blue runner)	TRAPS	43	262.4	78.4	29.9	254.0	43	454.1	428.1	94.3	325.0
Caranx latus	HOOK & LINE	6	479.5	68.5	14.3	492.5	6	2,229.2	807.2	36.2	2,212.5
(Horse-eye jack)	TRAPS	6	412.5	38.3	9.3	402.5	6	1,400.3	388.8	27.8	1,300.0

TABLE 6. Summary of fish length and weight by gear type for 1985 data (con't)

FAMILY – Family common name *Species name* (Species common name)	GEAR	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1985 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Caranx ruber	HOOK & LINE	2	565.0	233.4	41.3	565.0	2	3,712.5	3,800.7	102.4	3,712.5
(Bar jack)	TRAPS	114	241.8	48.1	19.9	230.0	114	282.1	179.3	63.6	196.0
	TRAPS & HOOKS	13	282.9	29.8	10.5	283.0	13	375.9	144.6	38.5	350.0
	UNKNOWN	1	430.0	.	.	430.0	1	1,200.0	.	.	1,200.0
Caranx spp.	TRAPS	3	333.3	135.8	40.7		3	975.0	1,064.5	109.2	
(Unidentified jack)											
LUTJANIDAE – Snappers											
Apsilus dentatus	HOOK & LINE	1	470.0	.	.	470.0	1	1,975.0	.	.	1,975.0
(Black snapper)											
Etelis oculatus	HOOK & LINE	57	423.2	147.0	34.7	385.0	57	1,368.5	1,596.6	116.6	800.0
(Queen snapper)	OTHER GEAR	11	536.8	98.0	18.3	550.0	11	2,254.1	1,280.0	56.8	1,820.0
	TRAPS	1	190.0	.	.	190.0	1	119.0	.	.	119.0
	TRAPS & HOOKS	1	740.0	.	.	740.0	1	6,370.0	.	.	6,370.0
Lutjanus analis	HOOK & LINE	11	504.5	168.2	33.3	370.0	11	2,824.2	2,185.6	77.4	2,412.0
(Mutton snapper)	OTHER GEAR	3	490.7	114.2	23.3	448.0	3	2,413.7	1,873.8	77.6	1,510.0
	TRAPS	74	401.8	121.9	30.3	370.0	74	1,424.9	1,296.0	90.9	832.0
	TRAPS & HOOKS	7	429.9	137.0	31.9	382.0	7	2,045.3	3,059.9	149.6	936.0
	UNKNOWN	2	586.5	5.0	0.8	586.5	2	2,218.5	1,512.5	68.2	2,218.5
Lutjanus apodus	HOOK & LINE	29	348.7	67.0	19.2	364.0	29	944.7	524.2	55.5	1,009.0
(Schoolmaster)	OTHER GEAR	11	249.2	10.2	4.1	250.0	11	284.1	24.6	8.7	290.0
	TRAPS	180	282.9	47.9	16.9	280.0	180	474.5	310.7	65.5	425.0
	TRAPS & HOOKS	9	298.2	52.9	17.8	295.0	9	555.9	378.8	68.1	454.0
	UNKNOWN	3	268.3	70.1	26.1	265.0	3	378.3	253.2	66.9	336.0
Lutjanus buccanella	HOOK & LINE	63	261.4	47.7	18.3	258.0	63	370.4	234.6	63.3	300.0
(Blackfin snapper)	TRAPS	148	305.2	45.5	14.9	306.0	148	488.0	204.6	41.9	455.0
	TRAPS & HOOKS	54	287.2	48.1	16.7	278.0	54	445.1	233.0	52.4	386.0
Lutjanus campechanus	HOOK & LINE	1	270.0	.	.	270.0	1	330.0	.	.	330.0
(Red snapper)	TRAPS	1	380.0	.	.	380.0	1	910.0	.	.	910.0
Lutjanus cyanopterus	HOOK & LINE	4	260.0	10.8	4.2	257.5	4	243.8	12.5	5.1	250.0
(Cubera snapper)											
Lutjanus griseus	OTHER GEAR	4	237.5	27.1	11.4	232.0	4	249.5	87.9	35.2	242.5
(Gray snapper)	TRAPS	5	331.2	251.7	76.0	218.0	5	1,749.4	3,522.4	201.4	169.0
Lutjanus jocu	HOOK & LINE	18	441.1	149.0	33.8	413.0	18	2,034.8	1,896.4	93.2	1,144.0
(Dog snapper)	TRAPS	18	358.3	122.6	34.2	330.0	18	1,103.1	1,153.6	104.6	602.5
	TRAPS & HOOKS	2	450.0	254.6	56.6	450.0	2	2,200.0	2,545.6	115.7	2,200.0
Lutjanus mahogoni	HOOK & LINE	14	331.7	38.5	11.6	329.0	14	596.7	219.6	36.7	568.5
(Mahogany snapper)	TRAPS	36	242.1	34.1	14.1	237.5	36	233.4	100.6	43.1	198.0
	TRAPS & HOOKS	1	258.0	.	.	258.0	1	312.0	.	.	312.0
	HOOK & LINE	38	243.0	35.0	14.4	240.0	38	223.0	106.4	47.7	
Lutjanus synagris	OTHER GEAR	28	274.3	49.9	18.2	272.5	28	380.1	183.8	48.4	359.5
(Lane snapper)	TRAPS	415	225.2	43.4	19.3	218.0	415	197.5	145.6	73.7	167.0
	TRAPS & HOOKS	11	214.3	36.0	16.8	195.0	11	198.6	136.2	68.8	216.0
	UNKNOWN	44	219.7	26.3	12.0	215.0	44	196.7	125.3	63.7	163.0
Lutjanus vivanus	HOOK & LINE	287	286.8	87.2	30.4	265.0	287	507.7	481.3	94.8	320.0
(Silk snapper)	OTHER GEAR	6	532.5	67.4	12.7	537.5	6	2,220.0	806.3	36.3	2,047.5
	TRAPS	25	253.3	106.8	42.2	218.0	25	444.2	959.6	216.0	175.0
	TRAPS & HOOKS	64	379.4	76.8	20.2	363.0	64	1,025.0	719.9	70.2	850.0
Ocyurus chrysurus	HOOK & LINE	1,236	314.5	60.0	19.1	300.0	1,236	549.5	354.1	64.5	450.0
(Yellowtail snapper)	OTHER GEAR	9	254.1	37.3	14.7	255.0	9	265.6	117.2	44.1	241.0
	TRAPS	654	255.5	48.1	18.8	244.0	654	293.9	212.2	72.2	227.0
	TRAPS & HOOKS	138	322.9	52.1	16.1	315.0	138	571.4	262.9	46.0	500.0
	UNKNOWN	25	284.6	44.8	15.8	296.0	25	393.4	178.8	45.5	410.0
Rhomboplites aurorubens	HOOK & LINE	107	201.7	38.6	19.1	195.0	107	150.2	121.5	80.9	122.0
(Vermilion snapper)	TRAPS	60	204.9	17.6	8.6	204.5	60	149.1	37.7	25.3	147.0
	TRAPS & HOOKS	11	355.6	37.0	10.4	350.0	11	747.5	202.3	27.1	680.0
	UNKNOWN	4	232.0	21.4	9.2	232.5	4	223.8	55.1	24.6	221.5
HAEMULIDAE – Grunts											
Anisotremus surinamensis	TRAPS	2	335.0	35.4	10.6	335.0	2	775.0	247.5	31.9	775.0
(Black margate)											
Anisotremus virginicus	TRAPS	17	254.7	69.8	27.4	240.0	17	488.1	341.5	70.0	375.0
(Porkfish)	TRAPS & HOOKS	6	235.3	29.0	12.3	228.5	6	400.0	181.0	45.2	362.5

TABLE 6. Summary of fish length and weight by gear type for 1985 data (con't)

FAMILY – Family common name / Species name / (Species common name)	GEAR	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1985 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Haemulon album	HOOK & LINE	5	467.6	108.2	23.1	477.0	5	2,347.8	1,468.0	62.5	2,069.0
(Margate)	TRAPS	36	396.2	148.8	37.6	380.0	36	1,596.7	1,345.8	84.3	1,200.0
	TRAPS & HOOKS	1	535.0	.	.	535.0	1	3,300.0	.	.	3,300.0
	UNKNOWN	4	293.3	111.7	38.1	245.0	4	693.5	730.5	105.3	363.5
Haemulon aurolineatum	OTHER GEAR	6	233.8	14.2	6.1	243.0	6	215.0	35.8	16.7	226.0
(Tomtate)	TRAPS	31	225.0	24.0	10.7	225.0	31	219.1	67.7	30.9	201.0
	UNKNOWN	1	207.0	.	.	207.0	1	181.0	.	.	181.0
Haemulon bonariense	TRAPS	1	220.0	.	.	220.0	1	201.0	.	.	201.0
(Black grunt)											
Haemulon carbonarium	TRAPS	30	206.0	14.4	7.0	207.0	30	191.0	33.9	17.8	196.0
(Caesar grunt)	TRAPS & HOOKS	1	226.0	.	.	226.0	1	255.0	.	.	255.0
Haemulon flavolineatum	OTHER GEAR	1	179.0	.	.	179.0	1	125.0	.	.	125.0
(French grunt)	TRAPS	418	191.6	24.4	12.8	190.0	418	163.3	78.2	47.9	150.0
	TRAPS & HOOKS	31	189.9	8.6	4.5	190.0	31	129.8	26.9	20.8	125.0
	UNKNOWN	2	161.5	9.2	5.7	161.5	2	84.5	14.9	17.6	84.5
Haemulon macrostomum	HOOK & LINE	4	206.8	13.4	6.5	206.5	4	196.0	36.9	18.8	196.0
(Spanish grunt)	OTHER GEAR	7	217.3	17.8	8.2	215.0	7	234.4	55.1	23.5	221.0
	TRAPS	28	201.9	42.9	21.2	217.0	28	319.5	271.1	84.8	199.5
	TRAPS	28	231.8	69.3	29.9		28	244.9	131.8	53.8	
	UNKNOWN	1	204.0	.	.	204.0	1	190.0		.	190.0
Haemulon melanurum	TRAPS	14	230.8	15.3	6.6	230.0	14	243.6	61.8	25.4	220.5
(Cottonwick)	UNKNOWN	1	210.0	.	.	210.0	1	185.0	.	.	185.0
Haemulon parrai	UNKNOWN	7	252.1	11.1	4.4	210.0	7	317.1	55.5	17.5	309.0
(Sailor's choice)											325.0
Haemulon plumieri	HOOK & LINE	64	251.5	30.8	12.3	250.0	64	326.4	68.4	21.0	228.0
(White grunt)	OTHER GEAR	51	225.7	31.8	14.1	219.0	51	237.6	85.4	36.9	216.0
	TRAPS	2,260	215.4	28.4	13.2	213.0	2,260	227.5	163.7	72.0	200.0
	TRAPS & HOOKS	209	220.0	20.6	9.3	215.0	209	232.0	75.8	32.7	225.0
	UNKNOWN	136	221.1	22.6	10.2	220.5	136	230.9	71.9	31.2	123.5
Haemulon sciurus	HOOK & LINE	2	182.5	17.7	9.7	182.5	2	123.5	29.0	23.5	259.0
(Bluestriped grunt)	OTHER GEAR	26	236.0	23.3	9.8	233.0	26	267.3	71.2	26.6	265.0
	TRAPS	216	228.9	28.4	12.4	230.0	216	264.7	101.3	38.3	255.0
	TRAPS & HOOKS	39	230.4	14.3	6.2	230.0	39	262.7	48.6	18.5	196.0
	UNKNOWN	19	213.6	28.2	13.2	206.0	19	207.1	72.8	35.1	364.0
Haemulon sp.	HOOK & LINE	1	282.0	.	.	282.0	1	364.0	.	.	
(Unidentified grunt)											
SPARIDAE – Porgies											
Archosargus rhomboidalis	TRAPS	7	234.3	11.0	4.7	235.0	7	232.1	31.3	13.5	250.0
(Sea bream)											
Calamus bajonado	TRAPS	44	213.3	32.8	15.4	204.0	44	261.0	110.2	42.2	217.5
(Jolthead porgy)	UNKNOWN	70	211.7	25.7	12.2	201.0	70	259.0	100.8	38.9	219.5
Calamus penna	HOOK & LINE	4	235.5	34.4	14.6	228.0	4	381.3	172.9	45.4	337.5
(Sheepshead porgy)	OTHER GEAR	25	202.9	26.4	13.0	201.0	25	224.4	86.9	38.7	212.0
	TRAPS	545	203.9	30.4	14.9	200.0	545	209.4	115.2	55.0	194.0
	TRAPS & HOOKS	14	257.8	147.8	57.3	165.0	14	389.0	440.3	113.2	130.5
	UNKNOWN	39	199.2	31.8	16.0	192.0	39	208.4	94.4	45.3	178.0
MULLIDAE – Goatfishes											
Mulloidichthys martinicus	OTHER GEAR	1	209.0	.	.	209.0	1	151.0	.	.	151.0
(Yellow goatfish)	TRAPS	648	210.4	19.8	9.4	207.5	648	189.0	56.4	29.9	175.0
	TRAPS & HOOKS	4	238.8	33.0	13.8	242.5	4	266.8	88.8	33.3	267.5
	UNKNOWN	6	215.7	21.3	9.9	215.5	6	188.2	60.3	32.1	193.0
Pseudupeneus maculatus	TRAPS	1,303	199.2	19.1	9.6	199.0	1,303	139.6	61.2	43.8	142.0
(Spotted goatfish)	TRAPS & HOOKS	43	154.0	12.9	8.4	153.0	43	68.6	22.4	32.7	65.0
	UNKNOWN	47	207.7	16.5	7.9	207.0	47	172.5	38.6	22.4	169.0
EPHIPPIDAE – Spadefishes											
Chaetodipterus faber	TRAPS & HOOKS	1	295.0	.	.	295.0	1	975.0	.	.	975.0
(Atlantic spadefish)											
CHAETODONTIDAE – Butterflyfishes											
Chaetodon ocellatus	TRAPS	2	125.0	0.0	0.0	125.0	2	75.0	0.0	0.0	75.0
(Spotfin butterflyfish)											

TABLE 6. Summary of fish length and weight by gear type for 1985 data (con't)

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1985 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
POMACANTHIDAE – Angelfishes											
Holacanthus ciliaris	TRAPS	22	285.7	45.5	15.9	282.5	22	693.2	309.2	44.5	612.5
(Queen angelfish)	TRAPS & HOOKS	1	320.0		.	320.0	1	800.0		.	800.0
Holacanthus tricolor	TRAPS	35	207.7	13.2	6.4	205.0	35	291.8	61.0	20.9	275.0
(Rock beauty)	TRAPS & HOOKS	2	205.0	7.1	3.5	205.0	2	225.0	35.4	15.7	225.0
Pomacanthus arcuatus	TRAPS	86	308.3	68.3	22.2	310.5	86	1,083.9	547.4	51.5	910.0
(Gray angelfish)	TRAPS & HOOKS	13	317.9	39.7	12.5	310.0	13	1,142.3	463.1	40.5	1,000.0
Pomacanthus paru	TRAPS	28	286.4	71.8	25.1	282.5	28	895.4	603.9	67.5	800.0
(French angelfish)	TRAPS & HOOKS	2	275.5	71.4	25.9	275.5	2	713.5	514.1	72.1	713.5
LABRIDAE – Wrasses											
Bodianus rufus	TRAPS	23	259.2	27.7	10.7	260.0	23	323.0	95.3	29.5	325.0
(Spanish hogfish)	TRAPS & HOOKS	4	244.5	34.5	14.1	244.5	4	281.3	110.6	39.3	275.0
Halichoeres radiatus	HOOK & LINE	2	332.5	7.8	2.3	332.5	2	662.5	53.0	8.0	662.5
(Puddingwife)	TRAPS	8	273.4	37.8	13.8	274.0	8	376.0	180.2	47.9	337.5
Lachnolaimus maximus	HOOK & LINE	4	400.8	17.2	4.3	400.0	4	737.8	299.5	40.6	636.5
(Hogfish)	OTHER GEAR	12	448.3	118.5	26.4	487.5	12	1,966.2	1,112.7	56.6	2,118.0
	TRAPS	81	379.0	130.2	34.4	340.0	81	1,446.9	1,499.2	103.6	750.0
	TRAPS & HOOKS	2	590.0	28.3	4.8	590.0	2	4,110.0	763.7	18.6	4,110.0
	UNKNOWN	4	425.5	152.1	35.7	412.5	4	1,996.3	1,762.4	88.3	1,574.5
SCARIDAE – Parrotfishes											
Scarus guacamaia	OTHER GEAR	1	555.0		.	550.0	1	4,320.0		.	4,620.0
(Rainbow parrotfish)	TRAPS	2	645.0	49.5	7.7	645.0	2	5,350.0	1,237.4	23.1	5,350.0
Scarus spp. (Unidentified parrotfish)	TRAPS	1	240.0		.	240.0	1	250.0		.	250.0
Scarus taeniopterus	TRAPS	191	255.9	21.1	8.2	255.0	191	328.1	76.4	23.3	312.0
(Princess parrotfish)	TRAPS & HOOKS	5	249.6	14.6	5.8	246.0	5	262.4	44.9	17.1	250.0
Scarus vetula (Queen parrotfish)	TRAPS	11	333.6	37.5	11.2	330.0	11	800.4	216.4	27.0	750.0
Sparisoma aurofrenatum	TRAPS	241	217.5	14.4	6.6	218.0	241	221.0	57.1	25.8	200.0
(Redband parrotfish)	TRAPS & HOOKS	1	185.0		.	185.0	1	200.0			200.0
Sparisoma chrysopterum	TRAPS	1,490	263.0	22.3	8.5	264.0	1,490	367.0	90.9	24.8	369.0
(Redtail parrotfish)	TRAPS & HOOKS	465	264.6	18.6	7.0	265.0	465	381.8	89.0	23.3	375.0
Sparisoma spp.	HOOK & LINE	1	220.0		.	220.0	1	310.0		.	310.0
(Unidentified parrotfish)	TRAPS	172	250.5	47.7	19.0	241.0	172	404.0	218.0	54.0	369.0
	TRAPS & HOOKS	20	250.5	38.9	15.5	240.0	20	578.8	484.0	83.6	425.0
Sparisoma viride	HOOK & LINE	1	275.0		.	275.0	1	400.0		.	400.0
(Stoplight parrotfish)	TRAPS	1,487	284.9	32.9	11.5	285.0	1,487	519.3	187.0	36.0	500.0
	TRAPS & HOOKS	258	280.6	29.7	10.6	279.5	258	514.0	173.7	33.8	475.0
	UNKNOWN	1	235.0		.	235.0	1	225.0		.	225.0
ACANTHURIDAE – Surgeonfishes											
Acanthurus bahianus	TRAPS	394	191.0	16.0	8.4	190.0	394	188.6	50.7	26.9	186.5
(Ocean surgeon)	TRAPS & HOOKS	16	188.4	18.3	9.7	190.0	16	179.4	49.3	27.5	196.0
Acanthurus chirurgus	TRAPS	325	239.3	30.2	12.6	240.0	325	334.7	104.2	31.1	340.0
(Doctorfish)	TRAPS & HOOKS	41	238.2	28.2	11.8	245.0	41	333.8	93.9	28.1	340.0
Acanthurus coeruleus	TRAPS	2,213	186.3	20.1	10.8	182.0	2,213	209.9	65.6	31.3	200.0
(Blue tang)	TRAPS & HOOKS	260	196.2	22.0	11.2	190.0	260	242.3	84.5	34.9	225.0
Acanthurus spp.	TRAPS	101	194.7	9.1	4.7	195.0	101	196.1	29.9	15.2	200.0
(Unidentified Acanthurid)	TRAPS & HOOKS	91	189.0	10.6	5.6	188.0	91	157.7	32.2	20.4	150.0
BALISTIDAE – Leatherjackets											
Balistes vetula	HOOK & LINE	86	308.5	42.[illegible]	13.8	305.5	86	834.5	380.9	45.7	800.0
(Queen triggerfish)	OTHER GEAR	1	290.0			290.0	1	628.0			628.0
	TRAPS	1,509	291.3	53.9	18.5	290.0	1,509	684.6	366.8	53.6	600.0
	TRAPS & HOOKS	86	279.0	44.9	16.1	270.0	86	608.3	286.0	47.0	539.0
	UNKNOWN	5	300.6	52.2	17.4	310.0	5	791.0	372.9	47.1	768.0
Canthidermis sufflamen	HOOK & LINE	12	375.1	28.4	7.6	370.0	12	1,191.4	268.2	22.5	1,150.0
(Ocean triggerfish)	HOOK & LINE	1	260.0			260.0	1	525.0		.	525.0
	TRAPS	4	331.3	19.3	5.8	335.0	4	968.8	250.3	25.8	900.0

TABLE 8. Summary of fish length and weight by gear type for 1985 data (con't)

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1985 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1985 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
OSTRACIIDAE – Boxfishes											
Lactophrys bicaudalis	HOOK & LINE	8	486.1	94.0	19.3		8	1,392.0	1,294.7	93.0	
(Spotted trunkfish)	OTHER GEAR	1	240.0	.	.	240.0	6	793.3	146.1	18.4	
	OTHER GEAR	6	437.7	31.8	7.3	240.0	1	325.0	.	.	325.0
	TRAPS	87	184.1	40.4	21.9	177.0	87	200.3	152.7	76.2	166.0
	TRAPS & HOOKS	1	175.0	.	.	175.0	1	150.0	.	.	150.0
	UNKNOWN	3	180.7	28.9	16.0	166.0	3	171.3	62.1	36.2	137.0
Lactophrys polygonia	OTHER GEAR	1	275.0	.	.	275.0	1	411.0	.	.	411.0
(Honeycomb cowfish)	TRAPS	373	238.5	42.5	17.8	236.0	373	282.6	140.9	49.9	255.0
	TRAPS & HOOKS	19	247.9	37.9	15.3	242.0	19	297.6	121.2	40.7	255.0
	UNKNOWN	9	227.3	44.9	19.8	212.0	9	266.2	214.0	80.4	183.0
Lactophrys quadricornis	TRAPS	215	208.8	39.2	18.9	200.0	215	172.0	96.8	56.3	147.0
(Scrawled cowfish)	TRAPS & HOOKS	4	294.3	33.8	11.5	299.0	4	410.5	193.4	47.1	368.5
	UNKNOWN	9	213.9	31.3	14.6	220.0	9	171.4	63.5	37.0	164.0
Lactophrys trigonus	TRAPS	11	303.4	53.9	17.8	310.0	11	574.7	187.0	32.5	622.0
(Trunkfish)	UNKNOWN	8	265.5	81.4	30.7	224.0	8	425.4	379.5	89.2	193.5
Lactophrys triqueter	TRAPS	64	170.3	30.5	17.9	166.5	64	163.5	77.8	47.6	148.5
(Smooth trunkfish)	TRAPS & HOOKS	3	185.3	18.6	10.0	180.0	3	208.3	38.2	18.3	200.0
	UNKNOWN	1	135.0		.	135.0	1	91.0	.	.	91.0
MISCELLANEOUS – Multiple species											
Uncategorized fish	HOOK & LINE	1	730.0		.		1	9,999.0	.	.	
(mixed fish)	HOOK & LINE	1	999.0		.		1	7,450.0	.	.	
	TRAPS	222	197.9	72.3	36.5		222	260.2	809.8	311.2	
	TRAPS & HOOKS	3	336.7	10.4	3.1		3	933.3	152.8	16.4	
	TOTAL =	26,317					26,317				

TABLE 7. Summary of fish length and weight by gear type for 1990 data

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
HOLOCENTRIDAE – Squirrelfishes											
Holocentrus ascensionis	BOTTOM LINE	4	220.8	18.9	8.6	220.0	4	207.5	64.0	30.8	225.0
(Squirrelfish)	FISH POT	8	208.4	19.5	9.4	205.0	8	179.3	39.3	22.0	170.0
	GILL NET	3	220.0	15.0	6.8	220.0	3	201.7	40.4	20.0	225.0
Holocentrus rufus	FISH POT	1	219.0	.		219.0	1	165.0	.		165.0
(Longspine squirrelfish)											
Holocentrus spp.	FISH POT	9	171.2	21.8	12.7	170.0	9	125.0	44.2	35.4	122.0
(Unidentified squirrelfish)											
SERRANIDAE – Sea basses											
Epinephelus adscensionis	FISH POT	1	678.0	.		678.0	1	5,102.0	.		5,102.0
(Rock hind)	LONGLINE	1	380.0	.		380.0	1	810.0	.		810.0
	OTHER	13	364.2	63.5	17.4	375.0	13	703.1	370.7	52.7	695.0
	SCUBA DIVING	32	228.5	160.6	70.3	190.0	32	730.5	411.8	56.4	597.5
	TRAMMEL NET	1	287.0	.		287.0	1	370.0	.		370.0
Epinephelus afer	GILL NET	1	280.0	.		280.0	1	370.0	.		370.0
(Mutton hamlet)											
Epinephelus cruentatus	BOTTOM LINE	188	236.4	30.9	13.0	240.0	188	249.3	107.6	43.2	226.0
(Graysby)	FISH POT	37	245.5	28.4	11.6	246.0	37	242.3	82.9	34.2	235.0
	GILL NET	15	223.9	25.3	11.3	230.0	15	197.1	41.2	20.9	210.0
	LONGLINE	3	201.7	23.1	11.5	215.0	1	150.0	.		150.0
	OTHER	1	240.0	.		240.0	1	185.0	.		185.0
	SCUBA DIVING	2	244.5	0.7	0.3	244.5	2	392.5	258.1	65.8	392.5
	TRAMMEL NET	1	267.0	.		267.0	1	355.0	.		355.0
Epinephelus fulvus	BOTTOM LINE	108	240.3	32.5	13.5	235.0	100	251.1	117.4	46.8	222.5
(Coney)	FISH POT	86	226.7	32.9	14.5	230.0	86	194.9	62.6	32.1	185.0
	GILL NET	41	219.2	20.7	9.5	220.0	41	176.6	70.2	39.8	170.0
	LONGLINE	6	236.7	7.1	3.0	235.0	5	224.0	18.5	8.3	230.0
	OTHER	3	220.7	20.0	9.1	222.0	3	144.7	101.7	70.3	106.0
	SCUBA DIVING	6	250.0	33.7	13.5	264.0	6	230.8	66.7	28.9	265.0
	TRAMMEL NET	10	227.1	34.4	15.2	225.5	10	190.9	90.3	47.3	172.5
Epinephelus guttatus	BOTTOM LINE	423	294.2	63.8	21.7	286.0	412	438.8	291.2	66.4	332.5
(Red hind)	FISH POT	142	272.6	51.2	18.8	265.0	140	282.4	147.1	52.1	235.0
	GILL NET	23	238.0	57.4	24.1	242.0	23	250.6	83.7	33.4	250.0
	LONGLINE	13	251.4	22.7	9.0	250.0	12	237.7	80.8	34.0	222.5
	OTHER	3	251.7	16.1	6.4	245.0	3	173.3	16.1	9.3	180.0
	SCUBA DIVING	157	370.5	59.7	16.1	370.5	157	742.5	348.7	47.0	690.0
	TRAMMEL NET	16	282.7	24.5	8.7	370.0	16	290.9	100.2	34.4	292.5
Epinephelus itajara	BOTTOM LINE	5	437.6	200.5	45.8	283.5	5	1,970.0	3,464.1	175.8	460.0
(Jewfish)	OTHER	2	365.0	487.9	133.7	346.0	2	14,063.5	12,184.2	86.6	14,063.5
	SCUBA DIVING	2	399.5	57.3	14.3	399.5	2	25,197.0	18,940.6	75.2	25,197.0
Epinephelus morio	BOTTOM LINE	1	256.0	.		256.0	1	225.0	.		225.0
(Red grouper)	FISH POT	1	465.0	.		465.0	0	.	.		
Epinephelus mystacinus	BOTTOM LINE	3	212.0	81.5	38.5	213.0	3	8,533.0	14,215.3	166.6	425.0
(Misty grouper)	FISH POT	1	433.0	.		433.0	1	1,365.0	.		1,365.0
	GILL NET	4	322.3	70.3	21.8	320.5	4	3,541.8	5,586.0	157.7	867.5
Epinephelus striatus	FISH POT	4	332.5	63.4	19.1	348.0	4	526.3	278.6	52.9	535.0
(Nassau grouper)	GILL NET	1	352.0	.		352.0	1	630.0	.		630.0
	SCUBA DIVING	31	437.5	69.6	15.9	445.0	30	1,144.8	516.6	45.1	1,162.5
Mycteroperca bonaci	SCUBA DIVING	37	560.9	158.4	28.3	550.0	36	3,383.1	2,927.1	86.5	
(Black grouper)											
Mycteroperca interstitialis	SCUBA DIVING	1	393.0	.		393.0	1	790.0	.		790.0
(Yellowmouth grouper)											
Mycteroperca tigris	FISH POT	1	280.0	.		280.0	1	230.0	.		230.0
(Tiger grouper)											
Mycteroperca venenosa	BOTTOM LINE	7	619.4	107.8	17.4	640.0	7	4,940.9	2,595.9	52.5	4,536.0
(Yellowfin grouper)	SCUBA DIVING	1	400.0	.		400.0	1	790.0	.		790.0
CARANGIDAE – Jacks											
Caranx lugubris	BOTTOM LINE	34	446.4	57.5	12.9	431.5	0	.	.		
(Black jack)											

TABLE 7. Summary of fish length and weight by gear type for 1990 data (con't)

FAMILY – Family common name *Species name* (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Caranx bartholomaei	BEACH SEINE	61	475.7	96.0	20.2	486.0	0	.	.		
(Yellow jack)	BOTTOM LINE	9	452.7	256.6	56.7	340.0	9	3,711.8	5,539.0	149.2	605.0
	FISH POT	2	277.5	96.9	34.9	277.5	1	680.0	.		680.0
	GILL NET	18	275.9	30.2	11.0	282.0	18	400.6	134.9	33.7	397.5
	LONGLINE	9	328.8	51.3	15.6	330.0	9	578.3	237.0	41.0	595.0
	SCUBA DIVING	1	412.0	.		412.0	1	1,340.0	.		1,340.0
	TRAMMEL NET	1	351.0	.		351.0	1	710.0	.		710.0
Caranx crysos	BEACH SEINE	1	257.0	.		257.0	0	.	.		
(Blue runner)	BOTTOM LINE	71	381.1	58.2	15.3	380.0	71	1,078.9	416.4	38.6	1,005.0
	FISH POT	1	322.0	.		322.0	1	500.0	.		500.0
	GILL NET	28	300.7	44.5	14.8	308.5	28	478.0	232.4	48.6	427.5
	OTHER	2	445.5	105.4	23.7	445.5	2	1,767.5	1,028.8	58.2	1,767.5
	GILL NET	16	286.5	146.6	51.2	253.5	16	945.4	1,907.0	201.7	
Caranx hippos	LONGLINE	1	585.0	.		585.0	1	3,515.0	.		3,515.0
(Crevalle jack)	OTHER	6	86.8	19.7	22.7	78.5	6	609.2	383.3	62.9	
Caranx latus	BOTTOM LINE	30	418.7	120.5	28.8	369.0	21	1,484.2	971.5	65.5	1,111.0
(Horse-eye jack)	GILL NET	66	169.8	26.0	15.3	170.5	63	114.5	53.2	46.4	106.0
	LONGLINE	28	316.1	65.9	20.9	319.0	27	600.7	292.0	48.6	550.0
	OTHER	21	383.9	110.0	28.7	320.0	0	.	.		
Caranx ruber	BEACH SEINE	48	198.1	81.4	41.1	150.0	28	51.7	21.7	42.1	48.0
(Bar jack)	BOTTOM LINE	46	324.8	32.3	9.9	316.0	44	547.2	186.5	34.1	505.0
	FISH POT	45	245.8	45.9	18.7	243.0	48	271.4	157.8	58.1	230.0
	GILL NET	106	279.5	37.3	13.4	277.5	79	344.7	131.0	38.0	320.0
	TRAMMEL NET	30	291.6	43.6	15.0	283.0	30	408.0	209.8	51.4	340.0
LUTJANIDAE – Snappers											
Etelis oculatus	BOTTOM LINE	352	400.5	138.4	34.6	360.0	115	750.2	900.6	120.0	390.0
(Queen snapper)											
Lutjanus analis	BEACH SEINE	76	259.5	64.6	24.9	257.5	32	280.5	340.5	121.4	79.0
(Mutton snapper)	BOTTOM LINE	57	447.4	146.3	32.7	445.0	50	1,779.4	1,643.6	92.4	1,218.5
	FISH POT	41	299.2	87.7	29.3	285.0	39	460.6	556.2	120.8	340.0
	GILL NET	125	241.5	115.4	47.8	207.0	125	889.6	4,938.6	555.2	150.0
	LONGLINE	18	366.0	108.9	29.8	336.0	14	953.5	1,229.8	129.0	560.0
	OTHER	4	583.0	157.3	27.0	621.0	3	3,237.3	2,249.4	69.5	4,536.0
	SCUBA DIVING	5	481.8	150.6	31.3	405.0	5	2,186.2	2,006.5	91.8	965.0
	TRAMMEL NET	1	252.0	.		252.0	1	240.0	.		240.0
Lutjanus apodus	BOTTOM LINE	44	376.5	87.1	23.2	392.0	43	1,251.1	1,076.2	86.0	1,185.0
(Schoolmaster)	FISH POT	30	253.2	70.6	27.9	244.0	29	270.0	118.0	43.7	245.0
	GILL NET	13	244.1	26.2	10.7	249.0	13	301.9	105.4	34.9	290.0
	OTHER	6	249.8	19.1	7.6	244.5	6	259.2	70.9	27.4	250.0
	SCUBA DIVING	21	317.5	70.6	22.2	300.0	21	590.2	387.2	65.6	455.0
	TRAMMEL NET	82	281.1	43.8	15.6	270.0	82	429.5	248.4	57.8	357.5
Lutjanus buccanella	BOTTOM LINE	56	303.5	86.6	28.5	307.0	45	446.2	310.3	69.5	345.0
(Blackfin snapper)	FISH POT	90	236.9	39.1	16.5	232.0	49	261.6	257.8	98.6	182.0
	GILL NET	2	215.5	2.1	1.0	215.5	2	162.5	10.6	6.5	162.5
Lutjanus cyanopterus	BOTTOM LINE	6	622.2	162.1	26.1	624.5	4	5,242.0	4,387.4	83.7	4,309.5
(Cubera snapper)	FISH POT	1	287.0	.		287.0	1	300.0	.		300.0
	OTHER	2	710.0	113.1	15.9	710.0	0	.	.		
Lutjanus griseus	BOTTOM LINE	4	415.3	114.7	27.6	400.0	2	2,589.5	1,470.1	56.8	2,589.5
(Gray snapper)	FISH POT	1	270.0			270.0	1	270.0	.		270.0
	GILL NET	3	280.0	75.5	27.0	290.0	3	443.3	183.4	41.4	380.0
	OTHER	1	280.0	.		280.0	1	280.0	.		280.0
	SCUBA DIVING	1	320.0	.		320.0	1	330.0	.		330.0
Lutjanus jocu	BOTTOM LINE	2	255.0	25.5	10.0	255.0	2	265.0	56.6	21.4	265.0
(Dog snapper)	FISH POT	1	483.0	.		483.0	1	1,630.0	.		1,630.0
	GILL NET	10	283.9	43.4	15.3	271.0	10	357.0	159.0	44.6	290.0
	OTHER	3	450.7	79.0	17.5	450.0	3	1,345.0	522.2	38.8	1,445.0
	SCUBA DIVING	22	430.0	95.2	22.2	417.5	22	1,401.0	1,166.2	83.3	1,120.0
Lutjanus mahogoni	BOTTOM LINE	2	262.5	74.3	28.3	262.5	2	280.0	212.1	75.8	280.0
(Mahogany snapper)	GILL NET	5	320.4	21.5	6.7	314.0	0	.	.		
	LONGLINE	3	310.0	8.0	2.6	310.0	0	.	.		
Lutjanus spp.	FISH POT	1	210.0	.		210.0	1	150.0	.		150.0
(Unidentified snapper)	OTHER	2	447.5	24.8	5.5	447.5	0	.	.		

TABLE 7. Summary of fish length and weight by gear type for 1990 data (con't)

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Lutjanus synagris	BEACH SEINE	79	214.7	38.4	17.9	208.0	62	178.3	106.1	59.5	147.5
(Lane snapper)	BOTTOM LINE	381	240.6	39.3	16.4	236.0	377	234.3	104.3	44.5	212.0
	FISH POT	509	217.5	36.8	16.9	214.0	506	175.1	96.2	55.0	156.0
	GILL NET	132	226.3	46.7	20.6	226.0	132	204.0	118.8	56.8	177.5
	LONGLINE	1,010	239.4	34.8	14.5	236.0	996	214.2	93.5	43.7	180.0
	OTHER	48	237.4	28.1	11.8	230.5	48	238.2	131.3	55.1	202.5
	TRAMMEL NET	13	253.6	22.9	9.0	257.0	13	302.3	112.9	37.4	310.0
Lutjanus vivanus	BOTTOM LINE	319	282.3	61.2	21.7	273.0	310	425.4	786.4	184.8	320.0
(Silk snapper)	FISH POT	294	259.6	52.3	20.2	251.5	225	288.9	218.3	75.6	230.0
	GILL NET	33	237.9	29.8	12.5	237.0	33	206.6	83.7	40.5	195.0
	LONGLINE	2	173.5	5.0	2.9	173.5	2	91.0	15.6	17.1	91.0
Ocyurus chrysurus	BEACH SEINE	429	240.7	44.3	18.4	235.0	110	227.7	136.1	59.8	210.0
(Yellowtail snapper)	BOTTOM LINE	1,196	282.7	53.1	18.8	280.0	1,048	413.3	1,628.7	394.1	310.0
	FISH POT	207	231.8	38.5	16.6	223.0	200	200.0	117.7	58.9	170.0
	GILL NET	90	237.4	37.5	15.8	227.5	90	231.0	116.3	50.4	202.5
	LONGLINE	120	283.1	48.9	17.3	276.5	84	297.0	146.8	49.4	255.0
	OTHER	56	279.6	43.2	15.5	281.5	56	351.7	145.4	41.3	332.5
	TRAMMEL NET	21	279.1	40.0	14.3	288.0	21	309.8	76.4	24.7	310.0
Rhomboplites aurorubens	BOTTOM LINE	527	214.9	39.9	18.6	212.0	481	186.8	112.3	59.5	170.0
(Vermilion snapper)	FISH POT	231	199.8	24.4	12.2	198.0	204	126.9	49.4	38.9	118.0
	GILL NET	75	205.6	26.5	13.9	200.0	75	140.1	58.5	41.8	130.0
	LONGLINE	3	195.3	17.2	8.8	192.0	3	119.3	29.1	24.4	116.0
HAEMULIDAE – Grunts											
Anisotremus surinamensis	BOTTOM LINE	4	268.0	51.0	19.0	256.0	4	536.3	373.9	69.7	387.5
(Black margate)	FISH POT	10	264.9	26.4	10.0	255.0	10	453.4	263.5	58.1	335.0
	GILL NET	7	263.4	55.1	20.9	244.0	7	329.9	98.6	29.9	265.0
Anisotremus virginicus	FISH POT	61	223.5	52.7	23.6	218.0	61	267.0	96.2	36.0	220.0
(Porkfish)	GILL NET	9	206.0	25.7	12.5	204.0	9	234.4	91.4	39.0	205.0
	OTHER	1	198.0	.		198.0	1	205.0	.		287.5
	TRAMMEL NET	26	221.6	33.2	15.0	221.0	26	289.9	92.9	32.1	285.0
Conodon nobilis	GILL NET	53	263.2	32.3	12.3	267.0	53	287.6	63.5	22.1	
(Barred grunt)											
Haemulon album	BOTTOM LINE	1	270.0	.		270.0	1	370.0	.		370.0
(Margate)	FISH POT	6	303.8	87.5	28.8	295.0	6	642.5	659.2	102.6	415.0
	GILL NET	1	220.0	.		220.0	1	205.0	.		205.0
Haemulon aurolineatum	BOTTOM LINE	9	174.7	30.4	17.4	166.0	9	101.9	44.5	43.6	76.0
(Tomtate)	FISH POT	21	152.3	9.7	6.4	153.0	21	68.7	18.9	27.6	64.0
Haemulon bonariense	FISH POT	1	193.0	.		193.0	1	150.0	.		150.0
(Black grunt)	TRAMMEL NET	2	287.0	43.8	15.3	287.0	2	530.0	141.4	26.7	530.0
Haemulon carbonarium	BOTTOM LINE	4	211.8	21.2	10.0	222.0	4	199.0	37.4	18.8	210.5
(Caesar grunt)	GILL NET	8	244.1	39.8	16.3	231.0	8	266.3	107.4	40.4	222.5
	TRAMMEL NET	6	235.8	44.2	18.7	215.5	6	271.7	126.0	46.4	222.5
Haemulon chrysargyreum	FISH POT	3	159.0	5.2	3.3	162.0	3	67.3	8.3	12.4	70.0
(Smallmouth grunt)											
Haemulon flavolineatum	BOTTOM LINE	3	170.7	14.0	8.2	175.0	3	95.0	39.5	41.6	94.0
(French grunt)	FISH POT	35	178.5	23.4	13.1	180.0	35	118.6	38.3	32.3	124.0
	TRAMMEL NET	8	193.6	29.6	15.3	184.5	8	173.5	80.8	46.6	147.5
Haemulon macrostomum	BOTTOM LINE	19	222.1	32.4	14.6	217.0	19	253.8	126.1	49.7	220.0
(Spanish grunt)	FISH POT	19	204.1	29.8	14.6	200.0	18	196.8	107.9	54.8	165.0
	GILL NET	9	223.3	22.9	10.3	215.0	9	248.3	93.2	37.5	220.0
	LONGLINE	2	302.5	38.9	12.9	302.5	2	550.0	332.3	60.4	550.0
Haemulon parrai	FISH POT	6	239.3	25.0	10.5	241.0	6	226.7	60.8	26.8	212.5
(Sailor's choice)	GILL NET	59	234.9	29.4	12.5	240.0	59	237.2	71.6	30.2	231.0
Haemulon plumieri	BEACH SEINE	29	173.2	18.3	10.6	172.0	0	.	.		
(White grunt)	BOTTOM LINE	701	232.9	29.0	12.5	230.0	700	264.0	90.5	34.3	250.0
	FISH POT	1,100	202.5	37.4	18.5	200.0	1,077	169.9	76.3	44.9	155.0
	GILL NET	329	222.2	25.5	11.5	222.0	329	226.6	85.5	37.7	215.0
	LONGLINE	58	239.6	26.9	11.2	236.0	57	280.1	92.9	33.2	260.0
	OTHER	19	199.6	25.6	12.9	195.0	19	154.5	61.4	39.7	135.0
	TRAMMEL NET	412	231.5	23.9	10.3	232.5	412	246.8	76.4	31.0	242.5

TABLE 7. Summary of fish length and weight by gear type for 1990 data (con't)

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Haemulon sciurus	BOTTOM LINE	29	232.7	37.5	16.1	233.0	29	270.9	120.7	44.6	270.0
(Bluestriped grunt)	FISH POT	115	202.7	29.0	14.3	195.0	98	163.8	79.6	48.6	135.5
	GILL NET	131	230.0	28.3	12.3	222.0	130	257.9	179.4	69.6	230.0
	OTHER	1	256.0	.		256.0	1	290.0	.		290.0
	TRAMMEL NET	80	229.1	31.8	13.9	230.0	79	238.1	91.6	38.5	210.0
Haemulon sp. (Unidentified grunt)	FISH POT	1	232.0	.		232.0	1	230.0	.		230.0
Pomadasys corcro (Burro grunt)	GILL NET	1	240.0	.		240.0	1	170.0	.		170.0
SPARIDAE – Porgies											
Archosargus rhomboidalis	BEACH SEINE	2	182.5	10.6	5.8	182.5	0	.	.		0.0
(Sea bream)	FISH POT	4	192.3	18.7	9.7	184.5	4	148.3	44.6	30.1	128.0
	GILL NET	2	171.0	1.4	0.8	171.0	2	115.0	7.1	6.2	115.0
Calamus bajonado	BEACH SEINE	1	400.0	.		400.0	0	.	.		
(Jolthead porgy)	BOTTOM LINE	8	222.5	44.3	19.9	204.5	8	289.8	251.1	86.7	200.0
	FISH POT	261	185.4	28.6	15.4	178.0	252	157.7	78.9	50.0	130.0
	GILL NET	190	197.4	27.3	13.9	192.0	189	205.9	93.4	45.4	180.0
	OTHER	4	162.5	7.6	4.7	161.0	4	40.5	14.9	36.8	41.0
	SCUBA DIVING	3	297.3	50.7	17.0	277.0	3	573.3	227.8	39.7	495.0
	TRAMMEL NET	51	208.0	52.6	25.3	206.0	48	234.9	126.5	53.9	210.0
Calamus penna	BEACH SEINE	5	181.8	32.5	17.9	170.0	0	.	.		
(Sheepshead porgy)	BOTTOM LINE	3	210.0	26.5	12.6	200.0	3	221.7	82.2	37.1	190.0
	FISH POT	59	173.9	20.0	11.5	170.0	59	130.2	49.3	37.9	118.0
	GILL NET	22	194.3	18.2	9.4	189.5	22	184.3	50.1	27.2	165.0
	GILL NET	2	187.0	11.3	6.1	187.0	2	157.5	10.6	6.7	157.5
	LONGLINE	6	239.5	54.8	22.9	253.5	6	388.3	144.3	37.2	435.0
	OTHER	5	236.2	41.5	17.6	245.0	5	322.2	151.1	46.9	345.0
	TRAMMEL NET	13	199.7	14.2	7.1	196.0	13	208.8	55.1	26.4	215.0
MULLIDAE – Goatfishes											
Mulloidichthys martinicus	FISH POT	96	185.0	29.3	15.9	184.0	95	126.5	67.6	53.4	106.0
(Yellow goatfish)	GILL NET	1	244.0	.		244.0	1	275.0	.		275.0
	OTHER	4	201.8	24.1	12.0	203.0	4	136.0	44.0	32.4	133.0
	TRAMMEL NET	8	212.8	18.1	8.5	218.5	8	172.0	52.8	30.7	192.5
Pseudupeneus maculatus	FISH POT	449	179.9	29.6	16.5	178.0	447	109.8	54.7	49.8	104.0
(Spotted goatfish)	OTHER	18	179.6	12.3	6.8	178.0	18	100.7	19.5	19.3	101.0
	TRAMMEL NET	3	188.3	11.1	5.9	187.0	3	137.0	24.4	17.8	126.0
EPHIPPIDAE – Spadefishes											
Chaetodipterus faber (Atlantic spadefish)	TRAMMEL NET	1	271.0	.		271.0	1	690.0	.		690.0
POMACANTHIDAE – Angelfishes											
Pomacanthus arcuatus (Gray angelfish)	TRAMMEL NET	1	305.0	.		305.0	1	1,370.0	.		1,370.0
LABRIDAE – Wrasses											
Bodianus rufus	FISH POT	1	296.0	.		296.0	1	330.0	.		330.0
(Spanish hogfish)	GILL NET	1	268.0	.		268.0	1	320.0	.		320.0
	OTHER	2	298.0	2.8	1.0	298.0	2	387.5	53.0	13.7	387.5
	SCUBA DIVING	2	277.5	10.6	3.8	277.5	2	322.5	38.9	12.1	322.5
	TRAMMEL NET	2	283.5	26.2	9.2	283.5	2	397.5	109.6	27.6	397.5
Halichoeres radiatus (Puddingwife)	TRAMMEL NET	1	283.0	.		283.0	1	300.0	.		300.0
Lachnolaimus maximus	BOTTOM LINE	6	495.7	98.0	19.8	502.5	6	2,412.2	1,677.0	69.5	2,349.5
(Hogfish)	FISH POT	28	284.8	69.0	24.2	256.0	26	528.3	504.1	95.4	342.5
	GILL NET	3	262.3	32.0	12.2	263.0	3	388.3	193.7	49.9	345.0
	OTHER	5	357.4	107.3	30.0	372.0	5	914.0	597.9	65.4	970.0
	SCUBA DIVING	156	409.5	102.5	25.0	400.0	154	1,311.6	1,263.6	96.3	1,110.0
	TRAMMEL NET	6	295.2	82.9	28.1	269.5	6	585.0	463.9	79.3	415.0

TABLE 7. Summary of fish length and weight by gear type for 1990 data (con't)

FAMILY – Family common name / *Species name* / (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
SCARIDAE – Parrotfishes											
Scarus coelestinus (Midnight parrotfish)	SCUBA DIVING	2	610.0	77.8	12.8	610.0	2	3,616.5	2,583.1	71.4	3,616.5
Scarus coeruleus (Blue parrotfish)	GILL NET	24	197.8	13.7	6.9	195.0	24	204.0	41.0	20.1	190.0
Scarus guacamaia (Rainbow parrotfish)	OTHER	2	495.5	54.5	11.0	495.5	2	1,660.0	91.9	5.5	1,660.0
	SCUBA DIVING	4	621.3	99.7	16.1	647.5	3	3,418.7	1,566.7	45.8	4,199.0
Scarus spp. (Unidentified parrotfish)	FISH POT	2	270.0	28.3	10.5	270.0	2	367.5	201.5	54.8	367.5
Scarus taeniopterus (Princess parrotfish)	FISH POT	51	245.2	12.2	5.0	244.0	51	268.4	42.9	16.0	255.0
	GILL NET	1	250.0	.		250.0	1	345.0	.		345.0
	OTHER	1	232.0	.		232.0	1	170.0	.		170.0
	SCUBA DIVING	1	400.0	.		400.0	1	1,025.0	.		1,025.0
	TRAMMEL NET	10	276.4	33.2	12.0	264.0	10	339.0	136.6	40.3	310.0
Scarus vetula (Queen parrotfish)	FISH POT	5	300.2	9.7	3.2	300.0	5	475.0	62.9	13.2	490.0
	GILL NET	37	287.7	54.0	18.8	297.0	37	509.5	169.3	33.2	500.0
	TRAMMEL NET	42	305.9	31.4	10.3	306.5	42	480.6	213.9	44.5	472.5
Sparisoma aurofrenatum (Redband parrotfish)	FISH POT	12	232.8	35.7	15.3	218.5	12	231.8	111.8	48.2	172.5
	GILL NET	24	229.6	11.4	5.0	232.0	24	200.2	24.5	12.2	197.5
	TRAMMEL NET	16	241.9	34.1	14.1	225.5	16	292.5	115.8	39.6	245.0
Sparisoma chrysopterum (Redtail parrotfish)	BOTTOM LINE	11	205.5	22.3	10.9	198.0	11	151.4	28.4	18.8	155.0
	FISH POT	323	245.8	30.9	12.6	245.0	312	279.3	105.6	37.8	270.0
	GILL NET	132	265.6	26.2	9.9	266.0	132	408.5	99.7	24.4	400.0
	OTHER	5	262.4	24.3	9.3	270.0	5	321.0	82.3	25.6	305.0
	TRAMMEL NET	256	275.5	25.9	9.4	274.0	256	379.4	87.2	23.0	375.0
Sparisoma rubripinne (Yellowtail parrotfish)	BOTTOM LINE	13	254.9	27.6	10.8	255.0	13	312.0	125.4	40.2	275.0
	TRAMMEL NET	1	315.0			315.0	1	245.0	.		245.0
Sparisoma spp. (Unidentified parrotfish)	BEACH SEINE	22	175.5	30.6	17.4	170.0	0	.	.		
	BOTTOM LINE	78	245.6	45.1	18.4	248.0	78	392.6	161.4	41.1	355.0
	FISH POT	62	221.6	28.2	12.7	226.0	62	273.3	104.7	38.3	267.5
	GILL NET	123	204.6	29.3	14.3	192.0	122	238.3	98.8	41.4	210.0
	LONGLINE	11	249.6	18.3	7.3	245.0	9	378.3	74.2	19.6	370.0
	OTHER	2	206.5	33.2	16.1	206.5	2	240.0	99.0	41.3	240.0
Sparisoma viride (Stoplight parrotfish)	FISH POT	130	255.8	32.6	12.7	250.0	130	330.7	139.5	42.2	292.5
	GILL NET	154	260.2	28.4	10.9	255.0	154	440.7	169.1	38.4	430.0
	TRAMMEL NET	495	287.5	32.3	11.2	288.0	495	467.5	162.8	34.8	450.0
ACANTHURIDAE – Surgeonfishes											
Acanthurus bahianus (Ocean surgeon)	FISH POT	4	198.3	26.3	13.3	195.0	4	200.0	37.6	18.8	200.0
BALISTIDAE – Leatherjackets											
Balistes spp. (Unidentified triggerfish)	FISH POT	1	240.0	.		240.0	1	425.0	.		425.0
Balistes vetula (Queen triggerfish)	BOTTOM LINE	3	319.0	42.5	13.3	342.0	3	786.7	406.3	51.7	945.0
	FISH POT	78	279.1	52.7	18.9	278.5	77	577.1	316.2	54.8	520.0
	OTHER	17	261.7	38.7	14.8	255.0	17	460.6	219.5	47.7	425.0
	TRAMMEL NET	28	241.8	23.0	9.5	243.5	28	357.5	100.5	28.1	370.0
OSTRACIIDAE – Boxfishes											
Lactophrys bicaudalis (Spotted trunkfish)	FISH POT	15	186.3	25.8	13.9	190.0	15	168.3	64.1	38.1	170.0
	LONGLINE	1	320.0	.		320.0	1	815.0	.		815.0
	TRAMMEL NET	3	390.0	164.6	42.2	480.0	3	316.7	126.5	40.0	264.0
Lactophrys polygonia (Honeycomb cowfish)	FISH POT	99	218.1	32.9	15.1	215.0	99	206.2	89.4	43.4	180.0
	GILL NET	11	253.1	62.5	24.7	253.0	11	422.1	351.0	83.2	250.0
	OTHER	8	220.9	32.1	14.5	221.0	8	149.5	81.8	54.7	140.0
	SCUBA DIVING	1	355.0	.		355.0	1	870.0	.		870.0
	TRAMMEL NET	3	217.3	8.5	3.9	214.0	3	230.0	20.0	8.7	230.0

TABLE 7. Summary of fish length and weight by gear type for 1990 data (con't)

FAMILY -- Family common name *Species name* (Species common name)	GEAR	1990 (LENGTH IN MM) N	MEAN	STD	CV	MEDIAN	1990 (WEIGHT IN GRAMS) N	MEAN	STD	CV	MEDIAN
Lactophrys quadricornis	BOTTOM LINE	1	380.0	.		380.0	1	1,036.0	.		1,036.0
(Scrawled cowfish)	FISH POT	38	204.1	35.8	17.8	205.5	38	156.0	65.9	42.2	140.0
	OTHER	3	280.3	49.3	17.6	270.0	3	341.7	140.9	58.3	195.0
	TRAMMEL NET	6	256.3	28.4	11.1	266.0	6	292.5	97.5	33.3	295.0
Lactophrys trigonus	BEACH SEINE	2	347.5	17.7	5.1	347.5	2	895.0	144.3	16.1	895.0
(Trunkfish)	BOTTOM LINE	3	360.3	21.5	6.0	360.0	3	836.7	170.1	20.3	830.0
	FISH POT	6	189.2	62.2	32.9	170.0	6	186.8	187.1	99.9	130.5
	LONGLINE	7	325.1	49.7	15.3	335.0	7	812.1	133.1	16.4	795.0
	TRAMMEL NET	6	230.7	93.7	40.6	200.0	6	363.3	366.9	101.0	225.0
Lactophrys triqueter	FISH POT	21	165.7	18.8	11.4	170.0	21	157.1	37.0	23.5	170.0
(Smooth trunkfish)	GILL NET	4	378.3	70.4	18.6	365.0	4	870.0	529.9	60.9	710.0

TOTAL = 18,258   14,701

Figure 1. Trends in total reef fish landings (A), fish trap use (B), and catch-per-unit-effort (C).

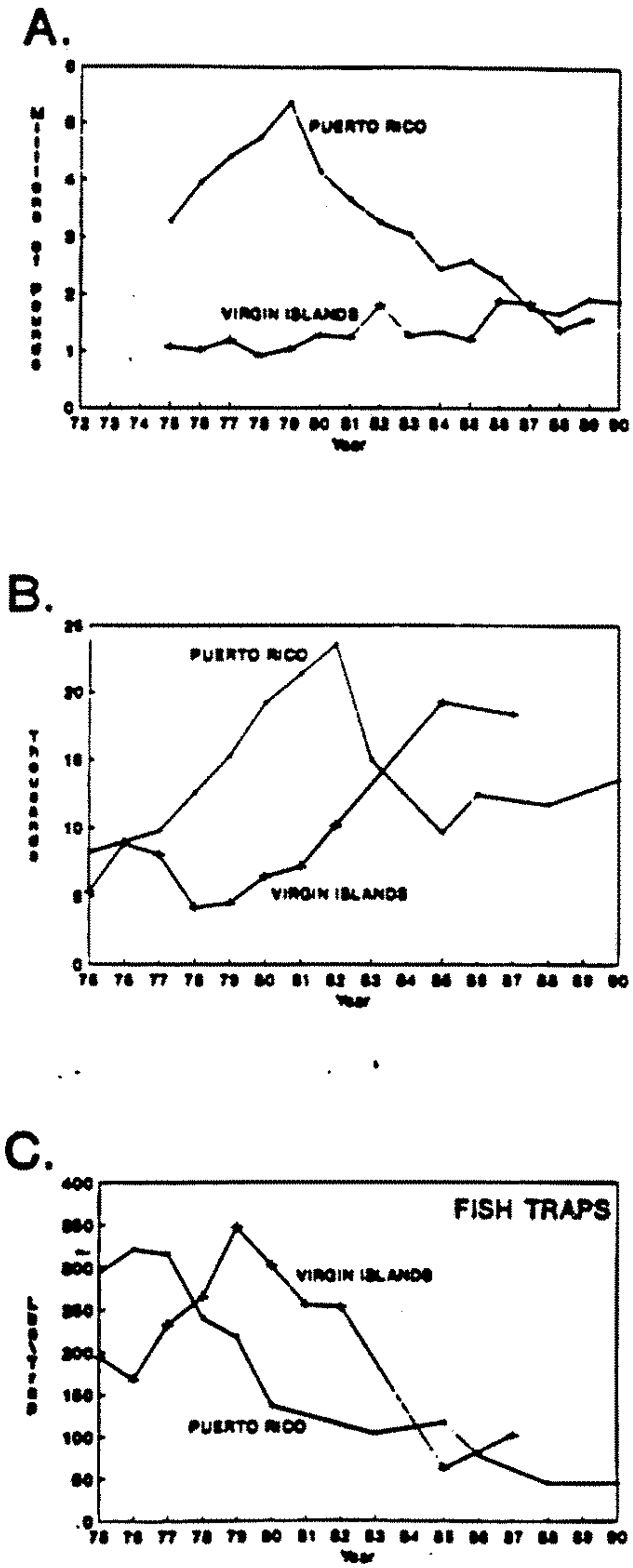


Figure 2. Red hind length-frequency data form Puerto Rico landings 1987-1991. Figure from Sadovy et al. in review.

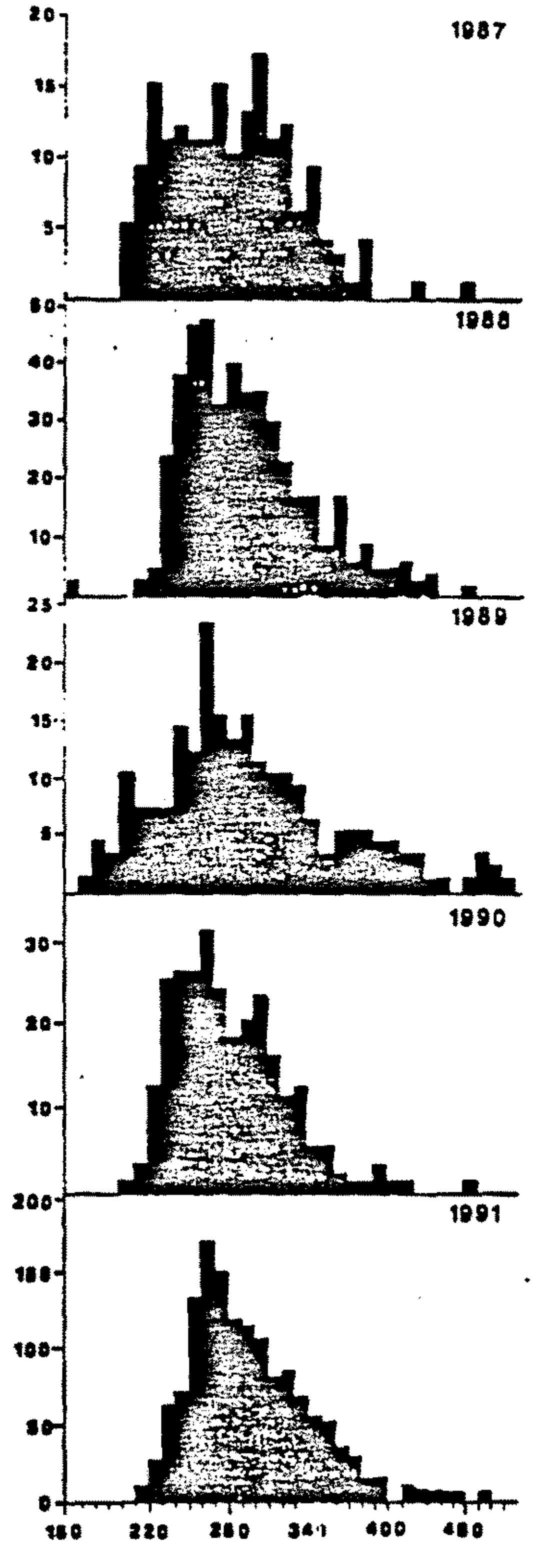


Figure 3. Red hind length-frequency comparison of 1984 and 1988 landings. Figure from Beets and Friedlander, in press.

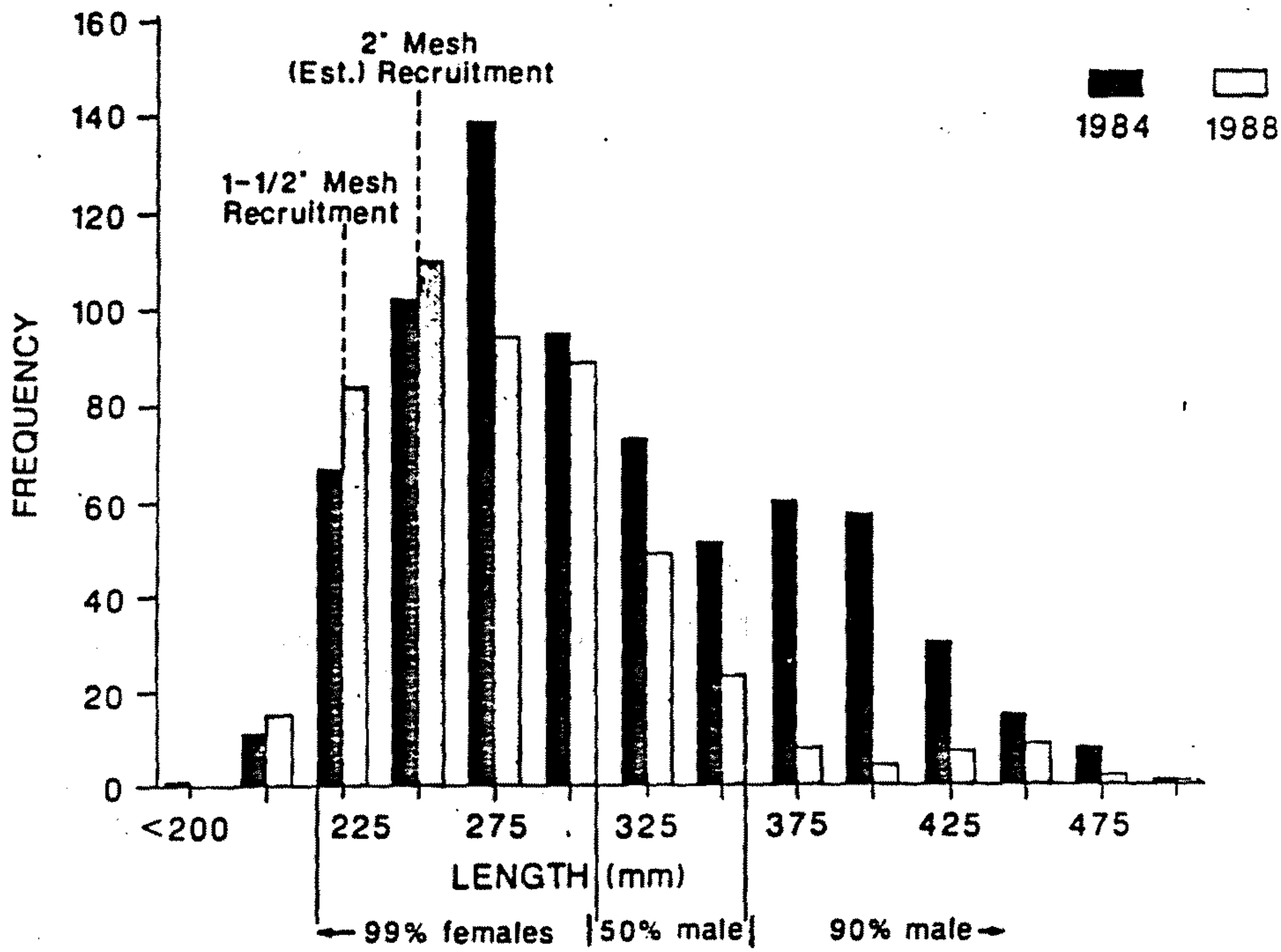


Figure 4. Red hind length-frequncy distribution for St. Croix 1984-1990. Figure from Beets and Friedlander, in press.

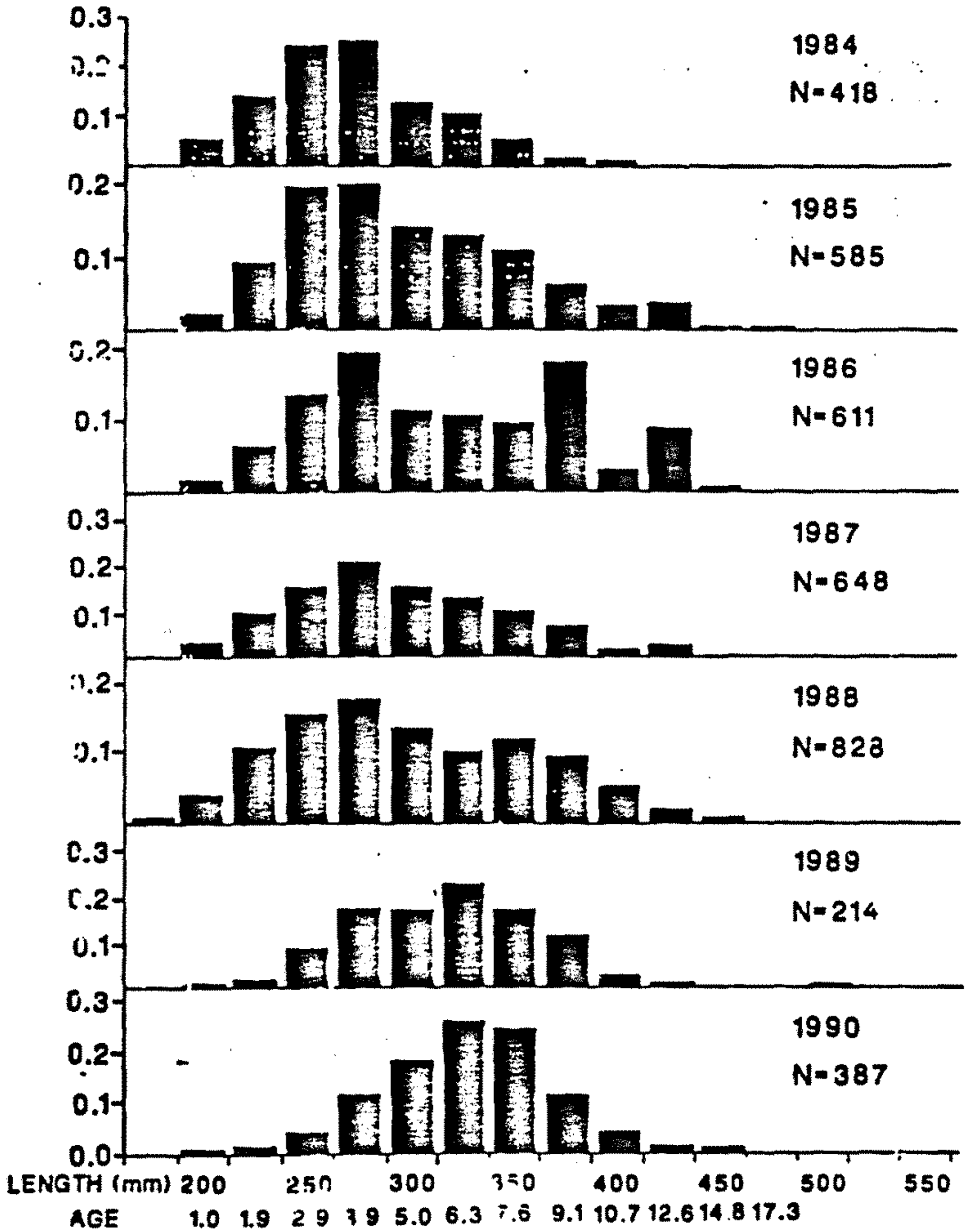


Figure 5. Red hind length-frequency distribution for St. Thomas 1984-1988. Figure from Beets and Friedlander, in press.

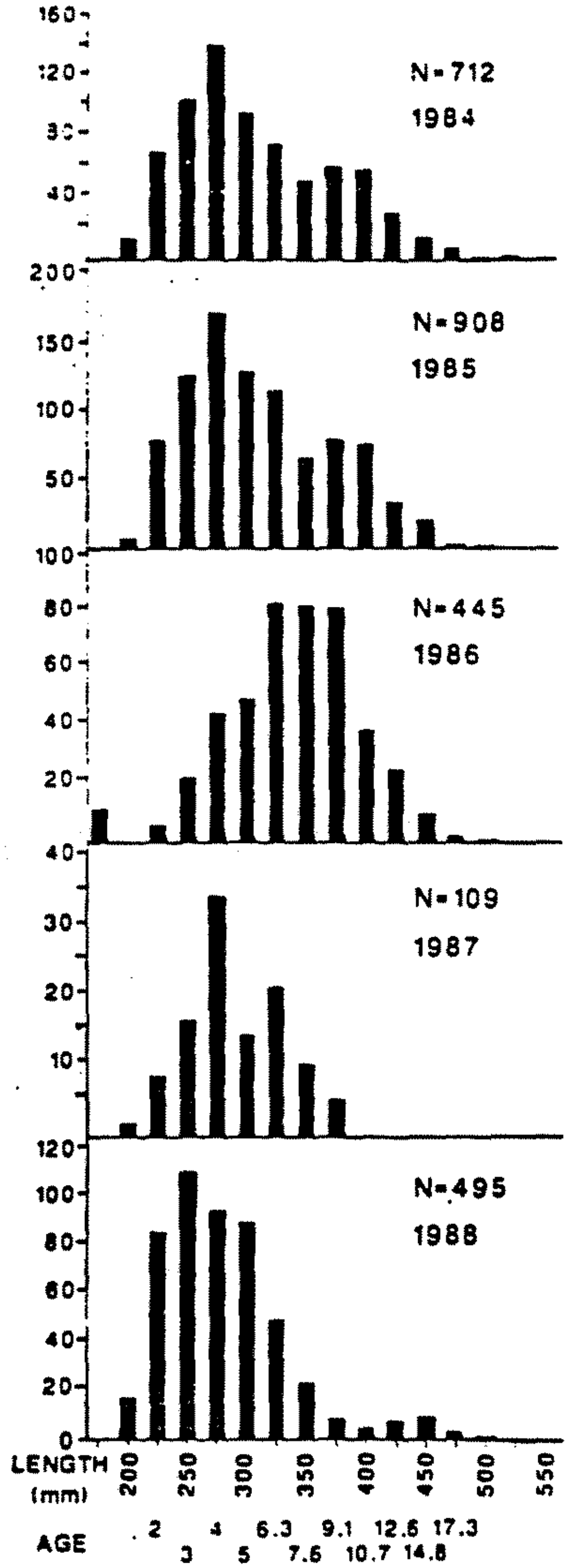


Figure 6. Red hind length-frequency distribution for Puerto Rico 1984-1990 (no data in 1986)

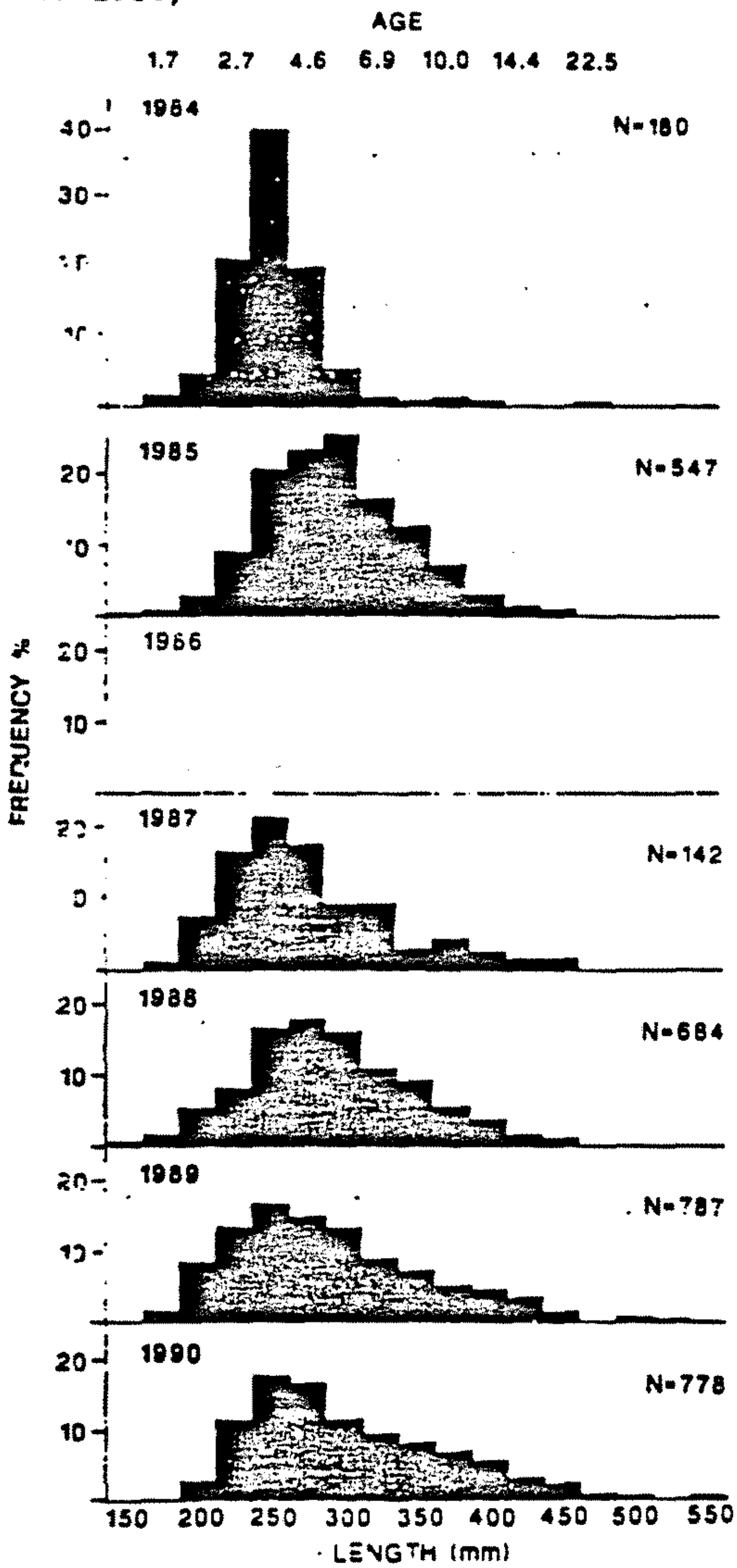
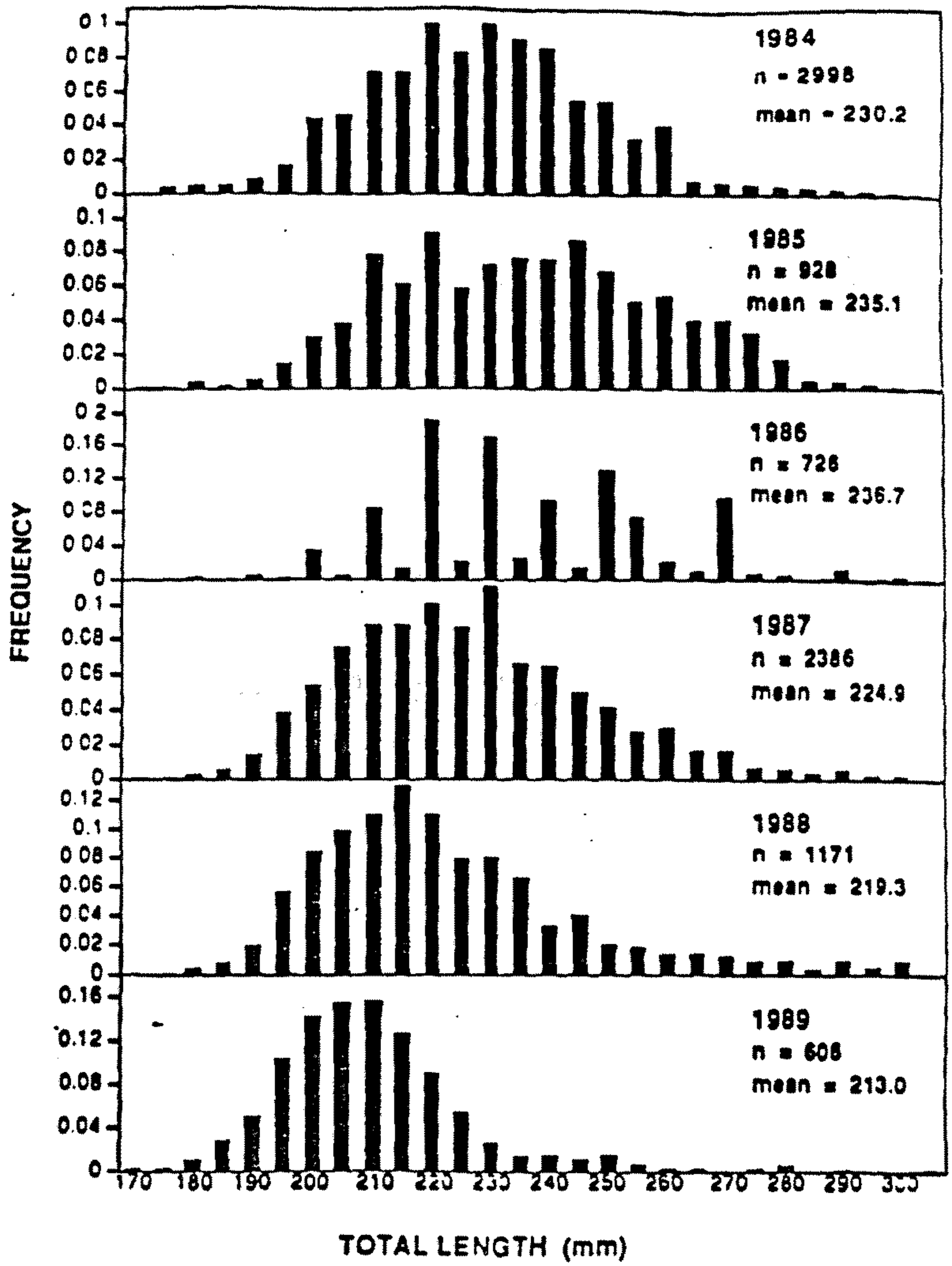
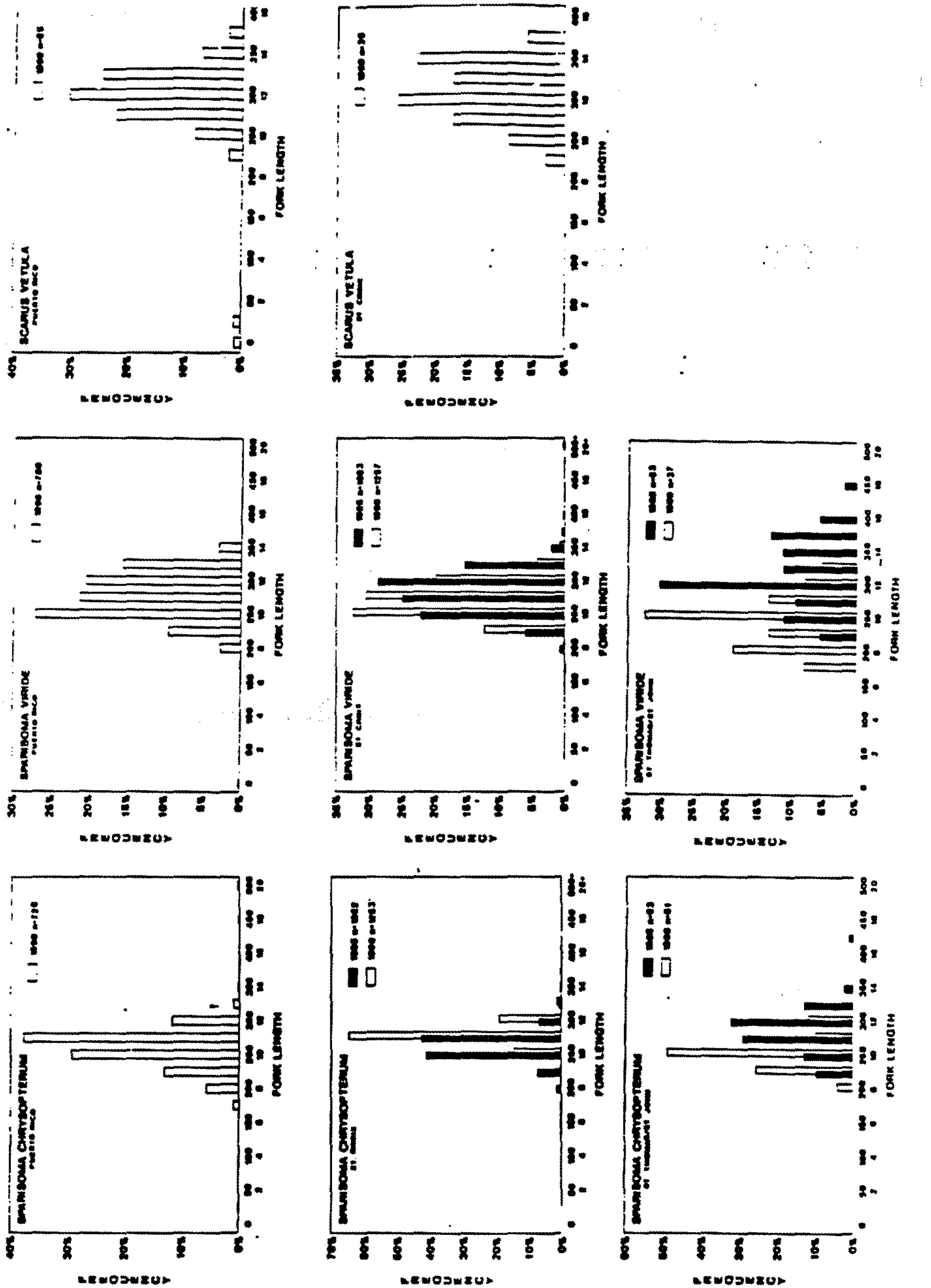
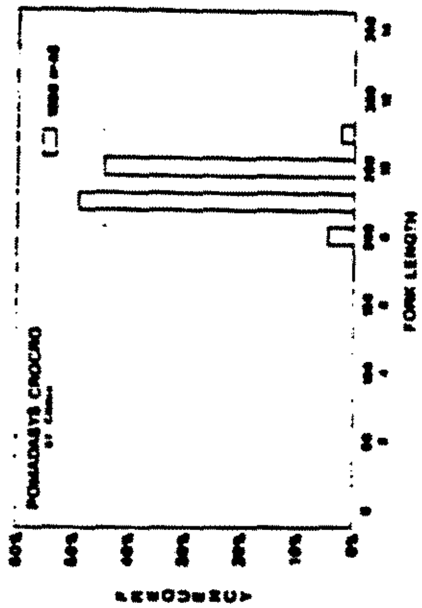


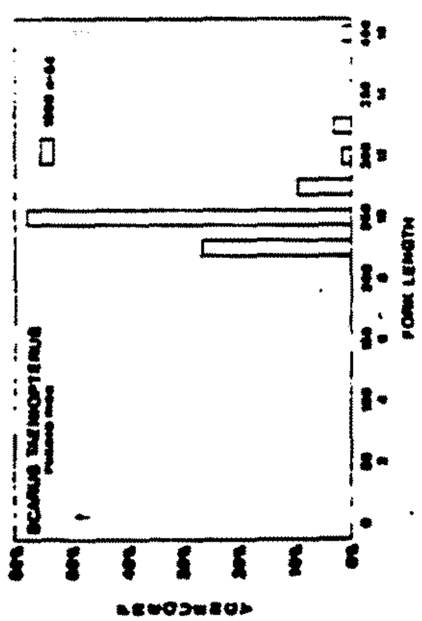
Figure 7. Coney length-frequency distribution for St. Croix 1984-1989. Figure from Beets et al. in press.

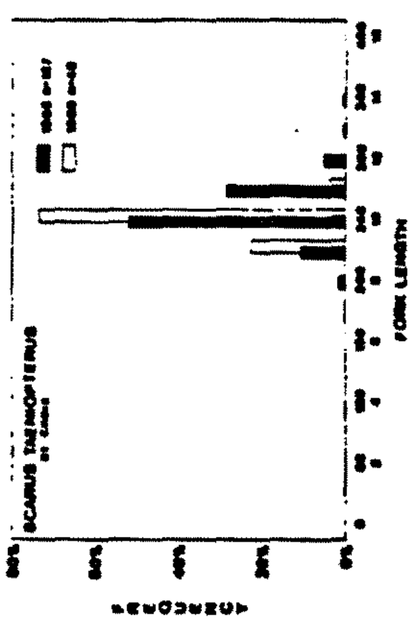


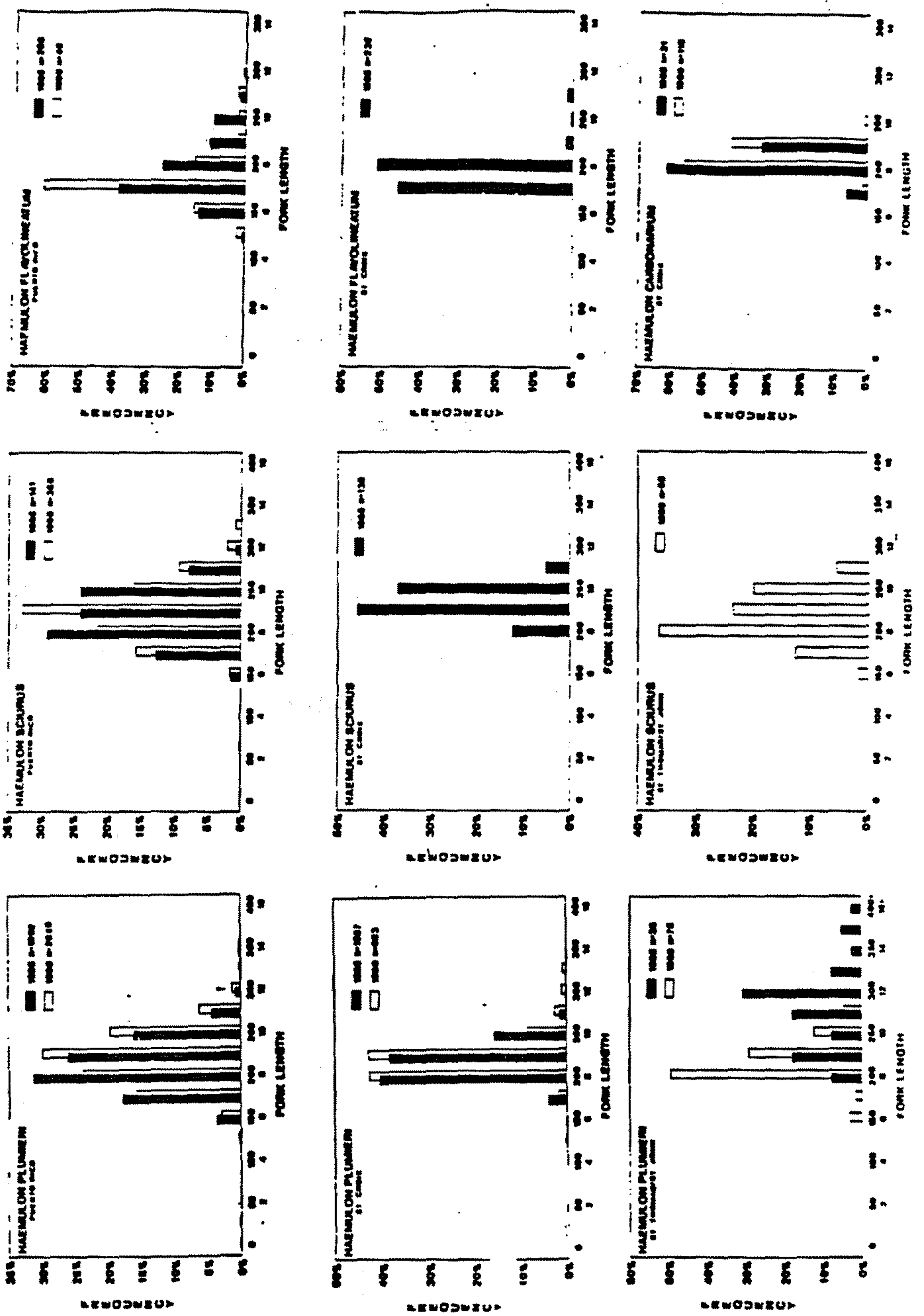
Appendix A. Graphical comparisons of length frequency by species for 1985 and 1990 based on reported biostatistical data. Upper number on x-axis denotes length in mm: lower in inches.

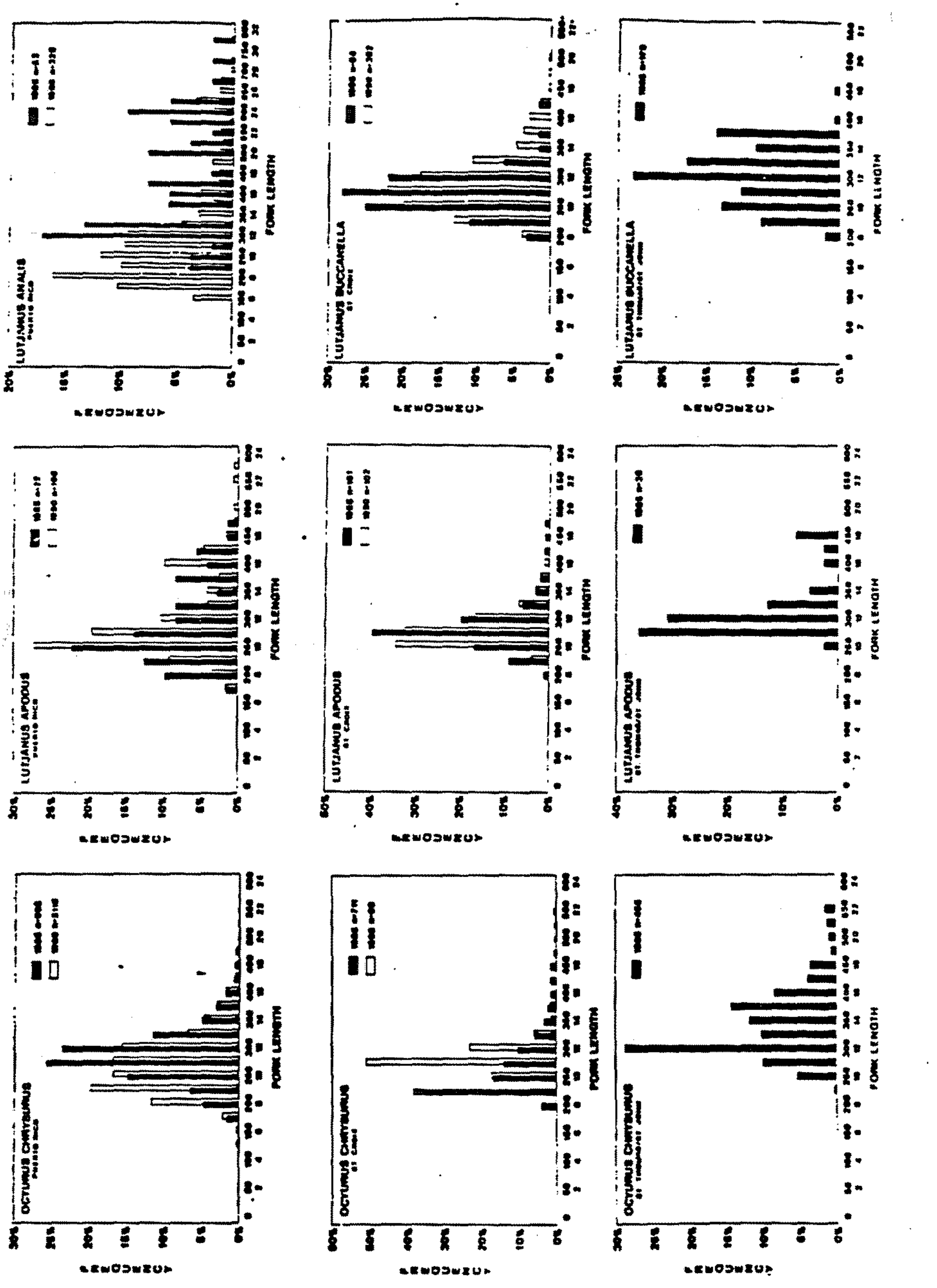

SCARUS VETULA
SCARUS VETULA
SPARISOMA VIRIDE
SPARISOMA VIRIDE
SPARISOMA VIRIDE
SPARISOMA CHRYSOPTERUM
SPARISOMA CHRYSOPTERUM
SPARISOMA CHRYSOPTERUM
FORK LENGTH
FREQUENCY


POMADASYS CROCRO
FORK LENGTH

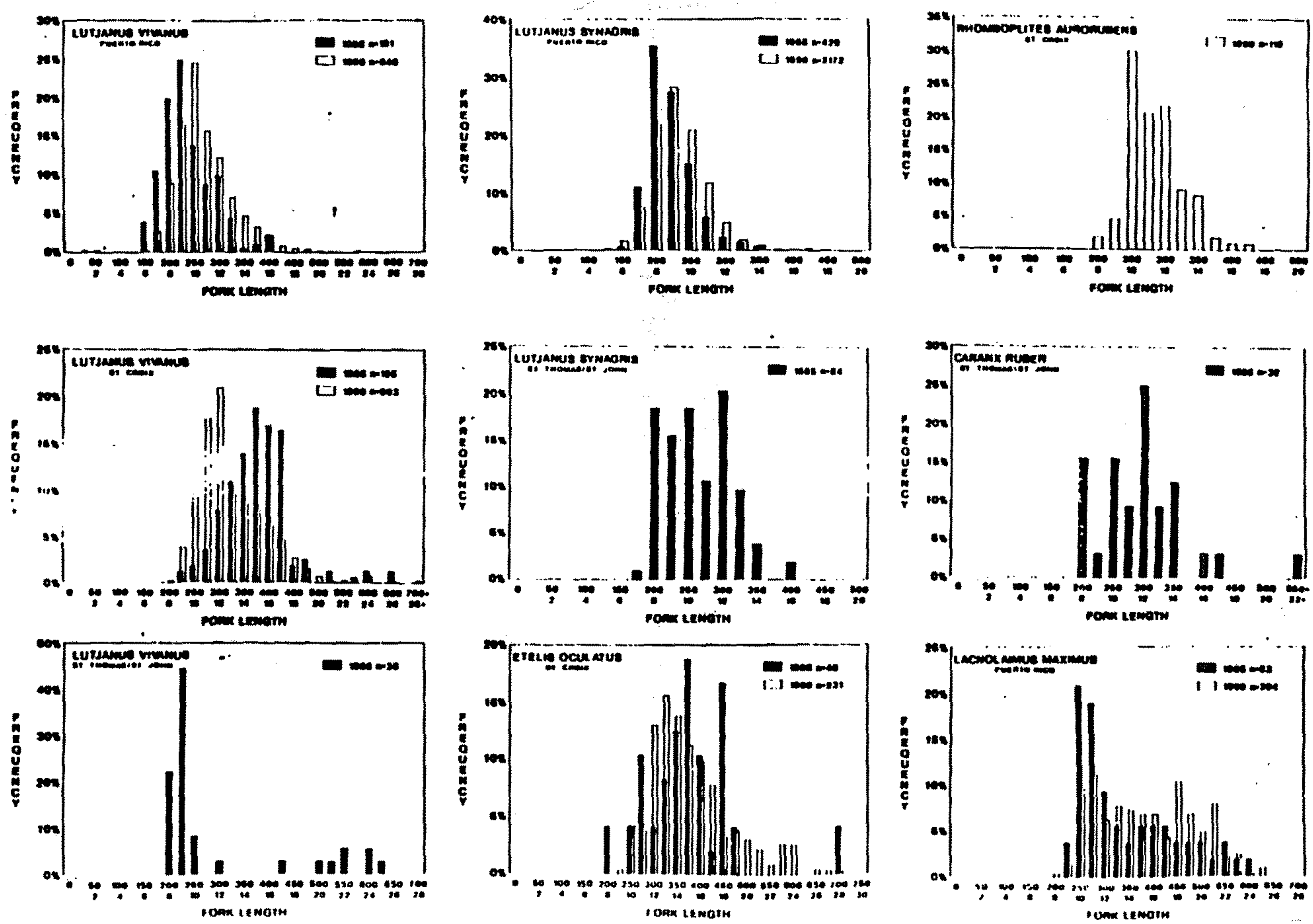

SCARUS TAENIOPTERUS
FORK LENGTH


SCARUS TAENIOPTERUS
FORK LENGTH

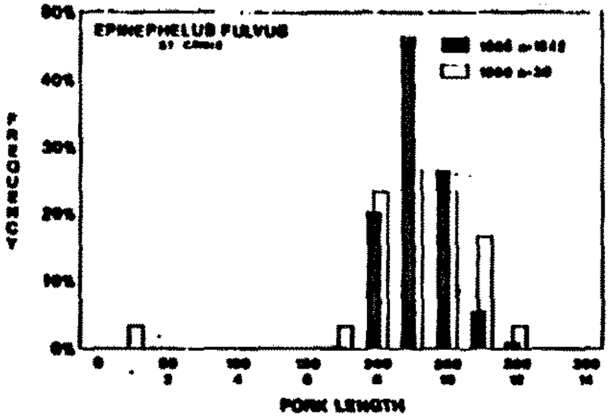

HAEMULON FLAVOLINEATUM
HAEMULON FLAVOLINEATUM
HAEMULON CARBONARIUM
HAEMULON SCIURUS
HAEMULON SCIURUS
HAEMULON SCIURUS
HAEMULON PLUMIERI
HAEMULON PLUMIERI
HAEMULON PLUMIERI
FORK LENGTH
FREQUENCY



LUTJANUS ANALIS
LUTJANUS BUCCANELLA
LUTJANUS APODUS
OCYURUS CHRYSURUS
FORK LENGTH
FREQUENCY



LUTJANUS VIVANUS
LUTJANUS SYNAGRIS
RHOMBOPLITES AURORUBENS
LUTJANUS VIVANUS
LUTJANUS SYNAGRIS
CARANX RUBER
LUTJANUS VIVANUS
ETELIS OCULATUS
LACHNOLAIMUS MAXIMUS
FREQUENCY
FORK LENGTH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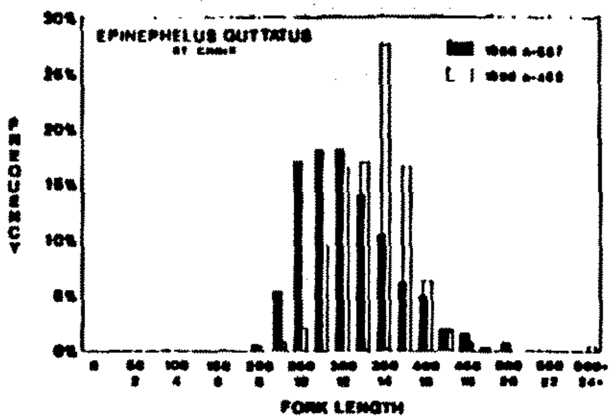
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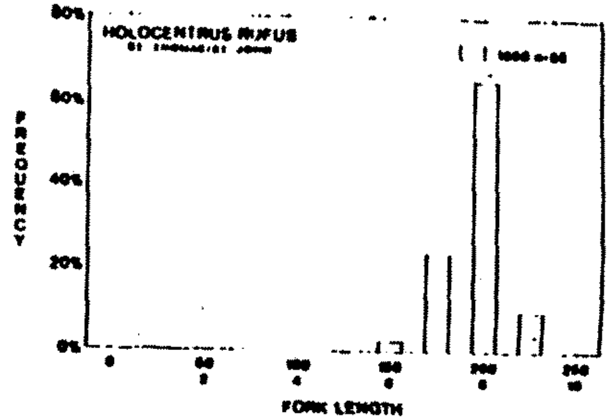
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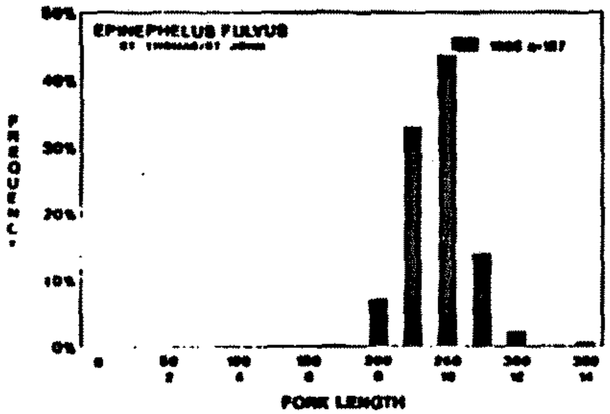
FORK LENGTH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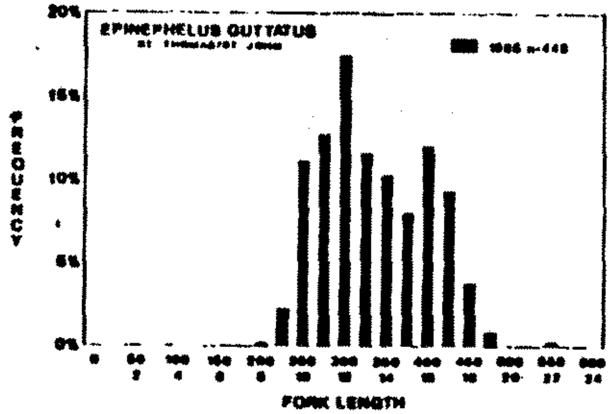
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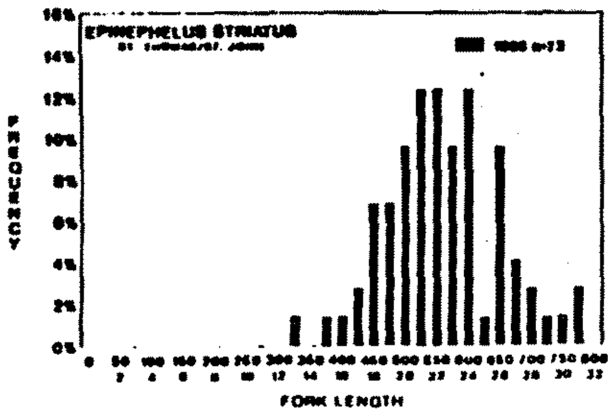
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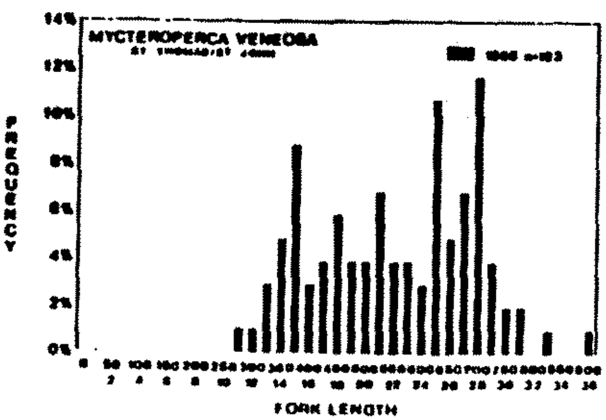
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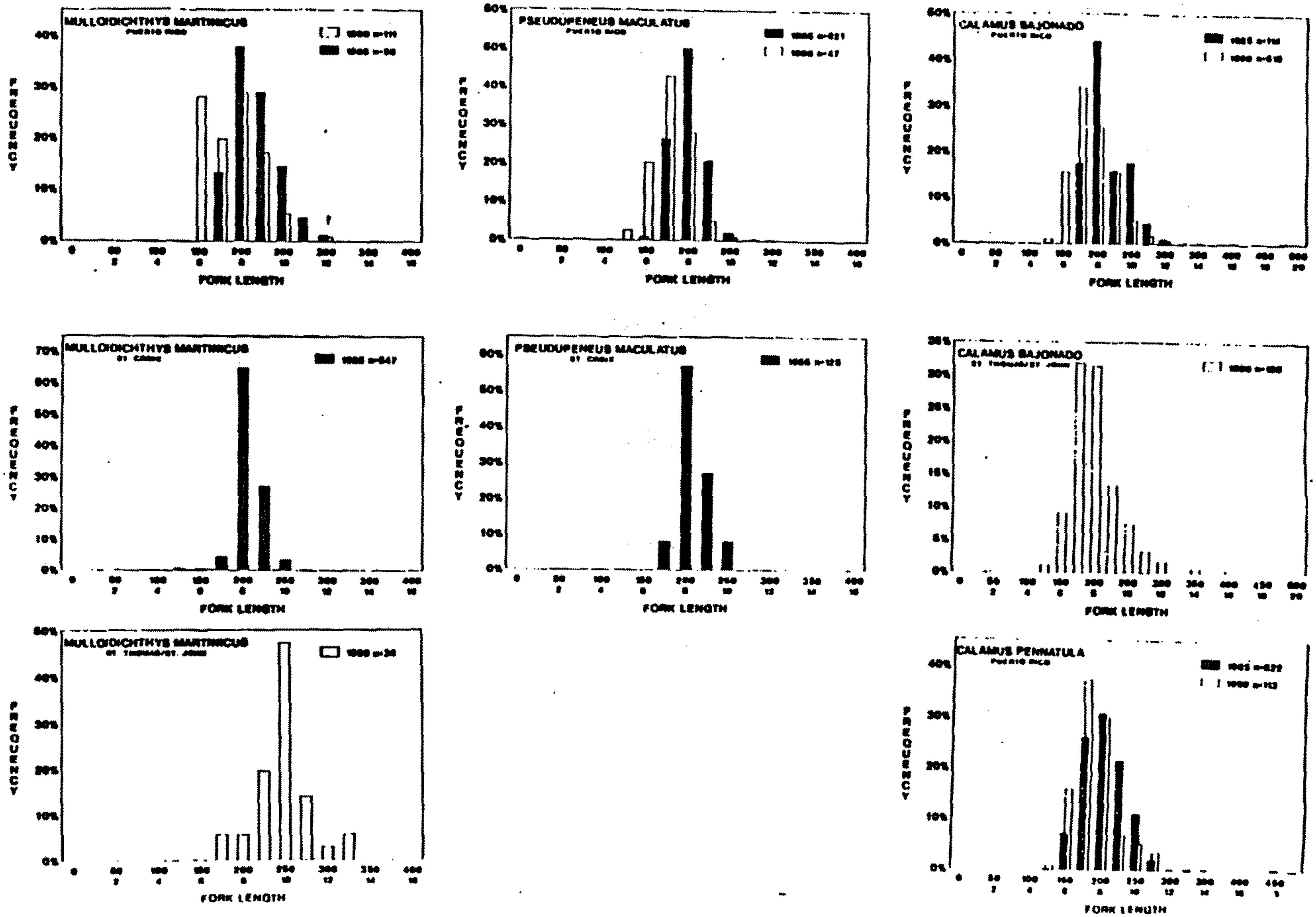
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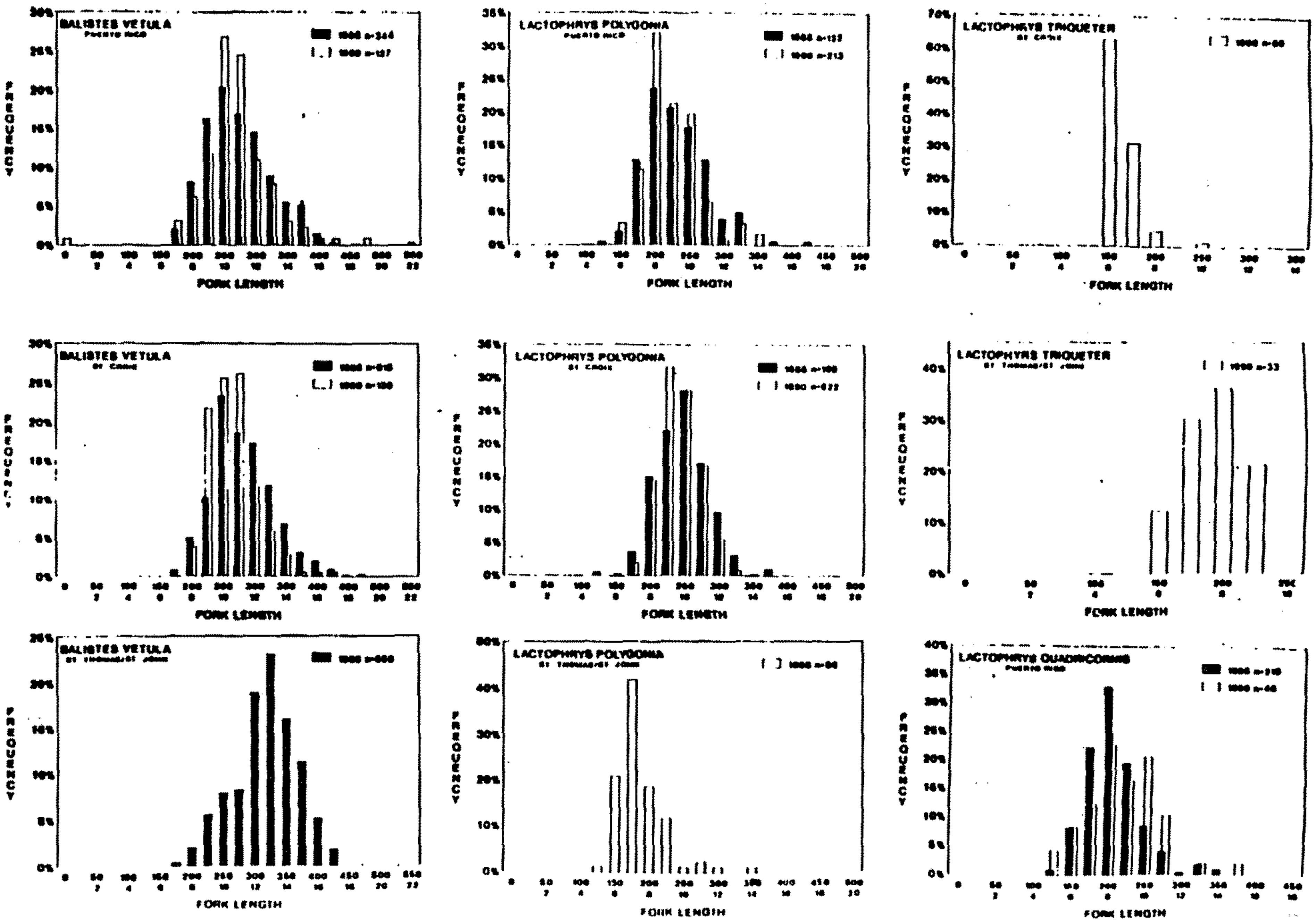
PSEUDUPENEUS MACULATUS
PUERTO RICO
CALAMUS BAJONADO
PUERTO RICO
MULLOIDICHTHYS MARTINICUS
ST CROIX
PSEUDUPENEUS MACULATUS
CALAMUS BAJONADO
MULLOIDICHTHYS MARTINICUS
CALAMUS PENNATULA
PUERTO RICO
FREQUENCY
FORK LENGTH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LACTOPHRYS POLYGONIA
PUERTO RICO
LACTOPHRYS TRIQUETER
ST CROIX
BALISTES VETULA
ST CROIX
LACTOPHRYS POLYGONIA
ST CROIX
LACTOPHRYS TRIQUETER
ST THOMAS/ST JOHN
BALISTES VETULA
ST THOMAS/ST JOHN
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LACTOPHRYS QUADRICORNIS
PUERTO RICO
FREQUENCY
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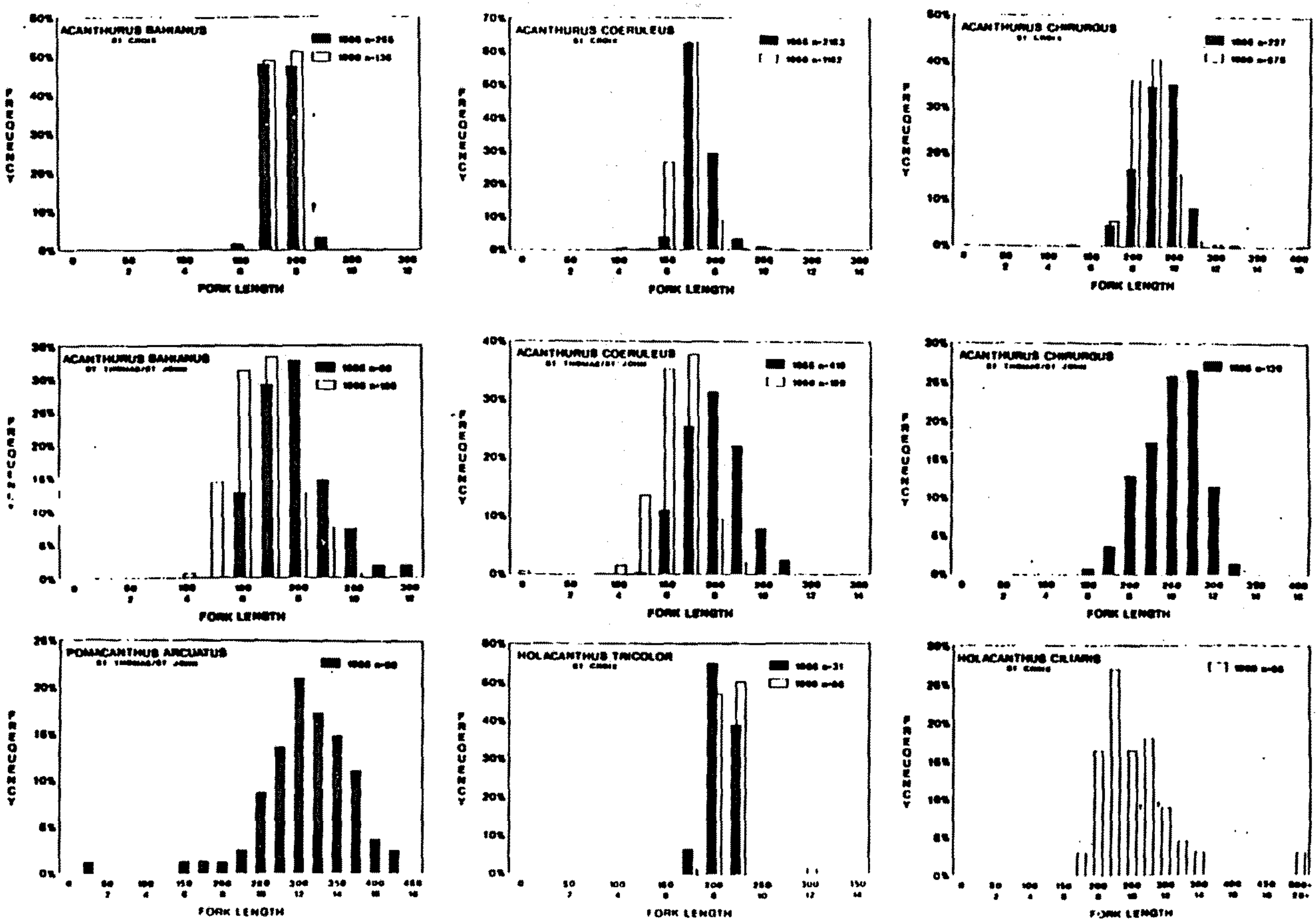
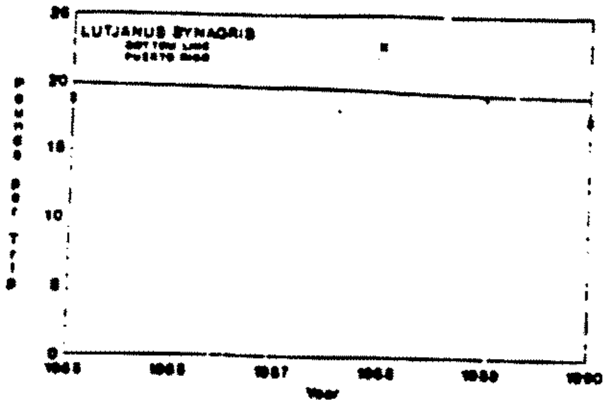
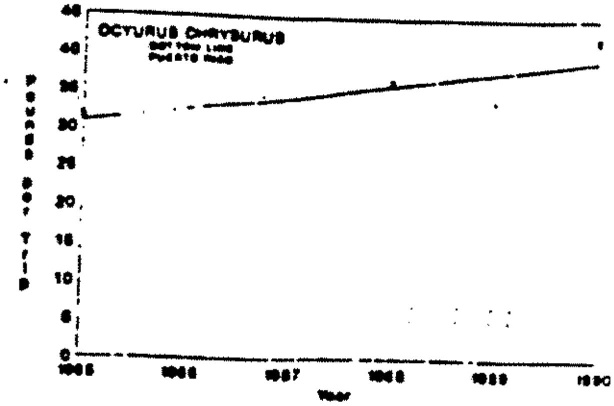
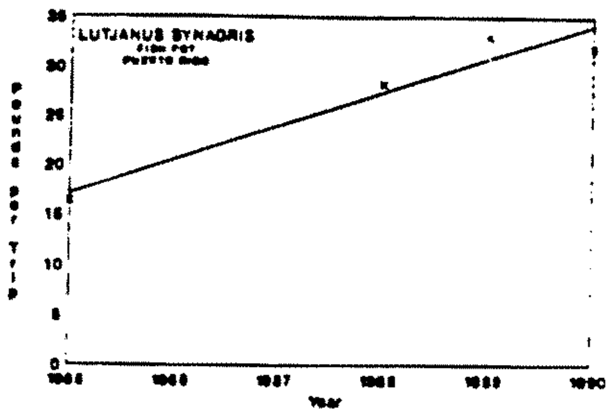

ACANTHURUS BAHIANUS
ACANTHURUS COERULEUS
ACANTHURUS CHIRURGUS
ACANTHURUS BAHIANUS
ACANTHURUS COERULEUS
ACANTHURUS CHIRURGUS
POMACANTHUS ARCUATUS
HOLACANTHUS TRICOLOR
HOLACANTHUS CILIARIS
FREQUENCY
FORK LENGTH

Appendix B. Trends in catch-per-unit effort for species by gear type. Simple linear trends were fit to the data and plotted courtesy of the CFMC. Trend lines are shown although too few years of data were available to justify the testing of statistical significance of the trends.


LUTJANUS SYNAGRIS
Pounds per Trip
Year


OCYURUS CHRYSURUS
Pounds per Trip
Year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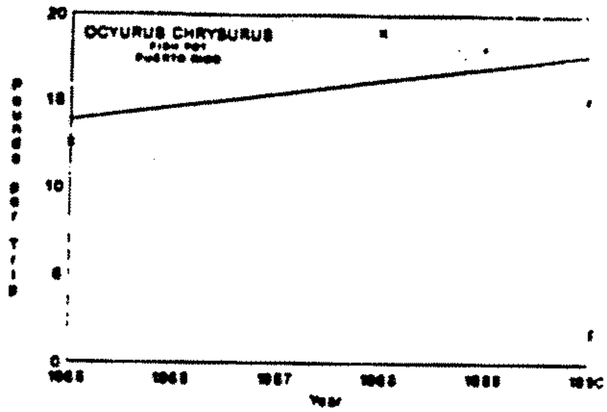
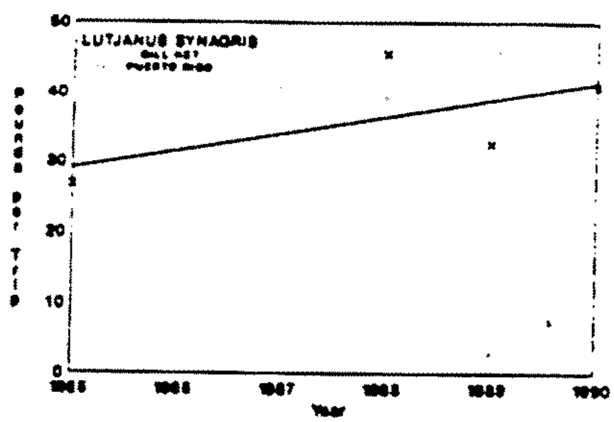
Pounds per Trip
Year


OCYURUS CHRYSURUS
Pounds per Trip
Year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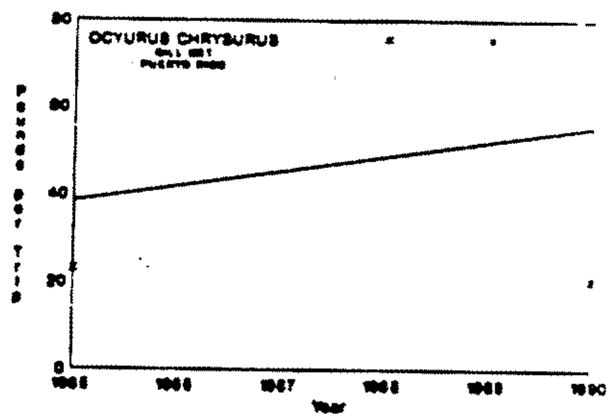
Pounds per Trip
Year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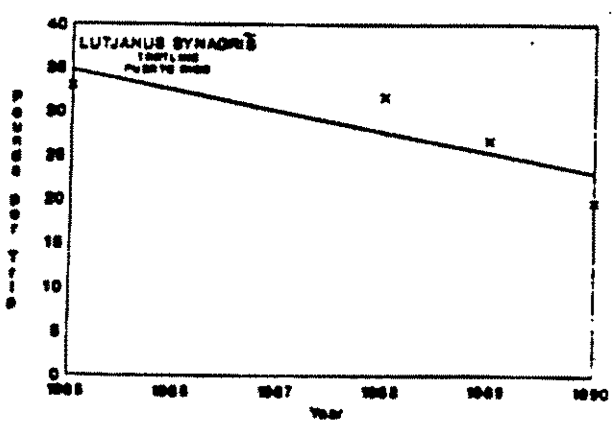
Pounds per Trip
Year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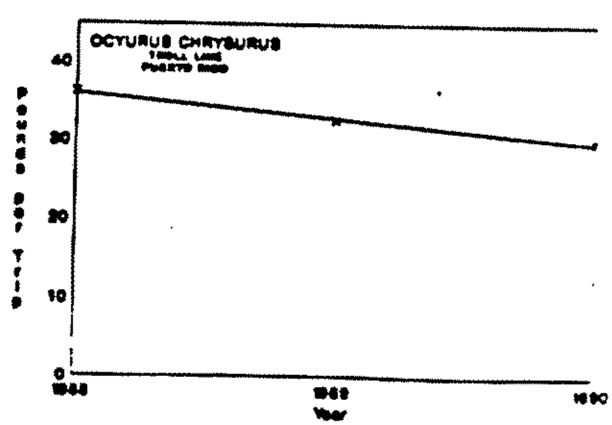
Pounds per Trip
Year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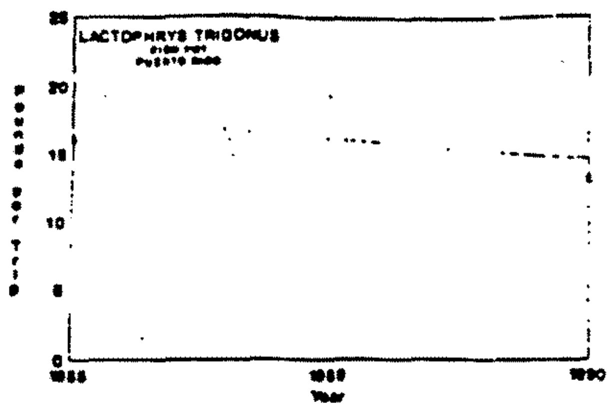
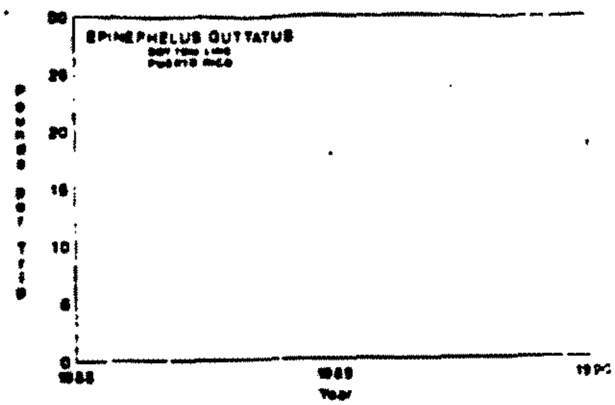
Pounds per Trip
Year


LACTOPHRYS TRIGONUS
Year
1988
1989
1990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Year
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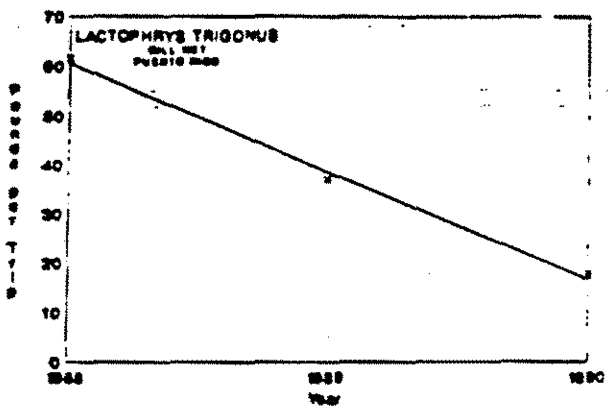
1989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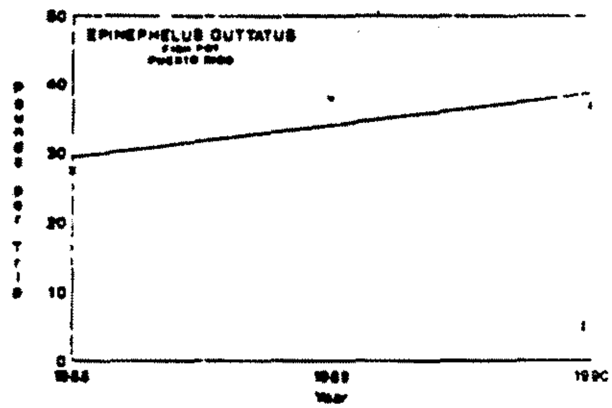
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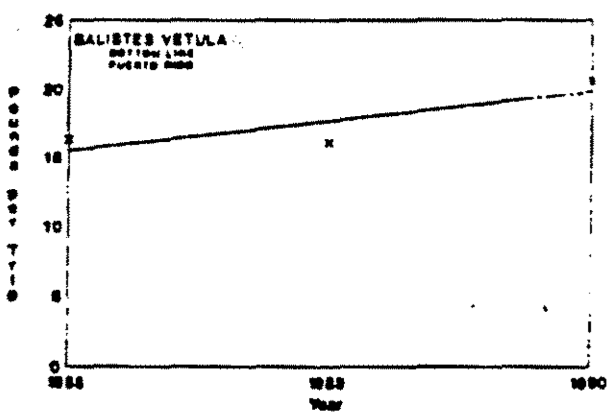
Year
1990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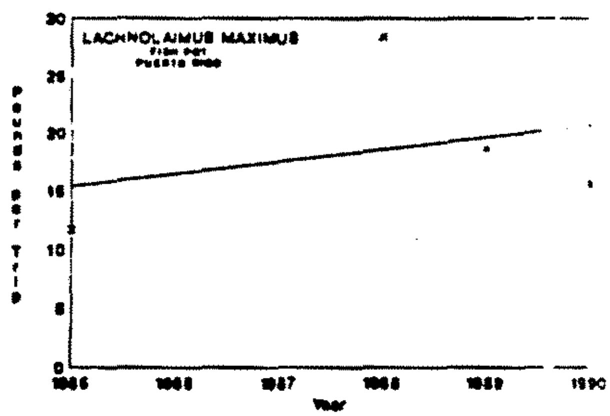
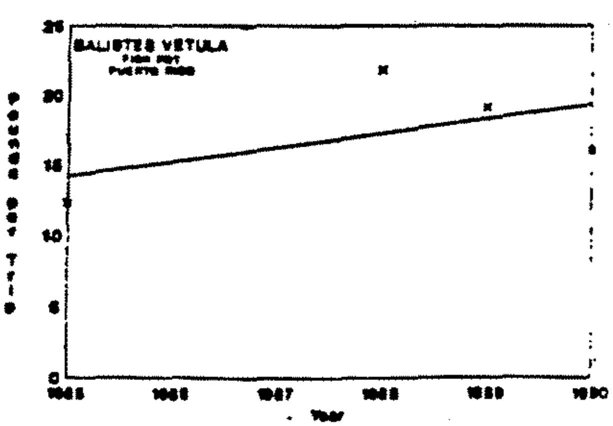
Year
1990


LACHNOLAIMUS MAXIMUS
Year
1990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Year
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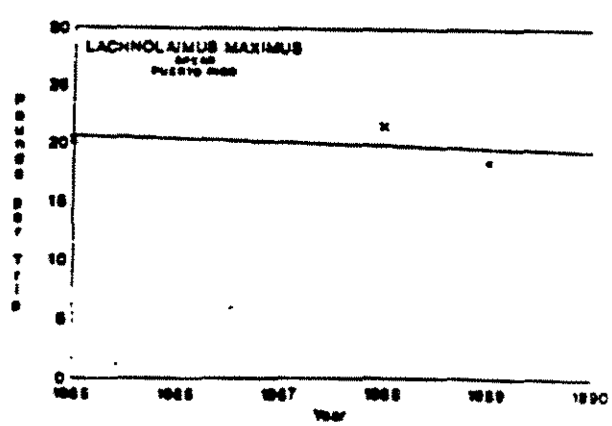
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Year
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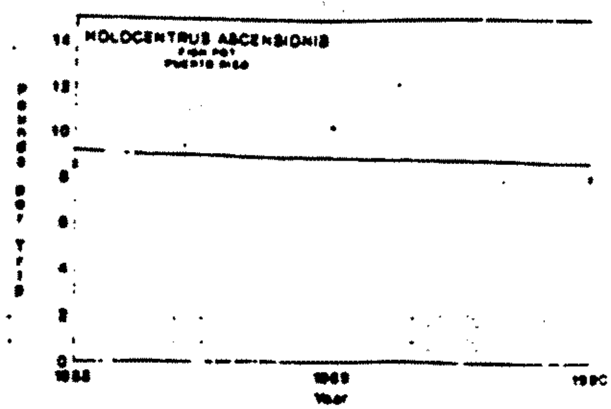
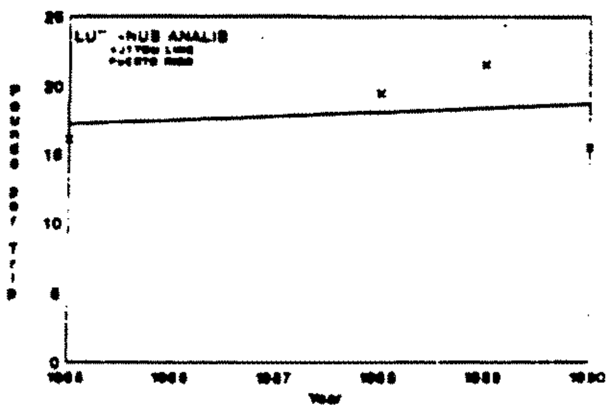
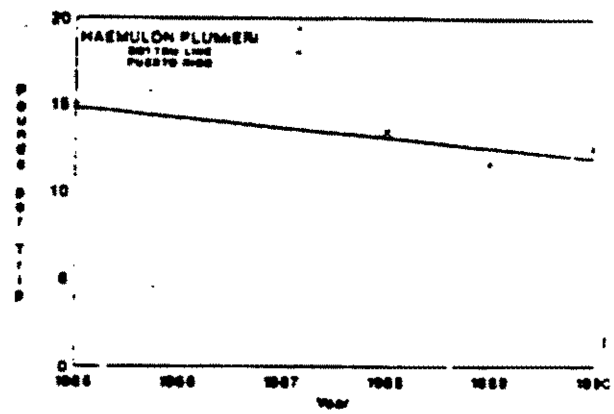
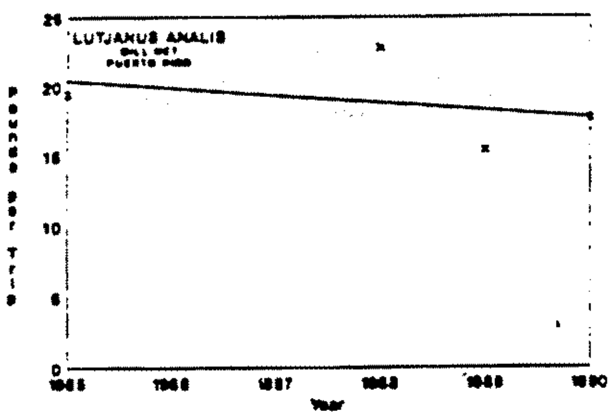

HOLOCENTRUS ASCENSIONIS
Pounds per Trip
Year


LUT -NUS ANALIS
Pounds per Trip
Year


HAEMULON PLUMIERI
Pounds per Trip
Year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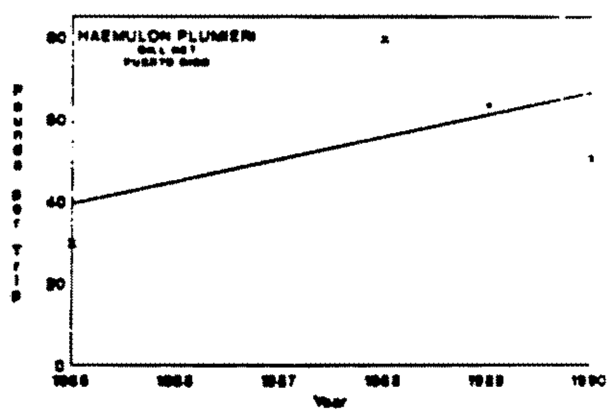
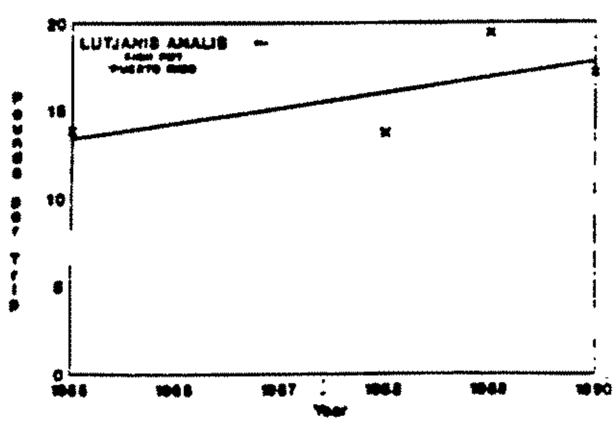
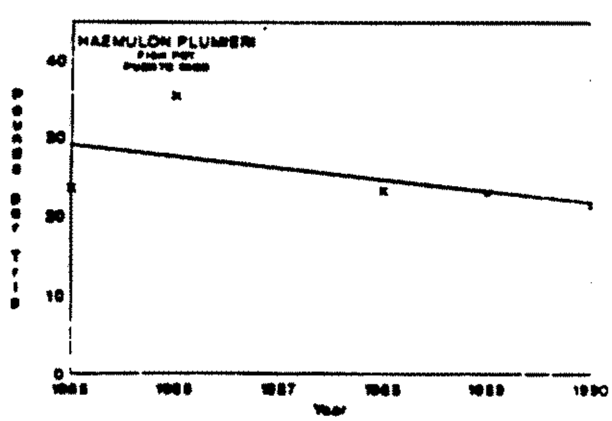
Pounds per Trip
Year


HAEMULON PLUMIERI
Pounds per Trip
Year


LUTJANIS ANALIS
Pounds per Trip
Year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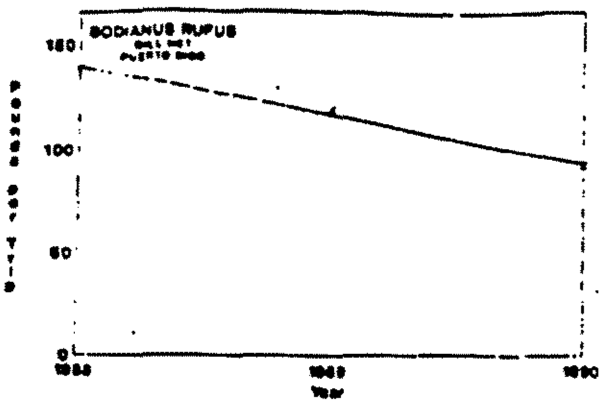
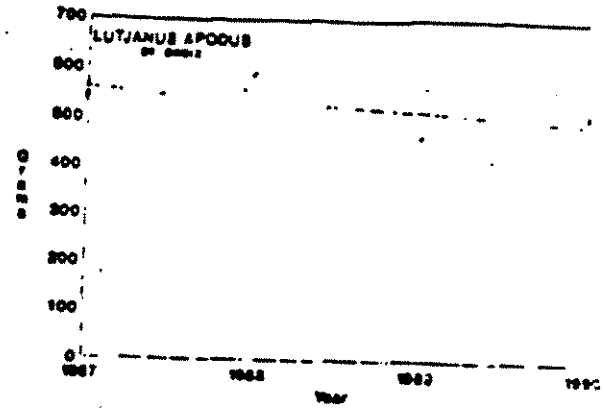
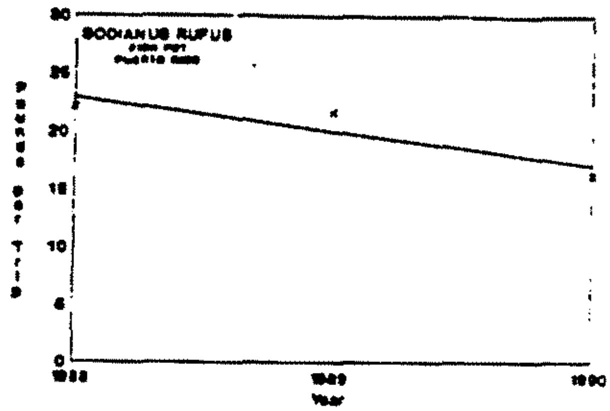
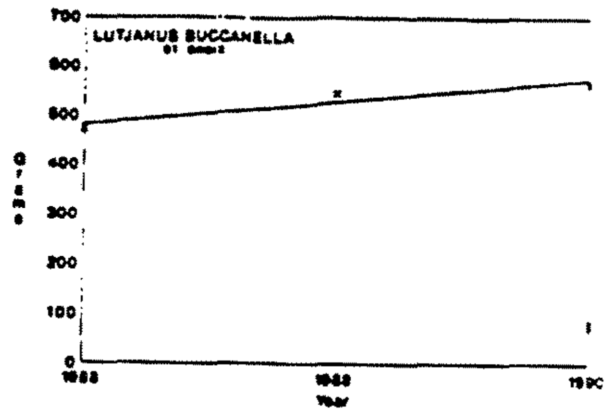
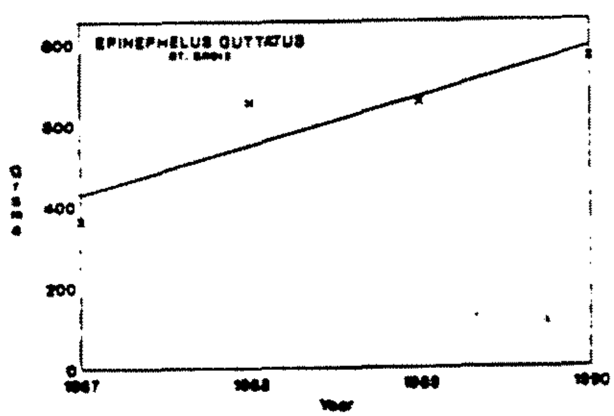
Pounds per Trip
Year

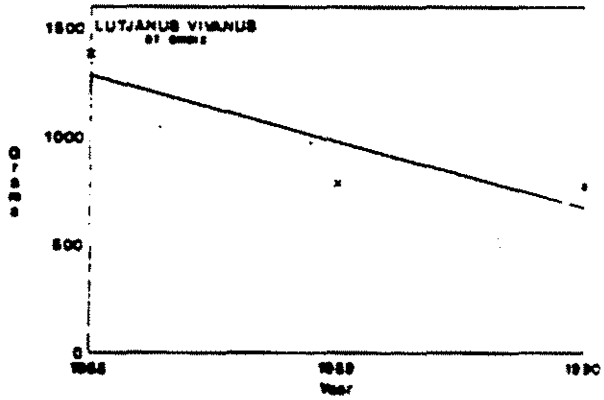

BODIANUS RUFUS
Pounds per Trip
Year


LUTJANUS APODUS
Grams
Year


BODIANUS RUFUS
Pounds per Trip
Year


LUTJANUS BUCCANELLA
Grams
Year


EPINEPHELUS GUTTATUS
Grams
Year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Grams
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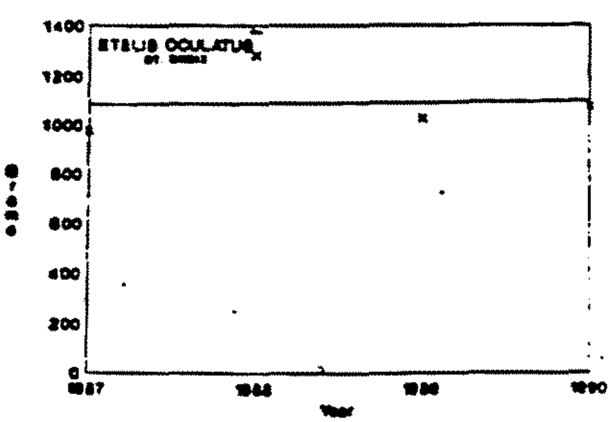
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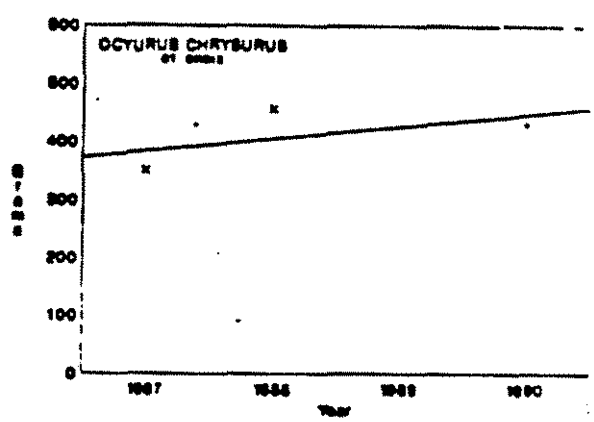
Year


OCYURUS CHRYSURUS
Grams
Year

APPENDIX II-B

SOURCE DOCUMENT
MARINE AQUARIUM TRADE

A PRELIMINARY ASSESSMENT OF THE EXPORT TRADE IN MARINE AQUARIUM ORGANISMS IN PUERTO RICO

Report Submitted to the

CARIBBEAN FISHERY MANAGEMENT COUNCIL

by

Yvonne Sadovy

Fisheries Research Laboratory
Department of Natural Resources
P O Box 3665
Mayagüez
Puerto Rico 00681

December, 1991

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INTRODUCTION

There has been concern in Puerto Rico over the last 2-3 years regarding what is perceived to be a growing export trade in marine organisms marketed for the aquarium industry. This trade characteristically involves the collection and sale of a wide range of tropical marine vertebrate and invertebrate organisms, as well as plant species, to private and, to a lesser extent, public aquaria. Concern has been expressed both by those active within the aquarium trade and those familiar with Puerto Rico's marine resources over the potential negative impact that increasingly intensive collection could have on fish and invertebrate populations, and the habitat with which they are associated.

There is no published information or database currently available in Puerto Rico regarding either the volume or nature of this trade, the species and areas exploited, the gears employed, or the number of businesses involved. Such information is essential for issues to be addressed concerning the exploitation and preservation of marine resources marketed for the aquarium industry. The purpose of this report is 4-fold:

1. to summarize what is known from tropical areas worldwide regarding the growth and possible impact of the aquarium trade;
2. to provide a first assessment of the nature and extent of this trade in Puerto Rico by documenting the number of people involved islandwide, by determining the species involved and by identifying the principal areas and methods of collection;
3. to describe the biology of key exploited species, or species complexes;

4. to identify information required for monitoring and assessing the trade on a continual basis, with suggested actions for the compilation of the appropriate biological and socio-economic data;

5. to provide recommendations for regulating the industry to enable commercial exploitation commensurate with conservation of the resource base.

WORLD TRADE IN MARINE AQUARIUM ORGANISMS

Trade in ornamental marine fishes began in the early 1950's (Wood, 1985). Since 1965, there has been a steady increase in international trade in coral reef organisms for private aquaria (Lubbock and Polunin, 1975). By 1979, the world trade in marine and freshwater ornamental fishes had an annual wholesale value of $600 million, with a 10-15% estimated annual growth. Marine species had a relatively small share of the market (Wood, 1985) although this proportion is increasing. Growth in the marine side of the industry has come about because of a combination of the widespread use of biological filters, improvements in the treatment of disease, the development of silicone seals enabling easy construction of aquaria, and the manufacture and marketing of synthetic salts allowing salt water to be available countrywide (Hess and Stevely, no date).

Marine organisms are predominantly exported from the Philippines, Hawaii, Taiwan, Hong Kong, Thailand, Singapore, Java, Queensland, Sri Lanka, Ethiopia, Saudi Arabia, Kenya, Mauritius, Florida and some Caribbean Islands (Lubbock and Polunin, 1975), although from a number of these locations fish are re-exported rather than actually collected (see below). The majority of marine organisms in world trade is exported from the Philippines, with 16% from Hawaii and Florida (this would include re-export from Caribbean countries). Major importers are the U. S. A., Hong Kong, western Europe, Japan, Canada and Australia. The cost, insurance, freight (c.i.f.) value of world trade in ornamental marine fish and invertebrates was estimated at $U.S. 24-40 million annually (Wood, 1985). This does not include international trade in dead coral and shells used for jewelry and ornamentation which may be substantial (Wells, 1981).

The majority of marine fish are tropical coral reef species which are largely collected from the wild, rather than cultivated, as is the case for 50-60% of freshwater ornamental species (Anon, 1979). All invertebrates are wild-caught (Wood, 1985). Imported animals are small species, or juveniles of larger species, usually less than 20 cm in length, although more commonly between 2-8 cm (Lubbock and Polunin, 1975). Since the mid-1980's, national and international trade has increasingly included "live rock". "Live rock" is a broad term used to describe several types of substrate colonized by marine organisms - four main types are distinguished; 1. rubble rock, 2. algae or plant rock, colonized by algae 3. false coral or anemone rock covered with anemones of the genera Ricordea and Rhodactis, and 4. sea mat or gravel rock colonized by anemone-like organisms, usually of the genus Zoanthus (Wheaton, 1989). The increased demand for live invertebrates that comprise "live rock" has developed with the increasing popularity of "living reefs" or "mini-reefs", private aquarium systems which generally include few fish species.

There is considerable variation in the manner in which collectors and exporters of marine aquarium organisms operate, and regarding the licencing and regulation of harvest practices and trade (Conroy, 1975; Anon., 1979). Collectors may themselves be exporters, or may sell to exporting middlemen. The diverse nature of the marine aquarium industry worldwide, and perceptions regarding its potential impact in exploited areas, are best illustrated by the following individual country accounts.

Southeast Asia

Philippines

A major supplier of tropical fish worldwide. In 1975 more than 80% of U. S. imports originated in the Philippines (Randall, 1984). More than 90% of exported fish are marine species (Lubbock and Polunin, 1975). From 1970-1979 the export value increased 20-fold and today aquarium fishes are within the top ten fishery products being exported. More than 40 companies export fish (Albaladejo and Corpuz, 1981). The Philippines has a reputation for poor quality fish because of the collection techniques employed which include the use of sodium cyanide and explosives (Dawson-Shepherd, 1977; Albaladejo and Corpuz, 1981). The average volume and destination of fishes exported every month is monitored with the assistance of the Fisheries Unit Personnel, National Export Coordinating Center (NECC). It was concluded that, without proper resource management, the supply of aquarium fishes would rapidly dwindle and extensive destruction of reefs would result (Albaladejo and Corpuz, 1981). There is high mortality of fishes between the time of collection and the time of export because of the limited experience of many people engaged in the industry, the collection methods used, fierce competition and low market prices.

Singapore

There is much re-export to the U. K. and other locations through Singapore from Thailand, Malayasia, Indonesia, Sri Lanka and the Philippines (Wood, 1985).

Indian Ocean

Kenya

Kenya is the largest supplier to the U. K. in East Africa. Collection is strictly regulated and demand exceeds supply (Wood, 1985).

Sudan

Export of native marine species for the ornamental trade is prohibited (Wood, 1985).

Red Sea

Little is exported because of strict regulations on collecting (Wood, 1985).

Sri Lanka

Between 25,000 and 30,000 boxes are exported annually containing approximately 200,000 fish and 400,000 invertebrates.

This is the largest exporter to the U. K. with 139 species appearing on exporters' trade lists. Many collectors believe that aquarium fish species are less abundant now than prior to the development of the aquarium trade. Fish from Sri Lanka are generally considered to be of acceptable quality (Wood, 1985). There is concern for the vulnerability of certain endemic or rare species to overcollection. Also, nothing is known of the secondary consequences of removing large numbers of fish or invertebrates from an ecosystem. It has been suggested, for example, that population explosions of coral-eating starfish, Acanthaster planci, in Sri Lanka, could have been caused by removal of fish that eat its larvae (Wood, 1985).

Maldives

Export of aquarium fish from the Maldives began in about 1980, and by 1988 exports had doubled (Edwards, 1988). The Maldives is now considered to be an attractive base for this industry because of an international airport with direct flights to Europe and abundant reefs. Two business are involved with 25 people. Holding facilities are good with central filtration, protein skimmer and sterilization capacity. Packaging techniques and practices are good. One hundred species are exported, although just 20% of species contribute to 70% of exports. Quality of fish is perceived to be good because of sound collection practices.

Fish are either exported directly from the Maldives or via Sri Lanka. Collection is regulated and the trade carefully monitored (Edwards, 1988). Tnere is concern over possible conflicts between the collection of fish and the tourist industry, as well as the potential for negative environmental and ecological impacts resulting from overexploitation. No collecting is permitted within approximately 1000 m of tourist islands (Wood, 1985). Quotas of 100,000 (fish plus invertebrates) have been introduced to prevent expansion of the trade and these are strictly enforced (Edwards, 1988). However, it is considered to be difficult to select which species should be subject to export quota. Some species are believed to be more likely to experience high levels of mortality if removed from the reef and thus need specific protection. For example, certain butterflyfishes do not feed well in captivity and their mortality is high. Other species are rare or live in limited or specialized habitats and are considered to be vulnerable to overcollection (e.g. Amphiprion spp.), or are important for reef health such as 'cleaners' (species of fish or invertebrate, commonly shrimp, that clean the ectoparasites from the bodies of other fishes).

Djibouti

The potential for developing an export trade in marine aquarium fishes in Djibouti was recently investigated to draft a preliminary management policy for the exploitation of marine ornamental fish. Evaluated were the nature of the resource base, the potential impact of collecting on the ecology of the area and on the artesenal fishery. If this trade were to be developed it would likely represent a major export. Djibouti has no national product or export and relies largely on foreign aid (Barratt and Medley, 1990). Recommendations developed from initial assessments recognized that exploitation should be based on resource availability and that there could be successful trade provided there is sufficient management and protection of resources from overexploitation. Certain species such as Amphiprion spp. were perceived to be particularly vulnerable to heavy exploitation because of easy capture and specialized habitat i.e. association with anemones.

Pacific

Australia

Australia's principal export trade is with the U. S. A. where some species may be held temporarily before re-export (Wood, 1985). Trade to the U. K. is limited largely because of long travel times. The size and nature of the aquarium fish industry is economically and ecologically important, and is expanding fast. However, little information is available on target species involved or on acceptable collection levels (Whitehead et al., 1986). Collectors must have prior written permission from the Government to use chemicals or explosives for collection. Permits and licences exist depending on whether collection is recreational or commercial, or whether it takes place in zoned (protected) or unprotected areas, to ensure reasonable collecting, to reduce user conflict, and to conserve reefs (Whitehead et al., 1986).

Hawaii

Hawaii is an important exporter of marine ornamental species. The fish are reputed to be of high quality and mortality is low because collection with chemicals and explosives is prohibited (Poollen and Obara, 1984; Wood, 1985). The trade is of economic importance but considered to be of potential damage to reef ecosystems. Collection is prohibited in marine conservation areas. Collectors need permits to use nets and are required to maintain fish, prior to export, in reasonable health and in adequate holding facilities, which are periodically inspected (Wood, 1985). They must also submit monthly catch reports (Walsh, 1978). Businesses are small and the collector is usually the exporter. More than 60 licenced collectors were involved in the early 1980's (Randall, 1984), with an estimated total of 89 people participating in the industry at all stages, including packing and shipping (Poollen and Obara, 1984). The most important single fish species exported is the yellow tang (*Zebrasoma flavescens*) followed by a number of butterflyfish, angelfish and other tang (acanthurids). Some of these species were noted to have declined in collections between 1976-1982 (Poollen and Obara, 1984) and many fish collectors recognize the need for management of the industry to prevent overexploitation.

Western Atlantic

Florida

Attention was focused on the aquarium trade in Florida in 1975 (Robins, 1976) when it was recognized that information on the biology and socio-economics, as well as possible user conflicts, was needed to characterize the industry. Florida exports both wild-caught as well as a small proportion of tank-bred species (mainly anemonefish). Mandatory landings figures have been collected from 1989 onwards from wholesalers. For April 1990 - March 1991, approximately 200 species, or species groups, were reported in landings data collected on trip tickets (Florida Marine Research Institute, Florida Department of Natural Resources (FDNR) data). Nearly two-thirds of the marine life fishermen live in Florida Keys (Januzzi, 1991). Because of many problems in the business, fishermen throughout Florida consider that some form of limited entry arrangement into the fishery is necessary (Januzzi, 1991).

The most frequently collected species reported were invertebrates (Condylactis gigantea - 316,000 organisms; sand dollars (several genera) - 211,000; various crabs - 120,000; turbinellid snails - 76,000; Lima scabra - 60,000, and substantial quantities of "live rock", recorded in pounds). The most frequently collected fish species were angelfish, wrasses, and damselfish (Holacanthus bermudensis - 28,000; Holacanthus tricolor - 27,000; Pomacanthus arcuatus - 17,000; Thalassoma bifasciatum - 16,000; Chromis cyaneus - 14,000). Considerably more invertebrates than fish were reported and there is concern particularly over the substantial numbers of anemones and volume of "live rock" being taken. Collection of "live rock" is to be phased out over the next three years. The economic importance of aquarium fishes has been reported to be high. For example, the U. S. dollar value from FDNR landings statistics in 1976, prior to the recent growth in the industry, indicated that aquarium fishes ranked eighth in economic importance in Florida (following grouper and king mackerel).

The taking of organisms for the aquarium trade is regulated in Florida State and Federal waters. As of January 1st, 1991, regulations (Chapter 46-42 - Marine Life) were in effect to protect and conserve Florida's tropical marine life resources and assure use of non-lethal methods of harvest. The taking of several species of vertebrate, invertebrate and plant is restricted. Longspine urchin, Diadema antillarum cannot be harvested. Some species are subject to maximum or minimum size limits. Bag limits or quotas are in force and there are permitting requirements for collection of plants and animals, or the use of certain collection methods. Quinaldine use requires a permit which allows up to a 2% quinaldine concentration in solution in seawater, mixed with isopropyl alcohol or ethyl alcohol (acetone may not be used as a solvent).

Curaçao

In 1970, four licenced exporters were known to be exporting marine ornamental fish and invertebrates, including "live rock", for the aquarium trade. Data on the export of fishes and invertebrates from Curaçao between 1972 and 1977 indicate that all fish were collected using quinaldine (Kruijf, 1978). After 1976 the taking of stony corals was prohibited. Principal species exported to the U. S. and Europe over this period were *Gramma loreto* - 48,185; *Condylactis giganteus* - 41,530; *Sabella* spp. - 34,586; *Centropyge argi* - 24,751; *Opistognathus aurifrons* - 24,244; *Holacanthus tricolor* - 14,272; *Myripristis jacobus* - 13,219; *Pomacanthus paru* - 10,693). Exports after 1975 declined for two reasons; collectors around Miami came to supply an increasingly large proportion of the U. S. market, and the opening of reef areas in Haiti produced supplies of organisms for the U. S. market at very low prices. Concern was expressed that two of the most commonly collected species, *H. tricolor* and *P. paru*, might require collecting limits because of their relatively low abundance (Kruijf, 1978). *Holacanthus ciliaris* - the queen angel - is a rare species which cannot be collected (Lubbock and Polunin, 1975).

Barbados

This is the principal Caribbean source of aquarium trade fishes to the U. K. and accounts for 2% of total U. K. imports (Wood, 1985). Use of quinaldine is not permitted.

U. S. Virgin Islands

Some export of marine organisms occurs. Licensing is required for the export of indigenous and endangered species (Jim Beets, pers. comm.) and a 10% export tax is in effect. Principal species exported are *Gramma loreto*, *Opistognathus aurifrons*, angelfish species and a number of invertebrates.

Hispaniola

Exports from Haiti increased in the mid 1970's (Kruijf, 1978). Fish prices were low and labor was cheap. Haiti is believed to be a principal shipper to the U. S. A. (Mark Derr, pers. comm.). Reports indicate that alcohol and quinaldine are used extensively to capture fish and that the resulting fish quality is poor. Substantial export activity has also been reported to occur from the Dominican Republic although specific information was unavailable.

Bahamas

Use of bleach for fish capture has been reported from the Bahamas (Hess and Stevely, no date).

Puerto Rico

Export of organisms for the aquarium trade began in about 1970. In the early 1970's, Lubbock and Polunin found Puerto Rico listing 49 species available for export (Lubbock and Polunin, 1975). In 1983, Puerto Rico supplied 0.1% of total U. K. imports, representing approximately 123,000 kg in weight. The U. S. is the principal import market. Until recently the number of collector/exporters has been small but over the last 2-3 years there has been an increase in collecting and export activity on the Island. Possible reasons for this are the excellent air transport facilities, the increased restrictions on Florida-based collectors, and increased demand for marine aquarium organisms in general. Listings of exported species are provided to Puerto Rico's Department of Natural Resources personnel at the Luis Muñoz Marín airport where shipments must be inspected. Summaries of these data are not compiled. The aquarium fish trade is not specifically regulated, although collection of a number of marine species (e.g. lobster with carapace length less than 3.5" and removal of corals including sea fan/gorgonian) is prohibited, as is the use of poisonous substances in Puerto Rico waters (regulated under Law No. 83, May 13, 1936, known as the "Ley de Pesca", and amendments), and the taking of "live rock" (Law No. 132, June 25, 1968, amended). The treatment of animals maintained in captivity is also regulated (Ley, 67 May, 1973, known as the "Ley para Protección de Animales"). Exporters do not have to be licenced and collectors are not legally recognized as commercial fishermen.

THE MARINE AQUARIUM TRADE IN PUERTO RICO (1990-1991)

Collection of Data

Information on the aquarium trade in Puerto Rico was obtained from conversations with knowledgeable contacts both within and outside the aquarium trade in Puerto Rico and in Florida, as well as officials of the Florida and Puerto Rico Departments of Natural Resources. All individuals known to be active in the export trade for a number of years were either visited at their business facilities or interviewed by telephone. Information was summarized on species, or species complexes, indicated on company trade lists as available in Puerto Rico, species, or species complexes, actually exported (by number of organisms), and numbers of boxes of organisms imported and exported per month, for 1990-1991. Export information was obtained from export packing lists of individual shipments (shipping lists) from a total of 92 (species composition of exports data) and 81 (boxes exported data) shipping lists, respectively (11 shipping lists had species composition data but did not show numbers of boxes exported). The shipping lists utilized do not constitute a random subset of all island exporters as some, not necessarily the biggest shippers, are more frequently represented than others.

<u>Collectors/Exporters</u>

Most collectors are exporters, although some collectors also sell their catch to an exporting middleman, or, less frequently, to Island pet shops. There are at least 6 export businesses on the Island. These are based in western and southern Puerto Rico and also out of San Juan. Three of these businesses have been established in the export trade for a number of years, others are relatively recent: several collectors started by selling locally and then later began to export. One recently established business is reportedly initiating a breeding program for Indo-West Pacific anemonefish (clownfish). Combined, the businesses depend on about 40 regular collectors working on a full- or part-time basis, with additional individuals collecting on a more casual basis. I would estimate that less than 100 people are involved in all phases of the aquarium trade, from collectors and their assistants, to biologists, packers and shippers. Most exporters depend for the majority of their income on the export trade, but often have other means of income outside of the aquarium industry.

<u>Methods Used for the Harvest of Marine Organisms</u>

Major collectors have their own boats, diving and collecting gear. Boats are in the order of 7 m in length. Collecting trips may be made 7 days a week if weather permits and demand is high, otherwise collecting trips may be made 3-4 days weekly. Demand tends to be highest in the winter and lowest in the summer months (Wood, 1985; pers. comm.). Collectors visit specific collecting areas depending on species being sought and indicate that they are careful to rotate the area of collection to avoid fishing too heavily in any one location. Collection is predominantly by SCUBA, generally down to 20 m but occasionally to 40 m for certain species. Mask and snorkel are commonly used in shallow-water areas.

Collection is by net (barrier, gill, drop or cast, and hand or dip nets), fish trap (1/4 - 1/2" mesh, and specialized traps - for example to catch Gramma loreto), chemicals such as 'Quinaldine', and slurp gun (not common). Cast nets are small circular nets with weights attached along the outer edge, and hand or dip nets are generally comprised of 1/8" monofilament mesh and may incorporate plastic panels. There are also reports that bleach, formalin and gasoline have been used on occasion, especially in the area of La Parguera. Quinaldine (2-methyl-quinoline) is mixed with isopropyl or ethyl alcohol or acetone, diluted with seawater and dispensed from bags, small plastic bottles or pressure sprayers. It is derived from coal tar and used in the manufacture of dyes and explosives (Hess and Stevely, no date). There is considerable debate regarding the short- and long-term effects of this chemical on fishes and invertebrates, although it is clear that it is toxic to certain species (see below). Many wholesalers are reluctant or refuse to purchase fish collected with quinaldine because they believe that mortality rates are higher than with net-caught fishes. Some collectors interviewed indicated that quinaldine-caught fish may be detected visually by damage to gills which come to look "burned" or pinker than the gills of fish not exposed to this chemical. Many locations prohibit the unpermitted use of quinaldine because of its perceived detrimental effects on marine organisms (e.g. Hawaii and Florida).

Areas Collected

Collection areas are north and south of the Rincón peninsula, Punta Arenas in Cabo Rojo (for sea mat - *Zoanthus*), and along the northwest coast to Arecibo for certain species such as angelfish and blennies (Fig. 1). The island of Desecheo 20 km west of Rincón is especially suitable for yellowhead jawfish (*Opistognathus aurifrons*), royal gramma (*Gramma loreto*) and pygmy angelfish (*Centropyge argi*). Collecting is also carried out extensively around the reefs and mangrove islands of La Parguera, especially for invertebrates and queen angelfish, as well as southeast of Ponce, especially off the island of Caja de Muertos, 8 km offshore, for angelfish and triggerfish, and between Ponce and Salinas. No collection sites could be confirmed off eastern Puerto Rico although collection has recently been proposed for Fajardo and Isla Cabra, and has been reported to occur sporadically in Culebra.

Species Collected

Species composition, as determined from trade lists and exporters' shipping lists, of 5 different shippers between 1990 and 1991, is shown in Table 1. A total of 155 species (plus a few "miscellaneous" invertebrate species which could not be identified to genus), or species groups, appeared on traders' lists, as available in Puerto Rico, 104 fish species and 51 (+ miscellaneous) invertebrates. Of these, 83 fish species and 23 (+ miscellaneous) invertebrates were noted as exported. Examination of a subsample of 92 shipping lists from 4 different shippers indicated that 6 species, or families, made up 70% of the total fish export: Gramma loreto; Opistognathus aurifrons; Holacanthus tricolor; Pomacanthus paru; Balistes vetula, and assorted blennies. Principal fish families exported were Grammidae, Opistognathidae, Pomacanthidae, Chaetodontidae, Pomacentridae, Holocentridae, Blenniidae, Labridae, and Balistidae. Individuals are taken between 3.5 - 13 cm depending on the species.

A wide variety of invertebrates was exported, in particular anemones, shrimps, crabs, flame scallop, and various echinoderms, e.g. brittlestars. There were difficulties in identifying to species a variety of species. Often, common names were used which are not species-specific or names of species not present in Puerto Rico, or even in tropical waters, were applied. Several species were listed as available on company trade lists (although not recorded as shipped) the taking of which is not permitted (e.g. lobster, gorgonian/sea fan). Removal of certain species would require removal of substrate and hence come under the definition of "live rock" (e.g. Ricordea florida). I believe that the volume of invertebrates exported is grossly under-represented in shipping lists. It has been reported, for example, that in a single day collectors take many hundreds of anemones from La Parguera.

Handling and Shipping of Marine Organisms

Animals are taken to holding facilities and generally retained for a few days prior to packing and export. Facilities vary from a small number of plastic "paddling pools" fed by a simple flow-through water system, to a series of glass and concrete tanks, under-gravel and ultra-violet filters, and protein skimmers. On several occasions I observed small numbers of unhealthy fish (pale in color, fins torn, listless) in holding facilities. Some collectors report that fish considered to be in less than good health are returned to the sea.

For shipping, animals are packed in single or double plastic bags. These are filled with oxygen by some shippers, and the bags closed and placed in boxes for shipping. Boxes vary in dimension from 30 x 43 x 43 cm (12 x 17 x 17") to 53 x 53 x 53 cm (21 x 21 x 21") and may or may not be lined with insulating material for stabilization of temperature, depending on shipper, destination and season. The majority of marine organisms is currently shipped out of San Juan (Luis Muñoz Marín airport) to the east and west coasts of the U. S. A., Canada, and to Europe, particularly to the U. K. and Germany. However, some export also occurs out of

Aguadilla, and reportedly on occasion through the postal system (Federal Express) and United Parcel Service (U.P.S.).

Listings of exported species are provided to Department of Natural Resources personnel at the Luis Muñoz Marín airport where shipments are inspected. Shipments must also be checked by the U. S. Division of Fish and Wildlife, who charge a $25 inspection fee, if for export outside U. S. territory

Estimates of mortality from the time of capture to the time of export reportedly varies between 10% and 20% depending on capture and handling methods, the level of skill of collectors and conditions of holding facilities. This estimate of mortality is high compared to mortality rates reported for net-caught fish in Hawaii (Poollen and Obara, 1984) and relative to the most commonly cited level in the industry of 10% (Wood, 1985). Some fish importers consider that mortality rates of more than a few percent are unacceptable (pers. comm. Richard Sankey).

Estimated Export/Import Volume (1990-1991)

From the shipping lists, it was determined that an average shipment of fish and invertebrates comprised 12 boxes (range 2 - 29) and that each box on average contained 31 organisms (range 7 - 100, depending on the species involved and their size). It was estimated from interviews with exporters that an average of at least 9 shipments a week leave Puerto Rico. This provides a monthly estimate of 432 boxes exported per month (9 x 12 x 4), and 5184 boxes per year, containing an annual total of 160,704 organisms (9 x 12 x 4 x 12 x 31). This does not include U. S.

mail or U. P. S. shipments. Exporters vary in the number of shipments from 1-3 per week. Boxes were estimated to weigh between 8-14 kg, if not containing coral or "live rock". To put into perspective the current volume involved in this trade, the estimated number of organisms exported is approximately equivalent to the total number of grouper reported landed annually by the commercial fishery of Puerto Rico (Fisheries Research Laboratory, PRDNR, unpubl. data). Grouper are among the most frequently landed fish categories on the Island.

The number of boxes exported appearing in Department of Natural Resources records (2448 for 10 months) (Table 2) is clearly a gross underestimate of true exports. This conclusion is supported in part by reports of zero boxes in June, July and August, 1991, during which months export shipments were made according to interviews with collectors/exporters. Furthermore, Department figures did not include shipments out of the Aguadilla airport where airport inspection activity is reported to be minimal. Substantial imports of marine organisms were also noted (Table 2).

SPECIES DESCRIPTIONS OF COMMONLY EXPLOITED MARINE ORGANISMS

Fish Species

For the majority of species exploited, there is little life history information available. Only data on the most commonly exported species, as determined from shipping lists, are summarized. However, other species of importance for the industry are damselfish, such as blue chromis, *Chromis cyanea*, the pygmy angelfish, *Centropyge argi*, and a number of squirrelfish species and blennies, in particular the red-lipped blenny, *Ophioblennius atlanticus*.

Gramma loreto - royal gramma, fairy basslet (Grammidae)

A violet/yellow colored fish commonly found in groups of 2-3 to dozens or more in clear waters down to about 60 m although generally in shallower water (Böhlke and Chaplin, 1968; Randall, 1983). Its range extends from Bermuda and the Bahamas throughout the Antilles to islands off Venezuela. It is apparently absent from Florida (Böhlke and Chaplin, 1968). It is found in high vertical relief habitat, in caves and under ledges in restricted home ranges where residency has been reported up to 76 weeks (Luckhurst and Luckhurst, 1978). It is mainly planktivorous (Luckhurst and Luckhurst, 1978), although it has been reported to feed on the ectoparasites of other fish (Eibl-Eibesfeldt, 1955). It attains just over 8 cm in total length and shows little sexual dimorphism other than a somewhat larger male mean size (Thresher, 1984). Reproduction in Puerto Rico occurs between January and June (Amador, 1982), and in Curaçao recruitment was noted through much of the year, with peaks in September and May (Luckhurst and Luckhurst, 1978). Information on the biology of this species is scattered and fragmented and there is some debate over its sexual pattern, which has been proposed to be hermaphroditic (Corsten and Corsten, 1974). This is considered to be a common western Atlantic species (Randall, 1983). It is captured predominantly using quinaldine with which 300-500 individuals may be captured in a day. Occasionally a specially designed hand trap may be used but catch rates are reported to be substantially lower than with quinaldine. Several aggregations of this species were monitored after partial or total removal (Kruijf, 1978). Replacement occurred within 1-4 weeks and was dependent on levels of recruitment into the area.

Holacanthus tricolor - rock beauty (Pomacanthidae)

A pomacanthid (angelfish) found in the western Atlantic from Georgia, Bermuda and the Bahamas to Brazil and in the Gulf of Mexico (Böhlke and Chaplin, 1968; Randall, 1983). It occurs to depths of approximately 10 m and forages solitarily during the day, feeding on algae and sponges, and occasionally ascidians, fish eggs, gorgonians and zooantharians (Neudecker and Lobel, 1982). It has been reported to attain 34 cm in length (Munro, 1983), although it is not generally of value to the aquarium trade at lengths greater than 13 cm. The young up to about 2.5 cm are yellow in color with a black spot on the upper side of the body posterior to the mid-point. This spot later grows to become the large dark area covering most of the body, and dorsal and anal fins (Randall, 1983). Juveniles may feed on the cutaneous mucus of larger cave-dwelling fishes (Thresher, 1984). Spawning has been observed at dusk in triplets or small groups of one male and several females, throughout much of the year (Moyer et al., 1983; Munro, 1983). The smallest mature female was recorded at 10 cm total length (Munro, 1983), and the eggs are planktonic. Individuals are relatively sedentary. Females have overlapping home ranges and males defend large territories with a mean area of approximately 1,000 m^2 which encompass a number of female home ranges (Hourigan and Kelley, 1985). The sexual pattern of this species is unclear and protogynous hermaphroditism has been proposed (Hourigan and Kelley, 1985). The species is sexually monomorphic. Rock beauty are caught using large hand nets, and with quinaldine.

Holacanthus ciliaris - queen angelfish (Pomacanthidae)

This angelfish is colored blue/green and yellow. There is no sexual dichromatism. It is distributed in the tropical western Atlantic from the Gulf coast of Florida and the southern Gulf of Mexico, through the Bahamas down to Brazil (Böhlke and Chaplin, 1968; Randall, 1983). It has been collected to a maximum length of 43 cm (Randall, 1983), and is often found in triplets or small groups (Thresher, 1984). Ripe fish have been reported in all months of the year except November and December (Munro et al., 1983). Individuals tend to stay in the same general area (Randall, 1962). This species is taken with nets and quinaldine. Its capture is banned in Curaçao because of its rarity (Lubbock and Polunin, 1975).

Pomacanthus paru - french angelfish (Pomacanthidae)

The adults of this species are grey and the juveniles are black with vertical yellow bands. Juveniles are known to pick the skin of various fish species and have been observed cleaning the teeth of large needlefish (Böhlke and Chaplin, 1968). It is distributed in the western Atlantic from the Bahamas and Florida to Brazil. Ripe individuals were collected from May to November in Jamaica (Munro, 1983). French angelfish have been reported to reach 41 cm (Randall, 1983), although only individuals up to about 13 cm are used for the aquarium trade. They are taken with hand nets and quinaldine.

Bodianus rufus - spanish hogfish (Labridae)

A red/violet/yellow fish with a black spot on the anterior portion of the spinous dorsal fin. It is recorded in the western Atlantic from Bermuda, the Bahamas and Florida to Brazil, including the Gulf of Mexico, the coast of Central America and Venezuela (Böhlke and Chaplin, 1968; Randall, 1983). This is a reef-associated species found down to about 40 m. The young pick parasites from larger fishes. Individuals have been reported to reach about 40 cm (Randall, 1983) and feed on crabs, sea urchins, brittlestars and mollusks. The social structure is characterized by stable dominance hierarchies that are linearly organized according to sex and relative size. Males are generally larger and dominate groups of up to 12 females in permanent territories (Hoffman, 1985). Females mature at about 10 cm and spawning occurs daily at sunset through much of the year. Eggs are planktonic and the species is protogynous (Hoffman, 1985). Individuals are predominantly caught by hand net and quinaldine.

Thalassoma bifasciatum - bluehead wrasse (Labridae)

This is one of the most abundant West Indian reef fishes and is distributed from Bermuda and the Bahamas, southern Florida, southern Gulf of Mexico, throughout the Caribbean Sea to the islands of the north coast of South and Central America (Böhlke and Chaplin, 1968; Randall, 1983). The species has several different color phases, exhibiting marked sexual dichromatism, and its name derives from the largest phase, that of the adult male. It feeds on small benthic animals and zooplankton, and the juveniles feed on the ectoparasites of other fishes (Randall, 1983). It spawns through much of the year in pairs or groups at about midday, is a diandric protogynous hermaphrodite, and produces planktonic eggs (Thresher, 1984). Some males defend territories and females have home-ranges. It is reported to reach about 15 cm (Randall, 1983). Only blueheads are caught for the aquarium trade in Puerto Rico resulting in differential male removal from exploited populations. Individuals are generally taken by hand nets to which they are attracted by bait such as crushed sea urchin.

Halichoeres radiatus - puddingwife wrasse (Labridae)

The puddingwife wrasse is known from Bermuda and North Carolina to Brazil (Böhlke and Chaplin, 1969), and is recorded to reach a length of 46 cm (Randall, 1983). It is found in areas of coral cover where individuals are often seen singly, and is somewhat secretive. The species exhibits sexual dichromatism and is reported to be hermaphroditic. The smallest mature female recorded was 16 cm in standard length (Warner and Robertson, 1978).

Opistognathus aurifrons - yellowhead jawfish (Opistognathidae)

A yellow/white colored jawfish which is found in the

Florida Keys and throughout the West Indies (Randall, 1983). It usually lives in sandy areas in vertical burrows lined with small stones or shell fragments above which it is most commonly seen to hover as it feeds on zooplankton (Randall, 1983; Thresher, 1984). It occurs in relatively shallow water and attains a length of about 10 cm (Randall, 1983). Its abundance has been reported to vary seasonally and it is often found in large groupings (Kruijf, 1978). Spawning occurs in the burrow and males incubate eggs in their mouth. Eggs hatch within 7-10 days and settlement occurs at about 10-15 mm (Thresher, 1984). The species is sexually monomorphic and is a popular aquarium fish (Thresher, 1984). It is caught predominantly by using quinaldine, although this species is reported to be particularly sensitive to quinaldine and is easily killed by overdosing (Colin, 1975).

Balistes vetula - queen triggerfish (Balistidae)

Distributed from Massachusetts to Brazil, this is a common species on reef or rocky areas, but ventures to adjacent sand rubble or seagrass areas (Randall, 1983). Adults are solitary diurnal feeders on a great variety of invertebrates but particularly on sea urchins, such as _Diadema_ (Randall, 1983). It may also be found in schools and has been reported to occur down to 100 m (Munro, 1983), although smaller individuals are generally found in shallow water. The queen triggerfish is reported to attain a fork length of 57 cm (Randall, 1983) and to mature sexually at about 17 cm (Munro, 1983). Ripe individuals have been collected between January and August in Puerto Rico (Erdman, 1976). This species is commercially exploited and rated number 16 of the 33 most economically-important fish groups in Puerto Rico in 1990 (Matos and Sadovy, 1991). Individuals are taken with quinaldine at about 5 - 7 cm length - only juveniles of this species are apparently exploited for the aquarium trade.

Invertebrate Species

A wide range of invertebrate species are taken, in particular brittlestars, cleaner shrimps, flame scallops and anemones (Table 1). Reports indicate that several hundred individuals of the anemone *Condylactis* may be taken in a single day from La Parguera, a location particularly popular for collection of invertebrate species. A number of species reported as being available on traders' lists are in reality what should most accurately be described as "live rock". For example, *Ricordea florida* must be removed with its rocky substrate and is considered one type of "live rock" in Florida. Certain species such as the flame scallop, some feather dusters and the christmas tree worm are typically removed with accompanying substrate and should likewise be considered "live rock". Collection of brittlestars and some tube worms may necessitate the lifting or displacement of rock or coral substrate. Some organisms are extracted individually from sandy substrates. Cleaner shrimp are removed from host anemones. The effect of the removal of cleaners (fish or shrimp species) on the general health of reef fish is unknown. The long- and short- term effects of using quinaldine both on individuals captured, or impacted when other species are being taken, or on associated habitat at time of capture are not clear. However, its effect is clearly toxic in some cases. This chemical has been shown to cause no damage to certain scleractinian corals during preliminary studies but was found to have a detrimental effect on two coral species, Agaricia agaricites and Meandrina meandrites (Jaap and Wheaton, 1975). Jellyfish may be killed instantly by quinaldine (Ireland and Robertson, 1974), and crustaceans and cephalopods showed signs of irritation at quinaldine concentrations used to anesthetize fishes, although it is unclear if it was the alcohol associated with the quinaldine or the quinaldine which causes the reaction (Hess and Stevely, no date). This chemical has also been shown to induce significant histopathological changes in the thyroids of mice, and thyroid abnormalities have also been encountered in people exposed to quinaldine (Dr. F. Khafagi, Director of Nuclear Medicine, Royal Brisbane Hospital, Herston, Brisbane, 4029, Australia).

BIOLOGICAL AND SOCIO-ECONOMIC DATA NEEDS

In order to monitor and evaluate the volume, nature and potential impact of the marine aquarium trade in Puerto Rico, information is needed, on an annual basis, on the number of individuals collecting and exporting organisms, the numbers and types of animals collected and exported, and the extent of trade in aquarium organisms within Puerto Rico i.e. non-export trade. Also, some means of measuring catch per unit effort (perhaps on a per trip basis) should be established.

Species identification of a number of invertebrate organisms needs clarification by direct examination of specimens, if possible, and the principal collection areas should be assessed regarding their significance, if any, as critical habitats. The capture methods employed need to be evaluated to ascertain to what extent these may impact detrimentally either targeted or non-targeted species and associated habitat. In particular, the short- and long-term impact of using quinaldine to collect vertebrate and invertebrate species must be addressed if limited use of this chemical is to be permitted.

The potential for user conflict between aquarium industry collectors, commercial fishermen and the tourist/recreational industry needs evaluation. Stock analyses of species exploited by more than one user group (such as the queen triggerfish, Balistes vetula) should be made to determine the combined impact of removal of individuals at distinct life history phases, by different user groups, on the overall condition of the stock. The impact of collection activities on areas programmed for tourist development, such as Caja de Muertos, should be evaluated.

Biological data on the life history of principal species exploited is inadequate, particularly with respect to reproductive biology, and special habitat requirements, vulnerability to collecting methods, if any, and abundance on a local and island-wide level. Assessment of commonly collected organisms regarding their suitability as aquarium species would enable formulation of recommendations concerning species considered appropriate for exploitation by the industry. For example, if mortality in aquaria is high (such as determined for certain butterflyfishes, see above), exploitation for the aquarium industry should be discouraged. It is necessary to assess the holding and shipping techniques utilized by collector/ exporters to ensure that mortality is minimized, the animals treated humanely, and hence that best use is made of exploited resources.

The time required for recolonization of an area following heavy collection should be assessed. For example, areas heavily collected in the Bahamas using rotenone and subsequently monitored were found to exhibit disturbances in population balance for at least 4 months following collection. Between 4-9 months were required to re-establish the pre-collection population equilibrium (Smith, 1973). The time required for recolonization by Gramma loreto was found to be dependent upon availability of recruits (Kruijf, 1978). A study by Taylor and Nolan carried out over 2.5 years in Hawaii on the 5 most frequently exploited fish species indicated that more heavily collected areas did not show greater reductions when compared to non-collected areas but did indicate population fluctuations in certain species for both collected and uncollected areas (Taylor and Nolan, 1978). Populations of heavily fished species (e.g. royal gramma, yellowhead jawfish, angelfish species, and a number of invertebrates) should be monitored to determine the impact of heavy collection, and how this may vary seasonally. Recommendations regarding appropriate periods for collection, or for protection of collected areas or species, based on biological knowledge of population responses to collection, could be made to reduce the possibility of over-exploitation.

MANAGEMENT OPTIONS AND CONSIDERATIONS

1. Collectors and exporters of marine organisms for the aquarium trade should be licenced to collect and export marine organisms, and the number of licences limited according to availability and suitability for exploitation of fish and invertebrate resources. To prevent further expansion of the industry until the necessary studies and evaluations are available, licences could be restricted to those individuals who can clearly demonstrate current and substantial activity in the industry in Puerto Rico. Licence applications should include socio-economic details of applicants.
2. Licenced collectors/exporters should be required to submit monthly reports on numbers of each species captured, as well as exported or sold in Puerto Rico, and location and method of capture. Listings should include both common and latin names.
3. Holding facilities and packing materials and techniques used for shipment should meet certain specified standards to minimize mortality and to ensure the good health and welfare of live organisms. Exporters should demonstrate knowledge of Commonwealth and Federal laws pertaining to the capture, treatment and shipping of marine organisms.
4. The use of quinaldine to capture fishes should be unequivocally prohibited on the basis of its proven toxicity to certain fish and coral species, pending further study of its effects, if this should be determined as necessary. The use of any other

capture method determined to be damaging to organisms harvested, or to the coral reef environment, should be prohibited, or carefully regulated.

5. Inspections of export shipments should be thorough and made on all shipments from both San Juan and Aguadilla (or others as necessary) airports, or any other shipment points. Inspectors need to be trained to recognize marine species of fish and invertebrates. Any box weighing over approximately 14 kg should be carefully inspected for coral or "live rock". Shipment weights should be noted, and monthly figures showing export volume (by number of boxes and by weight should be made available in summarized form.

6. Consideration should be given to the possibility of introducing annual quotas for the capture of certain vulnerable or uncommon species (possible candidates are sea horses and swiss-guard basslets), species which do not survive well in captivity, or species which may be of particular importance to the reef ecosystem, such as fish and invertebrates which clean ecto-parasites off other species. Global annual catch quotas, in addition to limited entry (item 1), should be introduced to prevent expansion of collection activity while the resource base and other biological questions are being assessed.

7. Consideration should be given to the imposition of size limits (minimum and/or maximum) to protect life history phases deemed to be particularly vulnerable to overexploitation.

8. A summary of laws which relate to all phases of the collec-

tion, handling, maintenance, and sale and export of organisms for the aquarium trade should be developed and pertinent regulations clarified and communicated to the industry.

9. Collectors and exporters of marine organisms marketed for the aquarium trade should be encouraged to participate fully in the development of a management policy for the fishery.

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I am grateful to the following people who shared with me their knowledge of the trade in aquarium fishes, provided me with relevant literature, and expressed their concerns for the future of the industry in Puerto Rico, and for its possible impact on marine resources. Without their cooperation, this report would not have been possible. In particular, I thank Enrique Acosta, Kazue Asoh, Jim Bohnsack, Conrado Calzado, Georgia Cranmore, Mark Derr, Angelo Félix, Craig Heberer, Hector Javier López, Longin Kaczmarsky, Bill McMillan, José Rafols, David Rivera, Gary Rogers, Richard Sankey and personnel of the Puerto Rico Department of Natural Resources.

LITERATURE CITED

Albaladejo, V. D. and V. T. Corpuz. 1981. A market study of the aquarium fish industry of the Philippines: an assessment of the growth and the mechanics of the trade. Proc. 4th Int. Coral Reef Symp. Vol 1:75-81

Amador, L. M. 1982. Reproductive biology of the fairy basslet; Gramma loreto Poey. M. S. Thesis. Univ. Puerto Rico, Mayagüez, Puerto Rico 39 pp.

Anon. 1979. International trade in tropical aquarium fish. International Trade Centre (UNCYAD/GATT), Geneva. 137 pp.

Barratt, L. and P. Medley. 1990. Managing multi-species ornamental reef fisheries. Prog. in U.W. Sci. 15:55-72

Böhlke, J. E. and C. C. G. Chaplin. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingstone Publishing Co., Wynnewood, Pennsylvania

Colin, P. L. 1975. The neon gobies. T.F.H. Publ., Neptune City, New Jersey.

Conroy, D. A. 1975. An evaluation of the present state of world trade in ornamental fish. FAO Fisheries Technical Paper, No. 146:128 pp.

Corsten-Hulsmans, C. J. F., and A. J. A. Corsten. 1974. Gramma loreto, een hermafrodiete Koraalvis van Curaçao: Oecologische aspecten en gevolgen van bevissing. Katholieke Universiteit Nijmegen, Netherland. Report. Zool. Lab. Dept. Dieroecologie No. 92. PP 64

Dawson-Shepherd, A. R. 1977. Collected in the Philippines. The Aquarist 7(10):5-14

Edwards, A. J. 1988. Preliminary report on the aquarium fish export trade of the Republic of Maldives. Centre for Tropical Coastal Management Studies, Univ. of Newcastle upon Tyne, U. K.

Eibl-Eibesfeldt, I. 1955. Uber Symbiosen, Parasitismus und andere besondere zwischenactliche Beziehungen tropischer Meeresfische. Z. Tierpsychol. 12 (2): 203-219

Erdman, D. S. 1976. Spawning patterns of fishes from the northeastern Caribbean. Agricultural and Fisheries Contributions, Department of Agriculture, Commonwealth of Puerto Rico Vol. 8 (2):1-36

Hess, D. and J. Stevely. No date. The aquarium reef fish collecting industry in Monroe County, Florida. Marine Resource Inventory, Monroe County Marine Advisory Program, Florida Cooperative Extension Service 27pp. Unpubl. report

Hoffman, S. G. 1985. Effects of size and sex on the social organization of reef-associated hogfishes, Bodianus, spp. Envir. Biol. Fish. 14:185-197

Hourigan, T. F. and C. D. Kelley. 1985. Histology of the gonads and observations on the social behavior of the Caribbean angelfish Holacanthus tricolor. Mar. Biol. 88:311-322

Ireland, P. J., and G. C. Robertson. 1974. A review of evidence relating to the use and effects of sodium cyanide and other methods commerially employed on coral fish collecting. British Marine Aquarists Association Booklet No. 2. 15 pp.

Januzzi, C. L. 1991. A guide to developing a limited entry program for the marine life fishing industry. Manuscript submitted in requirement for internship, Rosenstiel School of Marine and Atmospheric Science, MAF 705

Jaap, W. C. and J. Wheaton. 1975. Observations on Florida reef corals treated with fish-collecting chemicals. Florida Marine Research Publications No. 10:17 pp.

de Kruijf, H. A. M. 1978. Report on the export of fishes and invertebrates for the aquarium trade from Curaçao 1972-1977. STINAPA documentation series No. 1:24 pp.

Luckhurst, B. E. and K. Luckhurst. 1978. Diurnal space utilization in coral reef fish communities. Mar. Biol. 49:325-332

Lubbock, H. R. and N. V. C. Polunin. 1975. Conservation and the tropical marine aquarium trade. Envir. Conserv. 2(3):229-232

Matos, D. and Y. Sadovy. 1991. Puerto Rico Department of Natural Resources/National Marine Fisheries Service annual report for the Interjurisdictional Fisheries Program. June 21st, 1991:53 pp.

Moyer, J. T., R. E. Thresher and P. L. Colin. 1983. Courtship, spawning and inferred social organization of american angelfishes. Envir. Biol. Fish. 9:25-39

Munro, J. L. 1983. Caribbean coral reef fishery resources. ICLARM Studies and Reviews 7. 276 pp.

Munro, J. L., V. C. Gaut, R. Thompson and P. H. Reeson. 1983. The spawning seasons of Caribbean reef fishes. J. Fish. Biol. 5:69-84

Neudecker, S. and P. S. Lobel. 1982. Mating systems of chaetodontid and pomacanthid fishes at St. Croix. Z. Tierpsychol. 59:299-318

van Poollen, H. W. and A. M. Obara. 1984. Hawaii's marine aquarium fish industry profile. Studies on marine economics No. 3. Ocean Resources Office Contribution No. 14. 21 pp.

Randall, J. E. 1962. Tagging reef fishes in the Virgin Islands. Proc. Gulf Caribb. Fish. Inst. 14:201-241

Randall, J. E. 1983. Caribbean reef fishes (revised). T. F. H. Publ., Neptune City, New Jersey

Randall, J. E. 1984. Collecting reef fish for aquaria. In press. (cited in Woods, 1985)

Robins, C. R. 1976. Aquarium Fish Hobby: Its impact on the economy and environment of southern Florida. Proceedings of the Gulf Caribb. Fish. Inst. 28:83-86.

Smith, C. L. 1973. Small rotenone stations: a tool for studying coral reef fish communities. Amer. Mus. Novitat. 2512:1-21

Taylor, L., and R. Nolan. 1978. Papers and comments on tropical reef fish. Working Paper No. 34. August, 1978. Sea Grant College Program, University of Hawaii

Thresher, R. E. 1984. Reproduction in reef fishes. T. F. H. Publ., Neptune City, New Jersey, 399 pp.

Walsh, W. J. 1978. Papers and comments on tropical reef fish. Working Paper No. 34. August, 1978. Sea Grant College Program, University of Hawaii

Warner, R. R. and D. R. Robertson, 1978. Sexual patterns in the labroid fishes of the western Caribbean, I: the wrasses (Labridae). Smithsonian Contributions to Zoology. No. 254:1-27

Wells, S. M. 1981. International trade in ornamental corals and shells. Proc. 4th Int. Coral Reef Symp. 1:323-330

Wheaton, J. L. 1989. The marine-life fishery for "live rock": biological and ecological assessment of the product and implications for harverst. Florida Marine Research Institute, Flor. Dept. Nat. Res.:18 pp.

Whitehead, M. J. Gilmore, E. Eager, P. McMinnity, W. Craik and P. Macleod. 1986. Aquarium fishes and their collection in the Great Barrier Reef region. Great Barrier Reef Marine Park Authority Tech. Mem. GBRMPA-TM-13

Wood, E. 1985. Exploitation of coral reef fishes for the aquarium trade. Report to the Marine Conservation Society. U. K. 129 pp.

TABLE 1:

Fish and invertebrate species, or species groups, exported from Puerto Rico, or indicated on company trade lists available for export, according to trade lists and shipping lists for 1990/1

FISHES:

Elasmobranchs	SHARKS, SKATES, RAYS	
Gymnothorax miliaris	GOLDENTAIL MORAY	44
Gymnothorax funebris	GREEN MORAY	
Myrichthys oculatus	GOLDSPOTTED SNAKE EEL	4
Echidna catenata	CHAIN MORAY	
Muraenids	MORAY "EELS"	8
Plectrypops retrospinis	CARDINAL SOLDIER	183
Holocentrus ascensionis	LONGJAW SQUIRRELFISH	5
Myripristis jacobus	BLACKBAR SOLDIERFISH	242
Holocentrids	SQUIRRELFISH	3
Apogon maculatus	FLAME/FISH/CARDINAL	98
Astrapogon stellatus	CONCHFISH	1
Priacanthus arenatus	BIGEYE	24
Priacanthus cruentatus	GLASSEYE	26
Chromis cyanea	BLUE CHROMIS	439
Chromis insolatus	SUNSHINE DAMSELFISH	20
Abudefduf saxatilis	SERGEANT MAJOR	12
Stegastes partitus	BICOLOR DAMSELFISH	
Stegastes leucostictus	BEAUGREGORY	49
Stegastes planifrons	YELLOW DAMSELFISH	20
Stegastes dorsopunicans	DUSKY DAMSELFISH	
Microspathodon chrysurus	YELLOWTAIL/JEWEL DAMSEL	299
Pomacentrids	DAMSELFISH	8
Thalassoma bifasciatum	BLUEHEAD WRASSE	612
Clepticus parrae	CREOLE WRASSE	43
Halichoeres cyanocephalus	LIGHTNING WRASSE	20
Halichoeres radiatus	PUDDING WIFE	587
Halichoeres maculipinna	CLOWN WRASSE	34
Halichoeres garnoti	YELLOWHEAD/NEON WRASSE	122
Xyrichtys splendens	RAZORFISH/GREEN WRASSE	26
Bodianus rufus	SPANISH HOGFISH	462
Labrids	WRASSES	
Sparisoma chrysopterum	REDTAIL PARROTFISH	
Scarus taeniopterus	PRINCESS PARROTFISH	
Scarids	PARROTFISH	20
Centropyge argi	PYGMY ANGELFISH	345
Pomacanthus paru	FRENCH ANGELFISH	882
Pomacanthus arcuatus	GRAY ANGELFISH	7
Holacanthus ciliaris	QUEEN ANGELFISH	114
Holacanthus tricolor	ROCK BEAUTY	1552
Pomacanthids	ANGELFISH	7
Chaetodon capistratus	4-EYE BUTTERFLYFISH	133
Chaetodon ocellatus	SPOTFIN BUTTERFLYFISH	
Chaetodon striatus	BANDED BUTTERFLYFISH	338

FISHES continued:

Chaetodon aculeatus	LONGSNOUT/NOSE BUTTERFLY	111
Chaetodontids	BUTTERFLYFISH	98
Gramma loreto	ROYAL GRAMMA	11124
Serranus tabacarius	TOBACCO FISH	57
Serranus tigrinus	HARLEQUIN BASS	76
Serranus annularis	ORANGEBACK BASS	1
Serranus baldwini	LANTERN BASS	13
Serranus tortugarum	CHALK BASS	54
Serranids	BASSES	14
Liopropoma rubre	SWISSGUARD BASSLET	6
Hypoplectrus nigricans	BLACK HAMLET	
Hypoplectrus indigo	INDIGO HAMLET	
Hypoplectrus unicolor	BUTTER HAMLET	
Hypoplectrus puella	BARRED HAMLET	
Hypoplectrus guttavarius	SHY HAMLET	1
Hypoplectrus gummigutta	GOLDEN HAMLET	
Hypoplectrus aberrans	YELLOWBELLIED HAMLET	
Serranids	HAMLETS	12
Paranthias furcifer	CREOLE FISH/ANTHIAS	135
Epinephelus fulvus	CONEY/GOLD CONEY	53
Epinephelus guttatus	RED HIND	12
Serranids	GROUPER	47
Rypticus saponaceus	SOAPFISH	1
Equetus punctatus	SPOTTED DRUM	21
Equetus lanceolatus	JACKKNIFE FISH	22
Pareques acuminatus	CUBBYU/HIGH-HAT	205
Chaetodipterus faber	SPADEFISH	6
Amblycirrhitus pinos	REDSPOTTED HAWKFISH	31
Anisotremus virginicus	PORKFISH	17
Ophioblennius atlanticus	REDLIP BLENNY	451
Blenniids	BLENNIES	948
Gobiosoma spp.	NEON GOBY	
Quisquilius hipoliti	RUSTY GOBY	
Gobiids	GOBIES	
Opistognathus aurifrons	YELLOWHEAD JAWFISH	2631
Opistognathus whitehurstii	DUSKY JAWFISH	126
Scorpaenids	SCORPIONFISH (STONEFISH)	8
Bothus lunatus	PEACOCK FLOUNDER	
	FLOUNDER	23
Symphurus arawak	CARIBBEAN TONGUEFISH	
Dactylopterus volitans	FLYING GURNARD/SEA ROBIN	437
Hippocampus spp.	SEA HORSE	24
Sygnathids	PIPEFISH	3
Acanthurus coeruleus	BLUE/YELLOW TANG	367
Acanthurus chirurgus	SURGEON TANG/DOCTORFISH	50
Balistes vetula	QUEEN TRIGGERFISH	920
Xanthichthys ringens	SARGASSUM/REDTAIL TRIGGERFISH	74
Canthidermes sufflamen	OCEAN TRIGGERFISH	1
Melichthys niger	BLACK TRIGGERFISH	76

FISHES continued:

Aluterus scriptus	SCRAWLED FILEFISH	
Cantherhines macrocerus	WHITESPOTTED FILEFISH	22
Monacanthids	FILEFISH	28
Lactophrys, Acanthostracion	TRUNKFISH, COWFISH	
Canthigaster rostrata	SHARPNOSE PUFFER	36
Diodon hystrix	PORCUPINEFISH	2
Antennarius spp.	FROGFISH	70
Ogcocephalus spp.	BATFISH	6
Synodus intermedius	LIZARDFISH	1
Mullids	GOATFISH	9
Aulostomids	TRUMPETFISH	60

INVERTEBRATES:

Haliclona spp.	ORANGE TREE SPONGE	45
	RED SPONGE	146
	ELEPHANT EAR SPONGE	50
	GORGONIANS/SEA FANS	
Tubastrea aurea	ORANGE POLYP (CORAL)	
Condylactis	CLUSTER ANEMONE/PINKTIP	382
Bartolomea annulata	CURLIQUE ANEMONE	150
	COLONY ANEMONE	45
Stoichactis helianthus	CARPET ANEMONE	105
Ricordea florida	GREEN ANEMONE	
Phymanthus crucifer	ROCK ANEMONE	10
Heteractis lucida	STINGING ANEMONE	
Aiptasia tagetes	ANEMONE	
Zoanthus spp.	ORANGE TUNICATE(?)/SEA MAT	
Sabellastarte magnifica	SOLO FEATHER DUSTER	75
Sabellastarte spp.	COLONIAL/CLUSTER DUSTER	61
Spirobranchus giganteus	CHRISTMAS TREE WORM	
Panulirus argus	SPINY LOBSTER	
Periclimenes spp.	ANEMONE SHRIMP	
Stenopus hispidus	RED-BANDED CORAL SHRIMP	102
Stenopus scutellatus	GOLD SHRIMP	2
Alpheus armatus	PISTOL SHRIMP	162
Lysmata spp.	PEPPERMINT SHRIMP/ SCARLET/LADY	15
Thor amboinensis	BUMBLEBEE SHRIMP	
Pseudosquilla	MANTIS SHRIMP	
Other hermits		10
Paguristes cadenati	RED LEG HERMIT	
Mithrax sculptus	GREEN/EMERALD CRAB	20
Percnon gibbesi	SALLYLIGHT/URCHIN CRAB	
	DECORATOR/SPONGE CRAB	
Stenorhynchus seticornis	ARROW CRAB	78
Mithrax cinctimanus	ANEMONE CRAB	

INVERTEBRATES continued:

Cyphoma gibbosum	FLAMINGO TONGUE	
Lima scabra	FLAME SCALLOP	280
	SPINY OYSTER	
Charonia variegata	TRITON	
Oliva reticularis	MEASLE COWRIE/OLIVE SHELL	
Tridachia crispata	NUDIBRANCH	
	OCTOPUS	
Astropecten	SAND STAR	76
Oreaster reticulatus	RED BAHAMA/WEST INDIES STARFISH	83
Subclass OPHIUROIDEA	BRITTLESTAR	180
Ophioderma	RED/SERPENT/BURGUNDY BRITTLESTAR	481
Astrophyton	BASKET STAR	
	CRINOID	
Diadema antillarum	LONG SPINE URCHIN	
Lytechinus spp.	PIN CUSHION URCHIN	
Eucidaris tribuloides	PENCIL URCHIN	103
Echinometra spp.	PURPLE/ROCK URCHIN	
Valonia ventricosa	SINGLE CELL	
Pencillus capitatus	NEPTUNE SHAVING BRUSH	
MISCELLANEOUS INVERTEBRATES		135

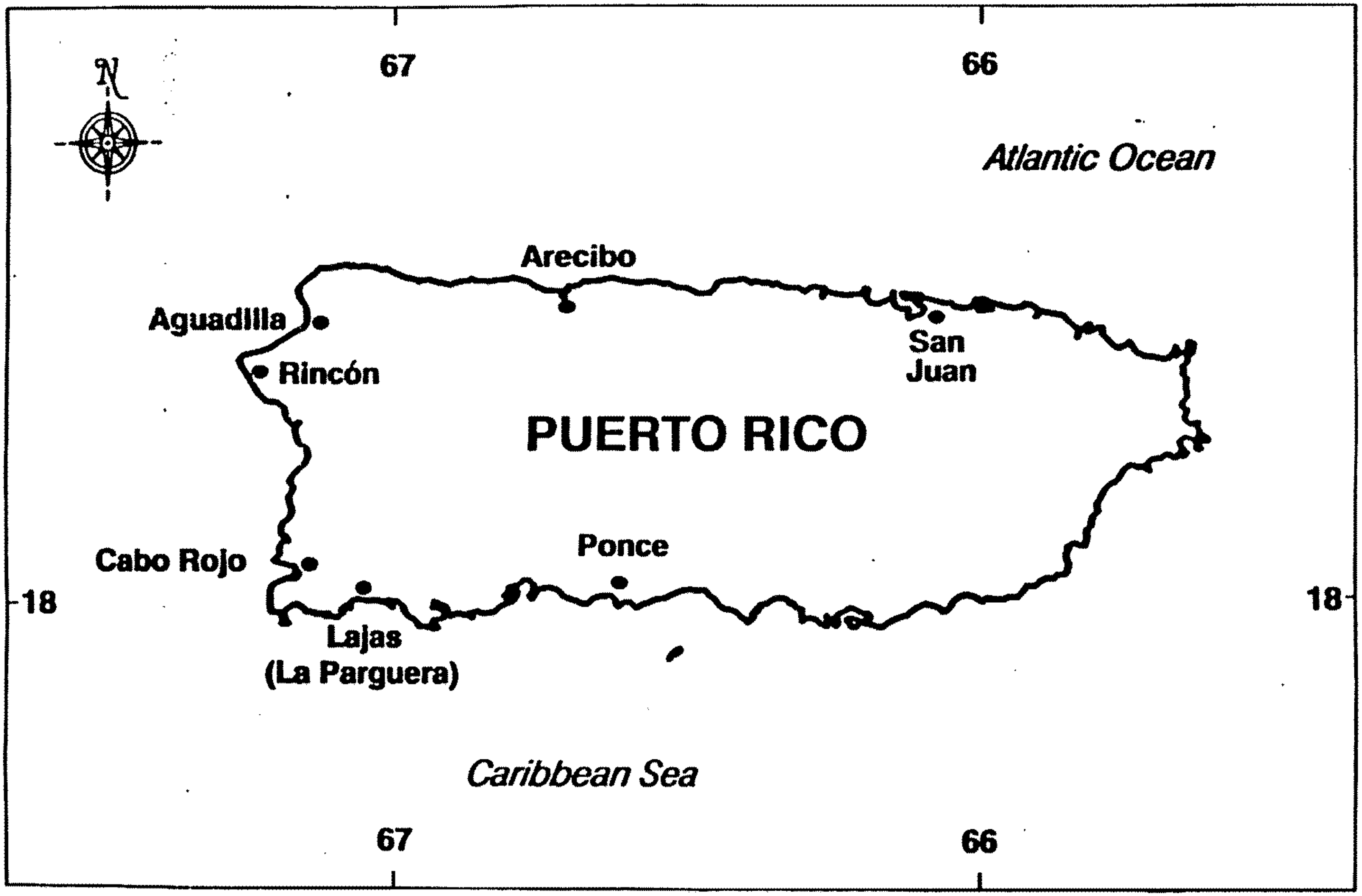
TABLE 2:

Numbers of boxes of marine fish and invertebrate species exported from and imported to Puerto Rico through the Luis Muñoz Marín airport by month for 1990 and 1991 (Source: Puerto Rico Department of Natural Resources)

	1990		1991	
MONTH	EXPORT	IMPORT	EXPORT	IMPORT
JANUARY	11	359	218	172
FEBRUARY	36	453	218	145
MARCH	0	0	98	192
APRIL	0	470	243	108
MAY	86	701	1,291	213
JUNE	332	637	0	154
JULY	239	726	0	149
AUGUST	146	0	0	87
SEPTEMBER	125	153	145	N/A*
OCTOBER	177	177	235	N/A
NOVEMBER	135	124	N/A	N/A
DECEMBER	114	167	N/A	N/A
TOTALS	1,401	3,967	2,448	1,220

* N/A - information not available

FIGURE 1: Collection areas discussed in text



APPENDIX III

INITIAL REGULATORY FLEXIBILITY ANALYSIS AND REGULATORY IMPACT REVIEW

INITIAL REGULATORY FLEXIBILITY ANALYSIS

and

REGULATORY IMPACT REVIEW

for

AMENDMENT 2 TO THE FISHERY MANAGEMENT PLAN

FOR THE SHALLOW-WATER REEFFISH FISHERY

of

PUERTO RICO AND THE U.S. VIRGIN ISLANDS

National Marine Fisheries
Service, Southeast Region

and

Caribbean Fishery
Management Council

May, 1993

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I. INTRODUCTION

Executive Order 12291 "Federal Regulation" established guidelines for promulgating new regulations and reviewing existing regulations. Under these guidelines each agency, to the extent permitted by law, is expected to comply with the following requirements: (1) administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action; (2) regulatory action shall not be undertaken unless the potential benefit to society for the regulation outweighs the potential costs to society; (3) regulatory objectives shall be chosen to maximize the net benefits to society; (4) among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and (5) agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefit to society, taking into account the condition of the particular industries affected by regulations, and the condition of the national economy, and other regulatory actions contemplated for the future.

In compliance with Executive Order 12291, the Department of Commerce (DOC) and the National Oceanic and Atmospheric Administration (NOAA) require the preparation of a Regulatory Impact Review (RIR) for all regulatory actions which either implement a new Fishery Management Plan (FMP) or significantly amend an existing plan, or may be significant in that they reflect important DOC/NOAA policy concerns and are of public interest.

The RIR is part of the process of preparing and reviewing fishery management plans. The RIR provides a comprehensive review of the level and incidence of impact associated with the proposed or final regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve problems. The purpose of the analysis is to ensure that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The RIR serves as the basis for determining whether the proposed regulations implementing the fishery management plan or amendment are major/non-major under Executive Order 12291, and whether or not the proposed regulations will have a significant economic impact on a substantial number of small entities under the Regulatory Flexibility Act (P.L. 96-354).

The purpose of the Regulatory Flexibility Act is to relieve small businesses, small organizations, and small governmental entities from burdensome regulations and record keeping requirements. Since small businesses will be affected by the regulations to be promulgated under the FMP, this document also serves as the Initial Regulatory Flexibility Analysis (IRFA) for the FMP. In addition to analyses conducted for the RIR, the IRFA provides an estimate of the number of small businesses affected, a description of the small businesses affected and a discussion of the nature and size of impacts.

The Small Business Administration (SBA) defines a small business in the commercial fishing activity, classified and found in the Standard Industrial Classification Code, Major Group, Hunting, Fishing and Trapping (SIC 09), as a firm with receipts up to $2.0 million annually, SBA defines a small business in the charter boat activity to be in the SIC 7999 code, Amusement and Recreational Services, not elsewhere classified as a firm with receipts up to $3.5 million per year.

II. PREVIOUS MANAGEMENT REGIME

The Fishery Management Plan for the Shallow-water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (FMP) became effective September 22, 1985. The FMP was prepared by the Caribbean Fishery Management Council to establish a management system for the shallow-water reef fish resources within the Exclusive Economic Zone (EEZ) and the waters under the authority of the Commonwealth of Puerto Rico and the Territory of the U.S. Virgin Islands, from the shoreline to the edge of the insular platform. Management was deemed necessary because a number of the major shallow-water reef fish species were thought to be overfished or in danger of being overfished.

The FMP established regulations to rebuild declining reef fish species in the fishery and reduce conflicts among fishermen. It established criteria on mesh size, escape panels and degradable fasteners for the construction of fish traps; required owner identification and marking of gear and boats; prohibited the hauling of or tampering with another person's traps without the owner's written consent; prohibited the use of poisons, drugs, other chemicals and explosives for the taking of reef fish; established a minimum size limit on the harvest of yellowtail snapper and Nassau grouper; and established a spawning season closure for the taking of Nassau grouper.

After implementation of the FMP, new information became available and this new information indicated that more stringent management measures were needed to accomplish the objectives of the FMP. For example, data from CODREMAR's Fishery Statistical Project showed a downward trend in these fisheries indicated by a shift in species composition of the landings and a decrease in volume of these landings.

Accordingly, in 1990 the Council implemented Amendment Number 1 to the Fishery Management Plan for the Shallow-Water Reef Fish Fishery. The major provisions of the amendment were to establish 1.5 inches (in the smallest dimension) as the minimum mesh size for fish traps, made 1/8" jute twine the only allowable material for escape panel fasteners, prohibited the catch of Nassau grouper, established a seasonal closure for all fishing activities in a red hind spawning area, provided an overfishing definition for shallow-water reef fish, provided for the collection of socio-economic data and revised the habitat section of the FMP.

III. PROBLEMS IN THE FISHERY

The problems originally identified by the Council when the FMP was implemented in 1985 and amended in 1990 were that some of the shallow-water reef fish species were overfished in biological as well as economic terms, the biological and sociological and economics data bases to be used to make management decisions needed improvement, the Governments of Puerto Rico and the U.S. Virgin Islands had different management regimes and certain reef fishes of Puerto Rico and the U.S. Virgin Islands were known to be ciguatoxic. These original problems have not been fully resolved and, with the exception of the latter problem regarding ciguatera, will be addressed by some of the management measures in this amendment.

More recently, the Council has noted that deep-water reef fish and most of the species of fish that enter the aquarium trade are not currently managed under the Magnuson act. Further it has been noted that the species involved in these two fisheries are being more heavily targeted over time and that they may need to be managed in the near future. In addition, certain fish species in the existing shallow-water reef fish management unit are thought to be in need of initial or further management. Accordingly, the Council has extended the problems to include the aquarium and deep-water species. For the purposes of the RIR the problems can be stated as:

1. Some of the shallow-water reef fish species are overfished in biological as well as economic terms.

2. The biological and sociological and economics data bases used to make management decisions need improvement.

3. The Governments of Puerto Rico and the U.S. Virgin Islands have different management regimes.

4. Deep-water reef fishes that occur in the waters off Puerto Rico and the U.S. Virgin Islands are being more heavily targeted in recent years and there is no current mechanism for managing these species.

5. Species of fish that comprise the aquarium trade are largely unmanaged at this time and certain harvesting methods such as the

use of chemicals are known to be deleterious to fishery habitats and cause direct or cryptic mortality to non-target species.

6. Jewfish are severely overfished.

7. Red hind remain overfished and the most recent stock assessment indicates that portions of the stock may be experiencing recruitment failure.

8. Mutton snapper stocks are declining.

IV. OBJECTIVES OF THIS AMENDMENT

This amendment contains management measures designed to meet the two main management objectives as defined in the original FMP and extends them to address a lack of Federal management for aquarium and deep-water species:

1. Obtain the necessary data for stock assessment and for monitoring the fishery.

2. Reverse the declining trend of the resource.

   a. Restore and maintain adult stocks at levels that ensure adequate spawning and recruitment to replenish the population.
   b. Prevent the harvest of individuals of species of high value (e.g., snappers, groupers, and others) that are less than the optimum size.

3. Provide for the management of depleted deep-water reef fish resources.

4. Provide for the management of species entering the aquarium trade.

V. ANALYTICAL APPROACH

Most of the measures in the amendment are specifically designed to help meet the primary objective of the FMP regarding rebuilding the stocks and thus resolving the primary problem, which can be generally described as biological overfishing. In the case of the shallow-water reeffish stocks the overfishing is well related to a combination of circumstances that have led to increased levels of fishing effort (see Chapter 6 of the original FMP for the shallow-water reeffish fishery). Since the rebuilding measures have a similar intent, it is clear that any changes in net economic benefits derived from the fishery depend heavily on the effect that the changed management strategy will have on the biological well being of the stocks. It is also clear that the combined biological effect of the measures can be used as the basis for the economic outcome. The measures will be looked at separately to determine whether or not they contribute, in a positive manner, to the RIR condition of realizing a net positive economic benefit (benefits net of public and private costs).

Those proposed measures that involve more restrictive fishing practices will involve an analysis that provides a contrast of short term losses with long term gains, a procedure common with management schemes designed to rebuild overfished stocks.
The net economic benefits (that can be negative or positive) will include the sum of (1) expected changes in producer surplus and consumer surplus for landings from the commercial fishery, (2) potential changes in consumer surplus derived from recreational fishing trips and (3) management costs (plan preparation, enforcement, additional data collection and public burden in terms of reporting costs).

The analysis used in this RIR will be almost entirely qualitative instead of quantitative. In other words, the RIR analysis will attempt to discover whether or not the proposed management measures can contribute to economic improvements in the fisheries but in most cases there will be no attempt to place estimated dollar values on the gains or losses discussed. There are some basic reasons for this. The first and major reason is that the data on the biology and economics of the fisheries is insufficient even though the biological and economic decline of the fisheries is well established (otherwise there would be no need for management measures). The second reason is that since the general state of the fishery is so well known, it is more important to see if there are plausible benefits at all vs. trying to place exact dollar values on benefits. This is not to say that existing data will be ignored because in most cases the existing reliable information can be used along with theoretical considerations and anecdotal information to produce reasonable determinations as to the possible economic outcome of the measures.

The discussion that follows contains two extremely important assumptions. First, it is assumed that all the measures that are implemented as regulations will be fully adopted by the Governments of Puerto Rico and the United States Virgin Islands. Second, it is assumed that the level of compliance with any resulting regulations will be high enough so that the potential benefits (to the extent that they exist) can actually be achieved. **IF THESE ASSUMPTIONS ARE VIOLATED THEN EVERYTHING That FOLLOWS WILL BE IRRELEVANT. THE OUTCOME OF THE MANAGEMENT EFFORT WILL BE A NET ECONOMIC LOSS BECAUSE THERE WILL BE NO BENEFITS WHILE GOVERNMENT AND PRIVATE COSTS WILL BE INCURRED.**

VI. ANALYSIS OF MEASURES

Adopted Measure 1. Expand the management unit to include the most important components of the deep-water reef fish fishery.

This measure will create administrative costs, but has no other direct economic impacts at this time because there are no specific measures presented by this action alone. The estimate of administrative costs incurred by the Council and NMFS for the amendment are $100,207 (refer to the Section VII) and the amendment contains a total of 9 sets of measures. Accordingly, the cost of this measure is estimated to be about $11,000.

According to the amendment being analyzed by this RIR, there are several important species of snapper and grouper that occur in deep water and are presently targeted by the same fishermen who pursue the shallow-water species. Assuming that some of these species are in need of management, the timeliness of the ability to manage becomes important. It can be presumed that if the deep-water species came under management, then it would be more likely that incentives and resources for investigating these species would be enhanced. If the information for specific management measures indicates the need for management, then specific measures can be implemented and management benefits would start accruing at the earliest possible date. If, on the other hand, the deep-water species become severely overfished before that information is known, then most or all of the value presently associated with the deep-water species would be lost for many years or perhaps forever. It is stated without proof that the long-term increase in the present value of the deep-water species exceeds $11,000 (the estimated cost of this amendment). Hence, the RIR determination is for a positive change in net national benefits associated with the ability to manage these resources.

Rejected Measure 1A. Do not incorporate deep-water reef fishes into the management unit (status quo).

Obviously, there are no additional administrative costs contemplated by this alternative. The economic issue then becomes whether or not the economic benefits from gaining the ability to manage the deep-water species will exceed the administrative costs of gaining this ability. The discussion presented under Measure 1 indicates that the loss in economic benefits of not managing at this time will exceed the costs of gaining the ability to manage.

Rejected Measure 1B. Develop a separate plan for managing the deep-water reef fish fishery.

As with Measure 1, this measure will create administrative costs and these costs would be associated with a full FMP. Although the cost to develop the original Shallow-water Reef Fish FMP was

$196,840, the original FMP was more complex since it included a number of specific management proposals and involved a larger complex of fishes. On the other hand, if a new FMP were to be developed it is likely that there would be specific measures in the new FMP at the start and the cost of the new FMP would be increased accordingly. Noting that the total first year cost of developing and enforcing this amendment is $139,207,the cost of preparing a new fishery management plan specifically for the deep-water reef fish species is estimated to be a minimum of $100,000.

The timeliness issue also becomes important in the comparison of this measure with Measure 1. Since FMP's typically take five or more years to develop and implement and this amendment should be adopted in less than a year, the ability to be able to manage on a more timely basis becomes important. Hence, this alternative is expected to yield a smaller amount of projected benefits than would be expected with the preferred measure.

Adopted Measure 2. Expand the management unit to include marine aquarium fishes (invertebrates would be managed under the Coral FMP).

This measure involves management costs in a manner similar to Measure 1, but differs because Measures 4 and 7 address specific additional measures that are predicated on the acceptance of this measure. For this reason the measure is more costly to develop and recalling the estimate of $11,000 for Measure 1, the cost of this measure is estimated at $33,000. The other discussions regarding the expectation of economic gains associated with the ability to manage will apply and the RIR concludes that this measure has positive net national benefits.

Rejected Measure 2A. Develop a separate FMP for marine aquarium organisms.

Refer to discussion under Measure 1B. The cost of this measure should be similar, i.e., in excess of $100,000.

Rejected Measure 2B. Do not incorporate marine aquarium fishes into the management unit (status quo).

Refer to discussion under measure 1A. There is a substantial and growing harvest of marine fish species for the aquarium trade. A recent report documents annual exports of over 160,000 marine organisms from San Juan alone and the total number of organisms harvested is thought to be considerably higher (Sadovy, 1991). This level of harvest is thought to be high enough to affect the stocks and provides evidence to support the case for management (Goenaga and Boulon, 1992 and Sadovy, 1991). In addition to the harvest volume there is a considerable associated value that supports a number of small businesses in harvesting, exporting,

TABLE 1.

Fish species, or species groups/families, exported from Puerto Rico according to export shipping lists for December 1991-August 1992. Numbers exported are individual organisms. Price ranges per organism are given when available (US$). Species additional to the report of Sadovy (1991) are denoted by '**'.

SPECIES/SPECIES GROUP	COMMON NAMES	NUMBER EXPORTED ($price range)
Unspecified elasmobranchs	SHARKS, SKATES, RAYS	1 (30.00)
**Ginglymostoma cirratum	NURSE SHARK	5 (8.00)
Anguilliformes		
Gymnothorax miliaris	GOLDENTAIL MORAY	7
Gymnothorax funebris	GREEN MORAY	
Myrichthys oculatus	GOLDSPOTTED SNAKE EEL	7 (8-22.00)
Echidna catenata	CHAIN MORAY	16 (8.00)
Unspecified muraenids	MORAY 'EELS'	4 (4-30.00)
Aulopiformes		
Synodus intermedius	LIZARDFISH	1 (2.00)
Beryciformes		
Plectrypops retrospinis	CARDINAL SOLDIER	109 (1.15-3.0)
Holocentrus ascensionis	LONGJAW SQUIRRELFISH	5 (3.00)
Myripristis jacobus	BLACKBAR SOLDIERFISH	126 (2.0-2.50)
Unspecified holocentrids	SQUIRRELFISH	46 (2.50)
Perciformes		
Apogon maculatus	FLAME/FISH/CARDINAL	152 (1.75-2.0)
Astrapogon stellatus	CONCHFISH	
Priacanthus arenatus	BIGEYE	
Priacanthus cruentatus	GLASSEYE	1 (6.50)
Chromis cyanea	BLUE CHROMIS	601 (1.5-2.5)
Chromis insolatus	SUNSHINE DAMSELFISH	8
Abudefduf saxatilis	SERGEANT MAJOR	
Stegastes partitus	BICOLOR DAMSELFISH	
Stegastes leucostictus	BEAUGREGORY	31 (3.00)
Stegastes planifrons	YELLOW DAMSELFISH	
Stegastes dorsopunicans	DUSKY DAMSELFISH	
Microspathodon chrysurus	YELL.TAIL/JEWEL DAMS.	403 (2.0-2.5)
Unspecified pomacentrids	DAMSELFISH	190 (0.75-2.0)
Thalassoma bifasciatum	BLUEHEAD WRASSE	1003 (1.75-3.0)
Clepticus parrae	CREOLE WRASSE	18 (3.00)
Halichoeres cyanocephalus	LIGHTNING WRASSE	174 (3.0-8.0)
Halichoeres radiatus	PUDDING WIFE	321 (2.0-3.75)
**Halichoeres pictus	PAINTED WRASSE	28 (2.5-3.0)
Halichoeres maculipinna	CLOWN WRASSE	7 (2.00)
Halichoeres garnoti	YELL.HD./NEON WRASSE	139 (2.0-2.50)
Xyrichtys splendens	RAZOR/GREEN WRASSE	54 (2.00)
Bodianus rufus	SPANISH HOGFISH	669 (1.75-5.0)
Unspecified labrids	WRASSES	48 (2.0-2.50)
Sparisoma chrysopterum	REDTAIL PARROTFISH	
**Sparisoma viride	STOPLIGHT PARROTFISH	37 (10-12)
Scarus taeniopterus	PRINCESS PARROTFISH	2
Unspecified scarids	PARROTFISH	14 (3.50)

SPECIES/SPECIES GROUP	COMMON NAMES	NUMBER EXPORTED ($price range)
Centropyge argi	PYGMY ANGELFISH	978 (4.0-8.0)
Pomacanthus paru	FRENCH ANGELFISH	556 (6.0-30)
Pomacanthus arcuatus	GRAY/BLACK ANGELFISH	93 (7-22)
Holacanthus ciliaris	QUEEN ANGELFISH	274 (8.0-55)
Holacanthus tricolor	ROCK BEAUTY	1853 (4.0-12)
Unspecified pomacanthids	ANGELFISH	19 (3.0-11)
Chaetodon capistratus	4-EYE BUTTERFLYFISH	209 (1.75-6)
Chaetodon ocellatus	SPOTFIN BUTTERFLYFISH	1 (4.50)
**Chaetodon sedentarius	REEF BUTTERFLYFISH	34 (3.00)
Chaetodon striatus	BANDED BUTTERFLYFISH	188 (1.75-6)
Chaetodon aculeatus	LONGSNOUT/NOSE B'FLY	105 (6.0-9.0)
Unspecified chaetodontids	BUTTERFLYFISH	149 (5.0-10)
Gramma loreto	ROYAL GRAMMA	15448 (1.15-3.0)
Serranus tabacarius	TOBACCO FISH	15
Serranus tigrinus	HARLEQUIN BASS	111 (2.0-3.0)
Serranus annularis	ORANGEBACK BASS	
Serranus baldwini	LANTERN BASS	15 (2.0-2.5)
Serranus tortugarum	CHALK BASS	
Unspecified serranids	BASSES	12 (3.50)
Liopropoma rubre	SWISSGUARD BASSLET	15 (15.00)
Hypoplectrus nigricans	BLACK HAMLET	
Hypoplectrus indigo	INDIGO HAMLET	
Hypoplectrus unicolor	BUTTER HAMLET	
Hypoplectrus puella	BARRED HAMLET	
Hypoplectrus guttavarius	SHY HAMLET	
Hypoplectrus gummigutta	GOLDEN HAMLET	
Hypoplectrus aberrans	YELLOWBELLIED HAMLET	
Unspecified serranids	HAMLETS	22 (2.0-2.50)
Paranthias furcifer	CREOLE FISH/ANTHIAS	29 (2.5-2.5)
Epinephelus fulvus	CONEY/GOLD CONEY	251 (2.0-2.50)
Epinephelus guttatus	RED HIND	
**Epinephelus striatus	NASSAU GROUPER	1 (8.00)
Unspecified serranids	GROUPER	135 (2.0-3.0)
Rypticus saponaceus	SOAPFISH	1
Equetus punctatus	SPOTTED DRUM	7 (9.00)
Equetus lanceolatus	JACKKNIFE FISH	
Pareques acuminatus	CUBBYU/HIGH-HAT	145 (1.5-4.0)
Chaetodipterus faber	SPADEFISH	
Amblycirrhitus pinos	REDSPOTTED HAWKFISH	185 (1.15-2.5)
Anisotremus virginicus	PORKFISH	4
Ophioblennius atlanticus	REDLIP BLENNY	1302 (1.0-2.5)
**	HORNED BLENNY	369 (3.00)
Unspecified blenniids	BLENNIES	115 (1.5-3.0)
Gobiosoma spp.	NEON GOBY	
Quisquilius hipoliti	RUSTY GOBY	
Unspecified gobiids	GOBIES	
Opistognathus aurifrons	YELLOWHEAD JAWFISH	1405 (3.0-5.0)

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SPECIES/SPECIES GROUP	COMMON NAMES	NUMBER EXPORTED ($price range)
Opistognathus whitehurstii	DUSKY JAWFISH	16 (3.5-3.75)
**	TIGER JAWFISH	330 (3.0-5.0)
Unspecified mullids	GOATFISH	15 (2.00)
Acanthurus coeruleus	BLUE/YELLOW TANG	782 (1.5-8.0)
Acanthurus chirurgus	SURGEON TANG/DOCTORFISH	
Tetraodontiformes		
Balistes vetula	QUEEN TRIGGERFISH	214 (2.0-18)
Xanthichthys ringens	SARGASSUM/REDTAIL TRIGGERFISH	444 (3.0-18)
Canthidermes sufflamen	OCEAN TRIGGERFISH	
Melichthys niger	BLACK DURGON/TRIGGER	260 (5.5-12)
Aluterus scriptus	SCRAWLED FILEFISH	1 (8.00)
Cantherhines macrocerus	WHITESPOTTED FILEFISH	12 (5.5-10)
Unspecified monacanthids	FILEFISH	29 (2.0-3.0)
Lactophrys, *Acanthostracion*	TRUNK/BOX/COWFISH	23 (2.5-6.0)
Canthigaster rostrata	SHARPNOSE PUFFER	112 (1.0-3.5)
Diodon hystrix	PORCUPINEFISH	3 (8.00)
Lophiiformes		
Antennarius spp.	FROGFISH	9
Ogcocephalus spp.	BATFISH	6 (2.5-6.5)
Sygnathiformes		
Unspecified aulostomids	TRUMPETFISH	9 (2.0-4.0)
Hippocampus spp.	SEA HORSE	23
Unspecified sygnathids	PIPEFISH	
Dactylopteriformes		
Dactylopterus volitans	FLYING GURNARD/ SEA ROBIN	43
Scorpaeniformes		
Unspecified scorpaenids	SCORPION/STONE/FISH	11 (2.25)
Pleuronectiformes		
Bothus lunatus	PEACOCK FLOUNDER	2 (2.50)
	FLOUNDER	2
Symphurus arawak	CARIBBEAN TONGUEFISH	
	TOTAL	**30,619**

SOURCE: Personal communication, Dr. Yvonne Sadovy.

retailing and associated operations (Sadovy, 1991). Sadovy (personal communication) has examined prices for a non-random sample of about 31,000 aquarium fish destined for export and noted that prices ranged from $1.15 to $30.00 per individual fish with the most common prices being in the $2.00 to $5.00 range (Table 1.) and this implies that the total annual export value of aquarium fish is well in excess of a million dollars annually. If the potential loss in current value from a lack of management is expected to exceed $6,000 (the cost associated with Measure 2), then it would be better, from an economics standpoint, to undergo the costs of management at this time. The RIR presumes this to be the case and therefore concludes that Measure 2B (status quo) has a negative economic outcome.

Adopted Measure 3. Retitle FMP to encompass the reef fish management unit.

This measure has a minimal cost and the value of avoiding confusion about the species being regulated under the amended FMP should exceed this minimum cost.

Rejected Measure 3A. No action. Retain current title of FMP.

See adopted Measure 3 above.

Adopted Measure 4. Restrict the collection of marine aquarium fishes to hand-held dip nets and slurp guns.

By implication this measure prohibits the use of chemicals, small-mesh fish traps and most nets. If Measure 2 is approved, then the question about outlawing the use of chemicals and small-mesh fish traps is moot because such use is already prohibited by the FMP. Therefore, this measure actually addresses the prohibition of the use of nets, other than hand-held dip nets, for the taking of marine aquarium fishes.

The most common harvest method appears to be the use of quinaldine (Sadovy, 1991) and since regulations in the current FMP prohibits the use of any chemicals, the harvesters are automatically limited to the use of certain capture gears, including nets of various kinds, but excluding small-mesh traps that are also prohibited under the current FMP. Among the allowable gear, the current use of slurp guns appears slight, while the use of hand-held nets appears more common. Assuming nets that would be illegal under the measure are used to some degree, there are existing economic reasons for such use and forcing the collectors to switch to another gear would have an economic cost. Further, since the harvesters will not be able to use quinaldine, nets such as barrier nets may be the best alternative, especially for the schooling species of aquarium fishes.

The amendment to the FMP suggests that there may be unspecified habitat and biological damage that occurs with the use of net gear, but does not provide any evidence of the type of damage suggested. Existing information on the harvest of aquarium fishes in several countries does not contain evidence to document habitat damage (Sadovy, 1991) and it is noted that the states of Hawaii and Florida do not prohibit the use of nets. Nonetheless, if the use of nets is minimal, it could be argued from an economics standpoint that the restriction of use has minor negative economic consequences. At the same time, minimal use would imply a small amount of habitat damage and a minor savings in terms of minimizing the habitat damage that may be caused by the use of net gear.

Overall it seems reasonable that since the use of quinaldine will be prohibited and since that gear is used to collect the bulk of the current harvest, the collectors would undoubtedly place greater reliance on the use of nets, including hand-held nets, and perhaps would use slurp guns to a greater degree. Pending the discovery of any data that provide evidence of unacceptable habitat damage from the use of nets, other than hand-held dip nets, the determination of the RIR is for a negative change in net national benefits if this measure is adopted.

<u>Rejected Measure 4A.</u> Allow the collection of marine aquarium fishes by all gear types currently deployed in the fishery (status quo).

Assuming that the aquarium fishes are to be managed and referring to the discussion under Measure 4, this measure would allow the continued use of chemicals, net gear and traps for taking aquarium fishes. It would also require further amendments (or more measures in this amendment) to the existing FMP because the existing FMP does not allow the use of chemicals or small mesh traps for the taking of any species in the management unit. Hence, while this measure is labeled as the status quo, it would in fact require further actions to be taken. These further actions would create additional costs. If one of the amendments was to continue to allow the use of quinaldine, the expected economic outcome would be negative. However, if an amendment or measure to continue to allow the use of certain types of small traps was proposed, the economic outcome is uncertain. This result obtains because there is no information to determine whether or not a small trap specifically designed for the taking of aquarium fishes would create problems, mainly in the enforcement area, relative to the current restrictions on trap and trap mesh sizes allowed or proposed for the taking of food fish. Hence the economic outcome of this rejected measure cannot be determined with regard to the small trap issue.

<u>Adopted Measure 5</u>. Require that fish traps be constructed as follows: (a) at a minimum, basic construction material must be of 1.5-inch hexagonal mesh wire or 2.0-inch square mesh wire; (b) escape openings at least 8 x 8 inches must be located on any two sides (except top, bottom, or side containing the funnel); (c) the

access door may serve as an escape opening provided it meets all requirements for size and location, and is fastened in such a manner that the door will fall open when the fasteners degrade; (d) panels covering the escape openings must be constructed of mesh at least as large as the mesh used in constructing the trap, and fastened with untreated jute twine 1/8-inch or less in diameter when traps are fitted with zinc anodes; or (e) fastened with 18-gauge ungalvanized wire or 1/8-inch jute twine (maximum diameter) if anodes are not used.

The biological evidence, although not necessarily conclusive, seems to indicate that escape panels of a proper design will lead, given sufficient time, to an increase in the total landings of target species. This result is forecast because some fish traps are lost or not fished often and the absence of escape panels leads to a "ghostfishing" situation. If the predicted biological implication is true, there should be a resulting increase in catch of reef fish and somewhat reduced prices as a result of the greater catches. However, the price reductions would not be great enough to reduce total revenues received by fishermen for the following reason. Because the area relies heavily on imports, the impact on total fish supplies and hence prices and total revenues will not be great. Hence, the total gross revenue obtained from the resource would be expected to rise as a result of the management action. On the cost side, the current rule calls for the same mesh sizes to be implemented by September 13, 1993 if research studies show that there were benefits from the larger mesh size. The studies have been completed, they document the benefits and the mesh size will be changed. Hence the RIR does not ascribe any additional costs to this part of the measure (this portion of the measure actually reverts to a status quo situation). Regarding the placement of the escape panels, fishermen will apparently be in favor of the change because they contend that the current rule requiring the panels to be on opposite sides of the trap can cause premature release of the catch from the weight of fish on the panel opposite the bridle during trap retrieval. If true, this implies that the cost of making the change must be small relative to expected increased revenues. Nonetheless, the one time increased costs associated with the initial switch to traps with the new type of panel will at least partially offset the benefits that may be associated with this measure. These costs have not been estimated at this time but the costs not only should be small, but the impact will probably be minimal. This is because it is expected that the fishermen would make the change during normal trap repairs or would incorporate the change into replacement traps at essentially no additional cost as compared with the costs of making the current openings.

Consumer surplus is expected to be greater with this measure because a larger poundage of fish purchased at roughly unchanged prices (recall the discussion that supplies are not expected to increase enough to materially affect prices). The recreational surplus is also expected to increase based on the usual assumption that the availability of larger numbers of fish provides increased fishermen satisfaction and hence larger benefits from any given level of fishing effort.

If the fastener materials mentioned in the measure (jute and wire) will not deteriorate at a rate that is sufficient to make the escape panel effective, then the portion of the measure that relates to escape panels must be rejected on economic grounds because there will be no benefits but the costs of implementing and enforcing the measure will be incurred. The evidence seems to show that the jute fastener may be effective, while the steel wire fastener will not be effective, especially if the trap construction incorporates the use of an anode. There is an additional consideration that if jute is used, then the fishermen will be encouraged to fish traps in a more timely fashion and will be encouraged to change the jute fastener material since it will be subject to deterioration and could result in a loss of the catch.

The predicted economic outcome of this measure is positive for the mesh size requirement. The RIR further concludes that the portion of the measure pertaining to escape panels will provide a net national benefit if the measure is modified to allow jute as the only allowable fastener material for the escape panels.

There is one important problem that may be relevant. Regarding the original assumption about compliance, which was stated earlier in the RIR, this measure will pose some enforcement problems since it would have to be enforced at sea to some degree. Hence, if the level of compliance with this particular measure is sufficiently low, it means that a forecast of overall positive changes in net national benefit would change to a negative forecast.

Rejected Measure 5A. Require only one escape panel, that should be the access door, made of 2-inch square mesh wire fastened with 18 gauge ungalvanized steel wire and located on one side of the trap. The door should be hinged at the bottom and cover an opening of no less than 8 x 8 inches.

All of the discussion about escape panels under Measure 5 applies here. The major difference between the measures is the requirement here for one, instead of two escape panels and a requirement for ungalvanized wire versus jute. Measure 5 calls for two escape panels because it is felt that the ghost-fishing phenomenon is much less likely to occur. The reasoning is that a lost trap can rest on one escape panel while another is in a position to open after the fastener deteriorates. The cost of the one panel measure is less than the two panel measure, but the gains from eliminating the possibility of ghost-fishing probably outweigh the minor extra costs involved. The costs are minor because it would be expected that the escape panel would be made from the original wire used in the trap construction as allowed by the measure. However, unless the jute fastener is utilized, this alternative measure will be not be effective and the RIR determination will be for a negative outcome. To summarize from the discussion of the adopted measure, the costs of regulation will be incurred but there will be no benefits.

Rejected Measure 5B. Retain current restrictions for fish-traps (status quo).

The major differences between the status quo and Measure 5 are that the no action alternative implies the continued use of jute rather than a jute/wire measure and that the escape panel placements differ. Regarding the jute versus wire fasteners, the analysis of Measure 5 indicated that if wire is allowed, then the measure has a negative economic outcome. Regarding the placement of escape panels, Measure 5 requires the use of two escape panels that can be located on any two sides of the trap (except top, bottom and the side containing the funnel) and the no action requirement is for the two panels that must be placed on opposite sides of the trap. The new measure incorporates fishermen's testimony that the opposite side requirement can result in a situation whereby the bridle is opposite one of the panels and the weight of fish can cause the opposite panel to open and allow the release of some or all of the catch.

Assuming that Measure 5 is altered to allow jute as the only fastener material, Measure 5 is superior to the no action alternative. Conversely, if ungalvanized wire is allowed as a fastener, the no action alternative is superior. This is because the benefits, that derive from the ability of the escape panels to open after a reasonable period of soak time, will be lost but the costs of management and trap conversion would still be incurred. Further, this loss of benefits would be expected to be greater than the increase in benefits that come from the provision of Measure 5 allowing the escape panels to be on adjacent, rather than opposite, sides of the trap.

Adopted Measure 6. Prohibit the harvest or possession of jewfish (*Epinephelus itajara*) in waters around Puerto Rico and the U.S. Virgin Islands.

Since landings of jewfish have not been specifically reported by Puerto Rico since at least 1980 and since there are very few biological samples of jewfish from either Puerto Rico or the U.S. Virgin Islands, it is clear that catches of jewfish have been small for several years.

A total closure can be viewed as extreme, but if the current value of producer surplus, consumer surplus and recreational surplus is essentially nil because landings are very low, then at worst the measure results in negative economic consequences that can be expressed as the government costs associated with implementing the measure. If a cessation of the apparently very small landings will result in a biological recovery necessary to open the fishery, then the value of the resulting catch would probably exceed the costs of management and the economic outcome would be positive. It is noted that a total ban on the take of jewfish in the southeastern U.S. has been implemented. In that case the RIR analysis determined that the non-consumptive value associated with the viewing of jewfish was found to exceed the value lost by commercial and recreational fishermen and consumers. On this point, values associated with viewing in the waters off Puerto Rico and the U.S. Virgin Islands are unknown.

Since so little information on jewfish is available, the RIR cannot be definitive on the economic outcome of this measure. However, the magnitude of any change in net benefit will be small and probably positive.

Rejected Measure 6A. Allow the unrestricted harvest of jewfish (status quo).

Refer to the discussion of Measure 6. Biological information is needed to forecast any economic benefits that may derive from this measure.

Adopted Measure 7. Prohibit the harvest and possession of certain species used in the marine aquarium trade.

The measure specifically identifies the species that are to affected. Two species that are currently managed by the FMP and need protection as juveniles are the red hind and mutton snapper. Seahorses are included because they are considered to be rare. Finally, three species of butterflyfishes are included because they do not survive well in captivity.

In an attempt to determine the possible impact of these prohibitions on harvest, work conducted by Sadovy, 1991 was utilized. As a part of the research to characterize the aquarium fish trade, Sadovy selected shipping lists for a non-random sample of species to be exported and recorded the numbers of animals by species and price. Of a total of 30,619 individual animals in this sample, there were no red hind or mutton snapper and there were 23 seahorses (price not recorded). There were 502 butterflyfish that may have been among the species affected and their prices ranged from $1.75 to $9.00. In total, 525 or 1.7 percent of that particular sample would have been prohibited from harvest and sale. Since the prices of these species are somewhat higher than the average price of other species being exported, it is concluded that about 2-3 percent of the value of the current harvest of aquarium fishes will be affected by the measure. While the total harvest is unknown, an annual total of over 160,000 individual animals was estimated as being exported via the San Juan airport (Sadovy, 1991). Using the same percentages as found in the sample, this implies that a minimum of about 2700 animals worth in the range of

$9,000 would be excluded from the export trade. Since Sadovy believes that the actual sale is much higher than the estimate of shipments from the San Juan airport, the loss in value shown above is truly a minimum estimate. Whatever the loss in sales value happens to be, in net national benefit terms the value lost would be some fraction of the loss in sales value (but this cannot be calculated in the absence of data on the cost of production and the demand framework involved).

The RIR determination is that there will be some loss of net national benefits associated with this measure and there will be costs associated with implementing and enforcing the measure. On the side of benefits, there is no information on that to base any conclusions on the value of protecting these species. There will clearly be some benefits in terms of additional non-use value of viewing the larger concentrations of these species, but this value cannot be quantified. As has been demonstrated, the magnitude of the losses is small and since the value of the benefits cannot be calculated, the RIR conclusion is that the change in net national benefits related to this measure cannot be forecast. Regardless of the direction of the change, it will be small.

Rejected Measure 7A. Only harvest and possession prohibitions-on food species and those protected by ancillary restrictions would apply to marine aquarium trade (status quo).

This measure is currently interpreted to apply only to Nassau grouper that has an existing harvesting prohibition per the FMP and to jewfish, which may undergo a harvest prohibition if Measure 6 of this amendment is adopted. Since neither of these species seems to enter the aquarium trade at present, and since this is essentially the status quo (if it is assumed that Measure 5 is adopted), there is no economic effect forecast.

Adopted Measure 8. Closure of additional red hind aggregation areas during the December through February spawning season.

A spawning aggregation area has been identified in the EEZ off the west end of Puerto Rico. The area lies to the west of Tourmaline buoy, west of Mayaguez, Puerto Rico. The best known location, based on historic productivity, covers an area of approximately 3 x 5 miles. The area is bounded by rhumb lines connecting the following points (see Fig. 1, in Appendix I of the amendment):

Point	Latitude N.	Longitude W.
A	18°11'	67°25.5'
B	18°11'	67°20.4'
C	18°8'	67°20.4'
D	18°8'	67°25.5'
A	18°11'	67°25.5'

Another red hind spawning aggregation area has been identified in the EEZ east of St. Croix, U.S. Virgin Islands, at the extreme eastern end of Lang Bank. The area is bounded by rhumb lines connecting the following points (see Fig. 2 in the amendment):

Point	Latitude N.	Longitude W.
A	17°50.2'	64°27.9'
B	17°50.1'	64°26.1'
C	17°49.2'	64°25.8'
D	17°48.6'	64°25.8'
E	17°48.1'	64°26.1'
F	17°47.5'	64°26.9'

The analysis of this measure is based on the assumption that the Council proposes to eliminate all fishing effort from these areas during the period of the closure. This would mean the exclusion of all commercial and recreational effort including trolling and spear fishing.

This measure provides several potential areas of benefits in the form of increased surpluses for producers, consumers and recreational fishermen. It could also produce less desirable side effects that can offset at least part of the potential gains. The various potential gains and losses will probably result in a net economic benefit from this measure as discussed below.

The proposed closure of these two red hind spawning areas is a classic example of foregoing short-term losses in producer and consumer surplus in exchange for stock rebuilding that provides for larger catches in the future. In such a scenario, it can be a fairly straightforward process to determine the direction, if not the magnitude of the change in net national benefits that is expected. This can be done if there is any information available on short-term harvesting profits (used as a rough estimate of producer surplus under some assumption of heterogenous firms), some estimate of any predicted change in consumer surplus and an estimate of consumer surplus associated with recreational fishing trips. Then, with some information on the future yield stream, the discounted value of the surplus streams can be estimated and compared with the short-term losses. However, in the case of the fisheries under discussion, there is no good information on the current levels or values of catches so the process cannot be followed. Furthermore, this case is somewhat more complicated than the normal case since the measure calls for a cessation of all recreational and commercial fishing activities for all species in the closure area. Hence there is a wider class of both benefits and costs (short-term losses) associated with this type of spawning area and these are discussed in the following paragraphs. Regardless of the complicating factors that preclude even a crude quantitative analysis, the available evidence on virtually all the species affected by the measure indicates that they are overfished and several, including red hind, are under a defined rebuilding program at the present time. The proposed spawning closure is designed to aid the rebuilding process and return some fishery value that has been lost via open-access fishing for a prolonged period of time.

Although the proposed measure is directed specifically at recovery of the red hind stock, there are obvious implications for all the species in the shallow-water FMP as well as for lobsters and pelagic finfish that are present in the area during the closure period. In addition, a closure implies if there is any existing cryptic mortality of released juveniles of red hind and other species, then it will be eliminated.

There is a body of thought that fishing on spawning aggregations may reduce spawning capability to a degree that exceeds the effect of removing the spawners. This effect is thought to result from a disruption of the species social structure (Shapiro, et al., in press) and would indicate that any given number of females of spawning age taken during spawning times would be less valuable than an equal number of females taken during non-spawning periods.

Although the present amendment does not contain details on the importance of these red hind spawning areas, i.e., there is no description of the percent of spawners represented by these aggregations or where the potential new recruits eventually go, there appears to be some level of agreement among those with knowledge of the fishery that these closures will almost surely result in a trend toward some stock recovery or at least a slowing of the present rate of stock decline. This should lead to benefits from the closures, even if total fishing effort does not change. The reason that total effort may not change is that fishermen may elect to fish adjacent areas. Even if this occurs additional effort in other areas may not significantly alter the total catch of fish because the present level of effort may be so high that increases (or decreases) in effort will not affect the total catch.

The possible relocation of effort just alluded to does have potential adverse consequences that are not related to the total fish catch. One consequence is that any potential gains from reduced mortality of undersized fish in the spawning closure areas will be offset by increased juvenile mortality in other areas. A second possible problem is that the fishermen may have knowledge of "second-best" spawning aggregations and the effort previously devoted to fishing on the spawning aggregations referenced in the measure may simply be relocated to other spawning aggregations. If this happens, then most of the potential benefits from the closure will be lost due to "damage" to these other concentrations of red hind spawners.

Regardless of potential adverse consequences of the relocation of fishing effort, there appears to be some consensus that there are biological benefits of some sort that derive from allowing a "rest period" for any heavily fished area. Although this concept is not well articulated or quantified in the literature, this IRFA/RIR assumes that such an effect exists and will not be offset by relocation of effort to other areas since the other areas are already "stressed" by the present level of effort. If this biological benefit actually exists, the effect should eventually translate into net positive economic benefits in terms of increases in producer, consumer and recreational surpluses.

These benefits (to the extent that they would actually be realized via state-federal cooperation and compliance with fishing regulations) should be more lasting than potential benefits from measures such as escape panel restrictions or other measures to regulate fishing gear. The reason for this is because even if increased overall benefits from this measure eventually attract new effort into the fishery, some of the benefits are described as being independent of total fishing effort.

This analysis assumes that the closures will not be so extensive as to halt all capture (for commercial and recreational purposes) of all species from a major portion of the waters surrounding Puerto Rico and the U.S. Virgin Islands. A total closure of all waters for a 2 1/2 month period during the height of the tourist seasons would undoubtedly cause major disruptions in commerce related to both commercial and recreational fishing. The temporary dislocation of the small firms involved would probably create the need for government expenditures that may exceed the expected economic benefits related to stock recovery.

This is one of the measures in the amendment which will create additional enforcement costs. Section VII of this RIR provides details on the enforcement costs, but to summarize, the annual total cost of enforcing three spawning closures is $39,000. Since this measure covers two of the closures, the annual enforcement cost is estimated at $26,000.

Considering all positive and negative influences on net national benefits discussed in this section, the RIR concludes that the imposition of these two spawning area closures for red hind is expected to result in a long-term increase in net national benefits that exceeds the expected short-term losses.

Rejected Measure 8A. Status quo.

Amendment One to the FMP contained an RIR analysis that predicted a positive economic outcome if other red hind spawning aggregations were described and closed. Since there is no new information to the contrary, the expected economic outcome of this no action measure is negative relative to the measure adopted by the Council.

Adopted Measure 9. Prohibit the harvest of mutton snapper (*Lutjanus analis*) in a spawning aggregation area off St. Croix from March through June of each year.

As with the proposal for the red hind closures, the effect of the measure is to eliminate all fishing in the area for the time shown. The spawning area is bounded by rhumb lines connecting the following points (see Fig. 3, Appendix I in the amendment):

Point	Latitude N.	Longitude W.
A	17°37.9'	64°52.6'
B	17°38.2'	64°52.1'
C	17°38.3'	64°51.8'
D	17°38.1'	64°51.4'
A	17°37.9'	64°52.6'

There is more data available to document fishing pressure in this area as opposed to the red hind areas covered by Measure 8. In particular, a 20-year fishing history indicates that CPUE has declined from over 500 pounds/trip to less than 100 pounds/trip for highliner vessels. Further the average size of mutton snapper taken from the spawning aggregation has decreased from over 10 pounds to five pounds and total effort has increased. This information provides good evidence of an overfished stock and mutton snapper is one of the species undergoing a rebuilding schedule under the FMP.

There will be annual enforcement costs of $13,000 for this measure. Refer to discussion of Measure 8.

A great deal of the discussion of Measure 8 applies here. Particularly in view of the biological evidence that indicates the possibility to rebuild the stock and regain lost values, this measure is fully expected to have a positive economic impact.

Rejected Measure 9A. Status quo.

See the discussion of Measure 9. The status quo will not have positive net national benefits relative to the proposed measure.

VII. MANAGEMENT COSTS

The RIR discussion of various of the measures being considered included some estimates of management costs and the reader is referred to those discussions as appropriate. Major categories of management costs typically include administrative costs incurred by the Council and NMFS, enforcement costs borne by the states, NMFS and Coast Guard, public burden costs associated with data collection and costs of developing and maintaining permits and data collection systems. In the case of this amendment there are no measures that mandate permits or directly create changes in data collection, so there are no costs associated with such items.

The Caribbean Fishery Management Council has provided detailed information on their administrative costs broken down into the categories as shown below.

Costs Related to Full Council and Council Committee

Estimated Cost of Council Members Compensation for One Council Meeting[1]	$4,549.00
Estimated cost of Travel Expenses for Council Members to One Council Meeting[2]	3,430.00
Estimated Cost of Compensation and Travel Expenses for One Council Meeting	7,979.00

The Council Meetings are estimated to last 16 hours. The Council devoted an average of 5.56 hours[3] per meeting to the development of the Second Amendment to the Shallow-Water Reef Fish FMP from the Seventy-first meeting to the seventy-seventh meeting.

Estimated Total Cost for Council and FMP Committee Meetings

5.56 hours divided by 16 hours = 34.7%
$7,979 x 34.7% x 9 meetings = $24,918

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[1]Based on the average of daily compensation for the years 1992, 1992 and 1993.

[2]Based on the average of Per Diem Cost for the years 1991, 1992 and 1993.

[3]Based on the total estimated hours devoted during Council Meetings and Shallow-Water FMP Committee Meetings divided by the number of events. Refer to List of activities associated to the Development of the Second Amendment.

Council Staff Time

It is estimated that the Executive Director devoted 10% of his time during the period 1991-1993, and the Fishery Biologist devoted 50% of her time during the period 1992-1993 to the development of the Second Amendment to the Shallow-Water Reef Fish FMP.

Estimated Cost for the Period - Executive Director	$14,735
Estimated Cost for the Period - Fishery Biologist	24,029
Estimated Cost for Staff	$38,764

Costs for Public Hearings

Public Hearings were held on June 10-13, 1991 in Mayaguez and Fajardo, Puerto Rico and in St. Croix, St. Thomas, USVI

Estimated Council Members Compensation	
1 Member x 1 day x 4 Public Hearings	$1,300
Estimated Travel Expenses - Council Member(s) 1	400
Estimated Travel Expenses - Staff Member (s) 2	800
Conference Room Fees	200

Additional hearings on the amendment and DSEIS were held from December 21-30, 1992 in Lajas, Cabo Rojo and Fajardo, Puerto Rico and in St. Thomas and St. Croix, U.S. Virgin Islands.

Estimated Council Members Compensation	
1 Member x 1 day x 5 Public Hearings	$1,625
Travel Expenses - 1 Council Member	300
Travel Expenses - Staff Members (2)	600
Estimated Cost for Public Hearings	$5,450

Scientific and Statistical Committee and Advisory Panel Meetings

The Scientific and Statistical Committee and the Advisory Panel Meetings were held on March 10-11, 1992 in San Juan, P.R. The members of these advisory bodies to the Council do not receive compensation. However, they are reimbursed for their travel expenses. There were three (3) SSC Members traveling from the U.S. and the rest from Puerto Rico and from the USVI. The AP members were traveling from Puerto Rico and from the U.S. Virgin Islands. Travel expenses for members traveling from the U.S. are estimated in $1,050 per member/per meeting, and travel expenses of the members traveling from P.R. and USVI are estimated in $175 per member/per meeting.

Estimated Travel Expenses of SSC Members from U.S.	$3,150
Estimated Travel Expenses of SSC Members from PR and USVI	875
Estimated Travel Expenses of AP Members	1,750
Estimated Cost for SSC and AP Members	$5,775

Summary of Estimated Caribbean Council Costs

Estimated Cost for Council and FMP Committee Meetings	$24,918
Estimated Cost for Staff	38,764
Estimated Cost for Public Hearings	5,450
Estimated Cost for SSC and AP Meetings	5,775

Total Estimated Council Cost for the Development of the Second Amendment to the Shallow-Water FMP $77,607

The NMFS incurred administrative costs during the development of the amendment and these costs are as follows.

NMFS Staff Time

Fisheries Management Division	$12,500
Permits and Regulations Branch	1,000
Economics and Trade Analysis Division	4,800

Printing and Duplication (Time and Material) $ 1,500

Travel to Meetings $ 2,800

Total NMFS Cost $22,600

There will be additional enforcement costs associated with the establishment of spawning area closures for red hind and mutton snapper. The balance of the new measures contained in this amendment are not expected to create additional enforcement costs since the new regulations will be enforced by existing patrols and on-shore efforts.

Enforcement Costs

National Marine Fisheries Service	$10,000
U.S. Coast Guard	14,000
Commonwealth of Puerto Rico	5,000
U.S. Virgin Islands	10,000
Total Enforcement Cost	$39,000

Cost of Public Burden for Reporting None

Cost of Permits and Data Collection None

SUMMARY OF COSTS OF AMENDMENT

Caribbean Fishery Management Council (One-time)	$77,607
NMFS Administrative (One-time)	22,600
Enforcement (Annual)	39,000
Public Burden	None
Permits and Data Collection	None
Total	$139,207

VIII. SUMMARY OF IMPACTS OF MANAGEMENT MEASURES

Table 2 follows and shows a summary of the effects on net national benefits that flow from this amendment. As explained in the section describing the analytical approach used in the RIR, most of the effects are described in terms of direction of change and it can be noted that in some cases there is no enough information available to make even this type of determination. This is the case for 3 of the 21 adopted and rejected measures in the amendment. Regarding those adopted measures for which a determination was possible, all are positive (not including no change for the status quo measures) except for the adopted measure which proposes to restrict the use of barrier nets and small mesh traps for the collection of aquarium fish.

TABLE 2.

SUMMARY OF LONG-TERM NET ECONOMIC BENEFIT FROM PREFERRED AND ALTERNATIVE MEASURES*

MEASURE	PRODUCER SURPLUS	CONSUMER SURPLUS	RECREATIONAL SURPLUS	PUBLIC/PRIVATE COSTS	NET ECONOMIC BENEFITS
1 Manage deep-water species by amendment	Positive	Small Positive	Positive	$11,000	Positive
1A Do not manage deep-water species	No Change	No Change	No Change	None	No Change
1B Develop FMP for deep-water species	Positive	Small Positive	Positive	$100,000	Smaller than Measure 1
2 Manage aquarium fishes by amendment	Small Positive	Small Positive	Small Positive	$33,000	Positive
2A Develop FMP for aquarium fishes	Positive	Positive	Positive	$100,000	Negative
2B Do not manage aquarium fishes	No Change	No Change	No Change	None	No Change
3 Retitle FMP	Small Positive	No Change	No Change	Small Cost	No Change
3A Do not retitle FMP	Small Negative	No Change	No Change	None	Small Negative
4 Restrict gear for collecting fishes	Negative	Negative	No Change	$11,000	Negative

TABLE 2. (cont'd)

MEASURE	PRODUCER SURPLUS	CONSUMER SURPLUS	RECREATIONAL SURPLUS	PUBLIC/PRIVATE COSTS	NET ECONOMIC BENEFITS
4A Status quo on gear for collecting aquarium fishes	No Change	No Change	No Change	None	No Change
5 After trap construction requirements	Positive	Positive	Positive	$11,000	Positive
5A Require only one escape panel for traps	Negative	Negative	Negative	$11,000	Negative
6 Prohibit harvest of jewfish	Unknown	Unknown	Unknown	$11,000	Unknown
6A Do not prohibit harvest of jewfish	No Change	No Change	No Change	None	Unknown
7 Prohibit harvest of certain aquarium fishes	Unknown (Small)	Unknown (Small)	Positive	$11,000	Unknown (Small)
7A No additional measures to restrict take of aquarium fishes	No Change	No Change	No Change	None	No Change
8 Close two red					

TABLE 2. (cont'd)

MEASURE	PRODUCER SURPLUS	CONSUMER SURPLUS	RECREATIONAL SURPLUS	PUBLIC/PRIVATE COSTS	NET ECONOMIC BENEFITS
8 Close two red hind spawning areas	Positive	Positive	Positive	$37,000	Positive
8A Do not close red hind areas	No Change	No Change	No Change	None	No Change

TABLE 2. (cont'd)

MEASURE	PRODUCER SURPLUS	CONSUMER SURPLUS	RECREATIONAL SURPLUS	PUBLIC/PRIVATE COSTS	NET ECONOMIC BENEFITS
9 Close a mutton snapper spawning area	Positive	Positive	Positive	$24,000	Positive
9A Do not close mutton snapper area	No Change	No Change	No Change	None	No Change

* NOTE: In the case of status quo measure, the RIR discussion gives net economic benefits relative to taking action. For example, if the adopted measure gives positive net benefit changes, the rejected status quo measure is described as having a negative net national benefit relative to the adopted measure. Also not that the summary table does not reference short-term losses and for those rebuilding measures which would have obvious short-term losses, a positive finding means that the long-term gains from rebuilding are expected to exceed the short-term losses.

IX. INITIAL REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act requires a determination as to whether or not a proposed rule has a significant impact on a substantial number of small entities. If the rule does have this impact then an Initial Regulatory Flexibility Analysis (IFRA) has to be completed for public comment. The IRFA becomes final after the public comments have been addressed. If the proposed rule does not meet the criteria for "substantial number" and "significant impact," then a certification to this effect must be prepared. The determinations for this amendment are based largely on the RIR which should be read in conjunction with the IRFA. In addition, the Social Impact Assessment (Appendix IV) source document contains an extensive demographic and ethnographic profile of the fishermen affected by the amendment.

For this proposed rule the "substantial number" part of the determination will hold because most of the 1500-2000 small firms operating in U.S. Caribbean waters will be affected by the combination of measures to regulate deep-water species, to create spawning closures, to regulate the taking of aquarium fishes and to revise trap construction requirements. The outcome of "significant impact" is less clear but can be triggered by any of these conditions.

- The regulations are likely to result in a reduction in annual gross revenues by more than 5 percent.

- Annual compliance costs (annualized capital, operating, reporting, etc.) increase total costs of production for small entities by more than 5 percent.

- Compliance costs as a percent of sales for small entities are at least 10 percent higher than compliance costs as a percent of sales for large entities.

- Capital costs of compliance represent a significant portion of capital available to small entities, considering internal cash flow and external financing capabilities.

- The requirements of the regulation are likely to result in a number of the small entities affected being forced to cease business operations. This number is not precisely defined by SBA but a "rule of thumb" to trigger this criterion would be two percent of the small entities affected.

Although the RIR does not quantify the short term reduction in catches that are necessary to provide for stock recovery and subsequent economic gains, the first criterion of a 5 percent reduction in gross revenues will be met via the combination of spawning closures, escape panel provisions and ban on the take of certain aquarium fishes. In fact, if there is not at least a 5 percent short-term reduction in take, there is almost no chance that the rebuilding goals of this amendment can be met. The other four criteria dealing with compliance costs and the number of small businesses which may be forced to cease operations will probably not be met. **Nonetheless, since the first criterion is met and since there will be some compliance costs involved for trap replacement/reconstruction, an IFRA is required.**

Explanation of Why the Action is Being Considered: Refer to RIR.

Objectives and Legal Basis for the Rule" Refer to RIR objectives. The Magnuson Fishery Conservation and Management Act of 1976 provides the legal basis for the rule.

Identification of Alternatives: Refer to RIR.

Demographic Analysis: Complete information is contained in the SIA. One of the major findings of the SIA is that the fishermen are generally part-time, can move from fishery to fishery as the occasion warrants and can even pursue another means of livelihood for short periods of time. While this will tend to ameliorate the individual income effects of these new regulations, the transfer of effort to other fisheries, if persistent, will eventually lead to the need for additional regulations in the alternate fisheries. Another major finding of the SIA is that the required fish trap modifications will not tend to eliminate part-time trap fishermen because even if most trap fishermen are part-time they tend to be persistent in their commitment to trapping. The SIA does point out that some marginal trappers could be forced into other fisheries, but this is probably more an economic rather than a social phenomenon. A final major finding of the SIA is while the spawning restrictions will not have a great effect on the fishermen because the resource is already depleted, there is no specific social information that can be directly related to the spawning closures.

Cost Analysis: Refer to RIR and specifically to section VIII (Summary of Impacts of Management Measures).

Competitive Effects Analysis: The industry is composed entirely of small businesses (harvesters, processors and charter boat operations). Since no large businesses are involved, there are no disproportional small vs. large business effects.

Identification of Overlapping Regulations: The amendment and the RIR carefully document the need to eliminate the possibility of conflicting or overlapping regulations promulgated by Puerto Rico or the U.S. Virgin Islands. In fact, the RIR specifically emphasizes that unless the corresponding state regulations are compatible, then there will be no benefits from management. It is understood that the two state-level governments involved will indeed pass compatible regulations as necessary. Since there is no foreign fishing involved and no other governmental entities with regulatory power, it is assumed that there will be essentially no overlapping regulations.

X. OTHER POSSIBLE ACTIONS

This RIR points out that the proposed set of measures do not provide for continuing long term benefits except for certain types of regulations. The reason discussed in the IRFA/RIR is summarized by stating that stock recovery tends to lead to an increase in the total amount of fishing effort and this in turn leads to a dissipation of the benefits from the original management actions. This outcome will not occur if proposed management rules are considered to be in effect long enough to realize the stock recovery and associated economic benefits but not long enough to allow the addition of a significant amount of new effort. In other words, if these measures can be considered as interim, then the identified benefits can be realized.

One problem with interim restrictions that provide benefits for some period of years put do not provide for effort controls is that the next set of rules has to be more restrictive if continuing benefits are to occur. This phenomenon is showing up in both of the U. S. mainland snapper/grouper fisheries. Both of the mainland Councils have FMP's for these fisheries and both Councils have a continuing history of formulating more restrictive rules.

Even though the class of alternatives involving limited entry, limited access or limited effort has been widely discussed for the Caribbean fisheries for a number of years, this discussion probably has to continue. There simply are no other long term types of alternatives that can be seen to resolve the problems associated with overfishing in shallow-water reeffish environments. The notion of some form of limited entry clearly has a host of stumbling blocks in the socio-political arena and that probably accounts for the reason that limited entry discussions have only recently resulted in implementation of limited access systems under the Magnuson Act. As examples of recent actions along this line, the South Atlantic Council recently implemented an individual transferrable quota (ITQ) system for the wreckfish fishery and the Gulf of Mexico Council is seriously considering an ITQ system for the red snapper fishery.

REFERENCES

The references used in the Regulatory Impact Review are found in Amendment 2 to the Caribbean Shallow-water Reef Fish Fishery Management Plan.

APPENDIX IV

SOCIAL IMPACT ASSESSMENT ON THE SHALLOW-WATER REEFFISH, QUEEN CONCH AND CORAL FISHERY MANAGEMENT PLANS

SOCIAL

IMPACT

ASSESSMENT ON THE

SHALLOW-WATER REEFFISH,

QUEEN CONCH AND

CORAL

FISHERY MANAGEMENT PLANS

SUBMITTED TO

THE CARIBBEAN FISHERY MANAGEMENT COUNCIL

BY

MANUEL VALDES PIZZINI, Ph.D.
CONSULTANT

SEPTEMBER, 1992

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SOCIAL IMPACT ASSESSMENT FOR
THE CORAL FISHERY MANAGEMENT PLAN

FIGURES:

SOURCE DOCUMENT OF THE SOCIAL IMPACT ASSESSMENT FOR THE QUEEN CONCH, SHALLOW-WATER REEFFISH AND CORAL FISHERY MANAGEMENT PLANS

INTRODUCTION

This document presents a social impact evaluation of three fisheries of Puerto Rico and the United States Virgin Island, managed by the Caribbean Fishery Management Council. The Council contracted this report to provide information required by the last amendment to the Magnuson Fishery Conservation and Management Act.

Different from the standard procedure in Social Impact Assessment (SIA), this document is fundamentally based on past research, and does not entail research done on the the specific fisheries affected by the Fishery Management Plans (FMPs) that require the information. These are: the Queen Conch, Shallow-Water Reeffish and the Coral Fishery Management Plans. Specific gears affected are: traps and diving. However, this report is based on original research, most of which was conducted by the author and his associates over the last 12 years.

Most of the materials and data sources employed in this report are derived from unpublished manuscripts and reports. Published materials are, of course, used in the preparation of this assessment. Results and projections of research in progress are also used in this document. Data on Life History of the fishermen, and Gill Net fishermen are preliminary results of analyses in progress. Information micro-levels of social analyses (households, production units (boats, gear and crew), communities, fishermen associations) are based on ethnographic materials, published reports and articles, as well as from unpublished reports done by our students on different areas of the Island of Puerto Rico. The information provided here also employs data from the CFMC, fieldnotes, and notes from meetings and conferences in which the fishermen and the researchers have participated.

This report covers both Puerto Rico and the U.S.V.I., but the bulk of the social, economic and cultural information comes from the former. The lack of social documentation on the USVI fisheries is one of the difficulties and gaps in the social information available to the Caribbean Fishery Management Council. This report identifies such gaps in information and points at areas of research that need to be covered in order to enhance the quality of the "socioeconomic" information needed to elaborate management plans, and for the decision making process.

The Source Document and each Social Impact Assessment have been prepared according to the guidelines distributed by NMFS, and written by Peter Fricke. Fricke has established that an appropriate SIA covers four basic aspects of the fishery: (1) Participation in the Fishery, (2) History, (3) Economics of the Fishery, and (4) Cultural and Social Aspects of the Fishery. This document is organized in the following manner: Section 1 A Note on Caribbean Fishermen and Fisheries Development, Section 2 The Fishermen of Puerto Rico, Section 3 The Fishermen of the United States Virgin Islands, Section 4 Fishing and Labor in Puerto Rico: Historical and Contemporary Perspectives of a Fundamental Concern in Management and Section 5 Key Issues in Fishery Resource Management in Puerto Rico and the United States Virgin Islands. These sections comprise the SOURCE DOCUMENT for the three management plans under assessment. Every major heading (underlined) in each section is numbered. The information provided in the document is the basic socioeconomic information needed in the understanding of the said fisheries, but with emphasis on the shallow-water reeffish fishery, and pertinent information, as available, to the Conch and Coral FMPs.

The **SOURCE DOCUMENT** is followed by three (3) Social Impact Assessments: **SIA 1: SHALLOW-WATER REEFFISH FISHERY, SIA 2, CONCH FISHERY** and **SIA 3, CORAL FISHERY.** Each SIA has information on (1) Participation in the Fishery, (2) History, (3) Economics of the Fishery, and (4) Cultural and Social Aspects of the Fishery. The information provided in each SIA is either presented anew (in reference to the data featured in the **SOURCE DOCUMENT**) or referenced from the document by number of section, major heading and page. The SIA includes a presentation of the basic management measures considered, and the probable social and cultural scenarios expected from the approval and enforcement of the measurements. The SIA ends with recommendations to improve the social and cultural data needed for the fishery.

Following Fricke's (1992) recommendations, this document presents a holistic approach to the process of social impact assessment. This report emphasizes the historical role of fishermen in the societies under study. It is a basic argument of this report, that in order to manage the fishery resources, one has to understand the historical process by which fishermen, as a class of producers, are inserted in these societies.

Fishermen are not part of a completely isolated social group, but an integral part of the sociopolitical and economic process. Thus, there is a close relationship between the macro economic and social processes, and the behavior, attitudes and practices of the fishermen of these islands. These fishermen are also part of a regional culture, and must be also understood in that context. The fishermen from Puerto Rico and from the U.S. Virgin Islands are, in essence, Caribbean fishermen, thus sharing social, cultural and occupational traits with their regional counterparts.

In the social sciences, as well as in resource management, there is the tendency to look at the aggregation of the individual traits of the resource users, as a step to produce a socioeconomic profile of that "clientele". Most reports and studies cited here use that approach in the understanding of fishermen. Needless to say, such information is valuable since it provides us with an accurate picture or portrait of a group of individuals at an specific moment in time. However, in this report I also include qualitative (ethnographic) and historical information that allows the manager to view and assess the participation of fishermen in a dynamic perspective, and stemming from a complex social and cultural context. What this means is that in addition to the percentages on social characteristics and patterns of resource utilization, this study provides depictions and analyses of social relations, cultural practices, the role of households and kinship in the fishing activities, the themes of the fishermen's discourse, their lifetime trajectories as related to labor and to fishing, and their views and praxis of the political process. All these aspects of the participation of fishermen in the local fisheries are discussed from a historical perspective. That is, analyzing the sociocultural aspects of the fishermen, in reference to the complexity of political and economic processes of the society at large, and such effort also include the pervasive process of resource management. This document also has an underlying argument that the thorough understanding of the fishermen woes must be anchored in the analysis of their partaking in different forms of labor participation in different sectors of the economy, and on a regional (the Caribbean) and global scale. These aspects of the society and culture of fishermen are used in the SIA's to extrapolate on the effects of different management measures, by simulating various scenarios.

SECTION ONE

A NOTE ON CARIBBEAN FISHERMEN AND FISHERIES DEVELOPMENT

The appropriate assessment of culture and society of the fishermen of Puerto Rico and the U.S. Virgin Islands, requires the understanding that they are part of the culture of the Caribbean fishermen, specially in reference to the practice of having an array of occupational activities. Those involved in the scientific and political process of fishery management must be aware that this "clientele" is part of an economic development process in which the state, now managing the resource, have been engaged, on a local and regional basis.

1.1 First: A Definition of Fishermen

The attempt to define fishermen is a difficult but necessary task, especially in the context of tropical fisheries, where diverse terms such as artisanal, small-scale, traditional, and semi-commercial are abundant and often used interchangeably (Cordell 1989:22). In the Caribbean islands, the term fishermen identifies people that fish on a full-time, part-time or mixed basis (Adams 1982, Stoffle 1986). Some researchers have elaborated on the technical and social heterogeneity of fishermen and its consequences; i.e. access to technology and the opportunities for capital accumulation (Cecil 1988). However, it still stands as a poorly defined sociological category, especially when associated with the phenomenon of social class. Caribbean fishermen are often viewed as peasants who occasionally engage in wage labor activities to cope with the constraints of household economic pressures (Price 1966, Benoist 1972, Poggie 1979). And many do engage in a pattern of varied productive activities, at unison or following a seasonal - annual cycle, including wage labor; such engagement is labelled in the literature as occupational multiplicity (Comitas 1962, Valdés-Pizzini 1990a). In this model, fishermen become differentiated through productive - ecological - seasonal adaptations and their recurrent insertion in wage labor, while in community settings they form part of an egalitarian social system.

Fishermen-farmers-laborers (Stoffle 1986) who utilize the labor arrangements of their domestic units for their well being also depend on the state for their sustenance, and for the development of infrastructure and capital. This pattern of survival has been essential throughout the history of the Caribbean people.

The societies and economies of the Caribbean have been dominated by the presence of the plantations and the haciendas. Originally using slavery and forced labor, later proletarians and peasants, these have been key factors in the shaping of the history of this archipelago. This history has been characterized by many as one of dependency relations, of underdevelopment, of sociocultural penetration and political and military intervention on behalf of the core countries of the world. The monocrop orientation of the plantation economy made the whole Caribbean region an enclave economic system that provided the Old World with valuable agricultural commodities.

In this context fishing was indeed a marginal activity. The consumption of fish, so vital in the dietary patterns of the people of the Caribbean from early colonial times, was satisfied mostly by imports of salted and dried fish from the European fish producers and from Newfoundland (Adams 1983). Thus, the omnipresence of the monocrop cultivation system and the availability of foodstuffs from foreign markets retarded the development of indigenous specialized fishing activities.

However, fishing was an important economic activity, despite its marginality. Fishing, in this area, arose from efforts of peasants and rural workers to complement their economic and dietary subsistence. This productive activity became historically a source of extra income and proteins for the Caribbean rural folk. As slavery was abolished and the demand for sugar production in the world market declined, a fraction of the new classes of peasants and rural proletarians began to settle in the areas marginal to the plantation fields, mainly in the coastal grounds and in the mangrove areas (Price 1966). Most of the labor force in those communities and environments in Puerto Rico, as in the rest of the Caribbean, alternated between fishing, farming and agricultural work in the fields in order to achieve satisfactory levels of subsistence.

1.2 Fisheries Development in the Caribbean

After World War II, most of the countries of the Caribbean initiated diverse programs for the development of their fisheries. These were characterized by low levels of technology and low production yield and were subsistence oriented. Despite the enormous efforts of those countries to raise the standards of the fisheries, they are still being defined as artisanal; with only some limited clusters of commercial and industrial fishing enterprises in a few islands. The classification of artisanal, or small-scale, is used to describe those fisheries with the following socioeconomic traits:

1. The fishers are the owners and the operators of the means of production (gears and seacrafts); and as independent producers they organize their own productive activities
2. The technology employed is simple: small and modest size vessels, inexpensive, manually operated gears, often elaborated by the fishermen or by local craftsmen, and fishing is performed in the inshore areas
3. The catch is sold directly to consumers or to middlemen trading in the local market, rather than to centralized fish markets
4. Fishing is often a part-time chore, since most of the fishers are also engaged in other productive activities, such as agriculture (Adams 1983, Berleant-Schiller 1981, Munro and Smith 1983).

The fisheries development programs in the Caribbean have been designed with the intention of making fishing prófitable on a large scale, as to supply the local market. The expectation is that an appropriate success can also produce for the export trade. These development schemes are planned and constructed on the basis of the potential of the insular environments; thus any development in the productive forces must be closely monitored and ensued in terms of the availability of the marine resources, based on the biologists' equations of the fisheries' maximum sustainable yield. In the reports of the Caribbean fishery scientists, the insular environments are viewed as limited in resources and incapable of sustaining high yields; therefore concluding that such condition imposes certain limitations to the development potential of the fisheries.

In this context, the fisheries are characterized by limited governmental capital investments and the goals of the planners are aimed toward the mechanization and modernization of equipment, improvements in the navigation technology and refrigeration systems, and rationalization of the marketing techniques. Yet the technical innovations can be handled by small work teams with a relatively simple division of labor. Thus, the fisheries tend to remain artisanal, but featuring higher yields due to the mechanization of their technology.

The aforementioned trend towards intensification exemplifies all the Caribbean fisheries' development plans. During the last forty years, the countries of the Caribbean, advised by experts from Canada, England and the United States, have religiously studied the potential of the insular environments, the market potentials and the possibility of training fishermen into more rational fishing techniques.

From 1965 to 1975 the developmental trend was geared toward the capture of pelagic species, and demersal fishing in the continental drop-off and the coastal shelf. Such plans, inspired to a certain extent by the enormous success of the Cuban fishing fleet, and suggested by the United Nations Special Fund and the projects of FAO, intended to improve the past "scant fishery developments" from 1940 to 1965 (Adams 1983). The potential success of those plans, which required large investments of capital, were destined to succeed only in those islands with the proper economic resources, such as in Puerto Rico. But overall, the success of those plans was limited and the focus of their efforts remained in the artisanal fisheries, which only allows limited investments.

Another major deterrent to fishing, according to the fishery scientists, is the lack of a navigational and seafaring tradition among the Caribbean fishermen. Therefore, there are scant, or non-existent possibilities for the establishment of an open sea fishery. Thus the fisheries are condemned to remain inshore oriented, and their development limited; in other words: to remain artisanal. The ideas that the Caribbean fishermen are afraid of the sea and seafaring, especially the black fishermen, that they are ignorant of navigation and do not have any love or understanding of fishing, or a tradition for navigation are common (Suárez Caabro 1979, and Adams 1983), as well as unfortunate.

Most of the fishery scientists have failed to give an adequate assessment and evaluation of the lack of a seafaring tradition. Even though the arguments described above appear constantly in their discourse, the understanding of the Caribbean fishermen as being essentially and foremost, tied to the plantation economy or to the petty commodity (agricultural) production began with the works of Sidney Mintz (in Steward et al. 1956). However, it was Lambros Comitas that initiated the assessment of fishing production as part of the Caribbean labor reality of occupational multiplicity (Comitas 1962), which has become a constant and prolific type of research in this area.

In spite of the major criticisms of the Caribbean development plans for the fisheries (Gordon 1981) those schemes have been successful in introducing the fishers to modernization, and therefore to the logic and mechanisms of the industrial and post-industrial world-economy. The mechanization of the fishing technology, the preservation of the catch, and the rationalization of the market's organization have had the effect of stimulating the fishermen to reproduce and buy the means of production with the utilization of cash in obtaining products manufactured in the industrialized countries. As in any other parts of the world, the process of development, leading toward the modernization of the fishing fleet, has also led to a constant capitalization of the fleets, and the sustained effort to increase the landings. This process is fueled by the creation of a demand for the fishery products, as it has been the case for Puerto Rico and the U.S. Virgin Islands. One could say, that resource depletion, has appeared almost as a function of capital investments in the fisheries on behalf of the state, and on behalf of fishing firms, stimulated by the increasing demand for fish and shellfish. Management of conch, lobster, and reef fish must not overlook such process.

SECTION TWO

THE FISHERMEN OF PUERTO RICO

Most fishermen in Puerto Rico are petty commodity producers, or artisanal fishermen. The kin-based type of operation, in which family members and relatives, including women, participate is fading due to labor competition from the industrial and service sectors of the economy. Of key importance for management is the social and cultural characteristic of the fishermen. Fishing is considered a form of independence and a therapy. Fishing is also a strong form of cultural identity and pride. Not all fishermen in Puerto Rico are small-scale. This section documents the fishery of Puerto Real in the southwest coast. The objective of that "portrait" is to present a documented process of changes in gears and technology in reference to capital investment in the snapper groupper fishery.

In Puerto Rico, as in the rest of the Caribbean, the fisheries are essentially artisanal or small-scale. The only industrial development in the fisheries corresponds to the American tuna canneries of the south coast, with foreign seiners that land their catch in the factories' docks, and the recent intrusion of U.S. based longliners targeting swordfish and other pelagics.

2.1 Fisheries Development in Puerto Rico

The artisanal fisheries in Puerto Rico have been the target of several development plans. Due to the scarcity of food imports during, and after World War II, mainly in the area of marine food stuffs, the government of the Commonwealth of Puerto Rico created a pilot program for the improvement of the fishing sector of the economy. The aim of the Programa de Villas Pesqueras (Program for the Fishing Villages) was to change the subsistence character of the fishing communities, into market oriented clusters of fishers.

Throughout this program the government of the island invested large sums of money in the development of an infrastructure, and the technological and environmental knowledge needed in the exploitation of the marine resources. These monies were invested in facilities for the fishermen, which consisted of wharfs, lockers for the fishermen, and a building allotted with a freezer and the appropriate facilities for storage, and market distribution of the catch. Funds were also allocated for the creation of fishermen's associations and cooperatives, and for the development of the Maritime Credit Institution, which helped the fishermen with loans for the acquisition of their vessels and gears.

The state also provided teaching programs for the training of fishermen in the rational catching techniques and navigational expertise (Picó 1974, Suarez Caabro 1979). With the creation of the Programa de Villas Pesqueras the fishing production of the island increased notably. The expectations of the program were to turn the artisanal fisheries into commercial ones, that is, a fishery characterized by a high level of technology, capital intensive, and high yields, although the parameter of those high levels have seldom been established.

In the decade of the 1970s the planners of the Commonwealth invested, as recommended by the O'Brien Report of 1972, in the development of two programs designed for the acquisition, by fishermen associations and individual fishers, of trawlers and large vessels to be employed in pelagic and demersal fishing. These programs failed to accomplish their goals since most of the fishermen were unable to adapt to the new technology, make it profitable, nor could they produce a surplus to invest in the fishery (CODREMAR 1980). Thus, the vast majority of the Puerto Rican fisheries are still considered artisanal.

As in the Caribbean fisheries development plans, the Puerto Rican fisheries schemes are also conditioned by the ecological and socioeconomic limitations of the fisheries, a contention which is supported with the statistics concerning the low yields and poor technological and capital developments in that sector of the economy. Therefore, further developments in this sector are limited by the poverty of the sea, and the low potential of its future yields. According to planners and fishery scientists, one important constraint consist of the attitudes of the fishermen; they are individualistic, conservative, slow to experiment with new technology, and therefore traditional and slow and difficult to change (CODREMAR 1980). According to Suarez Caabro, the fishermen also lack a seafaring tradition and even are afraid of the sea, a major obstacle in the improvement of their economic conditions since seafaring and seamanship requires "tradition and natural skills" that hardly comes through with the teachings at the fishing and navigation schools (Suárez Caabro). These stereotypes, which are fundamentally wrong, have permeated the strategies and planning in the local fisheries. Another deterrent to development consist of the fishermen's inability to save enough money to make the proper capital investment for the improvement of their vessels and gears; therefore such responsibility falls on the shoulders of the state and its concerned institutions.

2.2 The "Socioeconomic" Status of the Fisheries

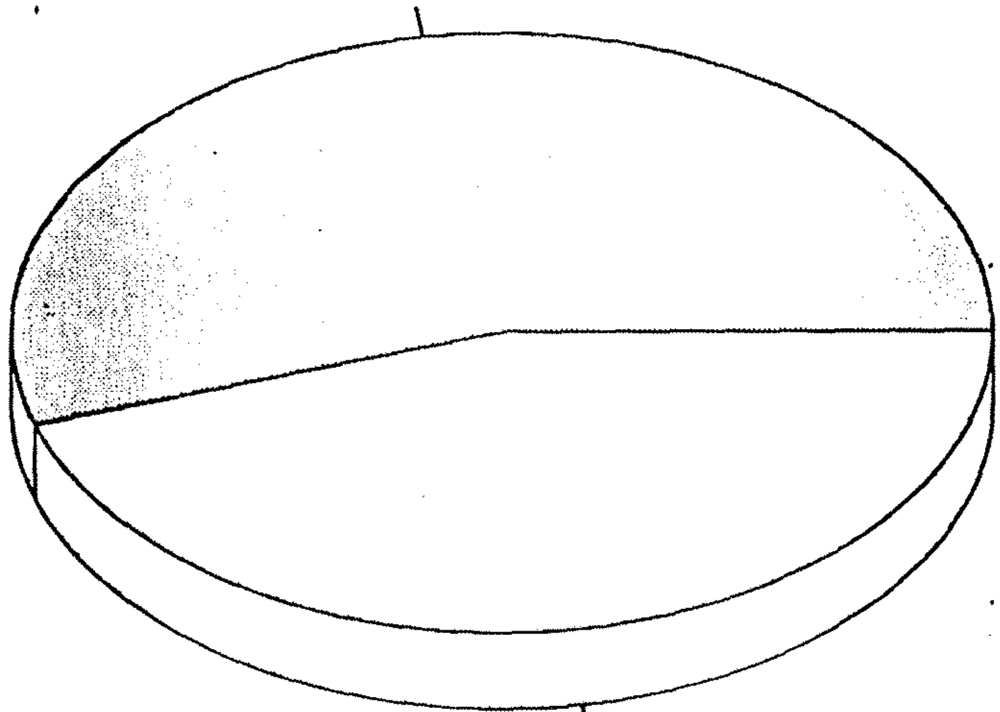
The Puerto Rican fisheries are characterized in the literature by the use of a "simple" technology. The most common gears are traps, line trolling, hand lines and nets. These gears are manually operated, although mechanization of some of their operations have started already in the hauling of traps. The vessels employed in the fisheries do have a limited travelling potential; they are for the most part row boats, sailboats and boats which have been modified by the installation of small inboard and outboard motors. About ninety percent of the total number of vessels are under 21 feet long, and eighty one percent have motors under forty horse power. Wooden vessels, mostly a product of local craftsmen, constitute the eighty-six percent of the total number of vessels (CODREMAR 1980). Consistently, all the reviews and studies of the fishery reveal that the main characteristics of the vessels, such as the skiffs, fishing smacks and schooners, have remain unchanged since the beginning of this century, except for the fiberglass coating they apply today for the protection of the wood (Ibid). Recently Matos and Torres agree that since 1976, fishing vessels have not changed much (Matos and Torres 1989). They reported that 52% of the fishing vessels were yolas or small wooden and/ or fiberglass boats. In their view, unchanged vessel size and motor power is an indicator of the status of the fishery, where fishermen cannot upgrade their technology in a significant manner, due to low economic returns.

Most of the fishing is done in the inshore habitats of the insular shelf, while a smaller number fish in the slope or shelf drop-off. The environments exploited consist of the mangrove forests, the reef areas, the grassbeds and rocky bottoms of the coastal waters. Fishing outings are performed daily, and the production units are usually back ashore around noon.

Ten years ago, Gutiérrez found that the fishermen sold the catch to the fishermen associations, located in the government built villas pesqueras, or sold it directly to the customers in the streets or to fish vendors, some of which are itinerant and do not have a permanent site to perform their transactions (Gutiérrez 1985). During that time, fishermen associations were an important and incipient institution for the defense of the fishermen interests and for the profitable disposal of the catch. In 1985 there were 45 fishermen associations, and 58 fishing centers or "villas pesqueras," used by an estimated number of 1,900 fishermen (Romaguera, Vega and Dones 1987). Most of the facilities (74%) were considered to be "active," or used by an association or by an independent user.

Half of the fishing population is engaged in that economic activity as a part-time chore, and do it because they cannot find jobs elsewhere (Gutierrez 1985). Strikingly similar results have been obtained by Romaguera et al. (1987), and by Matos and Torres (1989). In 1988-89 we found a slight increase in the number of fishermen devoted to fishing (Figure 1) but this could be due to the nature of the sample. More than forty percent of the population has been engaged in agricultural work in the past, following a well established socioeconomic pattern of the Caribbean fisheries, as already mentioned. Most of the fishers have been engaged in commercial and industrial work in Puerto Rico, and more than fifty percent of them in the United States (Gutiérrez 1985). Some of these migrants are returnees that retired from private or public jobs and complement their pensions, and social security benefits with the monetary returns of their catch. The Puerto Rican artisanal fisheries absorb portions of the unemployed labor force from other sectors of the economy as in other less developed societies. In Puerto Rico, with the demise of sugar cultivation and the drastic industrial and general unemployment, the fisheries are a labor buffer zone, in which many of its inhabitants are not full-time or traditional fishers and therefore fishing appears as a low priority occupation (CODREMAR 1980).

FIGURE 1
FISHING AS AN EXCLUSIVE ECONOMIC ACTIVITY



n=109

2.3 The Petty Commodity Character of the Puerto Rican Fisheries

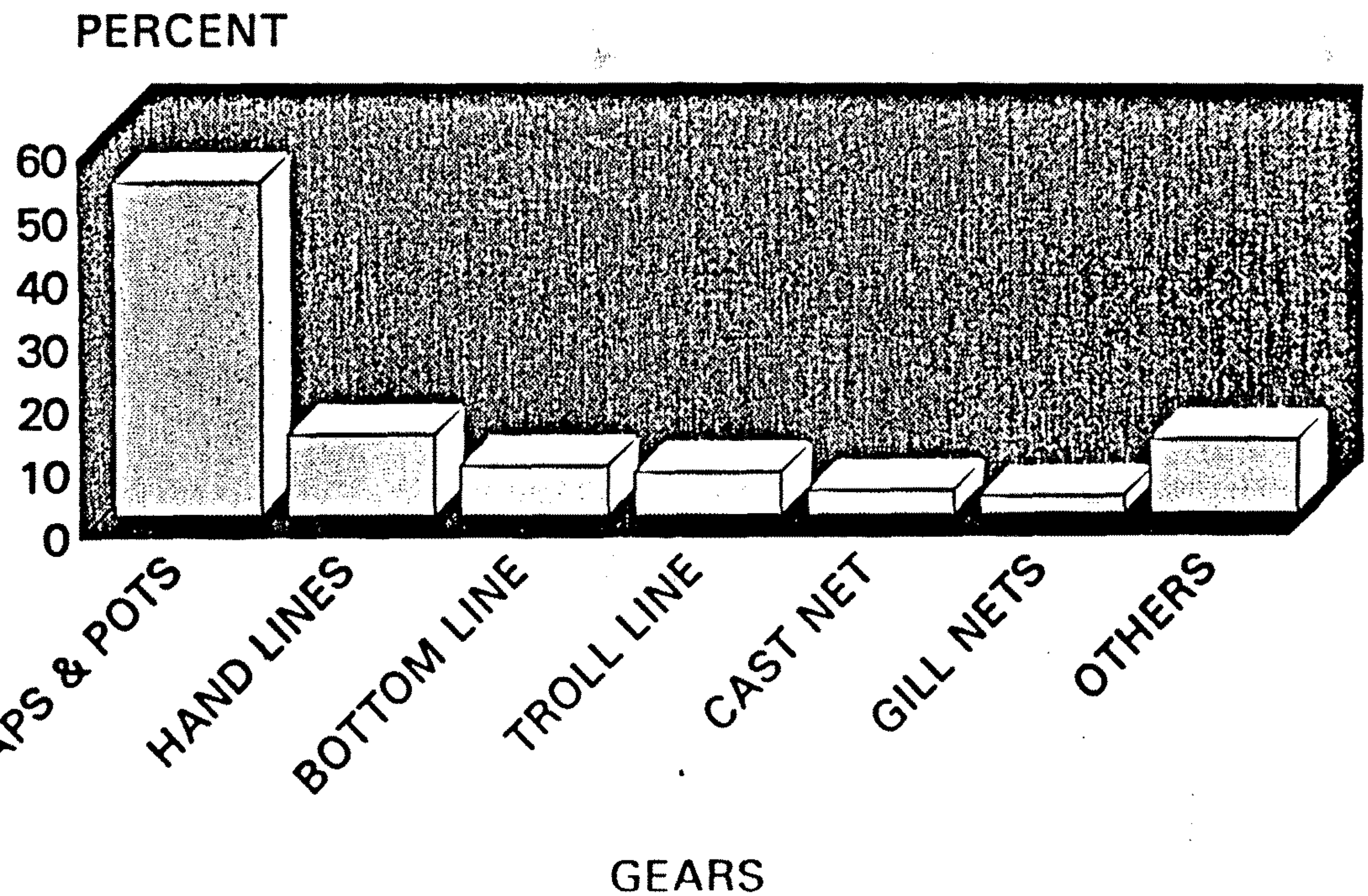
Fishing production in Puerto Rico is done by "artisanal fishermen" using "traditional methods." This multi-species, multi-gear, year-round strategy is archetypical of tropical fisheries exploiting a low biomass but high diversity of species. Most of the Island catch (averaging three million pounds per year) is captured with traps, gill nets, trammel nets, troll lines, trot lines, hand line, and beach seines. In terms of units of gears, traps, lines, cast nets and gill nets are the most important ones owned by the fishermen (Figure 2). Since 1982, the number of divers targeting high value reef fish, conch and lobster has increased fourfold throughout the Island. If a general category must be employed to describe the social and economic character of the local fisheries, without entering in a discussion of technology (types of boats, gears, mechanization, etc.) or magnitude (small-scale, commercial scale), petty commodity production is an appropriate one. Petty commodity mode of production is defined here as the organization in which the producers "appropriate the means of production and set the productive process in motion without intervention of non producers." Here, each producer owns the means of production individually, i.e. there is no class of non producers standing over the laborers with property rights in the means of production.

In a recent discussion of petty commodity production among fishermen, Russell and Poopetch (1990) use the term as "a useful way of distinguishing kin-based from non-kin based forms of commercial fishing" in industrial economies. However, they are also cautious in observing that the "fishing" households as such are under pressure by the industrial economy to participate in wage labor; thus, kin-based production fluctuates in the trajectory of the household or -as they prefer to label it- through the developmental cycle of kinship. That distinction is important for the case of Puerto Rico. A recent fisheries census estimates that 51% of the registered fishermen own the boats, while 60% own the gear (Matos y Torres 1989).

Survey, ethnographic data and life history interviews of the Puerto Rican fishermen suggest that fishing is fundamentally a kin-based operation, especially at the early stages of the developmental cycle, and one that involves affinal relatives at a later stage, when siblings are no longer available (Griffith, Valdés-Pizzini and Johnson 1992). (More than half of the fishermen interviewed (53.5%) reported to receive help from their family and relatives in fishing related activities). But, historically, monocrop agriculture early this century, industrial development, and labor migration to the United States have re-structured crew composition, and the social and economic relations in the fisheries. A consistent fact observed since 1930 (Jarvis 1932) is that half the population of fishermen is involved in it as a part-time chore; and do it because they cannot find jobs elsewhere (Gutiérrez 1985). Independent producers whose life trajectories have been intersected by diverse options and alternatives, most have engaged in different economic activities throughout their life histories (Griffith et al. 1992). Gutiérrez (1985), for example, found that most of the fishermen have had experience in agricultural work, and half of them have worked in industry and other activities in the United States.

In reference to the technology, petty commodity production in tropical fisheries is labelled as "small-scale" or "artisanal" because the technology employed - gears and boats - are usually manufactured domestically, by household members, following traditional cultural practices and use of local materials. Profitability in other sector of the economy limit the investments in that sector, and wage earnings in other areas attract producers, who otherwise would be working and investing capital in fishing enterprises, contributing to the low levels of capital accumulation and reproduction in fishing. In the Caribbean, as in other parts of the world, the state provides the instruments for the economic development of the fisheries sector, due to the poverty of rural proletarians and peasants to do so, and the diverting factors mentioned above.

FIGURE 2
MOST COMMON FISHING GEARS IN PUERTO RICO



Torres and Rosado 1989

2.4 Cultural Dimensions of Fishing as an Economic Activity

In cultural terms, fishing is an endeavor that evokes the most powerful images of identity and cultural strength. Fishermen in Puerto Rico have stated, loud and clear, that they, as a class, have historically been the dispossessed and the forgotten. They have also stated they have been historically displaced by their competing coastal users (recreational groups, tourist and hotels), and that they must claim their position in society. Culturally, the fishermen have an strong sense of identity and of independence. This duo of strong characteristics are always stressed by the fishermen when they speak in public. There are two cultural dimensions in which independence and identity are emphasized: how they view fishing as an occupation and as therapy, and their political culture, as exemplified in the fishermen associations.

Therapy: A Cultural Category

In 1982 Jaime Gutierrez conducted a survey of the Puerto Rican fishermen for the University of Puerto Sea Grant Program. Valdes-Pizzini worked in that project in every phase, including interviewing throughout the island, and the island municipality of Culebra. Two questions in the instrument ellicited information on their appreciation of fishing as a job. The very first question inquired on the reasons they had for fishing. It was a general, and open question that allowed the interviewee to express an array of reasons for fishing. Estimulated by the recommendations of John Poggie, hired by Sea Grant as a consultant for the preparation of the proposal, and following Poggie's theoretical interests (Poggie 1979) the project had an interest in assesing the levels of job satisfaction in the fishermen. While a direct question on job satisfaction was used in other, concurrent fishermen surveys (Valdés-Pizzini 1985, 1990a), in the 1982 survey, Gutierrez decided to ask the question using an alternative stimuli: Would you recommend fishing, as a job, to a young person you like?. Gutierrez expected fishermen satisfied with their job to respond: Yes, I would recommend fishing, as most of them (62.6%) did (Gutierrez 1985, Valdés-Pizzini 1990a).

In that survey fishermen elaborated several times, in response to both questions, a discourse in which they included the category of therapy as part of their conceptualization of fishing, and their relationship with that occupation. Unfortunately, therapy was masked in the process of coding, and superseded by a larger category of like it. The cultural category of fishing as therapy reappeared in the NSF funded Fishermen Life History Project. This time, therapy was a loud and clear element in their discourse, in which they explained their labor trajectory, and the process of semiproletarianization.

Before we engage in a precise exposition of cases, and a discussion of therapy and fishing in the occupational life history of the Puerto Rican fishermen, a rescue of that lost discourse from 1982 is needed, along with some reflections on the semiotics of therapy in Puerto Rico. For that purpose we "revisited" the 292 cases studied in 1982. The procedure in this revision simply consisted in evaluating the responses to questions number one and four. In that specific combination, 5.82% of the informants responded that fishing was a therapy. What does that means?

For the fishermen, fishing was foremost an occupation but it also has the quality of performing therapeutic benefits of the labor force. The mention of therapy tended to emphasize either why they fish (received the benefit of therapy) or why they recommended fishing to others. One of the informants clearly stated that fishing was "a mental and physical therapy", thus including the two larger medical and psychological categories of the term. In psychology therapy is usually defined as those activities developed to cure diseases, or to reduce pain or suffering. Therapy includes an array of activities which includes: recreational, occupational, groupal, relaxation activities with the objective of changing the "patient" behavior. Is that therapy for the fishermen? Collectively, the answer is affirmative.

Psychologically, when they speak of fishing as therapy they are also expressing that this activity helps the "relax", it is a "quiet" activity in which there are no pressures. The element of recreation, and leisure or entertainment as a therapeutic quality is also involved. Fishing is thus considered to be "a sport" and a "healthy" activity ("es un deporte... es sano y saludable"). In recommending fishing to young people, fishermen emphasized that fishing was a good therapy for them, since it was a way of earn a living while avoiding behaviors conducing to drug adiction. Fishing locates people away from drugs, alcoholism, and also it contributes to the avoidance of problems.

It is clear from this small number of fishermen (n = 17) that fishing play an important role as an occupational therapy. In four cases, when they mentioned therapy they clearly meant that fishing was an occupational alternative to other jobs they had in the past, and in one case fishing was recommended by a physician. The argument is that "I cannot work anymore" (in the industrial and commercial setting), therefore I am fishing. Injury is an evident cause. One fisherman expressed that [fishing] "is easier than other jobs... [I have] an injury in one leg", therefore cannot work because of the injury and, maybe more important, because of the pension. In this case, the informant explained what he meant by "easier":

> "[Fishing] has its advantages, it is a job as well as a therapy, one does not work for a boss, under the exploitation ("servidumbre") of no one, under no yoke... nobody intervenes, it is only you an nature... there is people who work 8 hours and earn a miser salary, [in fishing] one work less."

Another fisherman constructed the following discourse explaining his reasons for fishing: "I am handicapped... I receive social security [benefits]... my family used to fish... I earn some money... it is a therapy". In addition to the general physical and mental therapeutic qualities of fishing, as their emics or cultural viewpoint revealed, some fishermen also vest fishing of occupational therapeutic benefits that allow then to continue working while not working in the official economy. A hidden argument in their rethorics is that fishing has a niche in the informal sector of the economy, or at least is easier to participate in that sector without affecting the money transfer from the state. The frightening consequence (for the anthropologist and his formal models) in the analysis is that one of the meanings in this specific semiotics of fishing is that the argument of therapy confuses (or replaces, in a discoursive representation?) the perception of fishing as labor, as work, while protects the fishermen from excluding themselves from the danger zone of exclusion from the files of state benefits (food stamps, unemployment, social security benefits, tax exemption...).

Fishing as Therapy: A Cultural Category of the Fishermen?

Is it appropriate to say that fishing as therapy is a widely held cultural category among the Puerto Rican Fishermen, given the small percentage (5.82%) of direct responses to that issue? To solve that problem, we expanded the argument of the fishermen into two areas. In assessing fishing as therapy the cases we examined revealed that health and being a sport (a healthy, entertaining activity) were key elements in their explanation of therapy. Taking those two categories we find that those who considered fishing as a sport constituted 13% of the sample, and those who defined fishing as a healthy activity accounted for a 10% of the fishermen. The triad of related concepts or cultural categories therapy-sport-health represents close to a 29% of the Island fishermen interviewed in 1982. It is not our intention to inflate the percentages, to have a larger group of cases to discuss, since the core of the cases in this discussion are taken from the life history project. The gist of that strategy is to show the extensions of the conceptualization of fishing as therapy. All the elements of that discourse appear consistently in the interviews, the only element lost is therapy.

Associated with fishing as a sport, we find the following segments of discourse: "keeps your mind occupied in useful things"; "it is a distraction"; "keeps you away from drugs"; "it is entertaining, fun, it does not bore you"; "it is good and healthy"; it is a clean activity"; "it is a good exercise"; "a profitable sport". On the other hand, associated with fishing as a healthy activity we find the following segments of discourse: "it is good and healthy"; "it is peaceful"; "keeps your mind occupied, away from bad thoughts"; "clears the mind"; "keeps you young"; "one forgets problems and tensions"; "keeps you away from vices"; "it is a distraction"; "keeps young people away from delinquency". It is our contention that the notion of fishery as therapy is widely held by the fishermen, although it is often broken down in pieces of discourse containing the elements of health and sport. In those, the therapeutic effects of fishing are presented.

Therapy as a "Puerto Rican" Cultural Category? How to explain therapy as a cultural category, and as a concept associated with work and labor among the fishermen? Therapy is a sophisticated concept, and not a generalized term of the social sciences, as it is, for example, the concept of social class. Ethnographic impressions atest that the concept is also shared by the population at large, although there are no studies of such popularization. It is evident that the psycotherapeutic trends of the U.S. started to operate in the Puerto Rican population. The trends of the Island's economy, tainted by large money transfers and social services programs from the U.S. defined the scenario for the dissemination of therapy as a cultural category. Therapy entered the Puerto Rican household through the mental health clinics established by law in 1963, and through the programs of vocational rehabilitation. It appears to be a consensus among psychologists in Puerto Rico that labor, the mental and physical conditions of the labor force, treatment of migrants, the incorporation of injured laborers into the economy, and the rehabilitation of the lumpenproletariat (addicts, juvenile delinquents) have been a priority of such programs. Incorporation of people into the labor force becomes the objective of various government programs, based on the argument that labor is essential to social order.

That process was institutionalized with the incorporation into the Island of U.S. programs for vocational rehabilitation, under the administration of the Department of Social Services, in the Commonwealth of Puerto Rico. Services in vocational rehabilitation were fully established in the key moment of the return migration of the 70's, by which a large number of workers tried desperately to find jobs in an stressed labor environment. It also responded to the moment in which industrial development was in its peak moment. The "vocational" trend entered grade and high schools, and in the area of social services, rehabilitation programs prepared the young, the injured and the unemployed (often as a consequence of that industrial development) for their re-incorporation into their areas of work, or re- educate them into other labor areas suitable to their handicap or limitations. The array of services included: total "restoration" of the laborer into his environment; vocational training; establishment of small businesses (including fish-houses), materials for training (fishing gear, boats); social security benefits for disability (capital used to buy boats); and services to laborers injured in their jobs.

The constant "clinical" and programmatic intervention of the state in the configuration and the allocation of the labor force for the existing industrial and commercial order, has led, in our view to the popularization of the concept of therapy. Although far and distant from the motifs of our research, it is obvious that the fishermen, their families, relatives and neighbors had direct or indirect interaction with government agencies and their philosophy and praxis of vocational rehabilitation, and occupational, and mental therapy. In my view fishing is therapy against unemployment, it helped to maintain the economy of the domestic unit while keeping the mental integrity of these laborers in times of stress. This is not far from the fundamental objectives of the "art and science" of occupational therapy, in maintaining appropriate social functioning of the labor force, in promoting health conditions, and in facilitating learning of new productive skills in order to adapt to a new situation. While it is argued that fishing is an employment opportunity for the rural workers, these arguments shared by the fishermen suggest that it is also a therapeutic alternative for the industrial (local and migrant) de-proletarianization by decree, chance, injury and choice (Griffith, Valdés-Pizzini and Johnson 1992, in passim 56-58).

2.5 The Political Culture: Fishermen Associations

In most countries, fishermen constitute a small proportion of the ccupational structure; hence they tend to have a weak political position as a group, mainly in terms of negotiation and bargaining power vis-a-vis the state. Fishermen are also peasants and rural workers, marginal and isolated from the government apparatus, and therefore experience some difficulties in participating in state decision making processes. Orbach and Maiolo tend to associate the rise of political participation in the fisheries with the process of modernization. Their argument is that, with the international expansion of maritime economic activities, the expansion of capitalism stimulated the transformation and elaboration of existing legal mechanisms (e.g. licenses, laws. permits) for the control of access to the fishery, including the resolution of conflicts surrounding resource competition. These developments increased interaction between fishermen and the state, and the state and the fishermen became entangled in legal and political disputes concerning the impact and extent of the policies: under these circumstances, as well, fishermen were no longer marginal or politically isolated. Such political participation has thus became a necessary tool for the fishermen to influence the decision making process. Modernization not only involves the transformation of the techno-economic structure, it also stimulates in the fishermen "a process of learning to work with the new political and administrative contrains and requirements.." (Maiolo and Orbach 1982:7).

The key element in understanding the political culture and activities of the Puerto Rican fishermen resides in the workings of the fishermen associations. Throughout the Caribbean fishermen cooperatives and their variants (eg. associations) have been encouraged by governments, fishery agents and planners (Comitas 1962). Being independent producers operating within the economic boundaries of the household and communities of peers and relatives, fishermen are viewed as individualistic, often isolated personas, that even have independence as a psychological trait (Poggie 1980). By contrast, the potential for fisheries development (measured in higher landings, better technology, and higher ex-vessel prices per catch) lay in organizing the producers into cooperatives to circumvent the control of local dealers and merchants (Pollnac 1982). This would also facilitate the sharing of gear and vessels for the profit of the group, rather than for the benefit of one or two individuals.

In Puerto Rico, the state tried consistently yet unsuccessfully to develop cooperatives for the development of the Island fisheries. In the decade of the 70's with the law that created the Corporation for Fisheries Development (CODREMAR), a program for the development of fishermen association was initiated. Instead of a cooperative-like organization, the associations, partly encouraged by the state, became an instrument for the negotiation of vessels, gears and favors with the state (Gutiérrez et al 1986, Valdés-Pizzini 1985). One important trait of fishermen associations is that they have become lobbying agencies for the fishermen, serving their social, economic and political purposes and interests. Associations allowed for the collective participation of fishermen in the protection of their specific interests providing a vehicle with which they could adapt their behavior to the new managerial regimes.

Political participation of fishermen is also inextricably tied to changes in the coastal zone. With the demise of traditional agriculture, use of the coastal zone shifted from productive to leisure oriented activities and infrastructure. Demand for coastal space, by both the private and public sector, have threatened the existence of traditional coastal communities throughout the island. Local residents, often with few or no other economic and social alternatives, find themselves in the political predicament of rejecting development projects that seem to attempt to transform their traditional way of life. Opposition to these projects often underlies alliances among diverse political and environmental organizations.

A Model of Fishermen Associations

In contrast to the cooperative, fishermen belonging to an association usually own their boats and equipment and are responsible for their production and revenues. That is, they remain petty commodity producers with individual ownership over the means of production. Since the associations have to be incorporated into the governmental apparatus in order to function, the individuals chosen for the board of directors must have special capabilities and thus are selected from the most experienced and successful fishermen, many of whom also are viewed as social and moral pillars in their communities.

Presidents usually are outstanding members of the community that have some experience in lobbying or in political endeavors. They are well educated, knowledgeable of bureaucratic procedures and the workings of the system, and have contacts in the local or national government. Presidents tend to be bilingual; most have had lengthy experience as agricultural and factory workers in the United States. Although they are registered as fishermen and have licenses, many also hold other jobs and only fish in their spare time; at the same time, they are full time specialists in the old art of politics.

A president must have the proper rhetorical skills to be able to defend their interests. He must learn the rules of the political game and apply them; hence, he must be able to use and manipulate the following resources: the media, lawyers, political parties, and economic opportunities in the local, national and federal government sources. While these seem to be ideal characteristics, in fact they described members of the board of directors of several associations we studied throughout the Island (Gutierrez, McCay, Valdes 1986).

To be successful, associations must be politically neutral organizations, willing to accept fishermen from all the political parties and ideologies. Its members, especially the board of directors, must suppress their political inclinations since their primordial loyalties are not with the party but with the fishermen and their fundamental class and community interests. This is of course true for the case of Puerto Rico, where political affiliation is a very sensitive matter often dividing communities and families. Thus an association failing to avoid a political alliance or annexation to a party takes the risk of alienating a large segment of actual or potential members.

Presidents who successfully conceal their political interests are also able of manipulate both sides (parties in power) effectively and draw resources from both of them. To the extent that they are capable of concealing their political party affiliation and willing to present the association as an unitary block, the board of directors and the president will be in a better position to achieve their goals.

Fishing Association membership indicates, at the most basic level, a relationship with an institution that serves as a marketing outlet for one's catch; at the other extreme, membership in an association entails involvement in a wide variety of business and friendship relations with other fishers of the community, in particular the political struggles of fishers, including struggles for or against management or other initiatives of the Department of Natural Resources, the U.S. Navy, or the Caribbean Fishery Management Council. The effectiveness of fishing associations as either marketing or political institutions is highly variable from community to community around the island. Those who belong to associations join for a variety of reasons, but primarily to get access to government aid that sometimes accompanies association membership and for marketing purposes.

During political disputes, however, these associations are usually the most active organizations in mobilizing fishers to defend their interests, and membership in these cases may either swell beyond current fishers or embrace non-members in their struggles, as has been documented in cases of disputes (Valdés Pizzini 1990b). This seems all the more plausible when we consider the reasons fishers give for not belonging to associations, since those who choose not to belong most commonly base their decisions on the characteristics of the association itself in their area, saying that it is either highly disorganized or that no association exists in their area. While a disorganized association or no association may exist during normal periods, during crisis periods, as when fisheries managers threaten to restrict fishing, we have seen associations from other areas move into regions to aid in the mobilization and organization of fishers. Further, the existence of a powerful or politically active association in a community indicates a dedication to fishing that runs deeper than individuals or households, involving entire coastal communities of fishers.

The associations, as described here are still an important "institution" in the Puerto Rican fisheries. Effective management of fishery resources could be achieved through the closer integration of the fishermen's organizations (associations, clubs, cooperatives or federations) into the management process. Despite their actual status (recent reports suggest that these ornagizations do not wield power nor do they appeal to the large contituency they had in the past), they still are a respectable type of organization with a history of defending the interest of the fishermen against forces larger than their lives.

2.6 Alternative Routes in the Puerto Rican Fisheries Development

In contrast with most of the Puerto Rican artisanal fisheries, there is one remarkable case of differential development, characterized, in comparison with the rest of the fishermen communities, by high levels of technology, and capital investments in production and distribution. This is the commercial fishery of Puerto Real. This section is included here to document alternative processes in the context of the local "artisanal" or "small-scale" fisheries, associated with the shallow water reef-fish species, and conch. The information for this section comes from Valdés Pizzini (1985, and forthcoming) and it is based in fieldwork perform from 1979 to 1985. Recent developments in that community are not included in this depiction.

A Case Study: An Ethnohistorical Account of The Fishery of Puerto Real

According to government sources, Puerto Real is the Island's most important fish landing center. The municipality of Cabo Rojo also harbors other landing centers, all close to the 18 miles long insular platform that accommodates a continuum of habitats, including coastal lagoons, sheltered bays, mangrove forests, coral reefs, rocky and sand bottoms, turtle grass flats, algal plains (intersected by reefs) and the shelf drop-off. Those habitats produce the largest amount of fish and shellfish bio-mass in the Island (Weiler and Suarez 1980:7). In fact, Cabo Rojo's landings produce nearly 40% of the Island's total catch, the highest for any municipality. Production units from Puerto Real use the said inshore habitats, but a large portion of the landings come from their consistent exploitation of the shelf drop-off using reel lines, operated with electric motors; fishing reaches depths that range from 125 to 300 fathoms. This type of fishing targeting snappers and groupers is also performed in the waters of "nearby" Caribbean islands such as Nevis, St. Bartholomew, Saba, Dominican Republic and Turks and Caicos.

The Production Units. There are 37 active production units (a unit formed by boats, gear and crew), owned by people from Puerto Real. Most units (54%) are devoted to reel-line fishing in the drop-off and in other Caribbean islands. Second to reel line (27%) is trap fishing with occasional dermersal line fishing, or troll line in the inshore areas. Fishing using diving equipment, combined with occasional hand line fishing is becoming increasingly popular. Only 5 percent of the units use fishing nets and lines. The majority of the vessels in Puerto Real (43%) are large boats called "trawlers" by government officials, although they are not used in trawling but for reel-line fishing. They are equipped with diesel inboard motor, echo-sound gauge, radios, two or four electric winches for the reels, hydraulic winches, sleeping quarters and a kitchen. The average size of the boat is 36 feet. Twenty-two percent of the seacrafts have been classified by us as modern boats; these are similar to the trawlers, but smaller in size (both are called lanchas by the fishermen) averaging 24 feet in length. These "modern" boats are used for hauling traps in the inshore areas, and a few have been equipped with electric reels for such fishing operations in the shelf drop-off. Small boats or skiffs, some of which are produced locally, others in fiberglass-are the second most popular type of vessel used in the fishery. These small boats, called yolas, are used by divers, line and net fishermen and also by trap fishermen. The majority of the vessels exceed the 19 feet length (69%), horsepower exceed 40 hp (67%) and most use a combination of materials in their construction, including prominently fiberglass and metal (73%).

Crew. Production units in Puerto Real are operated by a population of approximately 85 fishermen, mostly in crews of two individuals, but in a few remarkable occasions three and four fishermen. Along with boats and gears, crews are organized as follows:

(1) Trawlers and modern boats used for bottom fishing using reel-line. These target snappers, groupers and an incidental by-catch of dolphinfish. Crews are composed of the skipper-fisherman and two to three proeles or deck hands (fishing crew). Fishing trips range from 5 to 15 days depending on the distance of the fishing sites. Crew composition here is the least stable in the fishery. Skippers are either the owners of the vessels (fishing them or subletting them to others) or sublet the vessel from their owners. Those subletting vessels were subject to change vessels. Most vessels change proeles more than once a year. Recruitment is made exclusively on the basis of labor availability. Unlike other types of crew arrangements, the proeles come from other communities in the municipality, instead of Puerto Real.

(2) Modern boats, fishing smacks and yolas used for trap fishing. These are usually hauled with the help of a gasoline winch, and target lobsters and reef fish. The number of traps operated by the unit ranges from 20 to 185, with an average of 102 traps per crew. Crews are composed of two individuals, the skipper and a deck hand. Fishing trips are organized on a daily basis, averaging 3 days a week, and five hours a day. Trap fishing has three types of crew ties, these are: father and son, in-laws, and friends (non-kin): sibling, and father and son ties are the most prominent.

(3) Small boats or yolas with crews of one and two fishermen. These crafts equipped with outboard motors are used to fish with lines and nets in the insular shelf. They are also used by teams of divers, most commonly, two divers and a pilot, targeting lobster, conch and reef fish. Fishing trips are held on a daily basis. Most of the crews involved in diving are not related to each other. Fishing nets in Puerto Real were practically disappearing during our fieldwork, with only one fishermen using it.

History of the Fishery

The most prominent characteristic of the fishery of Puerto Real is the existence of fish-houses or neveras, where fish is bought from the "producers" and sold locally or wholesale to restaurants and other buyers. They are called neveras, the Spanish term for refrigerator. The ability to conserve the fish for selling at a later date, became the central characteristic of these operations. Out of seven neveras, three have a long life history, while the reminder are incipient operations. The neveras, owned and operated by fish dealers or merchants, also own fishing boats and gear, which the merchants sublet to skippers and crew. Despite their consistent investment in production, the basis of their profits remains in the circulation of commodities: buying and selling fish, gear, equipment, fuel, ice, frozen imported bait (squid and mackarel) and other supplies that have both use value, and exchange value, for the fishermen as well as for the general public.

While the scant archival information available suggests that Puerto Real was during the nineteenth century, an important harbor and fishing center, there is no concrete evidence of commercial activities surrounding fishing production, except for sales of turtle shells to San Juan, probably for exportation. Both in government reports, as well as in our informants' accounts, commercial activities started in the 1930's when local fishermen devoted parts of their "free" time to sell the fish in nearby towns. Fish dealers from the municipality moved their operations to Puerto Real at the onset of the demise of the local maritime commerce and transportation. Following a known path of peasant differentiation these merchants established business relationships with local fishermen who were interested in selling their own catch by forming partnerships with the dealers. Some avoided those partnerships and, using the labor force of their households or their affines and their wives as "managers" of the fish-house, local fishermen established commercial operations. Profits obtained by the dealers selling fish attracted other dealers from the municipality to establish their operations in Puerto Real.

Investing capital, establishing kinship relationships with the local fishermen, through compadrazgo and marriage, the dealers became embedded in the fishery's social system, as dominant in the relations of production. The dealers invested in infrastructure which consisted of piers, warehouses, freezers, and satellite vending operations in nearby cities and towns. Fish dealers provided cash for financing productive activities, while buying the fish cheap due to that particular arrangement. The acute social differentiation between producers and buyers was consolidated in the 1940's. In this period the dealers bought fishing gear and boats to sublet to the fishermen, a situation that allowed them to buy the catch at a lower ex-vessel price. In buying a large number of fishing smacks, and adapting small gasoline motors to the boats, the dealers increased the production capacity of their operations, as well as the volume of fish landed for re-sale. Subletting, financing of fishing production, price control, control over fishing equipment, fuel and ice, were established by the dealers as strategies to maintain a tight control of independent producers and semi-proletarians while managing to increase their profits (Dibbs 1967, Blay 1972, Poggie 1979). As the process of indebting became pervasive, the alternatives for the fishermen were reduced to: abandon the fishery, sell their boats (usually to the dealer), or have another dealer buy their debt (in a process in which labor is viewed then as a commodity) at a nevera, and thus become tied to the control of the dealer buying it.

While the nevera increased the size and quality of its operations, it also recruited, as wage laborers, people from fishing households who preferred to work under better conditions at the fish-houses, and with a regular pay. But the nevera also became the "school" in which fishermen - turned into employees: clerks, truck drivers and salespersons - learned the skills and strategies of becoming a dealer. With the experience and earned saved, these laborers invested in pick-up trucks and ice boxes and started to peddle fish throughout the Island; some were able to buy or build a nevera, and entered in competition with the established dealers, their former bosses.

Early in the 1970's the fishery was operated by merchants who owned most of the fishing smacks and neveras. Thus these merchants controlled the market and labor relations, while being able to exact surplus value and profits (Dibbs 1967). Merchants consistently invested in new equipment, allowing their production units to increase the catch. In the 70's, the fishing smacks observed by sociologists and fishery agents were motorized with diesel and gasoline engines; this permitted them to fish for snappers and groupers in the shelf drop-off and in the fishing banks of La Mona Passage, between Puerto Rico and the Dominican Republic with regularity. The majority of the vessels devoted to trap fishing had mechanical trap haulers (Abgrall 1975). While fish traps were the fundamental fishing gear, increases in "ex-vessel" prices for snappers forced a shift from traps to reel-line gear, becoming a strong rival to the traditional trap fishing methods (Poggie 1980).

Late in that decade, the government initiated various programs by which large boats (such as the trawlers and modern boats described earlier) were sold to the fishermen throughout the Island, with the idea that the larger the boat, the larger the catch, and the profits. Unfortunately, inappropriate methods of technology and information transfer and the high vessels' prices resulted in the failure of the program in Puerto Rico, except in Puerto Real. With the navigation experience derived from merchant marine experience and fishing in La Mona Passage exploiting the high valued resources of the snapper-grouper fishery, fishermen from Puerto Real were able to use the technology appropriately. The trawlers for reel-line and the smaller boats for traps in a large platform area, with an increase in the number of traps from 20 to 150, could maintain a profitable operation. But not all the fishermen remained successful at this enterprise; some of them could not pay their loan debts, production costs remained high since merchants controlled the prices for the factors of production. The dealers applied for loans to buy vessels, and acquired them also by buying the debts of the fishermen.

This decade transition was marked by an increase in the fishing technology and harbor infrastructure, "aided" by government programs. This increase was also highlighted by a boost in the landings as the catch of snappers and groupers from the drop-off, the passage and the Caribbean islands became available. During my fieldwork in Puerto Real, the fishery was dominated by three dealers operating neveras; all came from fishermen families from the settlement or from the municipality; all bought boats and facilities from former dealers from the community, and all extended their relationship with the community through compadrazgo and marriage.

SECTION THREE

THE FISHERMEN OF THE UNITED STATES VIRGIN ISLANDS

Coming from distinct ethnic contexts (West Indian, French and Puerto Rican), the fishermen of the U.S.V.I. are also part of the Caribbean fishing culture discussed in this report. Reciprocity and occupational multiplicity are key aspects of their culture. Similar to their peers in Puerto Rico, these fishermen feel the pressure from development, and from the expansion of the tourist base.

Social knowledge on the fishermen of the USVI is scant and incomplete. There is no consistent body of data on the social characteristics of the users of the fishery resources. However, scattered information from various sources allow us to provide an approximate portrait of the social and cultural patterns. Similar to the history of Caribbean fisheries, fishing was an important economic activity in the context of slavery and the plantation system. Historical sources attest that the sea was an important resource for the slaves of these islands (Fog-Olwig 1985, for St. John). Fog-Olwig describes in detail the slave fishery, as one characterized by hook and line fishing from ashore, net fishing for fry, and pot fishing using estate row boats allowed for that purpose (1985). Archival sources explored by Fog-Olwig also confirm the existence of night fishing in the near shore areas for whelk, lobsters and crabs. The use of marine resources also included the collection of shells for the manufacture of lime. Women participation in the fishery explicitly described in the sources as based in the collection of shellfish along the shore. Similar to other areas in the Caribbean, fishing was a key aspect of the plantation system, since it provided additional sources of food for the planters' class and the slaves themselves (Valdés Pizzini 1985).

Again, similar to the rest of the Caribbean (including Puerto Rico), fishing became a subsidiary activity for peasants and freed slaves. Charcoal production, small-scale farming (usually shifting cultivation), intra and inter-insular trading, animal husbandry and fishing were integral part of a complex of subsistence and commercial activities in which the peasants and petty capitalists were engaged. A key argument, inherent to the fishery management decisions is that the notion of full-time fishing is not an appropriate cultural nor managerial category in the context of the Caribbean fisheries. The aforementioned complex of activities also including their insertion into wage labor, when it became available in the local economy (Fog-Olwig 1985:105, in passim). Such pattern of behavior (occupational multiplicity / pluralism, etc.) is derived from a historical process of adaptation to the physical and economic environment of these Islands.

3.1 <u>USVI Fisheries Early this Century</u>:

The "diverse" ethnic composition of the USVI fishery is one of its most remarkable aspects, and one which is superficially understood. As we have explained, there are participants in this fishery who are of a West Indian-Afro American heritage. I presume that they come from the early slave and peasant populations of the USVI, as well as from immigrants from other Caribbean Islands. However, the precision of this statement still need to be confirmed. For the Island of St. Croix I do not have any specific details except that most of the fishermen in that island appear to be of Puerto Rican origin. Puerto Ricans (and probably in large numbers from the Island of Vieques) migrated in the 1930's to the USVI to work in the sugar cane industry, and also to engage in a diversity of economic activities associated with that crop, fishing included.

For the island of St. Thomas, fishing is an activity performed by people of black, West Indian ancestry, as well as people of French ancestry. According to Highfield, the French of St. Thomas came from the island of St. Barthélemy between 1865 and 1870, attracted by the possibilities of agriculture and fishing, activities they performed, along with trading and navigation in the poverty-stricken St. Barts (Highfield 1979). These French migrants established in the village of Carenage (known also as Honduras) on the western side of the St. Thomas Harbor. The area in known as Frenchtown or Chacha town, although this is a pejorative term. A particular form of French, the Carenageois is employed by these people.

In the 1931 R.H. Fiedler and Norman D. Jarvis working for the U.S. Bureau of Fisheries conducted a survey of the USVI fisheries, and had the opportunity of encountering some of the participants I have described. At their arrival, fishing was done using pots or "nass" (40%), seines (30%), and lines (30%) and other types of gear (Fiedler and Jarvis 1932). In construction, the gears were comparable to those found in the U.S., while the crafts were described as "small, crudely built, and [are] unfit for rough sea or for trips of any length (1932). At the time of their visit pots or traps were constructed using wooden poles and chicken wire. Fishermen baited the traps with lobster, whelk, sea moss and conch meat, all of which eventually became high priced items in the fishery. Production units (a vessel and crew) had a range of 4 to 30 pots to fish. Turtle fishing using nets was an integral part of the fishery. The fleet was then compose mostly by rowboats of the yawl type (147), sailboats (38) and one motorized boat. Fishing by hand, at night and using a torch (as it was done by slaves and the freed in the past century) was also a common way of fishing for lobsters. Diving in shallow waters for conch, whelk and shellfish was also part of the fishery.

The human factor in the USVI fishery was estimated by Fiedler and Jarvis as 405 fishermen, most of which were considered "colored", and 91 "of the white race" (1932). Fishing was intensive, in terms of gears and numbers of boats and fishermen in St. Croix. These fishermen appear to be "employed" in fishing as a full-time activity. In St. Thomas fishing was, according to the authors, concentrated in Honduras (Carenage or Frenchtown), and the fishermen were of French descent. In the village of 500 people, 84 were "engage regularly in fishing as an occupation, while others fish occasionally or have other trades, such as making set pots or other types of gear (1932: 15). Other scattered fishermen, identified as "negro fishermen" in St. Thomas were devoted to farming and charcoal production, along with fishing. Fishing was basically for subsistence, and a surplus for the market In St. John there were a few large operators, probably in sailboats, selling the catch in the St. Thomas harbor to intermediaries in boats (bom boats) who sold the fish ashore to the women who marketed the fish in the island (1932, see Fog-Olwig 1985; 113, for a description of the process). But most crafts were rowboats, engaged in fishing for subsistence. Fishing was described by Fiedler and Jarvis as "a casual occupation", followed as a means of supplying food for the immediate families of the fishermen, with the surplus being sold to families unable to do their fishing (1932: 16). Fog-Olwig expands on the latter assertion and clarifies that fishing served in the larger context of exchanges and gifts in the St. John's society, and activity which is still carried on today, which gives fishing an importance greater than being a commodity for the market.

As early as in the 1930's, the USVI was considered a paradise for recreational and sport fishing. Fiedler and Jarvis describe the potential of the USVI by mentioning the availability of crevalle, kingfish, Spanish mackerel, barracuda and tarpon for the sportsmen. Demersal fishes are also mentioned, as attractive to the anglers, similar to the pattern of recreational fishing found in Florida (1932). They also mentioned the existence of the Deep Sea Fishing Club in Dennis Bay, St. John, as an example of the potential of the "industry".

Interestingly, other sources mentioned the development of sportfishing as late as in 1964. Sportfishing is nowadays a key element in the USVI fishery, one characterized by the "trawling for game fish in a motorboat using rod, reel and line" and an activity in which tourist engage, served by a fleet of charter boats, whose owners or operators are mostly of a U.S. continental origin (Johnston 1987, Griffith et al 1988, Chaparro 1992).

Present day USVI participants in the fishery appear to as the ones we have already described, a multi-species, multi-gear, all year round fishery. Jim Beets, from the USVI Division of Fish and Wildlife describes the fishery as...

> primarily a small-scale, artisanal fishery. Most commercial fishermen utilize small boats, 16 to 25 feet in length to harvest reef fish species located in the insular platform (Beets 1987).

The majority of the fishermen are devoted to trap fishing, a gear which have increase in effort, since the decline of the reef fish stocks. The human component in St. Thomas is fundamentally based in the area of Frenchtown, where the "Carenageois" speaking people live, following a pattern of thigh cultural boundaries through ethnic endogamy, linguistic separations, a distinct religious culture (Roman Catholic) and specialized occupations such as farming and fishing (Johnston 1987: 139). Fishermen from French cultural heritage also fish out of Hull Bay in the Northside. After World War II, economic change under the influence of the United States, opportunities for class and social mobilization through education and participation in the larger society have change the composition of the village (Highfield 1979: 11-12). People of West Indian origin have moved into the confines of the Carenage, and by the time of the linguistic study carried by Highfield, ethnic relations were "good". However, Highfield has pointed out that integration into the larger St. Thomian society have been easier that the people of West Indian origin, and have permitted their insertion into the public service, industries and political arena (1979). The West Indian component of the fishermen of St. Thomas live in villages in the East End on Coki Point and the Lagoon. According to recent anthropological studies, these fishermen have strong family and friendship ties with people in the island of St. John and in the British Virgin Islands (Johnston 1987).

In St. Croix the fishing fleet is composed by vessels ranging from 18 to 22 feet, constructed in fiberglass, powered by outboard motors (Tobias 1987). Due to problems of access to the shoreline, this fleet is composed by boats trailered to the launching sites in St. Croix. Traps are the main gear, followed by line fishing and diving. Proximity to deep waters in the north and west coasts make feasible for the fishermen to use small boats in targeting pelagic species (1987). A survey conducted by the DFW found that the fishermen of St. Croix are pessimistic about the future of their trade, and all of them responded that did not want their sons to be engaged in fishing. This contrast with what fishermen in Puerto Rico feel about their trade.

3.2 Changes in the Fishery:

In the Caribbean, fisheries follow the path led by the shifts in the regional and global economy. Functioning as a subsidiary activity for the mono-crop complex, or as a subsistence activity for peasants (farmers) or fishermen (as petty commodity producers), participation in the fishery depended on a variety of factors some of cultural and historical weight (cultural tradition of the French and West Indian to farming and fishing as fundamental Caribbean endeavors) or to the diversity of opportunities available in the recruitment of a wage labor force and the industrial and service sector expand their operations in these insular economies. The present day USVI, a former Dutch colony was during the nineteenth century a commercial entrepot of the Caribbean with a booming trading industry, fueled, to a certain extent by the plantation sector based on sugar cane production and the manufacture of rum. Early this century, with the sugar and rum industries almost defunct, wage labor in the public service became available in the island of St. Thomas, while the countryside followed the economic pattern described in this section.

Wage labor was also available in the sugar plantations in existence. Fishing, subsistence farming, in combination with other activities provided the local folk with the basic opportunities to maintain their families. In the 1920's, the increasing demand for beef in the island of Puerto Rico, led the island of St. Thomas to use the agricultural land for cattle ranching, which by 1926 had 80% of the productive land under livestock production (Johnston 1987: 91). According to Barbara Rose Johnston, who has intensively studied the process of economic and environmental changes in the USVI, the use of land and the demise of the small plots of lands for agricultural purposes in the hands on local people, specially those of black West Indian heritage, has been the result of major shifts in the economy of the USVI. These shifts have been stimulated by the increase of non-West Indian population in the USVI, the sale of land for speculative purposes, the rise of the public sector in the local economy, the construction boom due to the development of the tourist sector. The insertion of newcomers from higher socioeconomic levels building homes and summer cottages, and the number of hotels increased the price of land, a situation that precluded the local people from leasing land for shifting cultivation (1987: 96). Lack of access to coastal resources, as these became highly valuable, limited the array of economic opportunities that the people of the USVI had to maintain their families.

At the same time, the tourist boom of the 1960's brought a new dimension to the local fisheries: an increased demand for local fishery products and higher prices. The tourist boom increased the pressure for the resources, as those species seldom used for the market (conch, lobster, whelk and large size fish) were of a high value and demand. Fiedler and Jarvis observed that fish in the USVI was sold by the strap, not necessarily by the pound. A strap could have nearly six pounds and was sold in pre-tourism times for a dime, with enough fish for feeding a family (LaPlace 1987). The price for the different types or classes of fish (boil: grouper, snapper and goat fish; fry: grunt, bluefish, doctor fish and parrotfish; line: pelagics) increased in prices, as well as lobsters (1987). From a set of 10 to 30 traps in pre-WWII and pre-tourism times and using lobster for bait, the new conditions of the market increased the pressure on the resources, and some trap fishermen even engaged in diving for lobsters and conch (LaPlace 1987, Johnston 1987). According to fishery officials the number of fishermen have increased, as well as the units of gear, or effort measured as such. The number of licensed fishermen is increasing in the USVI, as of 1987 (Beets 1987).

Competition for the available fishery resources is evident in the increasing number of traps, licensed fishermen, and conflicts with other fishermen from Puerto Rico and the British Virgin Islands (BVI). Discussions held during the Fisheries In Crisis Conference of 1987 in St. Thomas reveal that fishermen from Puerto Rico have moved into USVI waters to exact fishery resources. At the same time, and based in historical and traditional patterns of shared resource utilization, fishermen from the USVI have encountered difficulties in fishing in traditional areas in the BVI (Johnston 1987). Theft of traps is another indicator of an increased effort and competition, a situation also encountered in Puerto Rico. Indeed, incidents between USVI fishermen and BVI authorities seemed to be related to issues concerning the theft of traps. The French fishermen were used probably as scapegoats for the theft. The incidents also may have a connection to the BVI fishermen's resentment of the USVI restrictions on the use of fishery resources in the Virgin Islands National Park in St. John, which appeared to be a traditional fishing ground for them, specially for turtle.

Competition for fishery resources is closely related to the overall pattern of economic development in the society in which it takes place. This collorary appears to be truthful for the USVI case. The development of a tourist economy has impacted artisanal fishing in many ways. It has increased the demand for certain species that were hitherto underutilized. The construction, service and tourist boom (all part of an interesting complex) practically eliminated the rural folk and the unemployment. Those who used to fish for daily consumption could not do it anymore, and thus demand for fish increased from the tourists as well as for the USVI residents. The tourist economy also attracted other types of fishing operations such as the longliners targeting swordfish. Various sources indicate that their presence also altered traditional market prices for various species. However, information this issue is scant, and inconclusive. Other participants in the fishery appeared as well. They are the sport and recreational fishermen, some of which also target the species caught by the small-scale fishermen. Recreational divers and fishermen are also targeting bait fish, lobster and whelk, among others.

3.3 Development and Environmental Concerns:

The sources examined clearly show that one of the main problems that the fishermen of the USVI face is the deterioration of the marine habitats due to the industrial and tourist activities, and increased use of the coastal zone. Johnston have summarized the plight of the USVI in the following manner:

> Increased commercial and pleasure boat traffic between the islands add noise and petroleum pollutants to the marine environment. Many of the pleasure boats regularly anchor in near shore areas, and grass beds and coral reefs are torn up in the process. Coastal development of marinas, desalination and power plants, and commercial land fills have resulted in the filling in or severe modification of bays. Mangrove lagoons have directly and indirectly modified by landfills, dredging, and the increased sedimentation and sewage discharge associated with coastal development. As these lagoons provide a sheltered and shallow environment for hundreds of immature marine organisms, the

destruction of these habitats threaten the long-term viability of certain local species. One of the social implications of these changes in the level of fishery resource exploitation and use of the coastal environment is an increased number of people vying for access to a more limited resource. Increased competition and resource scarcity nurture the need for capital-intensive technologies to go further out and fish deeper down, resulting in a patterns of increased specialization and territoriality (Johnston 1987: 169-171).

Such a concern was also brought at the Fisheries In Crisis Conference. According to fishery officials, the fishermen of the USVI have strong views about pollution, specially siltation and sewage, the decline of the mangrove areas and the amount of trash and waste from charter boats, yachts and cruise ships. A similar attitude and concern is found among the Puerto Rican fishermen who have expressed their apprehension for the state of the environment at Conferences and in interviews in our research.

This issue is extremely important. The recent trend in fisheries management is to include the habitat and the environmental factors into consideration. Meeting after meeting at the CFMC the issue of the environment is discussed. But when the FMP is in place and management options and regulations are discussed, they all are related to curtailing the fishermen' activities and seldom are pointed at the sectors responsible for the current state of the habitats. Fishermen are looking closely into such imbalances in management, and this is a crucial issue for all of us involved in the complex process of fisheries management.

3.4 Full-Time contra Part-Time Participation in the Fishery:

Fishery managers, and those involved with the analysis of this sector of the economy have underlined the importance of the extent of participation in the fishery. We tend to see work in the fisheries as a process in which there is full time or part time participation. In line with such perspective, the tendency is to see full time participation as a commitment to the activity, and as good trait of the participants since it is a proof of specialization, and capital investment, which leads to increase in the level of technology employed (see Valdés Pizzini 1985 for a similar treatment of a commercial fishery in southwest Puerto Rico). On the other hand, part time participation is viewed as the opposite and as a deterrent to the development of the fishery. Early observers of these fisheries seem to be on that track (Jarvis 1931, Fiedler and Jarvis 1932). What is most interesting is the fact that in discussions such as the USVI Conference on fishing, even some of the fishermen who spoke called fore the banning of part-time fishermen. LaPlace explained that

> Commercial fishermen complain about the number of part-time fishermen. Two thirds of the fishermen in St. Thomas are non-commercial, part-time fishermen. That's what is killing the commercial fishermen (LaPlace 1987: 9).

This sentiment was echoed throughout the conference, by full-time fishermen as well as by scientists interested in the process of limited entry to the local fisheries. The first step in reducing effort seems to be to eliminate the part-timers who in the view of the trap fishermen leave their traps unmanned for days, which serve as ghost traps killing fish. However, as we have seen in this report, part-time fishing is an essential component of the traditional West Indian economic culture, a pattern of adaptation that have prevailed since the early colonial times, and a system that allows the rural folk, and sometimes the urban poor to add cash and foodstuffs to their tables. The few full-time fishermen of the present day, most likely, came from households in which fishing was combined with farming and other activities. Management has to consider that one of the key role of tropical fisheries, specially in this part of the world is to serve as a labor buffer zone that allows the poor to survive in adverse economic situations, often brought by industrial development that have changed and eradicated their traditional links to the land and to the sea, and the subsistence and subsidiary activities that allowed their physical and mental survival. This issue could be related to the language in the FMP which recommends the use of large mesh size for the traps, which in turn will discourage the part-time fishermen, due to the reduced number of fishes per trap. A fisherwoman (part-time, for pleasure) and kin to fishermen explained the importance of such banning in a cogent manner:

> Of course, if you pass this measure, the part-time fishermen would have to sell their boats, traps and fishing gears, and join the poverty line. I think this is quite unreasonable because part-time fishermen are doing fishing on a part-time basis mostly because they cannot properly survive and support their family with their present income, so they sacrifice in good and bad weather to catch a few fishes to be able to enjoy some of the good things in life, as are enjoyed by the most fortunate people. By this measure your are encouraging more stealing in our community... Before passing such a measure, give a lot of thought to what this proposal would do to the little men (CFMC, Amendment Number 1, 1990, Appendix).

Social data for Puerto Rico and the USVI tend to support the essence of her assertion. Management procedures that are designed to eliminate the part-time fishermen should be reconsidered in the light of the overall participation of people in the fishery, the traditional role of fishing in the context of subsidiary activities, its role in the Puerto Rican and USVI (West Indian or French) patterns of resource utilization and adaptation, and the historical role of fishing in our insular economies.

SECTION FOUR

FISHING AND LABOR IN PUERTO RICO: HISTORICAL AND CONTEMPORARY PERSPECTIVES OF A FUNDAMENTAL CONCERN IN MANAGEMENT

It is strongly argued in this report that fishery management must take a close look to the fishermen, and their labor trajectories, in order to understand their participation in the fishery. In their life time they have four basic options: (1) to continue as a fishermen [or independent production], (2) to become a wage earner in any sector of the economy [or proletarianization: withdrawal from fishing to increasingly become a wage laborer, thus showing weak attachments to fishing as an economic strategy], (3) to be a fisherman and a wage earner at unison [semi-proletarianization: to actively participate in wage labor and in fishing as a consistent productive strategy], and (4) to return to fishing after a period as a wage earner [deproletarianization: the process of withdrawing from wage labor to engage in fishing on a full time basis, or as an independent producer]. In this section I discuss some of those options, in reference to the historical economic and social process that pervaded the life and communities of the fishermen. A process in which their household were of key importance.

4.1 Semi-proletarianization in the Puerto Rican Fisheries

Semi-proletarianization of the fishermen is indeed a pervasive process in the Puerto Rican fisheries, an issue taken lightly by government agencies, and needless to say, poorly understood despite past and recent efforts by social scientists and the state agencies (Gutiérrez 1985, Matos and Torres 1989). Such process, as an adaptation of the laborer to the process of uneven proletarianization, and the labor force market tendencies, imply, different patterns of fishery utilization on a synchronic and diachronic dimension, that is, in the specific moment in which fishermen use the resources, and as part of their lifetime trajectory in the world-economy, in which they participate in different manners. While proletarianization and the uneven integration of those producers into the economy proceeds steadily, the fishermen also become involved in an de-proletarianization movement. Simply stated, fishermen, or people from fishing households enter in the world-economy by means of wage labor in agriculture or industrial work in Puerto Rico, the United States or both at unison, as we have documented. In the midst of such circumstances wage laborers participate in fishing as a mean of adding monetary resources into their households, or as part of a seasonal strategy of subsistence. It is clear that in the life history of those laborers, at the very end of their useful, productive life for capital the become de-proletarianized by capital through the strategy of invoking the age of retirement, or they do so motu proprio to become eligible for social security benefits. In the origin they were borne from fishing households, and therefore, by tradition, cultural commitment, and personal choice they have to return to the cradle of their productive efforts. Such choices and strategies also correspond to a continuation of labor, of work and to receive additional remuneration, without the need of becoming obligated to correspond to the state requisite of tax payments. That issue is critical in the understanding of a lifetime of "eternal recurrence" to forms of labor and production.

Fishing is an activity of independent production (Valdés-Pizzini 1990a) which has historically de-commoditicized labor. Fishing represents an option or alternative to the efforts of capital to involve producers in wage labor or in the various types of uneven integration into the proletarian status. Laborers in all sectors of the economy may divert their labor as a commodity from the specified path, and become independent producers, fishermen. A decision on singularization comes from individual choice (creativity) to return to work settings that offer aesthetic and moral benefits, or through crises in the economy or in the life history of laborers. These two alternatives will be discussed through the life histories of fishermen (presently) or laborers who decommoditize their condition as proletarians. We contend that fishing is fixed in a position of defiance of the patterns of industrial work, namely: taylorism and fordism (time-scheduling and the assembly line) in the context of the fishermen' lives, driving them to assume a different position from society and workers. A particular form of household utopia, a space and time which remains autonomous from the pervasive process of industrial commoditization, a space redeemed from labor extraction, and regained for leisure, independent production, leisure and therapy.

4.2 Deproletarianization of the Workers in the Cane

Sugar cane production in the Caribbean is inextricably intertwined with fishing production. In these social formations fishing played a key role in the subsistence strategies of the slaved labor force in the sugar cane plantations. Richard Price in his "classic", but updated article on the history of Caribbean fisheries (Price 1966) documented, using historical materials from Martinique, that slaves with certain privileges were allowed to fish for their subsistence, the tables of the plantation managers, and even for the formation of market networks. Price contends that such privileges contributed to the development of adaptive skills and independence which contributed to their transition from slavery to freedom through manumission and or maroon societies (1966:1364). Fishing then offered a diversion from the path of labor control and commoditization within the plantation system as a source of wage labor. Fishing, perhaps heroically and mythical (a special mission performed by fishermen in their political discourse and praxis, and perceived by many political and social sectors of the Puerto Rican society, but barely understood (Valdés-Pizzini 1990b) constituted the axis of the formation of coastal communities, usually perceived as independent and vested with psychological and existential traits of verticality.

In that context, fishing presented a setting or set of circumstances that permitted the slaved labor force to articulate a parallel market system, which traded produced commodities, but also exchanged information and enhanced further contact with other individuals under the same labor conditions, a situation that served well the total rejection of the plantation system through escape, and formation of maroon communities (Price 1966). For Richard Price, fishing "served a function analogous to crafts and subsistence plots as a way out to the oppressive plantation system" (1966:1378). Puerto Ricó, in that respect was no different fróm other Caribbean formations. The coffee and sugar cane <u>haciendas</u> competed fiercely with the subsistence and small landholdings for labor.

With the advent of manumission, coastal communities sprouted in the fringes of the sugar cane plantations. Coastal settlements in Puerto Rico represented subsistence enclaves populated by freed slaves from the early moments of the colonization, and from creole population. In those, fishing, charcoal production, subsistence farming using swidden agriculture techniques, animal husbandry are the inventory of productive activities performed (Cardona Bonet 1985). Were official and informal harbors were installed, portions of the coastal population also participated in maritime occupations, all tied to the Spanish Crown's Seamen Guild, a branch of the Navy. This is important since only those belonging to the guild were able to fish at sea using boats.

There is major difference between sugar cane production and slavery in Puerto Rico and the British and French Caribbean. While the plantation system based on slave labor force was declining in the Caribbean, the slave trade and labor utilization was a its peak moment in Puerto Rico. It is at the end of the century when the hacienda system integrates in great numbers wage laborers. However such transition was slow and finally achieved with the U.S. occupation in 1898, and the advent of the central sugar cane factories of U.S. capital.

The agrarian economy of Puerto Rico during the first decades of the twentieth century was characterized by the following processes: the proletarianization of the labor force, the mechanization and modernization of sugar cane processing, the establishment of sugar cane central factories, and the concentration of the rural workers in company towns, in agro-towns and in urban centers dependent on that crop. Sugar cane production during that period increased notably. From 1898 to 1930 production increased fourfold, eventually reaching 1 million tons by the 1940's, becoming in that decade the economic activity responsible for 40 percent of total employment, 20 percent of the GNP and 20 percent of the amount paid in salaries and wages, and 62 percent of all exports (Heine and García-Passalacqua 1983:11). The Americanization of the Puerto Rican economy and society, brought, along with material rewards of such modernization, the systematic dispossession of farmers and peasants of their land, turning them into rural workers (Steward et al 1956), forced the rural independent producers to migrate into urban areas, created stagnation in the rural jobs demand (mainly because coffee production enter into a dramatic decline), increased labor discomfort and levels of pauperism that triggered diseases, hunger, and a continuum of rural and urban strikes from 1905 to 1940 (Heine and Garcia Passalacqua 1983, Garcia and Quintero 1982, Taller de Formacion Politica 1982, 1988).

It is rather difficult to put into a historical perspective the social and economic trajectory of fishing households in Puerto Rico due to the poverty of primary sources on that particular matter, and the state of social research. However, information available suggest that fishermen in the twentieth century were historically tied to the Seamen Guild of maritime occupations, thus having certain important ties with the merchant marine and merchant capital in general, and from the peasant coastal settlements which sprang at the fringes of harbors, coastal towns and haciendas (Valdés-Pizzini 1987). One is tempted to speculate with great precision that many of those coastal settlers were eventually incorporated into the ranks of the sugar cane workers. Another alternative in the realm of explanations is that wage laborers also became fishermen by the articulation of a low paying industry that forced a period of high production (the harvest or la zafra) and a waiting period (el tiempo muerto or the dead season) in which most of the cane cutters remained idle subsisting on advanced payments and credit on the company store (Mintz, in Steward et al 1956). While the analysis of the "Americanization" of the sugar cane industry in Puerto Rico have emphasized the massive proletarianization of the peasantry and the incorporation of laborers into full fledged capitalism and the world economy, it is obvious from our standpoint that the centrales dwell on the semi-proletarianization of the Puerto Rican labor force. This uneven proletarianization allowed, to a certain extent, that the centrales run profitable with rather low wages since the labor force, jointly with the productive efforts of the members of the household engaged in various activities to support the family. Although poorly understood by social scientists, fishing was central to those productive strategies of the laborers households. In The People of Puerto Rico Elena Padilla described an array of subsidiary activities sugar cane workers used, which included: chiripas, domestic activities for other households (laundering, seaming, cooking, cleaning), "illegal" rum production, gardening, hauling sand, gambling, and fishing.

Padilla includes as part of the strategies of those laborers the process of migration:

"Others migrate to San Juan or some other city in the island to find a job. In the past few years, specially since the end of World War II, many young men have migrated to the United States a number of times as contract labor to work in the agricultural harvest... Most migratory agricultural workers, however return to the community during winter when the sugar harvest begins. Men with families cannot travel to find work, and they stay in rural Nocora" (1956:285-286).

This pattern remains today except that the slow demise of sugar cane production forced men "with families" to migrate consistently in the same labor markets indicated by Padilla: New Jersey, Washington, New York, and Michigan.

Mintz also points at the role of subsidiary activities, often armed by the laborers discourse "One most live illegally here..."; and coincides with Padilla on the importance of fishing. However, Mintz makes an important distinction. Fishing was performed by full-time specialists, as well as by agricultural laborers. The passage in The People of Puerto Rico deserves full quotation, as it illustrates the pervasiveness of the centrales in "subsidiary activities" or in the semiproletarianization of the Puerto Rican labor force:

Fishing is year round activity which supplies full-time employment for about six adults in barrio Poyal. Yet even these full-time fishermen will be found some time working in the cane during the height of the harvest. Fishermen range from the full-time operators of sailboats...to those who fish from rowboats or from the shore for sport or for food for the family. Sailboats represent a very substantial investment of cash-about two hundred dollars. Because they enable the fishermen to use their nets and traps several miles offshore, and because of their large carrying capacity for the catch, sailboats are an enviable possession. But the cost of a sailboat is prohibitive and no sugar cane worker can hope to save enough to buy one. Besides, operating and maintaining a sailboat involves special skills not known to most local people. Full-time fishermen have a special status in the barrio. Their cash income is perhaps less than that of an energetic palero or foreman, but their boats represent a significant accumulation of capital and their skill and knowledge are much admired. When these fishermen are not at sea, they spend their time mending and making nets and traps, caulking their boats, repairing sail, and otherwise renovating equipment. A much more important group of fishermen numerically are those sugar cane workers who fall back on their fishing skill during the slack season in the cane. These men, about forty of them, fish from rowboats or along the shores and use their catches for food, to maintain social relationships via gifts of fresh fish, or to provide a small extra cash income (Mintz in Steward et al 1956: 362).

It follows from Padilla and Mintz that the context of fishing during the hegemony of the sugar cane centrales was one of "subsidiary activity" for rural laborers to earn an additional income, or to fill their tables with the piscatorial staples. Along with other economic activities, some of which fall in that shadowy zone often called the illegal or informal economy, fishing contributed to the subsistence of proletarianized households, while sugar cane wage work slowly initiated the households of independent producers (fishermen) into the workings of semiproletarianization. Distinctions between the two types of laborers / fishermen dwell in the time spend in each side of production, and the capital accumulated and invested in boats and gears, which was, and still is a sizeable amount. In the forties and fifties, the cost of a sailboat represented more than the average yearly earnings for a rural worker (Valdés-Pizzini 1985). Lack of skills, capital, and time precluded many people from entering into fishing, however many did manage to de-proletarianized themselves and turn to independent production of commodities rather than to become workers in the sugar cane centrales.

Since 1930 (as the records show) independent production (fishing) and sugar cane production battled for labor, space and household commitment. Norman D. Jarvis, a U.S. fisheries agent studied the fish markets of Puerto Rico and the U.S. Virgin Islands, and found that from 1,403 men engaged in fishing only 600 could be classified as full-time fishermen (independent producers), in his analysis Jarvis steted that...

> "The great majority of fishermen in Puerto Rico depend on plantation work, employment in the sugar centrales, or stevedoring at the docks and landings as much or more than they do fishing. Fishing is followed as a sole occupation only where their work can not be obtained or the demand for fish is fairly extensive (Jarvis 1932:14)".

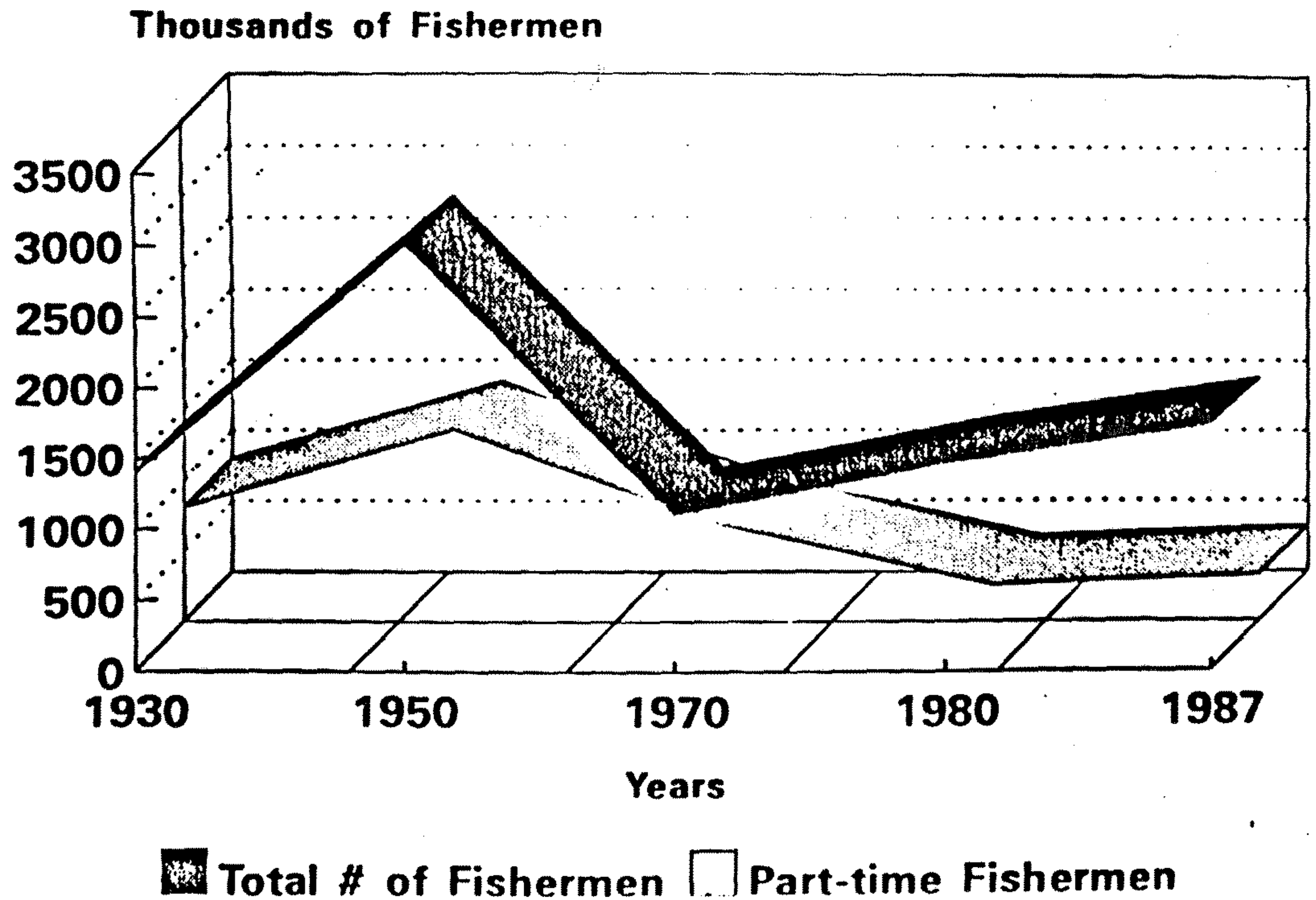
Interestingly, those areas where "full-time" fishing was indicated by Jarvis coincide with the major areas sampled in our life history study, and singularly, these are areas which have a historical background as official and unofficial harbors and trading centers in the island. Again, a historical tie between maritime occupation, merchant capital and the transition of that labor force into fishing, among other activities. A key finding was that the number of fishermen depended on the season. From June to January, when sugar cane was not being made, the number appeared to increase. In some cases Jarvis suspected that in some areas as in San Juan, few men who declared they were "full-time" fishermen only fished "at intervals between loading ships, or to supplement other irregular employment" (1932). Jarvis explanation of the dichotomy between full-time and part-time fishing as a matter of individual choices on behalf of the fishermen, one guided by market conditions and economic rationality. Jarvis argued that the fish market conditions were detrimental to the fishermen since fish use to spoil often, and "no regular channels exist for the distribution of the catch" (1932). While that argument is partially true, it appeared that "the condition of the fishermen has not improved as was expected under the American administration" (1932:15). Referring to older informants, and comparing notes with the 1899 Wilcox report on the Island's fisheries, Jarvis recognized that while retail price increased, the ex-vessel price did not in the same proportion, leaving the fishermen with a "a small margin for the replacement of boat and gear" (1932:15). One the other hand proletarianization, according to Jarvis had some benefits for the transformed fishermen, "working ashore he [the fisherman] is paid regularly, while the hours are shorter and the work often easier" (1932:14). But, that was not the case in the almost exclusively job available: working in the cane. What needs to be stressed here is that fishing as independent production competed with sugar cane production each performing, not a symbiotic function, but an act of labor articulation, participating at different levels of the incorporation of households into industrial, and the households negation to follow the path of labor commoditization.

De-proletarianization, in this particular context, features households who have been partially or completely incorporated into the sphere of industrial production, as in sugar cane production, who decided or become forced to leave that field. The Caribbean ethnology have documented the interest of sugar cane laborers to escape plantation work and to dodge proletarianization, mediated by fishing as independent production.

After Richard Price original remarks that fishing served as an alternative to the "oppressive" plantation system, anthropologists have discovered that fishing and occupational multiplicity conform a labor strategy of survival and semi-proletarianization in a world dominated by capital penetration and poorly remunerated wage work (Comitas 1960, Stoffle 1986). Caribbean people divide labor in working for oneself (as in fishing) and working for others (plantation and government work). Fishing as an artisanal activity invokes creative skills, and allow the Homo ludens to take over, in sharp contrast with plantation labor, a reason why fishermen in Puerto Rico recall fishing as a sport and as therapy (Mintz 1956). On the side of production, fishing also allows landless or small scale landowners to support their households without having to incorporate their efforts in full wage labor, as it has been documented in throughout the Caribbean (Valdés-Pizzini 1990a).

On the side of personal choice, it is clear that producers prefer to fish than to work in plantations. Sugar cane plantations, vis-a-vis fishing represent slavery, foremen and wage labor schedules, while fishing represent "independence" and control over oneself and the production process which produces a satisfaction not found in wage labor. (Levy 1976 and Valdés-Pizzini 1985, 1990a). This mentality is correlated with the findings in surveys that fishermen in Puerto Rico fish, among other reasons because they "like it", since it provides contact with nature, and give them the capability of structuring their time and efforts (Gutiérrez 1985). Other studies have shown that fishing among Puerto Ricans is also a matter of "spiritual and psychological" benefits, since fishing provides pleasure, freedom, a flexible time schedule, and "no bosses" (Blay 1972:64-65) In that context, de-proletarianization from the sugar cane industry must be interpreted.

FIGURE 3
PART-TIME AND FULL-TIME FISHERMEN IN PUERTO RICO



Source: Departament of Agriculture
and CODREMAR

4.3 The Demise of Sugar Cane Production

The Commonwealth of Puerto Rico responded to the consistent weakening of the sugar cane industry after 1940, with a development and modernization plan which provided the setting for the influx of U.S. capital in the form of transfer payments, and industrial development. In 1950 sugar production increased, but the increment in wages, and the drop in demand for sugar doomed the future of the once king of the island's economy. The Commonwealth ended buying the collapsing centrales from the local and U.S. companies and hacendados and forming the Commonwealth Sugar Corporation, which assumed the bankruptcy and demise of the industry. The Commonwealth's development strategies also estimulated the demise of the agricultural export economy, by creating industrial and commercial jobs in the urban centers that attracted large amounts or peasants and rural proletarians into the cities. The economic growth of the Island was and still is unable to cope with the demand for jobs in all sectors of the economy. The accretion of fertility rates and population growth triggered by the increasingly better medical services, and alimentation patterns, had the effect of augmenting the large numbers of unemployed rural proletarians, and lumpenproletariat flocking into the cities and the number of Puerto Rican migrating to the U.S., as seasonal rural migrant workers, and as part of the labor force in the urban centers (History Task Force 1979:141).

4.4 The Long and Winding Road of Deproletarianization

The road of deproletarianization is one of the less traveled one, and it is not an easy journey, but one that often takes many years in preparation, and a circular travel which includes the U.S. among other places. In the 1960's fishermen joined the ranks of laborers leaving the fields and moved the U.S. looking for a job, or better living conditions. The decline of the urban patterns of economic development in the northeast cities of the U.S., its fiscal crises, housing problems and crises joined in a conjuncture with an expansion of the welfare state and the massive transfer of federal funds and aid to the poor in Puerto Rico (Pratts 1987), both circumstances fueling the process of return migration in the Island, a trend in which many fishermen participated. The following cases illustrate that point:

> Once in Puerto Rico, X attempted another stint in proletarianization, in the garment industry in Mayaguez, an area of the economy in which he had previous experience in New York. This time, tax exemption was not enough to discourage factory owners to face labor, and the factory closed. X resorted to fishing, finally disengaging from wage labor, a path which started at childhood, the same period when X became initiated in fishing. Another fishermen, as in the southern coast, an area affected by high unemployment, basically a laborer, also followed the long and winding road of deproletarianization. From 1948 to 1955 Y worked loading sugar cane in the wagons in the Central Azucarera. The next year Y initiated a long history of jobs which included working in New York as a migrant worker, in cauliflower farms, migrating consecutively until 1959. In Puerto Rico Y worked in construction, mainly in the construction of a petrochemical plant. The "construction industry" was in a peak moment in the 1960's, mainly due to an increase in housing projects, and the building of the industrial infrastructure. Y using affinal relatives and cousins was able to ind jobs in that sector. With a <u>compadre</u>, Y managed to find a job as a mason, in housing projects in the south coast. After the construction boom ended locally Y travelled to Massachusetts to work for six months in the tobacco farms, a job found through the local office of the Department of Labor. Back in Puerto Rico, Y worked in a auto parts plant, in a hospital, for a total of nine months, when he went to New Jersey to work in a light fixture factory. The laberinthic journey of proletarianization in agriculture, the auto industry, farm labor in the U.S., and construction finally came to an end in 1976, when Y started to fish, this time, for therapeutic reasons.

Fishing, as expected, does not arises as an immediate or sudden alternative to wage work in the sugar cane fields. Once in the path of proletarianization, workers tend to remain as wage laborers for as long as they can. The benefits of social security, health and incapacitation insurance, and the assurance of weekly earnings accordingly to hours of work cannot be neither denied or down-played. In some cases, the fish market conditions (ex-vessel prices for the fishermen) were not lucrative enough, mainly during 1940 and 1950 as too engage in independent production as an economic alternative to wage labor. It required the concerted efforts of the household members to produce such desired change in labor status. Apparently, fish prices in the 1960's, when unemployment was at its best, were lucrative enough as to become a fisherman with the help of the wife and children, and in some cases, with the help of the money transfer of an ultimate welfare state. Social security, food stamps, and welfare payments, made available to many of the cases examined, specially late in their proletarian productive life (and to some in the absolute decline of their official proletarian life, incapacitated and injured from work) allowed them to become fishermen.

To structure in a sensible manner the processes discussed in this section we must say that these fishermen, found themselves in the same predicament that Taso and the social actors of The People of Puerto Rico found themselves: involved in sugar cane production by the economic pervasiveness of that industry in the coastal plains, thus turned into a rural proletariat, and the lack of similar economic alternatives in the coast or in the highlands. Peasants, coffee and tobacco farmers from piedmont and highlands areas, displaced by the U.S. tobacco companies flocked into the coastal plains and urban centers desperately looking for jobs or a stepping stone for the U.S migration. The route of proletarianization in which these rural households engaged took them to the sugar cane fields, to farms in the mainland, to industrial and service jobs there and in Puerto Rico, and in some cases, to jobs provided by the state as subsidiary to the rural proletariat in need, to maintain a labor reserve in motion.

Fisheries and the state played a similar role in the articulation of the wage labor force. The local government depended, and it has continued, on federal funds and programs to alleviate economic crises in the Island. The disarticulation of coffee, tobacco and "minor" (subsistence) crops farms, land accumulation on behalf of the U.S. companies, government land expropriation, land accumulation by the armed forces, and social displacement of the coastal settlements altered the life history of households in the coast and in the highlands, and painted a landscape with an immense potential for political action and violence, demonstrated through strikes and labor disputes.

During the 1940's and 1950's, detention of the deployment of social, labor, and political unrest was achieved by violent repression, and through various programs which included the Puerto Rico Emergency Relief Administration (PRERA), and the

Puerto Rico Reconstruction Administration (PRRA) which provided more than 230 million dollars between 1933 and 1941 in social and economic programs, which included housing food, and clothing for the rural poor. Still today the acronyms PRERA and PRRA evoke both harsh times and state benevolence, and the demeaning household state of abject poverty and helplessness. Industrial development was indeed structured, among other things, to slowly accommodate the rural workers into the hearth of industrial production, thus minimizing the substantial effects of the demise of export agriculture and sugar cane decline. But, the ultimate solution to the socioeconomic and political problems in the fields, and in urban centers was migration and population control by means of female women sterilization and other family planning strategies. The Commonwealth officially described migration as the escape valve of the Puerto Rican problems, and made subtle but effective efforts in maintaining such valve open, sending migrant farm workers to the mainland and to semi-permanent settlers to the industrialized cities of the northeast coast of the U.S..

Inevitably, the Island fisheries turned in this century into a labor buffer zone, in which the displaced, seasonally unemployed proletarian population found food, recreation and cash to maintain their families during la bruja. It is though that during the 1940 and 1950' the number of fishermen increased notably, due to unemployment in the Island. To most of the fishermen interviewed, the sea was the landscape the grew accustomed to in the coastal settlements in the fringes of the sugar cane centrales. A culture of chiriperos, learning to use the marine resources for the benefit of their household economy was an essential part of their life experience. The mangrove, lagoons, the reefs and the platform habitats provided them with a training grounds for a trade that could help them solve economic problems.

The critical context of the Island's fisheries is a difficult one that managers then to minimize. It is the context in which the rural workers in vast, known numbers have found solace from labor exploitation, therapy from injury or mental discomfort, food for their tables and cash for their expenses and subsistence, adding productive efforts to fisheries consistently used by a number of independent, specialized fishermen. Independent producers, proletarians and a semi-proletarianized labor force use the resources a unison, each with its own schedule, productive arrangements, and labor input, household commitments and political actions. Construction industry and the industrial development, which consistently proletarianizes fishermen or de-proletarianizes laborers and send them in the journey to their Ithaca, their beloved island, are also consistent forces in the privatization of access to the shoreline, mangrove forests destruction, sources of pollution, systematic destruction of estuaries and nursery areas, and the perceived decline of fishing. That is the predicament of the fisheries in Puerto Rico.

4.5 The Household as the Context and Domain for Deproletarianization

Disengagement from wage labor is not an individual decision, nor a process of such kind, but one which requires in many instances full participation of household members. At this micro level, the household, one cannot overlook the participation of the state in this process. The household provides labor and support for the separation of wage laborers from their jobs in their route to independent production.

Households are, in the context of fishing, containers, or units that engender and maintain fishermen in their communities and protect them from the tensions provoked by other social and economic forces. In that predicament households reproduce labor for the fishing enterprise, but cannot escape to face tensions produced by other sectors of the economy. In Puerto Rico, the logic and structure of the system allow each household to co-reproduce, among other things, laborers for the industry, public service or commerce. The educational system has responded to the development process through a variety of means which include universal education and vocational schools. During the last 10 years the massive transfer of funds from the Pell Grant and the Basic Educational Opportunity Grant (BEOG) propitiated the expansion of state and private colleges and universities and two year programs and trade school that have educated a large portion of the labor force. In that predicament, fishing households in Puerto Rico, more than anywhere else, have strong tensions in socializing children within the skills and productive culture of fishing, of independent production, and the state and expectations slowly inserting them into the status of wage laborers in the service and industrial sectors. And, there is always the alternative to join the ranks of the migrant farm workers or to take a plane an migrate to the United States. In many cases examined, the fishermen house features these intersections and tensions with the larger economy, and part of the solution is to become - the household - a container of laborers despite the petty commodity character of the household enterprise. In that context, the household network becomes, despite their petty commodity - capitalist character, a container of laborers, a unit that supports and contributes to the reproduction of the labor force during the economic crises.

> The Z siblings opted for staying in their municipality (ridden by unemployment) instead of migrating. The economic strength of the network of household businesses, labor pool, infrastructure, and means allows them to continue in a state of non-commoditization of their labor, in the hearth in independent production. The share system used by their father illustrates this point. He sells the catch, subtracts the expenses, and divides the money by three equal parts, despite the fact that he owns the boat and the gear, but their sons help him with the maintenance, motor repair, wood cutting for the traps' frames (an activity in which his wife also helps occasionally) and net mending. However, if they have to pay a loan or have additional expenses, the father waives the share system and gives them the money they need. In that manner, they are not circumscribed by how much they fish to cover the basic needs and financial commitments, but know that the cash will be provided, a financing provided by fishing, his colmado, and through (perhaps the most important) the wife's fritter business in the beach or the cake production. Each household with its own schedule and strategy of production offer the members economic asylum in they become unemployed, or provide with means to support their families while the situation improves.

4.6 A Lifetime of Labor and Independent Production

The diversity of strategies that allowed people to become fishermen and to leave wage labor; it is time now to explore the specifics of that trajectory. Sidney Mintz's distinction of type of fishing in Cañamelar, he observed becoming a full-time fisherman (or an independent producer) featured unsurmountable hurdles for the rural workers since the cost of sailboats were "prohibitive" for the workers in the cane, and represented a significant accumulation of capital. Time committed to sugar cane production also precluded wage laborers to engage in "full-time" fishing production, thus fishing became a "subsidiary" and seasonal activity, especially during what the Viequenses call, la bruja. Low prices for fish, lack of refrigeration facilities, and minimal capital investment made fishing a difficult trade to live from. Government officials evaluating the fisheries during the first part of this century agree that in the context of the prices and marketing structure, the fishermen earnings were quite meager, and did not allow for an adequate subsistence, nor for the intensive investment of capital (Jarvis 1932, Velez et al 1945).

> Z life history sheds light to those difficulties in entering independent production. He started fishing with one of his brothers who had a boat. They paid a man to build the traps and started their career in fishing. Afterwards, again with the help of two of his brothers, pooled the money to buy a small boat. Z share came from his wage labor in the cane. Their labor commitments only allowed the to "fish close to the shore", basically to eat and the remainder to sell. In 1953 Z bought an 10 hp outboard motor financed by the Department of Agriculture.

This conjuncture is eventful. The post war period marked the decline of sugar cane in the Island, in response to world prices, and the emphasis in industrial development and changes in the patterns of land use, and it also initiated an increase in the prices of fish and shellfish. Coincidentally, government programs for the labor re-incorporation into other sectors of the economy, and support of sugar cane laborers started to appear, jointly with efforts to "develop" the local artisanal fisheries.

In line with the strategy for development, the Commonwealth initiated efforts to increase production and improvement of marketing facilities, and fishermen opportunities at the moment in which prices increased (Iñigo 1967). Government efforts included: the motorization of the fleet through loans for their purchase (thus creating the fishing credit section at the Department of Agriculture), centers for the sale of gear and equipment at low prices, fishermen training courses, and the construction of landing centers called villas pesqueras (1967). A large portion of the fishermen interviewed by us, only started to buy motors and buy boats, when the capital was available through government development programs. But success in fishing and in capital accumulation at the household level depended on the array of activities in which relatives become engaged.

It follows from this analysis that the fishing households are a key element in the trajectories outlined in this report. Specifically, the degree and success of deproletarianization depends on the structure of the household, its ability to establish a network of units, and the utilization of joint skills in supporting and contributing to the welfare of the households. In the case of Puerto Rico, there are some elements that are absent in other cases of household networks, and that pertains to the fact that the workings of a state dependent on transfer payments makes possible for households to continue living without further efforts that could jeopardize their current flow of funds from government agencies. I am not arguing that the rural poor prefer not to work, but that the structure of the system permits them to benefit from social security, food stamps, incapacitation benefits, and therefore fishing allows the fishermen to find therapy, or to add an additional income or food for their tables, without incorporating members of their household in those chores. Children then remain in school in an attempt by both the household and the state to incorporate them into the university system, the Armed forces, the migrating farm workers, the flow of migrants to the U.S., but preferably into the industrial and service labor force. Inevitably, they become separated from fishing, but most learning the trade, in case they do not find jobs or become unemployed.

Most of the fishermen we interviewed proceeded historically to travel a journey in which their labor force became commoditicized by the social formation, and its participation in the international division of labor as part of the semi-peripheral tier in the world-economy, a position held in an interrelationship with the U.S. economy and labor markets. In that journey, these laborers, some of which originated in fishermen or in semi-proletarian households, intended to de-commodicitize their labor, to become deproletarianized in the long run. One has to distinguish well within the history of these trajectories, since capital resumes the participation of laborers in its industries accordingly to trends in labor demand and supply, and the cultural predicament of the context that provide labor in specific social and political circumstances. Simply stated, the labor force of certain ethnic groups is commoditized in relation to the current needs of capital, patterns of labor remuneration, structure of household participation in labor, political affiliations and strength, legal protection, and laborers' availability. Labor also becomes expendable when the demands for the commodities produced is reduced. Individual labor also becomes obsolete when the conditions of the laborer cannot fulfill the production expectations of the employees, in that context, illness (physical and mental) and injury (idem) disqualifies laborers to continue working. All these circumstances, well known, sends laborers to the ranks of the unemployed, but not necessarily to the ranks of the idle and unproductive. Sharing that structural background of socioeconomic conditions, the lives of the Puerto Rican fishermen, closely tied to the movements of the world-economy, feature and the individual level, in their authoritative discourse, their need to de-commoditicize their labor, to become independent. Forced perhaps by labor conditions, migrant nostalgia, unemployment, personal - domestic difficulties, these situations enhance perhaps the daydreaming of the workers in the midst of repetitious activities, or in the loneliness of a ship in the Pacific, boredom in a factory in Mayaguez, humiliation in a drugstore in Vieques, among the fumes in a fiberglass boat factory in New Jersey, in the sugar cane fields, in the U.S. farms of the northeastern coast, or in a salt pond in Cabo Rojo; dreaming perhaps of independence, as we have seen in the cases collected for the Life-History project (Griffith and Valdés-Pizzini, in preparation).

SECTION FIVE

KEY ISSUES IN FISHERY RESOURCE MANAGEMENT IN PUERTO RICO AND THE UNITED STATES VIRGIN ISLANDS

Fishermen believe that the weight of resource management is on their shoulders, and that they are considered the sole culprit of resource depletion. They argue that the process of management must incorporate an array of users and a set of situations that affect how the marine resources are used and conserved. In other words, management must engage in the analyses of these factors or key issues, in order to understand the full extent of its measures.

Regulations concerning the size of conch, the catch of red hind, measures of mesh size for traps, and other measures proposed and established by the FMPs will affect, in one way or another, the livelihood of the fishermen. CFMC documentation from public hearings suggest that, in general, fishermen agree on establishing certain regulations to protect the species, but seem to be inclined to reject limited entry schemes, and the potential reduction in the number of gears. Social processes in the last ten years suggest that the fishermen are willing to cooperate with resource management, but with important caveats. I will briefly discuss some of the key issues that need to be address in the FMPs, as they are pertinent to the status of the fisheries, and the welfare of the resource users. Data for this discussion is derived from a Delphi investigation on fishery conflicts in PR/USVI late in the 1980's (Valdés Pizzini 1990c).

5.1 Competition Between Recreational and Commercial Fishermen

One of the key issues is the increasing competition among recreational / sportfishermen (and the recreational sector or "industry" in general) and the commercial fishermen. The Griffith et al report (1988) submitted to NMFS shows that in various areas of the island of Puerto Rico and in the USVI there is competition for the reef fish resources, and the recreational fishermen also target those species that

the commercial fishermen traditionally catch, such as: snappers, groupers, yellowtail snapper, and hogfish, among others (1988: 28-29). These fishermen use similar gears as those used by the commercial fishermen, except for rod and reel, and gill nets. As one expert in the Delphi Report suggested...

> Both groups often target the same species groups such as snapper, grouper,grunt, etc. Since these species are under constant fishing pressure by both groups, with a consequent decline of the resource, a conflict is created - as a competition for the limited resource.

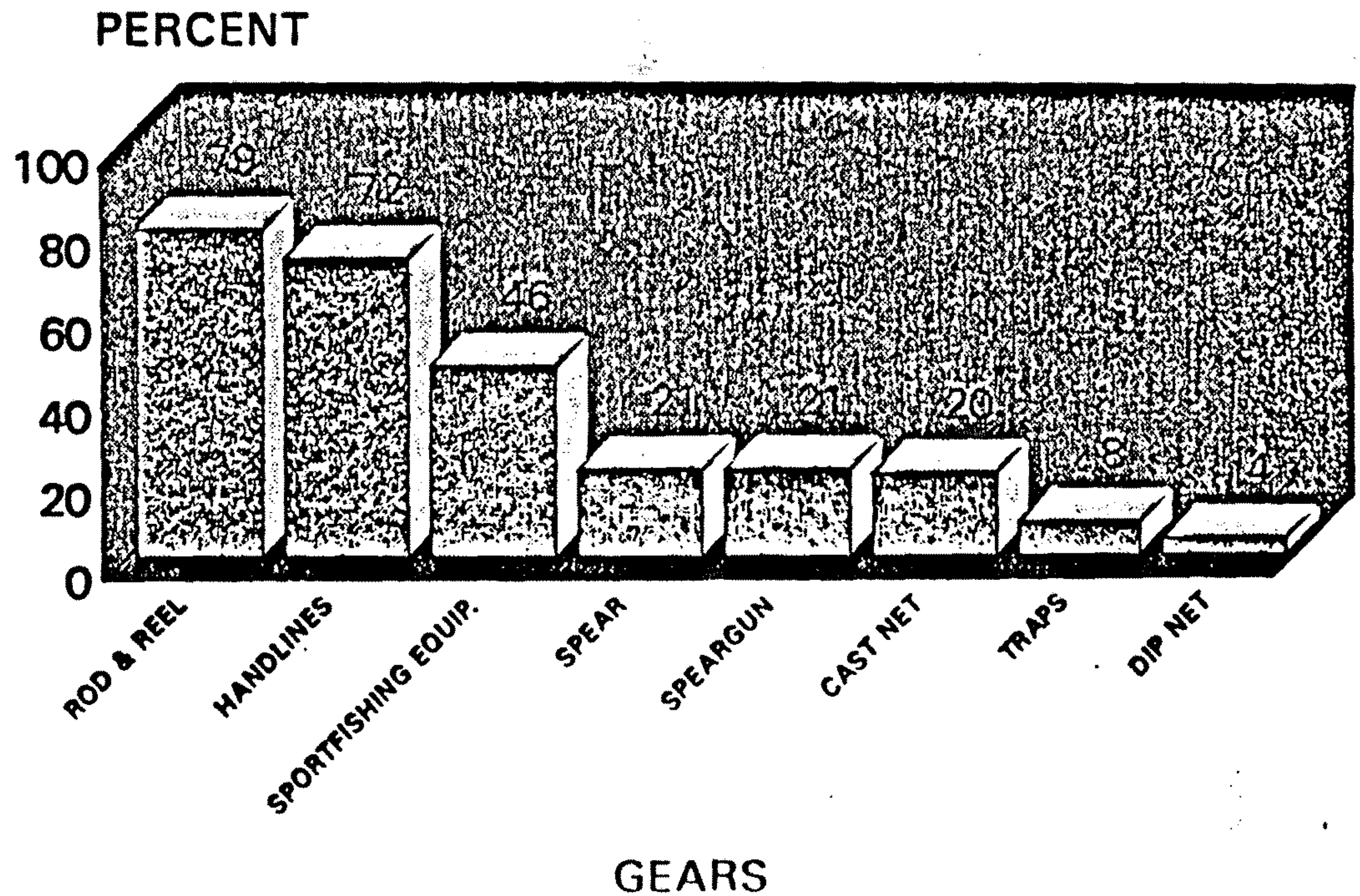
Recreational fishermen are also exerting pressure on the government agencies In their view the government should be more involved with the recreational fisheries by satisfying current needs such as public ramps and private marinas. They also want proper management of the species that compose the resourre, licensing systems. surveillance and better use of transportation taxes from fuel and boats. These fishermen are already competing with the commercial sector for the allocation of funds and services from the concerned government agencies. In a newspaper column, the issue was raised:

> The sportfishermen has for a long time been clamoring for attention. In government circles, it is the commercial fishermen who has been traditionally babied and protected. The commercials and the government have viewed the recreational sector as a bunch of kids with spinning rods, or a bunch of millionaires with big, flashy machines. So traditionally they ignore the interests of the sportman, refusing to even study the composition of that sector. Consequently, the government provides nearly nothing in the ways of facilities to that sector, despite the proven fact that sportfishing is a big income-producer and a boon to economic strength and tourism (Martin and Woods, 1987:59).

One issue which is related to the discussion on conflicts and the role of each group of fishermen in the region pertains to the need for a license for the recreational fishermen. In Puerto Rico, for example, the local commercial fishermen must have a license to be recognized as such and have to provide CODREMAR, on a voluntary basis, with landing information. The FMP's are constructed based on the landing information provided by the commercial fishermen. Recreational fishermen in PR/USVI probably outnumber commercials and we estimate that catch a higher number of pounds of pelagic and reef fish, since both groups target similar species (Griffith et al 1988). The reasons for a license have been thoroughly covered by Chaparro (1989). Most of the experts consulted in the Delphi project agree that the "recreational and sportfishermen should have a license". Interestingly, the majority of those who did not agree with the measure were recreational fishermen. Notwithstanding, they also had a very strong showing among those who agreed with the measure. One of the informants listed the benefits of the license system:

> The license for recreational fishermen is a need for the following reasons, among others: (A) it is a way of obtaining funds for the development of the activity, (B) the size of the population of sport fishermen would be known, (C) it would be possible to manage the resource more effectively.

FIGURE 4
GEARS USED BY RECREATIONAL FISHERMEN



Griffith et al. 1988

5.2 Coastal Access for the Commercial Fishermen

Coastal access is another crucial area of conflict between the recreational and commercial fishing sectors. Rapid development of coastal recreational activities appears to be correlated to coastal gentrification, and users conflicts. In Puerto Rico there are various cases, well documented, in which construction and utilization of recreational infrastructure, by both the public and private sector, have undermined community relations. As one expert pointed out:

> This problem persists actually because to reach the majority of places where fishermen go to fish, they must pass through private property, in others private apartment buildings have been constructed, etc. and the existing access was closed remaining in this way less available access places.

Access was also referred to as a problem related to physical access to fishing sites in the neighboring islands. Historically, these island served as an open access archipelago used by the local people not without complaints from the fishers and local authorities (Johnston 1987). But with the user pressure on the resources, fishermen had to cross boundaries, not without problems. As one informant clearly stated:

> The P.R. fishermen find relatively better resources in the U.S.V.I. and the same is true between U.S.V.I. and B.V.I. The B.V.I. have stopped foreign fishing in their waters and they have the most resources U.S.V.I. have implemented regulations and have impounded P.R. fishing boats. B.V.I. have confiscated U.S.V.I. and P.R. fishing boat. The situation will only worsen. Again support for limited entry is strengthening.

5.3 Competition Among Different Resource Users

Trap fishing, a traditional for of fishing in the Caribbean has encountered the wrath of different groups that have entered in competition with them for space and the fishery resources. Experts believe that trap fishing is an important problem in this area, and needs to be regulated.

The issue of ghost traps is an important one that is also the result of the high number of recreational and commercial vessels using the same maritime lanes. As one expert stated...

> There are common occurrences of recreational fisherman and boaters who unintentionally run over fish pot markers detaching them from the fish trap. Fish trap markers are also commonly detached as a result of storm weather or just plan left unattended for too long. I have on many occasions seen unmarked fish traps while diving. Traps full of dead or about to die fish. Creating the perpetual "Death Trap". In this day and age it seems to me that traps could be rigged with floatation devices that would self activate after a certain amount of time. A device that could be easily reset and redeployed."

5.4 Recreational Divers vs. Commercial Trap Fishermen

Recreational divers are considered as one of the largest and fastest growing group of resource users in PR/USVI. However, they are also passive users of the resource with a small number using spear guns for recreational underwater fishing It is known that divers (commercial fishermen) are considered a nuisance to trap fishermen. The Griffith report shows that recreational divers, are using the fishery through the utilization of spear guns, and spears, thus competing for reef-fish resources. Commercial divers are viewed as the nemesis of trap fishermen, and communities are often divided between divers and trappers (Gutierrez, McCay and Valdes-Pizzini 1986). For the trap fishermen, divers usually steal from their traps, and present an unfair competition for the available resources.

5.5 The Status of the Fishery and Overfishing

The majority of the panel experts (65%) interviewed in the Delphi project agree with the statement that the "fish and shellfish landings in PR/USVI are declining", an assertion that is consistent with the landing figures. Experts who disagree with that statement represented the commercial fishing sector. One may extrapolate that they disagree because they feel that landings have been under reported in the last decade.

In the Delphi Report, once th? premise of the decline of landings was established experts were asked if the decline was due to "overfishing". Most of them agree that overfishing was the cause of such decline. This issue was not resolved without a discussion. For one expert the "hard" evidence suggests that overfishing is actually occurring:

> From the point of view of fisheries management, it is said that there is overfishing when certain cues as the following occur: (A) the average size of the captured species declines, (B) the fishery does not provide for a maximum sustained production, (C) fishermen must move from traditional places to be able to capture something. Considering the previous statements it would be said that there is overfishing in Puerto Rico. Notwithstanding, studying the situation from a broader point of view it is evident that an abundant fishing resource can not exist in a place where fish hatcheries and dwelling places of fish are destroyed (reefs, marine grass prairies and mangrove swamps), rive's are canalized, eliminating or affecting estuaries, water is contaminated, fishing and nature's laws are not respected, etc. This demonstrates it is very possible that the diminishing of captures is due to the scarcity of the resource because of these factors and not to overfishing."

Another expert, in what I consider an essential argument in the issue of overfishing, consider that one should "qualify" what "overfishing" is, and what should also be weighed in considering the problem.

> Overfishing needs to be qualified - in many cases the problem is "people" and degradation of the environment - take a look at San Juan, Ponce, Mayaguez Bays and the Charlotte Amalie areas.
>
> Overfishing is merely one reason of many attributed to the decline in fisheries landings. Other attributing factors include, recreational fishing impacts, environmental degradation, destruction of important fisheries habitat, coastal development, degradation of inshore, water quality due to siltation, sewage, etc.

Similarly, when I inquiry on the issue of the capacity of the fishery to absorb both recreational and commercial fishing, on informant argued that:

> During the last 20 years the number of users (commercial - sportive) has increased tremendously. The habitat has been destroyed or damaged all over the island. It is necessary to give some rest to the capes, estuaries, etc., to control construction in areas of endangered habitat, to control pollution 100%."

In fact, one respondent classified the issue of pollution and habitat degradation, as an area of conflict:

> Conflict between fishermen (in general) and the industrial process of the island (contamination). Very important.

Fishermen and fisheries related people, in the USVI and Puerto Rico tend to agree that the current status of the fishery cannot be solely attributed to fishing pressure, but to a complex process of resource utilization in which the industrial and service sector must also share responsibilities. For the small-scale, commercial fishermen their traditional resource is being used by newcomers, such as the recreational and sport fishermen, and those who are extracting corals and tropical fish for the aquariums. Pollution and environmental degradation appears as a major concern of the fishermen in surveys and fieldnotes over the last decade. It is my assessment, that the appropriate discussion and management of the aforementioned issues will ease any regulations carried upon the shoulders of the fishermen. The fishermen are willing to collaborate in the process of management, if their concerns are taken care of. There is sociopolitical evidence of the adverse effects of public policy that disregards the concerns of the fishermen, specially when the opening argument features the sad state of the local fisheries, as a result of overfishing (Valdés Pizzini 1990c, in passim).

SOCIAL IMPACT ASSESSMENT FOR THE SHALLOW-WATER REEFFISH FISHERY MANAGEMENT PLAN

1. PARTICIPATION IN THE FISHERY

Fishermen in Puerto Rico come from fishermen households and families. There is people who enter the fishery as newcomers, from others sectors of the economy, but our research has concluded that most come from a fishing tradition. For example, Gutiérrez found that 80% of the fishermen interviewed for his study had relatives engaged in fishing (1985). In the Life-History project, we found that most fishermen start at the age of 12 with their parents, relatives or neighbors in their coastal communities. The vast majority (92%) learn the trade when they are under 18 years old. This suggest that people learn in their household or in their communities, while few learn it at another stage in life, and social context. More than half of the fishermen (53.5%) report that they receive some type of help from their family. Family still helps in the actual fishing activity and the processing of fish ashore Collaboration in the repair and construction of gears, in the maintenance of the vessels, and selling fish has diminished. Ethnohistorical data suggest that, forty years ago such participation was almost absolute. But, pressures from the industrial and service sector have absorbed the available labor force from the fishing households, integrating them into the "larger" economy.

Women, who contributed to mending nets, repairing gears, processing and curing fish, as well as fishing and taking care of the catch, have slowly become part of the industrial labor force leaving the fishing endeavor to the males. Unfortunately, the issue of gender in maritime and fishing activities in PR/USVI has not been studied. Ethnohistorical data from Puerto Real, and from the Life-History project suggest that women were important figures in the fishing sector, since they managed capital and owned boats while the males in their families fished for them. In small enterprises, they were in charge of handling the money and managing the business. Recent evidence from the cited studies, also suggests that they participation in the fishery, as fisherwomen, was also strong. It appears that, women and children (who are in school, in college, working in the "larger" economy) are becoming scarce for recruitment into the fishery, and unemployed males from other households in coastal-fishing communities are replacing them in the structure of work. Friends, relatives, distant relatives and hired hands constitute the bulk of the crew, one which is changing from being kin-based. The nature of their social networks related to fish also seem to be eroding, since less fishermen are now members of fishermen associations, as compared with the Gutiérrez survey.

Additional information on the socioeconomic profile of the participants in this fishery are discussed in sections...

2.2 The "Socioeconomic" Status of the Fisheries, Page 12.

2.3 The Petty Commodity Character of the Puerto Rican Fisheries, Page 16.

Discussion of the issues of access, the environment, and conflicts among resource users, as related to traps, the main gear affected by the measurements discussed in the FMP are presented in sections...

3.3 Development and Environmental Concerns, Page 41.

5.1 Competition Between Recreational and Commercial Fishermen, Page 65.

5.2 Coastal Access for the Commercial Fishermen, Page 69.

5.3 Competition Among Different Resource Users, Page 69.

5.4 Recreational Divers vs. Commercial Trap Fishermen, Page 70.

5.5 The Status of the Fishery and Overfishing, Page 70.

2. HISTORY

History of labor patterns in this particular fishery are discussed in ..

SECTION FOUR: FISHING AND LABOR IN PUERTO RICO: HISTORICAL AND CONTEMPORARY PERSPECTIVES OF A FUNDAMENTAL CONCERN IN MANAGEMENT, Page 45.

Also, for the USVI, in sections...

3.1 USVI Fisheries Early this Century, Page 35.

3.2 Changes in the Fishery, Page 38.

3. ECONOMICS OF THE FISHERY

Fishermen are a group of individuals who can adapt to a diversity of conditions and situations. Their lifetime kit of survival is impressive, they take risks and engage in difficult trajectories to support their families. Contrary to the common perception among the general public and some government officials, fishermen have a strong work ethic, which is divided in various sectors of the economy at one time, or throughout their lifetime. Data from the Life-History project reveals that the majority of the fishermen have migrated to the United States to work at one or more point in their lifetime. Preliminary data from a Labor Trajectory Chart constructed for this assessment, reveals that during the years that followed the World War II, fishermen (or people from fishing households) were integrated into the agriculture of Puerto Rico, but started to migrate to the United States in the decade that followed. From 1950 to 1965, the chart reveals that the bulk of the wage labor trajectories of these individuals was in the United States, engaging in agriculture (as migrant farm workers), in construction and industrial work. From 1965 to the present, those trajectories were based in Puerto Rico, in the construction, industry and services, which ended as one of the dominant sources of employment, specially government service. Only a handful migrated to the United States. This data coincides with our qualitative analysis of labor in previous section of this social impact assessment. The most impressive fact is that 91% of those interviewed had another job at one time in the Puerto Rican economy. One is tempted to suggest that if the economy of these island improve, a large number of fishermen will become re-inserted in other sectors of the economy. However, I must also warn that an unspecified number of those who have worked elsewhere are retired into fishing, or complementing their pensions with fishing (Griffith et al 1992). Indeed, data from the Life-History project reveals that only 15% of those interviewed maintain their families with the income from fishing. Fishermen sustain their households with a combination of sources of income that include transfer payments (social security, retirement pensions, food stamps) and income from other jobs, from different members of the household, the fisher included.

For the USVI, information on the economic aspects of the fishery participants is found in section...

3.4 <u>Full-Time contra Part-Time Participation in the Fishery</u>: 42

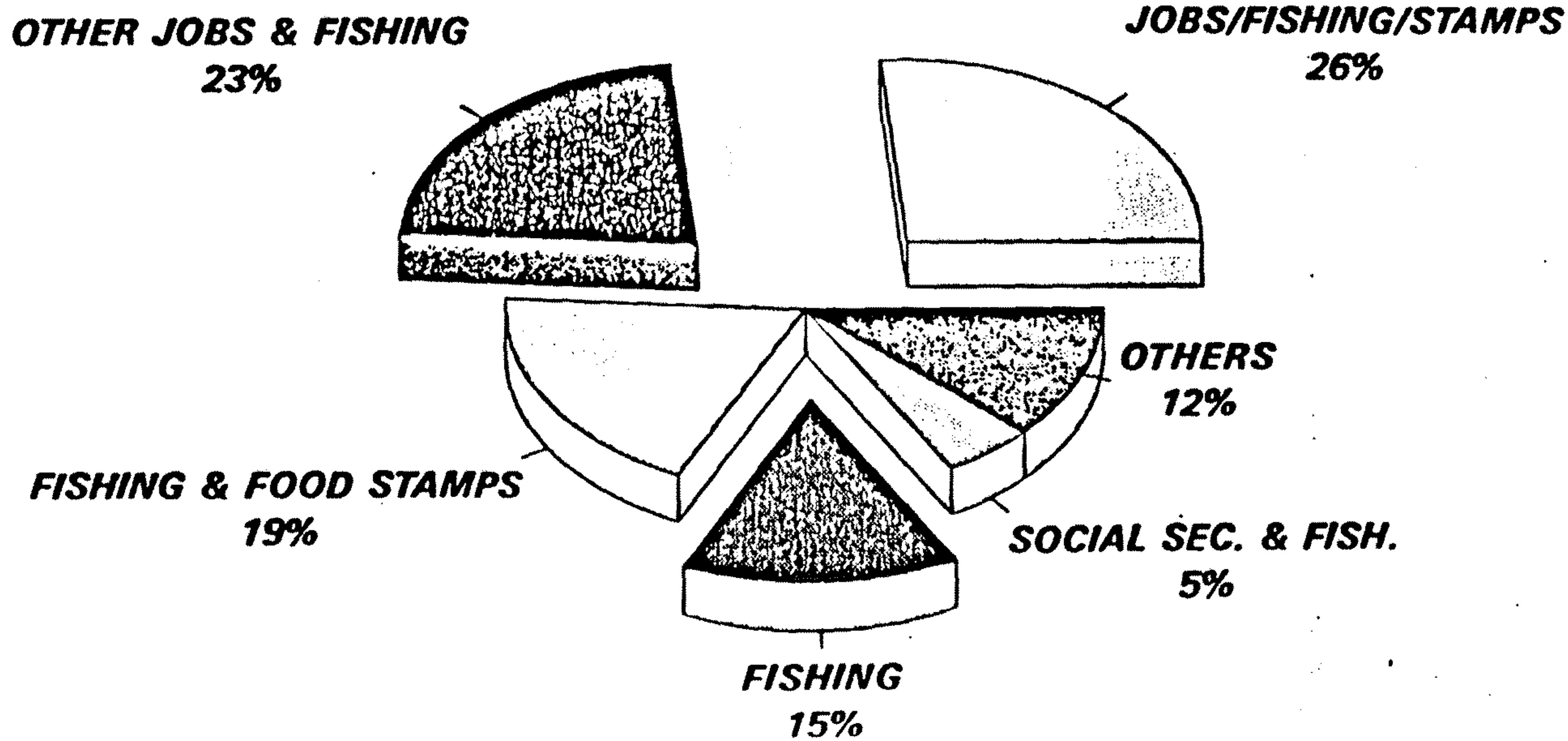
4. CULTURAL AND SOCIAL ASPECTS OF THE FISHERY

See sections...

2.4 Cultural Dimensions of Fishing as an Economic Activity, **Page 19.**

2.5 The Political Culture: Fishermen Associations, **Page 24.**

FIGURE 5
FISHING AS A SOURCE OF HOUSEHOLD SUPPORT



Life-History Project n = 109

Data for Gutiérrez, Matos and Torres, and Griffith et al, suggest that fishing is indeed a multi-species strategy, and that fishermen operate several gears at the same time, targeting a variety of species, over the course of a year. I do not foresee that FMP measurements will diminish effort, for example by reducing the number of fishermen devoted to traps, and thus the number of traps. It will shift effort to other gears and species.

Preliminary data from the gill net social assessment suggest that the fishermen are shifting into those gears not regulated, that offer less investment and competition from other user groups. An example of that is the fishery of Puerto Real. In that community, trap fishermen saw the opportunity to increase their income by shifting to the reel-line technology, and rigged their vessels to fish in the shelf drop-off for snappers and groupers, as they market price for these species increased. As the number of production units shifted toward reel-line, the number of divers started to increase. Leaving hand lines and traps behind, youngsters entered into a new dimension of fishing, and competing for highly priced resources, such as conch and lobster. Divers, pooling resources from their friends and neighbors, and trap fishermen, pooling resources from their households, entered few years ago in the collision course of competition for scarce resources. The alternative is to shift to other gears, such as gill and trammel nets, or to increase effort through trot lines ("palangres") and hand lines. Another alternative is to target pelagic species. In conferences in the Puerto Rico and the USVI, in the Delphi project, in private meeting, fishermen appear interested in targeting pelagics and even shifting to longline as a gear. This is a difficult option for several reasons. First, only a fraction of the vessels could be rigged to target those species, an only a handful of areas (such as Christiansted and Puerto Real, and perhaps few fishermen in St. Thomas) could join efforts and capital to target those species in a competitively manner. Second, small boats could target some species, such as tunas, but the structure and culture of the market could curtail the efforts, as it often happens among the fishermen of the northwest coast of Puerto Rico. Also, small boats such as the "yolas" are ill designed for the handling of large pelagics. Information and technology transfer from the university or the private sector is needed to appropriately prepare the fishermen. And third, another level of competition is expected when the artisanal and commercial fishermen move into targeting pelagics. Large pelagic are the mainstay of the important charter boat fleet, specially in the USVI (Chaparro 1992), who will enter into the political arena as such shifts appear.

Shifts in Gears: An Ethnographic Account of the Net Fishermen

First, a number of variables attest to the family and community basis of net fishing. Less than one third of the fishers in the 1987-89 group learned fishing from sources outside their family, and less than 20% reported learning fishing "alone" or "watching others." Closely related, consanguineal (blood-related) male kin, such as fathers, grandfathers, uncles, and older brothers, make up over 50% of those cited as teachers. While the life history project has revealed that fathers-in-law have been important in the expansion of fishing enterprises, within a common strategy of using daughters' marriages as occasions to enlist the aid of sons-in-law, only around 5% of net fishers interviewed said that they received their initial training as fishers from their wives' fathers. Instead, they tend to learn the basic features of fishing while relatively young and living at home, with fully 65.7% reporting that they learned to fish prior to their teens, and less than 10% reporting that they learned to fish after age 15. Further evidence of the importance of family in learning, becoming, and passing along the trade of net fishing are derived from the finding that 70.6% of those interviewed reported receiving help from their family in the multiple tasks associated with net and other fishing. This suggests that, upon founding their own households, through the receipt of help from family members they teach the young of the household how to fish.

From our examination of the data from the 1981-82 survey, we noted that net fishing was often complemented by other fishing methods in the development, over time, of a household's increasing reliance on fishing. Life history interviews show that Puerto Rican fisheries include a substantial number of users who move between different gear types, including nets, with different marketing strategies and crew types. In a survey of 170 net fishermen, they reported owning and using other gears. The most prominent one was lines, with 77% of the fishermen reporting it. In order of importance, the gears reported were: cast nets (52.9%), traps (33.5%), beach seines (13.5), diving gear (16%) and wooden traps (5.3%). Shifts in methods of exploiting the resource are, in turn, often related to one's movement between fishing and other occupations, as well as changes in the composition of the fisher's household, as the following case demonstrates.

<u>Case # 1.</u> Sylvan Cobra uses nets to fish, yet he dives and fishes with hooks and lines as often than using his nets, depending, in part, on the disposition of his catch. His fishing has always reflected his history of migration between the U.S. mainland and Puerto Rico, as well as developments in his own and related households. His father was a fisherman, but moved to New York with Sylvan's brother in the 1960s, while S.'s mother remained in Puerto Rico running a small seafood restaurant. From the ages of 16 to 19, Sylvan fished with a hook and line to supply his mother's restaurant. In 1967, at the age of 19, Sylvan joined his brother and father in New York, returned to Puerto Rico in 1968 to marry, returned to New York with his wife for three years, then went back to Puerto Rico to fish and to help manage his mother's establishment. This time, however, he fishes primarily with a trammel net that belongs to an owner of a fish market, at which time most of the catch went to the fish market.

Three years later, he divorced his wife and returned to New York; at the same time, his brother returned to Puerto Rico to relieve Sylvan in helping the mother tend the seafood restaurant. Sylvan remained in New York for eight years, where he married a second time. When he returned to Puerto Rico, instead of fishing, he worked in a hardware store for a year and a half, returning to fishing only after his divorce from his second wife and his returning to his parents' home to live and fish. The third time he joined another fisher in his community, a friend, combining his own equipment with that of his friend and fishing for himself instead of his mother or the owner of the fish store, but selling all of the catch that he did not use himself (or for his mother's restaurant) to another restaurant instead of to a fish market.

Sylvan's case illustrates the dynamic between three prominent features of Sylvan's life, features which are similar to the lives of many fishers in Puerto Rico: a) processes of household formation and dissolution; b) migration (or, more broadly, job search); and) fishing. Sylvan's cycles of migration and return, interrupting his fishing, stimulate shifts in the kinds of gears he utilizes, the social relations he enters into to fish, the disposition of his catch, and the ability of his fishing to sustain him without work in the formal sectors of the economy. Yet his movements between the island and the U.S. mainland seem as much related to rites of passage marking the birth, growth, decay, and death of households. Influencing him in this fashion are not only his own experiences with marriage and divorce, but also the experiences of his brother, his father, and his mother as their households undergo changes and as they move between jobs in New York and fishing in Puerto Rico. Sylvan's case thus illustrates the complex social arenas of Puerto Rican net fishing, including its role in supporting more than one household and its importance as a means of support during periods of unemployment. Other cases similar to Sylvan's emerge again and again from the life histories. Our second case, for example, involves a Puerto Rican fisher who was born in Puerto Rico but moved, at age 10, with his parents, to New York.

> Case # 2. Born in 1956, Marcos Olmo's childhood was divided between Guanica (1956-66), on the Southwest coast of Puerto Rico, and New York (1966-74). He did not learn to fish as a boy, as is common among Puerto Rican fishers, but rather learned in 1975, at age 19, a year after returning to the island. His initial fishing experiences involved hooks-and-lines and cast nets, but he included in his fishing enterprise both diving and trap fishing after taking a year away from fishing in his middle twenties (1980-81) to work in San Juan for an Airline. Adopting scuba tanks and traps as his principal gears was influenced first by his brother, who lived in California and knew how to dive himself, and second by entering into an arrangement with a doctor who owned a resort in Guanica and who was a friend to the man who taught Marcos how to fish. The doctor bought Marcos 25 traps to use to fish for the resort, at the same time hiring Marcos for maintenance work around the resort and for taking tourists to nearby islands for picnics and boat rides; this latter job drew upon the English skills he had learned in New York. Slowly Marcos began assuming more tasks and more responsibility around the resort, increasing his work load, his stress, reducing the time he could spend scuba diving for fish (a practice often associated with tranquility and relief from job stress), and eventually causing tensions with the doctor. In 1986, he quit to begin fishing full time, relying predominantly on his scuba gear but still using traps. After nearly two and one half years, until early in 1988, he switched from trap fishing to net fishing when his traps were stolen. Today, he cites the trammel net as his

principal gear, although he still dives and uses the hooks-and-lines and cast nets that he used originally.

This case reconfirms many points raised in the context of the previous case, while raising other issues as well. First, Marcos's ability to switch from traps to nets may seem to suggest that switching from gear to gear among Puerto Rican fishers is relatively easy. Indeed, among related gears this may be the case, especially since fishing itself demand a variety of skills that must be learned independent of the specific gear type being used: seamanship, navigation, seafood marketing, association membership, processing, and so forth are among those features of fishing that are only tangentially or indirectly related to the specific gears one uses. Nevertheless, switching from one gear to another, especially when the new gears are nets, is not always an easy or more productive move. In the biological section of our paper, which monitored the effectiveness of gill nets and trammel nets, we found that a knowledge of the substrate, or the characteristics of the bottom, are crucial to the successful placement of nets. Without some basic knowledge of the character of the bottom, nets become tangled in rocks and coral, causing low catch rates as well as additional time and effort in net retrieval and net repair. Marcos was able to switch from traps to nets because, combined with scuba diving, trap fishing results in becoming familiar with the landscapes of the sea floor. Trap fishing and net fishing resemble one another further in their reliance on triangulating the positions of the gears with reference to points and landmarks along the shore. Both gear types, being susceptible to theft, are set with a minimum number of markers or floats (sometimes traps have no markers at all, and fishers drag for them after they have soaked); trammel nets and gill nets tend to be used more during the evening or early morning hours and hence tend to be more difficult to find and steal. In both cases, however, being able to locate the gears with reference to shoreline features is a skill that both nets and traps demand.

Our final case builds upon the theme of combining nets with other fishing gears, as opposed to switching from one gear to the other, yet here we move beyond observations about intrinsic similarities between the gears, casting this theme in the light of a complex, multigenerational household that is able to use a number of gears at once by drawing upon a skilled pool of household and community labor.

Case # 3. The Martinez Family live in an extended family household consisting of two overlapping nuclear families (Father, Mother, Two Sons aged 14 and 19, the eldest Son's Wife, and a child of the younger couple). They live together on the South Coast of the island, in a single dwelling that is surrounded by fishing workshop spaces, food crops, and a small pen for keeping pigs.

Their fishing enterprise draws upon the collective experience of the father, mother, and the son, while the son's wife tends to the house, yard, and their child; clearly, the young woman's attention to domestic responsibilities allows the others to attend to fishing. Trammel nets and gill nets are but two varieties of gears in the fishing household, being combined with traps and a beach seine. This combination is possible because of the timing of the use of the gears, their various levels of labor intensity, and the fact that the father and son live and work together. The latter circumstance should not be underestimated, since the Martinez family reported that they used to use only traps, adding the nets after Angel, the son, learned to fish.

Angel began fishing with his father at the age of 7 or 8, reporting that his father was a strict but thorough teacher. By age 13 Angel was already going on fishing excursions alone, allowing his father to take time away from fishing to work at other jobs. The 14-year-old son has no interest in fishing and, in fact, does little work around the house because of various mental and physical disabilities.

The Martinez fish daily, during good weather, using not only the traps and nets (which both, of course, soak) but also the beach seine. Their schedule and their gear selection is driven by the seasonal weather shifts, associated changes in the water currents and conditions of the sea, and the combined effect of these factors on species availability. Additional time constraints arise from gear maintenance and construction. To construct and maintain traps may take as much as two to three hours per day, especially if we include the time necessary to find and cut the wood for the frame and buy the wire; to repair and maintain nets depends on their condition following use, but may take anywhere from one to five hours of work following each soak. The demands on the fishers' time would be even greater if it weren't for the fact that the elder woman in the household, Angel's mother, handles all the fish processing, leg work, and public relations associated with marketing the catch. They sell to both fish markets and out of their home, owning a freezer for this purpose.

The Martinez fishing enterprise does not only rely on the labor and expertise of the family, seeking other community members to aid them in fishing. When they hang the nets, usually, they use crews of three to four persons, always including Angel but often not including the father, since he was injured in one of his jobs and collects disability. He is capable of some fishing tasks, however, and accompanies Angel on fishing excursions whenever he feels it will not jeopardize his productivity. Those non-family crew members, then, share the catch with the Martinez, although the share arrangements differ by the specific gear used, the craft used to deploy and retrieve the gear, and the specific individuals from the community who help them.

With this case we return to recurrent image of the Puerto Rican net fisher as an individual who derives his skills and gear preferences with reference to family and community, entering the fishery, combining gears, and providing fish to consumers because of his relationship to other household members and other households. The complexity of gears and fishing styles in the Martinez case further illustrate the ways in which fishing, as a source of income and high quality protein for coastal communities, involves more than one household. Net fishing, moreover, is an intergenerational process, usually handed from father to son and, in each generation, combined with or enhanced by other fishing methods and styles. Switching from one gear to another, related gear is a behavior which is instructive not only from the perspective of adopting net fishing but also from the perspective of leaving net fishing (Valdés-Pizzini, Acosta, Ruíz and Griffith 1992. in passim).

The multi-species, multi-gear pattern of resource utilization of the shallow-water reeffish fishery must be taken into consideration in the analysis of the probable scenarios that the different measurements suggest. In summary, fishermen will adapt to other gears and fishery, if the use of an specific gear is curtailed.

Discussion on the Different Measures for the Shallow Water Reef Fish Management Plan:

Here, I will present the basic management measures, and indicate further the probable social and cultural scenarios that could be expected with the measures.

10.2.1 Establish 2 inches (in the smallest dimension) as the minimum size for fish traps.

"This measure could reduce the number of part-time fishermen. It has been argued that larger mesh would discourage the use of traps by part-time fishermen because average number of fishes per trap will decrease. However, it will provide better economic return to the full-time fisherman because the catch of larger fish, with the escapement of a greater number of juveniles, will bring higher market values. If 2" mesh size wire is readily available, no significant economic hardship is foreseen."

This is a critical measure that deserves more attention. It is possible that the fishermen could increase the mesh size to 2". However, if the intention is to eliminate the "part-time" fishermen, the rationale is erroneous. It probably will eliminate those marginal trap fishermen, and encourage those with strong households, and saved money. Our analysis of the Life History interviews reveal that trap fishermen appear to have a strong commitment toward fishing since they learned the trade at a younger age than those who do not use traps. Trap fishing is an activity that requires plenty of effort on behalf of the fishermen and their households ashore. Trap fishermen tend to have more household participation, family and relatives participation in fishing (as part of the crew) and in fishing related activities than those who do not use the gear. Management measures related to trap fishermen affect a large number of people in many ways. What follows is a detailed ethnographic account of the trap fishing process, as witnessed in Puerto Real, which shows the labor input of the fishermen, their effort, and the kin-based character of the enterprise.

A Case Study: An Ethnographic Account of Trap Fishing Effort and Household Participation in Puerto Real, circa 1983-84

Trap fishing, once the most important type of operation, is employed presently in Puerto Real with the schooners, modern boats, and as a recent development, with small fiberglass boats, similar to the skiffs. The most common crafts used are the modern boats with a length that range from 22 to 28 feet, and equipped with inboard diesel engines, compass, safety lights, radio and mechanical haulers. These vessels are built in fiberglass and wood, and their sale value averages the twenty-five thousand dollars.

The modern boats, or lanchas, come without a roof or top, however, all of them have one built by the local shipwright. The roof allows the fishermen to work more comfortably in the shade, thus avoiding the harsh tropical sun. This is important indeed, according to the fishers one of the incentives for changing vessels is the potential addition of such roofs, which allow a pleasant work in the sea. The top is also used for carrying the traps from the harbor to the fishing grounds and back. All the lanchas, as well as the schooners and the small boats have mechanical haulers for the traps. In the past, the traps were hauled by hand, but then the fishers had less traps and the wooden frame was lighter than the heavy iron rods used today.

The traps, or nasas, are designed and built in three types of shapes: (1) square type, (2) arrowhead type and (3) violin type (a crooked rectangle), being the arrow head and square types the most common. Originally the traps were built with a frame of wood and covered with chicken wire, with an entrance (nasillo), and a door located in the sides. Building the frame in wood required the fishers to go into the mangrove forest in a yola to cut the mangrove trees to be used in the construction of the traps. Once built, the nasas had to be cured, by absorbing seawater, and acquiring sea organisms and weeds which would attract the fishes into the trap. The curing process added some weight to the trap and also served as a testing period, to prove if the nasas were resistant enough to be placed in the fishing grounds. This process was done in the haven, in the mangrove areas or in the shallow coastal waters, mainly near Cayo Fanduca, were the nasas could be easily monitored.

Nowadays the nasas are built with welded iron rods, and therefore, they are more resistant to seawater and to the destruction and damage they usually suffer with the strong underwater currents, thus they are also less prone to be lost. No curing process is done presently. In Puerto Real the change from the old wooden nasas to the new type has been stimulated by the effectiveness and durability of the latter, which have been intensively promoted by the government.

The fishermen working in conjunction with their domestic units have interesting thoughts about the nature of their work and their relationship with the arte de nasas. A common argument in their discourse is that they prefer fishing with traps because "while one is asleep, the nasa is fishing". The logic of their argument resides in the fact that they do not fish, the traps do; their task is to see if the traps have caught something, three times a week. The fishers also consider that the amount of time they employ in fishing is low, when compared with fishing in the trawlers, therefore the former activity is far more easy and comfortable.

This view of their work is partial, they also know that the fishermen with an arte de nasas of their own has to work at the sea, and also at home. The arte de nasas demands an enormous amount of time and capital for their construction and maintenance. In Puerto Real the fishermen have artes that range from 20 to 185 nasas, with an average of a hundred and two traps per production unit, and an estimated cost of 30 dollars in construction materials per trap. Not all the traps are fishing in the water; a number of them are kept ashore for mending and repairing.

The domestic space, for those who own the arte de nasas, becomes a workshop. The basic repairment done to the traps comprises the replacement of the oxidated chicken wire , and the frame and panel damaged by the constant use, and the crashes with the rocks, and other underwater objects. Another type of repairment is to reweld the disconnected iron rods of the frame. A familiar scene in the house of a trap fisherman consist in the yard filled with traps, materials and welding equipment. They usually work outdoors, although some have a roofed area to work in the shade. It is indeed a frantic scene sometimes, the fishers with their sons and relatives repairing the traps or moving them to the piers in their pick-up trucks.

The fishing process starts with the preparation of the vessel the afternoon prior to the day of the trip. The fishermen, but most important perhaps, their sons prepare and clean the craft, giving maintenance to the equipment and to the engine. Regardless of the fish markets to which the units are associated, the fishermen take their crafts to the Rosas fish-house, since they are the only ones providing ice and fuel. At Rosas's they also buy parts for the engine, and other equipment they might need. In the piers they customarily use for mooring, the vessels are embarked with the traps that the fisher men will return to the water. At the time of the embarkment, friends and relatives of the fishermen, as well as people who do business, or pleasure with them, gather in the piers for some talking, drinking, and helping in the chores.

More than often, men who are unemployed help in the embarkment for a couple of dollars, beer, or the promise of fish. Children and adolescents usually join in this tasks in the crafts of their relatives and friends, in exchange of money, or without any remuneration since the skipper uses the craft for family excursions to the nearby beaches, which they all enjoy.

The process of embarkment and preparation of the vessels is not only part of the production process, but is also an essential thread in the web of social relationships. In this process the fishers visit the neveras and there they exchange beers, conversation and information with other fishermen, and with the people, friends and relatives that help in the embarkment. The information exchanged comprises the weather conditions (although they carefully listen to the Weather Bureau radio reports), the strength and patterns of the cur rents, the catches obtained by other fishers, the prices paid for materials, the sites and grounds to be visited, or avoided, their schedule, and community gossip in general.

In doing so, the fishermen maintain and reproduce the web of social relationships and communication in the fishery, and also provide the dealers with a good opportunity for monitoring the productive activities of the totality of the units, a key aspect of the competition among the casas.

Since the duration of the fishing outings is only from 4 to 6 hours in a day, the food supply they carry is a light one which consists of ham and cheese sandwiches in white bread, crackers, soda beverages, juices and a container with coffee. This provision of food is called el rancho. It is prepared early in the morning by the fishers or by their wives. The preparation of the clothing and the food, are the only tasks related to fishing in which the women participate.

In other fisheries, in Puerto Rico, and worldwide, women have an active participation in the production process. In Puerto Real, except for few cases (a woman who fishes for subsistence, and three women that repair and weave nets), women, in general, are excluded from a direct participation in the process of production, of fishing, but two women are involved in marketing activities.

The skipper of the vessel, el capitan, and its helper, or foretopman, el proel, meet in the harbor around 4:30 to 5:00 am in the summertime and at 6:00 am during the winter. The strategy is to arrive at the fishing grounds (half to one hour away from the harbor) with sufficient sunlight to be able to start their operations. The proel usually arrives first to the pier, and begins to make the final arrangements for the trip until the capitan joins him.

The travel from the harbor to the fishing grounds is handled by the capitan; in the meantime the proel rests or sleeps for a few more minutes, if everything is prepared aboard. The trip to the grounds averages 35 to 50 minutes in the modern boats, but the trips are faster in the small boats, and slower in the schooners. The capitan uses a compass to navigate. The knowledge and application of the sky, once an essential ken in the fishery, is presently null. Instead of the guiding lights of the stars, as reference points in the sky vault, the fishers of Puerto Real use the lights of the buildings, houses and communication towers ashore, for guidance during the dark hours.

Development and electrification in the rural areas have changed not only the landscape and the economy, but have also provided new elements for the mental mapping, and geographical reference points for the fishermen, who have exchanged the "moving" vault of the sky for the more stationary, and brighter lights of modernity.

Fishing trips in this method of fishing take about 4 to 6 hours during the day; and the fishers visit the grounds 3 to 4 times per week. The fishers of Puerto Real place their traps in the fishing grounds of La Partidura, Las Coronas, La Corona Larga, Bajo Gallardo and Cayo El Ron, but their efforts are concentrated in the rich areas of Buche, Abril La Sierra, and El Tulmarín.

The nasas are located in the bottoms of the inshore environment, mainly in the reef area, in the sand and muddy bottoms, and in the grassbeds and flats nearby the reefs. Traps are placed in sets of 2, 5, and 10, accordingly to the extension and richness of the grounds. In a given fishing area, such as Abril La Sierra, La Marca Vieja or El Bajo Gallardo, an unit may have as much as 50 to 100 nasas. The fishermen check an average of 35 nasas in each trip. The traps are located by the fishers in the fishing grounds helped by the use of land marks as reference points.

The position of the traps is identified in situ by the localization and recognition of the buoys they use. The traps have a piece of rope tied to the frame; the length of the rope vary according to the depth of the area in which it is used. At the end of the rope, made of synthetic materials, the fishers tie a plastic buoy, to serve as a floating mark that enables them to locate the traps in the surface of the water. This rope has another one tied about 10 to 15 feet from the main buoy, this one, el perro, the dog, also has a buoy. This device formed by the two buoys serve as a double marker for the localization of the traps, and facilitates the hauling process. The main rope has a length equal to the usual depth of the area, el perro adds few more feet to that length, thus facilitating the localization of the traps when the tide and the currents raise the seawater above the usual depths.

Finding the traps is the most difficult and important task in this type of fishing operation. For their location, the skipper uses land marks and a compass, meanwhile the proel stands high in the fore of the boat looking intensely for the buoys. It is the primary responsibility of the proel to locate them, although the capitan may leave the helm cabin to join the proel in the search. Accuracy and precision in this task saves time, fuel and money. Once the nasas are spotted the skipper helms the vessel slowly to the buoys, while the proel hooks the rope with a gaff, and starts pulling the rope on deck. In this moment the capitan shifts the gear to neutral, leaves the cabin, and helps the proel in tying the rope to the mechanical hauler, which brings the heavy trap and its catch on deck.

An alternative method of placing the traps consists in "drowning them" in the water; that is, to locate them in the bottom without the use of buoys. This traps are placed in sites close to the shoreline, which facilitates the use of land marks. In this operation the traps are set in pairs, each one tied to the other with a 30 feet long rope, or individually, with the trap tied to a weight. Locating the precise under water position with the use of land marks is the only way to find them. Once the site is located, the skipper proceeds to hook the rope with the grappling anchor. The production units using this type of operation use small boats with outboard motors, instead of the bigger vessels due to better maneuvering than can be made with the smaller crafts. The skipper helms the craft with one hand, and with the other he handles the rope with the grappling anchor, dragging it in the bottom, until the rope and the traps are hooked with the anchor. The traps are then hauled on deck with the use of a small gasoline which.

Once on board, the capitan and the proel empty the content of the nasa into a wooden box. The catch is pulled out by hand or with the use of a wooden sweep. The capitan selects those marketable species, and throws back into the water or keeps some in the trap as bait. Some fishermen smash the fish in order to spread the blood and smell in the area to attract other fishes. The most common species captured by the nasas are groupers, snappers, grunts, goatfish, triggerfish, trunkfish, parrotfish, hogfish, squirrel fish and spiny lobster.

Even though some traps are set in the grassbeds, in order to capture migratory schools of groupers and snappers, most of the traps in the west coast capture an assorted variety of species. The fishers are eager and impatient to find out the kind and amount of fish in each trap. One of the great expectations is to see if the trap caught lobsters, which is the item with the highest ex-vessel price in the fishery.

Before World War II lobsters had a low ex-vessel value, the fishers sold the lobsters themselves to clients that ordered them with anticipation, otherwise the were left in the traps. The price per pound was then of one and two cents. In fact, their value was so low that the lobsters were destroyed in the nasas to used them as bait, brought home to form part of the meals served in the fishers' tables or used to feed the pigs. During the war, and afterwards, the number of the United States military bases and troops in the island increased, thus boosting the demand for lobsters and seafood. The island's tourist development also contributed to the accretion in the demand for fish and shellfish. From the 1950s to the present the demand for lobster has been so great that the economic activities in the fisheries have jeopardize the existence of the stocks.

This situation has compelled the Caribbean Fisheries Management Council (CFMC), a program of preservation of the spiny lobster by limiting the capture to those lobsters with a size greater than three inches of carapace, and prohibiting the handling and capture of the "berried" females (with eggs).

In Puerto Real the fishermen are careful in observing the aforementioned regulations. They check that the lobsters have the required size, and if they have a pampana, a large orange mass under the carapace that indicates that the female is about to shed eggs, those lobsters are left untouched in the nasa. The fishermen seem not to resent the regulation, on the contrary, they favor it because they have observed that leaving the lobsters in the trap attract others into it, and also understand that the ultimate goal of the regulation is to replenish the stocks of the fishery.

After a trap is hauled (levantada) it is checked for damages. If the chicken wire panel is broken the fishermen repair it by sewing it with a wire, using pliers. But if the damages concerns the iron rods or if the panel is ruined, the nasa is returned to the harbor. When the minor repairs are finish, the trap is returned to the site if (1) the location is too recent (a week or two) or if (2) if the trap caught a fair amount of fish and lobsters. When a trap fails to catch fish it is moved to another point in the same area, or fishing ground.

The location process follows a random trial pattern which tries to avoid placing it close to other nasas. The proel is responsible for returning the trap to the sea. Accordingly to the capitan selection of the site he procures to throw the nasa in a way that its floor is placed facing the bottom and the entrance (el nasillo) facing up. This is done while the boat is moving to locate other series of traps.

In Puerto Real the trap fishermen locate and divide their arte in two or four different grounds, being two the most common. These nasas are visited on a rate of three days per week, and a fourth if the previous catches were low. The first day, as an example, a Monday, the first series of traps is visited, the next day, a Tuesday, the fishers rest. On Wednesday the second series of traps are visited, Thursday is for rest, and on Friday, the first series are revisited. Those who have more that two series of traps visit them once a week, without any revisitation during the week. A visit during Saturday, or Sunday is optional, and most of the fishers prefer no to sail in those days, if the week catches were good. Fishing more than four or five days a week is considered an aberration. One fisherman in the community, known for fishing almost everyday, is the object of a low keyed criticism and gossip among his peers, and even friends, who view him as a deviant. Indeed he is, he is one of the most successful fishermen in the community and an incipient entrepreneur dealing with fish.

The fishers follow, more or less, a fixed schedule as described above, but the pattern and number of their incursions per week depend on the weather conditions, and the need for cash at home, or the owners' pressure in the market houses. Resting may be a misleading term. By resting it must be understood that the fishers are not visiting the sites or hauling the traps. The "resting" day is usually employed in chores related to their domestic units, and, or related to the maintenance of the vessels and the traps. Alterations in the schedule are also made in order to mislead trap poachers.

Poaching is perhaps the most fundamental concern, in the reality or in the mythology of the trap fishermen, in Puerto Real, and island wide. Fishermen live in an eternal paranoic feeling that their traps are being poached, damaged and stolen by other fishermen. In the history, as well as in the ethnography of fishing in Puerto Rico (Gutiérrez Sánchez 1985) poaching is thought to be the most significant problem that the trap fishermen face. In Puerto Real this is also true, at least in their way of thinking.

For the trap fishermen poaching, and by association, the divers, are considered, along with the high number of <u>nasas</u> in the area, the key problems they face. The divers, both sportsmen and commercial fishers, are considered to be the culprit of the senseless plunder, theft and damage performed to their gear. For them, the divers are no longer hunters and gatherers, they just harvest the catch of the <u>nasas</u>. The rise of a business dealing with the divers' landings is, ideologically, to say the least, a threat to the fishermen, that view the divers as their enemy. In Puerto Real, the conflict between the divers and the fishermen is still underdeveloped due to the recent nature of the diving operations, thus the conflict and opposition permeates their discourse but not yet the social praxis. In a number of fishing communities we visited in our research, these two groups formed political factions that divided their communities.

In the fishery of Puerto Real two trap fishers are marked with a verbal scarlet letter, as poachers. They are despised and anathematized by their peers, friends and relatives. In their ideology, there is nothing more scornful and low than those who prey, as poachers do, on the work of others.

However, trap is a gear which is highly susceptible to be lost in the sea for many reasons. The area in which the traps are set is heavily travelled by sea crafts, thus sometimes the propellers are the culprit for the losses in ropes, and buoys which make the traps be lost forever. Deterioration of the ropes and materials, the strong currents and tides are also liable for the loss in gear and in the catch. This loss of a trap valued in more that 30 dollars is a grand loss for a poor fishermen, who strongly lament it. Nevertheless, according to the fishermen accounts, two fishermen and a diver, in separate occasions, were caught stealing and poaching their traps.

After the traps have been visited and worked, the capitan and the proel head back home. In their return trip to the harbor the capitan allows the proel to helm the craft, thus letting him learn and practice the navigation skills. In the meantime the capitan sorts the catch, and places the lobsters in a sack, which is constantly watered to keep the lobsters alive, and to add some weight. The rest of the catch is placed in wooden boxes and classified as first class (groupers, snappers, hogfish) second class (small groupers and snappers, white grunt and goatfish) and third class or brosa, chaff, (grunts, triggerfish, and small fishes in general). The trunkfish, due to their high value are assembled in a string, and sold separately, with a price similar to that of the lobsters.

The bulk of the traps' yield comprises second and third class fish paid at a ex-vessel value of 0.30 and 0.15 cent the pound. First class fish is cleaned, gutted and scaled, on the trip back. After it has been cleaned, the fish is returned to the wooden boxes and ice is poured over to preserve it. Once this task is finished, the proel and the capitan have a feast with the unfinished portions of the rancho, or food they brought for the trip.

At their arrival to the harbor, the employees of the market to which the unit sells the fish, receive, handle and weigh the landing, and the amount is given to the market's owner or administrator who calculates the amount to be paid to the fishers. The fishermen keep a small fraction of the catch for their consumption, or to distribute it among friends and relatives. In the harbor, few beers are a must before returning back home.

TRAP FISHING AS A KIN-BASED ACTIVITY

In Puerto Real the production units operating sets of traps have three types of crew ties, these are: (1) father and son, (2) in-laws, (3) siblings and (4) friends, being the siblings and father and son the predominant ones. This emphasizes the domestic character of this operation, although none of the siblings share homes.

Viewed in a cyclical and developmental perspective, these production units are first operated by father and son, the son learning the skills to operate the vessels and the arte. For this reason the bond between the father and the son is a close one. The skippers train and teach the proeles, their sons, in the best way they can. They are always giving them instructions, orders, and even scolding them when they do their task wrong. I witnessed several scoldings in which the capitan insisted that the proel had to "be more careful in the chores" and "to be more attentive to the skipper" and harshly encouraged them to "learn as much as you can, even more than I know". The points of the skippers were, in spite of the shame provoked by my presence, well taken by their sons.

In this first, if you will, phase of the life cycle related to trap fishing, the domestic unit, and the father-son-siblings bond is the dominant one. Even though the gears and the vessels are operated by the members of the domestic unit, the father maintains property rights over the gear and boat.

In the use and ownership of traps, more than any other gear, the fishers feature, to certain extent, a fetishist relationship with the objects of their work. The fishermen value high their gear, and in their discourse they speak about "my traps, my gear", instead of our arte de nasas. A factor that contributes to this relationship between the fisher and the gear is that while other gears, nets included, are manufactured in factories, the nasas are the product of their craftsmanship, and the output of the domestic effort, which is highly regarded by the people of Puerto Real.

The rationale of the possessive statements on behalf of the trap fishermen is to assert in the logic of the system that even though the gears and the vessel are worked by the whole domestic unit, they are the absolute owners of the means of production. Their sons will have to earn the ownership rights, which are left to those interested in continuing the fishing endeavors. For the skippers, their sons are perhaps their most precious possession, since they provide cheap labor and fidelity to the production unit, as well as company and partnership for them.

For this reason, the skipper and his wife are indulgent with their sons, providing them with all the goods and facilities that they need, and the parents can afford. The parents maintain them well dressed and clothed, and allow them to go to parties, but at the same time keeping them firmly tied to the domestic rules and loyalties.

The youngsters have the responsibility, while they live at home, and often beyond that residential tie, to help their fathers in fishing and in the repairment of the traps. However, they are not forced to choose fishing as their lifetime occupation, they are free indeed to select other chores. But a number of them select fishing since they have been predisposed by the socialization process to choose it. The sons of several trap fishermen showed a great enthusiasm toward fishing, and many were interested in following their fathers' footsteps, as some in fact did.

With the availability of industrial and commercial jobs in recent years, and the alternative of migration, the youngsters are able to shift, or to choose other occupations, thus leaving their domestic units. But the father-son bond is strong indeed, to the extent that the sons, even as full adults with families of their own, and living in other residences, and in other communities, visit often their fathers and help them in repairing the traps, and sometimes go out to fish with them.

The siblings, once the helpers of their father fishing chores, may become capitan and proel themselves, thus continuing the domestic piscatorial tradition. As a crew, the siblings represent the culmination of the cultural and productive socialization process, and both share the vessels and the gears left in inheritance by their father and other close relatives. In Puerto Real crews composed by siblings are common, all of which are found among trap fishermen.

The strong bond among crew members is not circumscribed to the consanguineal relatives; it is also extended to the affines. In Puerto Real, affinity, and the reciprocal obligations predisposed by the nature of the alliance, have a significant role in their social relationships, as well as in the process of production, and the inheritance of the knowledge and the means of production. In the behavioral aspect of the kinship relations in Puerto Real, people turn to the affines for help and advice, with ease and trust, and their relations are of a great social and personal meaning. The relations among affines are of respect, but also allowing intimacy and relajo, joking among them. The suegros and the cuñados, the father and brothers in-law are, for the man marrying a woman in their household, a source of knowledge, capital, jobs, friendship and partnership.

In the fishery, when a man does not have a son or a close relative working with him in the unit, an affine takes his place, and in the long run obtains, by inheritance, the rights over the means of production. The suegro, the father in-law, plays the role of a putative father in the production unit, for his son in law, and as such teaches him the operation of trap fishing, and navigation. The father and son in-law affinal link is often as strong as the consanguineal tie. In this relation, the skipper substitutes his son for his son in-law, and also improves the well being of their daughters' marriage. It is plausible to contend that affinal relations in the context of the crew ties in the fishery, are the effect of the poverty of capital or labor force, of the domestic units, and the relative richness, in knowledge, labor and capital, that such ties may bring to the households. In other words, one of the economic finalities of the alliance is to strength the production and domestic units (Valdés-Pizzini 1985: in passim).

10.2.7 A total closure of the Nassau grouper fishery is established, until the species is rebuilt to exploitative levels.

No major effects are identified for this measure, since in the CFMC hearings it has been established by the fishermen that the catches of the Nassau grouper are rare, that the resource is scarce, and that it should be protected. No specific social data is available to expand on this particular issue.

10.2.9 Data Collection: Gather catch/effort, length/frequency, as well as any necessary biological and socio-economic information, through the improvement of the existing state-federal agreements formulated by NMFS/PR/USVI and/or Council's own data gathering program.

Information is power, and the fishermen and their representatives have understood this axiom well before the state officials could comprehend it. It is my understanding that the events revolving on the establishment of a marine sanctuary in La Parguera, in the municipality of Lajas in Puerto Rico initiated a grueling process of negotiation for information between the fishermen and the state. Government officials could not come to grips with that fact, and often saw the issue as a blackmail on the fishermen's behalf. (These impressions come from my notes as a marine advisory agent dealing with both groups in Puerto Rico). In the midst of distrust, the fishermen and the fish dealers simply stop providing information to the government on landings and even on the number of fishermen and effort. Thus, reports on effort are often based on projections and adjustment on the data. It has been my contention that the fishermen must be integrated to the process of management. It is perhaps the time for co-management of the fishery resources. In this context information is crucial. State agencies and programs must integrate the fishermen in the process of data collection design. Fishermen will provide valuable information on how the information could be more readily available, the culturally appropriate ways of collecting the data with effectiveness and usefulness for both parties. In doing so, the agencies will benefit from the fishermen's insights, as well as from the political support of a process in which the fishermen participate actively.

The state also has a responsibility in gathering sociocultural data. The Fisheries Laboratory of the Department of Natural Resources has taken the initiative on that process through their census of fishermen and the analysis of effort and social variables (Torres and Matos 1989). Similar efforts, although to a limited scale have been taken by the USVI Division of Fish and Wildlife. These agencies could co-sponsor research efforts or co-design their fact gathering activities with specialists in the social sciences, in order to enhance the results of their efforts. Fact gathering activities which could be co-sponsored and co-designed are: focus groups for the analysis and recommendations of management measures; census of fishermen; survey research project; social sciences internships at the agencies for research activities; and analysis and re-analysis of historical documents on fishery utilization and development (this could include archival information and data on expenditures, landings, prices, development projects, investments on facilities).

10.2.10 To prohibit during the red hind spawning season, from December 1 through February 28, the use of any fishing gear capable of capturing reeffish, such as fish traps, hook and line, bottom nets, and spear, in an area southwest of St. Thomas enclosed by the quadrilateral formed by connecting the following four points in Chart 25641...

No major effects are identified for this measure, since in the CFMC hearings it has been established by the fishermen that the resource is becoming scarce, and that it should be protected. No specific social data is available to expand on this particular issue.

SOCIAL IMPACT ASSESSMENT FOR THE CONCH FISHERY MANAGEMENT PLAN

1. PARTICIPATION IN THE FISHERY

The Conch Fishery Management Plan presents specific measures for which there is no socioeconomic information, except from the Socio-economic Documentation of the Puerto Rican Fishermen (Divers) for the Conch Fishery Management Plan, (Valdés-Pizzini 1989) produced for the CFMC. This fishery, as it was stated in the said report, requires precise socioeconomic information which is not available at the present time. Social science research in the local fisheries grew strong in the early 1980's and targeted the traditional fisheries, and the snapper-grouper fishery. Social science was more interested then in the purely sociological aspects of the labor force, household composition, and formal organizations of the fishing communities, rather than in the management oriented problems, such as effort, competition, and the techno-economic aspects of resource utilization. When these studies (Gutiérrez 1985, Valdés-Pizzini 1985, Gutiérrez et al 1986) were well under way, diving surged as an important fishing operation. Thus, the results from the aforementioned projects did not include much information about these newcomers into the insular traditional fisheries.

Diving is a relatively new type of fishing activity in Puerto Rico, starting in full speed in the 80's, entering in a strong competition with the then dominant gear the traps. As a new process, and one which requires fishing skills (knowledge of fishing areas, species behavior, and navigation skills), it appealed to the young cohorts of the artisanal fishermen. Needless to say, youth is also a requirement due to the physical effort involved in the activity.

In a re-analysis of the Gutiérrez's survey conducted in 1981 we found that almost half (45%) of the divers in the sample (n=17) had other jobs or economic activities to support their households. In the Life-History project in 1988 we found that 80% of the divers had other jobs (n=21). The data suggests that there is a tendency among the divers to have other jobs, or that fishing is not an exclusive economic activity among this type of fishermen.

Although the number of interviews is insufficient to be representative, or to draw any final conclusion, it is safe to assert that divers are becoming more prone toward the traditional practice of occupational multiplicity. A probable explanation is that the scarcity of the resource forces them to seasonally engage in wage labor or in the informal economy, or that in periods in which the market is saturated with shellfish, and dealers are not buying their catch they have to look for other economic opportunities. There is no conclusive data on the aforementioned process, only educated guesses.

Data from the Life-History Project insinuate that diving is not a kin-based activity, in contrast with most gears, specially with gill nets and traps. It is expected, since diving is not part of the traditional assemblage of fishing artes or gears in Puerto Rico and the U.S. Virgin Islands. Only 40% of the divers responded to have family/relatives participation in the fishing (or related) process.

Diving appears as an important fishing activity due to the market demand for fishery "luxury" products, such as conch and lobster, as well as certain highly priced and valued reef fish such as hogfish (capitán).

Information on conflicts between the divers and other resource users is documented in section:

5.3 Competition Among Different Resource Users, Page 69.

2. HISTORY

This is a relatively new fishery, starting to develop late in the 1970's, therefore information is scant. Information on its historical development is available for the community of Puerto Real in Puerto Rico (Valdés Pizzini 1985), and it is reviewed documented in Valdés Pizzini 1989. Further historical notes appear in sections...

3.2 Changes in the Fishery, Page 38.

3. ECONOMICS OF THE FISHERY

No information is available at the present time on the social and cultural aspects of the economics of the divers, except for the information in Valdés Pizzini 1989, summarized in this section.

4. CULTURAL AND SOCIAL ASPECTS OF THE FISHERY

No information is available at the present time on the social and cultural aspects of the divers, except for the information in Valdés Pizzini 1989, summarized in this section.

MANAGEMENT MEASURES AND PROBABLE SOCIAL AND CULTURAL SCENARIOS

6.1 Prohibit harvest from Federal waters around St. Thomas and St.John until January 1, 1993.

There is no conclusive socioeconomic data to comment on this particular measure.

6.2 Establish a size limit for queen conch of nine (9) inches total length.

There is no conclusive socioeconomic data to comment on this particular measure. Fishermen and fishery scientists have noted that in certain areas, such as the east coast, there are morphological differences in the mature conch, and thus 9 inches is not a necessarily appropriate measure. Fishermen favor a shorter measure (8 inches) and allowing the fishermen to select those animals that are mature, looking at other characteristics of sexual maturity that could be visually assessed. In order to be enforceable, a size limit measures needs that the fishermen land the conch in the shell, which poses socioeconomic difficulties for the harvesters. A decrease in income is expected to occur, as they have expressed in public hearings.

6.3 Require that all conch, including queen conch, fighting conch, milk conch and other conch species be landed in the shell.

Divers in Puerto Rico use the traditional yola, or fiber-glass boats ranging from 15 to 21 feet, and outboard motor from 40 to 125 hp. for their fishing activities. In various meetings and activities they have expressed that if the conch is landed in the shell, it would be a cumbersome process, and it would limit their earnings. The diving operation is usually a two or three men operation, with a pilot and two divers extracting the resource. For safety and economic reasons, two divers seem to be the optimal number to operate underwater, although there is no social or economic data to support that assertion. If true, then travelling with three persons and a boat full of shell is not an economically feasible arrangement for the fishermen.

6.4 Prohibit the sale of undersized queen conch and conch shells.

There is no conclusive socioeconomic data to comment on this particular measure. Fishermen view this measure as an appropriate one to protect the resources, as expressed by some in public hearings. Only a handful of fishermen who collect these shells for the "souvenir" market would be affected, but I suspect that in the long run the benefit will outweigh the loss in income, which I assume is quite low, although I do not have any conclusive socioeconomic data on the probable impacts of this measure. Those who sell the shells will also benefit, by selling larger shells. It must be said that there is a consistent extraction of undersize conch and shell by swimmers, beach goers and other recreational resource users who use swimming areas nearby thalassia beds and areas in which juvenile conch roam. Education of conservation efforts among these resource users must also accompany efforts to regulate the commercial fishermen who use the resource.

6.5 Establish a bag limit for personal use fishermen of six (6) queen conch per day per person. A personal use fisherman is anyone who does not have a commercial fishing license or permit.

Although there is no socioeconomic information on possible impacts of this measure, in essence, the measure is an appropriate one in sociopolitical terms, since commercial fishermen see it deserving to share management responsibilities with the "recreational" harvesters of the resource.

It has been stated in this report that fishery management need to assess the participation of resource users, other than those targeted and labelled as primary users (usually, commercial users) of the marine resources. Competition for resources in the area of management includes those who use the marine resources for recreational and aesthetical purposes. It is known that the number of recreational divers is on the rise, and that dive shops are almost "universal" throughout the coastal zone in the Puerto Rico and the U.S. Virgin Islands, with a booming business of diving trips, equipment rental, and courses (Valdés-Pizzini, Gutiérrez and Chaparro 1991). As mentioned in the 1989 report, recreational users target the same species as the small-scale fishermen, and therefore compete with the divers for the extraction of the same resource. Recreational "fishermen" using snorkels, spears, and spearguns as their prefers gear and equipment, compete with the divers for their main species, in Puerto Rico and the U.S. Virgin Island (Griffith et al 1988, Olsen 1979).

6.6 Establish an annual closed season from July 1 to September 30.

There is no conclusive socioeconomic data to comment on this particular measure. Fishermen at public hearings seem to be willing to make concessions on closed seasons to protect the resource, although the period is considered long. More information on this particular measure needs to be collected. Existing data suggest that divers will be forced to enter into other sectors of the economy to support their families, as they seem to be consistently doing at the present time. I expect those who will remain in the fishery to shift gears, mainly hand lines and nets to cover for the closed season. Also, if diving remains as the core method of harvesting, then more pressure will be pressed on the reef fish, and lobster. Again, in a multi-species, multi-gear context of the fishery, fishermen will increase effort in other habitats and gears to compensate loss of income, in the context of lack of incentives for not to do so. A socioeconomic aspect of this measure that needs to be consider is the availability of the product in restaurants and supermarkets during the closure. Are imports, and / or sale of conch banned during the closed season?
That is an important question that need to be addressed, since, not surprisingly, the history of the fishery is often marked by the beatings of the market.

6.7 Require that all commercial fishermen have a permit or license.

There is no conclusive socioeconomic data to comment on this particular measure. However, fishermen in Puerto Rico have a "general" fishing license that allows them to harvest all fishery resources that are not restricted by size, sexual maturity or species.

SOCIAL IMPACT ASSESSMENT FOR THE CORAL FISHERY MANAGEMENT PLAN

At the present time there is no information available on the social, cultural or economic background of those involved in the Coral fishery. This sector appears to be of a recent development, and there is no social science data available on those involved in the fishery. It is possible that some commercial as well as recreational divers are involved in the fishery, thus expanding the resource base that they have exploited "traditionally." Similar to the predicament of the conch fishery, and the shallow-water reeffish fishery, it is possible that the recreational divers are exacting this resource for purely recreational reasons, but this is statement is based on conjecture. It is also possible that some commercial divers have shifted towards this new fishery, but there is no information on that process. It is known that commercial fishermen often engage in the harvesting of certain mollusks to sell as ornaments, but even in this respect the information we have is minimal.

1. PARTICIPATION IN THE FISHERY

No sociocultural information is available at the present time for the Coral FMP.

2. HISTORY

No sociocultural information is available at the present time for the Coral FMP.

3. ECONOMICS OF THE FISHERY

No socioeconomic information is available at the present time for the Coral FMP.

4. CULTURAL AND SOCIAL ASPECTS OF THE FISHERY

No sociocultural information is available at the present time for the Coral FMP.

MANAGEMENT MEASURES AND PROBABLE SOCIAL AND CULTURAL SCENARIOS

No socioeconomic or cultural information is available at the present time for the Coral FMP.

RECOMMENDATIONS

This Social Impact Assessment (Source Document and individual SIA for the FMPs) is major step forward into the integration of socioeconomic information in the FMPs and into the decision making and enforcement process. Clearly, the CFMC have taken the initiative of incorporating the best available data into the management plans. It must be said that the CFMC have also integrated social scientists in the Scientific and Statistical Committee, as well as in the Advisory Panel, thus complying with the spirit of the Magnuson Act on this respect. The CFMC have encouraged research in this particular area by recommending areas of research, stimulating researchers, providing technical help to those interested, supporting current efforts, and revising the goals and objectives of research programs such as the UPR Sea Grant College Program. Given that thrust of the CFMC, it is perhaps appropriate here to provide the council with aa handful of recommendation that could improve the process of utilization of social, cultural and economic information, and to enhance the procedure of the SIA. These are our personal observations and are provided here in good faith, as an interested party in such development:

Development Of Specific Social Impact Assessments For An Specific Fishery. The development of the SIA process should be planned ahead of time, allowing for the appropriate time schedule, research and discussion. The CFMC must have a projection of areas / fisheries / gears that fall in the management goals and objectives of the council. Efforts must be made to encourage researchers, agencies and universities to start early in the assessment of the social factors involved. Specific gears/fishery must be taken at a time. The CFMC has supported with technical help a SIA of the gill net and trammel net fishery in Puerto Rico. This project was supported by NMFS, S-K Funds. Information from that project will serve the CFMC, if this institution is embarked in the management of such gears.

It must be said that scientists from the SSC have warned that the issue of specificity must be critically assessed in the context of a multi-species, multi-gear fishery as the ones in PR/USVI. One gear, or one productive strategy using specific species and gear must be correlated with the concomitant productive strategies of the fishermen. The following specific study is needed:

Social, Cultural and Economic Aspects of the Trap Fishery. Since the Abgrall study cited in this report, and the Valdés Pizzini depictions of the southwest fishery in 1985, the social science literature is lacking of the current patterns of resource utilization, patterns of territoriality, and the economics of the fishery. It is important to understand how these fishermen will respond to changes in the fishery, in order to predict with greater precision the economic impacts on their households, and on the resource base, if shifts in gears are to occur, according to our forecasting.

Social, Cultural and Economic Aspects of the Divers. There is no information on this particular group of resource users. Key aspects of resource utilization such as territoriality, sources of support ashore, political participation (vs individualization), conflicts with other gears (traps and gill nets) historical aspects of the development of this gear, health issues associated with the use of scuba equipment (incidence of bends), mortality rate among divers (diving as an occupational hazard, and a "economic" variable in terms of risks), the market conditions for the fish and shellfish harvested by the divers, and the comparison of the divers with the other resource users.

Assessment of the Participants and Market Structure Associated with the Extraction of Coral. There is an urgent need to start canvasing the basic structure of firms and participants in this fishery.

Integration of Economists and Fisheries Biologists to the Process of SIA. As recommended by the Fricke report on SIA, this process must be an interdisciplinary one, in which specialist from different areas provide their expertise in assessing the key issues of the fishery, and understanding the intricate relationship between the natural resources and the social and cultural structure in which their use is given. Scientists associated with the CFMC have expressed this arguments separately in diverse forums, emphasizing the key need of understanding the sociocultural predicament of resource utilization and the complex political and economic processes that affect their well being. Such conclusion have also been widely discussed at the Fisheries in Crises Conference in St. Thomas, and the Conferencia Sobre El Futuro de Las Pesquerías, in Puerto Rico. The research project on gill nets and trammel nets is an example of such integration, where social anthropologist have worked hand in hand with fisheries biologists in assessing the status of the gear and the resource and social impact of their utilization in Puerto Rico.

One piece missing in this process is the analysis of the economic issues. It is my contention that the CFMC lacks crucial economic information, specially on the structure of the market in both PR/USVI. These are traditional fish markets based on the efforts of the fishermen's households selling the catch, fishermen associations, or intermediaries (ranging from fish peddlers to classical merchants engaging in the proverbial mercantile relations with the fishermen financing production and livelihood). There are regional/cultural differences inter and intra island, related to the names of the species, uses and price structure. In the context of such "traditional" market do operate the forces of change that have slowly transformed the social and market relations displacing traditional actors (such as women), via the technology transfers in transportation, refrigeration and navigation. The state has contributed to that development, paving the road for the intense forces of tourism (internal and external, as it is the case of Puerto Rico) that have increased the demand for fish. Such demand is satisfied, by the three main actors mentioned above, with local production and imports from all over the world. The local fish seller who finances the production of divers and snapper-groupers fishermen also imports lobster tails from New Zealand and snappers from Florida and Venezuela to satisfy demand during the lent season and other peak seasons. These actors compete with the supermarkets and food chains, as well as with other importers and producers for a share of the market. Fishery management cannot continue to assume that there is an absolute process of "tragedy of the commons" caused by the fishermen alone. These are triggered perhaps by the forces of supply and demand, and development. Technical and social analysis of such processes is also in the realm of the economists, and they must have a brighter presence in management in PR/USVI.

Priority to the United States Virgin Islands. Sociocultural, historical and economic information is available for Puerto Rico. However, in preparing this document, as well as in preparing the report on divers for the Conch Fishery Management Plan in 1988 I encountered lack of information on the sociocultural aspects of the fishery. This SIA presents a major effort in repairing such deficiency, by providing a historical approach to the utilization of marine resources. However, the USVI lacks a thorough analysis of the social, cultural and economic aspect of the local fisheries, in the way the Gutiérrez report (1985), or the Torres and Matos (1989) and the Romaguera et al (1987) presented the Puerto Rican fisheries. It is time for the development of a better data base, and for the development of such interest in the local community of social scientists. The Division of Fish and Wildlife and the University of the Virgin Islands have the personnel and the infrastructure to start small projects, with local students and scientists, in the assessment of the sociocultural parameters of the fishery. The University of Puerto Rico Sea Grant College Program could be instrumental in this through its "Seed Money" programs or the Marine Advisory Service, and contacts with the Eastern Caribbean Center, whose director is also a member of the CFMC SSC. The SSC social scientist could serve in the transfer of information and technology for such development, operating as a liaison between these institutions.

<u>References Cited</u>

Adams, John E.
1983 <u>Attitudes Affecting Food Habits: A Study of West Indian Attitudes Toward Fish as a Food</u>. Technical Report Prepared For the Division of Behavioral and Neural Sciences, National Science Foundation, Washington, D.C.

Abgrall, Jean F.
1975 <u>A Cost Production Analysis of Trap and Hand Line Fishing in Puerto Rico</u>. Ph.D. Dissertation, University of Rhode Island.

Beets, Jim
1987 Profile of a Collapsing Fishery: I & V. In <u>Fisheries in Crises</u>. St. Thomas, Conference Proceedings, Government of the United States Virgin Islands, Department of Planning and Natural Resources, and the Fish and Wildlife Division. Dennis Moore, editor.

Berleant-Schiller, Riva
1981 Development Proposals and Small-Scale Fishing in the Caribbean. <u>Human Organization</u>, 40:221-38.

Benoist, Jean, editor
1972 <u>L'Archipel Inacheve: Culture et Societe aux Antilles Francaise</u>. Montreal, Universite' de Montreal, Centre de Recherches Caraibes.

Blay, Federico G.
1972 <u>A Study of Relevance of Selected Ecological factors Related to Water Resources and the Social Organization of Fishing villages in Puerto Rico</u>. Mayaguez, University of Puerto rico Water Research Institute.

Cecil, Robert Gerald
1988 The Heterogeneity of Southeastern Caribbean Inshore Fisheries: A Problem for Industry Wide Development Planning. <u>Caribbean Studies</u>. 21(1-2): 213-231.

Cardona-Bonet, Walter A.
1985 <u>Islotes de Borinquen: Amoné, Abey, Piñas, Sikeo y otros): Notas para su Historia</u>. Oficina Estatal de Preservación Histórica, San Juan.

Chaparro, Ruperto
1989 The Licensing of Marine Recreational Fishermen in the Commonwealth of Puerto Rico. Profesional Papers, Texas A & M.

Chaparro, Ruperto
1992 Developing Strategies to Enhance Charter Boat Fishing Operations in Puerto Rico and the United States Virgin Islands. Final Report Submitted to the National Marine Fisheries Service.

Comitas, Lambros
1962 Fishermen and Cooperation in Rural Jamaica. Ph.D. Dissertation. Columbia University.

CODREMAR
1980 Fisheries and Marine Resources. Final Report on the Coastal Zone Management Program. Department of Natural Resources, The Commonwealth of Puerto Rico, San Juan.

Cordell, John
1989 Introduction: Sea Tenure. In A Sea of Small Boats. J. Cordell ed Cultural Survival Report 26, Cambridge, Mass.

Dibbs, J. L.
1967 Report of a Marketing Study of Two Puerto Rican Fishing Communities UNDP/FAO Caribbean Fisheries, Bridgetown, Barbados.

Fiedler R.H. and Norman D. Jarvis
1932 Fisheries of the Virgin Islands of the United States. Washington, D.C., U.S. Bureau of Fisheries, Investigational Report Number 14.

Fog-Olwig, Karen
1985 Cultural Adaptation and Resistance in St. John: Three Centuries of Afro-Caribbean Life. Gainesville, University of Florida Press.

Fricke, Peter
1992 Guidance for Social Impact Assessment for Marine Fishery Management and Planning. National Marine Fisheries Service Document.

Gordon, Edmund Tayloe
1981 Phases of Development and Underdevelopment in a Caribbean Fishing Village: San Pedro, Belize. Ph.D. Dissertation, Stanford University.

Griffith, David C., Manuel Valdés-Pizzini and Jeffrey Johnson
1992 Injury and Therapy: Trajectories of Proletarianization in the Puerto Rican Fisheries. American Ethnologist. 19(1) 53-74.

Griffith, David C., Manuel Valdés-Pizzini, Jeffrey Johnson
James D. Murray and Ruperto Chaparro
1988 Developing Marine Recreational Fishing in Puerto Rico and the U.S. Virgin Islands. Final Report submitted to the National Marine Fisheries Service.

Griffith, David C. and Manuel Valdés-Pizzini
in preparation Workers in the Sea: Trajectories of Proletarianization Among the Puerto Rican Fishermen. Book in Preparation.

Gutiérrez, Jaime
1985 Caracteristicas Personales y de Trabajo de los Pescadores en Puerto Rico. Research Report, University of Puerto Rico Sea Grant Publications.

Gutierrez, Jaime, Bonnie McCay, and Manuel Valdés-Pizzini
1986 La Pesca Artesanal y las Asociaciones de Pescadores en Puerto Rico Research Report, University of Puerto Rico Sea Grant Publications.

Heine, Jorge and Juan Manuel García Passalacqua
1983 The Puerto Rican Question. New York, Foreign Policy Association, Headline Series.

Highfield, Arnold R.
1979 The Frech Dialect of St. Thomas, Virgin Islands: A Descriptive Grammar with Texts and Glossary. Ann Arbor, Michigan, University Micro-Films

History Task Force (Centro de Estudios Puertorriqueños)
1979 Labor Migration Under Capitalism: The Puerto Rican Experience. New York, Monthly Review Press.

Iñigo, Felix
1968 El Fomento de la Industria Pesquera en Puerto Rico y sus Perspectivas. Agricultura al Día, Puerto Rico, 15(3-4), 116-119.

Jarvis, Norman D.
1932 The Fisheries of Porto Rico. U.S. Department of Commerce, Bureau of Fisheries Investigations Report 13(41).

Johnston, Barbara Rose
1987 The Political Ecology of Development: Changing Resource Relations and the Impacts of Tourism in Saint Thomas, United States Virgin Islands. Ph.D. Dissertation, University of Massachusetts.

Koester, Stephen K.
1985 Socio-economic and Cultural Role of Fishing and Shellfishing in the Virgin Islands Biosphere Reserve. Island Resource Foundation, Saint Thomas, U.S. Virgin Islands.

LaPlace, Joseph
1987 Profile of a Collapsing Fishery: IV. In Fisheries in Crises. St. Thomas, Conference Proceedings, Government of the United States Virgin Islands, Department of Planning and Natural Resources, and the Fish and Wildlife Division. Dennis Moore, editor.

Levy, Joseph
1976 Un Village du Bout du Monde: Modernisation et Structure Villageosie aux Antilles Francaise. Université de Montreal, Centre de Recherches Caraibes.

Maiolo, John L. and Orbach, Michael K.
1982 Modernization and Marine Fisheries Policy. Michigan, Ann Arbor Science.

Matos, Daniel and Zelma Torres
1989 Comprehensive Census of the Fishery of Puerto Rico. CODREMAR, Commonwealth of Puerto Rico, 1(3).

Munro, John L. and Smith, Ian R.
1983 Management strategies in multi-species complexes in artisanal fisheries Proceedings of the Thirty-Six Annual Meetings of the Gulf and Caribbean Fisheries Institute. November.

Olsen, David
1979 Socio-Economic Survey of Recreational Boating and Fishing in the U.S. Virgin Islands. Island Resource Foundation Report to the National Marine Fisheries Service, St. Thomas, U.S. Virgin Islands.

Picó, Rafael
1976 The Geography of Puerto Rico. Chicago, Aldine Publishing Company.

Poggie, John Jr.
1979 Small Scale Fishermen's Beliefs About Success and Development: A Puerto Rican Case. Human Organization, 38: 6-11.

1980 Small-scale Fishermen's Psychological Characteristics and Cooperative Formation. Anthropological Quarterly. 53 (1):20-28.

Pollnac, Richard. B.
1982 Sociocultural Aspects of Technological and Institutional Change among Small-Scale Fishermen. In Modernization and Marine Fisheries Policy, Maiolo and Orbach, editors.

Pratts, Saúl J.
1987 La Política Social en Puerto Rico. Santurce, Jay-Ce Printing.

Price, Richard
1966 Caribbean Fishing and Fishermen: A Historical Sketch. American Anthropology, 68:1363-83.

Romaguera, José M., Pedro Dones and José Vega
1987 Puerto Rico's Fishing Centers: An Assessment for Development. Technical Assistance Study for CODREMAR, The University of Puerto Rico at Mayagüez.

Russell, Susan D. and Maritsa Poopetch
1991 Petty Commodity Fishermen in the Inner Gulf of Thailand. Human Organization, 49(2): 174-187.

Steward, Julian H., Robert A. Manners, Eric R. Wolf,
Sidney Mintz, Elena Padilla Seda and Raymond L. Scheele
1956 The People of Puerto Rico. Urbana, The University of Illinois Press.

Stoffle, Richard W.
1986 Caribbean Fishermen Farmers: A Social Assessment of Smithsonian King Crab Mariculture. Research Report Series, Institute for Social Research, The University of Michigan.

Suárez-Caabro, José A.
1979 El Mar de Puerto Rico: Introducción a las Pesquerías de la Isla. Rio Piedras, Editorial Universitaria.

Tobias, William
1987 Profile of a Collapsing Fishery: II. Fisheries in Crises. St. Thomas, Conference Proceedings, Government of the United States Virgin Islands, Department of Planning and Natural Resources, and the Fish and Wildlife Division. Dennis Moore, editor.

Valdés-Pizzini, Manuel
1985 Social Relations of Production in Puerto de la Corona: Capitalism and Development in the Puerto Rican Fisheries. Ph.D. Dissertation, S.U.N.Y. at Stony Brook.

1987 Apuntes Sobre el Desarrollo Histórico de la Pesca en Puerto Rico. University of Puerto Rico Sea Grant Publications.

1990a Etnología Crítica del Trabajo en las Pesquerías de Puerto Rico y el Caribe Insular. Caribbean Studies, 23(1-2).

1990b Fishermen Associations in Puerto Rico: Praxis and Discourse in the Politics of Fishing. Human Organization, 49 (2): 164-173.

1990c Understanding Commercial-Recreational Fishermen User Conflicts in Puerto Rico and the United States Virgin Islands: Extension Approaches Toward Mitigation and Resolution. Final Report submitted to the National Marine Fisheries Service, St. Petersburg, Florida.

forthcoming "Amarrados a la Nevera": Construcción Etnográfica de los Procesos de Formación de Clase en la Pesquería de Puerto Real.

Valdés-Pizzini, M., J. Gutiérrez Sánchez and Ruperto Chaparro.
1991 In Support of Marine Recreational Fishing: An Assessment of Access and Infrastructure in Puerto Rico and the U.S. Virgin Islands. Mayagüez, UPRSGCP, Research Report, PRU-T-91-001, Project No. NA86-WC-H-06109.

Valdés-Pizzini, Manuel, Alejandro Acosta, Mervin Ruíz and David C. Griffith

1992 Assessment of the Socioeconomic Impact of Fishery Management Options Upon Gill Nets and Trammel Nets Fishermen in Puerto Rico. Final Report Submitted to the National Marine Fisheries Service.

Vélez, Martín, J. Díaz Pacheco, and P.B. Vázquez Calcerrada
1945 La Pesca y la Distribución de Pescado en Puerto Rico. Estación Experimental Agrícola, Universidad de Puerto Rico, Rio Piedras, Boletín Número 66.

Weiler, Deborah and José Suárez-Caabro
1980 Overview of Puerto Rico's Small-Scale Fisheries Statistics: 1972-1978. CODREMAR, 1(1).

APPENDIX V

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

L. APPENDIX I -- TABLES AND FIGURES

A. COVER SHEET

Final Supplemental Environmental Impact Statement (FSEIS)

Responsible Agency
Caribbean Fishery Management Council

Cooperating Agency
National Marine Fisheries Service

Title of Action
Amendment 2 to the Fishery Management Plan for the Shallow-Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (FMP)

Contact Person

Sr. Miguel Rolon, Executive Director
Caribbean Fishery Management Council
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Designation of the Statement

Final Supplemental Environmental Impact Statement

Abstract

The actions adopted by the Council incorporate important components of the deep-water reef fish fishery and the marine aquarium trade into the management unit described in the FMP. This action would add approximately 120 species to the management unit that currently contains 64 species. Comments on the DSEIS generally supported the adopted management measures which, among other things, prohibit certain destructive harvesting practices in the marine aquarium fishery (described under Adopted Measure 4); prohibit the harvest of certain declining or overfished resources, such as jewfish; recommend a permitting and reporting system by local governments; close two additional aggregation areas during the red hind spawning season and another during the mutton snapper spawning season to all fishing; support the designation of marine coral reef reserves; and recommend that the local governments prohibit the introduction of exotics in marine waters. However, several commenters opposed portions of the fish trap regulations, and the boundaries of one of the red hind spawning aggregation areas; this led the Council to adopt management measures that addressed their concerns.

A large number of juvenile reef fishes and other small reef-associated species are taken by the marine aquarium trade industry. A decline in abundance has been noted for some of the more desirable species in certain localities. The ecological

effects of their removal are unknown. Public testimony indicated that some of the gears currently or traditionally used for collecting marine aquarium fishes have the potential for deleterious effects on the fishery resource, its habitat, or both. One of the most popular methods of collection is by the use of chemical substances, the most common of which is quinaldine. Fishermen reported higher mortality rates of fish taken using quinaldine than for those collected using other methods. The use of other chemical agents, such as bleach, formalin, and gasoline for collecting marine aquarium fishes has been reported from various areas, and all are prohibited because of their potentially toxic effects on marine organisms, including corals. The use of explosives and chemical substances is currently prohibited by the shallow-water reef fish regulations that likewise apply to this fishery by amendment. Amendment 2 prohibits drop nets, gill nets, and small mesh fish traps and other gears traditionally used to harvest marine aquarium fishes, and that have a potential for damaging the reef resources.

The physical environment currently is adversely affected by the fishery; these effects should be reduced by the adopted actions. The fisheries currently provide benefits to its participants; however, these benefits would be reduced should continued growth of the fishery cause depletion of the resource. Short-term impacts on the user groups may be associated with the imposition of harvest restrictions designed to: (1) rebuild declining resources, and (2) curtail growth of the fisheries until limited access programs can be instituted under a subsequent amendment.

Comment Due Date

Comments on the statement must be received by: SEP 07 1993

The Final Supplemental Environmental Impact Statement (FSEIS) incorporates sections of Amendment 2 to the Fishery Management Plan for the Shallow-Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (FMP), as referenced. This document augments the EIS prepared for the FMP.

C. SUMMARY OF AMENDMENT 2

Amendment 2 to the Fishery Management Plan for the Shallow-Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (FMP), prepared by the Caribbean Fishery Management Council (Council) under the authority of the Magnuson Act, would incorporate important components of the deep-water reef fish fishery and the marine aquarium trade into the management unit described in the FMP. Since two fisheries and approximately 120 species would be added to the management unit (currently containing 64 species), the FMP would be retitled to include all reef fishes. Other management measures would restrict the collection of marine aquarium fishes to hand-held dip nets and slurp guns; specify that fish traps be constructed with two escape openings, utilizing wire panels and certain degradable fasteners; prohibit the harvest or possession of jewfish in the management area; prohibit the harvest of specified marine aquarium fishes; close additional red hind aggregation areas during the December through February spawning season; prohibit the harvest of mutton snapper in a spawning aggregation area off St. Croix from March 1 through June 30 of each year; recommend that the local governments issue annual permits for the sale of fish taken in federal or local waters, and require harvest reports; recommend that the local government monitor a spawning aggregation area for tiger grouper in waters near Vieques Island; recommend future designation of marine coral reef reserves at strategic locations; recommend that the local governments prohibit the unauthorized introduction of exotic species into marine waters; and recommend that local governments monitor the landings of red grouper to determine its status and need for protective action.

D. PURPOSE AND NEED FOR ACTIONS

The actions proposed in Amendment 2 address continuing and growing concerns by the Council over scarce resources, the need to protect important species when they aggregate for spawning, and the need to extend protection to other reef-associated species not presently in the management unit. Of some 350 species of shallow-water reef fish in the Caribbean, about 180 are landed throughout the region and collectively comprise the most important fishery in the islands. The management unit currently includes the 64 most commonly landed species that dominate the catch from the shoreline to the edge of the insular platform. At greater depths at the edge of the platform, another fishery occurs -- the deep-water reef fish fishery.

Initially, the Council anticipated developing a separate FMP for the deep-water reef fish complex; however, the Council decided that it would be more practicable and economical to incorporate those species into a single management unit for all reef fish. Distribution of some of the species overlaps with the shallow-water reef fishes, although they are more abundant as adults in deeper waters. Restrictive measures are not envisioned initially for deep-water species due to lack of data on the status of their populations; however, including them in the management unit permits regulatory action if necessary.

A large number of juvenile reef fishes and other small reef-associated species are taken by the marine aquarium industry. A decline in abundance has been noted for some of the more desirable species in certain localities. The ecological effects of their removal are unknown, and some of the most widely used collecting methods employ chemicals that damage the reef habitat and inflict mortality upon associated fishes and invertebrates. Expanding the management unit to include marine aquarium species would obviate the need for another separate FMP and provide a mechanism to initially manage this select group of fishes under the existing drug and chemical harvest restriction. Harvest of certain species either could be regulated or prohibited as necessary. These adjustments would require changing the title of the FMP, expanding the management unit, and updating the FMP to describe the fisheries incorporated. Marine aquarium invertebrate species will be included in the Coral FMP, which currently is under development.

Following collapse of the Nassau grouper resource, the red hind became an important species in the fishery; however, statistics show a decrease in the number of young fish in the population as concluded by the Stock Assessment Group. Whenever possible, the Council relies upon closing aggregation sites during spawning seasons to enhance reproductive capacity. Most species that aggregate during the spawning season are highly vulnerable to capture at that time. Allowing mature individuals the opportunity to spawn is important to reverse declines in abundance. Even some fishermen have requested closure of spawning aggregation areas for red hind. A spawning aggregation area off St. Thomas, described and closed during the 1989-90 spawning season (December-February) by emergency action, has been closed during each successive spawning season under Amendment 1. Two additional red hind spawning areas are being considered for closure under Amendment 2.

A pronounced decline in the abundance of jewfish has been noted throughout the management area and may extend throughout the Caribbean Basin. Similar declines in the Gulf of Mexico and off the south Atlantic coast of the U.S. led to a total prohibition on jewfish harvest in those areas. The Council believes that the jewfish should be protected throughout its range. The species appears to be scarce wherever it occurs and has unique biological characteristics that make it highly susceptible to overfishing. The U.S. Virgin Islands government has listed jewfish as a protected species, and prohibits its take in Territorial waters.

The basic objectives of the FMP are unchanged by this amendment, except they are extended to maintain deep-water reef fishes and marine aquarium fishes at levels that sustain adequate recruitment to replenish the populations. The local governments are requested to institute mandatory permitting and reporting requirements for fishing in both state and federal waters to obtain data on catch/effort relationships of species in the management unit. These data would be used to assess stocks, monitor population trends, and to restore and maintain stocks at optimum levels. Permits also would provide a sampling universe in the event some type of limited access program is considered for the future. Information collection on the marine aquarium trade should be expanded through the Puerto Rico Department of Natural Resources to obtain data on exports from Aquadilla and Ponce airports.

E. ALTERNATIVES INCLUDING ADOPTED ACTIONS

While a multitude of management alternatives are available, those viewed by the Council as either impractical or of little benefit were not subjected to further consideration. For example, size limits inflict high rates of release mortality on undersized fish, thereby adversely impacting both the human sector and the rebuilding effort; accordingly, the Council rejected this approach in favor of site-specific spawning aggregation closures.

E.1. Description of the Adopted Actions

Some of the management measures taken to public hearing were either rejected by the Council or modified as recommendations to the local governments; these were analyzed and available for public comment in the DSEIS. The following discussion is limited to alternatives adopted by the Council.

Adopted Measure 1. Expand the management unit to include the most important components of the deep-water reef fish fishery.

Including these species in the management unit will allow the Council to take appropriate management actions as necessary to conserve or restore important components of the resource. Inclusion of the deep-water species is a procedural change that in itself offers no impact on the deep-water environment. However, managing the deep-water complex, by offering the possibility for appropriate management action on a timely basis, indirectly will affect the status of the resource. Additional rationale and background for this action is found in Amendment 2, Section III (A). Table 1A, Appendix I, provides a complete listing of the revised management unit depicting the overlap of deep-water and shallow-water species. Although the action would add only 14 species to the management unit, the deep-water fishery includes one of the most valuable reef species, the silk snapper, which may already border on growth overfishing. Others, such as red grouper (Epinephelus morio) and tiger grouper (Mycteroperca tigris), are certainly candidates for management action, but the condition of the stocks presently is undetermined.

Adopted Measure 2. Expand the management unit to include marine aquarium fishes.

The number of individuals of key species harvested by the marine aquarium trade appears to be declining. However, the aquarium trade fishery is not specifically regulated, and the Council determined that the important aquarium fish species listed in Amendment 2 should be added to the management unit, to allow future regulation as appropriate. A listing of the additional species was obtained from a preliminary description of the marine aquarium trade, compiled by the Puerto Rico Department of Natural Resources, Fisheries Research Laboratory, for the Council (Sadovy, 1991). That report provides a description of the marine aquarium trade in Puerto Rico, the U.S. Virgin Islands, and other areas, including harvest methods, collection areas, handling and shipping, as well as a description and list of the most commonly collected species (Table 2A, Appendix I). The report was used as a source document for the management options considered. Additional background information is provided in Amendment 2, Section III(A). The amendment currently contains a number of interim measures to curtail effort and destructive harvest methods until the data base can be generated to support a limited access program. Additional discussion of limited entry is deferred until the Council proposes and analyzes such a system under a future FMP amendment.

Adopted Measure 3. Retitle FMP to encompass the reef fish management unit.

Since the management unit has been enlarged to include fishes other than shallow-water reef fish, the Council suggests the document be retitled, "Fishery Management Plan for Reef Fishes of Puerto Rico and the U.S. Virgin Islands." This title accurately describes the fisheries for shallow-water reef fish, deep-water reef fish, and marine aquarium fishes. There are no direct economic impacts on fishery participants, resource or physical environment associated with changing the title of the FMP. However, social benefits would result from dispelling the confusion that might be incurred to managers and, more importantly, to fishermen responsible for conforming to the regulatory program tailored to conserve reef resources.

Adopted Measure 4. Restrict the collection of marine aquarium fishes to hand-held dip nets and slurp guns.

The most frequent collecting gears are nets (barrier, gill, drop or cast nets, and dip nets), small mesh (1/4 - 1/2 inch) fish traps, slurp guns, and chemicals, such as "Quinaldine" (2-methyl-quinoline), chlorine, formaldehyde, and gasoline. Although the long- and short-term effects on reefs and associated organisms of using quinaldine to stun fish are inconclusive, many dealers are reluctant to purchase fish taken by this method because mortality rates appear higher than with fish collected using other methods. Public testimony (except for one commenter who advocated barrier nets) indicated a distinct potential for excessive fishing mortality and habitat damage associated with these gear types. Restricting the collection of marine aquarium organisms to hand-held dip nets and slurp guns will reduce this potential. The FMP currently bans the use of noxious chemicals and small-mesh fish traps for managed species. Adding the aquarium trade species to the management unit (thereby applying the FMP's regulation) in effect prohibits those gears in the marine aquarium fishery.

The use of nets currently is not restricted by the FMP. Exclusion of nets (other than hand-held dip nets) from the fishery is necessary at this time, primarily because the gear reportedly has potential for damaging the diminishing reef habitat. Specification of allowable gear (slurp guns, hand-held dip nets) makes this change and also eliminates the possibility of other more destructive gear being developed and introduced into the fishery.

Adopted Measure 5. Require that fish traps be constructed of 1.5-inch hexagonal or 2.0-inch square mesh wire with two escape openings at least 8 x 8 inches square on any two sides of the trap (except top, bottom or side containing the funnel). The openings must be covered with panels of mesh at least equivalent to that of which the trap is constructed, and fastened with either untreated jute twine up to 1/8 inches in diameter (if zinc anodes are used) or 18 gauge ungalvanized iron wire or 1/8 inch untreated jute twine (maximum diameter) if anodes are not used.

The existing fish trap construction requirements specify that escape openings be located on two opposing sides of a trap (excluding the top, bottom, and side with funnel). However, information from fishermen indicated that the panel opposite the side where the bridle is attached may inadvertently open upon retrieval, thereby releasing the catch prematurely. In response to industry concerns, the action allows a choice of sides for locating the escape openings.

Existing regulations also require that the door and escape panels be fastened with untreated jute twine 1/8-inch or less in diameter. Acceptable rates of degradation in seawater were shown for jute twine, thereby allowing the lost or abandoned trap to open in a reasonable time frame. Fishermen felt that this requirement is burdensome because of the amount of time required to retie the fastenings upon retrieval of a trap, and suggested 18 gauge ungalvanized wire as an alternative material that could be replaced more quickly than jute.

Zinc anodes, however, are used on many traps to prevent corrosion, thereby extending the life span of wire fasteners. Traps using zinc anodes, if lost or abandoned, could fail to open after an acceptable period of time. Their continued fishing, over time, is a source of excessive fishing mortality ("ghost fishing"). Wires of various sizes and compositions were not tested by the Council.

The FMP provides for a conversion from 1.5-inch square mesh wire to a minimum size of 2.0-inch square mesh wire in fish traps by September 14, 1993. This action is supported by studies conducted during the interim rule making period in waters off Puerto Rico (Appeldoorn and Posada, 1992). Hexagonal mesh wire of 1.5 inches may continue to be used in trap construction after this date. The Council concluded that the conversion to 2.0-inch square mesh on September 14 would reduce resource waste through excessive mortality to small or juvenile reef fishes as compared to the use of 1.5-inch square mesh wire for traps. Fishermen contended jute twine is overly burdensome because of the amount of time required to retie the fastenings each time a trap is hauled, and recommended allowing alternative wire fastening materials. The use of 18 gauge ungalvanized wire on traps without anodes, while not adequately studied, was adopted by the Council to address the concerns raised by those fishermen.

Adopted Measure 6. Prohibit the harvest or possession of jewfish in waters around Puerto Rico and the U.S. Virgin Islands.

Jewfish occur off both coasts of Florida, throughout the Gulf of Mexico and the Greater Antilles, and along the southwestern Caribbean coast (FAO, 1978). A disjunct population also occurs along the Pacific coast from Costa Rica to Peru. The species appears to be no longer abundant anywhere within its range. A pronounced decline in the abundance of jewfish has been noted within the management area and may extend throughout the Caribbean Basin. The U.S. Virgin Islands government has listed jewfish as a protected species, and prohibits its take in Territorial waters.

Jewfish are highly residential and grow upwards of seven feet and 700 pounds, which makes them prime targets for spearfishing. The unusual size and appearance add aesthetic appeal for underwater photographers and divers. Since the jewfish is a slow-growing and late-maturing fish, recovery from overfishing likely would require many years. These characteristics, coupled with a relatively low density throughout their range, make jewfish highly susceptible to overfishing. The action would be consistent with protection of jewfish by the U.S. Virgin Islands government and in the southeastern United States.

Adopted Measure 7. Prohibit the harvest of certain marine aquarium fishes.

The status of many species of marine aquarium fishes has not been determined, but some are uncommon while others are heavily exploited without restriction. All marine aquarium fishes will benefit from the gear restrictions contained in this amendment.

Because of the intensifying and uncontrolled harvest of marine aquarium fishes in Puerto Rico, and based on experiences elsewhere, there is a need to regulate this fishery. By adding marine aquarium fishes to the Shallow-Water Reef Fish FMP, the harvest and possession of the young of species that presently are in a rebuilding mode would be subject to prohibition until those resources have recovered. This group currently includes red hind and mutton snapper.

A number of criteria were examined in selecting species to be precluded from harvest in the marine aquarium trade, whereby the Council considered inclusion of species that are: (1) locally rare and therefore potentially vulnerable to harvest for the aquarium trade; (2) harvested either recreationally or commercially as food fish in other fisheries; (3) considered unsuited for the aquarium trade because they do not survive well in captivity; and (4) of more value to the habitat than if harvested.

Finally, a number of species that are targeted heavily for the aquarium trade should be assessed in terms of stock condition. These species include royal gramma, *Gramma loreto*, rock beauty, *Holacanthus tricolor*, yellowhead jawfish, *Opistognathus aurifrons*, french angelfish, *Pomacanthus paru*, queen angelfish, *Holacanthus ciliaris*, pygmy angelfish, *Centropyge argi*, bluehead wrasse, *Thalassoma bifasciatum*, puddingwife wrasse, *Halichoeres radiatus*, blue chromis, *Chromis cyanea*, and red-lipped blenny, *Ophioblennius atlanticus*.

Accordingly, prohibiting harvest of the following species initially is proposed for the marine aquarium trade.

seahorses - *Hippocampus* spp.
red hind - *Epinephelus guttatus*
mutton snapper - *Lutjanus analis*
foureye butterflyfish - *Chaetodon capistratus*
banded butterflyfish - *C. striatus*
longsnout butterflyfish - *C. aculeatus*

Other species may be added as vital information is gathered from stock assessments generated by research and the reporting system recommended as part of this amendment.

Adopted Measure 8. Closure of additional red hind aggregation areas during the December through February spawning season.

During the spawning season, some species of reef fishes are aggressive and extremely vulnerable to capture. Many larger fishing vessels have the capacity to efficiently harvest and deplete fish populations aggregated for spawning. Protecting spawning aggregations is a biologically sound management practice preferred by the Council over other approaches, such as size limits that inflict high rates of release mortality on undersized fish, or labor-intensive quota management and monitoring. Because aggregating fish are highly susceptible to capture by a wide range of gears (hook and line, trap, spears, etc.), a total ban on use of gear capable of taking the species is necessary to protect spawning aggregations.

There is a body of thought that fishing on spawning aggregations may reduce spawning capability to a degree that exceeds the effect of removing the spawners. This effect is thought to result from a disruption of the species social structure (Shapiro, et al., in press) and would indicate that any given number of females of spawning age taken during spawning times would be more valuable than an equal number of females taken during non-spawning periods.

The proposed amendment does not contain details on the importance of these red hind spawning areas (i.e., there is no description of the percent of spawners represented by these aggregations or where the new individuals are eventually recruited). However, there appears to be some agreement among those with knowledge of the fishery that these closures almost surely will result in a trend toward some stock recovery or at least a slowing of the present rate of stock decline. This should lead to benefits from the closures, even if total fishing effort does not change. The reason that total effort may not change is that fishermen may elect to fish adjacent areas. Even if this occurs, additional effort in other areas may not significantly alter the total catch of fish because the present level of effort may be so high that increases (or decreases) will offer no significant effects.

Relocation of effort does have possible adverse consequences that are not related to the total catch of fish. One consequence is that any potential gains from reduced mortality of undersized fish in the spawning closure areas will be offset by increased juvenile mortality in other areas. A second possible problem is that the fishermen may have knowledge of "second-best" spawning aggregations, and effort simply may be relocated to other spawning aggregations. If this happens, then most of the potential benefits from the closure would be lost through "damage" to these other concentrations of red hind spawners. Regardless of potential disadvantages of the relocation in fishing effort, there appears to be some consensus that there are biological benefits that derive from allowing a "rest period" for any heavily fished area.

The red hind is recently declining in abundance and aggregates to spawn between December 1 through February 28. A red hind aggregation area in the EEZ southwest of St. Thomas was closed during the spawning season in 1989 in response to requests from fishermen and fishery scientists. At that time, no other red hind spawning areas had been delineated. The Council has since identified two additional red hind spawning aggregation sites and a closure is included in Amendment 2 to guard against further declines in the resource.

The first area, designated as Tourmaline Bank, lies in federal waters off the west end of Puerto Rico, and, based on historic productivity, covers approximately fifteen square miles. The area is shown in Fig. 1, Appendix I. Another red hind spawning aggregation area has been identified in the EEZ east of St. Croix, U.S. Virgin Islands, at the extreme eastern end of Lang Bank. Based on public comments, the area was reduced in size to more accurately reflect the actual aggregation area (as depicted in Fig. 2).

Adopted Measure 9. Prohibit the harvest of mutton snapper in a spawning aggregation area off St. Croix from March through June of each year.

Mutton snapper, typically taken in insular shelf waters by hook and line and fish traps, form large spawning aggregations near the time of the full moon from March through June (Tobias, 1986). As described for red hind (Measure 8), spawning individuals are extremely vulnerable to capture by a wide variety of gears; commercial landings data indicates a decline in mutton snapper catch-per-unit-of-effort. Accordingly, a total ban on fishing in the identified area of spawning would serve to protect the mutton snapper resource.

A mutton snapper spawning aggregation area recently has been identified in the EEZ off the southwest coast of St. Croix (Fig. 3). In keeping with the Council's preferences for controlling harvest in spawning aggregation areas, the U.S. Virgin Islands, Division of Fish and Wildlife, has recommended that the area be closed to all fishing from March 1 through June 30 of each year to protect the species. Such a ban is expected to affect the human environment, to the extent that the local economy depends on fishing in the aggregation area during the spawning season.

E.2. Evaluation of the Adopted Actions

E.2.a. Evaluation Relative to the National Standards

The seven National Standards are specified in the Magnuson Act. As detailed in this document, the various preferred options adhere to the National Standards which, among other requirements, specifies that measures prevent overfishing while achieving optimum yield from the fishery. Further information on compliance with the various National Standards is found throughout Amendment 2.

E.3. Rejected Alternatives to the Adopted Actions

Rejected Measure 1A. Do not incorporate deep-water reef fishes into the management unit (status quo).

Rejected Measure 1B. Develop a separate plan for managing the deep-water reef fish fishery.

Species that are not included in an FMP cannot be managed under the Magnuson Act. Therefore, in the event that problems develop with unmanaged species in the deep-water reef fish complex, substantial biomass decline and losses to fishermen could accrue before corrective action would be possible.

Development of a separate FMP, as suggested by several commenters, requires additional public input and preparation, and therefore could take two years or more. Time lags in management translate into monetary losses to fishermen in the long term. Such delays in implementation of appropriate management measures could significantly increase the amount of time required for resource recovery. Development of a separate FMP also would incur considerable expenditures by the Council and Federal government. Accordingly, Measures 1A and 1B would significantly impact both the deep-water reef fish resource and, in turn, the human environment, and, for these reasons, were rejected by the Council.

Rejected Measure 2A. Develop a separate FMP for marine aquarium organisms.

Initially, the Council anticipated developing a separate FMP for the deep-water reef fish complex and marine aquarium fishes. However, the basic problem with separate FMP's for reef fish and marine aquarium organisms is that many of the species overlap both fisheries, either as adults and juveniles, and thus could fall under contradictory management programs. Amendment of one FMP may require amendment of the other as well to avoid incompatible management measures, thereby increasing associated costs substantially. The likelihood of this is reduced under a single FMP. Accordingly, the Council later decided that it would be more practicable and economical to incorporate those species into a single management unit for all reef fish. While this rejected option is administrative in nature and does not in itself have any environmental impact, the unnecessary delays and expense of developing a new FMP may deter effective management and ultimately impact the status of the resource.

Rejected Measure 2B. Do not incorporate marine aquarium fishes into the management unit (status quo.)

This alternative would not be responsive to the needs of the marine aquarium fishery because it would allow indiscriminate harvest of limited resources and damage of the habitat to continue. Allowing indiscriminate harvest and habitat damage ultimately impacts those who rely upon the resource to sustain their livelihood. If resources are not protected, competitive harvest most likely will continue until it is no longer economically feasible. Other users, such as tourist dive-boat operations, also could be impacted by overexploitation and habitat damage. Consequently, this option (no management of marine aquarium trade) could significantly impact both the resource and the human environment.

Rejected Measure 3A. No action -- retain current title of FMP.

Retaining an inaccurate title for an FMP is an administrative change that could confuse managers and, more importantly, the fishermen responsible for conforming to the FMP's regulations. Otherwise, neither this action (status quo) or Adopted Measure 3 (changing the FMP's title), by themselves, would affect the human environment or status of the resource.

Rejected Measure 4A. Allow the collection of marine aquarium fishes by all gear types currently deployed in the fishery (status quo).

According to public testimony to the Council, some of the gears currently or traditionally used for collecting marine aquarium fishes damage either the resource, its habitat, or both. Perhaps the most popular method of collection is by the use of chemical substances, the most common of which is quinaldine -- a coal tar derivative used in the manufacture of dyes and explosives. Quinaldine, when used to stun fish, reportedly causes higher rates of fishing mortality compared to other techniques. Fishermen have reported local use of other chemical agents (including bleach, formalin, and gasoline) for collecting marine aquarium fishes; all of which are toxic to various forms of marine life. The use of chemical substances and explosives is currently prohibited by the shallow-water reef fish regulations that likewise would apply to this fishery by amendment.

Cast nets (drop nets), barrier nets (gill nets), and specialized small mesh fish traps are other gears traditionally used to harvest marine aquarium fishes. Small mesh fish traps are already prohibited under existing minimum mesh-size regulations. Although the extent of net damage to reefs cannot be quantified, the potential for damage is generally recognized. However, there are no specific studies available to support such contentions.

Rejected Measure 5A. Require only one escape panel, which should be the access door, made of 2-inch square mesh wire fastened with 18 gauge ungalvanized iron wire and located on one side of the trap. The door should be hinged at the bottom and cover an opening of no less than 8 x 8 inches.

This option is supported by the fishermen and the Council AP over current measures and the adopted measure (Measure 5), which both include a requirement for two escape panels. However, a lost trap might be positioned so that a single panel would be obstructed or incapacitated in such a way that it would not allow fish to escape. Two escape panels (one of which may be the access door) provide more assurance against this possibility, thereby reducing the chances of ghost fishing. The resulting benefits to the resource should outweigh any inconvenience to the industry. Accordingly, the Council rejected this single-door alternative in favor of Option 5.

Rejected Measure 5B. Retain current restrictions for fish traps (status quo).

Continuation of existing requirements (no action) would prevent allowance of a choice of sides for locating the escape openings and a choice between two fastening materials. In this regard, status quo could cause more inconvenience and economic impacts on the human environment. Adopted Option 5 specifies the minimum size of the escape opening and the material and mesh size of the panels and, depending on the type of wire from which the trap is constructed, is more restrictive than status quo.

More importantly, both current regulations and the preferred option address the concerns associated with excessive fishing mortality from continued ghost fishing. Those concerns are resolved by requirements that enhance the escapement of fishes from lost traps through the strategic location of panels and degradation of fasteners within a reasonable time frame. However, legitimate concerns have surfaced regarding placement of the escape openings on opposite sides of a trap, and the continued use of 1.5-inch square mesh wire (see discussion under Preferred Measure 5). Basically, the location of escape openings on opposite sides of a trap can trigger the release of fish prematurely by pressure from the weight against a panel during hauling. Also, additional studies to evaluate size composition of species in the catch by various mesh-sized traps generally supported the efforts of other researchers, and indicated that 2.0-inch square mesh would result in the release of substantially greater numbers of small or juvenile fishes as contrasted to 1.5-inch square mesh (Appeldoorn and Posada, 1992).

Rejected Measure 6A. Allow the unrestricted harvest of jewfish (status quo).

Although data are inadequate for a stock assessment, the species reportedly is so scarce that sufficient data likely will never be available. Allowing continued harvest could result in the reduction of the jewfish population to a level that would require an unusually extensive time period for recovery, or result in displacement of the species altogether. This option, while minimizing impacts to the human sector dependent on jewfish for income, certainly would not be responsive to the needs of this unique resource.

Rejected Measure 7A. Only harvest and possession prohibitions on food species and those protected by ancillary restrictions would apply to the marine aquarium trade (status quo).

While some species of marine aquarium fishes are abundant, certain species are uncommon and may be highly susceptible to overharvest. This alternative would not provide the protection this latter group deserves. It is possible that some species are already overfished while others may provide greater benefits as components of the reef ecosystem rather than being harvested. Often species in short supply are in great demand; therefore, conservation measures are needed to guard against further decline and to protect the interests of collectors/exporters dependent upon these resources for their livelihood. As currently expressed, the no-action alternative would protect only the young of prohibited species (i.e., Nassau grouper and jewfish), and to a large degree basslets (genus Liopropoma) that appear to be most susceptible to harvest by chemicals that are prohibited under the FMP.

Rejected Measure 8A. Do not close additional red hind spawning aggregation areas during the December through February spawning season.

Leaving the identified areas unprotected from intensive fishing effort could lead to the demise of the spawning aggregations, and declines in local abundance, at least to the extent that local populations of red hind are dependent on these aggregations. As detailed elsewhere in the document, this option (no action) definitely would contribute to a continued decline of the red hind resource, thereby leading to negative impacts on the industry. According to the most recent stock assessment (Appeldoorn, et al., 1992) red hind may already be recruitment overfished.

Rejected Measure 9A. Status quo -- Do not prohibit the harvest of mutton snapper in a spawning aggregation area off St. Croix from March 1 through June 30 of each year.

The vulnerability of mutton snapper to harvest when aggregated for spawning (as described elsewhere in the document) has prompted the curtailment of fishing activity during the spawning season in waters under the jurisdiction of the South Atlantic Council. Similar action is being contemplated by the Gulf of Mexico Council. This option (no action), while not directly affecting the human environment, would impact the mutton snapper stock, and in turn, users of the resource.

E.4. Recommendations to Local Governments and Other Agencies, as Approved by the Council

Recommendation 1. Require an annual permit for the sale of reef fish, including marine aquarium fish.

An annual permit would be required to sell reef fish from the management area. The permit system would be operated by the local governments with appropriate assistance from NMFS. The permit requirement provides an estimate of the universe of potential participants, thereby facilitating management of the fisheries. The action also offers a tool for enforcement and compliance, since a permit would be denied to anyone with an outstanding violation in any fishery. An appropriate fee may be charged by the local governments to recover costs of administering the program.

In addition, a permitting system allows management of fishery participation, which the Council may choose to control in the future through a system designed to limit entry. By capping participation in the fishery, limited entry would allow a sustained fishery, but could impact the human environment. Such a system would be addressed by the Council under a separate FMP amendment.

Recommendation 2. Require periodic reports from those engaged in the sale of reef fish, including marine aquarium fishes.

The data generated by this requirement would help determine actual participation, thereby eliminating speculative permit holders from the information base. Better information also would be provided on the catch and the amount of effort expended in the reef fish fishery, thereby allowing fishery scientists and managers to more accurately assess the status of resources in the management area. The data also would serve as the foundation for future development of limited access programs for the reef fish fisheries.

Recommendation 3. Closely monitor the condition of red grouper resources from expanded data collection efforts to determine appropriate management needs.

Various actions to restrict the harvest of red grouper were considered by the Council. Based on recommendations of the Council's advisory panel (AP) and scientific and statistical committee (SSC), such action has been delayed until the condition of the resource can be determined.

Red grouper, like jewfish and Nassau grouper, are so scarce that sufficient data may never become available to assess the condition of the resource. Therefore, continuation of unrestricted harvest of red grouper, which this action allows, may not serve resource conservation. However, a total prohibition on harvest would necessitate the release of all red grouper, even those taken from deep water. The Council recognizes that release mortality could offset potential benefits of the harvest prohibition, thereby impacting both the resource and the user groups. Monitoring the status of the red grouper population is encouraged under the preferred option, and will help provide for timely management of the resource.

Recommendation 4. Recommend that the local government monitor the spawning aggregation area for tiger grouper in waters near Vieques Island to obtain biological and socioeconomic information over a two-year period through a comprehensive permitting and reporting program implemented by Puerto Rico.

The tiger grouper is a deep-water species that is being added to the management unit. Although reports (FAO, 1978) indicate a general distribution throughout the range and that the species "commonly" reaches a length of 40 cm. (16 inches), there is little information on local abundance around Puerto Rico and the U.S. Virgin Islands. Information on abundance within the management area, as indicated by both the SSC and AP, is requisite to formulating a position on harvest limitations. Based on observations by Sadovy, Colin, and Domeier (ms. 1992), the tiger grouper aggregates for spawning in waters about 120 feet in depth and is targeted by spearfishermen. The species reportedly is reluctant to enter traps and is taken infrequently outside the aggregation season. Up to 18 boats have been observed on the highly circumscribed spawning grounds at the same time. Estimated annual harvest from the aggregation is about 24,000 pounds or 4,900 fish. Spawning activity outside the area has not been observed and aggregation spawning may represent the total reproductive output for tiger grouper. Therefore, the estimated total number of fish removed (4,900) could constitute a significant portion of the adults using this spawning site each year, and eventually lead to the demise of the aggregation as has occurred in other grouper species.

A spawning aggregation of tiger grouper has been identified in waters near Vieques, Puerto Rico. The AP recommended immediate protection of the spawning aggregation while studies are pursued to determine abundance. In July 1991 the Council recommended that the government of Puerto Rico take appropriate action to protect a spawning aggregation of tiger grouper in waters near Vieques. The National Marine Fisheries Service added its support to the proposed closure, recognizing that protection of spawning aggregations is an effective management tool and is preferred by the Council over measures that induce high rates of mortality (size limits) or that are difficult and costly to monitor (size limits and quotas).

Placing tiger grouper in the management unit paves the way for cooperative management to protect this species in waters under federal jurisdiction. Should Puerto Rico decide upon closing the spawning aggregation area off Vieques, the Council may close adjoining areas or other spawning aggregation areas as deemed necessary to protect the resource.

Recommendation 5. Recommend that the local governments work in cooperation with other agencies as necessary to establish marine coral reef reserves in strategic locations throughout the management area.

Tropical coral reefs are highly complex ecosystems that support a diversity of species. The basic habitat itself is composed of living organisms, some of which are highly prized by collectors, and others that are highly fragile and susceptible to sedimentation or other forms of degradation.

Ecological and life history characteristics of many reef fishes, such as slow growth rates, late maturity, spawning aggregation behavior, and sex reversal, make them particularly vulnerable to overfishing. Larger individuals generally are targeted and are aggressive and disposed to high fishing mortality. Coral reefs are the cornerstone of several important fisheries in the management area, and establishing a number of these areas as marine reserves is a worthy concept. Fishery reserves ensure against management and recruitment failures, primarily by protecting older and more fecund fishes. More specifically, marine reserves would: (1) serve as a gene pool or spawning stock reservoir to prevent depletion of fisheries by ensuring recruitment to surrounding areas; (2) help rebuild overfished reef fish resources; (3) guard against overfishing of other species not yet in a state of decline; (4) decrease the need to resort to other, more severe management actions; (5) establish a baseline for evaluating management actions in nearby areas; and (6) provide natural reef communities for educational and research sites (Bohnsack, 1990).

However, one of the most difficult challenges facing fishery managers considering development of marine reserves is balancing the traditional consumptive fisheries with alternate uses of reef resources, such as eco-tourism, sport diving, and aesthetics. Amendment 2 endorses marine reserves as a conceptual design; more precise boundaries and user restrictions would be proposed (and analyzed) under subsequent FMP amendments.

In the management area, the most important coral reef resources are: shallow-water reef fish, spiny lobster, marine aquarium organisms (including corals and other invertebrates), and deep-water reef fishes. The marine coral reef reserve concept cross-cuts the objectives of different FMP's, and would be proposed as a measure in each FMP affected.

The SSC and AP both reviewed proposed management options for Amendment 2, and encouraged the development of marine reserves, recognizing that the number and extent of such areas and designation of their use would require cooperation by local and federal governments, as well as users of the resource. Accordingly, the Council will request input from the public on the feasibility of marine reserves in the management area. However, since details of the reserves have not been finalized, the impacts on the user groups, physical environment, and resource cannot be quantified at this time, but would be expected to be beneficial.

Recommendation 6. Recommend that the unauthorized introduction of exotic species into marine waters be prohibited.

Unauthorized introduction of exotic species into the management area, whether deliberate or accidental, could result in biological catastrophes such as the displacement of more desirable species from their niches, or adverse modification of the genetic composition of the desirable species. Introduction of exotics has become a problem elsewhere; for example, 47 exotic species of finfish are listed as established in the continental United States (Courtenay, et al., 1991). These species were introduced accidentally, or with human assistance, (1) from aquaculture facilities, (2) by introduction for biological control or sport fishing, and (3) by release of aquarium fish. Although most of these species are confined to freshwater, others are euryhaline and adapt readily to the oceanic environment. Some marine species also have been introduced successfully.

Most states, including Puerto Rico and the U.S. Virgin Islands, regulate the introduction of exotic species. By reducing the possibility of exotics displacing the native species and affecting the genetic makeup of the resource, this action should benefit the environment. The Council recognizes that such action would prevent similar problems throughout the management area. However, recent legal guidance indicates that direct action cannot be undertaken to prevent introduction of exotic species not managed under the Magnuson Act. Accordingly, Amendment 2 was revised to replace the previously considered federal action to control exotic species introductions with Recommendation 6, which would defer action to local governments to expand existing regulations to include marine waters.

F. AFFECTED ENVIRONMENT

F.1. Introduction

The actions proposed in Amendment 2 address continuing and growing concerns by the Council over scarce resources, the need to protect important species when they aggregate for spawning, and the need to extend protection to other reef-associated species not presently in the management unit. The affected environment encompasses: (1) the physical environment, primarily the insular platform and in deeper waters, reef areas and slopes characterized by rocky ledges, and corals; and (2) the fishery resource, including the currently managed shallow-water reef fish resource, and the deep-water resource and a large number of smaller reef fishes and other reef-associated species taken in the marine aquarium trade (substantial overlap occurs in the fisheries). These components are discussed in the following sections.

F.2. Habitat and Fishery Environment Information

Information on the shallow-water reef fish habitat first was provided in the FMP, and significantly updated in Amendment 1. Amendment 1 contains a comprehensive description of all habitat elements relating to the reef environment.

F.2.a. Physical Environment

The management area includes the environment from the shoreline to a depth of ca. 300 fathoms and covers a variety of habitat. As described in the FMP's habitat section, about 30 bottom types are found around Puerto Rico, and about 50 around the U.S. Virgin Islands. The bottom varies with depth, and consists of varying amounts of gravel, rock, sand, mud, and clay. Inshore habitat is dominated by seagrasses, mangroves and fringing reefs. Further offshore, the geologic platform supports bank reef areas -- the environment most of the reef fish occupy. The basic habitat unit on the platform is the bank coral reef, a highly complex and productive ecosystem that supports a diversity of species. At greater depths at the edge of the platform, another habitat area occurs -- the deep-water reef and slopes characterized by rocky ledges and corals.

Damage to reef habitats already has been reported for some of the most widely used methods to collect marine aquarium fishes, including chemicals, and nets. In response, the Council has adopted actions to prohibit the use of these gear types and thereby reduce the associated potential for damage to the physical environment.

F.2.b. Fishery Resource

The management unit currently includes the 64 most commonly landed species that dominate the catch out to the insular platform. Table 1A provides a listing of the revised management unit depicting the overlap of deep-water and shallow-water species. The deep-water reef fish species are more common at depths beyond the platform. Fishes inhabiting the deep-water reef areas and slopes characterized by rocks, ledges, and corals generally are prosecuted with heavy duty traps and by electrically powered reels; bottom longlines are deployed to a limited extent. Thirteen species currently not listed in the shallow-water reef fish management unit are major components of the deep-water landings (Erdman, 1979). One other species (tiger grouper) was added at the suggestion of the SSC and AP. Six species of snapper (Lutjanidae); black snapper (Apsilus dentatus), queen snapper (Etelis oculatus), blackfin snapper (Lutjanus buccanella), silk snapper, wenchman (Pristipomoides aquilonaris), and vermilion snapper (Rhomboplites aurorubens); four species of grouper (Serranidae), yellowedge grouper (Epinephelus flavolimbatus), red grouper, misty grouper (Epinephelus mystacinus), and tiger grouper; two species of jacks (Carangidae), greater amberjack (Seriola dumerili), and almaco jack (Seriola rivoliana); and two tilefishes (Malacanthidae), blackline tilefish (Caulolatilus cyanops), and sand tilefish (Malacanthus plumieri) are taken predominantly in deep waters and are included in the expanded management unit. Their inclusion will allow the Council to take appropriate management action to conserve or restore important components of the reef fish fishery.

A total of 105 species or species groups of fishes appeared on trade lists and shipping lists from Puerto Rico in 1990/91 (Table 2A). Eighty-three species of fishes were noted as exported, and seven species, or families, accounted for over 70 percent of the total fish export. In order of decreasing numbers these were: royal gramma, Gramma loreto; yellowhead jawfish, Opisthognathus aurifrons; assorted wrasses; rock beauty, Holacanthus tricolor; assorted blennies; queen triggerfish, Balistes vetula; and French angelfish, Pomacanthus paru. Other species, such as queen angelfish (Pomacanthus ciliaris), blue chromis (Chromis cyanea), and pygmy angelfish (Centropyge argi), are less numerous but in high demand. At least 20 to 30 species taken in the marine aquarium trade also are valued as food fish. Some of these are highly prized as aquarium fish, notably rock beauty, French angelfish, and queen triggerfish; while others are being protected from overfishing as adults, such as red hind and possibly other serranids. A wide variety of invertebrates, including corals, also are exported. The aquarium fish trade is not specifically regulated and, in Puerto Rico, exporters are not required to be licensed and collectors are not treated as commercial fishermen.

The ecology and life history characteristics of many reef fishes make them particularly vulnerable to overfishing, such as slow growth rates, late maturity, spawning aggregation behavior, and sex reversal. Larger individuals (generally males) are targeted, and are aggressive and disposed to high fishing mortality. A decline in abundance has been noted for some of the more desirable species in certain localities. The ecological effects of their removal are unknown, and some of the most widely used collecting methods employ chemicals that damage the reef habitat and inflict mortality upon associated fishes and invertebrates.

Most species that aggregate during the spawning season are highly vulnerable to capture at that time. Allowing mature individuals the opportunity to spawn is important to maintain or increase reproductive capacity and reverse declines in abundance (Bohnsack, 1990). As a result, the Council relies on closing aggregation sites during spawning seasons to ensure spawning success, and is considering closures for three additional areas under Amendment 2. The rationale for aggregation site closures is described under Adopted Measures 8 and 9.

Since the status of other marine aquarium fishes has not been determined, a detailed assessment of the status of individual species currently is unavailable. However, the recommended permitting and reporting system should provide information to evaluate these species.

F.2.c. Human Environment

The human environment is defined as the natural and physical environment, and the relationship of people with that environment. The shallow-water and deep-water reef fish fisheries directly affect its participants. The magnitude of these impacts depends on the fishery's economic importance to participants, related secondary industries, and the fishing communities. These factors are quantified in the regulatory impact review (RIR) , and social impact analysis prepared under contract for the Council.

As described in the FMP, the industry historically was centered around a small-scale subsistence fishery, with most of the vessels less than 26 feet and powered by outboards. With the recent increase in technology and the use of larger boats, fishermen now have the capability to efficiently cover a greater area and deplete spawning aggregations. This capacity was demonstrated during the destruction of the Nassau grouper spawning aggregation (when fishing techniques were even less efficient). Monroe (1974) reported handline and fish trap catches up to 1000 kg per day by fishermen harvesting from a Nassau grouper breeding aggregation, off St. Thomas, U.S. Virgin Islands.

In 1989, 18,722 fishermen with 1,107 vessels landed 2,305,004 pounds of reef fish (Appeldoorn et al., 1992). During the past two years, the number of fishermen has significantly increased and traps are now set in "strings" with as many as 15 traps per string. Appeldoorn, et al. (1992) noted a recent shift in effort to the deep-water fishery, and an overall decline in catch per unit effort. Should this trend continue, reef fish resources may become depleted to the extent that an economic collapse of the industry occurs. The anticipated consequences of each proposed and alternative option on the user groups is described in the appropriate section of this document.

About 100 people currently are engaged in the marine aquarium trade in Puerto Rico and a much smaller number in the U.S. Virgin Islands. Most collectors are exporters; however, some collectors sell to exporters or to local pet shops. Currently, there are about six export businesses in Puerto Rico with a similar number involved in intra-island trade.

Major collectors have their own equipment, and collect from 3 to 7 days a week depending on weather and demand. Collectors visit specific areas and generally rotate collecting sites to avoid overfishing an area. Collection is commonly by SCUBA down to 20 meters but occasionally to 40 meters for certain species; mask and snorkel are commonly used in shallow waters. The most frequent collecting gears are nets (gill nets, cast nets, and dip nets), small mesh (1/4 - 1/2 inch) fish traps, slurp guns, and chemicals.

Fishermen testifying before the Council have reported resource or habitat damage by some of the gears used in the marine aquarium trade. The use of other chemical agents with a potential for adverse impacts, such as bleach, formalin, and gasoline for collecting marine aquarium fishes has been reported from various areas, and all are prohibited because of reports of their toxicity on marine organisms, including corals. The use of explosives and chemical substances is currently prohibited by the shallow-water reef fish regulations that would likewise apply to this fishery by amendment.

Drop nets, gill nets, and small mesh fish traps are other gears traditionally in use to harvest marine aquarium fishes. Additional scientific studies are needed to analyze the impacts of these gears; nonetheless, public testimony indicates that these gears all have a potential for damaging reefs or reef resources. Small mesh fish traps are already prohibited under existing minimum mesh-size regulations, and further restrictions of the other gears are supported by available scientific information. Hence, the need to protect the reef fish environment by expansion of the FMP is demonstrated.

F.3. Effect on the Coastal Zone

Section 307 (c) of the Coastal Zone Management Act of 1972 requires that all Federal activities that directly affect the coastal zone be consistent with approved state coastal zone management programs to the maximum extent practicable. The Council has submitted this amendment to the appropriate state agencies of Puerto Rico and the U.S. Virgin Islands to determine if it is consistent to the maximum extent practicable with their approved coastal zone management programs.

F.4. Effects on Flood Plains and Wetlands

The management measures will not adversely affect flood plains or wetlands. However, continuation of status quo would affect the fishery resources in wetland habitats adjacent to the management area.

G. ENVIRONMENTAL CONSEQUENCES OF ACTIONS

G.1. Long-term Productivity of Stocks

Many of the species targeted in the deep-water, shallow-water, and marine aquarium trade fisheries appear overfished, and action is necessary to replenish the resource by protecting spawning stocks. In particular, the spawning aggregation area closures are essential to ensure sustained productivity. These closures should help the stock recover, or at least slow the rate of resource decline. Accordingly, the spawning season area closure should lead to benefits, even though fishermen fish adjacent areas and the overall level of fishing effort does not change. However, one possible adverse consequence of this shift of effort is that the decreased juvenile mortality (within the aggregation) may be offset by similar harvest outside the spawning aggregation.

This document and Amendment 2 contain descriptions, to the extent possible, of the status and management needs of the marine aquarium fish, deep-water, and shallow-water reef fish stocks. The marine aquarium industry takes a large number of juvenile red hind and other small reef-associated species, and a decline in local abundance has been noted for some of the more desirable species. The effects of their removal on the long-range status of the stocks cannot be quantified, but are expected to be negative. Furthermore, bleach, quinaldine and other collecting methods used in the marine aquarium fish industry may damage the reef habitat and inflict mortality upon associated fishes and invertebrates. These impacts may, over time, degrade the long-term productivity of the resource.

G.2. Ocean and Coastal Habitats

The potential of certain gear types for habitat damage is referenced in Amendment 2, and briefly described under Section F.2.C of this document. In particular, the unregulated use of chemical agents and certain nets could adversely impact the habitat, especially reef areas, and the resources utilizing these areas. Amendment 2 would benefit ocean and near-shore habitats given the potential gear damage associated with continuation of unregulated fishing practices.

G.3. Public Health and Safety

Safety of the fishing fleet is not expected to be affected by continuation of the fishery or the management measures being considered for Amendment 2. Accordingly, there will be no direct effect on public health and safety resulting from the proposed management measures.

G.4. Effects on Endangered or Threatened Species and Marine Mammal Populations

Gill nets, hook and line, fish traps, and chemicals are used for harvest in the marine aquarium fish trade, or in the deep-water and shallow-water fisheries. Buoy or vertical lines associated with these gear have the greatest potential for interaction with marine mammals or protected species. Amendment 2, by expanding the management unit and specifying trap designs in the shallow-water and deep-water reef fish fisheries and allowable gear in the marine aquarium trade, should reduce the potential (if any) for impacts on endangered or threatened species and marine mammal populations. Accordingly, a biological assessment and Section 7 consultation under the Endangered Species Act (ESA) indicated that neither the directed fisheries nor Amendment 2 would jeopardize marine mammals, the recovery of endangered or threatened species, or adversely impact their critical habitat. Additional details are available in the consultation and supporting documents.

G.5. Cumulative Adverse Effects and Substantial Impacts on Stocks

The ecology and life history characteristics of many reef fishes, such as slow growth rates, late maturity, spawning aggregation behavior, and sex reversal, make them particularly vulnerable to overfishing. Moreover, the fisheries primarily rely on fish traps which remove large numbers of juveniles, and may capture significant amounts of other species as incidental catch. Ghost fishing by lost or abandoned traps, if occurring in large enough numbers, may threaten fishery resources. As a result, continuation of the rapidly expanding fishery may adversely impact the stock, and in turn, the human environment. Amendment 2 offers a variety of management proposals designed to prevent overfishing and implements rebuilding programs; which when considered in combination, the actions should substantially benefit the stocks, with virtually no adverse effects. Conversely, to allow spawning populations to be overexploited during periods of unusual vulnerability is not biologically sound. Therefore, continuation of excessive fishing mortality when species are aggregated for spawning could compound impacts on already impoverished resources.

Many of the public comments on the DSEIS noted that coastal development, sedimentation, and other activities have negatively impacted the fishery resource. Amendment 2 is expected to help reverse this trend over time, thereby providing benefits to some degree. No mitigation measures related to the proposed actions are recommended at this time but may become necessary as additional data are acquired. There will be no irreversible and irretrievable commitment of financial and personnel resources.

G.6. Economic Effects

The proposed actions will necessitate a degree of adjustment by the user groups in order to achieve the goals of the FMP. About 1,882 fishermen in Puerto Rico and 425 in the U.S. Virgin Islands reported reef fish landings in 1989. While an unknown portion of the fishery will be economically impacted by Amendment 2, the entire fishery ultimately will gain from the conservation measures.

Adding the marine aquarium fishes to the shallow-water management unit will cause significant short-term effects on the aquarium trade, primarily in Puerto Rico where more people are involved. Species in short supply are usually those in greatest demand; therefore, conservation measures are needed to guard against further declines and to protect the interests of the industry dependent upon these resources for their livelihood. In the absence of Council development of a limited access program, effort will continue to increase in the marine aquarium trade due to a combination of increased demand, improved air transport facilities, and increased restrictions on activities in other countries. Additional information can be found in Amendment 2, particularly the RIR which analyzes the economic effects of the proposed and alternative actions.

G.7. Federal Agencies That May Be Affected

U.S. Department of Commerce
    Office of Ocean and Coastal Resource Management

U.S. Department of the Interior
Fish and Wildlife Service
National Park Service
U.S. Department of Transportation
U.S. Coast Guard
U.S. Department of Energy
U.S. Environmental Protection Agency
Caribbean Fishery Management Council

H. LIST OF PREPARERS

Amendment 2 and the Final Environmental Impact Statement were prepared by the Caribbean Fishery Management Council, with assistance from NMFS Southeast Regional Office.

I. LIST OF AGENCIES, ORGANIZATIONS AND PERSONS TO WHOM COPIES OF THE FSEIS WERE SENT

U.S. Department of Commerce
Office of Ocean and Coastal Resource Management
U.S. Department of State
U.S. Department of Agriculture
U.S. Department of Interior
Fish and Wildlife Service
National Park Service
U.S. Department of Transportation
U.S. Coast Guard
U.S. Environmental Protection Agency, Region II
Caribbean Fishery Management Council
Commonwealth of Puerto Rico
Government of U.S. Virgin Islands

J. SUMMARY OF PUBLIC COMMENTS RECEIVED ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT -- AMENDMENT 2 TO THE FISHERY MANAGEMENT PLAN FOR THE SHALLOW-WATER REEF FISH FISHERY OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS

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The draft SEIS was released for public review and comment from December 11, 1992 through January 25, 1993. Commenters included: (1) local and Federal agencies; (2) commercial fishermen; (3) fish dealers and processors; and 4) individuals or organizations representing diverse fishery interests including the commercial sector, fish processing, environmental conservation, and scientific research community. The Council also provided an additional 15-day period for public comments on an expanded list of species for which a harvest prohibition is proposed for the marine aquarium trade (Measure 7).

J.1. Summary of Major Comments and NMFS Responses

The Environmental Protection Agency, local agencies (U.S. Virgin Islands Department of Planning and Natural Resources; Puerto Rico Fishery Development and Administration Program), the Puerto Rico Fisheries Research Laboratory, a conservation organization (Nature Conservancy) and several individuals sent comments on the various management measures. Two U.S. Virgin Islands legislators posed procedural questions, and suggested delays in implementation to allow additional public hearings. However, the required hearings and opportunities for public comment comply with the National Standards of the Magnuson Act, which also requires appropriate action be taken as soon as possible based on the best available scientific information.

Remarks by organizations and agencies (Environmental Protection Agency, Nature Conservancy, and U.S. Virgin Islands Department of Planning and Natural Resources), generally supported the proposed actions, but noted the urgent need for additional studies and implementation of reef fish management measures. However, several of the comments included criticism and suggestions for specific measures proposed under Amendment 2. All such comments and NMFS responses, are attached (with each response number referring to one or more comments). Some written comments also suggested additional changes in other fishery management plans; these were outside of the scope of the shallow-water reef fish FMP and are not included here. Letters received during the comment period are contained in Appendix II.

Comment (1): The Puerto Rico Fishery Development & Administration Program (PRFDAP) commented that inclusion of the deep-water fishery in the management unit, while more cost effective than developing a separate plan, also extends the FMP's objectives and management authority into an excessively wide variety of habitat. A fishery research laboratory biologist voiced similar concerns.

Response (1): The Council considered the environmental, biological, social, and economic consequences of various combinations of the two interrelated reef fish fisheries and coral habitat and resources. Since the deep-water reef fish fishery and the shallow-water complex overlap in terms of habitat and species, the Council chose to take appropriate action and incorporate the two fisheries into a single reef fish FMP by adding to the existing management unit fourteen species caught in the deep-water fishery. Amendment 2, while extending the FMP's jurisdiction over a wider range of habitat, allows the Council to take appropriate action as necessary to conserve or restore the fourteen species considered to be important components of the deep-water reef fish fishery and recommended for inclusion in the management unit. Conversely, development of a separate FMP for the deep-water complex would be time-consuming, costly, and could prevent corrective action as needed to address overfishing or other problems in the fishery.

Comment (2): The St. Croix Fisheries Advisory Committee suggested modification of the proposed annual December through February seasonal closure of a red hind spawning aggregation area in the EEZ east of St. Croix, U.S. Virgin Islands. This would exclude fishing for: (1) the major components of the deep-water fishery; and (2) certain fishing for migratory pelagic species within the 50-fathom contour (considered economically important and located adjacent to the shallower aggregation area).

Comment (3): A member of the Council's advisory panel suggested allowing all fishing outside 50 fathoms during the proposed seasonal closure of the red hind spawning aggregation area, as referenced in the previous comment.

Comment (4): A commercial fisherman objected to any closure of the red hind spawning aggregation site specified in the previous two comments, stating that only three individuals target red hind (due to bad local weather) during the spawning season. The fisherman stressed the need to avoid impacts to these individuals and others who harvest lobster in the area, and suggested delay of a complete closure until further studies indicate that the red hind aggregation is overfished. A U.S. Virgin Island's legislator lended support to the objections.

Comment (5): The PRFDAP opposed the proposed closure of either the red hind or mutton snapper spawning aggregation areas, stating that insufficient data exists to prove that the resource is being affected. The commenter noted that since catches are abundant in the aggregation areas during the spawning season, many families would be adversely affected.

Response (2,3,4,5): Mutton snapper already has been exploited to the extent that commercial landings are declining. The Council's Stock Assessment Group concluded that the number of young red hind in the population is decreasing (recruitment overfishing), which may be due to intensive fishing in the aggregations. In response, Amendment 2 establishes a rebuilding plan providing total protection of young of the species considered in a rebuilding mode (including mutton snapper and red hind). The rebuilding plan includes aggregation site closures during spawning seasons, which already has been shown to enhance reproductive capacity in other areas and fisheries.

A red hind spawning aggregation area off St. Thomas has been closed during the spawning season (December-February) each year starting in 1989-1990. Two additional red hind spawning areas, recently identified, warrant protection and are being considered for closure under Amendment 2. Based on comments received from industry representatives and members of the St. Croix Fisheries Advisory Committee (Comments 2 and 3), this area is now delimited to waters less than 50 fathoms in depth. The area formerly extended to the 100 fm. contour but was reduced because of comments that indicated unnecessary impacts to the fisheries for large pelagics (tuna, dolphin, wahoo, and marlin) and deep-water snapper.

Amendment 2 also proposes protection of an area identified in the EEZ off the southwest coast of St. Croix, where mutton snapper aggregates for spawning from March through June of each year. As proposed by the U.S. Virgin Islands Division of Fish and Wildlife, the area closure would extend to all fishing, since the species is especially vulnerable to either directed or incidental harvest.

Several commentors suggested status quo, whereby the specified areas would be unprotected from intensive fishing effort that could lead to the demise of the spawning aggregations, and declines in local abundance. Moreover, both red hind and mutton snapper may be caught while fishing in the aggregation for other species (including the deep-water complex listed in comment number 2). The suggested exemption of other fisheries within the aggregation boundaries specified in Amendment 2 would create an enforcement loophole whereby harvesters may fish the reef fish aggregation while claiming to be targeting the exempted species. The resulting fishing mortality could impede the rebuilding program. The Council's proposal of a total closure within each identified aggregation area, while objected to by some commenters, is based on the best available scientific information and is supported by NMFS.

Comment (6): The president of a Puerto Rican fishermens' organization stressed the need for additional studies on tiger grouper and expressed socioeconomic concerns about the Council's previous recommendation to the local government for total closure of a tiger grouper spawning aggregation area near Vieques, Puerto Rico from February 1 - April 30 of each year (subsequently deleted from Amendment 2 following public hearings).

Comment (7): The PRFDAP stated that tiger grouper aggregate for spawning and require regulation, but that public hearings first should be held in Vieques.

Comment (8): Two individuals affiliated with the University of Puerto Rico (UPR) supported a complete harvest prohibition for tiger grouper throughout the management area, and also suggested additional studies of that species as well as Nassau grouper.

Response (6,7,8): Fishing pressure reaching excessive levels was documented on the Vieques tiger grouper spawning grounds located in waters under the jurisdiction of Puerto Rico. Other grouper spawning populations have proven to be extremely vulnerable to exploitation, and no tiger grouper spawning has been reported outside of the Vieques aggregation. The Council in July 1991 recommended that the government of Puerto Rico take steps to protect the aggregation. At that time, NMFS added its support to the proposed closure.

The Council subsequently determined, based on guidance from its Advisory Panel (AP), that insufficient information existed to recommend a total harvest prohibition on tiger grouper as supported by two of the commenters. The Council, however, recognized that additional data was needed on the management needs of the spawning population. Accordingly, Amendment 2 includes a recommendation that the local government monitor the aggregation area to obtain biological and socioeconomic information over a two-year period through its comprehensive permitting and reporting program. This addresses the concerns raised under Comment 6.

Amendment 2 also proposes inclusion of tiger grouper in the management unit, as suggested by the Council's Scientific and

Statistical Committee (SSC) and AP and is supported by several of the commenters. This paves the way for further protection of the species when warranted in waters under federal jurisdiction.

The Council has not scheduled a public hearing in Vieques (Comment 7), but has conducted other hearings and provided ample opportunity for public comments, which comply with NEPA and Magnuson Act requirements. As a result, NMFS does not agree that management be delayed until an additional hearing on Amendment 2 can be scheduled and held in the requested area.

Comment (9): One individual offered various comments supporting the marine reserve concept and Amendment 2. It was suggested that tiger grouper was a deep-water species rarely taken by fishermen, and therefore does not warrant protection under the marine reserve concept.

Comment (10): Two individuals affiliated with UPR suggested a possible modification of the reserve concept whereby zones, once established, would be opened to fishing on a rotational basis.

Response (9,10): Recognizing that the marine reserve concept offers numerous conservation benefits, the Council is recommending under Amendment 2 that local governments, in cooperation with other agencies, work to establish marine coral reef reserves in strategic locations throughout the management area. Due to the time and public input needed to develop an effective and equitable reserve management program, the specific locations and restrictions were not included in Amendment 2. Such actions will be the subject of future Council deliberations, environmental analysis and amendment process (upon Council approval). The Council may then choose to incorporate some form of zone rotation into the reserve management system.

Comment (11): The two individuals associated with UPR supported, in general, no action (status) for fish trap regulations. However, the commenters suggested a number of new management measures, including several to be designed to avoid loss during hurricanes and other severe storms (such as mandatory removal of all traps from the water).

Comment (12): A commercial fish house owner (a member of the Council's AP), and the PRFDAP suggested replacing the existing fish trap construction requirement of two escape panels with only a funnel and access door (already used in most of the fishery), stating that it was highly unlikely that a lost trap would be positioned so as to prevent escape of fish.

Response (11,12): The recent stock assessment and other scientific information supports continuation of the management measures to ensure escapement of juvenile fishes from fish traps (the dominant gear), to maximize optimum size and prevent overfishing in the fishery, one of the FMP's objectives. Currently the regulations require two escape panels (one on each of two opposite sides) covered by a panel of a mesh size no smaller than that of which the trap is constructed and fastened with untreated jute twine up to 1/8 inch in diameter. The access door, under certain conditions, may serve as one of the two escape panels, if certain conditions are met so that the door will fall open when the twine degrades.

Following extensive discussion and public hearings, the Council revised Amendment 2 to limit allowable construction materials to 1.5-inch hexagonal mesh wire. The Council also voted to recommend that 2.0-inch square mesh wire and escape openings of at least 8 x 8 inches be located on any two sides (except top, bottom, or side containing the funnel). Under the revised proposal, the panels covering the escape openings must be fastened with untreated jute twine (up to 1/8 inches in diameter) when traps are fitted with zinc anodes, or with either 18-gauge ungalvanized wire or 1/8-inch untreated jute twine if anodes are not used. These requirements provide greater assurance of adequate escapement from fish traps compared to status quo (which several of the commenters supported). Available scientific information indicates these action should help prevent continued fishing and subsequent mortality by lost or abandoned traps (ghost fishing).

Several other fish trap management measures were suggested, including an additional requirement that fish traps be removed and secured during catastrophic weather events (to reduce ghost fishing). These actions were not taken to public hearings for Amendment 2 and therefore could only be implemented by an additional amendment, subject to Council action and Secretarial approval.

Comment (13): The PRFDAP suggested that: (1) laboratory or scientific aquaculture projects be excluded from any marine aquarium fishery harvest restrictions, and (2) authority to issue such exemptions be given either to their agency or the Puerto Rico Department of Natural Resources.

Response (13): The FMP already contains a clause whereby the Regional Director can, under certain conditions, exempt other prohibited activities for the purpose of research or data collection. This currently cannot cover other types of aquaculture facilities, such as private fish farms that culture marine aquarium fish for profit. Furthermore, any such exemption from the regulations should contain sufficient safeguards and conditions to prevent abuse and prevent the deliberate or accidental release of exotic species, which could displace or modify the genetic composition of more desirable species.

Comment (14): The two UPR affiliates also suggested: (1) incorporation of invertebrates into the FMP already implemented for reef fish; and (2) changes to the local permit system, including a requirement of monthly landing reports and release mortality data.

Response (14): The Council, while deliberating options for regulation resources in need of management, determined that marine aquarium invertebrate species should be separately managed from the deep-water and shallow-water reef fish fisheries. The Council is recommending, under Amendment 2, that the local agencies administering the permit program require periodic reporting to more accurately determine actual participation as well as the catch and the amount of effort expended in the reef fish fishery. The details of the local permitting and reporting system is at the discretion of the local agencies; however, NMFS suggests that reporting intervals and other requirements be patterned after systems already tested and proven successful in other fisheries (i.e, monthly, or upon completion of a fishing trip).

Comment (15): A member of the St. Croix Fisheries Advisory Committee objected to prohibiting harvest of several of the species proposed for protection under Measure 7, and stated that careful self-management on St. Croix has allowed us to fish the same areas for the past seven years without an observed decrease in target species.

Response (15): Although there is currently only one collector of aquarium fishes operating out of St. Croix, U.S. Virgin Islands, there are a few that operate out of St. Thomas. The Council is concerned that effort may increase because of added restrictions in the Florida fishery, improved export facilities, and increased demand for the product. Increased effort and harvest could occur at such a rate that further damage would be inflicted upon diminishing coral reef habitat, and its fragile aquarium fish community.

Comment (16): One of the individuals affiliated with UPR stated that only about one-half of the species harvested in the aquarium trade that deserve protection are included in the proposed amendment. The commentor felt that many other groups of fishes are exploited and should be included, such as those with special ecological niches and feeding habits (cleaning species) whose removal would be detrimental to the integrity of the reef.

Response (16): Species initially included in the amendment were extracted from the exportation list compiled from trade lists and shipping lists for 1990-1991 submitted to the Department of Natural Resources personnel at the Luis Munoz Marin Airport in San Juan, Puerto Rico. Completeness was never intended, but rather a preliminary listing was generated that would include those species in high demand so that protection could be afforded as necessary. The list or management unit may be expanded, as appropriate to incorporate additional species that deserve protection by future amendment. To attempt to add to the management unit at this time would only frustrate management of the marine aquarium trade as further public comment would have to be invited through the hearing process. The document supplied by the commenter contains a considerable amount of useful information on symbiotic relationships of reef-dwelling species and may serve as a point of departure for expanding the management unit. Besides, very little information is presently available on these other species.

Comment (17): A marine life collector made several comments about Measure 7, and supported the harvest prohibitions proposed for the six listed species, except for the longsnout butterflyfish.

Response (17): This species was listed for protection because of its reportedly low rate of survival in captivity. Should evidence become available that this information is incorrect, the management unit can be adjusted accordingly.

Comment (18): The marine life collector also stated that the laws governing the aquarium trade in Florida would adapt well in Puerto Rican waters.

Response (18): Florida Marine Life laws are largely based upon size limits and bag limits or quotas. These types of restrictions do not blend well with the current management style in the Caribbean as they are too labor intensive for the available monitoring and enforcement capabilities. As a result, this suggestion was rejected by the Council, which in all likelihood will continue to rely upon spawning season closures and harvest prohibitions as with other species of reef fishes.

Evaluation of the Public Comments--Specific Issues and Concerns

Numerous issues and concerns were raised by members of the public who commented at the public hearings and in most cases, submitted written remarks (all addressed in the previous section). Other speakers offered general remarks, including catch data and landing trends, and made suggestions for managing other fisheries; these topics are outside the scope of Amendment 2 and the EIS and therefore are excluded from this discussion. Comments addressing Amendment 2 at the public hearings overwhelmingly supported most of the management measures. However, most comments on fish trap management objected to the regulations subsequently rejected by the Council.

Verbal comments regarding Amendment 2 and the EIS and not duplicated by written remarks are addressed in this section by category.

- One commenter at the public hearings stated that the aquarium fishery should be managed separately from the reef fish FMP.

  Many of the species overlap both fisheries as adults and juveniles, and species desirable in the aquarium trade are juveniles of reef fishes that are utilized for other purposes as adults. Accordingly, establishing a separate management regime for the aquarium trade may contravene selected management measures designed to rebuild resources in the reef fish fishery. As a result, the rebuilding programs (and subsequent amendments) would have to be compatible, and amendment of one FMP may require amendment of the other, thereby increasing associated costs substantially. The concept of separate plans not only would be costly, but could prevent proper management of the resource, and therefore was rejected by the Council.

- Another commenter suggested allowing a 3/4-inch mesh barrier net in the marine aquarium fishery.

  This comment is not supported by the available information which indicates that barrier nets (including the specified mesh size) have the potential of causing damage to the resource or its habitat, or both, and therefore was rejected by the Council. Following extensive deliberations, the Council adopted Measure 4, which restricts the gear allowed in the marine aquarium fishery to hand-held dip nets and slurp guns.

- An individual cited socioeconomic concerns in opposition to the marine reserve concept.

  Amendment 2 recommends that local governments, in cooperation with other agencies, work to establish marine coral reef reserves in strategic locations throughout the management area. The Council recognized that additional public input was needed to develop an effective and equitable reserve management program that maximizes benefits while reducing unnecessary economic disruption of the fishery. Accordingly, the specific locations and restrictions were not included in Amendment 2 but will be subjected to Council action and the amendment process. Socioeconomic issues such as those raised by the speaker may be addressed at that time.

- Another commenter stated that fishing for tiger grouper is feasible only when the species is aggregated for spawning, and suggested that protective action be delayed until additional studies are completed.

  These concerns, similar to those responded to under Comments 6, 7 and 8, were addressed by the Council's determination that insufficient information existed to recommend a total harvest prohibition on tiger grouper. The Council, however, recommended that the local government monitor the aggregation area to obtain data over a two-year period through its comprehensive permitting and reporting program.

- Three of the public speakers supported a prohibition on the unauthorized introduction of exotic species.

  Most states, including Puerto Rico and the U.S. Virgin Islands, regulate the introduction of exotic species, and the Council agrees with the commenters that extending the prohibition into federal waters would enhance enforcement. However, NOAA legal counsel has advised that such action must exclude exotic species not managed under the Magnuson Act. Accordingly, Amendment 2 does not propose federal action but recommends that the local governments implement such a prohibition.

X. REFERENCES

Appeldoorn, R.S. and J.M. Posada, 1992. The efforts of mesh size in Antillean fish traps on the catch of coral reef fish. Final Rept. to the Caribbean Fishery Management Council, December 1992.

Appeldoorn, R., J. Beets, J. Bohnsack, S. Bolden, D. Matos, S. Meyers, A. Rosario, Y. Sadovy and W. Tobias. 1992. Shallow water reef fish stock assessment for the U.S. Caribbean. NOAA Technical Memorandum NMFS-SEFSC-304, 70 pp.

Bohnsack, J. 1990. The Potential of Marine Fishery Reserves for Reef Fish Management in the U.S. Southern Atlantic. A report to the South Atlantic Fishery Management Council from the Coastal Resources Division, Miami Laboratory, SEFC, NMFS, NOAA. CRD/89-90/04.

Caribbean Fishery Management Council. 1985. Fishery management plan, final environmental impact statement, and draft regulatory impact review for the shallow-water reeffish fishery of Puerto Rico and the U.S. Virgin Islands. 69 pp.

Caribbean Fishery Management Council. 1989. Amendment 1 to the fishery management plan for the shallow-water reeffish fishery of Puerto Rico and the U.S. Virgin Islands, preliminary environmental assessment and regulatory impact. 30 pp.

Courtenay, W.R., Jr.; Jennings, D.P.; and Williams, J.D. 1991. Exotic fishes, Appendix 2. In: Common and scientific names of fishes from the United States and Canada, Fifth ed., Amer. Fish. Soc. Spec. Publ. No. 20, pp. 97-107.

Erdman, D.S. 1979. Proposed management data for deep-water reef fishes (Fishery Management Plan, FMP) for the Caribbean Fishery Management Council. Report of Scientific and Statistical Committee, Sep. 20, 1977.

Food and Agriculture Organization of the United Nations (FAO), 1978. FAO species identification sheets for fishery purposes; Western Central Atlantic Fishing Area 31; Vol. 5.

Monroe, J.L. 1997. The mode of operation of Antillean fish traps and the relation between ingress, escapement, catch and soak time. J. Cons. Int. Explor. Mer. 35:337-350.

Sadovy, Y. 1991. A preliminary assessment of the export trade in marine aquarium organisms in Puerto Rico. P.R Dept. of Nat. Res., Fish. Res. Lab. Manuscript 43 pp.

Sadovy, Y., Colin, P.L., and M.L. Domeier, 1992. Aggregation and spawning in the tiger grouper, *Mycteroperca tigris* (Pisces: Serranidae). Manuscript 13 pp. plus figs.

Shapiro, D.; Y. Sadovy; and M. McGehee. In press. Size, composition, and spatial structure of the annual spawning aggregation of the red hind, *Epinephelus guttatus* (Pisces: Serranidae).

Tobias, W. 1986. Assessment of the population dynamics of snapper/grouper spawning aggregations. Dept. of Comm. Ann. Rept. PL 88-309, 6 pp.

Comentarios Relacionados a la Segunda Enmienda al Plan de Manejo Pesquero para Peces de Arrecife de Aguas Someras en Puerto Rico e Islas Vírgenes Americanas, con Enfasis en la Prohibición de la Explotación para el Mercado de Acuario de Peces de Arrecife y "Rocas Vivas" ("Live Rocks").

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Reporte sometido al
Consejo de Administración Pesquera del Caribe

25 de enero de 1993

24 de enero de 1993

Sr Miguel Rolón
Director Ejecutivo
Consejo de Administración Pesquera del Caribe
Banco Popular, Suite 1108
Hato Rey, P.R. 00918

RE Comentarios relacionados al Acta de Alternativas del Borrador para Vistas Públicas de la Segunda Enmienda al Plan de Manejo Pesquero para Peces de Arrecife de Aguas Someras en Puerto Rico e Islas Virgenes Americanas

Estimado Señor Rolón

Reciba mi habitual saludo y felicitación en el nuevo año, deseandole el mayor éxito en su trabajo. Adjunto, incluyo, conjuntamente con mi compañera, Leonor Alicea, algunos comentarios relacionados a las enmiendas propuestas al Plan de Manejo para Peces de Arrecife. Agradeceré, como de costumbre, el Consejo me mantenga informado de todos los aspectos relacionados a este proceso, particularmente, en el caso del Plan de Manejo para Corales. Hasta entonces.

Cordialmente,

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Table 1A. Species in the Expanded Management Unit for Shallow-Water and Deep-Water Components of the Reef Fish Fishery. (Species with asterisk occur in both fisheries; double asterisk = predominantly deep water.)

Scientific Name[1]	Common Name[1]	Spanish Name(s)[2]
Holocentridae	Squirrelfishes	
*_Holocentrus ascensionis_	Squirrelfish	Gallo, candil
*_H. rufus_	Longspine squirrelfish	Candilero
Serranidae	Sea basses	
Epinephelus adscensionis	Rock hind	Cabra mora
E. cruentatus	Graysby	Mantequilla
**_E. flavolimbatus_	Yellowedge grouper	Mero aleta amarilla
*_E. fulvus_	Coney	Mantequilla
*_E. guttatus_	Red hind	Mero cherna
E. itajara	Jewfish	Mero grande
*_E. morio_	Red grouper	Mero guasa
**_E. mystacinus_	Misty grouper	Guasa
*_E. striatus_	Nassau grouper	Cherna
*_Mycteroperca venenosa_	Yellowfin grouper	Moro pinto, Guajil
*_M. tigris_	Tiger grouper	Dientes de sable
Malacanthidae	Tilefishes	
**_Caulolatilus cyanops_	Blackline Tilefish	Domingo
**_Malacanthus plumieri_	Sand tilefish	Jolocho
Carangidae	Jacks	
Caranx bartholomaei	Yellow jack	Guaymen amarillo
C. crysos	Blue runner	Cojinua
C. latus	Horse-eye jack	Jurel ojon
*_C. lugubris_	Black jack	Jurel negron
C. ruber	Bar jack	Cojinua

[1] Names are from the American Fisheries Society List of Fishes, 1991.

[2] From Erdman, 1983, and FAO, 1978.

Table 1A (Continued)

**Seriola dumerili	Greater amberjack	Medregal
**S. rivoliana	Almaco jack	Escolar, Medregal
Lutjanidae	Snappers	
**Apsilus dentatus	Black snapper	Chopa negra
**Etelis oculatus	Queen snapper	Cartucho
*Lutjanus analis	Mutton snapper	Sama
L. apodus	Schoolmaster	Pargo amarillo
**L. buccanella	Blackfin snapper	Negra
L. griseus	Gray snapper	Pargo prieto
*L. jocu	Dog snapper	Pargo colorado
L. mahogani	Mahogany snapper	Rayado de yerba
*L. synagris	Lane snapper	Rayado
**L. vivanus	Silk snapper	Chillo
Ocyurus chrysurus	Yellowtail snapper	Colirrubia
**Pristipomoides aquilonaris	Wenchman	Muniama de afuera
*Rhomboplites aurorubens	Vermilion snapper	Besugo
Haemulidae	Grunts	
*Haemulon album	Margate	Viuda
*H. aurolineatum	Tomtate	Mulita, mula
H. flavolineatum	French grunt	Condenado
*H. plumieri	White grunt	Cachicata
H. sciurus	Bluestriped grunt	Ronco amarillo
Sparidae	Porgies	
Archosargus rhomboidalis	Sea bream	Chopa
Calamus bajonado	Jolthead porgy	Bajonado
C. penna	Sheepshead porgy	Pluma
+C. pennatula	Pluma	Pluma
Mullidae	Goatfishes	
Mulloidichthys martinicus	Yellow goatfish	Salmonete amarillo
*Pseudupeneus maculatus	Spotted goatfish	Salmonete colorado

Table 1A (Continued)

Chaetodontidae	Butterflyfishes	
Chaetodon capistratus	Foureye butterflyfish	Mariposa
C. ocellatus	Spotfin butterflyfish	Mariposa
C. striatus	Banded butterflyfish	Mariposa
Pomacanthidae	Angelfishes	
Holacanthus ciliaris	Queen angelfish	Isabelita
H. tricolor	Rock beauty	Isabelita medioluto
Pomacanthus arcuatus	Gray angelfish	Cachama blanca
P. paru	French angelfish	Cachama negra
Labridae	Wrasses	
Bodianus rufus	Spanish hogfish	Loro capitán
Halichoeres radiatus	Puddingwife	Capitán de piedras
Hemipteronotus novacula	Pearly razorfish	Doncella cuchilla
Lachnolaimus maximus	Hogfish	Capitán
Scaridae	Parrotfishes	
Scarus coelestinus	Midnight parrotfish	Judio
S. coeruleus	Blue parrotfish	Brindao
S. croicensis	Striped parrotfish	Loro
S. guacamaia	Rainbow parrotfish	Guacamayo
S. taeniopterus	Princess parrotfish	Loro
S. vetula	Queen parrotfish	Loro
Sparisoma aurofrenatum	Redband parrotfish	Loro
S. chrysopterum	Redtail parrotfish	Loro
S. rubripinne	Redfin parrotfish	Loro
S. viride	Stoplight parrotfish	Chaporra
Acanthuridae	Surgeonfishes	
Acanthurus bahianus	Ocean surgeon	Medico
A. chirurgus	Doctorfish	Medico
A. coeruleus	Blue tang	Medico

Table 1A (Continued)

Balistidae	Leatherjackets	
Balistes vetula	Queen triggerfish	Puerco
Canthidermis sufflamen	Ocean triggerfish	Turco
Melichthys niger	Black durgon	Japonesa
Xanthichthys ringens	Sargassum triggerfish	Puerquito
Ostraciidae	Boxfishes	
Lactophrys bicaudalis	Spotted trunkfish	Chapin
L. polygonia	Honeycomb cowfish	Chapin
L. quadricornis	Scrawled cowfish	Chapin
L. trigonus	Trunkfish	Chapin
**L. triqueter*	Smooth trunkfish	Chapin

†Not listed by AFS.

Table 2A. Species or species groups of aquarium fishes on trade lists and shipping lists for export from Puerto Rico 1990/91. (Species noted by an asterisk are taken at larger sizes as food fish.) Modified from Sadovy, 1991.

Scientific Name	Common Name	Number
Elasmobranchs	Sharks, skates, rays	-
Gymnothorax miliaris	Goldentail moray	44
Gymnothorax funebris	Green moray	-
Myrichthys oculatus	Goldspotted snake eel	4
Echidna catenata	Chain moray	-
Muraenids	Moray "eels"	8
Plectrypops retrospinis	Cardinal soldier	183
*Holocentrus ascensionis	Longjaw squirrelfish	5
Myripristis jacobus	Blackbar soldierfish	242
Holocentrids	Squirrelfish	3
Apogon maculatus	Flame/cardinalfish	98
Astrapogon stellatus	Conchfish	1
Priacanthus arenatus	Bigeye	24
Priacanthus cruentatus	Glasseye	26
Chromis cyanea	Blue chromis	439
Chromis insolatus	Sunshine Damselfish	20
Abudefduf saxatilis	Sergeant major	12
Stegastes partitus	Bicolor damselfish	-
Stegastes leucostictus	Beaugregory	49
Stegastes planifrons	Yellow damselfish	20
Stegastes dorsopunicans	Dusky damselfish	-
Microspathodon chrysurus	Yellowtail/jewel	299
Pomacentrids	Damselfish	8
Thalassoma bifasciatum	Bluehead wrasse	612
Clepticus parrae	Creole wrasse	43
Halichoeres cyanocephalus	Lightning wrasse	20
*Halichoeres radiatus	Puddingwife	587
Halichoeres maculipinna	Clown wrasse	34
Halichoeres garnoti	Yellowhead/neon wrasse	122
Xyrichtys splendens	Razorfish/green wrasse	26
*Bodianus rufus	Spanish hogfish	462
Labrids	Wrasses	-
*Sparisoma chrysopterum	Redtail parrotfish	-
*Scarus taeniopterus	Princess parrotfish	-
*Scarids	Parrotfish	20
Centropyge argi	Pygmy angelfish	345
*Pomacanthus paru	French angelfish	882
*Pomacanthus arcuatus	Gray angelfish	7
*Holacanthus ciliaris	Queen angelfish	114
*Holacanthus tricolor	Rock beauty	1552
*Pomacanthids	Angelfish	7
*Chaetodon capistratus	4-eye butterflyfish	133
*Chaetodon ocellatus	Spotfish butterflyfish	-
*Chaetodon striatus	Banded butterflyfish	338
Caetodon aculeatus	Longsnout/nose butterfly	111
*Chaetodontids	Butterflyfish	98
Gramma loreto	Royal gramma	11124
Serranus tabacarius	Tobacco fish	57
Serranus tigrinus	Harlequin bass	76
Serranus annularis	Orangeback bass	1
Serranus baldwini	Latern bass	13
Serranus tortugarum	Chalk bass	54
Serranids	Basses	14
Liopropoma rubre	Swissguard basslet	6
Hypoplectrus nigricans	Black hamlet	-

Table 2A (Continued)

Hypoplectrus indigo	Indigo hamlet	-
Hypoplectrus unicolor	Butter hamlet	-
Hypoplectrus puella	Barred hamlet	-
Hypoplectrus guttavarius	Shy hamlet	1
Hypoplectrus gummigutta	Golden hamlet	-
Hypoplectrus aberrans	Yellowbellied hamlet	-
Serranids	Hamlets	12
Paranthias furcifer	Creole fish/anthias	135
*Epinephelus fulvus	Coney/gold coney	53
*Epinephelus guttatus	Red hind	12
*Serranids	Grouper	47
Rypticus saponaceus	Soapfish	1
Equetus punctatus	Spotted drum	21
Equetus lanceolatus	Jackknife fish	22
Pareques acuminatus	Cubbyu/high-hat	205
Chaetodipterus faber	Spadefish	6
Amblycirrhitus pinos	Redspotted hawkfish	31
Anisotremus virginicus	Porkfish	17
Ophioblennius atlanticus	Redlip blenny	451
Blenniids	Blennies	948
Gobiosoma spp.	Neon goby	-
Quisquilius hipoliti	Rusty goby	-
Gobiids	Gobies	-
Opistognathus aurifrons	Yellowhead jawfish	2631
Opistognathus whitehurstii	Dusky jawfish	126
Scorpaenids	Scorpionfish (Stonefish)	8
Bothus lunatus	Peacock flounder/flounder	-
Symphurus arawak	Caribbean tonguefish	-
Dactylopterus volitans	Flying gurnard/sea robin	437
Hippocampus spp.	Sea horse	24
Sygnathids	Pipefish	3
*Acanthurus coeruleus	Blue/yellow tang	367
*Acanthurus chirurgus	Surgeon tang/doctorfish	50
*Balistes vetula	Queen triggerfish	920
*Xanthichthys ringens	Sargassum/redtail/triggerfish	74
*Canthidermes sufflamen	Ocean triggerfish	1
*Melichthys niger	Black triggerfish	76
Aluterus scriptus	Scrawled filefish	-
Cantherhines macrocerus	Whitespotted filefish	22
Monacanthids	Filefish	28
*Lactophrys, Acanthostracion	Trunkfish, cowfish	-
Canthigaster rostrata	Sharpnose puffer	36
Diodon hystrix	Porcupinefish	2
Antennarius spp.	Frogfish	70
Ogcocephalus spp.	Batfish	6
Synodus intermedius	Lizardfish	1
*Mullids	Goatfish	9
Aulostomids	Trumpetfish	60

FIGURE 1. PROPOSED RED HIND AREA CLOSURE -- TOURMALINE BANK

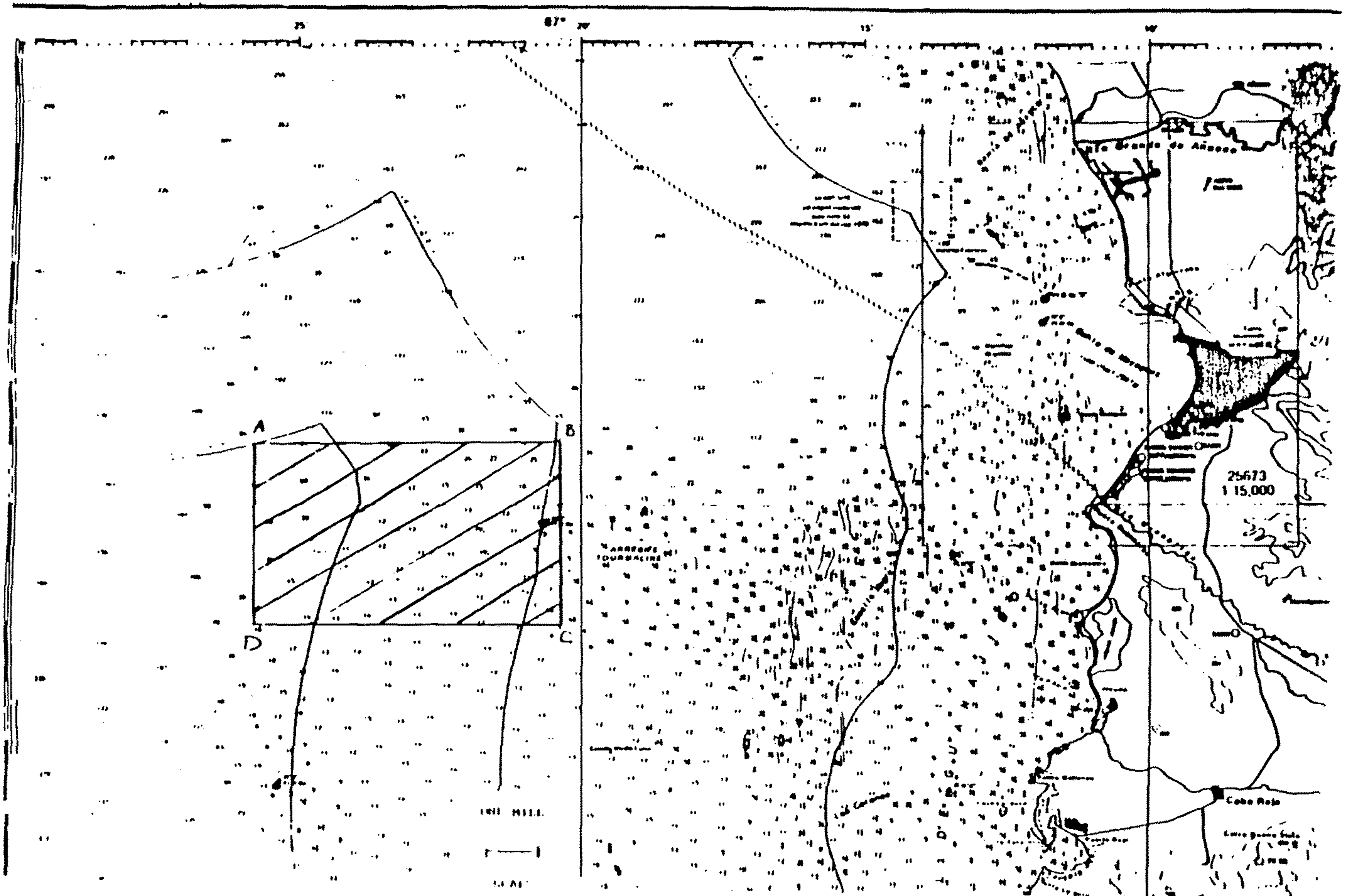


FIGURE 2. PROPOSED RED HIND AREA CLOSURE -- LANG BANK

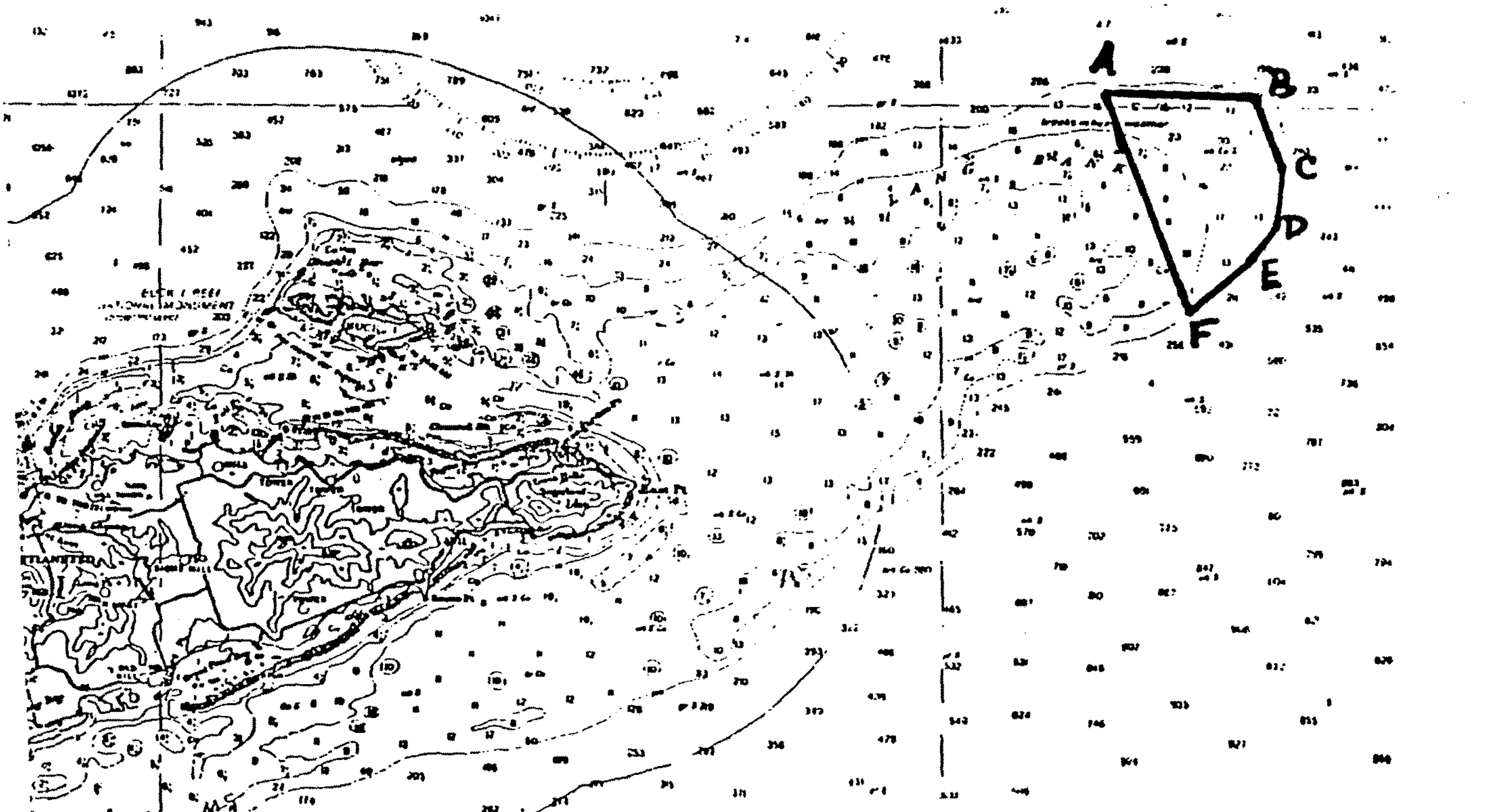
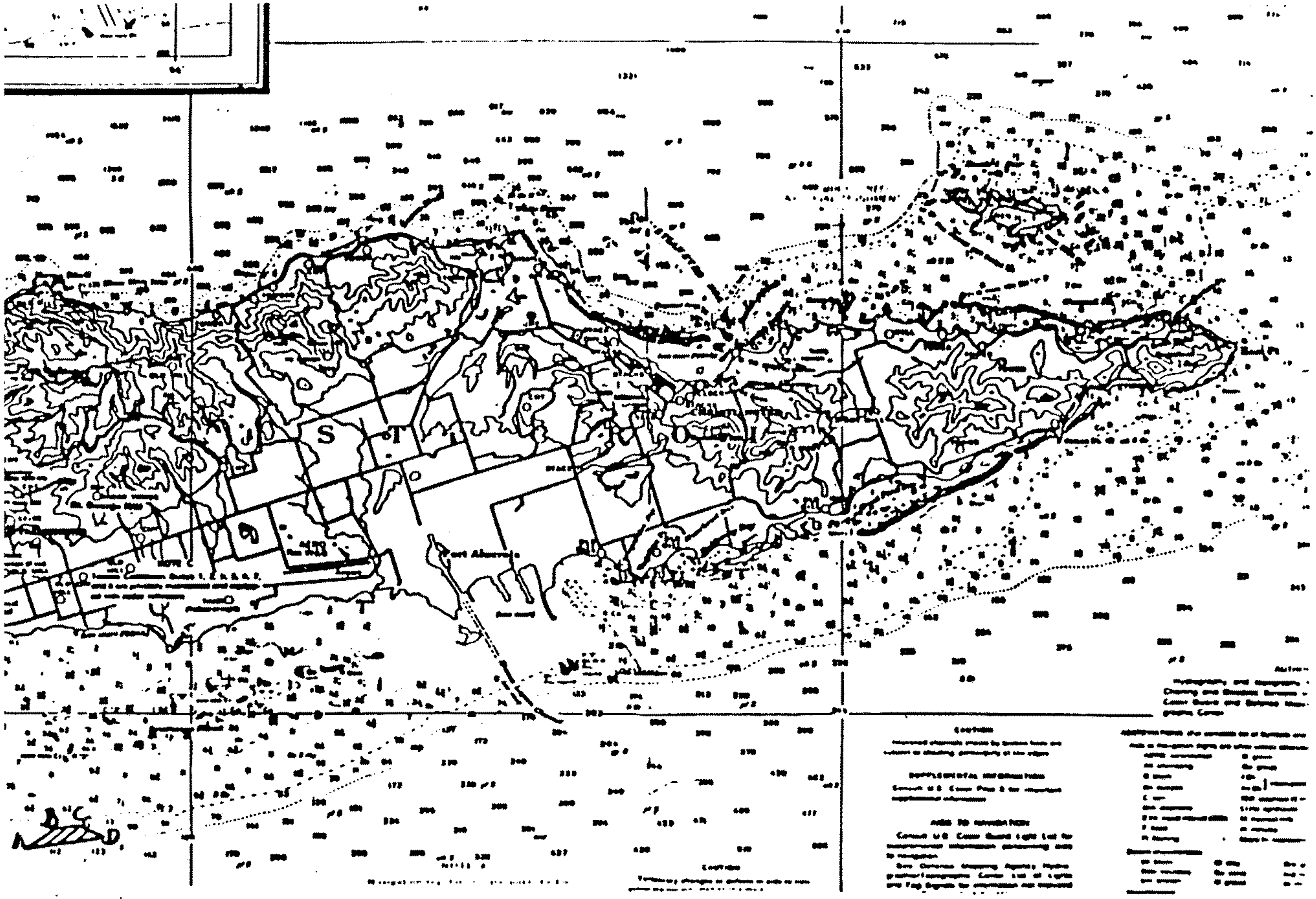


FIGURE 3. PROPOSED MUTTON SNAPPPER AREA CLOSURE -- ST. CROIX



M. APPENDIX II -- LETTERS RECEIVED DURING COMMENT PERIOD

[illegible]
[illegible]
[illegible]
26 Federal Plaza
New York, New York

FEB - 1 1993

JAN 22 1993

Mr. William W. Fox, Jr.
Assistant Administrator for Fisheries
National Marine Fisheries Service
Silver Spring Metro Center #1
1335 East West Highway
Silver Spring, Maryland 20910

Class: LO

Dear Mr. Fox:

The Environmental Protection Agency (EPA) has reviewed the draft supplemental environmental impact statement (EIS) for Amendment 2 to the Fishery Management Plan (FMP) for the Shallow-water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609 12[a] 84 Stat. 1709), and the National Environmental Policy Act.

EPA commented on the project's final EIS on August 19, 1985. Since that time, the Caribbean Fishery Management Council (CFMC) has determined that various shallow-water species should be protected from over exploitation when they aggregate for spawning, and that the protection should be extended to the deep-water reef fish fishery. With this in mind, the National Marine Fisheries Service (NMFS) has prepared the draft supplemental EIS to address this project's modifications. Specifically, the proposed Amendment 2 to the FMP adds approximately 120 species to the management unit, and implements a variety of other management measures. Based on our review, we offer the following comments.

Overall, we believe the FMP will provide environmental benefits to aquatic resources. In particular, the ban on chemicals such as chlorine, formaldehyde, gasoline, and quinaldine for capturing marine aquarium fish will reduce mortality rates of target species and reduce impacts to reef resources. Moreover, the prohibition of collecting gears such as barrier, gill, drop, or cast nets reduces the potential for damaging reef habitat. In a related matter, we concur with the establishment of marine coral reserves at strategic locations within the management area. We believe this measure would help maintain biodiversity by ensuring recruitment into the surrounding sea.

Reef closures should be emphasized as an important part of the amendment even though specific reef sites are not named. In addition to their clear importance in stock maintenance, fishery reserves provide a natural system, which does not otherwise exist, for the study of population dynamics of snapper-grouper species. Reef closures should be an important component in accomplishing the original plan objective of obtaining the necessary data for stock assessment and for monitoring the fishery. In addition, a study conducted by the South Atlantic Fishery Management Council shows that non-consumptive uses (i.e., diving opportunities) can be an economically competitive benefit that is enhanced by reserves. We strongly endorse Option 13 to establish a strategic system of coral reef reserves in the management area.

Thank you for considering our views.

Sincerely,

David Allison
Director, Fisheries Conservation Program
Center for Marine Conservation

Kathleen Sullivan
The Nature Conservancy

ESTADO LIBRE ASOCIADO DE PUERTO RICO
Departamento de Agricultura
SAN JUAN, PUERTO RICO 00908

25 de enero de 1993

Sr. Miguel Rolón, Director Ejecutivo
Consejo de la Administración
Pesquera del Caribe
Banco de Ponce, Suite 1108
Hato Rey, PR 00918

Estimado señor Rolón:

Luego de asistir a dos vistas públicas, leer y analizar el documento sobre el Plan de Manejo Pesquero tenemos los siguientes comentarios:

1. Entre los cambios que incluye este documento está la prohibición para la captura de peces marinos de acuario o de importancia comercial, especialmente en su etapa juvenil. Estamos de acuerdo con la medida, siempre y cuando el lenguaje utilizado sea más específico pero no amplio y vago, lo cual puede traer malas consecuencias para el desarrollo de la acuacultura.

   El uso de técnicas acuícolas puede mejorar las poblaciones naturales y servir para producir peces de acuario. Sin embargo, estos dos usos podrían verse afectados por la reglamentación propuesta, si se aprueba tal y como está redactada.

   Por lo tanto recomiendo que se modifique el lenguaje utilizado para que se permita capturar especies marinas para utilizarlas como padrotes en un laboratorio o para propósitos de investigación científica. La autorización de estos permisos debe recaer sobre el Departamento de Recursos Naturales y/o el Programa.

2. Se debe limitar la captura o colección de especies marinas de acuario a las redes de mano (balayo) y a la pistola de succión. La utilización de agentes químicos, como la quinaldina, para la captura de organismos acuáticos es prohibida en Puerto Rico.

3. El Programa se opone a que los pescadores comerciales tengan que construir dos escapes a sus nasas. Con la que construyen para despescar su nasa es suficiente. Pero los amarres de esa puerta deben de ser de un material que su vida útil no sea más extensa que la de la nasa para que de esta forma si se extravía no destruya los peces y mariscos que capture.

4. No se debe cerrar para la pesca las áreas de agrupación de desove de los peces, propuesto por el plan sin tener suficientes datos para constatar que se le está haciendo daño al recurso. Hay que tener en cuenta que en esta epoca es cuando único las capturan en abundancia y el cierre total va a ser en detrimento para muchos padres de familia.

   El Programa no recomienda el cierre de estas áreas hasta tanto no se tengan datos que prueban que esta acción de los pescadores está, o es la que está afectando estas especies. Además, no creemos que estos cierres deben ser por un periódo tan extenso de tiempo como lo propuesto por el plan.

   Una de las especies que realiza estas agrupaciones y requiere ser reglamentada, es el mero diente de sable o tigre (Mycteroperca tigris). Esto ocurre en las aguas de la Isla Nena. Los pescadores que capturan este mero en esta época son los de Vieques. La única vista pública celebrada en la costa Este de la Isla fue en Fajardo a las 7:00 p.m. Esto imposibilitó a los pescadores viequenses a asistir a la misma. Lo más prudente que puede hacer el Consejo de Pesca es celebrar vistas públicas en la Isla de Vieques ya que van a ser los más afectados por esta medida.

5. La prohibición de la pesca del mero sapo (Epinephelus itajara) no va a traer un mayor impacto en la pesca o a los pescadores comerciales. Esta es una especie cuya captura es mínima. Por lo tanto, el Programa está a favor de la misma.

6. La introducción de especies exóticas debe de ser reglamentada por el Departamento de Recursos Naturales. Hoy en día no existe reglamentación y la venta e introducción de especies marinas exóticas a nuestra isla se encuentra sin ningún tipo de control.

   El Programa entiende que la implantación de la reglamentación en la entrada de éstas especies exóticas tiene que llevarse a cabo por el Departamento de Recursos Naturales lo antes posible.

7. Entendemos que la extensión que sugiere el Consejo de la Administración Pesquera del Caribe en ampliar el Plan de Manejo de Peces de arrecifes somero hasta las de aguas profundas (300 brazas) va a ampliar demasiado los objetivos del mismo. Reconocemos que ampliar este Plan de Manejo disminuirá los costos incurridos por el Consejo. Pero nos preocupa la planificación e incorporación del manejo de los habitáculos tan diversos como son los de aguas someras y profundas.

Recomendamos al Consejo buscar la forma de que más pescadores comerciales asistan a estas vistas. En las celebradas en el área Oeste solamente nueve pescadores comerciales asistieron. Puede ser el local donde se realizan, el área, la hora, el lenguaje utilizado en el texto o la citación a las vistas.

Entiendo que se debe de explicar con lujo de detalle cómo se llevará a cabo. Hasta tanto esto no se logre el Programa no recomienda esta ampliación.

Sin nada más a que hacer referencia, quedo

JAIME GONZALEZ AZAR
Director Ejecutivo PFDAP

Mr. Jaime Gonzáles Asar
Executive Director
Fishery Development & Administration Program
Department of Agriculture

<u>Unofficial Translation</u>
<u>77th Meeting</u>

1. Among the changes included in this document is the prohibition to harvest aquarium marine fishes, or juvenile fish of commercial importance. We agree with the measure, as long as the language used is more specific, and not extensive and vague, which can bring bad consequences for the development of aquaculture.

   The use of aquaculture techniques can enhance natural population and can be used to produce aquarium fishes. Nonetheless, these uses can be affected by the proposed regulation, if it is approved as it is. 13

   We recommend modifying the language used, to allow for the capture of marine species to be used as sires brood stock in a laboratory or for scientific purposes. The issuing of these permits should be the responsibility of DNR and or the Program.

2. It is necessary to limit the capture or collection of aquarium marine species to hand net (balayo) and slurp guns. The use of chemical agents, such as quinaldine, for the capture of aquatic organism, is prohibited in Puerto Rico.

3. The Program opposes the use of two escape panels for the traps. It is enough with the door used now to unfish their traps. However, the material used to fasten these doors should not last more than the trap itself to prevent that, if the trap is lost, it will not continue to catch fishes. 12

4. Fish spawning aggregation areas should not be closed to fishing without having enough data to prove that the resources are being affected. During the spawning season, catches are abundant and a total closure could affect many families that depend on these resources. 5

   The Program does not recommend a total closure of these areas until there is enough data to prove that the fishermen actions are, or could be, affecting these species. Also, we believe that these closures should not be for the lengthy period proposed by the Plan.

   One of the species that aggregates and which requires regulation is the tiger grouper. They occur in the Vieques 7 area. The fishermen who capture this grouper during this season are from Vieques. The only public hearing in the east coast was held in Fajardo at 7:00 p.m. This made it impossible for the Vieques fishermen to attend. What the Fishery Council should do is hold public hearings in Vieques since they are the ones most affected by the measure.

5. The prohibition to fish the jewfish will not have major impact on commercial fishing or fishermen. This species is one of the least captured. Therefore, the Program is in favor of the same.

6. The introduction of exotic species should be regulated by the Department of Natural Resources. Today there are no regulations and the sale and introduction of exotic marine species in our Island is not being controlled.

   The Program believes that the implementation of regulations for the introduction of these exotic species should be done as soon as possible by the Department of Natural Resources.

7. We understand that the suggestion of the Caribbean Council of extending the Shallow Water Reef Fish Fishery Management Plan to deep waters (300 fathoms) will expand too much its objectives. We know that expanding the Management Plan will reduce costs incurred by the Council. However, the management of such different habitats as are shallow and deep waters is of concern to us.

Our recommendation to the Council is to find a way to make possible that more commercial fishermen attend the hearings. Only nine fishermen attended the ones held in the West Coast. There can be a problem with the place used, the area, the time, the language used in the text, or the hearings notices.

It should be explained in detail how it will be held. Until these details are done, the program does not recommend this expansion.

18 January 1993

Miguel Rolon, Executive Director
Caribbean Fisheries Management Council
Suite 1108, Banco de Ponce Building
Hato Rey, Puerto Rico 00918

Dear Mr. Rolon:

On behalf of the St. Croix Fisheries Advisory Committee (STX-FAC) we wish to thank you for the opportunity to address the proposed measures to Amendment 2 of the Shallow Water Reef Fish FMP at the public hearing held December 29, 1992 on St. Croix. The STX-FAC fully supports the endeavors of the Caribbean Fishery Management Council (CFMC) to preserve and protect the region's fisheries resources for continued maximum yield by conservation and active management of those resources within the management area. Likewise, the STX-FAC has a similar mandate for fisheries resources within the territorial waters surrounding St. Croix

The STX-FAC would like to address additional comments to proposed measure 8 of Amendment 2 to the Shallow Water Reef Fish FMP, which states:

"Closure of additional red hind spawning aggregation areas during December through February spawning season, as follows:

(b) Another spawning area in the EEZ, east of St. Croix, U.S. Virgin Islands, at the extreme eastern end of Lang Bank, which is bounded by rhumb lines connecting the following points:

POINT	Latitude N	Longitude W
A	17°50.4'	64°28.5'
B	17°50.7'	64°25.8'
C	17°49.5'	64°25.5'
D	17°48.3'	64°26.0'
E	17°47.4'	64°27.5'
F	17°50.4'	64°28.5

The STX-FAC endorses the proposed closed season and closed area for the red hind spawning aggregation in the EEZ east of St. Croix, as specified in Amendment 2 #8(b). We recognize that continuous fishing pressure by traditional fish traps and handline techniques on the spawning aggregation of red hind will result in further population declines in the inshore territorial waters. The continual harvest from the spawning aggregation by relatively few fishermen will result in a great loss to many fishermen.

The proposed red hind spawning area closure encompasses approximately 12 sq. mi. at the head of Lang Bank, east of St. Croix. The spawning aggregation occurs in waters 10-30 fathoms in depth (60-180 ft.). Waters seaward of the spawning aggregation area, those beyond 50 fathoms in depth (300 ft.), support active deep water snapper and pelagic fisheries. In fact, the end of Lang Bank serves as a "natural" fish attracting device.

Deep water snapper and occasionally some deep water grouper species are harvested by handline and vertical set line techniques. Trolling for pelagic species is very popular along the edge of Lang Bank between 50-100 fathoms water depth (300-600 ft.). A substantial commercial and recreational (charter and sport) fishery exists for large migratory pelagics (tuna, dolphin, wahoo, marlin) during the same period at which the red hind aggregate for spawning. December through February also coincides with the peak tourism season, which is the mainstay of the charter vessel fleet. The inability of these commercial and recreational fisheries to continue seaward of the 50 fathom (300 ft.) contour, during the red hind closure period, will pose additional adverse socio-economic impacts during existing austere economic times.

In order to allow the deepwater snapper and pelagic trolling fisheries to continue during the red hind closure period, the STX-FAC would like to make the following recommendations:

(1) The red hind spawning aggregation area, delintated by the boundary points descibed in Amendment 2 #8(b), be closed to all fishing in waters less than 50 fathoms depth (300 ft.);

2

(2) The possession of any shallow water reef fish species, as listed in the Shallow Water Reef Fish FMP, within the closure area shall be prohibited, with the exception of the following species:

black snapper (*Apsilus dentatus*)
queen snapper (*Etelis oculatus*)
blackfin snapper (*Lutjanus buccanella*)
silk snapper (*L. vivanus*)
wenchman (*Pritipomoides aquilonaris*)
vermilion snapper (*Rhomboplites aurorubens*)
yellowedge grouper (*Epinephelus flavolimbotus*)
red grouper (*E. morio*)
misty grouper (*E. mystacinus*)
tiger grouper (*Mycteroperca tigris*)
greater amberjack (*Seriola dumerili*)
almaco jack (*S. rivoliana*)
blackline tilefish (*Caulolatilus cyanops*)
sand tilefish (*Malacanthus plumieri*).

The 14 species listed above are the major components of the deep water reef fish fishery.

(3) Fishing for deep water reef fish species, as listed in (2), with handlines and vertical set lines and trolling for migratory pelagic species:

blackfin tuna - *Thunnus atlanticus*
yellowfine tuna - *T. albacares*
skipjack tuna - *Katsuwonus pelamis*
little tunny - *Euthynnus alletteratus*
king mackeral - *Scomberomorus cavalla*
wahoo - *Acanthocybium solanderi*
dolphin - *Coryphaena hippurus*
blue marlin - *Makaira nigricans*
sailfish - *Istiophorus albicans*
white marlin - *Tetrapturus albidus*
spearfish - *T. pfluegeri*

shall be permitted in waters seaward of the 50 fathom contour.

2

Thank you once again for the opportunity to allow us to address this most important issue and to jointly manage our valued fisheries resources.

Sincerely yours:

Elizabeth H. Gladfelter, Ph.D.
Chair, St. Croix Fisheries Advisory Committee

Jose Sanchez
Vice Chair, St. Croix Fisheries Advisory Committee

Board Members, St. Croix Fisheries Advisory Committee

cc: Mr. Roy Adams, Commissioner, Department of Planning and Natural Resouces
Mr. Eric Dawson, Commissioner, Department of Economic Development and Agriculture
Ms. Ann Seiler, Director, V.I. Division of Fish and Wildlife

I

Fernando Correa Chino

Apreciado Amigos

Pues Enpezare diciendole que yo En Las Cosas de La Pesca yo No me voi A Oponer A Lo que ustez cred. Pero si Le dire que yo si tengo Proebas que Muchas Cosas de Lo que ustedes estan Por Hascr estan Mar Pero ustedes son Los que decid y Brecar con Los Pescador No es Facir Porque unos quieren una Casa y Los otro quieren otra yo tengo unos Video de Los Tiradore de taraya otros de Pescadore de Azuelo En Los Mueble otros tirandole Piedra A Los Pescado otro con Chichoro de Camarones Matando toda La Criansa y El mas Malo el chichoro de Arastre Hector tu Save como eso Mata el Pejes y no Notifique.

II

A Rueña y no iso Nada
Pero el si me contesto
Cuando yo se estaba Aser
cando las Eleciones y
Mira que yo si ledi
quejas Pues yo iba Aser
o tratar de aser una
canferencia de Prenza Para
que el Pueblo supiera la
Verda Hector yo me boi
A orvidar de esto Porque
yo se y confio En que esta
Nueba Aministracio Preque
Vien y yo boi Ablar con
los pescadore Aver si
estan conforme con copera
y dar los estaditicas Vien
o ustedes Puede coger A un
Pescador Para que trabaje
en esto tu save que ay
Mucho Pescadores que No
dan los estadisdica Vien
y otro las dan Mar Para
Apareser Asi como Pescado
por si viene un tenpor

III

Pero esto, si te digo
y estoi Ablando con
todo hos de Sur Pique
tu save que yo si Conosco
A Casi todo hos Pescadores
subre has hachas del
Covierno que se las
dieron A Muchos Por
Fabores Pohiticos como
en Salinas A ho derbahe
A Nachito eh Precidente
de Salinas Pues eh No es
Pescador y tu ho Saves
A Mihhan eh de dacua
Pues eh No es Pescador y
ho que Ase es he hebantan
do NASA Agenas Pescador
de caLa es boro Perrihhan
y otros que yo Conosco
esa Lancha se has dieron
A Gente que No Save NADA
Por eso es que Fracasan

yo tengo video de todos
hos Pescadores y que
MATANZA de LANCOSTINE

IIII

dios Mio yo No los Curpo
Porque yo se que todo Necesi
Mos. Pero tu save lo que
Asen los buzo Acoralan
A las piedra con un Chinch
y Acaban con todo eso
Lo Ase los dominicano y
otros de aqui tanuien
Hector tiene que Auer un
Plan de Pesca y Pronto

HEctor Vega

Aqui esta la Prueba del
Señor Rogena de que si
el savia y No y so Nada
que Clase de direstor
Por eso yo lo iba Aser con
Pruebas si el Canaba de
Nuevo Pero Cojio el Mont
dale Recuedo de mi Parte

dile que todo
le Salga mal

IIIII

el Mero diente de sable que
es de Entrada. Mira Hector
te boi A decir Cuales estan
en Peligro Porque tu saues
que yo soi. un Pescardo que
e CAMIÑAdo, Mucho el loro
LA PAlometa el chapin LA
Pluma el Mero chesna el
Callo el Purpo ustede. Saue
que el Purpo si es el Primer
que Ai que Protege si quedan
Arcuno La Culirouia Ay Mucha
Porque es an Pege Jarisco y
solo de Azuelo se Cage No como
Lo demas el Robalo LA
JArcA y otros si ba Aser
Santuario Ay que dejar un
Par de Islas tanuie No toda
Para turismo Como esta Pasando
que el Garey No tiene tonde
Anidar y lo que Ase es destru
chendo todo el Auiente Como
en CAJA de Muerto y Carocoles en
SALINAS

IIIIII

de Los ArcFicc Para Proteger
eL pege Lo Primero que Ai
que Acer es Sacar Los buzo
Pues A Los ArcFicc es que
todo eL Mundo ba A pesca
Por que Nadie ba A Pescar
en Arena. Pues tu Save que
Ai No ay Nada. y Mira te digo
que Lo pelan Le dira Asta
Los Medi~~c~~os Pues yo estoi
de Acuerdo en Lo que Se
dijo. en Acer SantUario
Para Protejer eL Pege Pero
No eL Mero diente de Sable
Ni La Cuaba Porque ese
Pege ay Mucho y La Cuasa
Nadie La Pesca Porque tu Save
que eso es de Ondo. eL Mero
Sapo Si Porque esó si esta
en Pelicro tu Save Porque
Pues Aqui Los buzo Lo trai
todo Los dia y tu Save que eL
Mero es de Viviend a No como
~~el otra~~ A

Thomas H. Daley
Post Office Box 1382
Kingshill, Virgin Islands 00851-1382

JAN 25

January 14, 1993

United States Department of Justice
National Oceanic and Atmospheric Administration
Caribbean Fishery Management Council
Suite 1108 Banco De Ponce Building
Hato Rey, Puerto Rico 00918-2577

Dear Sir/Madam:

The following correspondence is being submitted to you in response to the proposed closure of Long Bank.

When closure for Long Bank was first proposed, the facts I presented then to the counsel. They gave the assurance that it would be taken off their agenda until they could have made proper study of the area. Once again, here are the facts:

(Please check chart)

Long Bank

"Rolls in Bad Weather"

Rolling months here are from October to April. Except for the passing of hurricanes, the roughest months are December to April.
"Check Weather Bureau"

These months cover the spawning months for Red Hind and Nasau Grouper. So, because of the bad weather, distance out, choppy seas and strong current, fishermen hardly go fishing in that area during these months.

4

"Hurricane"

The natural phenomena that nature uses as a gardening for the seas or clean up of our environment.

"Hugo"

It must be remembered that inspite of immense damage done to our trees and many thought they would have died they came back. If we had cut those trees, they would have died, but, because it was nature's doing they came back. The very trunks and even the roots spring new leaves and our growth is back even better than before. So, true also, is the sea. The only difference is man lives on land and has to wait to see what happens on the

Facts:

Many species that were thought to be scarce are now showing up in good numbers and those that were here are even in greater numbers.

Example:

(Lobster) More lobsters are now being caught on St. Croix than has been in the last 15 years. In the proposed closure area I am averaging 100 per week. (Tuna) The market here on St. Croix is flooded with Tuna. Fishermen are limiting the amount they catch for fear of sale.

We should expand by planting attractors and education on Long Line. There is a buoy 8 miles North of St. Croix. It is individual lobbying from fisherman with the company who owns the buoy who now not doing business. On St. Croix, that may make it possible to remain.

Hawaii has done it and it works, why can't we instead of "Thou shalt not do this and do that". Let the counsel be remembered as the group of men who helped to make the industry what it could be.

I say let us preserve through expansion, plant more fish attractors, get more fishermen away from shelf reliance and re-educate the public that larger fish can be just as tasty and nutritious.

Suggestions

I know that our counsel has a reputation of taking a hard stand on conserving. It is that same hard stand I am asking the counsel to take, only, this time, to save a dying industry. Instead of making tougher and tougher laws that would certainly kill the industry they conserve through expansion. They should table all proposal and take a hard look at the industry after Hugo.

Area Closure

Should only be done when decrease in stock or size is visible by overfishing. In the Long Bank area, these are not true. The Hind that spawn on Long Bank has an average of over 2 pounds and sometimes as big as even 6 pounds. These Hind only come to the area for spawning and are never again seen in fishery around St. Croix.

Because of conditions earlier stated, there are only 3 fishermen, with a total amount of less than 200 traps. This is prime area for lobster fishing, which is all year round peaks form October to April. I average better than 100 pounds per 8 day set. At peaks, the other fishermen catch report can be obtained if true reporting has been done. You see this is a small area and reporting like this could create overfishing on long bank.

"Take a good look at St. Croix"
Post Hugo

Un official Translation

Mr. Fernando Correa - Puerto Rico - (Jan 12)

-Many of the items to be approved are not good. He has videos that show fishing with (taraya), with hooks, people throwing stones to the fishes, and (chinchorro) killing the shrimp fishery, and of (chinchorro de arrastre).

-He offered to hand the statistics to the fishermen convince them. Some of them do not release the information, and others give inaccurate numbers, only to be counted as fishermen in the event that a hurricane hits.

-The Government gave boats to people who do not have fishing skills, as political favors. (He mentioned some names.)

-He has videos of fishermen killing small lobsters. He thinks the divers use (chinchorro) nets (in the stones), and deplete everything. There are persons from the Dominican Republic and Puerto Rico.

-A Fishery Management Plan is needed, very soon.

-He sent a letter to Mr. Rohena, and he understands that he knew about this situation and did not do anything.

- He thinks that the species in danger are: (el loro, la palometa, el chapín, la pluma, el mero chesna, el callo, el pulpo). This last one needs urgent protection.

-The (colirrubia) is abundant, because is an elusive fish that is best taken with hooks, not like the (róbalo, jarca) and others.

-If a sanctuary is to be established, at least a pair of islands should be left, and not use all of them for tourism. Everything is destroyed--the turtle does not have where to nest. The ecosystem is destroyed, like in "Caja de Muerto" and the shells in Salinas (Puerto Rico).

-To protect the fish the first thing to do is to get the divers out of the reefs. They fish at the reef and even doctors comes.

-He agrees with sanctuaries to protect fish, but not tiger grouper or (la guasa), because there is abundance of tiger grouper, and (la guasa) is not usually taken, because it is a deep-water fish. 9

-Agrees that (el mero sapo) is in danger. The divers take them daily. (El mero es de vivienda.)

(Mr. Correa sent copy of a letter he received from Hon. Santos Rohena, dated October 22/92).

9000 CONTENTMENT ROAD, SUITE 9
CHRISTIANSTED, ST. CROIX
U.S. VIRGIN ISLANDS 00820

Mary-Ann Pickard
SENATOR

P O BOX D
(809) 773-2424

January 21, 1993

JAN 22 1993

Miguel A. Rolon
Manger
Caribbean Fishery Management Council
Suite 1108
Banco De Ponce Building
Hato Rey, Puerto Rico 00918-2577

Dear Mr. Rolon:

My office was informed of your meeting to be held on the closing of the Long Bank Fishing site on January 25, 1993. As a Senator, this causes me great concern for the plight it will bring on my people. I am especially concern for the people who depend on fishing for a living on the island of St. Croix in the U.S. Virgin Islands.

Our economy will not permit us to find alternate work for the fishermen should this closing take place. We have already lost the southern grounds to the larger industries such as Hess and Vialco, and to lose this avenue of a livelihood for the fishermen would be disastrous.

I am requesting that you do not make any final decisions at this time which will allow time for my office to investigate alternative means to this situation.

Sincerely,

Mary Ann Pickard
Vice President

cc: Hon. Alexander A. Farrelly
Delegate to Congress/Ron De Lugo
St. Croix Commercial Fishermen

skov fishing co.

JENS P. SKOV

P.O. BOX 2879 • #16A QUEEN STREET, CHRISTIANSTED, ST. CROIX, V.I. 00822
(809) 773-4571 • (809) 773-9446

Mr. Miguel A. Rolon, Executive Director
Caribbean Fishery Management Council
Suite 1108
268 Munoz Rivera Ave.
Hato Rey, P.R. 00918
19 January 1993

Dear Mr. Rolon,

I am writing to you in regards to Amendment Two To The Fishery Management Plan For Shallow Water Reef Fish Of Puerto Rico and The U.S.Virgin Islands. My concern is with the area to be closed in the EEZ east of St. Croix at the eastern end of Lang Bank, Ammendment 8b.

I am in agreement that the spawning aggregation of the red hind should be closed to all fishing, however by closing the entire area to fishing poses an economic hardship on our fisherman. Fisherman fishing for pelagics and deep water snapper would be unable to fish this vital fishing area due to its location. This area of Lang Bank is a natural fad which attracts the pelagics and is fished by sport, commercial, and recreational fisherman on a daily basis. Fisherman from all of these areas would suffer economically if this area were to be closed to them, sport fisherman or charter fisherman would lose a prime area during the height of our tourist season, commercial fisherman would also be affected when the pelagic and snapper are most in demand by our hotel and restaurants, and recreational fisherman would not be able fish and have their occasional fresh fish dinner.

The closing of this area at this specific time coincides with our Tuna, Dolphin and Snapper season. What I suggest would be to close this area only to the 50 fathom drop or ledge where the hind spawning grounds would not be affected. 3

skov fishing co.

JENS P. SKOV

P.O. BOX 2879 • #16A QUEEN STREET, CHRISTIANSTED, ST. CROIX, V.I. 00822
(809) 773-4871 • (809) 773-9446

Another suggestion would be that anyone caught in the area in possession of a red hind would be in violation, no matter where the fish was caught.

I am totally in agreement in closing the red hind spawning aggregation, but cannot justify what would be accomplished by closing down a very lucrative fishing area for other species of fish which are not being overfished. 3

In addition, in amendment 3 the requirement that fish traps be constructed with two escape openings is completely unfounded. The door if fastened with the correct material will open on a ghost trap and be an escape panel and if the trap falls on its side the funnel will serve as an escape hatch. This is known by all fisherman who fish traps and has been expressed by myself and others at various times to the Council. The scenario of a trap falling on its side and being wedged between coral cutting off the two means of escape that I stated above is highly unlikely. 12

We hope that this letter is given a good amount of consideration and that a compromise beneficial to all can be made.

Sincerely,

Jens P. Skov

Jens P. Skov, Fisherman
C.F.M.C., A.P.Member
St. Croix Fisheries Advisory Panel Member

cc:St. Croix F.A.C.
JPS/pas

Asociación de Pescadores
Puerto Real - Fajardo, Inc.
Box 515 Puerto Real
Fajardo, Puerto Rico 00740 Tel. 863-2641

23 de diciembre de 1992

Consejo de Adm. Pesquera del Caribe
Banco Popular Suite 1108
Hato Rey Puerto Rico 00918

Re: Diego Mitchell Rivera
Presidente de la Asociación de Pescadores
Fajardo Inc.Playa Puerto Real
Fajardo P.R 00740

Exponiencias de Diego Mitchell Rivera
en vistas publicas, el 23 de diciembre de
1992, en el Mesón Criollo

Señor Presidente ó Representante del Consejo:

Comienzo mi exponiencia con algunas preguntas:

- ¿Que tiempo hace que se descubrió el mero tigre ó diente sable?
  ¿De donde viene ó que saben de éste pez?

- ¿Que estudio se ha hecho para tomar esa determinación tan drástica?
  ¿Cual es el tamaño maximo?
  ¿Cuál es la estadía de éste pez aqui?
  (Digo drástica porque se cierra el área a toda pesca.

- ¿Porque se cierra el área a toda pesca, si no se hizo asi con el mero cherna?

- ¿Saben ustedes lo que quiere decir este cierre a la pesca de este pez?

Que Puerto Rico se presta para cuidarle los peces a los pescadores de Estados Unidos y cojer la escasa plataforma que tenemos para criadero de peces, para los Norteamericanos.Me explico, los peces vienen de lo hondo hacia la plataforma, los americanos pueden bregar con estos cierres porque tienen suficientes plataformas y buenas enbarcaciones para pescar. Y los pescadores tienen buen apollo de parte del gobierno, no asi los pescadores puertorriqueños, no tenemos suficiente plataforma, ni apollo del gobierno.

It is un-American to create hardship on a people where it is not necessary and to close down an entire fishery for one species. Especially, it is not proven that overfishing is being done. Each island in the Caribbean has its distinct difference. St. Croix, because of its Geographic location from the rest of the island has a smaller shelf, yet many species that are scarce in other area are in abundance."

The fishermen of St. Croix have suffered immensely and are asking the counsel to take a good look after Hugo. Knowing that we have lost the entire South Side to Hess Oil, which is still expanding and West of Christiansted to LaValle to recreational divers.

Difference

St. Croix does not have the tourism that Puerto Rico and the rest of the Virgin Islands have, but we have deep waters close to our shore line. Let the Counsel, together with our Governor and Legislature petition Hess, WAPA, etc., those agencies who are responsible for the impact on our environment to help plant some attractor buoys. The people of Hess Oil Virgin Islands, etc., have always been very generous to our community needs and they will be especially now that this is a part of their doing.

Thank you in advance for your cooperation and expeditious attention to this matter.

Please feel free to contact me at the above address or telephone (809) 778-[illegible]38, if additional information is needed.

Sincerely,

[signature]

Thomas H. Daley
Commercial Fisherman

cc: Governor Alexander Farrelly
Virgin Islands Legislature
Delegate to Congress Ron De Lugo
Virgin Islands Water And Power Authority
Hess Oil Virgin Island
Department of Conservation
St. Croix Fishing Advisory Panel
St. Croix Commercial Fishermen

ENCLOSURE

December 23, 1992 :

Caribboan Fishery Management Council
Banco Popular Suite 1108
Hato Rey, Puerto Rico 00918

Letter from Diego Mitchell Rivera
President of the Fajardo Inc. Fishermen
Association, Playa Puerto Real
Fajardo, Puerto Rico 00740

Mr. President or Council Representative:

I will begin asking a few questions:

1. How long has it been since the tiger grouper was discovered? Where does he come from, and what do you know about him?

2. What studies have been made to take such a drastic determination?
   What is the maximum size?
   For how long does this fish stay in our waters?
   I mentioned is drastic measure because you are proposing a total closure to this fishery?

3. Why are you proposing a total closure to the tiger grouper fishery, if it was not done that way with the red hind?] 6

4. Do you know what this closure means to the fishery of this fish?
   It means that Puerto Rico saves the fishes to the fishermen of the United States, and use our scarce platform as fish nursery for the americans. Let me explain myself, the fishes come from the depth to our platform, the americans can deal with these closures because they have enough platforms and good vessels for fishing, and they also have help from the government, unlike the fishermen from Puerto Rico, we do not have enough platform neither enough government help.

   That is why, as leader of the fishermen I am opposed until a convincing study that prove the need of an area closure for the tiger grouper is done.] 6

   I am opposed because NOAA is having no consideration with the Puerto Rican fishermen, and it has a tremendous economic impact on the platform fishermen. I hope that the Puerto Rican government take into consideration the presentations of the Puerto Rican fishermen and that they legislate to protect them and not the american fishermen. That a study be done by Puerto Rican scientists together with the fishermen, so that we can do whatever is convenient and reasonable, and if an economic impact is necessary, then lessen it the most possible.

or lo tanto como lider de los pescadores me pongo hasta se haga un studio combincente que pruebe la necesidad de un cierre al área de esobe del pezdiente sable ó merotigre.
Me opongo porque es una falta de consideración de la N.O.A. a los pescadores puertorriqueños y porque produce un inpácto económico tremendo a los pescadores de la plataforma. Espero que el gobierno de P.R tome consideración, las ponencias de los pescadores puertorriqueños y legisle protegiendo a los pescadores puertorriqueños y no a los americanos. Que se haga un estudio por los científicos de P.R en conjunto con los pescadoresyy entre todos hagamos lo que sea conveniente y razonable y si es inevitable un inpacto económico que sea lo menos posible.

Diego Mitchell Rivera.

Representante Augusto Sanchez
Senadora Luisa Lebrón

The Nature Conservancy

1815 North Lynn Street
Arlington, Virginia 22209
(703) 841-4860
Fax: (703) 841-4880
Fax: (703) 841-1283

Latin America Program

RECEIVED JAN 2 1993

FACSIMILE

This is a 3 page document, including this cover sheet.

Date: 1/25 Time: ________

PLEASE DELIVER IMMEDIATELY TO:

NAME: Miguel Rolon

COMPANY: Caribbean Fisheries Council

FAX: 809 766-6239

SENT BY:

NAME: Kathleen Sullivan

COMPANY: TNC

FAX: (703) 841-4880

MESSAGE:

If there is a problem with the transmission, please call Susan at (703) 841-4860.

Center for Marine Conservation

January 25, 1993

Miguel A. Rolon
Executive Director
Caribbean Fishery Management Council
Banco de Ponce Building, Suite 1108
Hato Rey, PR 00918

Dear Mr. Rolon:

The Nature Conservancy and the Center for Marine Conservation are writing jointly to comment on Amendment 2 to the Fishery Management Plan for the Shallow-water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands. Our organizations are concerned that current management measures are not sufficient to halt the decline in reef fish populations. We have concluded that several of the preferred options in the proposed amendment are essential if the original plan's objectives are to be achieved and, consequently, we strongly support options 1, 2, 5, 6, 7, 8, 10, 11, 13, 14, and 15.

Based on the experience resulting from marine fisheries reserves at several tropical sites, we support the proposed protection of spawning aggregations and the establishment of a strategic system of reef closures. The best available science shows that marine fisheries reserves are an effective tool in protecting fish stocks and are perhaps the only management measure capable of doing so. In particular, they are demonstrably successful in restoring spawning stock biomass of groupers and snappers. These measures would assure a steady supply of recruits to the fishery and ensure against the possible failure of management measures in consumptive zones to prevent stock collapse. The snapper-grouper fishery is well suited for such management because adults are sedentary, their development rate is slow in many cases, and their reproductive capacity increases significantly with increased size.

The proposed closure of additional spawning aggregation sites for the red hind and mutton snapper is essential to recovery of these species; therefore, we strongly support options 10 and 11. The jewfish appears to be the most seriously impacted species. The severe declines in jewfish abundance must be met with stringent management measures. We strongly urge that the total prohibition against harvest of the jewfish, already established in continental U.S. waters, be extended into the Caribbean management area. We support protection of the jewfish throughout its range.

1725 DeSales Street, NW, Ste. 500 Washington, D.C. 20036 (202) 429-5609 Telefax (202) 872-0619

We also support the NMFS's and the CFMC's efforts to ensure the prohibition of unauthorized introduction of exotic species into marine waters. We believe this measure would reduce the possibility of exotic species displacing the native fauna.

Through discussions with the NMFS, we understand that a coordinated enforcement approach between the U.S. Coast Guard, NMFS, and state units will be used when the proposed amendment to the FMP is implemented. We believe that enforcement will be an important feature to the success of the FMP. Accordingly, we suggest that the final supplemental EIS identify federal and state commitments to enforcement of the proposed FMP amendment.

Based on our review of the draft supplemental EIS, we believe that this project will result in several beneficial environmental impacts. Therefore, in accordance with EPA policy, we have rated the draft supplemental EIS as LO, indicating that we do not object to its implementation.

If you have any questions or wish to discuss this letter, please contact Ms. Laura J. Livingston, Assistant Chief, Environmental Impacts Branch, at (212) 264-8428.

Sincerely yours,

Robert W. Hargrove, Chief
Environmental Impacts Branch

cc: M. Rolon, CFMC

Legislature of the Virgin Islands
1000 Contentment Road, Suite # 2
Senate Building, Christiansted
St. Croix, U.S. Virgin Islands 00820

JAN 2 1

FAX TRANSMITTAL SHEET

Date: January 21, 1993

To: Mr. Miguel Rolon
Executive Director, Caribbean Fishery Council

Fax #: 1-766-6239

From: Senator Holland L. Redfield II

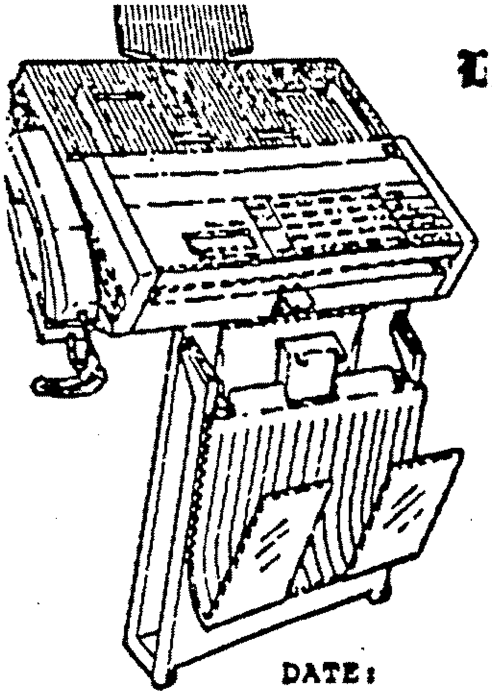
Senate Building - Legislature of the V.I.

Fax #: (809) 773-4748

Telephone #: (809) 773-3510 / 772-7418 / 772-7404

Message: Memorandum: Long Bank Closure and enclosure.

Pages: 5 (including cover sheet)



Legislature of the Virgin Islands

Senate Building, Christiansted
St. Croix U.S. Virgin Islands 00820

P.O. Box "B"

FAX TRANSMITTAL SHEET

DATE: 1-22-93

TO: Miguel A Rolon

FAX# 766 6239

FROM: Mary Ann Pickard
Senator 20th Legislature

FAX# 773-7424

RE:

PAGES: 2
(including cover sheet)

DUPLICATE

Legislature of the Virgin Islands

3000 Contentment Road, Suite #2
Senate Building, Christiansted
St. Croix, U.S. Virgin Islands 00820

(809) 773-7418
(809) 773-7404
Fax (809) 773-4748

HOLLAND L. REDFIELD II
Senator

TO: Mr. Miguel Rolon
Executive Director
Caribbean Fishery Management Council
San Juan, Puerto Rico

FROM: Holland L. Redfield II
Senator
20th Legislature of the Virgin Islands

SUBJECT: Long Bank Closure

DATE: January 21, 1993

Enclosed, please find a facsimile copy from Mr. Thomas H. Daley, who is a commercial fisherman on the island of St. Croix, Virgin Islands regarding the upcoming decision by the Caribbean Fishery Management Council on the closing the Long Bank areas in Puerto Rico and the U.S. Virgin Islands Territory.

I believe the correspondence is self explanatory and refers to my Daley's concern.

As you are aware, we have a brand new Legislature and I am requesting that you delay any decision you have made on the Long Bank Closure so members of the 20th Legislature can review you plan and help make a decision that will better serve the fishermen both on Puerto Rico and the U.S. Territory.

cc: Mr. Thomas H. Daley
File

Legislature of the Virgin Islands

Senate Building
3000 Contentment Suite 2
Christiansted, St. Croix, U.S.V.I. 00820-3469

Gerard Luz James, II
Senator

JAN 27 1993

January 25, 1993

Miguel A. Rolon, Executive Director
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Caribbean Fishery Management Council
Suite 1108, Banco de Ponce Bldg.
Hato Rey, Puerto Rico 00918-3699

Dear Mr. Rolon:

This is in response to your notice for public comment on the proposed management measures which will affect the fisheries around the U.S. Virgin Islands.

The proposed measures were brought to my attention by Mr. Thomas Daley, one of our local fishermen. His primary concern is the closure of Lang Bank during the December through February spawning season of the red hind. Mr. Daley maintains that from December to April very little fishing occurs in that area due to weather conditions and closure is warranted only if there is over fishing. Consequently, your proposed action is unnecessary. However, Mr. Daley stated that in the proposed closure area he has caught an average of 100 lobsters per week from October to April. Thus, closure of Lang Bank would deprive him of income for those months.] 4

I recognize that we must protect our environment and natural resources; however we must balance its interests with those of the fishermen.

Based on Mr. Daley's information, closure would create unnecessary hardship on him and others who rely on fishing for their livelihood.

Please furnish me with the information gathered to support your determination that Lang Bank should be closed during the spawning season of the red hind.

I look forward to your response.

Sincerely,

Gerard Luz James, II
Senator

GOVERNMENT OF THE VIRGIN ISLANDS OF THE UNITED STATES

DEPARTMENT OF PLANNING AND NATURAL RESOURCES

DIVISION OF FISH AND WILDLIFE

LAGOON STREET COMPLEX, ROOM 203, FREDERIKSTED

ST. CROIX, U.S. VIRGIN ISLANDS 00840

30 December 1992

Mr. Miguel Rolon, Executive Director
Caribbean Fishery Management Council
Suite 1108, Banco De Ponce Building
Hato Rey, Puerto Rico 00918

Dear Mr. Rolon:

On behalf of the Division of Fish and Wildlife, I wish to thank the Caribbean Fishery Management Council for their diligent efforts in the development and refinement of the Shallow-Water Reef Fish FMP and the opportunity afforded to comment on the proposed Amendment 2 at the public hearing conducted on St. Croix on 29 December. I would like to submit this letter as a means of written forum to provide comment on Amendment 2 of the Shallow-Water FMP. Comments made herein are to supersede any and all statements made by me on 29 December at the public hearing in relation to item (9) which states:

> Prohibit the harvest of mutton snapper (Lutianus analis) in a spawning aggregation area off St. Croix, from March through June of each year. The area is in the EEZ off the southwest coast of St. Croix, U.S. Virgin Islands, and is bounded by rhumb lines connecting the following points:

Point :	Latitude N.	Longitude W.
A	17° 37.9'	64° 52.6'
B	17° 38.2'	64° 52.1'
C	17° 38.3'	64° 51.8'
D	17° 38.1'	64° 51.4'
A	17° 37.9'	64° 52.6'

Based on information obtained from commercial fishermen and Division of Fish and Wildlife records from 1981, mutton snapper (Lutianus analis) have been harvested for more than 20 years by commercial fishermen from a spawning aggregation off the southwest coast of St. Croix. This aggregation is located between 2.1 and 3.2 nautical miles southwest of Long Point in 10-27 fathoms of water (3-50m). Most commercial fishing occurs at night by handline fishermen in outboard-powered vessels less than 6 m in length; however, fish traps and most recently gill nets have been used to harvest mutton snapper in this area. Weather permitting, more than 30 fishing vessels can be counted nightly for one week after the full moon during the months of March through June fishing for mutton snapper. This fishing effort is most heavily concentrated in 10-15 fathoms (18-27m) of water depth. Catches have been reduced from greater than 500 lbs of fish per boat to less than 100 lbs per highliner. Fish weights have been reduced from greater than 10 lbs/fish (4.5 kg) to 5 lbs/fish (2.3 kg).

Several attempts have been made to locate the spawning aggregation by Division divers/researchers during the day; however, no significant numbers of mutton snaper have been observed above 15 fathoms (27m). Small groups of mutton snapper have been observed by divers in waters deeper than 15 fathoms (27m), but no attempts have been made to assess population numbers in deeper water.

NOAA-NOS chart #25641 (21st edition, December 8, 1990) depicts the boundary line between the Territorial Sea and Exclusive Economic Zone to be very close to the shallow insular shelf platform in the area of the spawning aggregation. As typical of grouper spawning aggregations (Colin et. al., 1987; Olsen and La Place, 1978; personal communication-P. Colin, D. Shapiro, G. Dennis and Y. Sadovy), it is believed that the actual mutton snapper spawning aggregation/event occurs in the deeper waters of the federal Exclusive Economic Zone immediately off the insular shelf edge at depths of up to 27 fathoms (50m). Fishermen do not fish for the snapper in waters off the insular shelf edge due to the steepness of the slope and inability to securely anchor their vessel. Due to the fishing techniques employed (e.g. heavy chumming-highliners using the most chum), mutton snapper are attracted from deeper water up the insular shelf outer slope to the shelf edge. The steepness of the slope affords a relatively short distance for the fish to travel to the awaiting fishermen. The federal waters adjacent to this slope not only serve as the potential site for the actual spawning event but also the ingress/egress corridor used by the fishermen to attract the fish for harvest. The steepness of the outer shelf slope and short linear distance between the 10 and 100 fathom contour requires that the closure area extend from the 10 to 100 fathom contour as indicated.

The Division of Fish and Wildlife fully supports the establishment of a spawning area closure for mutton snapper in the EEZ as proposed in Amendment 2 (9). The effectiveness of this area closure on the spawning aggregation of mutton snapper will be greatly enhanced with the joint closure of adjacent territorial waters from which the mutton snapper are harvested. This recommendation will be forthcoming as evident through present discussions on the subject by the St. Croix Fisheries Advisory Committee.

Thank you for opportunity to address this most important issue.

Sincerely,

William Tobias,
Fisheries Biologist

CC: Ann Seiler, Director
Division of Fish and Wildlife

LITERATURE CITED

Colin, P. L., D. Y. Shapiro and D. Weiler. 1987. Aspects of the reproduction of two groupers, E. guttatus and E. striatus in the West Indies. Bull. Mar. Sci. 40:220-230.

Olsen, D. A. and J. A. La Place. 1978. A study of a Virgin Islands grouper fishery based on a breeding aggregation. Proc. Gulf. Carib. Fish. Inst. 131:130-144.

DEPARTAMENTO DE RECURSOS NATURALES

DRN

21 de enero de 1993

JAN 25 1993

Sr. Miguel Rolón
Director Ejecutivo
Consejo de Administración Pesquera del Caribe
Edificio Banco de Ponce
Piso 11, Oficina 1108
Hato Rey, Puerto Rico 00918-2577

P/C Walter Padilla
Director.

Estimado Señor Rolón,

Sirvase la presente para brindar comentarios en torno a algunos aspectos relacionados a los peces utilizados para acuarios marinos, los cuales se proponen proteger mediante la Segunda Enmienda al Reglamento del Plan de Manejo para los Peces de Arrecife de Aguas Someras. Los comentarios que aquí se vierten se hacen en calidad de contribución informativa y en ningún momento representa la posición oficial del Departamento de Recursos Naturales en torno a alguna medida especifica.

Mi primera preocupación se basa en la terminología utilizada en el documento que propone las medidas sobre la segunda enmienda al plan de manejo para peces de arrecife de aguas someras para P.R. e I. V. A. A mi entender, la terminología utilizada en el documento, peces para acuarios marinos y peces de arrecifes, crea una división irreal en términos de funcionalidad ecológica. Esta connotación podría prejuiciar la importancia ecológica de los aquí llamados peces para acuario en los arrecifes de coral. El término peces para acuario puede interpretarse como algo totalmente estético. Personas no conocedoras podrían confundir estos peces para acuario con peces meramente ornamentales como el goldfish (*Carassius auratus*) u otros que ni siquiera son marinos y esto podría afectar la evaluación de medidas como las presentadas aquí. Hay que enfatizar que el 50-60 % de los peces para acuarios de agua dulce son producidos artificialmente, mientras que casi todos los peces e invertebrados marinos para acuarios marinos son colectados en su ambiente natural (Ver referencias en Sadovy 1991). Todos los organismos que viven en los arrecifes de coral tienen una función ecológica sumamente importante, ya sean los que son usados en acuarios o los de importancia para la pesquería, exista o no solapamiento de la misma especie en ambas

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industrias. El mantenimiento de parte del balance de los arrecifes de coral viene como resultado de los distintos roles ecológicos que llevan a cabo la gran diversidad de especies presentes. Aunque hay solapamiento intraespecífico e interespecífico en términos de roles ecológicos dentro de los organismos presentes en los arrecifes, hay muchas grupos que se han especializado. Por ejemplo, los individuos pertenecientes a la familia Chaetodontidae (peces mariposas) se caracterizan por tener incluída en su dieta pólipos de corales y poliquetos (gusanos marinos). La familia Pomacanthidae (peces ángeles), entre otras cosas, se alimentan de esponjas (Vicente, comunicación personal). Dentro de la familia Balistidae, el peje puerco, Balistes vetula, muy importante en la pesquería comercial, se alimenta principalmente de erizos de mar y otros invertebrados (Randall, 1983). Otro rol importante que juegan algunas de las especies de las familias Chaetodontidae y Pomacanthidae (juveniles) y la familia Labridae (juveniles y adultos) es la de remover ectoparásitos a muchas otras especies tales como los meros (familia Serranidae), los cuales son claves para la pesquería comercial. En otras palabras, todos los organismos pertenecientes a los arrecifes de coral participan de una forma u otra en la cadena de alimentos influenciando de forma directa o indirecta a todos los extremos de la pirámide de alimento, desde el plancton hasta los carnívoros primarios. Hay que aclarar que aunque no hay estudios de todas las diferentes especies de invertebrados y peces de arrecifes de coral, se puede inferir de las especies estudiadas, y de principios ecológicos generales, que no existe independencia entre el ambiente pelágico (plancton) y el fondo (bentos), sino que se influencian mutuamente y aparecen combinadas en un sistema de orden superior (Margalef, 1980).

Otro aspecto de preocupación es lo que podría significar la remoción de juveniles de los aquí llamados peces de acuario con respecto al balance de los arrecifes de coral. Basado en el informe escrito por la Dra. Sadovy (1991), el 70% del total de peces de acuario con más alta demanda esta constituído por individuos pertenecientes a las familias Grammidae, Opistognathidae, Pomacanthidae, Chaetodontidae (Peces Mariposas), Pomacentridae (Damicelas) Holocentridae, Blenniidae, Labridae y Balistidae. Los individuos capturados tienen un tamaño que varía de 3.5 a 13 cm según la especie. La gran mayoría de los organismos son colectados en etapas juveniles, ya que los colores son más intensos y por ende más llamativos para el mercado de acuarios. Ya que se conoce poco sobre los tamaños de madurez sexual de los peces utilizados para acuarios marinos, existiría un riesgo potencial de afectar estas poblaciones y el arrecife como tal. Cuando se habla en términos de pesquería comercial, sabemos la importancia que tiene el evitar remover individuos juveniles. Estos, al no reproducirse, no aportan progenie y por lo tanto la especie podría peligrar. Este mismo principio debe ser aplicado a los organismos aquí llamados invertebrados y peces de arrecife para acuario, ya que los arrecifes de coral se caracterizan por contener una gran diversidad de especies pero con baja densidad. Esto es clave ya que implica que la remoción de peces de arrecife aunque parezca mínima podría afectar el balance de los arrecifes de coral.

Otra forma en que podría afectarse el delicado balance de los arrecifes de coral es la extracción selectiva de algunas especies. Ya que no todas las especies de peces e invertebrados de arrecifes de coral tienen valor económico, podría ocurrir monopolización del hábitat por parte de alguna de las especies con poca o ninguna demanda. Un ejemplo real que he observado en distintos arrecifes, especialmente en el área de la Parguera, ha sido la disminución dramática de especies de la familia Pomacanthidae, tales como; Pomacanthus arcuatus, P.paru y Holacanthus ciliaris. En el área de Piñones, en Loiza y en las playas de el Condado, en San Juan, prácticamente no se encuentran H. ciliaris y P. paru que eran abundantes hace unos años atrás. He notado lo mismo en el área de Bajura en Isabela, añadiendo a los ya mencionados, el peje puerco, Balistes vetula. En La Parguera, a la vez que se notó el decenso de las especies mencionadas se noto el dramático aumento de algunas especies de la familia Pomacentridae, tales como Eupomacentrus fuscus. Las especies pertenecientes a la familia Pomacentridae se caracterizan por ser muy agresivas y territoriales y no tienen demanda real como peces para acuario. Una posible explicación para la alza y disminución marcada de estas especies podría ser la monopolización como resultado de la extracción selectiva. Obviamente, la monopolización, no importa de que especie, sería detrimental para el balance de los arrecifes.

Un planteamiento expuesto en la vista pública celebrada en La Parguera, fue el de colectar en ciertas áreas por un tiempo y luego esperar un período razonable sin colectar para que se reestablezca el área antes de volver a colectar. La teoría envuelta en este planteamiento, a mi entender, se queda en el papel. La logística que envolvería dicho planteamiento es improbable ya que sería muy dificil determinar cuando y donde se podría colectar. Prácticamente habría que pensar en dividir los arrecifes y áreas concernientes entre los diferentes colectores para evitar la sobreexplotación. El entendimiento, la comunicación, la conciencia ambiental y el deseo de compartir que tendrían que desarrollar todas las personas envueltas sería muy complicado y poco funcional. Habría mayores complicaciones, cuando personas y/o compañías de fuera de Puerto Rico se interesaran en este mercado. Esto es muy posible ya que en Florida, Estado en que esta industria esta avanzada, las restricciones han aumentado dramáticamente (Sadovy, 1991). Por otro lado, el área donde se han explotado más los peces e invertebrados con propósitos para acuarios marinos es en las Filipinas. Según Ralph Turingham, biólogo marino de la Universidad de las Filipinas, la explotación de los peces para acuarios ha sido detrimental para los arrecifes locales. En comparación con el tamaño y la diversidad marina de las Filipinas, Puerto Rico es mucho menor en ambas. No obstante, estos errores ajenos podrían ser vivo ejemplo del futuro de nuestros arrecifes de coral.

La medida número dos del documento sobre la Enmienda 2 al Reglamento del Plan de Manejo para los Peces de Arrecife de Aguas Someras que propone prohibir la captura de peces para acuarios con equipo que no sea redes de mano y equipo de succión, es de importancia fundamental. Es de conocimiento general que el uso de otras artes de pesca tales como la atarralla, trasmallo, mallorqín, nasas y productos químicos causan daño tanto al hábitat como al recurso. Otros tipos de redes, como el mostrado en las vistas públicas celebradas en La Parguera contienen potalas de plomos en la parte inferior, siendo este el extremo que hace contacto con el substrato. Estas potalas tienden a romper corales y otros tipos de substratos, ademas de revolver el fondo que causaría sedimentación que afectaría a los corales cercanos. Estas observaciones son basadas en mi experiencia personal cuando utilizé este tipo de redes en investigaciones científicas cuando fui estudiante del Departamento de Ciencias Marinas en el Recinto Universitario de Mayagüez. La restricción de utilizar sólo redes de mano y equipo de succión evitaría este tipo de problema y a la misma vez controlaría el número de individuos capturados diariamente siendo una pelea mas justa para el recurso y el hábitat. La importancia de proteger corales y otros tipos de substratos se basa en que la mayoría de las especies de peces e invertebrados marinos utilizados para acuarios viven asociados a estos utilizándolos entre otras cosas, como refugios. Numerosos estudios han demostrado que muchas especies de peces de arrecife de coral tienen preferencia por ciertos tipos de substratos y otros aspectos relacionados a los arrecifes de coral (Sale, 1969; Williams and Sale, 1981; Shulman et al., 1983; Sale et al, 1984; Shulman, 1984, 1985; Victor, 1986). Por otro lado, reclutas de algunas especies de peces de arrecife, tienen preferencias por substratos que contengan individuos de su misma especie irrespectivamente del tipo de substrato (Sweatman, 1983, 1985, 1988; Sweatman & John, 1990; Tacher, 1991). Por lo tanto, la remoción de individuos de algunas especies marinas podría ser tan dañino como alterar el substrato para otras.

Más contundente que los problemas anteriormente expuestos, es la reciente evidencia científica de que los arrecifes de coral no son sistemas estables ni predecibles como se creía, sino que son inestables e impredecibles rigiéndose por un sistema de reclutamiento de juveniles al azar ó de lotería. Este modelo ha sido expuesto y defendido por autoridades en el campo de las ciencias en diferentes investigaciones (Sale and Dybdahl, 1975; Sale, 1977, 1979, 1980; Talbot et al,1978; Williams, 1980). Este modelo ecológico concluye que es improbable que encontremos las mismas especies en un mismo lugar siempre. Las implicaciones de este modelo para nuestro propósito en el presente es fundamental.

Debido a que esta data científica reciente concluye que el reclutamiento de juveniles se basa en un patrón al azar, no es posible asegurar que la especie colectada y reemplazada sean la misma. Por lo tanto, el funcionamiento de programas de colección controlada no necesariamente funcionarían.

Toda la información expuesta anteriormente establece, a mi entender, que es extremadamente importante extender el Plan de Manejo a las especies envueltas en el mercado de acuarios marinos. Esta, debe ser complementaria a la urgente implementación de estudios de la biología de las especies extraídas en esta industria. También es de orden prioritario estudios que evalúen el efecto que tiene la remoción de estas especies en los arrecifes de coral como hábitat ecológico.

La incertidumbre de la magnitud del efecto negativo de esta creciente industria a nuestros arrecifes de coral exige la implantación de refugios marinos (áreas especiales en donde se prohiba la extracción de organismos totalmente). La necesidad de establecer arrecifes de coral como refugios es quizás la única forma de protegerlos. Esta medida es quizás la mejor alternativa si queremos proteger y conservar un recurso tan valioso e importante como lo es el arrecife de coral y los organismos asociados a él.

Espero que estos comentarios sean de utilidad al implementarse las determinaciones finales sobre las medidas propuestas.

Atentamente,

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Referencias

Margalef, R. 1980. Ecologia. Casa Editora Omega.

Randall, J. E. 1983. Caribbean reef fishes. T. F. H. Publ., - Neptune City, New Jersey.

Sadovy, I. 1991. A preliminary assesment of the export trade in marine aquarium organisms in Puerto Rico. Report submitted to the Caribbean Fishery Management Council. December, 1991.

Sale, P. F. 1969. Pertinent stimuli for habitat selection by the juvenile manini _Acanthurus triostegus sadvicensis_. Ecology 50, (2) 616-623.

Sale, P.F. and R. Dybdahl. 1975. Determinants of community structure for coral reef fishes in an experimental habitat. Ecology 56:1343-1355.

Sale, P. F. 1977. Maintenance of high diversity in coral reef fish communities. Am. Nat. 111, 337-359.

Sale, P. F. 1979. Recruitment loss and coexistence in a guild of territorial pomacentrids. Oecologia 42 (2), 159-177.

Sale P. F. 1980. The ecology of coral reefs. Oceanogr. Mar. Biol. Ann. Rev. 18, 367-421.

Sale, P. F., W. A. Douglas and P. J. Doherty. 1984. Choice of microhabitats by coral reefs fishes at settlement. Coral Reefs 3, 91-99.

Shulman M. J. 1984. Resource limitation and recruitment pat terns in a coral reef fish assemblage. J. Exp. Mar. Biol. Ecol. 74, 85-109.

Shulman, M. J. 1985. Coral reef fish recruitment: effects of the spatial distribution of predators and shelter. Ecology 66 (3), 1056-1066.

Shulman, M. J., J. C. Ogden, J. P. Ebersole, W. M. McFarland, S. L. Miller and N. G. Wolf. 1983. Priority effects in the recruitment of juvenile coral reef fish. Ecology 64 (6), 1508-1513.

Sweatman, H. P. A. 1983. Influence of conspecifics on choice of settlement sites by larvae of two pomacentrid fishes (_Dascyllus aruanus_ and _D. reticulatus_) on coral reefs. Mar. Biol. 75, 225-229.

Sweatman, H. P. 1985. The influence of adults of some coral reef fishes on larval recruitment. Ecol. Monogr. 55, 469-485.

Sweatman, H. P. 1988. Field evidence that settling coral reef fish larvae detect resident fishes using dissolved chemical cues. J. Exp. Biol. Ecol. 124, 163-174.

Sweatman, H. P. & J. S. John. 1990. Effects of selective settlement and of aggresion by residents on distribution of young recruits of two tropical damselfishes. Mar. Biol. 105, 247-252.

Tacher, M. 1991. Influence of substrate and conspecifics on the settlement of a Red Sea coral reef fish. Unpublished Master Thesis. Univ. of P.R.

Talbot, F. H. , B. C. Russell, & G. R. V. Anderson. 1978. Coral reef fish communities: unstable high-diversity systems ?. Ecol. Monogr. 49, 425-440.

Victor, B. C. 1986. Larval settlement and juvenile mortality in a recruitment-limited coral reef fish population. Ecol. monogr. 56, 145-160.

Williams, D. M. 1980. Dynamics of the pomacentrid community on small path reefs in Onem Tree Lagoon (Great Barrier Reef). Bull Mar. Sci. 30, 159-170.

Williams, D. M. & P. F. Sale. 1981. Spatial and temporal patterns of recruitment of juvenile of coral reef fishes to coral habitats within " One Tree Lagoon", Great Barrier Reef. Mar. Biol. 65, 245-253.

DEPARTMENT OF NATURAL RESOURCES
Fisheries Research Laboratory

The present letter offers comments in relation to the fishes for marine aquarium, proposed to be protected in the Second Amendment of the Shallow Water Reef Fish. The comments observed here are for information purposes and not necessarily the Department of Natural Resources official point of view.

The wording used in the document that proposes measures for the Second Amendment to the Shallow Water Reef Fishes Management Plan for Puerto Rico and the U.S. Virgin Islands, is the first point that worries me. To my knowledge, the wording used in the document, "fishes for marine aquarium and shallow water reef fishes", divides them in terms of their ecologic functions.

This could create prejudice as to the ecological importance of the herewith called aquarium fishes in the coral reefs. The term aquarium fishes could be interpreted as a totally aesthetic term, and people with little or no knowledge on this could mistake aquarium fishes with ornamental fishes, like the goldfish (Carassius auratus), for example. This could affect the evaluation of measures like the ones hereby presented. It has to be emphasized that 50 to 60% of the fishes for fresh water aquariums are artificially harvested, whereas almost all marine invertebrates and fishes used for aquariums are collected from their natural habitat. (See references from Sadovy, 1991). All organisms that live in the coral reefs have a very important ecological function, whether they are fished for aquariums or for commercial purposes.

All the organism that live in the coral reef have their own important ecological functions. For example, individuals that belong to the Chaetodontidae family (butterfly fishes), feed from coral polyps and marine polychaetes. The Pomacanthide family (angel fishes) feed from sponges, among other things (Vicente, Comunicación Personal). The triggerfish, Balistes betula, that belong to the Balistidae family, and which is of commercial importance, feeds from sea urchins and other invertebrates (Randall, 1983). Other species that belong to the Chaetodontidae, Pomacanthidae (juveniles) and the Labridae (adults and juveniles) families, remove ectoparasites from other species like the groupers (Serranidae family), which are very important to the commercial fishery. In other words, all the organisms that belong to the coral reef are very important to the reef.

Another aspect of concern is the effects, caused by the removal of juveniles of aquarium fishes, on the coral reef. Based on the written study by Dr. Sadovy (1991), 70% of the fishes that are caught for aquarium fish belong to the Grammidae, Opistognathidae, Pomacanthidae, Chaetidontitae, Pomacentridae, Holocentridae, Blenniidae, Labridae and Balistidae. The size of the individuals captured range from 3.5 to 13 cm, depending on the specie. The great majority of the species collected are juveniles, this is because at this stage their colors are more brilliant and this makes them more appealing to the market. Talking in terms of commercial fishery, it is well known the importance of not catching juvenile fishes in order to let the specie reproduce. I believe this same principle should be applied to the invertebrate organisms and reef fishes for aquariums. Even the minimum removal of reef fishes could affect the balance of the coral reef.

Another way in which the delicate balance of the coral reef could be affected is by the selective extraction of some species. Given that not all invertebrates and fishes in the coral reef have commercial value, a monopoly of the habitat by another specie of little or no demand, could occur. A very good example, observed in various reefs, especially in the Parguera area, is the dramatic decrease of species that belong to the Pomacanthidae family, such as: Pomacanthus arcuatus, P.paru and Holacanthus ciliaris. In the Piñones area, Loiza and the Condado Beach area in San Juan, the H. ciliaris and the P. paru, who were abundant a few years ago, can not practically be found. The same problem has been observed in the Bajura area, in Isabela, adding the triggerfish, Balistes vetula, to the fishes previously mentioned. In Parguera, an increase on some other species belonging to the Pomacentridae family have been observed at the same time other species belonging to the families previously mentioned are decreasing.

A statement exposed at the public hearings held in La Parguera, was to collect in some areas for a period of time and then stop collecting for some other reasonable time to give the area the opportunity to recover. I believe it would be very difficult to determine when and were the collection could take place. There would be further complications if companies from outside the island became interested in this market, which is very possible since in Florida, were this market have dramatically increased (Sadovy 1991).

The second measure of the document, that proposes to prohibit the harvest of aquarium fishes with any other gear but hand net and slurp guns, is very important. The use of other gear such as: trammel nets, casting nets, gillnets, and quimical solutions, among others, are very harmful either to the resource as much as the habitat. Other types of nets with lead weights, like the ones shown at the public hearing, can even harm the substrate and cause sedimentation that would affect the coral reef. These observations area based on my scientific experience when I was a student of the Marine Sciences Department of the University of Puerto Rico, in Mayaguez. The gear restrictions would control the number of individuals captured daily making it more even to the species and the habitat. The importance of protecting the coral reef and other types of substrates is because the majority of the fish species and marine invertebrates that are removed for aquarium are associated to the coral reef and use it as their shelter. In conclusion, the removal of individuals of other marine species could be harmful to the coral reef system.

More overwhelming than the previously exposed problems, is the recent scientific evidence that the coral reefs are not stable systems, but unpredictable and unstable, ruled by a system that reclute juveniles at random. This model has been exposed and defended by authorities in this field with a number of investigations (Sale and Dybdahl, 1975;p Sale, 1977, 1979, 1980, Talbot et al, 1978, Williams, 1980). This ecological model concludes that it is improvable that we find the same species at the same place always. The implications of this model for our present purpose is fundamental.

Given that this recent scientific data concludes that the recruitment of juveniles is based on a pattern at random, it is not possible to assure that the collected and the replaced species be the same. That is the reason why the controlled collection programs would probably not work.

All the information previously exposed establishes, to my knowledge, that it is extremely important to extend the Management Plans to the all the species involved in the marine aquarium market. It is also of utmost importance to make studies to evaluate the effect that the removal of these species may cause to the ecological habitat of the coral reef.

Marine refuges should be established due to skepticism on the magnitudes of negative effects that this growing industry can cause to the coral reefs. The need to establish coral reefs as refuges is probably the only way to protect them. This measure may be the best alternative if we want to protect such a valuable and important resource and the organisms associated to it.

I hope this comments are useful to the implementation of the final determinations of these proposed measures.

(Signed) Mario Tacher
Natural Resources Specialist
Fisheries Research Laboratory

TABLA DE CONTENIDO

I. Trasfondo general

El estado de salud de las comunidades costaneras en Puerto Rico, particularmente, los arrecifes de coral, praderas de hierbas marinas y humedales, al igual que sus pesquerías asociadas, se ha deteriorado en gran medida en años recientes De acuerdo a Appeldorn et al (1992), en los pasados trece años, los desembarcos de peces de fondo de todas las especies han disminuido de 2,402 toneladas metricas (tm) en el 1979 a sólo 519 tm en 1990, lo que representa una dramática reducción de 78% Por otro lado, el desembarco de pargos (Lutjanidae) se redujo durante el mismo periodo de tiempo de 340 a solo 80 tm, lo que representa una reducción de 76% Esto nos sugiere que el evento o combinación de eventos que han causado esta disminución son básicamente similares en terminos proporcionales al comparar los datos de todas las especies con los pargos en particular

La regulación o medidas de manejo en la pesca de peces de arrecifes no debe limitarse, sin embargo, únicamente a peces de importancia comercial alimenticia También debe incluir las demás especies, incluyendo aquellas de importancia para el mercado de los acuarios El establecimiento de medidas regulatorias rápidas es muy importante también en el caso de los invertebrados marinos, corales y en los arrecifes de coral y sistemas asociados, ya que en años recientes se han reportado cada vez más y más eventos masivos como mortandades de erizos, peces, pelícanos, delfines, blanqueamiento de corales, etc Ver a Williams y Bunkley-Williams

(1990) para una revisión detallada Estos eventos, asociados en ocasiones a fenómenos naturales y en otras a factores antropogénicos han contribuido a la degradación de las comunidades marinas tropicales Los arrecifes de coral y otros sistemas asociados (ej praderas de hierbas marinas, fondos de arena, humedales, etc.) requieren una protección como ecosistemas integrados, donde el énfasis no sea únicamente en especies particulares, si no en la protección de la biodiversidad en general, las cadenas alimentarias y de los procesos funcionales de los ecosistemas (ej. flujo de energía, flujo de nutrientes, flujo genetico, etc)

A continuación, sometemos algunos comentarios especificos relacionados a las propuestas enmiendas al Plan de Manejo Pesquero para Peces de Arrecife de Aguas Someras en Puerto Rico e Islas Virgenes Americanas

II. Exportación de organismos en el mercado de acuarios.

De acuerdo a Sadovy (1991), en Puerto Rico se colectaron entre 1990 y 1991 sobre 155 especies marinas (identificadas) para el mercado de acuarios, de las cuales 104 fueron peces. Unas 83 especies de peces y cerca de unas 25 especies de invertebrados se exportaron. Cabe señalar que sólamente en este mercado el valor estético es el importante. Por tal razon, aquellos peces que sufran del rigor del estrés causado por el manejo en peceras y estanques (ej. decoloración, enfermedad, laceraciones o heridas, etc.) son descartados. Basándonos en los estimados de mortalidad fluctuantes entre 10 y 20% del total de capturas (Sadovy, 1991) y en los datos de exportación a través del aeropuerto internacional Luis Muñoz Marín durante 1990 y 1991 (160,704 organismos), tenemos que el total de organismos marinos extraídos de los arrecifes para exportación sólamente (sumando la mortalidad) totalizaron entre 176,774 a 192,845. A estas cifras hay que añadir aquellos organismos muertos durante los procesos de captura, conservadoramente otro 10%, lo que llevaría a un estimado de unos 208,915. Finalmente, si se añadieran las cifras de exportación a través de otros aeropuertos (ej. Aguadilla), el correo federal y compañías privadas (ej. U.P.S.), así como el mercado local, más las mortandades asociadas, este total pudo muy bien haber alcanzado de 400,000 a 500,000 organismos.

Una de las especies de peces más afectadas es _Gramma loreto_ (Grammidae) con una exportación estimada en 11,124 organismos. Este pez no solamente es hermoso por su coloración amarillo brillante y violeta, si no que, además de ser planctívoro, esta especie se alimenta también de ectoparásitos de otras especies de peces. En otras palabras, su remoción puede tener impactos adversos en la salud general de la ictiofauna arrecifal, posiblemente generando un desbalance ecológico en el arrecife. Típicamente, se utiliza quinaldina para su captura, la cual resulta detrimental para otras especies en el arrecife, particularmente, para los invertebrados sésiles (ej. corales, anémonas, zoántidos, etc.).

Otro grupo altamente explotado son los peces ángeles (Pomacanthidae), con unos 2,907 individuos exportados entre 1990 y 1991 (Sadovy, 1991) Este grupo se ha convertido en uno muy raro en muchos de nuestros arrecifes (observaciones personales). Los juveniles de Pomacanthus paru se han observado "limpiando" los dientes de agujones (Belonnidae). Los adultos de muchos peces ángeles se alimentan de esponjas El remover un organismo que controle naturalmente las poblaciones de esponjas en el arrecife podría resultar en un desbalance en las poblaciones naturales de estas, lo cual podría resultar en un sobrecrecimiento de los corales

Adicionalmente, otras especies explotadas por este mercado incluyen al lábrido Bodianus rufus, el cabeza azul Thalassoma bifasciatum (Labridae) y los góbidos limpiadores Gobiosoma spp (Gobiidae), de vital importancia ecológica para la ictiofauna arrecifal en sus estapas juveniles ya que también se alimenta de ectoparásitos de peces. Los góbidos se consideran unos de los principales limpiadores de parásitos en el arrecife. Su captura con químicos puede implicar la degradación o destrucción de corales masivos (Diploria spp.) o esponjas donde usualmente habitan estas especies.

Otros grupos incluyen los tiburones y mantarayas, especies que requieren grandes espacios y movimiento constante. Además, se explotan grupos de importancia alimenticia como los loros

(Scaridae), meros (Serranidae) y pejepuercos (Balistidae), entre otros. De igual forma, se exportan sobre 55 especies de invertebrados incluyendo corales, anémonas, coralimorfos, esponjas, gusanos, crustáceos, moluscos y equinodermos (Sadovy, 1991), al igual que diversas especies de algas marinas.

En Puerto Rico han desaparecido muchas especies de peces e invertebrados de localidades costaneras, particularmente, en aguas someras. El pescador hoy día tiene que moverse a aguas más profundas y retiradas de la costa para obtener la pesca que en el pasado se obtenía en la costa. Esto puede ser el resultado de un sin número de factores como la contaminación, sedimentación, destrucción de habitáculos naturales, sobrepesca, factores naturales, etc. En muchos arrecifes deteriorados también se pueden observar reducciones o desapariciones de especies estéticamente importantes (observaciones personales). Añadir una presión de pesca con sustancias químicas como la quinaldina, "Potenone", gasolina, formaldehído y cloro, entre otras, sobre especies que ejercen un control ecológico clave en el arrecife (ej. limpiadores de parásitos, esponjívoros o herbívoros) es innecesaria y sumamente dañina. Muchas de las especies exportadas son etapas juveniles de especies de importancia alimenticia, otras, son muy raras en el arrecife, altamente especializadas o poseen razones de crecimiento y madurez sexual muy lentas. La conservación de este recurso es vital porque representa una importante parte física y funcional del arrecife, cuyo valor ecológico, pesquero, farmacológico y turístico es incalculable.

En cuanto a las "rocas vivas" ("live rocks"), el impacto de su explotación puede ser detrimental a la integridad arrecifal por diversas razones, algunas de ellas discutidas por el Proyecto Reefkeeper (1991) y enumeradas adelante conjuntamente a otras listadas a continuación:

1 Las rocas vivas son el habitáculo natural de un sin número de especies, funcionando como área de protección y alimentación (Wheaton, 1989)

2 Su remoción puede alterar la salud arrecifal (Causey, 1989) y su ecología natural

3 Su remoción alterará las cadenas alimentarias en el arrecife mediante la remoción de productores primarios y diversos consumidores primarios y secundarios (Wheaton, 1989). Muchos de estos consumidores son pequeños invertebrados, eslabones intermedios en la red alimentaria entre los productores y consumidores mayores como los peces y el hombre.

4. Las "rocas vivas" sostienen el crecimiento de una alta cantidad de algas filamentosas y algas endolíticas, los principales contribuyentes a la productividad primaria arrecifal Su remoción afectará adversamente la productividad primaria natural (Wheaton, 1989).

5 La remoción de "rocas vivas" puede envolver la remoción inadvertida de corales (ej *Siderastrea* spp., *Favia fragum*, *Dichocoenia stokesii*) o de larvas recién establecidas La remoción de corales está prohibida por ley.

6 Las "rocas vivas" también incluyen otros invertebrados sésiles como anémonas, hidroides, coralimorfos y esponjas La explotación comercial para el mercado de acuarios de estos grupos debe ser prohida

7 La deposición de carbonato de calcio en el arrecife es un fenomeno sumamente lento, por lo que su explotación, a traves de la remoción de "rocas vivas" (ej carricoche), superara desproporcionalmente su renovación natural. Por tal razon, es inapropiado considerar este recurso como uno renovable

8 La remoción de 'rocas vivas' altera el relieve vertical y complejidad estructural del arrecife (Causey, 1989), así como su calidad (Bohnsack, 1990)

9 Remover fragmentos de corales muertos (carricoche) eliminaría el habitáculo natural de un gran numero de invertebrados crípticos (ej. equinodermos, gusanos, crustáceos) y peces.

10 La remoción de "rocas vivas" puede contribuir a aumentar las razones de bioerosión y erosión física y química del arrecife, así como la erosión costanera

11 La regeneración de muchos de los invertebrados removidos es muy lenta en muchos tipos de "rocas vivas", por lo que su explotación puede implicar una reducción o desaparición local de ciertas especies.

12 La remoción de "rocas vivas" equivale a fragmentar el ecosistema arrecifal, a destruir nichos escológicos, en ocasiones, muy estrechos y especializados, y a reducir la heterogeneidad espacial (Peters, 1990) y la diversidad de especies (Landmeier, 1990)

13 La remoción de "rocas vivas" contribuye a la degradación de los arrecifes. Nuestros arrecifes de coral no necesitan de un estresor antropogénico adicional a los existentes. Estos requieren acciones correctivas.

14. La remoción de "rocas vivas" equivale a remoción pseudo-legal de corales ya que estos son removidos en etapas larvales o juveniles de forma inadvertida.

15. La decisión de prohibir la remoción de "rocas vivas" sólo afectaría a un número muy reducido de personas, mientras que su conservación y preservación siginificará un beneficio a la ecología y salud arrecifal, a la conservación de la biodiversidad y al público en general

Finalmente, cabe citar el borrador de las enmiendas propuestas al Plan de Manejo de Peces de Arrecife (versión en español), el cual lee textualmente en la página 4, párrafo 2, línea 5 "Se desconocen los efectos ecológicos que la remoción de peces puedan ocasionar en al ecosistema arrecifal, además del efecto nocivo o de mortandad que los químicos puedan ocasionar a los peces e invertebrados asociados a este hábitat". Además, un número significativo de las especies explotadas ha registrado recientemente reducciones poblacionales. De acuerdo a Wheaton (1989), las poblaciones de peces de arrecife no pueden sostener una explotación intensa debido en parte a sus estrategias y ciclos reproductivos.

III. Recomendaciones de manejo

A. Recomendaciones sobre la explotación de especies de peces e invertebrados por el mercado de los acuarios

1. Prohibir la explotación comercial para el mercado de acuarios local y extranjero de peces e invertebrados marinos. Esto incluye la remoción de "rocas vivas" ("live rocks").

2. Declarar delito estatal y federal la remoción, posesión y manejo comercial de "rocas vivas" en Puerto Rico y las Islas Vírgenes Norteamericanas, sus aguas territoriales y las aguas federales.

3. Estudiar la biología y el comportamiento de todas las especies explotadas por el mercado de acuarios, incluyendo al menos factores como: su función en los procesos del arrecife, su biología reproductiva, madurez sexual, ecología y alimentación, previo a considerar el reestablecimiento de cualquier nivel de explotación comercial.

4. Evaluar el estatus poblacional de muchas de estas especies, particularmente, aquellas altamente especializadas, y determinar si se requiere listar alguna como especie rara, vulnerable, amenazada o en peligro de extinción. Creemos que puede existir un número considerable de especies exportadas en las categorías de raras, vulnerables o amenazadas.

5. Estudiar cual es el impacto de estas actividades sobre los arrecifes de coral y comunidades coralinas, previo a considerar el reestablecimiento de cualquier nivel de explotación comercial. Mientras se desconozca la manera en que se afecta el arrecife con la remoción de peces, invertebrados o "rocas vivas", debe restringirse al mínimo, o en lo posible prohibirse.

6. Implantar un programa de acuacultura de éstas especies como una posible medida de reintroducción de organismos removidos del arrecife, de mantenerse el mercado de forma controlada y limitada.

7 De mantener un mercado reducido y controlado, debe prohibirse la explotación de especies de peces limpiadores de parásitos, especialistas (nichos estrechos), especies raras, especies de importancia alimenticia, esponjivoros, coralívoros, especies pelágicas o especies de gran tamaño, al igual que los invertebrados sésiles y las "rocas vivas".

8 De mantener un mercado reducido y controlado, deben requerirse licencias, limitando el numero de exportadores, especies explotadas, numero de organismos, áreas de explotación, metodos de pesca (prohibiendo las sustancias químicas), etc

9 Se deben reqerir informes mensuales sobre el mercado de exportación y el mercado local Esta información debe incluir también datos sobre mortalidad

10 Incorporar al plan de manejo para regular la pesca de peces de arrecife el plan para regular la explotación de peces de arrecife e invertebrados en el mercado de los acuarios. Este último (invertebrados) actualmente se considera por separado en el plan de manejo de corales bajo preparación. Ambos planes conllevan, en última instancia, medidas de protección de los arrecifes como ecosistemas. Esto eliminaría la posibilidad de conflictos, reduciría los

costos de implementación y garantizaría una mayor integración y protección al ecosistema arrecifal.

11. Expandir la unidad de manejo del plan para cubrir aguas profundas arrecifales (ej. bordes de plataforma insular)

12. Establecer áreas de manejo adicionales a la del Arrecife Tourmaline, al menos en los arrecifes de La Cordillera, Cayos Caribe, La Parguera, Aguadilla, Isla de Mona, Vieques y La Conga

B. Recomendaciones sobre la propuesta veda en la pesca del mero Epinephelus itajara.

1. Prohibir su pesca, no solamente en las áreas especiales de manejo, si no en todo Puerto Rico. Esta especie está actualmente protegida en las Islas Vírgenes Norteamericanas

2. Evaluar su estatus poblacional y determinar si se requiere listar como especie rara, vulnerable, amenazada o en peligro de extinción. Creemos que su estatus podría estar entre amenazada o en peligro de extinción

3. Estudiar su biología reproductiva, madurez sexual, ecología y alimentación, y posibilidad de acuacultura y reintroducción de juveniles al arrecife para restaurar las poblaciones naturales.

4 Realizar el mismo tipo de estudio con el mero guasa <u>Epinephelus morio</u> y el diente de sable <u>Mycteroperca tigris</u> y considerar el cierre de áreas de agregación y desove, al menos durante su época reproductiva entre diciembre y enero

C. Recomendaciones alternas relacionadas a la propuesta restricción en el tamaño de los orificios de las nasas de pesca.

1 No limitar más allá de las restricciones actuales la utilización de nasas

2 Establecer un sistema de información sobre los desembarcos de pescadores con nasas y de licencias para la venta de peces y mariscos de arrecifes en general.

3 Establecer criterios de seguridad de identificación y amarre de nasas a cuerdas y boyas para reducir la posibilidad de perdida de nasas durante marejadas.

4 Remover todas las nasas del agua durante eventos meteorológicos intensos como tormentas y huracanes.

5. Evaluar la acuacultura como alternativa para reintroducir especies de importancia comercial al arrecife y reestablecer las poblaciones naturales.

6 Implementar un programa de arrecifes artificiales con el objetivo de proveer nuevos habitáculos para la recolonización de peces e invertebrados y revitalizar la pesca con nasa o con otras artes Ver apéndice 1

7 Establecer reservas naturales o artificiales para el desove y propagación de especies de importancia comercial

8 Desarrollar un sistema de pesca rotando cada cierto tiempo las áreas de pesca para evitar la sobre-explotación de los bancos pesqueros Esto puede incluir la rotación de áreas de pesca entre arrecifes naturales y artificiales

9 Controlar o eliminar actividades adversas a la integridad de los ecosistemas marinos como la contaminación, eutroficación, destrucción de habitáculos naturales, construcción de marinas y rompeolas, dragados, sedimentación, manejo descuidado de embarcaciones, pesca recreativa con arpón, uso recreativo intenso, etc

10 Considerar siempre aquellas alternativas menos adversas a los pescadores artesanales, especie en peligro de extinción en Puerto Rico De implementarse cualquier acción en detrimento de éstos, debe proveerse una alternativa viable para reducir o eliminar cualquier efecto adverso

Ch. Recomendaciones sobre el establecimiento de refugios de arrecifes de coral.

1. Establecer reservas marinas para el desove, reproducción y propagación de especies de importancia comercial.

2. Establecer reservas marinas para la preservación de los ecosistemas arrecifales.

3. Establecer reservas marinas para la conservación y estudio de los ecosistemas arrecifales

4. Considerar la designación de reservas en los arrecifes La Cordillera, La Conga, Cayos Caribe, Caja de Muertos, La Parguera, Tourmaline e Isla de Mona

5. Reforzar las alternativas de manejo de corales y peces de arrecife mediante la protección integral del ecosistema y sus procesos, eliminando así la posible implementación de alternativas más drásticas (ej. vedas periódicas, prohibiciones de pesca, etc.).

6. Incorporar los planes de manejo de pesca de peces de arrecifes y de manejo de corales para reducir o eliminar la posibilidad de cualquier conflicto de manejo. Esto reduciría una vez más los gastos de implementación, esfuerzos y manejo.

D. **Recomendaciones sobre especies exóticas.**

1 Sustituir la prohibición de "la introducción no autorizada, en el mar, de especies exóticas" por "prohibir la introducción en el mar de especies exóticas", eliminando el "no autorizada"

E. **Titulo del plan.**

1 Integrar el plan de manejo de corales y el de pesca de peces de arrecife bajo el titulo de "Plan de Manejo para Arrecifes de Coral y Peces de Arrecifes de Puerto Rico e Islas Vírgenes Americanas"

IV. Referencias citadas

Appeldoorn, R., C. Beets, J. Bohnsack, S. Bolden, D. Matos, S. Meyers, A. Rosario, Y. Sadovy, & W. Tobias. 1992. Shallow water reef fish stock assessment for the U.S. Caribbean. NOAA Technical Memorandum NMFS-SEFSC-304. 70 pp.

Bohnsack, J. 1990. Biólogo de investigaciones pesqueras, Administración Atmosférica y Oceánica Nacional (NOAA). Comunicación personal escrita dirigida a Albert C. Jones, NOAA, mayo, 1990

Causey, B. 1989. Manejador del Santuario Marino Nacional de Looe Key, Florida. Comunicación personal escrita dirigida a John Mark Dean, Director del Proyecto Reefkeeper, enero, 1989

Landmeier, D 1990 Instructor adjunto, Nova University, Ocean Science Center Comunicación personal escrita dirigida a Alexander Stone, Director del Proyecto Reefkeeper, agosto, 1990

Peters, E.C 1990 Investigadora, Museo Nacional de Historia Natural Comunicación personal escrita dirigida a Alexander Stone, Director del Proyecto Reefkeeper, agosto, 1990.

Project Reefkeeper. 1991 Petition for rulemaking and/or fishery management plan action to prohibit the taking and landing of live rock June, 1991. 85 pp.

Sadovy, Y. 1991. A preliminary assessment of the export trade in marine aquarium organisms in Puerto Rico Report submitted to the Caribbean Fishery Management Council, December, 1991 42 pp

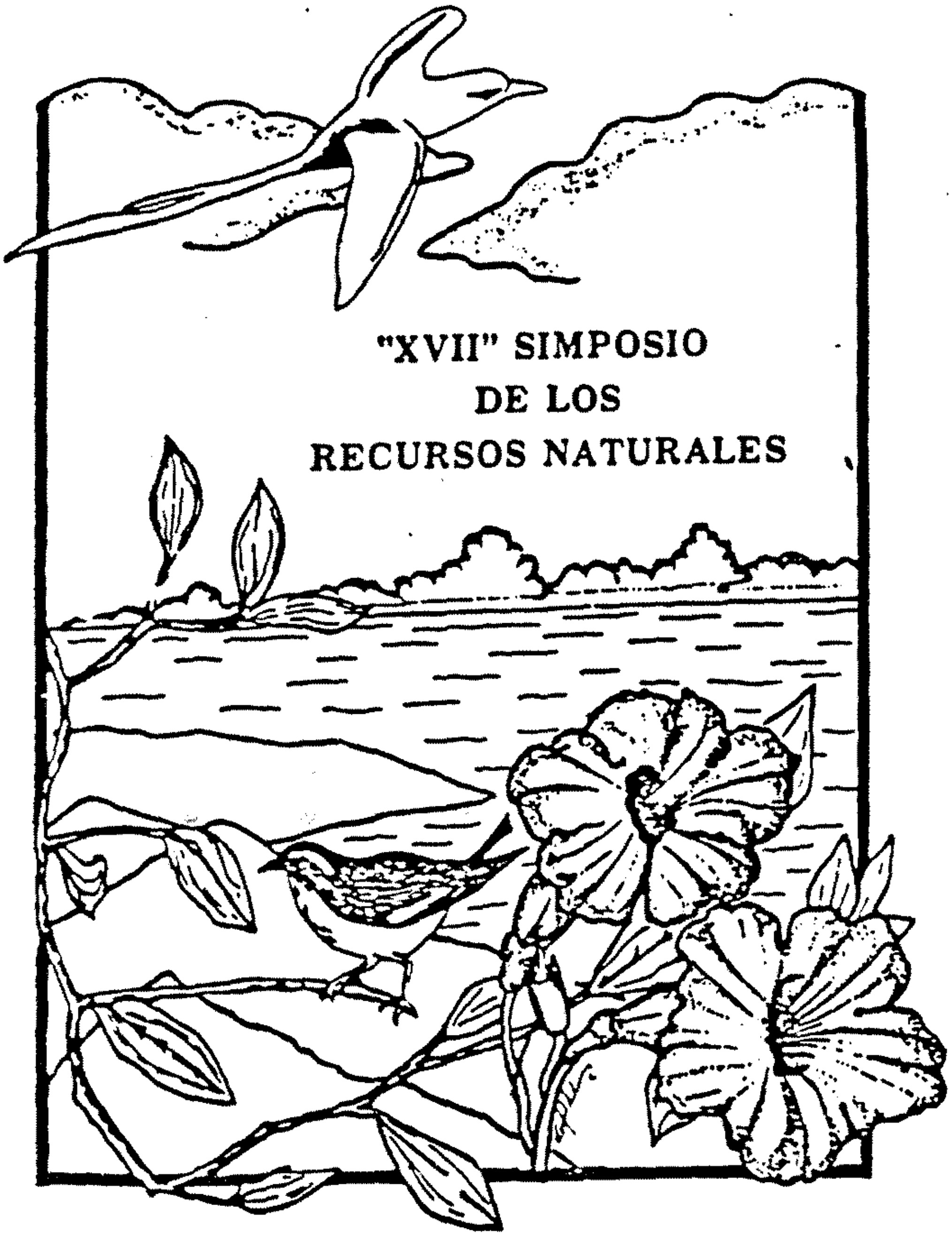
Wheaton, J L 1989 The marine life fishery for "live rock": biological and ecological assessment of the product and implications for harvest Fla Mar Res Inst Rpt. 18 pp

Williams, E H , Jr., & L. Bunkley-Williams 1990a The world-wide coral reef bleaching cycle and related sources of coral mortality. Atoll Res. Bull., 335 1-71

APENDICE 1

Trabajo sobre arrecifes artificiales:

Hernandez-Delgado, E.A., y L. Alicea Rodriguez. 1992. Arrecifes artificiales, una alternativa para el mejoramiento del ambiente marino en Puerto Rico. Una revisión corta. Memorias del XVII Simposio de los Recursos Naturales, 13-14 de noviembre de 1991. Departamento de Recursos Naturales, San Juan, P.R. 255-274.



"XVII" SIMPOSIO DE LOS RECURSOS NATURALES

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CELEBRADO EN EL AUDITORIO DEL

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ARRECIFES ARTIFICIALES, UNA ALTERNATIVA PARA EL MEJORAMIENTO DEL AMBIENTE MARINO EN PUERTO RICO: UNA REVISION CORTA

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INTRODUCCION

Uno de los problemas ambientales en Puerto Rico que requiere mayor consideración es el acelerado deterioro de los arrecifes de coral. Los arrecifes pueden deteriorarse naturalmente mediante procesos de bioerosion (Hutchings, 1986). Estos procesos pueden incluir predación por especies coralívoras y destrucción mediante perforación. Aunque éstos procesos ocurren naturalmente en los arrecifes, podrían verse afectados adversamente debido al impacto de actividades humanas. De acuerdo a Goenaga (1986), existen diversos factores antropogenicos que afectan adversamente el desarrollo y el mantenimiento de los arrecifes coralinos. Entre ellos se encuentran la remosión de la capa vegetal en las laderas de las montañas y en colinas cerca de la costa, lo cual causa un incremento en la sedimentación y una posible eutroficación de las aguas costaneras, afectando la transparencia del agua. Similar efecto tienen los dragados de fondos marinos. Tambien se observa la frecuente destrucción de corales debido al tránsito o anclaje de embarcaciones y por prácticas militares, particularmente en la costa este de Puerto Rico. Otros factores adversos son las descargas de plantas de tratamiento sanitario, contaminantes industriales, descargas termales e incrementos en la deposición de desperdicios sólidos, particularmente plásticos (observaciones personales).

Sin embargo, uno de los problemas más importantes es la sobrepesca de especies de importancia comercial en nuestros arrecifes costaneros. Esto ha diezmado las poblaciones de muchas de éstas hasta el punto de la desaparicion en varias localidades de algunas especies (observaciones personales). Esta sobrepesca, en ocasiones podría causar un desbalance ecológico en el arrecife que podría afectar la composición de especies en el sistema, posiblemente teniendo también efectos en la razón de bioerosión.

En años recientes, se ha propuesto la pesca de altura como una alternativa para la reducción de la presión pesquera sobre los arrecifes de coral. La realidad es que esto no ha resultado. Sin embargo, el Gobierno no ha explorado seriamente la implementación de un programa de arrecifes artificiales como una alternativa viable para mejorar el ambiente marino y reducir la presión de pesca sobre los arrecifes naturales. De acuerdo a Stone (1982), existe evidencia que documenta el uso de arrecifes artificiales en Japón desde el siglo XVIII como una herramienta para mejorar el ambiente marino e incrementar la concentración de peces, y por ende la pesca. A partir de la década de 1930, los japoneses comienzan a explotar comercialmente con éxito los arrecifes artificiales como fuente de pesca. En los Estados Unidos no es si no hasta la década de 1950 que comienzan a realizarse estudios sobre arrecifes artificiales, y comienzan a explorarse otros usos, no solamente comercial. Hoy día, en muchos países en vías de desarrollos se ha comenzado a explorar el uso de arrecifes artificiales como alternativa para aumentar la pesca y mejorar las condiciones de nutrición de las personas.

Stone (19974) define un arrecife artificial como una estructura hecha con objetos naturales o artificiales colocados intencionalmente en algún lugar del ambiente marino, aunque también existen arrecifes artificiales en embalses (Moring et al., 1989). Esto se hace con el propósito de mejorar las condiciones del ambiente, propiciando un incremento en la concentración de peces e invertebrados en ambientes desprovistos de relieve natural con fondo irregular como lo son los arrecifes naturales, cuevas o fondos escabrosos. Bohnsack y Sutherland (1985) clasifican los arrecifes artificiales en tres amplias categorías: arrecifes de fondo, de agua y superficiales. Sin embargo, las plataformas petroleras pueden considerarse como una cuarta categoría, ya que son un agregador adecuado de peces e invertebrados (Dugas et al., 1979; Mcintosh, 1981; Seaman, et al. 1989b). De acuerdo a Sonu y Grove (1985), para construir un arrecife artificial se requiere una certificación oficial del Gobierno. Esta requiere que los arrecifes artificiales cumplan con unos niveles oficiales de construcción divididos en cuatro grandes categorías: durabilidad, seguridad, funcionamiento y economía.

A continuación presentamos algunas de las alternativas para la construcción de arrecifes artificiales y las ventajas y desventajas de cada una de ellas. Tambien, se discuten posibles localidades óptimas para este tipo de desarrolllo, así como algunas recomendaciones para reducir el impacto de la erosión terrestre, contaminación y destrucción de los arrecifes de coral costaneros.

TIPOS DE ARRECIFES ARTIFICIALES

A través de los años se ha utilizado una gran diversidad de materiales para construir arrecifes artificiales. Tomando en consideración la enorme generación de desperdicios sólidos en Puerto Rico hoy día, la implementación de un programa de arrecifes artificiales podría contribuir, en parte, a reducir la cantidad de ciertos tipos de desperdicios sólidos depositados en los vertederos (ej. pedazos de concreto, plásticos, neumáticos, metales, etc.) mediante su reutilización.

El modelo y materiales a implementarse dependerá del objetivo que se persigue. De acuerdo a Stone (1978), entre los materiales usados comúnmente se encuentran la chatarra de automóviles viejos y embarcaciones, sin embargo, su vida útil es relativamente corta debido a la corrosión. En diversos estudios se ha evaluado la utilidad de otros materiales de construcción como tubos de cañería y pedazos de concreto de diversos tamañas (Buckley y Hueckel, 1985; Carlisle, 1982), así como bloques de concreto dada su alta durabilidad en el ambiente marino y relativo bajo costo (Davis, 1985; Randall, 1963, 1965; Risk, 1981). Carlisle (1962), Sheehy (1976), y Zahary y Hartman (1983) construyeron varios modelos de concreto de diversa geometría. Las ventajas de los modelos de concreto son su facilidad de anclaje al fondo debido a su peso y su superficie áspera que permite una mayor colonización de algas marinas e invertebrados sésiles (Bailey-Brock, 1989; Fitzhardinge y Bailey-Brock, 1989).

Davis et al (1985), Feigenbarum et al. (1985), Grant et al. (1982), Grove (1982) e Inversen y Bannerot (1984) construyeron unidades experimentales de rocas y peñascos, materiales naturales, mientras que Downing et al. (1985), Feigembaum et al. (1985), Spanier et al. (1985), Stone (1974, 1979) y Walton (1982) construyeron diversos modelos experimentales con neumáticos de automóviles. La ventaja particular de los neumáticos es que permiten una gran diversidad de diseños y su duración en el ambiente marino es casi incalculable. Sin embargo, sus desventajas están en que requieren un anclaje adecuado, ya que son muy livianos. Por otro lado, de acuerdo a Fitzhardinge y Baile-Brock (1989), su superficie, al igual que la de otros plásticos, es muy suave, reduciendo así la colonización de invertebrados sesiles.

Sato (1985), y Sonu y Grove (1985) presentan una buena descripción de los diversos modelos de acero, cromio y concreto reforzado de diversa geometría y tamaño utilizados exitosamente en Japón. También se han utilizado diversos tipos de polímeros plásticos como el PVC, usando en combinación con bloques de concreto por Alevizon et al. (1985). Recientemente, se han utilizado blosques de ceniza compactada y desechos de carbón (Stone, 1982; Woodhead, et al., 1982), sin embargo, podría existir un posible riesgo a la vida marina dependiendo de la composición de las cenizas compactadas. De acuerdo a Bohnsack y Sutherland (1985), también se han utilizado mezclas de concreto y polietileo, plástico reforzado con fibra de vidrio y la electrodeposición de elementos encontrados naturalmente en el agua.

Por otro lado, Feigenbaun et al. (1989), Gooding y Magnuson (1967), Matsumoto et al. (1981), Samples y Sproul (1985), y Workman et al. (1985), Samples y Sproul (1985), y Workman et al. (1985) estudiaron la importancia ecológica de los atractores flotantes de peces, mientras que Yamauchi (1984) estudió la importancia de los atractores flotantes en la maricultura. Beets (1989), por su parte, utilizó un modelo combinado de arrecife de fondo y atractor flotante. En la tabla 1 se comparan diversos materiales para construir arrecifes artificiales en términos de durabilidad, disponibilidad, costos y problemas.

PROPOSITOS PARA EL USO DE ARRECIFES ARTIFICIALES

Mejorar el ambiente marino

Según Stone et al. (1979), un arrecife artificial podría cambiar un fondo desprovisto de relieve irregular (ej. fondo arenoso) a uno altamente productivo. Sin embargo, Bohnsack (1989), y Bohnsack y Sutherland (1985) cuestionan si realmente ocurre un incremento en biomasa o simplemente se atraen especies de arrecifes cercanos sin incrementar la biomasa. Pero, lo que sí está claro, es que en muchos lugares la composición de especies ha aumentado dramáticamente luego de la implementación de los arrecifes artificiales (Stone et al. 1979). De acuerdo a Bohnsack (1989), se han sugerido varios mecanismos para esto: 1) proveer alimento adicional, 2) incrementar la eficiencia alimentaria, 3) proveer protección contra predadores; 4) proveer nuevos habitáculos para el reclutamiento de individuos; y 5) un mecanismo indirecto, ya que los peces al moverse al nuevo habitáculo artificial crean un nuevo espacio en el arrecife natural que puede ser colonizado por nuevos individuos.

Manejo de pesquerías

Factores como el aumento poblacional, desarrollo urbano e industrial en las costas, así como el aumento en el número de complejos hoteleros han contribuído al aumento en la presión pesquera en arrecifes costaneros (Bhnsack y Sutherland, 1985). También han contribuído al aumento en la sedimentación y descarga de contaminantes a la costa. Según Mcintosh (1981), la sobrepesca, junto a otros factores, han aumentado la demanda por bancos pesqueros pero reducido el recurso, entonces, lo menos que se puede hacer es renovar el recurso. De acuerdo a Feigenbaun et al. (1989), la pesca local provee solo el 7% de los mariscos consumidos en la Isla anualmente. La implementación de arrecifes artificiales sería una alternativa adecuada para el manejo de pesquerías, ya que según Stone (1978), la construcción y el uso inteligente de estos arrecifes puede ayudar a conservar y a renovar los recursos pesqueros marinos.

Está claramente establecido que el propósito principal en la implementación de arrecifes artificiales es mejorar el fondo marino y las pesquerías, mediante el aumento de la densidad de algas, invertebrados y sobre todo, peces. Muchos han sido construídos para atraer peces adultos, otros para incrementar el desove, reclutamiento y supervivencia de juveniles. La mayoría han sido establecidos para atraer especies de importancia comercial. Los arrecifes de fondo en muchas ocasiones son utilizados para atraer peces de arrecife o de fondo de importancia comercial como los arrayaos. (Haemulidae), meros (Serranidae) y pargos (Lutjanidae), segun Risk (1981), Lukens (1981), y Alevizon et al (1985). También, pueden servir como habitáculo a decenas de especies, tanto de peces (Stone et al, 1979) como de invertebrados marinos (Risk, 1981), los cuales podrian servir como alimento a otras especies.

La implementación de atractores flotantes de peces, de acuerdo a Gooding y Magnuson (1987), Matsumoto et al. (1981), Samples y Sproul (1985), y Workman et al. (1985), puede ser muy útil para atraer especies pelágicas de importancia comercial como las sierras o atunes (*Scombridae*). Estos atractores flotantes han sido utilizados exitosamente en Puerto Rico por Feigenbaun et al. (1989), para atraer dorados (*Coryphaena hippurus*), petos (*Ancanthocybium solanderi*) y barracudas (*Sphyraena barracuda*). De acuerdo a Seaman et al. (1989a), los arrecifes artificiales podrían permitir la explotación máxima de un recurso pesquero. Sin embargo, se requiere determinar previamente cuál es el objetivo de establecer un arrecife y cual es o son las especies particulares que se desean atraer.

Maricultura y acuacultura

Los arrecifes artificiales de fondo generalmentes se utilizan para atraer peces de arrecife u organismos bentónicos. Estas son especies generalmente asociadas a alguna estructura como rocas, cuevas o corales que les brinden protección. Sin embargo, también pueden ser herramientas muy útiles para la acuacultura. Sheeny (1978) construyó arrecifes de pedazos de tubos de cañería de concreto para proveer un nuevo habitáculo para la langosta *Homarus americanus* con sumo éxito. Por otro lado, ya Davis (1985) utilizó arrecifes de bloques de concreto para la propagación de la langosta *Panullirus argus*. Esto nos sugiere la posibilidad y adecuacidad de implantar un programa de arrecifes artificiales para propagar la población de langostas en Puerto Rico, uno de los mariscos más sobrepescados en el país.

Los arrecifes artificiales, tanto flotantes como de fondo, pueden ser utilizados en la acuacultura para cultivar ostras o almejas (Ardizzone et al., 1989). Según Yamauchi (1984), también pueden ser de gran valor en la maricultura para el crecimiento de algas o esponjas marinas de importancia comercial, mercado no explotado en Puerto Rico.

Mitigación de daños al ambiente marino

Los arrecifes artificiales, de acuerdo a Seaman et al. (1989a), han comenzado a uatilizarse recientemente como mecanismos para mitigar el impacto de actividades humanas en la costa. Grove (1982) construyó arrecifes de rocas para propagar especies de algas marinas afectadas por la construcción de una planta de energía nuclear en California. Mientras tanto, Davis (1985) utilizó arrecifes para mitigar el impacto de la construcción de una marina en Florida enlas poblaciones de la langosta *Panulirus argus*. Esto ayudó a que la población de langostas no desapareciera del área durante la construcción ya que se les proveyo de un habitáculo alterno como refugio. Inversen y Bannerot (1984) hicieron un trabajo similar para reducir el impacto de la construcción de otra marina sobre la ictiofauna local.

El continuo desarrollo residencial e industrial en Puerto Rico nos llevará a un eventual aumento en las descargas sanitarias e industriales en la costa. Muchas de estas descargas, como las descargas termales de Bahía de Jobos, en Salinas, y la de la recién construída planta de tratamiento regional de Humacao, tienen los puntos de mezcla en medio de zonas de importancia ecológica o pesquera. La relocalización de estos puntos de descarga, junto al establecimiento de arrecifes artificiales podrían ser una alternativa para reducir el impacto en el ambiente costero. Finalmente, los arrecifes artificiales, dependiendo del material utilizado, pueden ser un instrumento de gran valor para tratar de propagar y reintroducir especies de invertebrados sésiles (ej. corales) en lugares donde los habitáculos naturales han sido destruidos por actividades humanas.

Estudios ecológicos

El valor ecológico de los arrecifes artificiales es indiscutible, no solo por su valor biológico, si no porque abre la posibilidad de llevar a cabo diversos tipos de estudios. Los habitáculos artificiales pueden ser excelentes modelos para estudios ecológicos poblacionales de colonización (Lukens, 1981; Schoener, 1974), biogeografía (Walsh, 1985), estudios de predación de hierbas marinas (Randall, 1965), dinámica poblacional de la ictiofauna (Randall, 1963; Stone et al. 1979), estudios comparativos de la morfología de arrecifes artificiales (Risk, 1981; Walsh, 1985), así como estudios del impacto de las corrientes marinas en el establecimiento de comunidades bentónicas en el arrecife artificial (Baynes y Szmant, 1989). Beets (1989) utilizó un modelo combinado de arrecife artificial de fondo solamente.

Control de erosión en la costa

De acuerdo a Bohnsack y Sutherland (1985), hay arrecifes artificiales que funcionan como rompeolas y para el control de la erosión de las playas. Este factor debe considerarse seriamente en Puerto Rico, ya que debido a la acelerada erosión de arena en nuestras costas, ciertos tipos de arrecifes artificiales podrían convertirse en una alternativa para controlar la erosión y como un amortiguador de la energía del oleaie en caso de fuertes marejadas. Sin embargo, para que su uso como control de erosión costanera sea efectivo,, tiene que implementarse en combinación con otras alternativas de manejo como prohibir la extracción de arena de las playas, dunas y estuarios, así como con la construcción de dunas artificiales. Otras recomendaciones de control de erosión que podrían combinarse con los arrecifes artificiales son enumeradas por Cintrón (1981), Martínez et al. (1983), y Nichols y Cerco (1983).

Otras ventajas de los arrecifes artificiales

Mcintosh (1981) y Stone (1974, 1982), discutieron la importancia de los arrecifes artificiales como punto de referencia para peces y pescadores, incluisve, también en tareas de rescates. De acuerdo a Bohnsack (1989), los arrecifes artificiales tienen otras ventajas como la de crear nuevas oportunidades para la pesca, reducir el conflicto de usos sobre otras áreas naturales, ahorrar tiempo y combustible en la navegación, reducir los esfuezos en la pesca, hacer la localización de peces una más facil y predecible, aumentar el acceso público a los bancos pesqueros y seguridad mediante el establecimiento de arrecifes artificiales cercanos a la costa y aumentar la cantidad de peces mediante la agregación. A estas ventajas podría añadirse que el establecimiento de arrecifes artificiales podría proveer una nueva alternativa de recreación para los amantes del deporte del buceo. A pesar de que la mayoría de los modelos artificiales han sido construidos con propósitos experimentales, otros han sido construídos con propósitos únicamente recreativos (Stone, 1974).

Por otro lado, los arrecifes artificiales también pueden funcionar como un obstáculo contra el arrastre de redes de pesca en áreas donde se desee evitar la pesca de ciertos peces. Sin embargo, la ventaja principal sería la de reducir presiones de sobrepesca en determinadas especies en arrecifes naturales y mitigar impactos detrimentales en el ambiente marino (Davis, 1985; Inversen y Bannerot, 1984). También pueden ser utilizados para restaurar la productividad de áreas cercanas a la costa que han sido destruídas por contaminacion o por operaciones de dragados o rellenos.

EFECTOS DE LOS ARRECIFES ARTIFICIALES EN LA DINAMICA POBLACIONAL DE LOS PECES DE ARRECIFE

La aparición de organismos marinos en un arrecife artificial es un evento rápido. De acuerdo a Risk (1981), luego de 24 horas de haberse colocado una unidad experimental de bloques y rocas en Discovery Bay, Jamaice, ya se encontraban dos especies de peces: la damisela *Eupomacentrus fuscus* (Pomacentridae) y la morena *Gymnothorax moringa* (Muraenidae). Resultados similares encontraron Stone (1978) y Alevizon et al. (1985) luego de 48 horas. Los primeros peces en llegar pueden ser juveniles o adultos, dependiendo del tamaño de los espacios disponibles enla estructura, generalmente como refugio contra depredadores.

El patrón de reclutamiento tiene relación con la época del año y la localización geográfica. De acuerdo a Stone et al. (1979), un nuevo arrecife artificial puede ser atractivo para peces juveniles probablemente por la poca competencia de colonización. La estacionalidad en la abundancia de juveniles es evidente para muchas especies, así como la variabilidad en la intensidad de reclutamientto entre años (Walsh, 1985). Este encontró en su estudio que existía una razón de cambio entre censos de 37.4%, mientras que la persistencia máxima de una especie en las unidades experimentales fue de seis meses. Se sugirió que el movimiento de peces adultos entre los arrecifes naturales y los artificiales fue el responsable de esas variaciones en la composición de especies. Usualmente, la etapa climax de la comunidad puede alcanzarse entre varios meses y unos dos años, dependiendo de la complejidad del arrecife y de la comunidad.

Un aspecto muy importante es la colonización de algas. Estas son la base de la cadena alimenticia, por lo que su presencia es vital para atraer herviboros, que a su vez atraen carnívoros de diversos niveles. La colonización de algas contribuye grandemente a la estructura física del arrecife e incrementa la colonización por pequeños crustáceos también. Esto causa que las densidades de peces en las unidades experimentales o sus alrededores sean mayores a la de los ambientes aledaños (Buckley y Hueckel, 1985; Walton, 1982).

En diversos estudios se han comparado las comunidades entre los arrecifes artificiales y arrecifes naturales o áreas controles cercanas como fondos deprovistos de relieve irregular. En la mayoría de éstos, los arrecifes artificiales presentan una densidad y biomasa mayor de peces que los ambientes naturales (Bohnsack y Sutherland, 1985). Clarke et al. (1967) encontró una biomasa de peces treinta y cinco veces mayor en arrecifes artificiales que en fondos sin relieve. Walton (1982) encontró cerca de cuatro veces la densidad y nueve veces la biomasa de "flatfishes" (Pleuronectidae, Bothidae), y unas ocho veces la densidad y la biomasa de todos los peces en arrecifes artificiales, en relación a fondos desprovistos de relieve irregular.

Por otro lado, estudios como los de Randall (1963) y Stone et al. (1979) encontraron una similaridad general en la estructura de las comunidades entre arrecifes artificiales y arrecifes naturales. Se ha concluído que la habilidad de utilizar tanto un arrecife artificial como uno natural depende de las especies. Bohnsack y Sutherland (1985) reportaron resultados donde también se encontró una mayor biomasa y densidad de peces en arrecifes artificiales. Esto puede deberse a que los arrecifes artificiales tienen una estructura más compleja que los arrecifes naturales. Mientras tanto, Feigenbaun et al. (1989) reportaron incrementos en la pesca de especies pelágicas al noreste de Puerto Rico, proveyendo una alternativa a la sobrepesca de especies bentónicas. Existe evidencia contundente de la efectividad de los arrecifes artificiales como agregadores de peces, alcanzando niveles similares a los arrecifes naturales o mejorando éstos. Basándose en estos resultados, podría afirmarse que la implantación de arrecifes artificiales cerca de arrecifes naturales afectados por cualquiera de los factores anteriormente discutidos podría ser una alternativa viable para renovar las poblaciones de peces.

LUGARES ADECUADOS PARA EL ESTABLECIMIENTO DE ARRECIFES ARTIFICIALES EN PUERTO RICO

Teóricamente, los lugares mas adecuados para ubicar arrecifes artificiales podrían ser aguas de poca a moderada profundidad (ej. 20 a 50 pies) y de pocas corrientes. En las aguas costaneras de Puerto Rico existen varias zonas en las cuales de podría implementar un programa adecuado de arrecifes artificiales. En la costa norte, dadas sus características de fuertes corrientes, aguas turbias y mayor profundidad, existe un desarrollo limitado de arrecifes naturales. En adición, recientemente, la sedimentación sobre arrecifes de coral ha aumentado (Goenaga, 1986; observaciones personales). Además, el acelerado desarrollo urbano e industrial enla zona costanera, la descarga de efluentes primarios de plantas de tratamiento de aguas usadas en Palo

Seco y Barceloneta y la descarga de contaminantes industriales en el litoral entre Carolina y Arecibe posiblemente han contribuido a disminuir las poblaciones de peces en los pocos arrecifes bordeantes en la costa. El establecimiento de arrecifes artificiales de fondo cerca de la costa, en conjunto con atractores flotantes de peces podría resultar en una alternativa efectiva para aumentar la densidad y biomasa de peces. Adicionalmente, podrían representar una alternativa como control contra la erosión en la costa, Ya que el norte se caracteriza por su profundidad, con toda probabilidad los atractores flotantes podrían ser los más adecuados.

En la costa sur existen también varias zonas donde se podrían establecer estas unidades artificiales, como cerca de Las Mareas, en Guayama, donde se encuentra una petroquímica. También, podrían establecerse en el área de Bahía de Jobos, donde hay descargas termales de la planta de enérgía eléctrica de Aguirre, en Salinas, así como en las aguas costaneras frente a Ponce debido a la rápida sedimentación de arrecifes y descarga de aguas usadas. El área de Peñuelas y Guayanilla también presenta un habitáculo ideal para establecer arrecifes artificiales por la destrucción de fondos y arrecifes debido a dragados para puertos y contaminación por descargas industriales y termales de petroquímica y plantas eléctricas.

Una ventaja que ofrece la costa sur sobre las demás zonas costaneras de la isla es la menor velocidad de las corrientes, mayor transparencia de sus aguas, menor profundidad promedio y mayor amplitud de la plataforma insular. Esto propicia un habitáculo más adecuado para establecer arrecifes artificiales de fondo. Adicionalmente, en la zona suroeste, en especial, entre La Parguera y Cabo Rojo, la presión de pesca sobre los arrecifes coralinos es la mayor en el país. Posiblemente, el establecimiento de arrecifes artificiales, en conjunto con períodos de veda enla pesca de ciertas especies, el alternar los períodos de pesca entre arrecifes naturales y artificiales, y la implementación de leyes más estrictas podrían ser una alternativa para aumentar la densidad y biomasa local de peces y mariscos de importancia comercial.

Las aguas en la costa este también proveen un ambiente adecuado para establecer arrecifes artificiales, debido a que posee grandes bancos de arena sumergidos entre Vieques, Culebra y Puerto Rico. Adicionalmente, podrían ser un instrumento para mejorar la pesca comercial y artesanal en Vieques y Culebra, donde muchos arrecifes naturales han sido destruidos debido a prácticas militares. También pueden ser una herramienta útil en la zona noreste de la Isla, donde el desmedido desarrollo urbano y construcción de marinas y complejos hoteleros han causado un rápido deterioro en la costa. Igualmente, pueden establecerse módulos artificiales frente a la costa de Yabucoa, al sureste del país, donde las descargas contaminantes de dos petroquímicas y la operación del puerto de Yabucoa han afectado adversamente la pesca local.

RECOMENDACIONES PARA EL CONTROL DE CONTAMINACION Y MANEJO DE TIERRAS

La sedimentación de los arrecifes de coral es tal vez la mayor amenaza que reciben los ecosistemas costaneros en el país. Se requiere la implementción de prácticas de construcción y prácticas agrícolas más adecuadas para así reducir enlomás posible la erosión del suelo. Esto requiere una enérgica acción del Gobierno en esa dirección. Por otro lado, se requiere un mejor funicionamiento de las plantas de tratamiento de aguas usadas, muchas de las cuales están actualmente sobrecargadas, así como una implementación más efectiva del programa de pretratamiento industrial. Ambos problemas contribuyen a la eutroficación de las costas. Esto podría causar un aumento en la turbidez de las aguas, asifixiía de los pólipos de coral, explosiones poblaciones de algas y sobrecrecimiento de éstas sobre los corales, matándolos eventualmente.

Otra alternativa es la reforestación con especies nativas de zonas desprovistas de capa vegetal y de áreas inundables de los embalses, así como de las áreas aledañas a las cuencas hidrográficas para así reducir las razones de erosión del suelo. Esto puede complementarse conun adecuado programa de educación comunal para actuar contra el problema de erosión de suelos y de la contaminación del agua.

Es indispensable implementar medidas que reduzcan el flujo de nutrientes hacia los ríos. Las medidas deberán desarrollar metodos para reducir y tratar los efluentes de zonas agrícolas, implementación de un programa vigoroso para el tratamiento secundario ya existente y el establecimiento de sistemas de tratamiento terciario son indispensables en algunas ocasiones. De no implantarse estas medidas previo al desarrollo de un programa de arrecifes artificiales en Puerto Rico, su utilidad, con toda probabilidad, se vería reducida.

CONCLUSIONES

En Puerto Rico, así como en otras partes del mundo, existe un problema ambiental muy serio, en particular en la zona costanera. Los arrecifes de coral costaneros se están viendo afectados adversamente por diversas actividades humanas como la rápida destrucción en la zona costanera como consecuencia del creciente y desplanificado desarrollo urbano, turístico e industrial. Por otro lado, un aumento en la sedimentación en los arrecifes, descargas de aguas usadas y efluentes industriales, así como la sobrepesca de especies de importancia comercial han acelerado este deterioro. Todos estos factores han contribuido a la disminución en la densidad de peces y en la cantidad de especies de importancia comercial en algunas áreas.

El establecimiento de arrecifes artificiales, en conjunto con vedas por temporada y de tamaño en la pesca de ciertas especies de importancia comercial, el alternar los periodos de pesca entre los arrecifes naturales y artificiales, y la implementación efectiva de leyes que regulan la pesca y el desarrollo desplanificado en la costa, podrían ser una alternativa adecuada para el mejoramiento del ambiente marino costanero. También recomendamos la otorgación de incentivos economicos o de otros tipos para el establecimiento y la pesca en arrecifes artificiales.

El Gobierno debe considerar seriamente el implementar un programa de arrecifes artificiales para mitigar el impacto de la erosión costanera y descargas de contaminantes en la costa como complemento a otras alternativas de manejo de recursos. También, los arrecifes artificiales podrían ayudar a mitigar el impacto de las prácticas militares en Vieques y Culebra, así como podrían convertirse en un medio adicional de recreación acuática. A pesar de que los arrecifes artificiales no son la solución a los problemas ambientales en la costa, su efectividad para mejorar el ambiente marino y las pesquerías ha sido demostrada, por lo que deben ser considerados una alternativa viable en la planificación para el manejo de los recursos costaneros.

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BIBLIOGRAFIA

Alevizon, W.S., J.C. Gorham, R. Richardson & S.A. McCarth. 1985. Use of man-made reefs to concentrate snappers (Lutjanidae) and grunts (Haemulidae) in Bahamian Waters. Bull. Mar. Sci. 37(1): 3-10.

Ardizzone, G.D., M. F. Gravina, & A. Belluscio. 1989. Temporatl development of epibenthic communities on artificial reefs in the Central Mediterranean Sea. Bull. Mar. Sci. 44(2):592-608.

Bailey-Brok, J.H. 1989. Fouling community development on an artificial reef in Hawaiian waters. Bull. Mar. Sci. 44(2):580-591.

Baynes, T.W., & A.M. Szmant. 1989. Effect of current on the sessile benthic community structure of an artificial reef. Bull. Mar. Sci. 44(2)545-566.

Beets, J. 1989. Experimental evaluation of fish recruitment to combinations of fish aggregating devices and benthic artificial reefs. Bull. Mar. Sci. 44(2):973-983.

Bohnsack, J.A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioural preference? Bull. Mar. Sci. 44(2)631-645.

Bonsack, J.A., & D.L. Sutherland. 1985. Artificial reef research. A review with recommendations for future. Bull. Mar. Sci. 37(1):11-39.

Buckley, R.M. & G.J. Hueckel. 1985. Biological processes and ecological development on an artificial reef in Puget Sound, Washington, Bull. Mar. Sci. 37(1):50-69.

Carlisle, J.G., Jr. 1962. Housing scheme for fishes. Sea Frontiers. 8(2):68-75.

Carlisle, J.G., Jr. 1982. Artificial reefs off California, An update. Sea Frontiers. 28(6):339-343.

Cintrón, G. 1981. Environmental impact of sand extraction activities in the insular shelf. Inshore and Nearshore Resources Training Workshop, University of the South Pacific, Suva, Fiji. 13-17, July, 1981. 27 pp.

Clarke, T.A., A.O. Flechsig & R. W. Grigg. 1967. Ecological studies during Project SEALAB II. Science. 157:1381-1389.

Davis, G.E. 1985. Artificial structures to mitigate marina construction impacts on spiny lobster. *Pannulirus argus*. Bull. Mar. Sci. 37(1):151-156.

Dawning, N., R.A. Tubb, C.R. El-Zahr & R.E. McClure. 1985. Artificial reefs in Kuwait, Northern Arabian Gulf. Bull. Mar. Sci. 37(1):157-177.

Dugas, R., V. Guillory & M. Fisher. 1979. Oil rigs and off-shore sport fishing in Louisiana. Fisheries. 4(6):2-10.

Feigenbaum, D., C.H. Blair, M. Bell, J. R. Martin & M. G. Kelly. 1985. Virginia Artificial Reef Study. Descriptions and results of year 1. Bull. Mar. Sci. 37(1):348-355.

Feigenbaun, D.A., Friedlander, & M. Bushing, 1989. Determination of fish attracting devices for enhancing fisheries in Puerto Rico. Bull. Mar. Sci. 44(2):950-959.

Fitzhardinge, R.C., & J.H. Bailey-Brock. 1989. Colonization of artificial reefs materiales by corals and other sessile organisms. Bull. Mar. Sci. 44(2):567-579.

Goenaga, C. 1986. Los arrecifes costaneros en Puerto Rico. Estado actual e implicaciones sociales. Science-Ciencia. 13(2):78-91.

Gooding, R.M. & J.J. Magnuson. 1967. Ecological significance of a drifting object to pelagic fishes. Bull. Mar. Sci. 37(1):179-188.

Grant, J.J., K.C. Wilson, A. Grover & H.A. Togstad. 1982. Early development of Pendleton Artificial Reef. Mar. Fish. REv. 44(6-7):53-60.

Grove, R.S. 1982. Artificial reefs as a resource management uption for siting coastal power stations in Southern California. Mar. Fish. Rev. 44(6-7):24-27

Hutchings, P.A. 1986. Biological destruction of coral reefs. Coral Reefs. 4:239-252.

Iversen, E.S. & S.P. Bannerot. 1984. Artificial reefs under marina docks in Southern Florida. N. Amer. J. Fish. Management. 4:294-299

Lukens, R.R. 1981. Ichthyofaunal colonization of a new artificial reef in the Northern Gulf of Mexico. Gulf Res. Rep. 7(1):41-46.

Martinez, R.F., L. A. Encarnación, L.M. Cruz. 1983. Dune restoration in Puerto Rico, A manual for environmental managers. Department of Natural Resources, San Juan, P.R. 44 pp.

Matsumoto, W.M., T.K. Kazama & D.C. Aasted. 1981. Anchored fish aggregating devices in Hawaiian waters. Mar. Fish. Rev. 43(9):1-13.

McIntosh, G.S., Jr. 1981. A concept for artificial reefs as fishery management tools in the United States. Proceedings of the Fourth International Coral Reef Symposium, Manila, Vol. 1:99-103.

Moring, J.R., M. T. Negus, R.D. McCullough, & S. W. Herke. 1989. Large concentrations of submerged pulpwood logs as fish attraction structures in a reservoir. Bull Mar. Sci. 44(2):609-615.

Nichols, M., & C. Cerco. 1983. Coastal dunes for protection and sand resources Department of Natural Resources, San Juan, P. R. 89 pp.

Randall, J.E. 1963. An analysis of the fish populations of artificial and natural reefs in the Virgin Islands. Caribbe. J. Sci. 3(1):31-47.

Randall, J.E. 1965. Grazing effect on sea grasses by herbivorous reef fishes in the West Indies. Ecology. 46(3):255-260

Risk, M.J. 1981. Artificial reefs in Discovery Bay, Jamaica, Atoll. Res. Bull. 255-91-100

Samples, K.C. & J. T. Sproul. 1985. Fish aggregating devices and open-access commercial fisheries: A theoretical inquiry. Bull. Mar. Sci. 37(1):305-317

Sato, O. 1985. Scientific rationales for fishing reef desing. Bull. Mar. Sci. 37(1):329-335

Schoener, A. 1974. Colonization curves for planar marine islands. Ecology. 55:818-827

Seaman, W. Jr., R. M. Buckley & J.J. Polovina. 1989a. Advances in knowledge and priorities for research, technology and management related to artificial aquatic habitats. Bull. Mar. Sci. 44(2):527-532.

Seaman, W., Jr. W.J. Lindberg, C.R. Gilbert, & T.K. Frazer. 1989b. Fish habitat provided by obsolete petroleum platforms off Southern Florida. Bull. Mar. Sci. 44(2):1014-1022.

Sheehy, D.J. 1976. Utilization of artificial shelters by the American lobster. (*Homarus americanus*). J. Fñish. Res. Board Can. 33.1615-1622.

Sonu, C.J. & R.S. Grove. 1985. Typical Japanese reef modules. Bull. Mar. Sci. 37(1):348-355.

Spanier, E.M., Tom & S. Pisanty. 1985. Enhancement of fish recruitment by artificial enrichment of man-made reef in the Southeastern Mediterranean. Bull. Mar. Sci. 37(1):356-363.

Stone, R.B. 1974 Artificial reefs. Sea Frontiers. January-February, 1974-25-33

Stone, R.B. 1978. Artificial reefs and fishery management. Fisheries. 3(1):2-4.

Stone, R.B. 1982. Artificial reefs: Toward a new era in fisheries enhancemente? Mar. Fish. Rev. 44(6-7):22-3.

Stone, R.B., H.L. Pratt, R.O. Parker, Jr. & G.E. Davis 1979. A comparison of fish populations on an artificial and natural reef in the Florida Keys. Mar. Fish. Rev. 41(9):1-11.

Walsh, W.J. 1985. Reef fish community dynamics on small artificial reefs: The influence of isolation, habitat structure, and biography. Bull. Mar. Sci. 36(2):357-376.

Walton, J. M. 1982. The effects of an artificial reef on resident flatfish populations. Mar. Fish. Rev. 44(6-7):45-48.

Woodhead, P.M.J., J.H. Parker & I.W. Duedall. 1982. The Coal-Waste Artificial Reef Program (C-WARP): A new resource potential for fishing reef construction. Mar. Fish. Rev. 44(6-7):16-23.

Workman, I.K., A.M. Landry, Jr., J.W. Watson, Jr. & J.W. Blackwell. 1985. A midwater fish attraction device study conducted from hydrolab. Bull. Mar. Sci. 37(1):377-385.

Yamauchi, K. 1984. The formation of ***Sargassum*** beds on artificial substrata by transplanting seedlings of ***S. horneri*** (Turner) ***C. Agardh*** and ***S. muticum*** (Yendo) Fensholt. Bull. Jap. Soc. Sci. Fish. 50(7):1115-1123.

Zahary, R.G. & M. J. Hartman. 1983. Portable artificial reefs of fixed geometry. Prog Fish-Cult. 45(1):58-59.

TABLA 1a. Comparación de materiales de construcción de arrecifes artificiales en términos de: durabilidad, disponibilidad, costos y problemas.

Material	Durabilidad	Disponibilidad	Costos	Problemas
Chatarra de autos	**Pocos años**	**Fácil**	**Barato**	**Corrosión y Anclaje**
Embarcaciones hundidas	**Variable**	**Variable a Difícil**	**Variable**	**Corrosión**
Tubos de cañería de concreto	**Indefinida**	**Variable**	**Barato**	**Transportación**
Pedazos de concreto	**Indefinida**	**Fácil**	**Barato**	**Transportación**
Bloques de concreto	**Indefinida**	**Fácil**	**Barato**	**Transportación y Anclaje**
Modelos prefabricados de concreto	**Indefinida**	**Difícil**	**Variable**	**Transportación**
Rocas	**Indefinida**	**Fácil**	**Barato**	**Transportación**

TABLA 1b. Comparación de materiales de construcción de arrecifes artificiales en términos de: durabilidad, disponibilidad, costos y problemas.

Material	Durabilidad	Disponibilidad	Costos	Problemas
Neumáticos	**Indefinida**	**Fácil**	**Barato**	**Anclaje**
Modelos de:				
- concreto reforzado	**Indefinida**	**Variable**	**Variable**	**Transportación**
- cromio	**Indefinida**	**Difícil**	**Variable**	**Superficie lisa**
- acero	**Indefinida**	**Variable**	**Variable**	**Superficie lisa**
- PVC	**Indefinida**	**Fácil**	**Barato**	**Superficie lisa y Anclaje**
Cenizas compactadas	**Variable**	**Difícil**	**Costoso?**	**Contaminación?**
Atractores flotantes	**Variable**	**Variable**	**Variable**	**Anclaje y Navegación**
Modelos combinados	**Variable**	**Fácil**	**Barato**	**Anclaje**

RECOMMENDATIONS ON THE SHALLOW WATER REEF FISH FMP AMENDMENT 2
BY MR. EDWIN HERNANDEZ AND MS. LEONOR ALICEA, BIOLOGISTS
JUNCOS, PUERTO RICO

UNOFFICIAL TRANSLATION
77TH MEETING

1. --- To prohibit the commercial exploitation of native and exotic fish species and invertebrates for the aquarium trade, including the removal of live rocks.

2. --- To declare State and Federal felony the removal, possession and commercial handling of live rocks in Puerto Rico and the US Virgin Islands, as well as territorial and Federal waters.

3. --- To study the biology and behavior of all species that are being exploited in the aquarium trade industry, including factors such as: its role in the reef process, its reproductive biology, sexual maturity, ecology and feeding, prior to the restoration of any commercial exploitation level.

4. --- To evaluate the population status of these species, particularly those that are highly specialized, and to determine which should be listed as uncommon species, vulnerable, threatened or endangered. We believe a number of exported species could be considered among the uncommon, vulnerable or threaten species.

5. --- To study the impact of these activities on the coral reefs and coral communities, prior to any consideration of the restoration of commercial exploitation levels. As long as we do not know the way the reef is affected by the removal of fish, invertebrates or live rocks, it should be minimized or prohibited.

6. --- To introduce an aquaculture program for these species as a possible measure to restore reef fish populations, and to keep a controlled and limited market.

7. --- If a reduced and controlled market is attained, the overfishing of parasite cleaner fish species, specialist (narrow niche), uncommon species, food value species, sponges, corals, pelagic or big size species, as well as invertebrate sessile organism and live rocks, should be prohibited

8. --- If a reduced and controlled market is attained, there should be restrictions with regards to: license, the number of exporters, exploitable species, organisms, fishing sites, and fishing methods, banning the use of chemicals.

9. --- Monthly reports on export and local markets should be required. This information must include mortality data.] 11

10. --- To incorporate to the regulatory Shallow Water Reef Fish Fishery Management Plan the regulatory plan for the reef juveniles fish and invertebrate exploitation of the aquarium trade. The latter one (invertebrate) has been considered separately in the actual preparation of the coral management plan. Both plans carry with them, in the last instance, measures to protect the reef as ecosystems. This will eliminate the possibility of conflicts, reduce implementation cost, and guarantee a greater integration and protection of the reef ecosystem.

11. --- Expand the management unit of the plan to include deep reef waters (e.g. insular shelf edge).

12. --- Establish additional management areas (in Puerto Rico) in addition to the Tourmaline Reef, to include at least, the reefs of La Cordillera, Cayos Caribe, La Parguera, Aguadilla, Isla de Mona, Vieques, and La Conga.

RECOMMENDATIONS ON A PROPOSED CLOSURE FOR TIGER GROUPER

--- Prohibit the fishery, not only in the special management areas, but throughout Puerto Rico. This species is at present protected in the US Virgin Islands.] 8

--- To evaluate its population status and to determine whether it may be required to list these species as rare, vulnerable, threatened or endangered. We believe that its status may be either threatened or endangered.

--- Study its reproductive biology, sexual maturity, ecology and feeding habits. Also study the possibility of aquaculture (projects) and the reintroduction of juveniles to the reef in order to restore the natural population.

--- Conduct the same type of study with the mero guasa (Nassau Grouper), Epiniphelus morio and the Sabber Tooth Mycteroperca tigris, and to consider the closure of aggregation and spawning sites, at least during the reproductive season between December and January.

ADDITIONAL RECOMMENDATIONS RELATED TO PROPOSED MESH SIZE FOR FISH TRAPS

--- Not to limit to the utilization of fish traps beyond present restrictions.

--- To establish a data collection system for fish trap landings and licenses for the sale of fish and shell fish. 11

--- Establish methods of fish trap identification and security systems for fish trap buoys, to reduce the possibility of loosing them during bad weather .

--- Remove all fish traps from the water during intense bad weather events, such as storms and hurricanes.

--- Evaluate the possibility of using aquaculture as an alternative to reintroduce important commercial species to the reef and to restore natural populations.

--- Implement a program of artificial reefs with the objective to provide new habitats for the recolonization of fishes and invertebrates, and to enhance the fishing with fish traps and other methods.

--- To establish natural reserves for the spawning and propagation of commercially important fishes.

--- To develop a zone system to rotate fishing areas periodically to prevent overexploitation of fishery banks. These may include rotation between natural reefs and artificial ones. 10

--- To control or eliminate negative activities which may threaten the integrity of marine ecosystems such as: pollution, eutrophication, natural habitat destruction, construction of marinas and breakwaters, dredging, sedimentation, unsafe boating, recreational fishery with speargun and intense recreational use.

--- To consider the alternatives that are less adverse to the artisanal fishermen, who are an endangered species in P.R.; and to provide feasible alternatives whenever detrimental activities occur.

RECOMMENDATIONS ON CORAL REEFS REFUGES

--- Establish marine reserves for spawning, reproduction, and propagation of important commercial species.

--- Establish marine reserves for the preservation of reef ecosystems.

--- Establish marine reserves for the conservation and study of reef ecosystems.

--- To consider the designation of La Cordillera, La Conga, Cayos Caribe, Caja de Muertos, La Parguera, Tourmaline and Isla de Mona as reserves.

--- To reinforce the alternatives of coral and reef fish management, through the intervening integral protection of the ecosystem and its processes thus eliminating the possible implementation of drastic alternatives (e.g. season closures, fishing prohibitions, etc.)

--- To integrate the reef fish and coral management plan to reduce or eliminate the possibility of any management conflict. These will reduce, again, implementation costs, efforts and management.

14

--- Substitute the wording on the prohibition of "introduction of non-authorized exotic species in the sea" with "Prohibit the introduction of exotic species in the sea", eliminating "Non-Authorized".

--- To integrate the coral and reef fish management under a "Coral Reef and Reef Fish Management Plan of Puerto Rico and the U.S. Virgin Islands".

* Other recommendation on Live Rock not included at this time.

P.O. Box 5134 Sunny Isle
St. Croix, USVI 00823
March 25, 1993

Mr. Miguel Rolon

Caribbean Fishery Management Council
Suite 1108 Banco de Ponce Bldg.
Hato Rey, P.R. 00918-2577

Dear Miguel,

Thank you for forwarding me the information on the Council meeting which took place at Ponce on Feb. 10-11.
Please include the following comments in any future discussions regarding the harvest of Marine Aquarium Fishes.

As the only commercial fisherman of aquarium fishes in the USVI, I think that it is very important to consider how limited the fishing pressure is on individual islands in assessing stock conditions. While I agree that some general restrictions should apply, as in the case of Butterfly fish, blanket restrictions on some other species would be unfair. Careful self-management here on St. Croix has allowed us to fish the same areas for the past seven years without a decrease in the observed target fish stocks and an actual decrease in fishing effort utilizing the same handnet-only methods.

If in the future you are considering minimum size restrictions for certain species which are unsuitable aquarium fish at these small sizes, please include me in your discussions. As a trained biologist I would also like to be included, if possible, in any evaluation of the importance of cleaner fishes to the reef ecosystem, as my personal research and daily observations are extensive in this area and would certainly help your efforts.

Sincerely,

Lonnie Kaczmarsky
St. Croix AP

ATT. Dr. Miguel Rolón

MAR 3 1 1993

3/29/93

Caribbean Fishery Management Council
Suite 1108 Banco de Ponce Building
Hato Rey, Puerto Rico 00918-2577

Council Members,

The following comments are in response to the changes proposed on the subject measures at the Council meeting held on February 10-11, 1993 at Ponce.

Discussion:

1. The species Liopropoma rubre or the Swissguard Basslet is a shy and evasive fish found only in the back recesses of caves. The reason for the low catch quota and subsequently high price is not because of rarity or diminishing stock but because few collectors are willing to put in the time and patience required to catch this elusive prize.

2. On the subject of Queen Triggers it should be noted that they are primarily collected only a few months of the year, and from only a handful of places across the island. I do not feel this warrents closure, because they grow at a rapid pace and once they get 4-5 inches they become extremely vicious and unmangeable and many imports are reluctant to deal with them.

4. Marine Exports and Collectors are concerned with the listing of CLEANER FISHES as they are all important to the Aquarium Trade. With the exception of the French Angel (Pomacanthus paru) none of the listed fishes are collected in there juv. phase when they are removing parasites. The French Angel as well as all members should be protected under the Florida Marine Life Regulations. I have sent a copy along with this letter. 17

3. I am in favor of prohibiting harvest of all the listed species with the exception of the Longnose Butterfly (Prognathodoes aculeatus) I have been told by my customers that it does eat and has good success in the marine aquarium. 18

In closing I would like to add that with the removal of chemicals all species will have a great deal of protection, and as in the past I would like to recommend that Export permits and Collecting permits be put in place as soon as possible. I also feel that the laws governing the Aquarium trade in Florida would adapt well in Puerto Rican waters.

Thank you for your time,

Gary Rogers

Specific Authority.-- 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S.
History.-- New 1-1-91.

46-42.003 Prohibition of Harvest: Longspine Urchin.-

No person shall harvest, possess while in or on the waters of the state, or land any longspine urchin, Diadema antillarum.
Specific Authority.-- 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S.
History.-- New 1-1-91.

46-42.004 Size Limits.--

(1) Angelfishes.--

(a) No person harvesting for commercial purposes shall harvest, possess while in or on the waters of the state, or land any of the following species of angelfish, of total length less than that set forth below:

1. One-and-one-half (1 1/2) inches for:
   a. Gray angelfish (Pomacanthus arcuatus).
   b. French angelfish (Pomacanthus paru).
2. One-and-three-quarters (1 3/4) inches for:
   a. Blue angelfish (Holacanthus bermudensis).
   b. Queen angelfish (Holacanthus ciliaris).
3. Two (2) inches for rock beauty (Holacanthus tricolor).

(b) No person shall harvest, possess while in or on the waters of the state, or land any angelfish (Family Pomacanthidae), of total length greater than that specified below:

1. Ten (10) inches for angelfish, except rock beauty (Holacanthus tricolor).
2. Six (6) inches for rock beauty.

(2) Butterflyfishes.--

(a) No person harvesting for commercial purposes shall harvest, possess while in or on the waters of the state, or land any butterflyfish (Family Chaetodontidae) of total length less than one (1) inch.

(b) No person shall harvest, possess while in or on the waters of the state, or land any butterflyfish of total length greater than 4 inches.

(3) Gobies -- No person shall harvest, possess while in or on the waters of the state, or land any gobie (Family Gobiidae) of total length greater than 2 inches.

(3) Jawfishes -- No person shall harvest, possess while in or on the waters of the state, or land any jawfish (Family Opistognathidae) of total length greater than 4 inches.

Specific Authority.-- 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S.
History.-- New 1-1-91.

46-42.005 Bag limit.--

(1) Except as provided in Rule 46-42.006 or subsections (3) or (4) of this rule, no person shall harvest, possess while in or on the waters of the state, or land more than 20 individuals per day of tropical ornamental marine life species, in any combination.

(2) Except as provided in Rule 46-42.006, no person shall harvest, possess while in or on the waters of the state, or land more than one (1) gallon per day of tropical ornamental marine plants, in any combination of species.

(3) Except as provided in Rule 46-42.006, no person shall harvest, possess while in or on the waters of the state, or land more than 5 angelfishes (Family

23 de marzo de 1993

Sr. Miguel Rolón
Director Ejecutivo
Consejo de Administración Pesquera del Caribe
Banco Popular, Suite 1108
Hato Rey, P.R. 00918

RE: Comentarios relacionados a los cambios propuestos a las medidas relacionadas al comercio de peces de acuario.

Estimado Señor Rolón:

Reciba un cordial saludo. Por este medio, remito algunos comentarios relacionados al comercio de peces de acuarios. Recibo con una mezcla de satisfacción y frustración parte de los cambios propuestos para regular la explotación de peces de acuario. Satisfacción, en primer lugar, porque se ha iniciado una acción para conservar algunas especies vulnerables. El no haber tomado acción permitiría continuar la explotación desmedida del recurso.

16

Sin embargo, basándonos en el estudio de Sadovy (1991), en Puerto Rico se exportaron entre 1990 y 1991 sobre 100 especies de peces de arrecife. Creo que ha sido un desacierto excluir cerca del 95% o más de las especies de las medidas de protección. Más preocupante resulta el que no se incluyeran grupos de peces los cuales considero como muy vulnerables a este tipo de explotación debido a sus nichos ecológicos y hábitos alimentarios sumamente especialistas, cuyo rol altamente específico en el arrecife podría ser detrimental a su integridad.

El documento acompañante titulado Comentarios relacionados a los cambios propuestos a las medidas relacionadas al comercio de peces de acuario. ¿Qué hacer con aquellas especies que aún no han sido protegidas? discute algunos aspectos de la ecología arrecifal como la limpieza de ectoparásitos en los peces, al igual que presenta un listado preliminar de algunas especies y gupos de peces que requiern protección lo antes posible. Espero sean de alguna utilidad al Consejo.

Atentamente,

Edwin A. Hernández Delgado

Universidad de Puerto Rico
Departamento de Biología
Apt. 23360
Río Piedras, P.R. 00931-3360

Comentarios relacionados a los cambios propuestos a las medidas relacionadas al comercio de peces de acuario. ¿Qué hacer con aquellas especies que no han sido aún protegidas?

Edwin A. Hernández Delgado
Universidad de Puerto Rico
Depto. Biología
Apt. 23360
Río Piedras, P.R. 00931-3360

23 de marzo de 1993

Recientemente, el Consejo de Administración Pesquera del Caribe aprobó unas medidas conducente a proteger varias especies de peces de la explotación del mercado de acuarios. Específicamente, se propone prohibir la captura de los caballitos de mar *Hippocampus* spp. (Sygnathidae), mero cabrilla *Epinephelus guttatus* (Serranidae), el pargo sama *Lutjanus analis* (Lutjanidae) y tres especies de mariposas: *Chaetodon capistratus*, *C. striatus*, *C. aculeatus* (Chaetodontidae).

Sin embargo, basándonos en el estudio de Sadovy (1991), en Puerto Rico se exportaron entre 1990 y 1991 sobre 100 especies de peces de arrecife. Creo que ha sido un desacierto excluir cerca del 95% o más de las especies de las medidas de protección. Más preocupante resulta el que no se incluyeran grupos de peces los cuales considero como muy vulnerables a este tipo de explotación debido a sus nichos ecológicos y hábitos alimentarios sumamente especialistas, cuyo rol altamente específico en el arrecife podría ser detrimental a su integridad. A continuación, discuto algunos aspectos de la ecología arrecifal los cuales deben ser considerados al preparar una lista más amplia de especies a protegerse, así como un listado preliminar de algunas especies o grupos de peces, los cuales entiendo requieren medidas de protección similares lo antes posible.

Importancia de las asociaciones biológicas en el arrecife

El arrecife de coral es uno de los habitáculos de mayor importancia biológica en el planeta debido a su valor ecológico, poseer una alta biodiversidad, su alta productividad biológica, mantener complejas redes alimentarias y por su incalculable valor socioeconómico y estético, entre otros. También se cree son muy importantes en el control de los niveles de CO_2 atmosférico. Sin embargo, los arrecifes se caracterizan por las complicadas interacciones biológicas de sus componentes.

Como ejemplo, los corales viven en una relación simbiótica con un grupo de dinoflagelados conocidos como zooxantelas, los cuales son vitales para la productividad neta del arrecife de coral, la deposición de carbonato de calcio ($CaCO_3$) (Odum y Odum, 1955), y para el crecimiento del coral (Simkiss, 1964). Las zooxantelas también proveen muchos de los nutrientes esenciales a los corales (Muscatine y Cernichiari, 1969; Pearse y Muscatine,

1977) a la vez que contribuyen a su respiración y producción de mucosa. Según Davies (1984), el coral Pocillopora eydouxi, del Pacífico, usa 51% de la energía fijada mediante fotosíntesis en respiración, 48% en la producción de mucosa y 0.9% en crecimiento. Mientras Muscatine et al. (1981) observó que las zooxantelas contribuyeron un 63% y 69% a la respiración de P. damicornis y Fungia scutaria, respectivamente. Cualquier disrupción en esta relación simbiótica podría ser detrimentral para los corales y el arrecife como sistema.

De igual forma, existe otro gran número de interacciones biológicas en los arrecifes de coral. Esto incluye asociaciones entre diversos grupos representados en la meiofauna (ej protozoarios, gusanos planos, copépodos), esponjas, sipuncúlidos, poliquetos, gastrópodos, pelecípodos, cirripedios, decápodos, equinodermos y peces (Patton, 1976). Por ejemplo, algunos grupos de crustáceos asociados a corales pueden ser muy importantes para estos últimos ya que los crustáceos se alimentan del sedimento que se acumula sobre la mucosa de los corales (Patton, 1976).

Sin embargo, una de las relaciones simbióticas más importantes del arrecife es la de los organismos limpiadores de ectoparásitos. Un ejemplo de ésto son los camarones del género Periclimenes spp., (Palaemonidae) especies incluídas en el listado preparado por Sadovy (1991), sobre especies exportadas por el comercio de acuario. Este grupo vive siempre en estrecha asociación con varias especies de anémonas (Humann, 1992b) y es uno de los limpiadores más importantes del arrecife. Otros grupos incluyen a peces de los géneros: Gobiosoma, Pomacanthus, Chaetodon, familia Labridae, algunos pomacéntridos y otros.

Según Randall (1962), este fenómeno fue descubierto, aunque no descrito como tal, por Beebe y Tee Van (1928) en el lábrido Thalassoma bifasciatum en Haití y Bermuda. Estos asumieron que sólo se removían partículas de alimento no ingerido por otros peces. Luego, Longley describió en la década de 1930 el mismo comportamiento como la remoción de ectoparásitos. Contrario al Pacífico, donde el género Labroides (Labridae) es básicamente el limpiador principal, en el Atlántico occidental existe un gran número de especies limpiadoras.

De acuerdo a Limbaugh (fecha no precisada) en un artículo titulado "Cleaning Symbiosis" en la revista "Scientific American" (ver apéndice 1), una sola "estación de limpieza" en un arrecife de coral de las Bahamas puede ser visitada hasta por 300 peces en un periodo de seis horas. Según este autor, los peces visitaban, inclusive en varias ocasiones durante el día la misma estación o diversas estaciones de limpieza, invirtiendo casi el mismo tiempo en esta actividad que el que invertían en su alimentación. Esto nos sugiere el grado de importancia que reviste la limpieza de ectoparásitos para la ictiofauna arrecifal.

Más aún, esto nos sugiere que la presencia de estaciones de limpieza en los arrecifes puede tener un rol crítico en determinar la distribución y concentración de las poblaciones de peces arrecifales. De hecho, en muchas ocasiones, donde hay agregaciones de peces en el arrecife es precisamente donde se encuentran las estaciones de limpieza (observaciones personales) Estas típicamente se encuentran entre corales masivos (ej. Diploria spp., Montastrea spp., Siderastrea siderea y otros), entre esponjas y cerca de hendiduras, cavernas y rocas. Esto nos sugiere que tanto la destrucción del hábitat natural de estos organismos, como la remoción de los organismos limpiadores puede ser detrimental para la composición de la ictiofauna arrecifal.

Según Limbaugh, un pequeño experimento de remoción de las especies limpiadoras en dos arrecifes de parcho en las Bahamas donde los peces eran muy abundantes demostró que al cabo de varios días el número de peces disminuyó drásticamente. Al cabo de dos semanas, casi todas las especies habían desaparecido a excepción de aquellas territorialistas. De éstos que quedaron, muchos desarrollaron diversos tipos de enfermedades parasíticas, ulceraciones, laceraciones sin sanar y infecciones bacterianas.

Finalmente, según Limbaugh, desde el punto de vista evolutivo, la simbiosis de limpieza es vital ya que evidencia las adaptaciones morfológicas y de comportamiento de muchas especies. Desde el punto de vista ecológico, los limpiadores son unas de las especies claves en el arrecife ya que determinan en parte el arreglo y composición de especies en hábitats particulares como los arrecifes de coral. En cuanto a la zoogeografía de los peces marinos, los limpiadores podrían ser uno de los factores limitantes en la dispersión de las especies. Y más importante aún para el humano, los limpiadores de parásitos tienen un incalculable beneficio socioeconómico al remover los parásitos de especies de importancia cormercial para el humano, sosteniendo así importantes pesquerías. Estas especies vienen a tener el rol del "doctor del arrecife".

Todo esto evidencia el impacto que podría tener el destruir una simple estación de limpieza en un arrecife. Más aún, nos suguiere la posibilidad de considerar el número de estaciones de limpieza en el arrecife como uno de los posibles monitores de salud arrecifal. El grado en que la destrucción de hábitat natural del arrecife y por ende, estaciones de limpieza, ha afectado las poblaciones de peces, disminuyendo su densidad, composición o diversidad, aunque posible, es difícil de establecer. Sin embargo, definitivamente, es un factor de peso que debe llevarnos a considerar prohibir la explotación comercial por el comercio de acuarios de las especies limpiadoras.

A continuación, un listado de algunas de aquellas especies y grupos prioritarios para ser incluidos en dicha prohibición:

1. Gramma loreto ("Fairy basslet")

Una de las especies de peces más afectadas es Gramma loreto (Grammidae) con una exportación estimada en 11,124 organismos

(Sadovy, 1991). Este pez, además de ser planctívoro, se alimenta también de ectoparásitos de otras especies de peces. Típicamente, se utiliza quinaldina para su captura, la cual podría resultar detrimental para otras especies en el arrecife, particularmente, para los invertebrados sésiles (ej. corales, anémonas, zoántidos, etc.).

2. *Pomacanthus* spp. y *Holacanthus* spp. (Peces ángeles)

Los peces ángeles (Pomacanthidae), fue otro de los grupos con mayor exportación, unos 2,907 individuos (Sadovy, 1991). Este grupo se ha convertido en uno muy raro en muchos de nuestros arrecifes (observaciones personales). Los juveniles de *Pomacanthus paru*, *P. arcuatus*, *Holacanthus ciliaris* y *H. tricolor* se alimentan de algas y detrito, y ocasionalmente se han observado limpiando ectoparásitos de diversas especies de peces (Randall, 1983). Los adultos de muchos peces ángeles se alimentan de principalmente de esponjas, aunque incluyen en su dieta tunicados, zoántidos y algas. El remover un organismo que controle naturalmente las poblaciones de esponjas en el arrecife podría resultar en un desbalance en las poblaciones naturales de éstas, lo cual podría resultar en un sobrecrecimiento de éstas en los corales. Además, al remover los juveniles, se estaría eliminando también otro limpiador de parásitos.

3. *Bodianus rufus* (Capitán de piedra)

El lábrido *Bodianus rufus* es otra especie frecuentemente capturada en etapas juveniles, en la cual también es un limpiador de ectoparásitos en otros peces (Humann, 1992a; Randall, 1962, 1983). Como adulto, se alimenta de invertebrados bentónicos como crustáceos, erizos, estrellas quebradizas y moluscos.

4. *Thalassoma bifasciatum* (Cabeza azul)

El cabeza azul (Labridae), tanto en su etapa juvenil, como en la adulta es uno de los principales limpiadores de ectoparásitos de otros peces (Humann, 1992a; Rolfe, 1980). También se alimenta de una gran variedad de invertebrados de fondo, zooplancton y ectoparásitos de otros peces (Randall, 1983). Según Feddern (1965), su dieta incluye crustáceos ectoparasíticos en peces (ej. isópodos) y copépodos de vida libre.

5. *Halichoeres* spp. (capitanes)

Varias especies del género *Halichoeres* (Labridae) son exportadas por el comercio de acuario (Sadovy, 1991). Estos peces son carnívoros, alimentándose mayormente de cangrejos erizos, gusanos poliquetos, moluscos y estrellas quebradizas (Randall, 1983). El grupo es uno de los predadores más abundantes en el arrecife. Una reducción en sus poblaciones podría resultar detrimental para el arrecife al permitir un posible aumento en las densidades poblacionales de invertebrados coralívoros y de organismos erodadores o perforadores de corales a niveles locàles

6. Scaridae (loros)

Varios miembros dentro de la familia de los loros también son exportados por el comercio de acurio. Los loros son unos de los peces más dominnates en los arrecifes de esta región, son herbívors y muy eficientes en la utilización de los nutrientes (Randall, 1983). Tambien pueden raspar pedazos de rocas y de corales durante su proceso de alimentación, por lo que contribuyen a la producción de sedimentos y reciclaje de nutrientes y de $CaCO_3$ en el arrecife.

7. Seranidae (meros)

Sadovy (1991) presenta un amplio listado de especies de esta familia exportados, incluyendo especies de importancia alimentaria para el humano como el mero cabrilla Epinephelus guttatus y E. fulvus. Tambien varias especies dentro del genero Hypoplectrus, incluyendo H. unicolor, H. guttavarius, H. gummigutta, H. aberrans, H. indigo, H. nigricans y H. puella. La mayoría de éstas están clasificadas por Randall (1983) como muy raras y de una distribución muy limitada. De hecho, según Grana Raffucci (1992), en Puerto Rico, hasta ese momento, sólo se había reportado H. unicolor. Esta familia completa debe recibir también inmediata protección.

8. *Gobiosoma* spp. (gobis limpiadores)

Los góbidos limpiadores del género *Gobiosoma* spp. (Gobiidae) son de vital importancia ecológica para la ictiofauna arrecifal ya que también se alimentan de ectoparásitos de peces (Humann, 1992a, Randall, 1983). Los góbidos se consideran unos de los principales limpiadores de parásitos en el arrecife. Estos habitan en cabezas de coral (Randall, 1983) y en esponjas (Gudger, 1950). Su captura con químicos (ej. quinaldina) puede implicar la degradación o destrucción de corales masivos (ej. *Montastrea* spp. y *Diploria* spp.) o esponjas donde usualmente habitan estas especies.

9. *Astrapogon stellatus* ("Conchfish")

Esta especie, perteneciente a la familia Apogonidae, está también incluida en el listado preparado por Sadovy (1991). La misma ya podría, de por sí, estar seriamente amenazada ya que habita como comensal en la cavidad del manto del carrucho *Strombus gigas* (Randall, 1983). Esto nos sugiere que ya está sujeta a la misma presión de sobrepesca a la que está sujeta el carrucho, por lo que debe ser protegida lo antes posible. Además, de esta forma también se protegería al carrucho, su hospedero natural. Existen dos especies bastante similares *A. alutus* y *A. puncticulatus*, las cuales habitan en conchas de carruchos muertos (Humann, 1992a). De igual forma, debieran ser protegidas.

10. *Priacanthus* spp. (ojones, catalufas)

Dos especies de la familia Priacanthidae fueron reportadas por Sadovy (1991): *Priacanthus arenatus* y *P. cruentatus*. Ambas especies tienden a ser más activos en horas nocturnas. Durante el día se ocultan dentro de hendiduras y cavernas en los arrecifes (Humman, 1992a). Estos son carnívoros, alimentándose principalmente de peces pequeños, crustáceos y gusanos poliquetos (Randall, 1983), pudiendo tener un posible rol importante en controlar las poblaciones de especies crípticas en los arrecifes

11. Holocentridae (gallitos)

Varias especies dentro de esta familia fueron exportados por el comercio de acuarios en Puerto Rico entre 1990 y 1991 (Sadovy, 1991). Esto incluyó a *Plectrypops restrospinis* (toro cardenal), *Holocentrus ascensionis* (gallo), y *Myripristis jacobus* (torito), entre otros. Este grupo es de hábitos nocturnos y durante el día se oculta dentro de hendiduras y cavernas en el arrecife. Los holocéntridos son carnívoros, se alimentan mayormente de crustáceos (Randall, 1983) y son uno de los principales grupos nocturnos del arrecife. Su contribución al acerreo y reciclaje de nutrientes en el arrecife mediante procesos de excresión podría ser muy importante.

12. Pomacentridae (damiselas, cromis, sargentos)

Este grupo es uno de los de mayor representación en el arrecife. Incluye grupos carnívoros (ej. *Chromis* spp.), herbívoros como los sargentos (ej. *Abudefduf* spp.) y omnívoros como las damiselas (ej. *Stegastes* spp.), aunque existen sus variaciones en este último grupo (Randall, 1983). Estudios realizados sobre el contenido estomacal de los pomacéntridos en el Pacífico sugieren observaciones similares (Hiatt y Strasburg, 1960). Muchas de las especies del género *Stgastes* presentan un comportamiento muy agresivo y territorialista, lo que dificulta su mantenimiento en acuarios (Rolfe, 1980). Según Reese (1973), algunos pomacéntridos pueden permanecer en un mismo territorio desde algunas semanas hasta más de dos años y medio. Por otro lado, según Sale (1973), una de las ventajas de ese comportamiento en los pomacéntridos es el posible mantenimiento de una jerarquía social. Remover estas especies del arrecife, no sólo podría generar problemas para otras especies en los acuarios, si no que podría alterar la estructura social de las poblaciones naturales en el arrecife. Finalmente, de acuerdo a Emery (1973), los pomacéntridos son predados por diversos grupos de organismos, por lo que son vitales en el proceso de importar y distribuir energía en la comunidad arrecifal.

13. <u>Chaetodipterus faber</u> (pagualas)

Varios individuos de esta especie de la familia Ephippidae fueron exportados (Sadovy, 1991). La misma presenta diversos cambios de coloración entre sus etapas juveniles y adulta, pudiendo llegar a alcanzar un tamaño de cerca de 1 metro, muy difícil de mantener en un acuario común y corriente. Su dieta es sumamente diversa, incluyendo organismos sésiles como esponjas, zoántidos (anémonas coloniales), gusanos poliquetos, corales gorgóneos, algas y tunicados pelágicos (Randall, 1983). Esta especie se ha tornado rara en algunos arrecifes de la región este de Puerto Rico (observaciones personales).

14. <u>Amblycirrhitus pinos</u> ("hawkfish")

Esta especie es la única en el Atlántico occidental dentro de la familia Cirrhitidae y es muy rara, según Randall (1983).

15. <u>Anisotremus virginicus</u> (canario)

Esta especie, perteneciente a la familia Haemulidae (boquicolorados), fue una de las especies exportadas con mayor frecuencia (Sadovy, 1991). En sus etapas juveniles también es un removedor de ectoparásitos de otros peces, mientras que como adulto se alimenta de diversos invertebrados (Randall, 1983).

16. Syngnathus caribbaeus ("pipefish")

Esta especie, de la misma familia de los caballitos de mar Hippocampus spp. (Sygnathidae), debe recibir igual protección que estos últimos debido a su rareza y posible vulnerabilidad a esta explotación.

17. Balistes vetula (pejepuerco) (Balistidae)

Este es uno de los depredadores arrecifales más explotados por el comercio de acuario. Su valor ecológico es vital para el arrecife. Según Brawley y Adey (1982), la sobrepesca de depredadores en el arrecife puede ser responsable del incremento en las densidades poblacionales de especies coralívoras como el molusco gastrópodo Coralliophila abbreviata. Observaciones similares fueron reportadas por Hernández Delgado (1993), donde una inusual alta cantidad de C. abbreviata predaba en el coral Acropora palmata en Playa Sardinera, Isla de Mona, coincidiendo con un bajo número y baja diversidad de predadores en el arrecife.

18. Xanthichthys ringens (pejepuerco del sargaso)

Este balistido es bastante raro. En su etapa adulta rara vez se observa en aguas menores de 100 pies de profundidad. Sin embargo, como juvenil, se observa en ocasiones flotando en sargaso en la superficie del mar, de donde es atrapado. Esto nos sugiere que el remover selectivamente a los juveniles de la especie podría afectar a largo plazo el reclutamiento de nuevos individuos en los arrecifes profundos, reduciendo eventualmente la población.

19. Monacanthidae ("Filefishes")

Varias especies de esta familia son exportadas. Estos peces se caracterizan por sus hábitos secretos, tratando de ocultarse entre los corales gorgóneos, plantas, etc. Se alimentan principalmente de esponjas, hidroides, gorgóneos, etc. (Randall, 1983).

20. Mullidae (salmonetes)

Este grupo de peces bentónicos se alimenta de invertebrados y es uno de los peces de mayor valor alimentario para el humano. Debe ser excluido del comercio de acuarios.

21. Ostraciidae (chapines)

Los chapines se han tornado hoy día bastante raros en muchas localidades (observaciones personales). Estos son de gran valor alimentario para el humano. Además, de acuerdo a Randall (1983), al ser colocados en peceras, tienden a secretar una sustancia venenosa que puede matar a los demás peces, inclusive a ellos mismos.

22. <u>Diodon hystrix</u> (guanábano)

Este pez de la familia Diodontidae también fue exportado por el comercio de acuarios. Este tiene un gran valor alimentario para el humano y es uno de los depredadores importantes del arrecife. Se alimentan principalmente de invertebrados bentónicos protegidos por conchas, espinas y exoesqueletos (Randall, 1983).

Este listado no agrupa todas las especies que requieren protección o al menos requieren estudios lo antes posible para determinar si requieren protección. Sin embargo, nos brinda una idea general de algunos aspectos de su ecología que deben ser considerados prioritariamente al preparar una lista más amplia excluyéndolos del comercio de acuarios. Estudios relacionados a sus ciclos y épocas reproductivas deben ser llevados a cabo como parte del banco de datos evaluados. Alguna de esta información ya existe para algunas especies (Munro et al., 1973).

Finalmente, cabe citar el propio borrador no oficial (traducido a español) del 1 de marzo de 1993, el cual resume las medidas del Consejo. En su página 4, en la sección donde se discute el efecto de no haber tomado ninguna acción al respecto, se establece que "es posible que algunas especies estén siendo sobrepescadas, mientras otras pueden proveer grandes beneficios como componentes del ecosistema coralino en vez de ser capturadas". Es precisamente, ésto lo que podría ocurrir de no proteger también las especies y grupos listados arriba.

Recomiendo al Consejo reconsiderar incluir la prohibición de estas especies y grupos de peces a las medidas de manejo propuestas para regular el comercio de peces de acuario. Ojalá esta información pudiera ser de utilidad en la evaluación y reconsideración de las mismas.

Literatura citada

Beebe, W., & J. Tee Van. 1928. The fishes of Port-au-Prince Bay, Haiti, with a summary of the known species of marine fish of the island of Haiti and Santo Domingo. Zoologica N.Y. 10(1):1-279.

Brawley, S.H., & W.H. Adey. 1982. Coralliophila abbreviata: A significant corallivore. Bull. Mar. Sci. 32(2):595-599.

Davies, P.S. 1984. The role of Zooxanthellae in the nutitional energy requirements of Pocillopora eydouxi. Coral Reefs. 2:181-186.

Emery, A.R. 1973. Comparative ecology and functional osteology of fourteen species of damselfish (Pisces: Pomacentridae) at Alligator Reef, Florida Keys. Bull. Mar. Sci. 23(3):649-770.

Feddern, H.A. 1965. The spawning, growth, and general behavior of the bluehead wrasse Thalassoma bifasciatum (Pisces: Labridae). Bull. Mar. Sci. 15(4):896-941.

Grana-Raffucci, F.A. 1992. Catálogo de nomenclatura de los peces de Puerto Rico y las Islas Vírgenes. Publicación Científica Miscelánea Núm. 3, Departamento de Recursos Naturales, San Juan, P.R. 145 pp.

Gudger, E.W. 1950. Fish that live as inquilines (lodgers) in sponges. Zoologica. N.Y. Zool. Soc. 35(7):121-126.

Hernández Delgado, E.A. 1993. Informe preliminar sobre el estado de los recursos marinos de Isla de Mona y algunas recomendaciones de manejo. Reporte preliminar sometido a la Comisión de Recursos Naturales y Calidad Ambiental, Cámara de Representantes, Estado Libre Asociado de Puerto Rico, San Juan, P.R. 18 de marzo de 1993. 43 pp. + App.

Hiatt, R.W., & D.W. Strasburg. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. Ecol. Monogr. 30(1):65-127.

Humann, P. 1992a. Reef Fish Identification, Florida, Caribbean, Bahamas. (N. DeLoach, Ed.). New World Publications, Inc., Orlando, FL. 267 pp.

Humann, P. 1992b. Reef Creature Identification, Florida, Caribbean, Bahamas. (N. DeLoach, Ed.). New World Publications, Inc., Orlando, FL. 320 pp.

Limbaugh, C. (Not dated). Cleaning symbiosis. Sci. Amer.:42-49 (Xerox copied).

Munro, J.L., V.C. Gaut, R. Thompson, & P.H. Reeson. 1973. The spawning seasons of Caribbean reef fishes. J. Fish. Biol. 5:69-84.

Muscatine, L., & E. Cernichiari. 1969. Assimilation of photosynthetic products of zooxanthellae by a reef coral. Biol. Bull. 137:506-523.

Muscatine, L., L.R. McCloskey, R.E. Marian. 1981. Estimating the daily of carbon from zooxanthellae to coral animal respiration. Limnol. Oceanogr. 26(4):601-611.

Odum, H.T., & E.P. Odum. 1955. Trophic structure and productivity of a windward coral reef community on Eniwetok atoll. Ecol Monogr. 25:291-320.

Patton, W.K. 1976. Animal associates of living reef corals. 1-36 In: O.A. Jones, & R. Endean (Eds.), Biology and Geology of Coral Reefs, Vol. III. Academic Press, New York, N.Y.

Pearse, V., & L. Muscatine. 1971. Role of symbiotic algae (Zooxanthellae) in coral calcification. Biol. Bull. 141:350-363.

Randall, J.E. 1962. Fish service stations. 8(1):40-47.

Randall, J.E. 1983. Caribbean Reef Fishes, Revised Ed. T.F.H. Publications, Neptune City, N.J. 350 pp.

Reese, E.S. 1973. Duration of home residence by coral reef fishes on "home" reefs. Copeia. 1973(1):145-149.

Rolfe, A.R. 1980. Marine Behavior and Aquarists Guide to Tropical Fishes and Invertebrates. Rolfe Associates, St. Thomas, USVI. 32 pp.

Sadovy, Y. 1991. A preliminary assessment of the export trade in marine aquarium organisms in Puerto Rico. Report submitted to the Caribbean Fishery Management Council. San Juan, P.R. 43 pp.

Sale, P.F. 1971. Extremely limited home range in a coral reef fish, Dascyllus aruanus (Pisces; Pomacentridae). Copeia. 1971(2):324-327.

Simkiss, K. 1964. Possible effects of zooxanthellae on coral growth. Experientia. 20:140.

APENDICE 1

CLEANING SYMBIOSIS

The invasion of the oceans by skin-diving biologists has led to the discovery that a surprisingly large number of marine organisms either live by cleaning other marine organisms or benefit by being cleaned

by Conrad Limbaugh

While skin diving in the cool water off the coast of southern California in the spring of 1949, I observed a brief and seemingly casual meeting between a small golden kelp perch (*Brachyistius frenatus*) and a walleye surfperch (*Hyperprosopon argenteum*) twice its size. The walleye had separated itself from a milling school of its fellows several yards away and was holding itself rigid with fins extended, its body pointed at an unnatural angle to the surface of the water. The three-inch kelp perch spent several minutes picking at the silver sides of the walleye with its pointed snout. Then the kelp perch darted into the golden leaves of a nearby kelp plant, and the walleye returned to lose itself in the activity of the school. At the time I recorded this event in my notes only as an interesting incident.

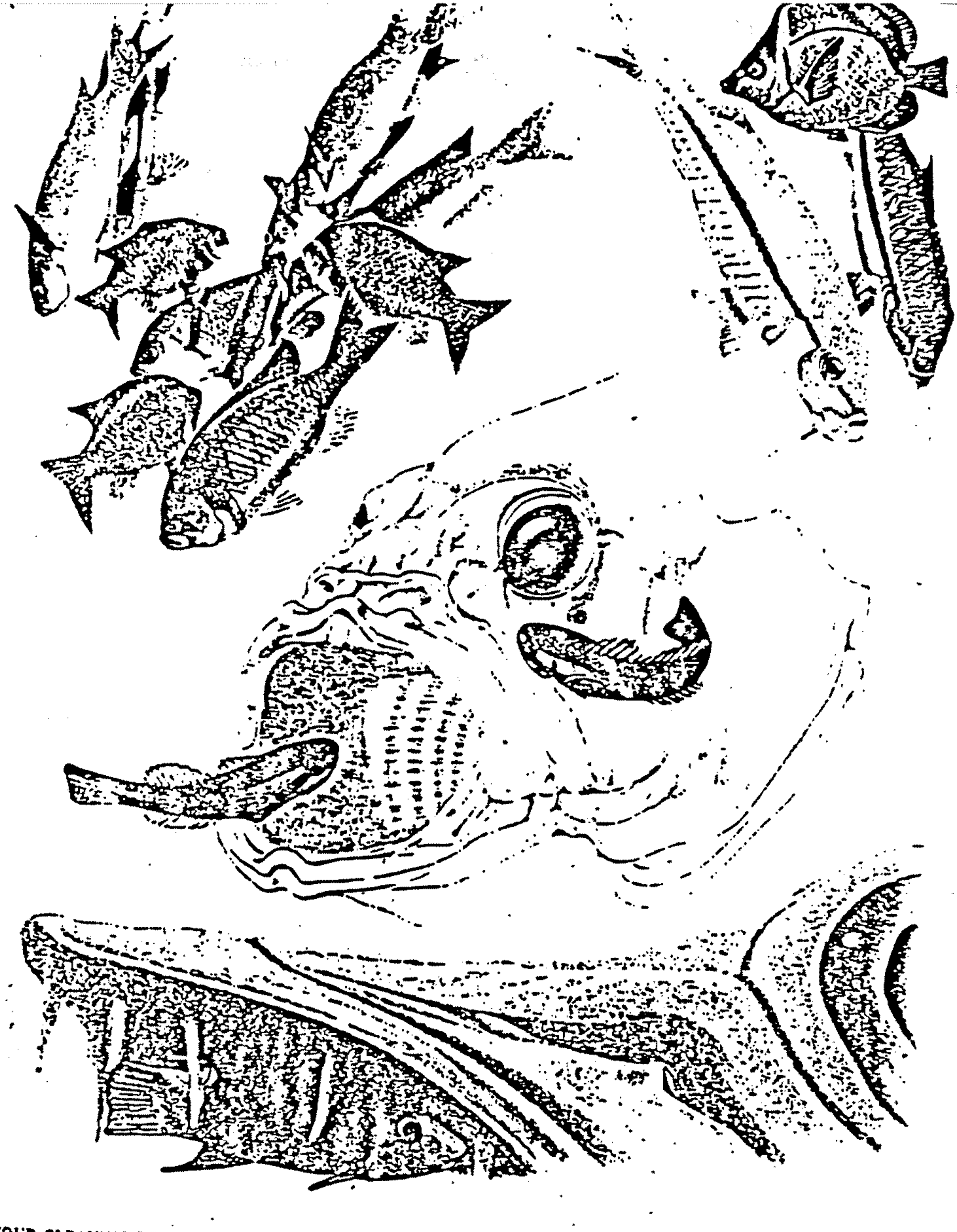
Since then my studies and the observations of others have convinced me that this was not an isolated episode. On the contrary, it was an instance of a constant and vital activity that occurs throughout the marine world: cleaning symbiosis. Certain species of marine animal have come to specialize in cleaning parasites and necrotic tissue from fishes that visit them. This mutually beneficial behavior promotes the well-being of the host fishes and provides food for those that do the cleaning.

The relationship between the cleaner and the cleaned is frequently so casual as to seem accidental, as in the encounter that first caught my attention. On the other hand, one finds in the Bahamas the highly organized relationship between the Pederson shrimp (*Periclimenes pedersoni*) and its numerous clients. The transparent body of this tiny animal is striped with white and spotted with violet, and its conspicuous antennae are considerably longer than its body. It establishes its station in quiet water where fishes congregate or frequently pass, always in association with the sea anemone *Bartholomea annulata*, usually clinging to it or occupying the same hole. When a fish approaches, the shrimp will whip its long antennae and sway its body back and forth. If the fish is interested, it will swim directly to the shrimp and stop an inch or two away. The fish usually presents its head or a gill cover for cleaning, but if it is bothered by something out of the ordinary, such as an injury near its tail, it presents itself tail first. The shrimp swims or crawls forward, climbs aboard and walks rapidly over the fish, checking irregularities, tugging at parasites with its claws and cleaning injured areas. The fish remains almost motionless during this inspection and allows the shrimp to make minor incisions in order to get at subcutaneous parasites. As the shrimp approaches the gill covers, the fish opens each one in turn and allows the shrimp to enter and forage among the gills. The shrimp is even permitted to enter and leave the fish's mouth cavity. Local fishes quickly learn the location of these shrimp. They line up or crowd around for their turn and often wait to be cleaned when the shrimp has retired into the hole beside the anemone.

Such behavior has been considered a mere curiosity for many years. The literature contains scattered reports of cleaning symbiosis, including a few examples among land animals: the crocodile and the Egyptian plover, cattle and the egret, the rhinoceros and the tick-bird. As early as 1892 the German biologist Franz von Wagner had suggested that the pseudoscorpion, a tiny relative of the spider that is frequently observed stealing a ride on larger insects, is actually engaged in removing parasitic mites from these insects. The U.S. biologist William Beebe in 1924 saw red crabs remove red ticks from sun-bathing marine iguanas of the Galapagos Islands. While diving in the coral waters off Haiti four years later, Beebe also saw several small fishes of the wrasse family cleaning parrot fish. Mexican fishermen in the Gulf of California refer to a certain angelfish (*Holacanthus passer*) as *El Barbero*. They explain that this fish "grooms the other fishes" and so deserves its title as "The Barber."

Recognition of cleaning symbiosis and its implications has come only in recent years. The gear and the technique of skin diving have given marine biologists a new approach to the direct observation of undersea life. They have discovered numerous examples of cleaning behavior, enough to establish already that the behavior represents one of the primary relationships in the community of life in the sea. The known cleaners include some 26 species of fish, six species of shrimp and Beebe's crab. This number will undoubtedly increase when the many marine organisms now suspected of being cleaners have been studied more closely. It now seems that most other fishes seek out and depend on the service they render. The primary nature of the behavior is evident in the bright coloration and anatomical specialization that distinguish many cleaners. It appears that cleaning symbiosis may help to explain the range of species and the make-up of populations found in particular habitats, the patterns of local movement and migration and the natural control of disease in many fishes.

The importance of cleaning in the ecology of the waters off southern California became more and more apparent to me during the early 1950's as I accumulated observations of cleaners at work. My notes are particularly concerned with



FOUR CLEANING RELATIONSHIPS are depicted in this drawing by Rudolf Freund. In each the cleaner is in color. At top left a señorita (*Oxyjulis californica*) cleans a group of blacksmiths (*Chromis punctipinnis*). At top right are a butterfly fish (*Chaetodon nigrirostris*) and two Mexican goatfish (*Pseudupeneus dentatus*); in center, two neon gobies (*Elecatinus oceanops*) and a Nassau grouper (*Epinephelus striatus*); at bottom, a Spanish hogfish (*Bodianus rufus*) in the mouth of a barracuda (*Sphyraena barracuda*).

the performance of the golden-brown wrasse (*Oxyjulis californica*), commonly called the señorita. This cigar-shaped fish is abundant in these waters and well known to fishermen as a bait-stealer.

Certain fishes, such as the opaleye (*Girella nigricans*), the topsmelt (*Atherinops affinis*) and the blacksmith (*Chromis punctipinnis*), crowd so densely about a señorita that it is impossible to see the cleaning activity. When I first saw these dense clouds, often with several hundred fish swarming around a single cleaner, I thought they were spawning aggregations. As the clouds dispersed at my approach, however, I repeatedly observed a señorita retreating into the cover of the rocks and seaweed nearby. Often the host fishes, unaware of my approach, would rush and stop in front of the retreating señorita, temporarily blocking its path. In less dense schools I was able to observe the señorita in the act of nibbling parasites from the flanks of a host fish. While being cleaned blacksmiths would remain motionless in the most awkward positions—on their sides, head up, head down or even upside down.

The material cleaned from fishes by the señorita and other cleaners has not been thoroughly studied. Among the organisms I have noted in the stomach contents of cleaners are copepods and isopods: minute parasitic crustaceans that attach themselves to the scales and integument of fishes. I have also found bacteria, and on several occasions I have seen señoritas in the act of nibbling away a white, fluffy growth that streamed as a milky cloud from the gills of infected fishes. Especially in the spring and summer months off California and farther south in the warmer waters off Mexico, many fishes display this infection; it ranges from an occasional dot of white to large ulcerated sores rimmed with white. Carl H. Oppenheimer, now at the University of Miami, has shown that this is a bacterial disease by infecting healthy individuals with material taken from diseased fishes.

Judging by the diversity of its clientele, the señorita is well known as a cleaner to many members of the marine community. Among the species that seek out its services I have counted pelagic (deep ocean) fishes as well as the numerous species that populate the kelp beds nearer shore. The black sea bass (*Stereolepis gigas*) and the even larger ocean sunfish (*Mola mola*) seem to come purposely to the outer edge of the kelp beds, where they attract large numbers of señoritas, which flock around them to pick off their parasites. I have also observed the señorita at work on the bat ray (*Holorhinus californicus*), showing that the symbiosis embraces the cartilaginous as well as the bony fishes.

Since first recognizing cleaning behavior in these southern California fishes, I have studied it in numerous places down the Pacific Coast of Mexico, in the Gulf of California, in the Bahamas and in the Virgin Islands. Observations such as mine have been paralleled in the literature by other skin-diving biologists and by underwater photographers. From 1952 to 1955 Vern and Harry Pederson made motion pictures in the Bahamas of cleaning behavior in a number of species of fish and in the violet-spotted shrimp that bears their name. In 1953 the German skin diver Hans Hass suggested that the pilot fish associated with manta rays ate the parasites of their hosts. Irenaus Eibl-Eibesfeldt, a German biologist, published notes in 1954 on cleaning behavior he had witnessed in fishes in Bahamian waters, he expressed the belief that it is common in the oceans of the world. In the Hawaiian and Society islands John E. Randall of the University of Miami identified as cleaners four fishes of the genus *Labroides*, two of which were new species.

A few generalizations about cleaning symbiosis may now be attempted. In the first place, the phenomenon appears to be more highly developed in clear tropical waters than in cooler regions of the seas. The tropical cleaner species are more numerous and include the young of the gray angelfish (*Pomacanthus aureus*), the butterfly fish (*Chaetodon*), gobies (*Elecatinus*) and several wrasses such as the Spanish hogfish (*Bodianus rufus*) and the members of the genus *Labroides*. Even distantly related species have analogous structures for cleaning, such as pointed snouts and tweezer-like teeth; this suggests convergent evolution toward specialization in the cleaning function. In the tropical seas the cleaning fish are generally brightly colored and patterned in sharp contrast to their backgrounds; it appears that most fishes that stand out in their environment are cleaners. Since cleaning fishes must be conspicuous, it is logical that they should have evolved toward maximum contrast with their surroundings. (The parasites on which they feed have evolved toward a maximum of protective coloration, matching the color of their hosts, and are usually invisible to the human observer of cleaning behavior.) In general these fishes are not gregarious and live solitarily or in pairs. In Temperate Zone waters, on the other hand, the cleaners are not so brightly colored or so contrastingly marked. They tend to be gregarious, to the point of living in schools, and are more numerous, though the number of species is smaller.

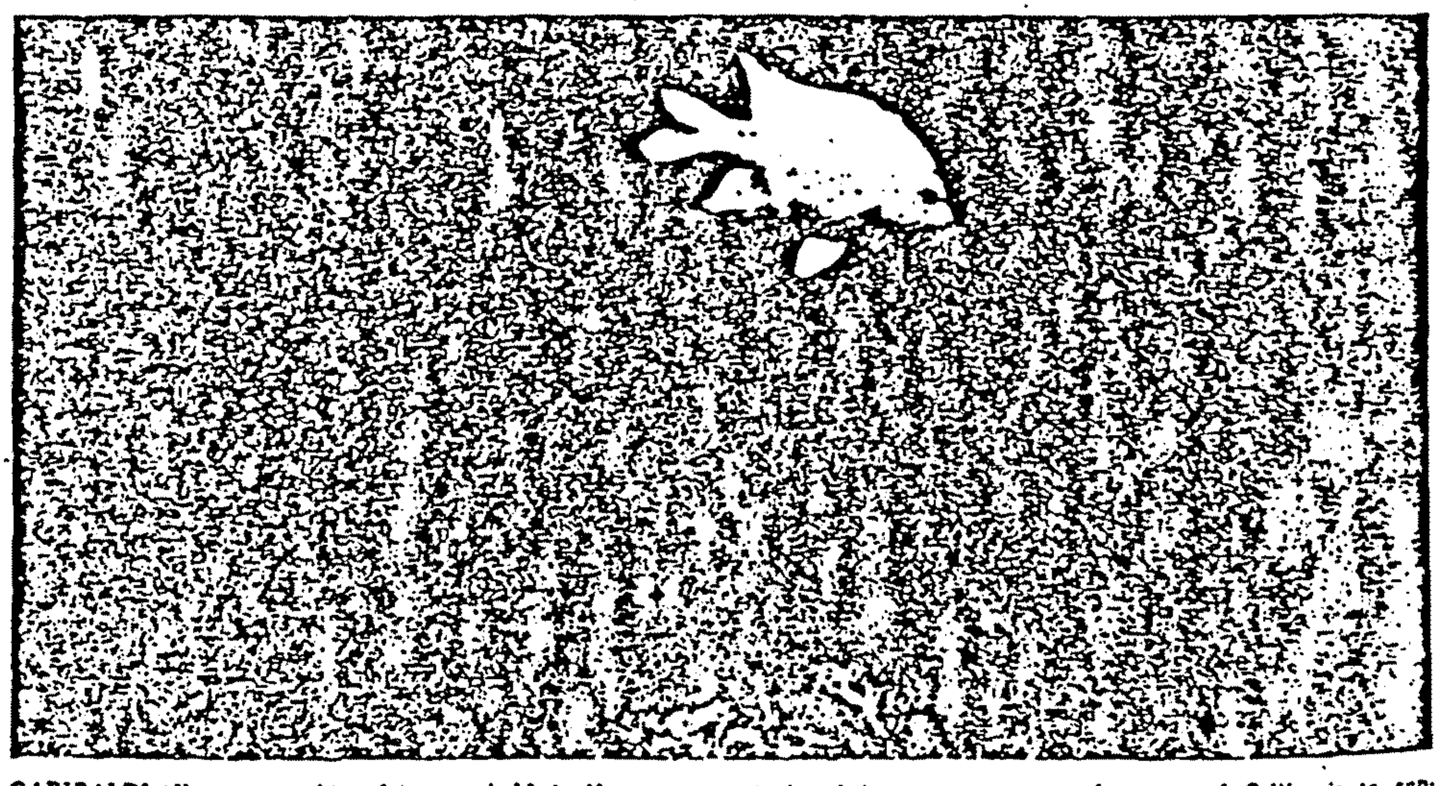
The cleaning behavior of the tropical forms is correspondingly more complex than that of the Temperate Zone species. Whereas the latter simply surround or follow a fish in order to clean it, the tropical cleaners put on displays not unlike those shown in courtship by some male fishes. They rush forward, turn sideways and then retreat, repeating the ritual until a fish is attracted into position to be cleaned. Frequently they sense the presence of a fish before a human observer can, and they hasten to take up their station before the fish arrives to be cleaned.

Some species clean only in their juvenile stage; none of them appears to depend exclusively on the habit for its food. Again, however, the tropical species come closer to being "full time" cleaners. One consequence of their higher degree of specialization is that they enjoy considerable immunity from predators. In an extensive investigation of the food habits of California kelp fishes I never found a señorita, a close cousin of the numerous cleaning wrasses of the tropics, in the stomach contents of other fishes. I have seen it safely enter the open mouth of the kelp bass, a fish that normally feeds on señorita-size fishes. On the other hand, the kelp perch, a more typical Temperate Zone cleaner, frequently turns up in the stomachs of fishes that it cleans. The immunity of certain cleaners is so well established that other fishes have come to mimic them in color and conformation and so share their immunity. Some mimics reverse the process and prey on the fish that mistake them for cleaners!

The same generalizations may be made in contrasting the cleaning shrimps of the Tropical and Temperate zones. Only one of the six known species occurs outside the tropics; this is the California cleaning shrimp (*Hippolysmata californica*). It is a highly gregarious and wandering animal, at the other pole of behavior from the tropical species as represented by the solitary and sedentary Pederson shrimp of the Bahamian waters. The California cleaning shrimp does not have the coloration and marking to make it stand out from its environment. So far as I have been able to determine, it does not display itself to attract fishes. These California shrimps wander abroad in troops numbering in the hundreds, feeding on the bottom at night and retiring to cover during the day. They act as cleaners when they come upon an animal, say a lobster, in need of cleaning or when a fish, perhaps a moray eel, swims into the crevice where they have found shelter. They will crawl rapidly over the entire outside surface of the animal, cleaning away everything removable, including decaying tissue. A lobster that has been worked over by a team of these shrimps comes out with a clean shell; a human diver's hand will receive the same treatment. Fishes do not seem to be bothered by these rough attentions, although the moray may occasionally jerk its head as if annoyed.

In some cases the shrimps may enter the mouth of the moray to get at parasites there, but not without risk, the stomachs of morays have yielded a considerable number of these shrimps. In

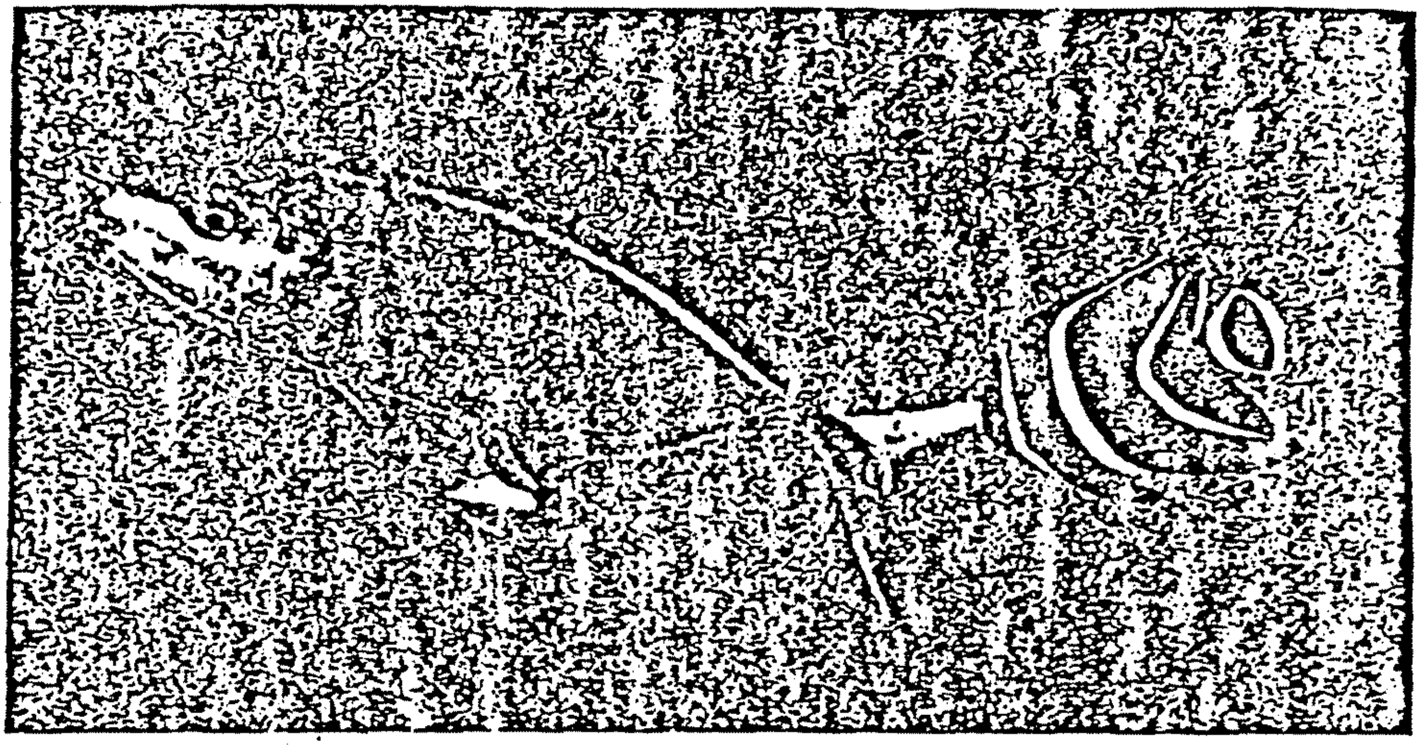
SPOTTED GOATFISH (*Pseudupeneus maculatus*) is host to the smaller Spanish hogfish. The hogfish is found in the tropical waters from Bermuda and Florida to Rio de Janeiro, in the Gulf of Mexico and around Ascension and St. Helena islands in the South Atlantic.



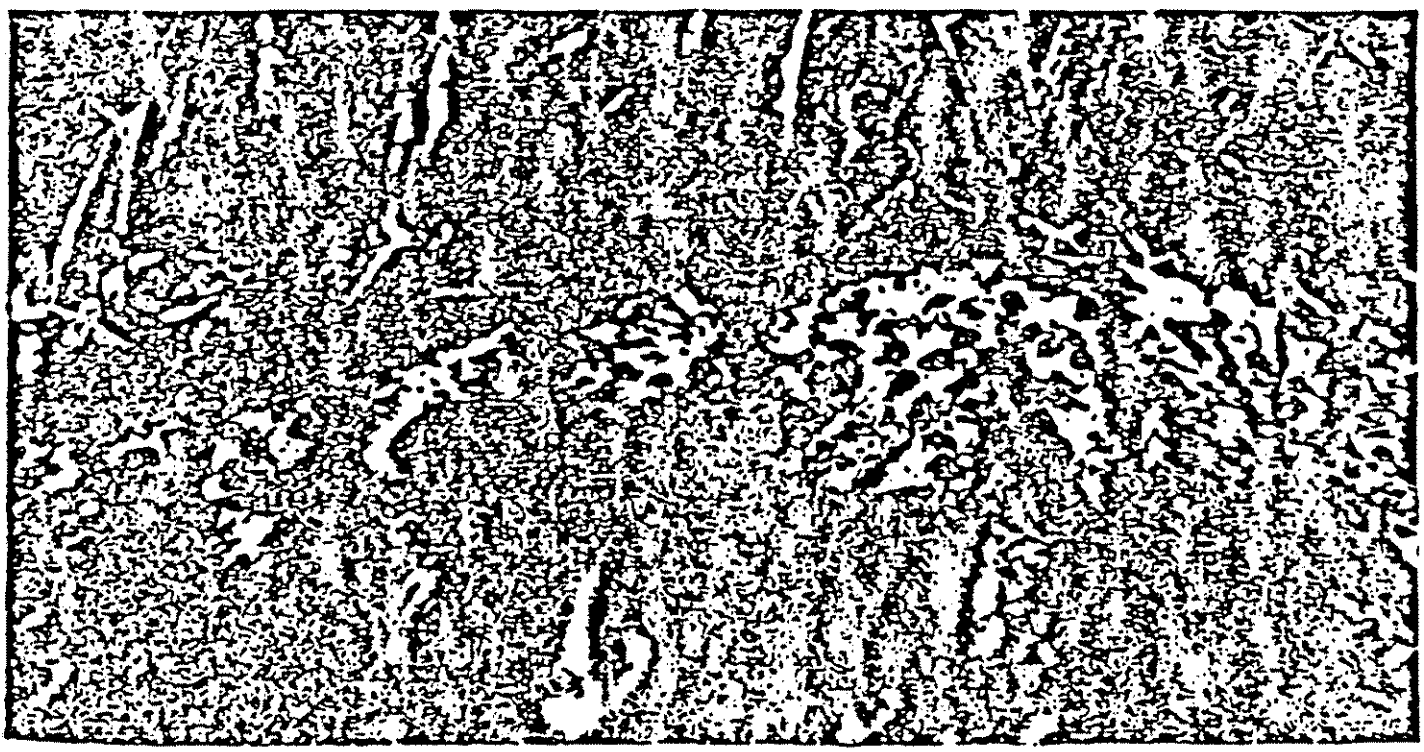
GARIBALDI (*Hypsypops rubicunda*) at top holds itself at an unnatural angle while being cleaned by a señorita. The latter, which is found in temperate waters from central California to central Lower California, cleans more than a dozen species of fish.

contrast, the tropical cleaning shrimps, all of them more exclusively specialized as cleaners, seem to have the same immunity from predation as the tropical cleaning fishes. With their bright colors, their fixed stations and their elaborate display behavior, they are plainly advertised to the community as cleaners and attract hosts rather than predators. It is easy to visualize the evolutionary path by which the more complex cleaning symbiosis may have developed from the imperfect cleaner-host relationships such as that of the California shrimp.

In the summer of 1955, in the Gulf of California near Guaymas, I noted that cleaning behavior appeared to be concentrated at rocky points: each point was manned by two butterfly fish and one angelfish. I assumed that the concentration of other fishes arose from the



JUVENILE GRAY ANGELFISH (*Pomacanthus arcuatus*) at right cleans external parasites from the tail of a bar jack (*Caranx ruber*). Below the jack is another cleaner, the Spanish hogfish. This photograph and those on the opposite page were made by the author.



"CLEANING STATION," consisting of a sponge (*light area with small, dark protuberances*) surrounded by turtle grass, is manned by a juvenile gray angelfish. The station, located off New Providence Island in the Bahamas, was photographed by the author's wife.

fact that these points constitute the intersection of the communities of fishes on each side. In 1958 Randall, reporting on his studies of the cleaning wrasses in the Society Islands, observed that fishes came from comparatively long distances to the sites occupied by the cleaners, not just from the immediate community. The Pederson brothers made the same observation in the Bahamas, reporting that the cleaners congregate in regular "cleaning stations" in the coral reefs and attract host fishes from large areas.

Subsequent studies have confirmed these observations. The various species of cleaning fish and shrimp tend to cluster in particular ecological situations at coral heads, depressions in the bottom, ship wreckage or the edge of kelp beds. Their presence in these localities accounts in great part for the large assemblages of other fishes that are so frequently seen there. Even a small cleaning station in the tropics may process a large number of fish in the course of a day. I saw up to 300 fish cleaned at one station in the Bahamas during one six-hour daylight period. Some of the fishes pass from station to station and return many times during the day, those that could be identified by visible marks, such as infection spots, returned day after day at regular time intervals. Altogether it seemed that many of the fishes spent as much time at cleaning stations as they did in feeding.

At cleaning stations inhabited by thousands of cleaning organisms, cleaning symbiosis must assume great numerical significance in determining the distribution and concentration of marine populations. In my opinion, it is the presence of the señorita and the kelp perch that brings the deep-water coastal and pelagic fishes inshore to the edge of the kelp beds on the California coast. Most concentrations of reef fishes may similarly be understood to be cleaning stations. Cleaning symbiosis would therefore account for the existence of such well-known California sport-fishing grounds as the rocky points of Santa Catalina Island, the area around the sunken ship *Valiant* off the shore of Catalina, the La Jolla kelp beds and submarine

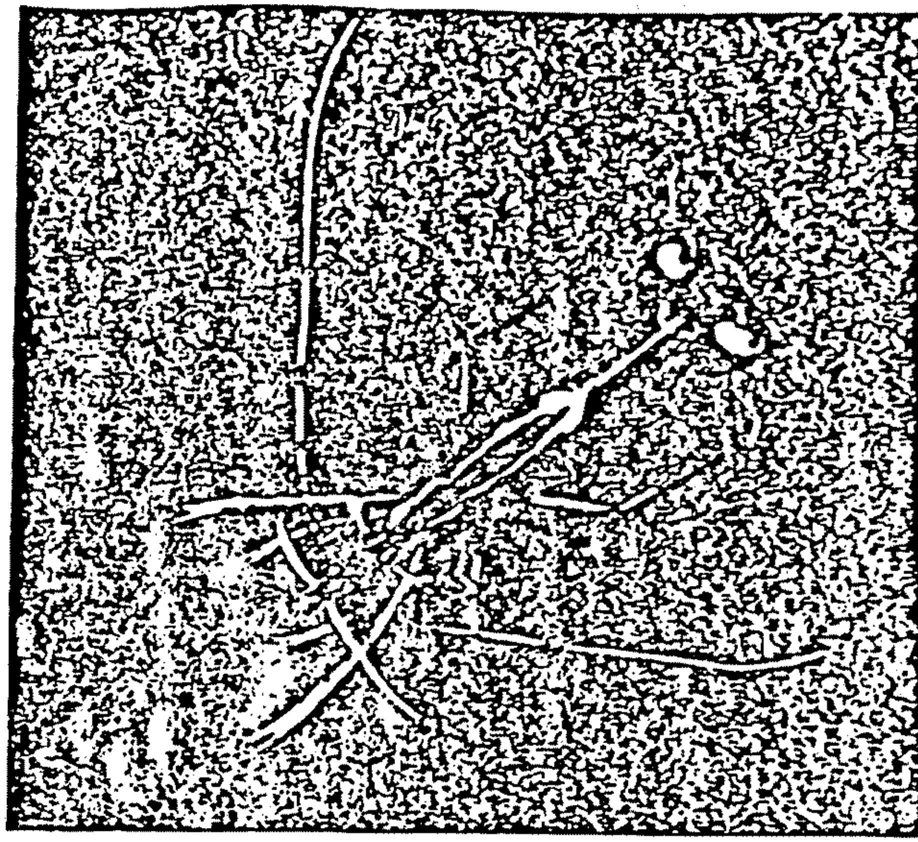
BLACKSMITHS IN GROUP waiting to be cleaned by a single señorita (*slender fish in nearly horizontal position at right center*) assume various positions. This photograph was made by Charles H. Turner of the State of California Department of Fish and Game.

canyon and the Coronado Islands.

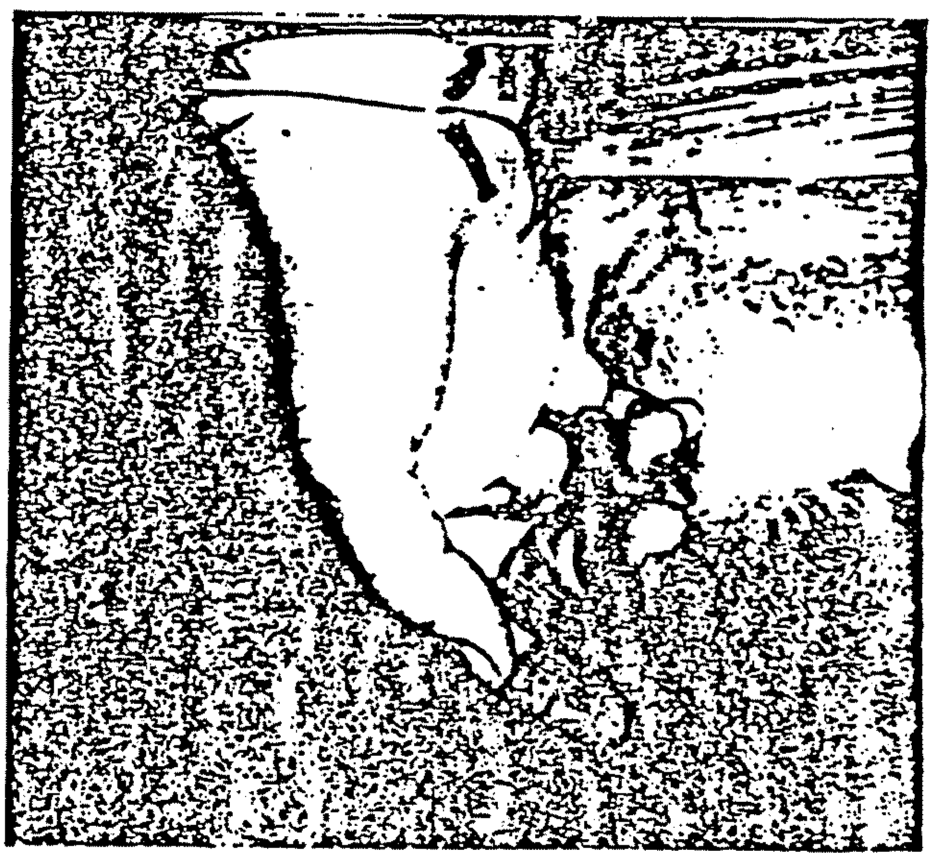
These generalizations of course call for further observation and perhaps experimental study. In a modest field experiment in the Bahamas I once removed all the known cleaning organisms from two small, isolated reefs where fish seemed particularly abundant. Within a few days the number of fish was drastically reduced, within two weeks almost all except the territorial fishes had disappeared.

This experiment also demonstrated the importance of cleaning symbiosis in maintaining the health of the marine population. Many of the fish remaining developed fuzzy white blotches, swelling, ulcerated sores and frayed fins. Admittedly the experiment was a gross one and not well controlled, but the observed contrast with the fish populations of the nearby coral heads was very striking. Certainly it appeared that the ailments occurred because of the absence of cleaning organisms. This impression was strengthened when a number of local fishes that had been maintained in an aquarium were found to be developing bacterial infections. I placed a cleaner shrimp in the aquarium, and it went to work at once to clean the infected fishes.

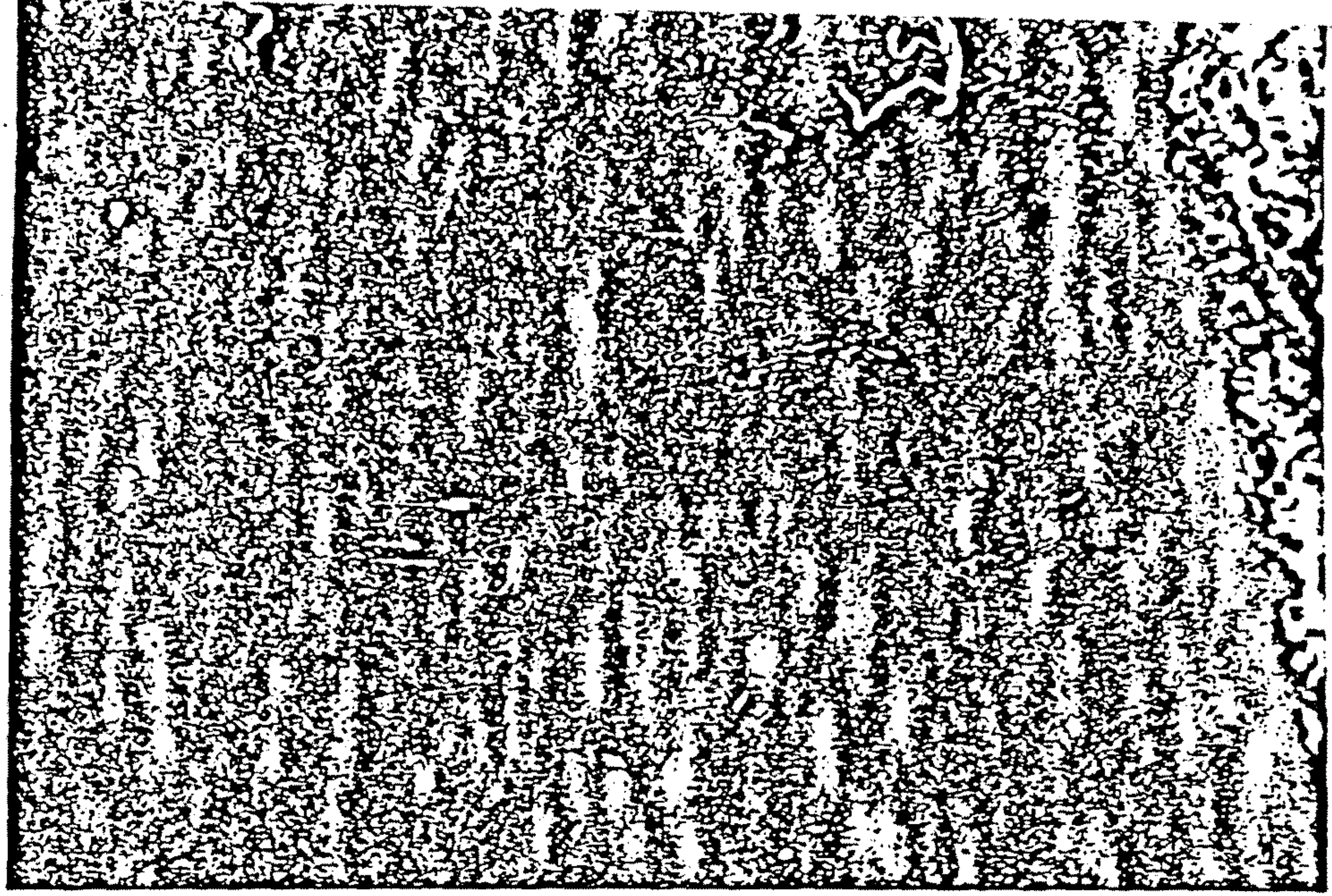
Symbiotic cleaning has some important biological implications. From the viewpoint of evolution it provides a remarkable instance of morphological and behavioral adaptation. Ecologically speaking, cleaners must be regarded as key organisms in the assembling of the species that compose the populations of various marine habitats. Cleaning raises a great many questions for students of animal behavior; it would be interesting to know what mechanism prevents ordinarily voracious fishes from devouring the little cleaners. In zoogeography the cleaning relationships may provide the limiting factor in the dispersal of various species. In parasitology the relationship between the cleaning activities on the one hand and host-parasite relations on the other needs investigation. The beneficial economic effect of cleaners on commercially important marine organisms must be considerable in some areas. The modern marine-fisheries biologist must now consider cleaners in any thorough work dealing with life history and fish population studies. From the standpoint of the philosophy of biology, the extent of cleaning behavior in the ocean emphasizes the role of co-operation in nature as opposed to the tooth-and-claw struggle for existence.



PEDERSON CLEANING SHRIMP (*Periclimenes pedersoni*) attracts hosts by waving its antennae, which are longer than its body. Shell-like objects (*upper right*) are shrimp's uropods, or "flippers." Photograph was made by F. M. Bayer of Smithsonian Institution.



CALIFORNIA CLEANING SHRIMPS "clean" the author's hand, even to picking at his fingernails. These shrimps clean everything that is removable from the exterior of a host.



CALIFORNIA MORAY EEL (*Gymnothorax mordax*) has its external parasites removed by four California cleaning shrimps (*Hippolysmata californica*). At upper left is a fifth shrimp. This photograph and the one at right below were made by Ron Church.

SPANISH HOGFISH (*top*) in process of cleaning ocean surgeon (*Acanthurus bahianus*) was photographed by author in Bahamas.

LIONFISH (*Pterois volitans*) is host to a very much smaller cleaning wrasse (*purple fish in center*) of undetermined species.