

COMPARISON OF CATCH RATES, CATCH COMPOSITION AND OPERATIONS OF GILLNETS AND TRAMMEL NETS IN CORAL REEF AREAS WITH NOTES ON THE SOCIO-ECONOMIC ASPECTS OF THE FISHERY

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ABSTRACT

Fishing practices and catches of gillnets and trammel nets for coral reef fishes were investigated. Two approaches were utilized: a) A comparative fishing experiment was conducted to estimate capture efficiency, Catch per Unit Effort (CPUE) and species composition and b) A demographic profile of the fishery was conducted using questionnaire surveys. The results from the experimental fishing indicated that there is a significant difference in capture due to mesh size and hanging ratio in the inner and outer reef. However, the difference is less noticeable in mangrove areas. The estimated annual landing for this study was 235,872 lb/year and 248,460 lb/year for gillnets and trammel nets respectively. These results are very close to the landings reported by the Fisheries Marine Laboratory for 1993. The use of a multidisciplinary approach (fisheries biology and social) allowed us to have a more clear understanding of the resource exploited and the nature of the user of this resources.

KEY WORDS: Gillnets, Trammel nets, Fisheries, Socio-economic, Puerto Rico

RESUMEN

Técnicas de pesca y las capturas de trasmallos (gillnets) y los mayorquines (trammel nets) de los pescadores de arrecifes fueron investigadas. Dos

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metodologías fueron utilizadas: a) Un experimento comparativo de la eficiencia pesquera fue conducido en orden de estimar la capturar por unidad de esfuerzo (CPUE) y a la composición de la especies y b) Un perfil demográfico de la industria pesquera fueron conducidos usando encuestas. Los resultados de la pesca experimental indicaron que hay una diferencia significativa en la captura debido al tamaño de de la malla de las redes y a la forma como la red esta colgada en la parte interior y de afuera de arrecife.. Sin embargo, la diferencia es menos sensible en áreas del mangle. Las descargas anuales para este estudio fueron 235.872 lb/year y 248.460 lb/year para los trasmayos y los mayorquines lo respectivamente. Estos resultados están muy cerca de las descargas reportadas por el laboratorio Marina de las Industrias Pesqueras para 1993. El uso multidisciplinario de biología pesqueras y ciencias sociales permitió que tuviéramos una comprensión más clara el recurso explotado y de la naturaleza del usuario de este los recursos.

PALABRAS CLAVES: Trasmallos, Mayorquines, Pesquerias, Socio economico, Puerto Rico.

INTRODUCTION

Gillnets and trammel nets are widely used in artisanal fisheries in developing countries because they are efficient, relatively inexpensive and catch a high number of commercially valuable species (Valdés-Pizzini et al, 1992). For instance in Puerto Rico, gillnets and trammel nets accounted for approximately 16% of the total catch in 1989 and 1990. This percentage increased to 21.5% in 1991 and 1992, and to 23.3% in 1993. The increase can be attributed to the declining catch rates in the more traditional trap fishery, and a re-direction of effort toward the use of gillnet and trammel nets over fish traps (Matos and Sadovy, 1990, Acosta, 1992).

In a recent study in which a panel of fishery experts assessed user conflicts in the region, gillnets and trammel nets were viewed as gears targeted for banning or for extreme regulation. Such assessment was due to the perceived adverse impact of these gears on coastal and reef fisheries resources, and the problems associated with to recreational use of these resources. (Valdès- Pizzini, 1990). These fisheries in reef and associated habitats are socioeconomically important because they provide a relatively cheap source of protein to the people and employ many fishermen. These fisheries are now essentially unregulated. Regulations or any management schemes will have an impact on the livelihood of many people, considering the direct and indirect jobs generated by the use of these gears.

The present work is part of a multidisciplinary (fisheries and social) analysis of gillnets and trammel net fishing in Puerto Rico. The results of the fisheries component has been published by Acosta (1993), Acosta (1994) and Acosta and

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Appeldoorn (1994). In this paper we will only present a review of the commercial catch and the more relevant results of the experimental fishing conducted during the study. The goal of this paper was two-fold. First, to describe the gillnet and trammel net fishery along the south-west coast of Puerto Rico. Second, to acquire basic information on gillnet and trammel net fishermen, and to examine their attitudes toward management of these gears.

METHODS

Sampling of Biological data

This study used 12 experimental gillnets and trammel nets, one each of four mesh sizes (7.6, 8.8, 10.1, and 12.6 cm stretched mesh), in combination with three hanging ratios (1:1, 1:2, and 1:3). Here, the four mesh sizes refer to the small-meshed section of the trammel nets. An individual net measured 50m in length. The nets were used in a ganged sequence to create a single experimental net 200m long. The nets were fished in the coral reef (inshore and offshore) and mangrove areas off La Parguera in Southwestern Puerto Rico. Nets were set for 12h periods starting in the afternoon around sunset and hauled the following day around sunrise. Details of the sampling area and experimental designs are provided in Acosta (1993), Acosta and Appeldoorn (1994).

Demographic of the Fishery

The attitudes of gillnet and trammel net fishermen were investigated by questionnaire survey. One hundred seventy three fishermen were interviewed, from which 170 were used in the analysis. The survey was conducted on all four coasts of Puerto Rico. The questionnaire consisted of 104 questions in four groups. The first group of questions was aimed at developing a profile of the respondents; the second group of questions were aimed to determining the use pattern of these gears; the third group was aimed to determining the ecological knowledge of the fishermen and the four group was aimed to determining their socioeconomic status.

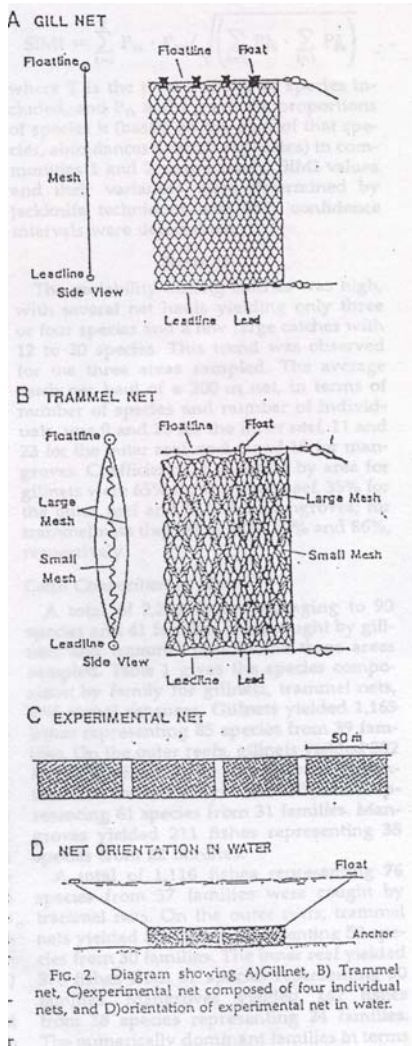


Figure 1. A) Gillnet, B) Trammel net, C) Experimental net composed of four individual nets, and D) net orientation in water.

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RESULTS AND DISCUSSION

Fishing Operation

The procedure used when fishing gillnets and trammel nets are similar. The main difference is in the fishing grounds, gillnets are usually fished in the inner reef and mangrove areas; trammel nets are usually fished in the outer reef (the edge of the platform and in waters 40 to 60 feet deep). These gears are usually fished in gangs of three or four nets, approximately 100 to 150 fathoms each, or individually in distinct locations. A float is attached to the headline; this is used to find the net and to identify it from other gear. A heavy weight is attached to the leadline in order keep it from being carried away by the current (Figure 1). The nets are set while steaming slowly with the current or drifting with it. The weighted groundrope is released over the side while the headline is pulled out automatically by the sinking net. The nets are soaked between 4 and 6 hours. The time periods depends on the species fished, environmental conditions and moon cycle. Reef species deteriorate quickly after being meshed and the smell of rotten fish attract sharks and rays which eat the catch and destroy the nets.

Hauling of the nets is by hand, even in the larger boats which carry winches to haul the fish pots. Two men are usually involved in the hauling and clearing of the net, however, there are several single boat fishermen. When there are too many fish to clear as the net is hauled, the net is bundled to one side and cleared later. In some cases the net is stacked in a drum ready for fishing again. All the corals, seagrasses, algae and other debris, as well as any other animals entangled in the nets, must be removed. Fouled nets tangle as they are being released and as a consequence collapse on the bottom instead of fishing effectively.

Gillnets and Trammel nets History

In 1990 the CODREMAR Fisheries Laboratory showed a record high number of gillnets = 788 and trammel nets= 507. In forty years, from 1930 to 1970, the number of nets almost doubled, while in the last thirty the number tripled. As shown in Figure 2, the number of nets over time have increased, although there are downward periods, believed to be due to inaccurate information. The available information indicates that the south and north coast are the areas with the major number of nets (Figure 3). Explanations for this regional distribution are not conclusive. However, we believe that the increase in the number of nets in these areas may be due to the fishermen's ability to use nets in competition with traps, at a lower cost. Also, as turtle fishing became prohibited, the use of turtle nets (volantes) may have shifted toward gillnets. Use of gillnets in the northern coast has been historically proven, specially for areas of mangroves and estuaries. The southern coast offers calm waters, and reef and mangrove areas typical of

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conditions for the use of these gears without major problems.

In explaining the increase in the number of gillnet and trammel nets, we expected the use of beach seines to have decreased, providing space and the apropiated conditions in the fisheries for the use of other nets. However, the number of beach seines appear to be increasing, despite regulation restricting their use.

Gillnet and Trammel net Utilization

Gillnets and trammel nets are used on an average of 3 days a week. Each fishermen owned an average of 3 gillnets, although the mode was one. The mean number of hauls made per fishing trip was estimated to be 3. This factor is greatly dependent upon the dimensions of the net used. Overall, gillnets are more abundant than trammel nets, perhaps due to the degree of difficulty in the operation of the gear, and the complexity of gear repairsments. Although fishermen reported to own and use other gears, gillnets and trammel nets are used primarily with hand lines, troll lines, or alone. Throughout the north coast these nets are used almost in an exclusive form. On the south coast, most of the fishermen operate the gears and line unison, while in the east coast the number of fishermen using both patterns is almost equally divided. On the west coast, however, most fishermen use other gears (lines) when operating gillnets.

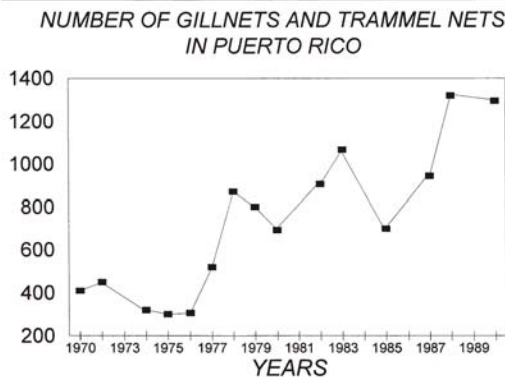


Figure 2.
Number of
Gillnets and
Trammel nets
in Puerto Rico
from 1970 to

1990.

Gillnets and trammel nets are employed in different habitats. Most of the

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operation throughout the island is done on sea grasses and sandy flats of the insular platform. Trammel nets are used in deeper waters and closer to the reef areas. Table 1 presents the fishing habitats reported to be used by gillnet and trammel net fishermen.

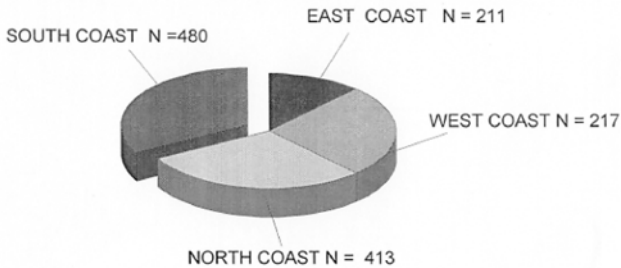
Table 1. Habitats preferences(%) for fishing gillnets and trammel nets by Puerto Rican Fishermen.

Habitats	Gillnets	Trammel nets
Thalassia flats	50%	25%
Sand flats	48%	9%
Coast/Shoreline/Mangroves	41%	7%
Reef Areas	37%	46%
Rivers/mouth	12%	4%
Inlets	9%	3%

Catch Rate

An approximated estimate of the average annual landing can be derived from information provided by the respondents and from the results of our own experimental fishing. The estimated annual landing for gillnets and trammel nets was 235,872 lbs/year and 248,460 lbs/year respectively. These results are based an average number of three day fishing days per week, an average number of three day fishing days per week and a Catch per Unit Effort (CPUE) of 0.936 kgs/net for gillnets and 1.132 kgs/net for trammel nets. These values are very close to the landings reported by the Fisheries Marine laboratory for 1993. However, our estimates of CPUE are probably lower than that of the fishermen due to the different net design and soak time that we used. Also, the estimation of total landing per gear was subject to bias since the average number of hauls and number of trips were estimated based on opinions of the fishermen rather than direct observations. At the same time, the estimates from the Fisheries Department might be low due to possible under reporting of catch and trip tickets on the part of the fishermen.

*NUMBER OF GILLNETS AND TRAMMEL NETS
BY GEOGRAPHICAL AREA IN PUERTO RICO*



Figure

3. Number of gillnets and trammel nets in Puerto Rico by Geographical area.

Catch Comparison Between Gillnets and Trammel Nets

Table 2 compares the total catch of gillnet and trammel nets by hanging ratio, mesh size and area. It can be observed that the difference in catch is variable between inner reef, outer reef and mangrove areas. Trammel nets are more efficient than gillnets at higher hanging ratio. Comparison by mesh size showed that trammel nets catches are improved when the mesh sizes are low or high, particularly in the outer reef and mangrove area. Gillnets and trammel nets target a wide variety of species. In our experimental fishing the most abundant species were: White grunt *Haemulon plumieri*, bluestriped grunt *Haemulon sciurus*, stoplight parrotfish *Sparisoma viride*, and sea bream *Archosargus rhomboidales*. Fishermen reported a wider variety of species on the north coast, including mullets, jacks, snook, croackers and mojarras. This is due to the fact that a large number fishermen fish in the mouth of rivers and in estuarine areas. On the other coast, grunts, snappers, jacks and parrotfishes comprised the bulk of the catch. Trammel nets were reported to catch more parrotfishes, lobster, trunkfish and hogfish on the south and west coast where the larger reef areas are located. Although only briefly mentioned in the survey by the fishermen, our personal experience and the results of our own fishing experiment indicate that sharks and rays are a very important component of

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the catch of these gears.

Demographic Characteristics

Age

Examining the socio-economic demographic data, It is observed that net fishing is a predominantly male activity (similar to fishing in general), yet is not confined to any specific age group. Instead, as figure 4 shows, the ages represented in the sample are normally distributed in statistical sense, with few fishers falling at the young or old extremes and most (77.1%) falling in the forty to sixty year old group. When compared with the fishermen populations in general, net fishermen appear to be older in age than the rest of their peers in Puerto Rico (Figure 4).

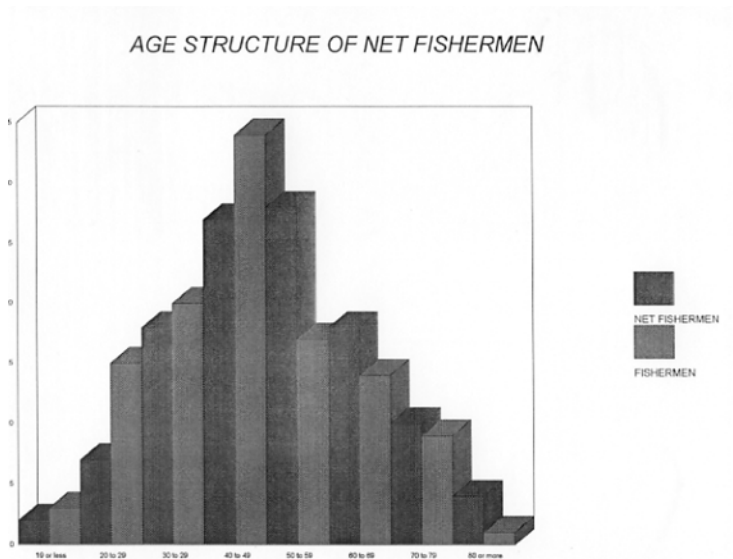


Figure 4.

Age structure of gillnets and trammel net fishermen in Puerto Rico

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Table 2. Ratio of gillnet : trammel net catch by hanging ratio, mesh size and fishing area. Data from Acosta and Appeldoorn (1994).

Catch ratio			
Hanging ratio	outer reef	inner reef	mangrove
1 : 1	1.14	5.21	5.43
1 : 2	0.76	0.69	1.54
1:3	0.63	0.95	0.60
Mesh size			
7.6	0.50	1.46	0.83
8.8	1.44	1.85	3.39
10.1	1.09	0.58	2.62
12.7	0.67	1.20	0.49

Education

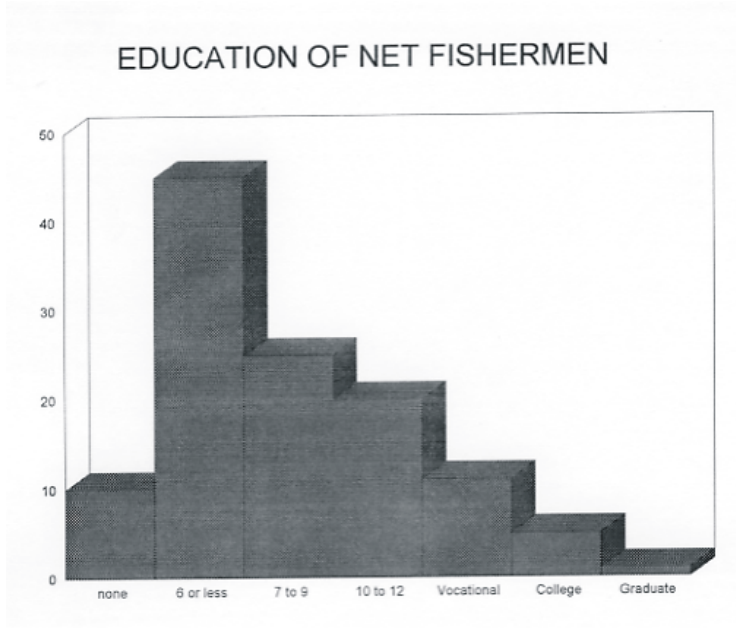
Half of the net fishermen have an education of less than sixth grade (Figure 5). When compared with the general population of fishermen, net fishers have less education. The data suggest that net fishermen are older and less educated than the rest of the fishermen and probably are more tied to fishing as a livelihood. They seem to be a more traditional group than their peers.

Fishing Background

Similar to their peers, net fishermen learned the trade when they were under 16 years of age. Most of them come from a family of fishers (84.7%). Fifty three percent reported that they receive help from their family (domestic unit) in their fishing and fishing related activities, showing a similar trend with other fishermen. Relative and friends are the basic component of the crew, although 20.6% reported to fish by themselves (Figure 6). The Puerto Rican industrial and service economy is now attracting fishermen's wives and children, disengaging them from the traditional coastal and marine jobs. Other unemployed youngsters and adults are essentially the replacement of relative in the crews. However, net fishing is still an activity that recruits from the main and the relatives households for cooperation in

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labor. Most of the net fishermen interviewed in this study reported that they did not belong to a fishermen association. Although the data we have is not conclusive at this time, it seems that net fishermen have less inclination to belong to these associations, than the rest of the fishermen.



Figure

5. Education of Gillnets and Trammel net fishermen in Puerto Rico

Social Characteristics

Net fishermen appear to be more dependent on fishing than any other group of fishermen that we have studied. As shown in figure 7, a high percentage of them reported to be engaged in fishing as their exclusive economic activity (71%). Throughout the 80's social research has demonstrated that half of the fishermen's population is engaged in other jobs, conforming to a well known pattern of occupational multiplicity (Valdéz-Pizzini, 1990). In comparison with the rest of the fishermen, net fishermen are almost exclusively devoted to fishing as a economic activity. The skewedness to the upper age cohorts may be associated with this

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behavior; these fishermen tend to be older, and thus out of the service and industrial economic activities due to advanced age.

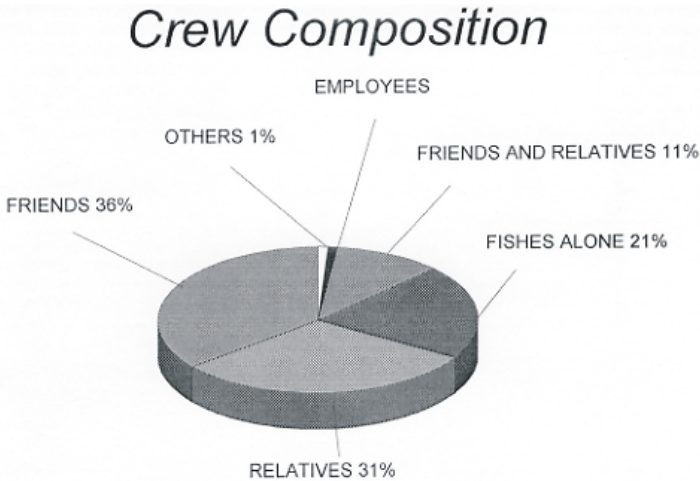


Figure 6.

Crew composition gillnets and trammel net fishermen in Puerto Rico

Associated with this finding is the fact that a relatively large percentage of the net fishermen (36.5%) reported that their household income depends exclusively on fishing, while only 15% of the other fishermen report that dependence. Figure 8 indicates the breakdown of the income for net fishermen's households. Eighty five percent (85.6%) depend on fishing, combined with a variety of transfer payments (pensions, social security, food stamps). Interestingly, their predicament as independent producers engaged almost exclusively in fishing without the patterns of occupational multiplicity exhibited by their peers is also reflected in the ways they dispose of the catch. Most fishermen, sell the catch themselves in their own business, in the streets, or directly to restaurants (Figure 9).

Our results also indicate that most of the net fishermen (68.7%) have worked in the United States, or have lived for a period of time on the mainland. A large percentage of those who worked on the mainland worked as farm workers (28%), and almost 60 percent of them did so for 5 years or less. Forty six percent of the net

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fishermen have worked in agriculture in Puerto Rico. This indicates that a large percentage of the net fishermen, as other fishermen have been incorporated into the larger economy at one time.

Patterns of Ownership

Most of the fishermen interviewed (81%) reported to own their own fishing boat. Several reported having from 2 to 4 boats. Most of the boats are made of wood, fiberglass or a combination of both. Most of the boats (around 75%) are under 18 feet long, and have motors under 35 hp. Those reporting owning more than one boat are usually financially well off fishermen, fish dealers registered as fishermen, or owners of gear.

There are some dealers that financed the fishing activity and held control over the local market and fishermen. These dealers owned fishing nets and leased them to the local fishermen for a fee, or for a differential in the current ex-vessel price paid to those who own their boats and fishing gear. Net fishermen reported owning and using other gears. The most common one was lines(hook and lines) with (77%) of the fishermen reporting it. In order of importance, the gears reported were: cast nets (52.9%), fish traps (33.5%), beach seines (13.5%), scuba gear (16%) and lobster traps or cajones (5.3%).

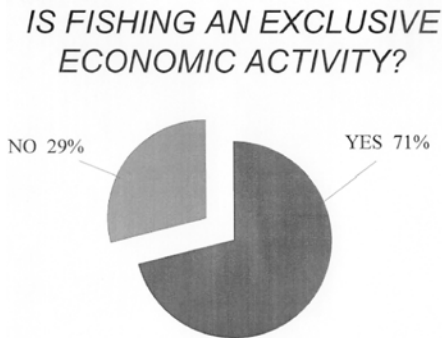


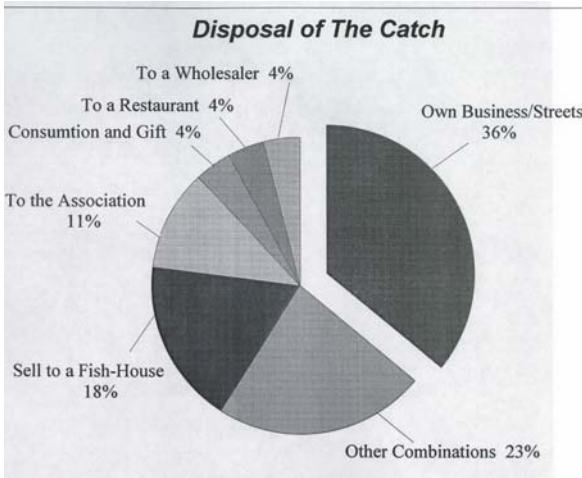
Figure 7. Is fishing an exclusive economic activity

for gillnets and trammel net fishermen in Puerto Rico?

Gillnet and Trammel Net Dimensions

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Gillnet dimensions are similar to those reported by Torres et al, (1989) in their census of fishermen and gear. Results are given in table 3. For all areas, the majority



of the length dimensions reported ranged from 150 to 200 fathoms. The most common mesh size is around 3 inches (7.6 cm).

However, on the north coast the most common mesh size appears to be around 2 and 2.5 inches (5 and 6.2 cm). Many fishermen reported mesh size around one inch (2.53 cm) in this area. This is probably due to the use of gillnets for small estuarine fishes (as reported by the fishermen), and for bait fish, additionally the lower dimensions in gillnet height reported for the north coast are also probably associated with the bait fishery in shallow estuarine waters.

Trammel net dimensions are smaller than those reported by Torres and Matos (1989). According to our data, trammel nets appear to be longer and higher on the northern coast. In term of mesh size, all coast exhibit similar ranges in size, although the east appears to have a larger outer mesh size, while the west coast features a higher inner mesh size (Table 3).

Advantages and Disadvantages for Using Gillnets and Trammel Nets

Most fishermen reported that gillnets and trammel nets fish fast, are easy to use and produce fairly reliable catches. Fishermen mentioned often that the gear could be used alone or by two people . Both gears catch economically valuable fish. Fishermen added that trammel nets fish any kind of fish, especially larger fish, and also fishes lobsters, which have a high price in the market. Most of the fishermen indicated not major disadvantages in these gears.

Figure 8. Sources of household income for gillnets and trammel net fishermen in Puerto Rico.

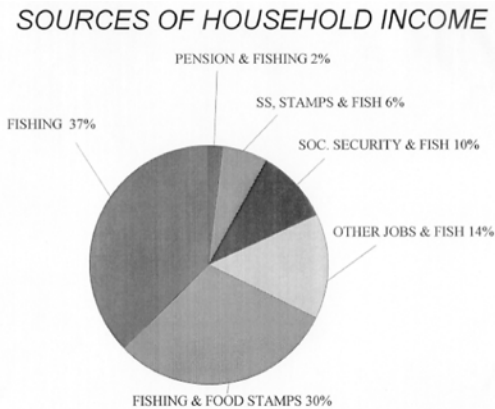


Figure 9. Disposal of the catch by gillnets and trammel net fishermen in Puerto Rico

Table 3. Gillnet and Trammel net dimensions by coastal area. L = Outside mesh

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size, S = inner mesh size

Gillnets	NORTH	EAST	WEST	SOUTH
LENGTH (f)	143	114	150	118
HEIGHT	3'	7.5'	9'	8'
MESH SIZE	2"-3"	2"-3.25"	2"-3.5"	2.5"-3.5"
Trammel nets				
LENGTH (f)	141	90	103	73
HEIGHT	9'	3.5'	3'	3.5'
MESH SIZE (L)	12"-6"	14"-12"	12"-6"	12"-8"-6"
(S)	4"-3"	3"-2"	4"-3"	3"

However, a number of them mentioned the following drawbacks: the gear breaks easily when fishing, due to rocks or the natural action of entangled fishes; nets are difficult to repair and maintain. Trammel net fishermen also mentioned that this gear is cumbersome to operate, and more expensive than gillnets.

CONCLUSIONS

We found that the most important problem that the net fishermen face is the increasing number of boats and recreational craft, such as jet skies, in the fishing areas. These are thought to be the culprit of interference with fishing activities and destroying the gear. Competition for space and resource is also an important issue. Recreational fishermen compete with the net fishermen for fish and fishing areas. Divers, in particular, are considered to place an unfair competition and are often mentioned as responsables for low catches. Some net fishermen using a small mesh size are considered also unfair competition and liable for the destruction of fish. It is often mentioned that trammel nets and gillnets are responsible for the depletion of reef fish. This study demonstrated that these gears catch larger fish and that most fishermen use large mesh size. However, there is a small number of fishermen using small mesh sizes which should be regulated.

The profile of the fishermen indicates that most of them consider themselves full-time fisherman, and they depend on the fishery for a significant portion of their

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livelihood. The predominance of older fishermen, most to whom have been gillnet fishing all their lives, indicates that this type of fishing is not attractive to young fishermen.

When we asked the fishermen about the status of their catches on a scale of poor to good, they indicated that they have been perceiving changes and that they were for the worst. They were mainly concern with changes in species composition and overfishing. Changes in species composition is a general pattern observed in the landing data over time. The major changes have been within groupers, parrotfishes and grunts, primarily the white grunt, *Haemulon plumieri*, and red hind, *Epinephelus guttatus* (Appeldoorn and Meyers, 1993). This may be one of the reasons why young fishermen are not entering the fishery. Informal discussions of management measures oriented to controlling overfishing indicates different attitudes of the fishermen for the implementation of these measures. The fishermen were against measures that would limit the number of nets, however, changes in mesh size and closing areas were viewed as possible alternatives.

None of the above mentioned management measures will succeed if the managers do not have a sound scientific knowledge of the user and the resources. Without a proper understanding of the natural patterns of variation, abundance, interactions, etc., in the biological assemblages, there is no way that conservation could be enhanced by managerial intervention (Underwood, 1993). At the same time, without detailed knowledge of the patterns of exploitation, the reasons for and the possible effectiveness of management, the usefulness and success of any management scheme cannot be predicted. The results of this project presents an unique opportunity to use social and fisheries biological data, in an inter-disciplinary effort aimed at the collection and application of the appropriated information needed to elaborate a management plan or procedures which are sensitive to social, economic and historical factors affecting the fishery. The use of multidisciplinary approaches allowed us to have more clear understanding of the resource exploited and the nature of the user of those resources. Stock assessment is only part of the answer to improve fisheries resources. Knowledge of socio-economic information will permit managers to define polices with high probability of acceptability on the part of the fishermen.

ACKNOWLEDGMENTS

We thank the fishermen which participated in the study for their ideas and comments. To all the students of the University of Puerto Rico at Mayaguez who worked in different phases of this project. We also thank Shawn Kadison who reviewed the manuscript for us. Financial support was provided by National Oceanic Atmospheric Administration (NOAA), National Marine Fisheries Service

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(Grant # NA17FL0100-1) and Puerto Rico Sea Grant Program (Grant # R/LR-06-10).

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