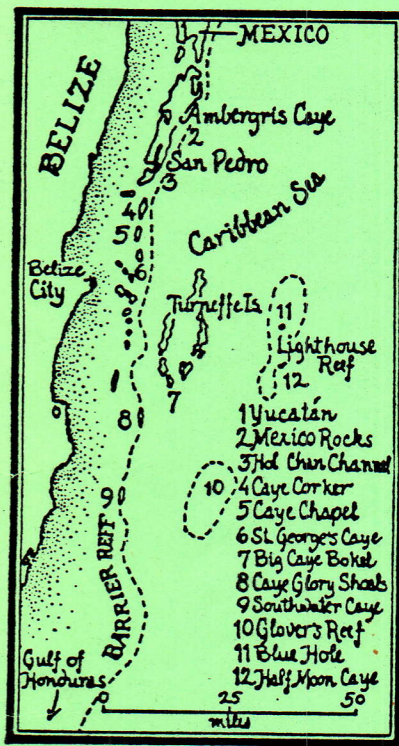
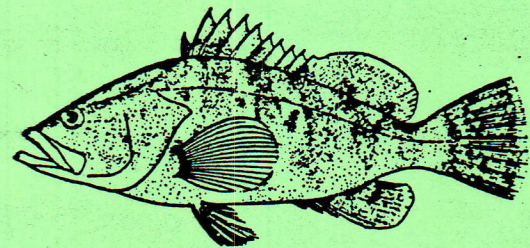


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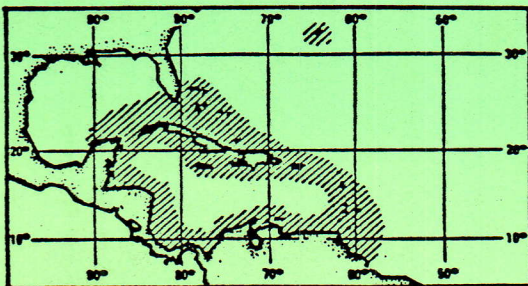
Fisheries Management Report  
of the

# BELIZEAN GROUPE FISHERY



## FISHERY MANAGEMENT PLAN FOR NASSAU GROUPE

DECEMBER 1991



PRELIMINARY FISHERY MANAGEMENT PLAN  
FOR THE  
NASSAU GROUPER (*Epinephelus striatus*) FISHERY

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## INTRODUCTION

### Development of the Plan

This Nassau grouper management plan for Belize was prepared by the authors at the request of the Belize Fisheries Department, a division of the Ministry of Agriculture and Fisheries. This work was sponsored by a grant to the senior author, from Wildlife Conservation International, a division of the New York Zoological Society. The first phase in the development of this plan was the implementation and completion of a study of the life history of Nassau grouper in Belize by the senior author (Carter et al., 1991). Subsequent to this research was preparation of a profile summarizing all available information on the biology of and fishery for Nassau grouper. This fisheries management plan constitutes the second phase. We gratefully acknowledge the support and cooperation of the staff of the Belize Fisheries Department throughout this endeavor.

### Problems Addressed by the Plan

The status of Nassau grouper populations on the coast of Belize is poorly known. Data are available from selected localities along the Barrier Reef Complex, in particular the spawning banks, that indicate that the population structure of adults are effected at particular localities. Sex ratios are female biased and length frequencies are significantly reduced for adult Nassau grouper populations from historically heavily fished areas such as Cay Glory when compared to recently discovered and more pristine areas on the offshore atolls of Lighthouse Reef and Glovers Reef. The growth and mortality data necessary for yield per recruit (YPR) analyses of Belize coast populations do not exist.

Nassau groupers are recognized as one of the most commercially important food fishes inhabiting tropical western Atlantic reefs and offer a valuable source of income to local fishermen. In Belize, from 1972-1984, groupers, primarily E. striatus, constituted the second most commonly caught and most valuable family of marine fishes. In 1984, 200,000 pounds of grouper were caught worth \$546,650 (Vasquez, 1984). In Belize, Nassau grouper are taken primarily with handlines, spearguns and fish pots throughout the year, but the most intensive fishing in Belize and probably generally throughout the Caribbean area is over localized spawning aggregations during one or two weeks each year. Localized spawning aggregations of E. striatus have been known to local fisherman in Belize for generations and have provided the basis for a flourishing folk fishery.

Intensive fishing over aggregations are thought to have potentially severe detrimental effects on future fishing yields. Throughout the Caribbean government officials, local fishermen and the scientific community have reported dramatic declines in commercial grouper stocks and in several instances, the complete disappearance of local spawning aggregations. In Belize, all banks have experienced reductions in stock size for groupers

as evidenced by declining catches per fishing effort. A once highly productive grouper fishing bank off Rocky Point, Ambergris Cay, no longer serves as a spawning aggregation site for Nassau grouper. This is of particular concern since aggregation fishing directly removes reproductively active fish from the spawning ground prior to release of gametes, thus depressing future fishing yields. However, the effect on future reproductive potential cannot be fully evaluated until we gain a better understanding of grouper population structure, social organization, breeding behavior, and proximal cause of sex change.

The primary purpose of this management plan is to help the Belize Fisheries Department control overfishing where it occurs in both the handline fishery and spear-fishery, prevent collapse of spawning aggregations, and promote coordinated research and monitoring to obtain the necessary biological, economic and social data to effectively manage the Nassau grouper fishery. Ultimately, the goal of this management plan is to perpetuate the Nassau grouper resource in fishable abundance throughout its range and generate the greatest possible economic and social benefits from its harvest and utilization over time.

## DESCRIPTION OF STOCK

### **Species Distribution**

The Nassau grouper, Epinephelus striatus, is one of the most common large serranids in the Caribbean and occurs in a broad area between the 23 C isotherm that stretches from Bermuda and Florida, throughout the Yucatan Peninsula to Venezuela.

The Nassau grouper is primarily insular and most abundant throughout its range in the West Indies. It appears to be absent from the Gulf of Mexico where it is replaced by its closest relative the Red grouper, E. morio. In northern latitudes, the young of a few have been taken north of these limits.

Nassau grouper of all size and age are most abundant in relatively shallow waters, less than 50 meters, in and about coral reefs, and adjacent sea grass beds. E. striatus can be described as bottom-dwelling, solitary predators that live in reef crevices and caves and rarely venture far from cover.

### **Abundance and Present Condition**

Quantitative data on relative abundance and present condition of the Nassau grouper population in the Caribbean is lacking however commercial catches have dramatically declined since the 1950's. This decline has been attributed largely to intensive fishing over aggregation sites and loss of habitat due to reef degradation.

## **Ecological Relationships**

Groupers are large, predacious fish that consume a broad range of prey including fish, crab, shrimp and other crustaceans including lobsters. The importance of plant material in their diet has not been resolved. Nassau groupers feed at all times during the day, but are most active near dawn and dusk. Because Nassau grouper can exert considerable predation pressure on many different fish and invertebrates, major reductions in grouper populations could cause population increases in these other species.

Groupers are generally sedentary and are dependent on a hard substrate habitat. Many groupers often use shelters to facilitate their ambush mode of feeding. They lurk within shelters or rest motionless on the substrate until their prey venture close enough to be captured with a quick lunge and rapid ingestion through expansion of their large mouths, dilation of gill covers, and a rapid drawing in of a current of water. Nassau grouper also forage in caves, cracks and crevices sucking benthic invertebrates into their mouths. Because of this feeding method and the strong competition on the reefs, it is likely that spatial distribution of the grouper is determined in part by suitable hard substrate. Nassau grouper rarely leave the reef onto which they are deposited after maturation, leaving only to spawn. Nassau grouper also display strong home reef specificity, returning back to their home reef even after being transported to other reefs.

Adult Nassau grouper have few predators except large carnivorous fishes such as barracuda, sharks, and moray eels. Large sea mammals could conceivably prey on groupers. Interspecific competition between groupers is probable considering the similarity in food habits, distribution and size between family members. It is probable that the distribution and feeding habits of the grouper are related to this fact.

## **Estimate of Maximum Sustainable Yield**

There are no published estimates of MSY or yield per recruit (YPR) for Nassau grouper in Belize. YPR analysis requires estimates of natural and fishing mortality rates which generally are not well known.

## **Probable Future Condition**

The future condition of Nassau grouper populations in Belize is dependent on several factors. Populations are dependent on recruitment of larvae spawned by adult populations, knowledge of whether those recruits are progeny from local spawning aggregations or larvae carried into Belize from distant regions by offshore currents, adequate coral reef habitat for newly settled recruits and young adults, the relative importance of protogyny, and trends in fishing effort. Fishing effort is likely to increase

with the growing human population and the increased demand for fresh grouper fillet by the export market. Degradation of the reef in general and loss of suitable habitat for various life history stages of the Nassau grouper may also lead to declines in both juvenile and adult populations. Left unchecked, the Nassau grouper fishery in Belize will continue to decline in future years and eventually lead to a collapse of the commercial fishery and potential permanent loss of spawning stocks which are vital for recruitment.

## DESCRIPTION OF HABITAT

### **Condition of Habitat**

Until recent years, the coastal resources of Belize have remained largely undisturbed, due primarily to a pattern of low population density and minimal disturbance to the land and sea by industrial and agricultural development. However in recent years there have been dramatic changes that threaten the integrity of these coastal resources. Tourism-based development has greatly increased recreational use of coastal areas for diving, boating, swimming and sport fishing. All of these activities in excess contribute to reef degradation. Overfishing has depleted the supply of grouper and pollution for the first time is becoming a major concern in terms of sewage discharge from vessels, marine debris, littering, siltation of reef from dredging operations and chemical runoff from increased agricultural production, especially citrus in the central and southern sections of the country.

### **Habitat Areas of Particular Concern**

The critical areas in the Belize ecosystem are for the most part unknown because the life history information necessary is not available for nearly all species of the reef. For the Nassau grouper, it is entirely dependent on the reef habitat and resources for its survival. Because of this fact the entire marine ecosystem of the reef is a critical habitat for the grouper, however, traditional spawning areas are of the utmost importance. These areas, known well by local fishermen have been reported for the following localities: Cay Glory, Northern Two Cay at Lighthouse Reef, Glovers Reef Atoll, Mauger Cay at Turneffe Island Atoll, Gladdens Spit and Rocky Point.

### **Habitat Protection Programs**

To date no marine or coastal areas have been established specifically for the protection of Nassau grouper populations. However, several protected areas have been established throughout Belize in an effort to protect the reef resources in general. These areas include the Hol Chan Marine Reserve at Ambergris Cay, the Half Moon Caye Natural Monument on Lighthouse Reef, and eight Crown Reserves and Bird Sanctuaries that include offshore mangrove cays and small islands in coastal lagoons where seabirds,

wading birds and song birds nest. The purpose of these Crown Reserves is to maintain breeding populations of certain birds and their nesting habitat from degradation and destruction. The Half Moon Cay Natural Monument, established in 1982, includes Half Moon Cay, which is home to a red footed booby colony, as well as significant portions of the reef, inner lagoon, and deep water. The Hol Chan Reserve, established in 1987, encompasses approximately 300 ha of marine habitat and includes a portion of the barrier reef as well as adjacent sea-grass beds and mangroves.

The success of the Hol Chan Reserve has encouraged the proposal of several additional reserves. A formal proposal has been submitted by Wildlife Conservation International (WCI) and the Belize Fisheries Department for a multiple use plan for Glovers Reef, including a substantial reserve. Other proposed sites are Laughing Bird Cay, Sapodilla Cays, the Tobacco Reef area off Dangriga (including South Water Cay, Carrie Bow Cay, Wee Wee Cay and possibly Tobacco Cay) and a manatee biosphere in northern and southern Lagoons.

At the present time, there is no common agency or governmental policy responsible for the management of all these various protected areas. The Belize Audubon Society has a formal agreement with the government to manage the Half Moon Cay area and the other six protected bird nesting sites. The Hol Marine Reserve is managed by the Fisheries Department under the auspices of the Ministry of Agriculture and Fisheries. In addition, the potential series of reserves along the reef coincides with a regional plan, Paseo Pantero, sponsored by RENARM and WCI, which may include marine reserves along the coasts of Mexico, Guatemala, and Honduras. Efforts are also underway by government to designate a portion of the Belize Barrier Reef as a World Heritage Site. In general there is a growing involvement by a wide variety of international conservation agencies and governments in the planning and development of a comprehensive coastal zone management program for Belize. Many of these conservation initiatives, although not specifically intended to protect the Nassau grouper, nevertheless will do so by maintaining the integrity of the habitat upon which this species depends.

#### FISHERY MANAGEMENT JURISDICTION, LAWS, AND POLICIES

The area under concern for the fishery management of the Nassau grouper, the barrier reef ecosystem off the coast of Belize, is not under any specific national agency's dominion. Fishing is regulated by the Fisheries Department and a Fisheries Administrator. Currently this department is under-staffed and ill-equipped to adequately monitor fish stocks and harmful fishing trends. Current regulations on fishing in general include limiting net mesh size, prohibition on placement of fishing gear near the reef, and gear restrictions in spawning areas. Most groupers are caught on handlines and spear-fishing to a lesser extent. Several non-governmental groups are active in maintaining the few reserves in the area.

## **Management Institutions**

The Ministries are represented on the National Economic Mobilization Council (NEMOC) which was established by the Ministry of Economic Development. This council is charged with the implementation of the National Development Plan and is liaison to the Cabinet and the National Assembly.

## **Laws, Regulations, and Policies**

The Ministry of Agriculture and Fisheries manages the Fisheries Ordinance while the Ministry of Trade and Commerce oversees the Supplies Control Ordinance. The Ministry of Economic Development controls the Development Incentives Ordinance and the Ministry of Tourism and Environment is responsible for the Monuments and Antiquities Ordinance.

## **DESCRIPTION OF FISHING ACTIVITIES**

### **History of Exploitation**

Historically, the artisanal fishery has expanded from 255 fishermen in 1955 to 1,200 in 1985. Currently the fishing pressure is increasing and drops in catch numbers for groupers and other fish have been noted in several areas on the reef. In the 1950's local Belizean fishermen landed grouper catches well in excess of 100,000 pounds annually (Craig, 1969). In striking contrast fishermen landed less than 30,000 pounds in 1986. Unfortunately, aggregation fishing directly removes reproductively active fish from the spawning grounds and thus may have severe detrimental effects on future fishing yields.

### **Domestic Commercial and Recreational Fishing Activities**

Commercial fishing is the major source of fishing activity on the reef but recreational fishing is experiencing rapid growth. The export market, despite government requirements for prescribed poundage sold in the local market, is extremely lucrative, and attractive enough to encourage further exploitation and development. Fishing represents between 3-5% of the gross domestic product, largely from the export of Spiny lobster, grouper, conch and snapper. In Belize, from 1972-1984, groupers, primarily E. striatus, constituted the second most commonly caught and most valuable family of marine fishes.

The fishing industry in Belize consists of approximately 800 fishermen in four major, export oriented cooperatives and about 400 independent fishermen who fish the reef areas inside the barrier reef and the outer atolls. The success of Belize's export fishing

industry can be attributed to the cooperatives which collect, process and package the fish for export. The cooperatives also provide certain services to the fishermen such as giving them loans or providing ice for their boats. To ensure that the Belizean population can acquire affordable, healthy seafood the government of Belize regulates the price of fish and requires the cooperatives to market a portion of their catch locally. Since Belizeans prefer more popular fish such as snapper, mackerel and grouper, the lower value species are being under-utilized. Therefore a consumer education program is recommended to promote consumption of less popular species such as shark and mullet to balance the utilization of Belize's fish resource (Nicolait et. al., 1984).

### **Description of the Grouper Folk Fishery**

In Belize, grouper spawning aggregations have formed the basis of a flourishing folk fishery. For decades, fishermen have taken to sea in small dug-out dories to catch groupers at highly productive banks. Inside the reef crest fishermen build tiny mangrove thatched huts that they occupy as temporary shelters throughout the grouper fishing season. In the surrounding shallows fishermen construct fish corrals, called "tenedores." Fish are caught on handlines baited with small blue-striped grunts. Hooked fish are rapidly hauled to the surface, winded, and placed on stringers fastened to the stern of the boat. Fishermen wind a grouper by piercing the swim bladder with the point of a hollow metal tube to relieve the pressure that results from surfacing too quickly. At the peak of the season each fishermen may land an average of 300 per day, but the commercial catch has fallen from 130,00 lbs to less than 27,00 lbs over the last ten years.

### **DETERMINATION OF OPTIMUM YIELD**

The goal of this management plan is to perpetuate the Nassau grouper resource in fishable abundance throughout its range and generate the greatest possible economic and social benefits from its harvest and utilization over time.

#### **Specific Management Objectives**

1. *Attain over time optimum yield*
2. *Maintain a spawning stock sufficient to minimize the possibility of recruitment failure.*

Nassau grouper probably does not reach sexual maturity until age five or six at which time it participates in the annual spawning ritual over localized areas in late December and early January. While on the spawning banks, sexually ripe Nassau grouper may be subject to high

fishing mortality prior to release of gametes thereby reducing the number of individuals that may successfully contribute to future generations. There is evidence to suggest that under severe fishing pressure or disturbance, effected Nassau grouper populations may fail to form spawning aggregations resulting in a collapse of the fishery.

3. *Promote the cooperative collection of economic, social and biological data required to effectively monitor and assess management efforts relative to the overall goal.*

Effective management of the Nassau grouper resource is hindered by the lack of reliable and consistent nationwide catch and effort data from commercial and recreational fisheries. There is a lack of information on population dynamics, including stock size, age, and size composition, natural and fishing mortality rates, and the parameters required for the development of yield models. Cooperative data collection procedures must be developed to obtain the necessary data for fishery management.

4. *Promote cooperative research that improves understanding of the biology and fisheries of Nassau grouper.*
5. *Promote harmonious use of the resource among various components of the fishery through the coordination of management efforts among the various political entities having jurisdiction over the Nassau grouper resource.*
6. *Promote determination and adoption of the highest possible standards of environmental quality and habitat protection necessary for the natural production of Nassau grouper.*

Habitat requirements for larval and juvenile Nassau grouper have not been defined. The effects of extensive losses of coral reef habitat and pesticides and pollutants entering the reef systems need to be determined. Advancing offshore technology and energy demands might conceivably cause deterioration of large areas to the extent that successful reproduction cannot occur. both short and long term environmental changes, such as alterations in coastal land use (agriculture, industry, residential development) can adversely impact the Nassau grouper population.

## Specific Management Measures

The following management strategy is recommended to obtain the above objectives:

### A. PERMANENT MARINE FISHERY RESERVE (MFR)-30% OPTION

We recommend marine fishery reserves be established for 20% of the marine and coastal habitat (spawning banks) utilized by the Nassau grouper spawning stock. We further recommend that traditional fishery management practices be applied to the remaining marine and coastal habitat outside the traditional spawning bank sites. Of the five known active grouper fishing banks in Belize, we recommend that the grouper fishing bank located off the northeast point of Glovers Reef Atoll be closed. The Glovers Reef Atoll fishing bank is the best choice for closure since it 1) impacts the fewest number of fishermen; 2) is adjacent to the proposed management zone and park; 3) can be readily monitored over time by the fisheries reserve personnel; and 4) represents a sizable portion of the Belize spawning stock of Nassau grouper. Setting aside 1 out of 5 known areas protects approximately 20% of the known grouper spawning stock from commercial and recreational fishing. We are hopeful that in the near future carefully selected marine fishery reserves will be established throughout the entire barrier reef ecosystem with the goal of protecting a minimum of 30% of all reef fish spawning stock biomass (SSB). To achieve this goal we recommend including 30% of representative cross-section of the barrier reef ecosystem as MFRs on the basis that removing 30% of the habitat from fishing protects 30% of the population and 30% of the spawning stock at equilibrium. Ideally, MFR sites will include representative habitats in proportion to their occurrence and importance to various species. The remaining 70% of the marine habitat will be managed by traditional regulatory methods listed below.

The target SSB was selected based on theoretical and empirical evidence that stocks are likely to collapse when they fall below 20% of the unexploited SSB level (Goodyear, 1989). In practice, SSB should be higher than the critical 20% SSB level. The 20% target assumes that the remaining 80% of the habitat will be effectively managed to optimize yield and maintain the existence of spawning individuals. However given the resources presently available to the Belize Fisheries Unit, it is unlikely that adequate management in fished areas will be achieved. Therefore we recommend that MFRs be increased to include at least 30% of the habitat.

Specific MFR sites should be selected based on the best available scientific information. We recommend that the Coastal Zone Planning Unit of the Fisheries Department identify MFR's as part of their on-going Coastal Zone management Project. A Coastal Zone Management planning team should establish criteria for the selection of sites. We refer the planning team to reserve criteria listed in Bohnsack, 1990.

## B. TRADITIONAL MANAGEMENT MEASURES

### 1. *Size Limits*

For Nassau grouper, a minimum standard length (SL) size limit of 30.5 cm (12.0 inches) is recommended and/or a standard length at which 50% of the females become mature. The purpose of the minimum size limit is to protect the spawning stock and increase yield.

### 2. *Permanent Limited Entry*

We recommend holding the number of fishermen presently fishing the banks at Cay Glory, Northern Two Cay, and Mauger Cay at their current levels. This is accomplished by issuing one-time only, non-transferable permits to individual fishermen currently fishing the banks. These individuals can continue to handline fish the banks without restriction of quotas, etc. However no new fishermen may apply for a permit nor may a fisherman transfer the permit to another person such as a relative.

Permanent limited entry will reduce fishing mortality by attrition as the number of fishermen using the banks decline overtime. The major advantages of this approach are: 1) the livelihood of those fishermen currently utilizing the banks is protected. This is particularly important for older fishermen who have for decades, traditionally harvested fish from those banks and have no viable alternative should they be displaced; and 2) permanent limited entry will facilitate the collection of vital fisheries statistics since fisheries officers can require each registered "grouper" fisherman to give a complete report of each season's catch.

### 3. *Permanent Reserves* (see section A)

### 4. *Maintaining Existing Fisheries Regulations*

To date, the government of Belize does not allow the catching of fish with SCUBA, forbids the use of traps outside the reef, has set a minimum net mesh size of 3.8 cm for fin fish, requires the registration of all fishermen and boats, and forbids the use of poison when fishing. In addition, in 1983 it passed an important amendment which gives the Minister of Agriculture and Fisheries the authority to designate any area in Belize waters a marine reserve and prohibit people from entering the reserve. Continued enforcement of existing fisheries regulation is described in the Fisheries Ordinance Act of 1981. Current bans on explosives, poisons, traps, spearguns, etc. should be maintained and the under-staffed Fisheries Department supplemented in order that they may enforce these laws effectively.

### C. ADDITIONAL RECOMMENDED ACTIONS

#### 1. *Resource Diversification*

We recommend that the Fisheries Department and the Caribena Fishing Cooperative jointly undertake a research and development program for the mariculture of Nassau grouper. The existing conch culture facility in San Pedro Town, Ambergris Cay is ideally suited to conduct such a study. We strongly urge the government of Belize and the fishing cooperatives to make grouper mariculture a number one priority.

#### 5. *Research and Monitoring Activities*

We recommend that the Fisheries Department establish a new staff position specifically for the collection and analysis of long-term fishery statistics vital to the monitoring and assessment of Grouper stocks as well as other commercially important fin fish species. Such data collection should be integrated and coordinated to include fisheries scientists throughout the Caribbean who are currently undergoing similar research, such as Mexico. Specifically there should be a call for a yearly, systematic collection of the following data from each of the Grouper banks:

1. Fishing Effort (No. of fishermen, time expended, etc.)
2. Catch Statistics (subsamples of SL, weight, sex ratios, etc.)
3. Seasonal Environmental Data (water temp., tides, weather, etc.)
4. Landing reports from each registered fisherman.

### D. MANAGEMENT MEASURES NOT RECOMMENDED

The following are traditional management measures that were reviewed but considered inappropriate and ineffective for managing the grouper fishery in Belize.

1. Catch Quotas
2. Seasonal Closures
3. Pulse Fishing
4. Annual Limited Entry
5. Habitat Alteration
6. Supplementary Stocking
7. Gear Restrictions

## ACKNOWLEDGEMENTS

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## LITERATURE CITED

- Carter, J., G. Marrow, and V. Pryor. 1991. Aspects of the Ecology and Reproduction of Nassau Grouper, Epinephelus striatus, off the Coast of Belize, Central America. In review by The Gulf and Caribbean Fisheries Institute.
- Craig, A.K., 1969. The grouper fishery of Cay Glory, British Honduras. *Annals of the Association of American Geographers*. Vol. (59, (2)):252-263.
- Goodyear, C.P. 1989. Spawning stock biomass per recruit: The biological basis for a fisheries management tool. ICCAT Working Document SCRS/89/82. 10 pp.
- Nicolait, Robert, et. al., 1984. Belize, Country Environmental Profile A Field Study. Robert Nicolait & Associates Ltd.:Belize City, Belize CA.
- Vasquez, H.P. 1984. A profile of the fishing industry of Belize, Central America. Belize Fishermen Coop. Assoc. Ltd. pp.1-10. Status Report.

