A Preliminary Study of Gillnet, Trammel Net and Beach Seine Catches from Southwest Puerto Rico with Notes on Length-Frequency

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ABSTRACT

This paper presents the results of the analysis of biostatistical data collected by port samplers of the Corporation for the Development & Administration of the Marine Lacustrine & Fluvial Resources of Puerto Rico (CODREMAR). Data were analyzed for species composition for three fishing gears (gillnet, trammel net, and beach seine) on the south and west coasts of Puerto Rico for 1986 and 1987. The fishing gear types analyzed in this study showed similarities in composition on both the south and west coasts. Gillnets showed the broader size ranges for all the species followed by trammel nets and beach seine. Length -frequency distributions showed a general pattern of smaller fish being landed in the south coast. Due to the inconsistent sampling effort, the species composition reported may not represent the true species composition of these fishing gears. Incomplete data collection also limited the assessment of seasonal variability by species. Suggestions on how to improve the database are given.

SUMARIO

Este trabajo presenta los resultados del análisis los datos biostadísticos recolectados por los agentes de la Corporación para el Desarrollo y Administracion de los Recursos Marinos, Lacustres y Fluviales de Puerto Rico (CODREMAR). Los datos fueron analizados para estimar la composición de captura de tres artes pesqueros (filete, mayorquín , y chinchorro) en la costa sur y costa oeste de Puerto Rico, durante 1986 y 1987. Los artes pesqueros analizados en este estudio muestran similitudes en la composición de captura en ambas costas. Los filetes mostraron la mas amplia talla de captura para todas las especies seguidos por los mayoquines y chinchorros. El análisis de la distribuciones de las tallas por especies mostro la tendencia de que los peces mas pequeños fueron descargados en la costa sur. Debido a la inconsistencia del muestreo, la composición de captura reportada no representa la verdadera composición de captura para estos artes pesqueros. La incompleta recollección de datos limitó la evaluación de cambios temporales de las especies. Sugerencias de como mejorar los datos son presentadas.

INTRODUCTION

Puerto Rico fisheries can be considered as nearshore or reef fisheries, and the nature of the substrate limits the kind of fishing gears used. The most commonly used gear in Puerto Rico (PR) is the fish trap (Antillean and arrowhead traps), accounting for 34% of the total landings in 1987. It is followed in importance by hook-and-line and gillnets, which accounted for 19% and 16% of total landings in 1987, respectively. Although the fish trap is the

dominant gear, there has been a steady decrease in total landings in the last few years, going from 1.5 million pounds (681.818 kg) in 1984 to 745,658 lbs (338.935 kg) in 1987. A survey conducted by the Corporation for the Development &Administration of the Marine Lacustrine & Fluvial Resources of Puerto Rico (CODREMAR) indicated that, according to fishermen, the main reason for the decline in trap use was that theft or loss of the traps due to bad weather, coupled with the high cost of building new traps and low yields, did not allow a profitable operation.

Most of the trapping in Puerto Rico takes place on the south and west coasts. As a consequence of low yields in the trap fishery, some fishermen have shifted their fishing effort totally or temporarily toward other gears, such as gillnets and trammel nets, which yield better results. The nature of the Caribbean trap fishery is reasonably well understood, or a least well documented. However, there is little information about the nature of net fisheries in the Caribbean or in Puerto Rico, especially in terms of the biology and ecology of important species caught by gillnet, trammel net, and beach seine. Statistical information on landings and fishing effort for these gears during the last few years was very poor or absent. In order to fill this gap, CODREMAR started a system of collecting monthly biostatistical data for the commercially important species for all fishing gears. Their database contains monthly information by gear, area, depth and fishing effort as well as biological information about the catch.

The present paper is a preliminary description of the species composition and length-frequency distribution of the most abundant species caught by gillnets, trammel nets, and beach seines, on the south and west coasts of Puerto Rico . This kind of information is essential, especially at this time when management strategies are being developed for species in danger of, or already being, overfished.

METHODS

Commercial biostatistical data collected by port samplers of CODREMAR for the south and west coasts of Puerto Rico during 1986-87 and compiled into the CODREMAR database were used for this analysis. Figure 1 shows the different port sampling locations on the southwest coast of Puerto Rico.

Data were analyzed for species composition for the three fishing gear (gillnet, trammel net, and beach seine). Further analyses concentrated on the seven most abundant species caught by these gears. Data for individual species were compared by coasts and by gear when possible. Yearly comparisons were not attempted due to the difference in sampling effort during the two years. Species codes and scientific names are based on Erdman (1983).

Comparisons of length-frequency distributions by gear and location were made for the most abundant species for each year. A Kolmogorov-Smirnov two sample test was used to test differences between the length-frequency

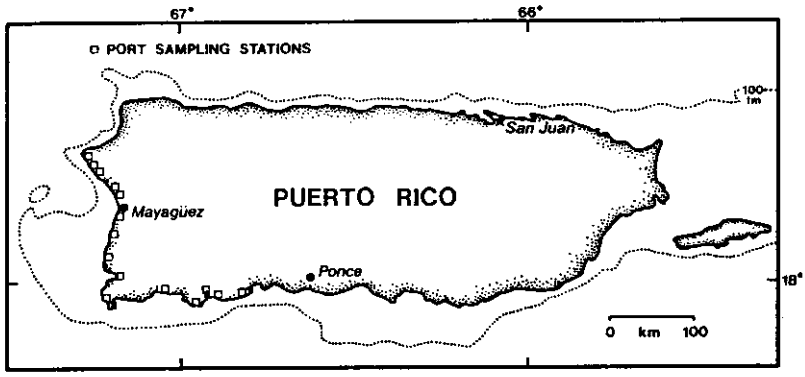

Figure 1. Map of Puerto Rico, showing CODREMAR port sampling stations.

distributions by gear and by location (Sokal & Rohlf, 1981). Statistical analysis were conducted on an IBM microcomputer using SYSTAT (Wilkinson, 1987).

The three fishing gears are defined according to the terminology used by CODREMAR in the comprehensive fishery census of 1988 (Torres-Rosado *et al.*, 1988).

Beach seine (Chinchorro)

Net made of mesh webbing and consisting of two wings and a bag or bunt. Mesh sizes range from 1 to 6 inches (2.54 to 15.24 cm) in the south coast and from 0.5 to 12 inches (1.27 to 30.48 cm) in the west coast.

Gillnet (Trasmallo, filete)

A net in which fish are caught by their gill covers or entangled in the meshes of the net. Gillnets can be suspended at the surface, midwater or anchored to the bottom. The mesh sizes ranged from 1 to 4 inches (2.54 to 10.16 cm) in the south coast and from 0.5 to 4 inches (1.27 to 10.16 cm) in the west coast.

Trammel net (Mayorquin)

The net has three curtains of netting, suspended from a common cork line, and a common lead line. Two different meshes are used; the inside webbing is smaller than the outside webbing. Mesh sizes in the south coast ranged from 2 to 7 inches (5.08 to 17.78 cm) and from 0.5 to 12 inches (1.27 to 30.48 cm) in the west coast.

RESULTS

The database for gillnets, trammel nets and beach seines consisted of 77 and 50 samples for 1986 and 1987, respectively. Sampling was spread over a period of 8 months (April to December) in 1986, with October having the most samples (14) and September and July having only one sample. During 1987 the sampling was spread more evenly over the year, with the largest number of samples taken in February, May and October (4) and one sample recorded in July and December. Data on effort, gear type and depth fished were collected, but not consistently enough to allow further analysis.

Species Composition

A total of 77 species were reported in the records from 1986-1987. Fifty-nine species were recorded in 1986 and 40 in 1987. A break down of the total species composition presented in the database by gear and location for both years is given in Appendix 1.

Gillnets

Sixty species were taken by gillnets for the south and west coasts during 1986-87. In 1986, 41 species were reported for the south coast and 22 for the west coast. Similarly, for 1987 more species were found on the south coast (22) compared to the west coast (16). Table 1 presents the relative abundance (percentage by number) by location and gear for the most abundant species caught by gillnets.

Trammel nets

Forty-one species were represented in the trammel net fishery. Fourteen species each comprised more than 1% of the catch for the south and west coasts in 1986 (Table 2). *Sparisoma viride* was the most important species with 43.5% of the catch by number for the south coast and *Haemulon sciurus* was most abundant for the west coast with 21.5% in 1986. In 1987 eighteen species accounted for more than 1% of the total catch. *Calamus pennatula* accounted for 30.3% of the catch for the south coast with *Sparisoma viride* and *Haemulon plumieri* accounting for 26.5% and 22.1%, respectively. Table 2 presents the relative abundance (percentage by number) by location and year for the top species.

Table 1. Species comprising more than 1% of the total number of fishes captured by gillnets at the South and West coast of Puerto Rico during 1986 and 1987 (Species composition is based in the biostatistical data)

	GILLNETS			
	1986		1987	
	% by number SOUTH	% by number WEST	% by number SOUTH	%by number WEST
Sparisoma viride	22.0	46.0	7.2	4.9
Haemulon plumieri	18.0	19.9	20.7	38.4
Haemulon carbonarium		5.4		
Ocyurus chrysurus	11.5		5.9	3.5
Apsilus dentatus		3.7		
Caranx ruber	9.1	4.6	10.3	
Calamus pennatula	7.2	< 1%	22	
Calamus bajonado	6.6	1.3	< 1%	< 1%
Haemulon sciurus	3.5	7.7	7.1	22.5
Lutjanus synagris	5.7	< 1%	5.5	
Epinephelus fulvus	2.8	< 1%	< 1%	< 1%
Scarus vetula	1.1			
Caranx bartholomaei		1.3		
Lutjanus apodus	< 1%		3.6	4.9
Balistes vetula	< 1%			2.8
Anisotremus virginicus	< 1%	1.7	< 1%	6.3
Gerres cinereus	< 1%		< 1%	1.4
Bodianus rufus		< 1%	< 1%	< 1%
Lactophrys triquete			1.7	
Calamus penna			2.1	
Acanthurus chirurgus				6.3
Scarus coelestinus				2.2
38 other species	12.5	10.1	13.9	6.8

Beach seines

A total of 35 species were represented in the database for the beach seine fishery. Eighteen species each accounted for more than 1% of the catch (Table 3). The most abundant species by location was *Ocyurus chrysurus*, accounting for 48.2% and 36.6% of the catch for the south and west coasts in 1986 and 17.5% for the south coast in 1987. Data for the west coast for beach seine was not collected in 1987. Table 3 gives the relative abundance (percentage by number) by location and year for the top species.

Length-frequency distributions

Length frequency distributions were generated by gear and location for the

Table 2. Species comprising more than 1% of the total number of fishes captured by Trammel nets for the South and West coast of Puerto Rico during 1986 and 1987. (Species composition based on biostatistical data)

	TRAMMEL NETS			
	1986		1987	
	% by number SOUTH	% by number WEST	% by number SOUTH	% by number WEST
Sparisoma viride	43.5	11.1	< 1%	26.5
Haemulon plumieri	7.1	18.6	11.7	22.1
Ocyurus chrysurus	1.7	7.6	17.1	< 1%
Caranx ruber	4.1	11.1	2.9	3.7
Calamus pennatula	4.6	1.5	30.3	1.8
Calamus bajonado			3.9	
Haemulon sciurus	20.9	21.5	< 1%	11.5
Epinephelus fulvus	1.7	1.9		< 1%
Caranx bartholomaei		2.3	6.8	
Lutjanus analis			5.3	
Lutjanus apodus	4.4	9.2		1.2
Balistes vetula	1.7	< 1%	< 1%	< 1%
Mulloidichthys martinicus	< 1%	< 1%	2.9	
Anisotremus virginicus	1.2	1.3		4.9
Lachnolaimos maximus	1.9	1.5		< 1%
Kyphosus incisors			7.3	
Haemulon flavolineatus		5.4		1.5
Acanthurus chirurgus				11.8
Acanthurus bahianus				1.1
Scarus guacamaia			3.4	
Archosargus rhomboidalis			3.9	
Sparisoma chrysopterum		2.7		8.3
20 other species		4.3	4.5	5.6

most important species.

Haemulon plumieri (white grunt): Figure 2 shows the length-frequency distributions of samples taken by gillnet, trammel net and beach seine on the south coast. It can be seen that the broadest size range is taken by gillnets and the smallest by trammel nets catches. Figure 3, for the west coast in 1986, shows that beach seines are catching the smallest fish, and that gillnets and trammel nets are catching the same size range. Table 4 gives the mean size for each species by gear and location.

Results from the Kolmogorov-Smirnov test by gear and location (Table 5) showed no significant differences between the distributions by coast; however, a significant difference ($p \leq .05$) was found between gillnets and trammel nets on

Table 3. Species comprising more than 1% of the total number of fishes captured by beach seines at the South and West coast of Puerto Rico during 1986 and 1987. (Species composition is based on the biostatistical data).

	BEACH SEINE			
	1986		1987	
	% by number SOUTH	% by number WEST	% by number SOUTH	% by number WEST
Haemulon plumieri	12.8	15.3	12.0	
Ocyurus chrysurus	48.2	36.6	17.5	
Caranx ruber	1.3	6.7	3.0	
Calamus pennatula	17.6	10.3	33.0	
Calamus bajonado	4.0	< 1%	4.0	
Haemulon sciurus	1.8	2.4	< 1%	
Lutjanus synagris	5.8	12.1		
Caranx bartholomaei	< 1%		7.0	
Lutjanus analis	< 1%	5.4	5.5	
Scianidae	1.9			
Mulloidichthys martinicus	< 1%		3.0	
Anisostremus virginicus	1.1			
Gerres cinereus			1.0	
Sparidae	1.0			
Calamus calamus		1.6		
Malacanthus plumieri			1.0	
Archosargus rhomboidalis			4.0	

the south coast. Gillnet distributions between the two coasts were not significant ($p > .05$); this lack of significance may be attributed to the variability of the data and the larger range of sizes in the distributions of the samples from the west coast. Figure 4 compares length-frequency distributions between gillnets and beach seines for the south coast in 1987. In contrast to 1986, the size range is smaller for both gears in 1987.

Sparisoma viride (stoplight parrotfish). Figures 5 and 6 show length-frequency distributions for gillnets,trammel nets and beach seines for the south and west coasts, respectively, in 1986. The size distributions for gillnets and trammel nets at the two locations are very similar, except for the slightly greater number of larger fishes from the west coast. The difference observed between coasts for trammel nets may be attributed to the difference in sample size.

Caranx ruber (bar jack). Figures 7 and 8 compare length-frequency distributions of gillnets, trammel nets and beach seine by location for 1986. Trammel-net distributions between coasts are similar, but with differences in the

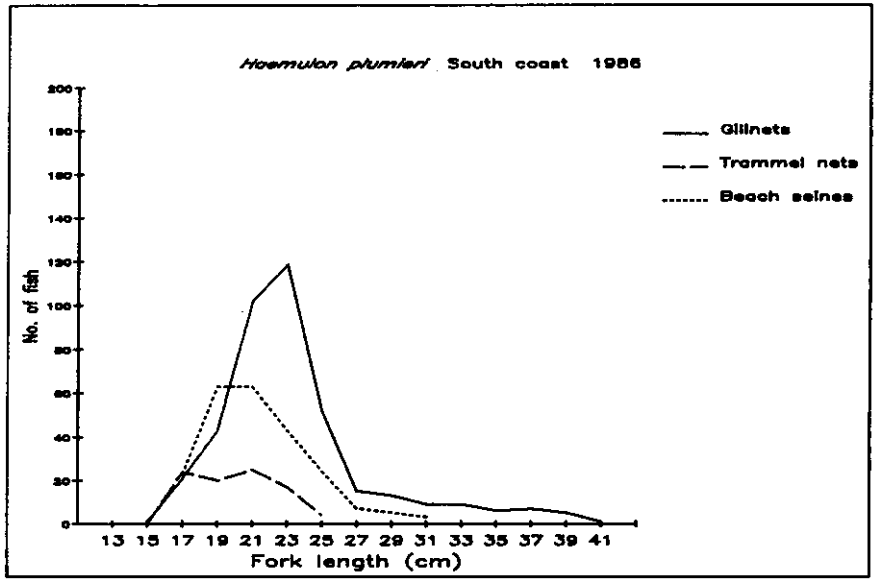

Figure 2. Length frequency distributions of *Haemulon plumieri* captured by gillnets, trammel nets and beach seines for the South coast of Puerto Rico during 1986.

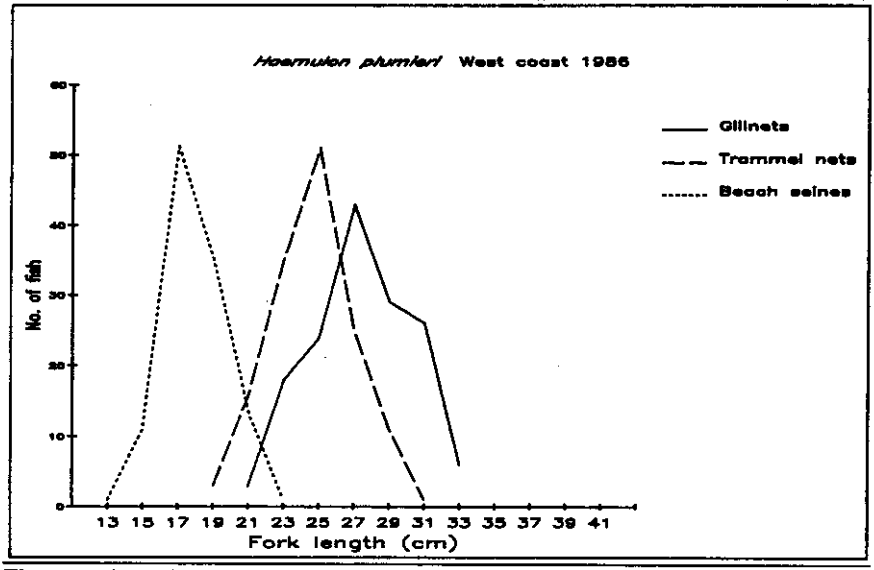

Figure 3. Length frequency distributions of *Haemulon plumieri* captured by gillnets, trammelnets and beach seines for the West coast of Puerto Rico during 1986.

Table 4. Mean sizes and standard deviation for the most abundant species by gear and by location for 1986 and 1987. GN=gillnets, TN=tramel nets, BS=beach seines, S=south, W=west.

SPECIES	GEAR	AREA	MEAN	S.D	#OBS
1986					
Haemulon plumieri	GN	S	22.5	4.57	404
	GN	W	24.0	2.81	149
	TN	S	20.4	2.74	101
	TN	W	22.5	12.40	100
	BS	S	20.4	2.84	171
	BS	W	17.1	23.00	112
Ocyurus chrysurus	GN	S	25.8	5.78	223
	BS	S	23.5	4.80	565
	BS	W	19.9	2.95	268
Lutjanus synagris	GN	S	24.9	20.30	122
	BS	S	22.6	45.00	133
	BS	W	19.4	34.00	89
Caranx ruber	GN	S	25.7	4.13	196
	GN	W	29.6	10.00	37
	TN	S	27.5	12.00	17
	TN	W	26.2	50.0	62
	BS	S	19.5	21.00	152
Sparisoma viride	GN	S	26.2	34.50	486
	GN	W	29.4	45.00	346
	TN	S	33.5	21.60	177
	TN	W	34.7	46.00	59
Haemulon sciurus	GN	W	23.3	13.60	68
	TN	S	20.6	28.20	58
	TN	W	23.3	37.00	84
Calamus pennatula	GN	S	21.2	26.00	155
	TN	S	20.2	47.60	20
	TN	W	18.8	20.50	8
	BS	S	21.9	38.80	207
1987					
Haemulon plumieri	GN	S	21.6	2.14	108
	GN	W	24.3	2.24	56
	TN	W	22.4	2.16	155
	BS	S	20.1	1.88	26
Haemulon sciurus	GN	S	22.8	2.76	45
	GN	W	26.4	13.00	31
	TN	W	23.0	2.08	81
Calamus pennatula	GN	S	19.7	3.30	121
	BS	S	22.7	4.69	66
Sparisoma viride	GN	S	24.5	2.72	38
	TN	W	29.1	4.12	180
Lutjanus synagris	GN	S	22.6	5.10	29
Caranx ruber	GN	S	25.4	8.90	54

Table 5. Variability in the length frequency distribution between three fishing gears by location for the most abundant species using the Kolmogorov-Smirnov tes. * indicates distributions are different from p=0.1 and 0.05, respectively. GN=gillnets, TN=tramel nets, BS=beach seines. S=south, W=west

SPECIES	GEAR COMPARISONS	PROBABILITIES
1986		
Haemulon plumieri	GNS vs GNW	0.065
	TNS vs TNW	0.998
	BSS vs BSW	0.998
	GNS vs TNS	0.022*
	GNS vs BSS	0.166
	TNS vs BSS	0.894
	GNW vs TNW	0.998
	GNW vs BSW	0.894
	TNW vs BSW	0.998
Ocyurus chrysurus	GNS vs BSS	0.216
	BSS vs BSW	0.236
Lutjanus synagris	GNS vs BSS	0.186
	BSS vs BSW	0.198
Caranx ruber	GNS vs GNW	0.264
	TNS vs TNW	0.844
	GNS vs BSS	0.111
	TNS vs BSS	0.526
Sparisoma viride	GNS vs GNW	0.986
	TNS vs TNW	0.421
	GNS vs TNS	0.986
	GNW vs TNW	0.435
Calamus pennatula	GNS vs TNS	0.524
	TNS vs BSS	0.262
	GNS vs BSS	0.150
1987		
Haemulon plumieri	GNS vs BSS	0.109
	GNW vs TNW	0.450

modes, which may be be attributed to the difference in sample sizes. Gillnets and beach seines show larger differences in size distribution between coasts; however these were not statistically significant (Table 5). The broadest size ranges for gillnets were observed in the south coast and in the west coast for beach seines.

Ocyurus chrysurus (yellowtail snapper). Figure 9 shows size compositions from beach seine samples by coast for 1986. The size distributions are similar, although smaller fish were found in the west coast. Figure 10 shows the

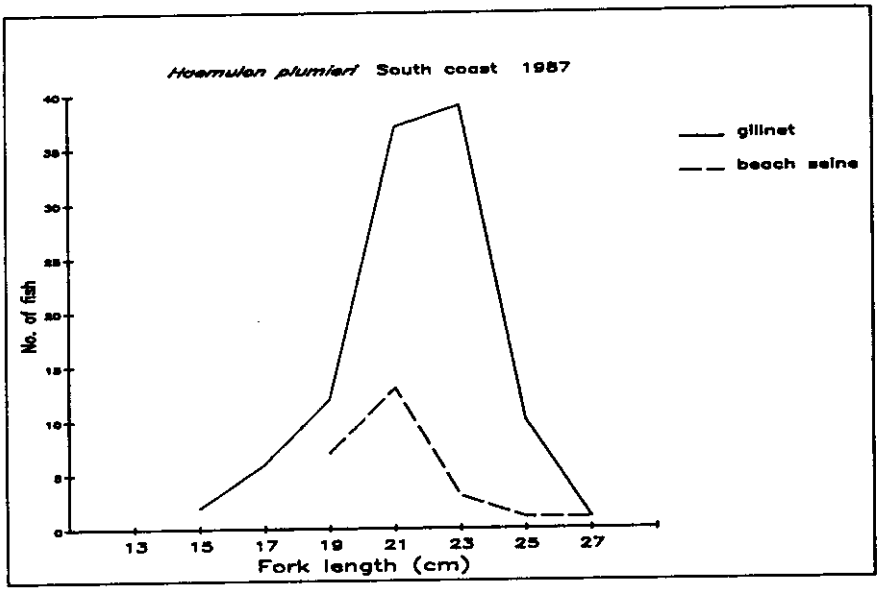

Figure 4. Length frequency distributions of *Haemulon plumieri* captured by gillnets and beach seines for the South coast of Puerto Rico during 1987.

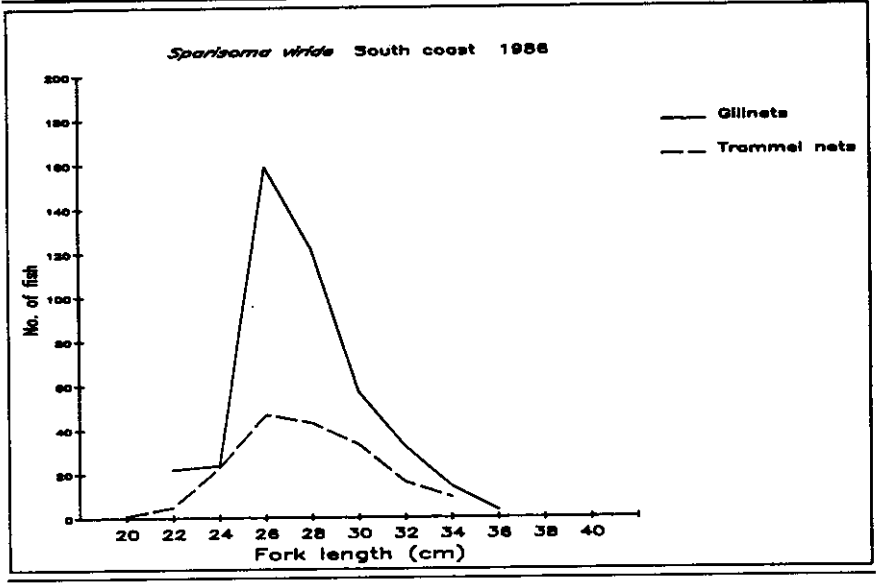

Figure 5. Length frequency distributions of *Sparisoma viride* captured by gillnets and trammel nets for the South coast of Puerto Rico during 1986.

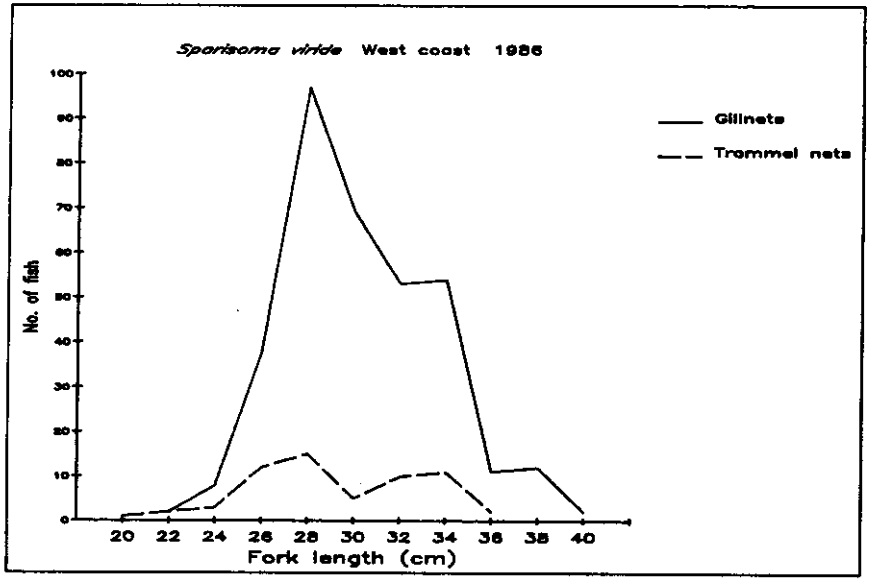

Figure 6. Length frequency distributions of *Sparisoma viride* captured by gillnets and trammel nets for the West coast of Puerto Rico during 1986.

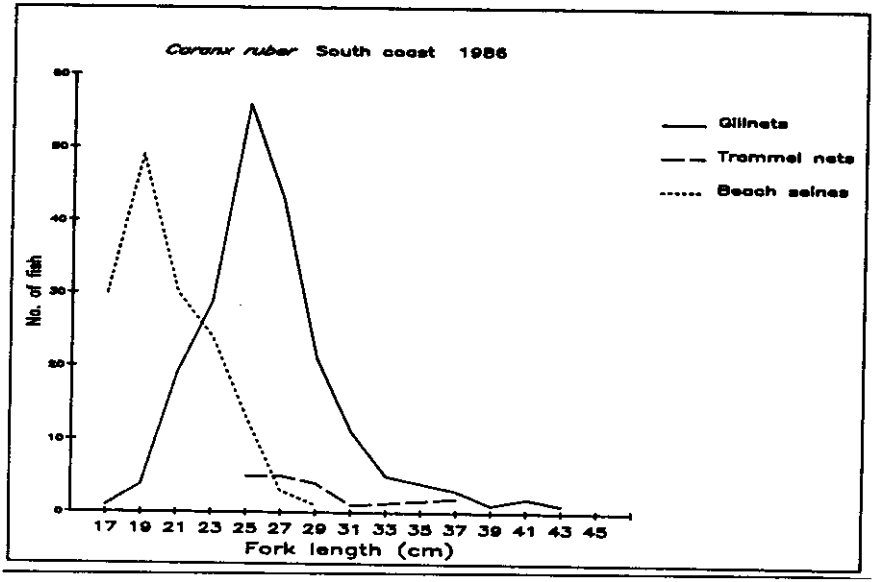

Figure 7. Length frequency distributions of *Caranx ruber* captured by gillnets, trammel nets, and beach seines for the South coast of Puerto Rico during 1986.

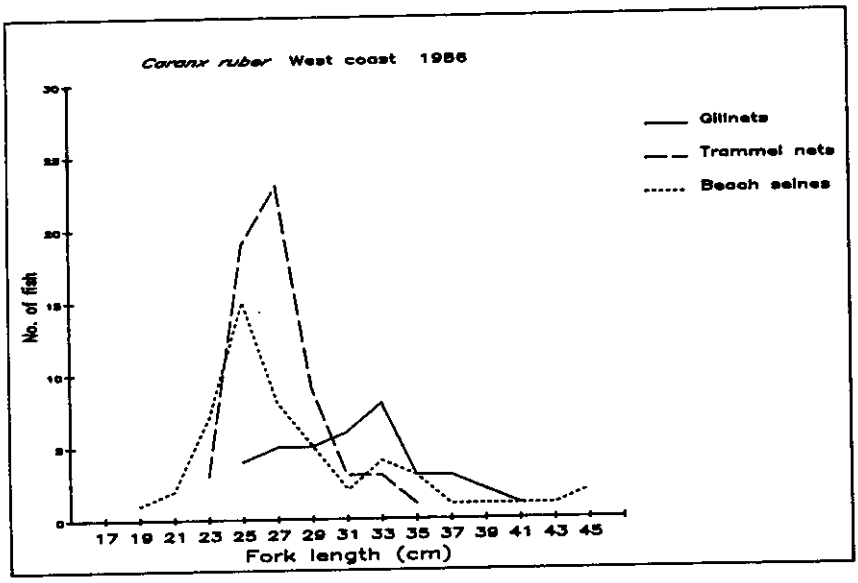

Figure 8. Length frequency distributions of *Caranx ruber* captured by gillnets, trammel nets and beach seines for the West coast of Puerto Rico during 1986.

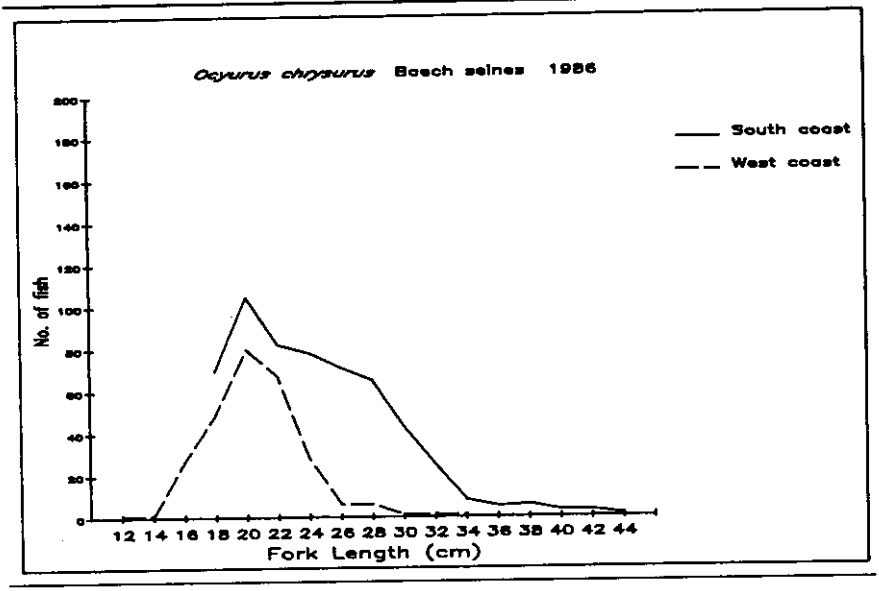

Figure 9. Length frequency distributions of *Ocyurus chrysurus* captured by beach seines for the South and West coast of Puerto Rico during 1986.

comparison between gillnet and beach seine for the south coast. Gillnets occasionally caught smaller fishes than beach seines.

Lutjanus synagris (lane snapper). Figure 11 shows length-frequency distributions for beach seines by coast. More fish were taken on the south coast than on the west coast. Figure 12 shows the comparison of *L. synagris* caught by gillnets and beach seine on the south coast.

Calamus pennatula (pluma). Length-frequency comparisons by gear for the south coast in 1986 and 1987 are given in Figures 13 and 14, respectively. The size distributions for gillnets and beach seines look similar and are not significantly different (Table 5).

Haemulon sciurus (bluestriped grunt). Length-frequency distributions from gillnets and trammel nets are presented in Figure 15. There is no significant difference in size distribution between the two gears (Table 5). However, the difference in size range may possibly be attributed to the selectivity of the gears.

DISCUSSION

One of the most common obstacles to carrying out stock assessments is the absence of adequate data. This often occurs because the main user of the data, the fisheries scientist, does not have direct control over the collection of much of the data, especially the statistics of the commercial fishery (Gulland, 1983). The most important data from the fisheries is information on the total catch. Apart from knowing the total weight landed, it is important to know where the fish are caught, where the fish are landed, type of species, and gear used. Collecting data on species is more difficult, especially when the number involved is very large. However, it is vital. Even closely related species can differ very much in their biological characteristics (growth, mortality, etc.), and these can be very important for managers.

Detailed understanding of how the fishery actually operate allows the user of the data to interpret the data coming from the data collection system. For example it may show that up to a certain time, fishermen used the same type of gillnet in the same way, and the catch per fishermen was a good index of abundance. But, later they used longer nets, new materials and stayed out fishing for more hours every day. The catch per fisherman would then have to be adjusted to account for the changes in the fishery.

The analysis showed similarities in species composition among gear types and between coasts. However, mean size of capture for individual species changed according to gear and location (Table 4). This can be observed in the case of *Haemulon plumieri,* which showed higher mean size of capture by gillnet followed by trammel net, and beach seine. This can probably be considered a general trend due to gear selectivity. Gillnets are selective for fish size according to the mesh size used. In Puerto Rico, mesh size for gillnets range from 0.5 to 6 inches. The ranges for the south and west coast are from 1 to 5 in

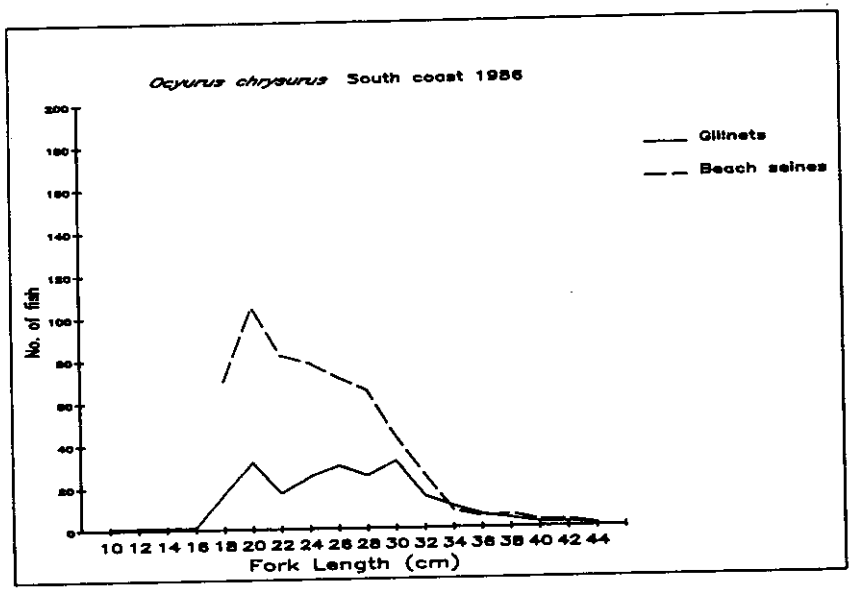

Figure 10. Length frequency distributions of *Ocyurus chrysurus* captured by gillnets and beach seines for the South coast of Puerto Rico during 1986.

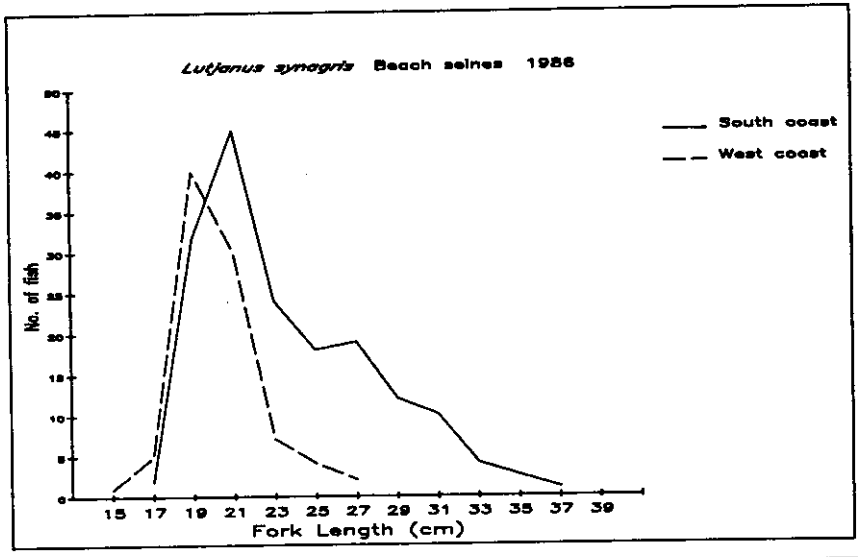

Figure 11. Length frequency distributions of *Lutjanus synagris* captured by beach seine for the South and West coast of Puerto Rico during 1986.

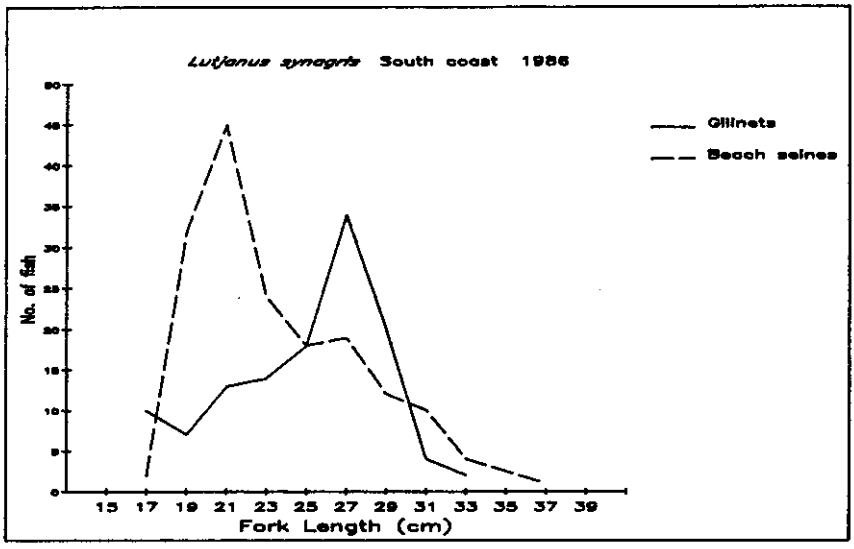

Figure 12. Length frequency distributions of *Lutjanus synagris* captured by gillnets and beach seines for the South coast of Puerto Rico during 1986.

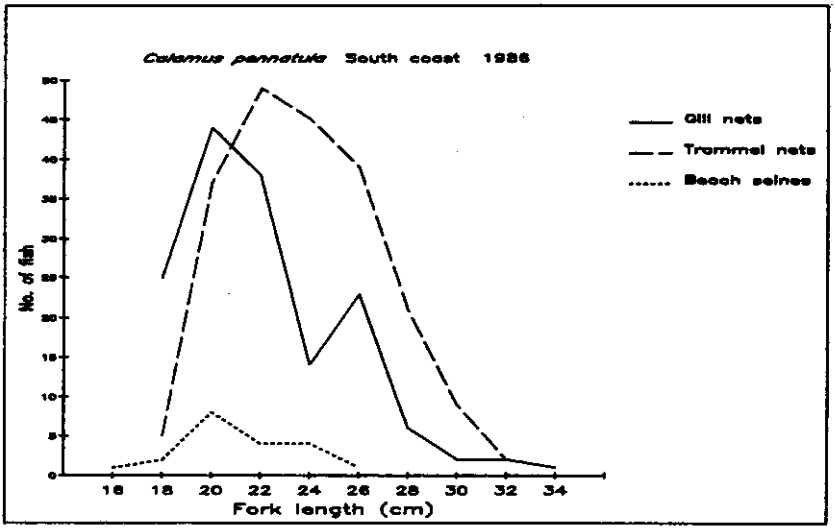

Figure 13. Length frequency distributions of *Calamus pennatula* captured by gillnets, trammel nets and beach seines for the South coast of Puerto Rico during 1986.

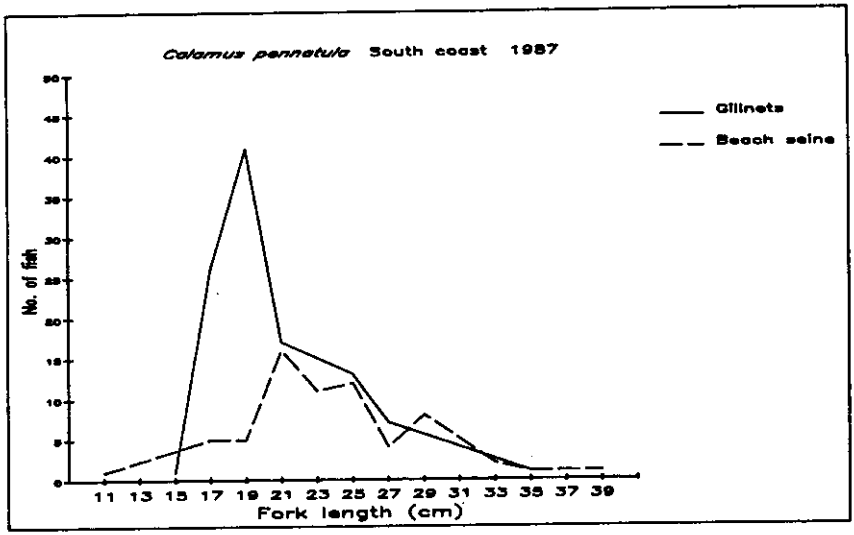

Figure 14. Length frequency distributions of *Calamus pennatula* captured by gillnets and beach seine for the South coast of Puerto Rico during 1987.

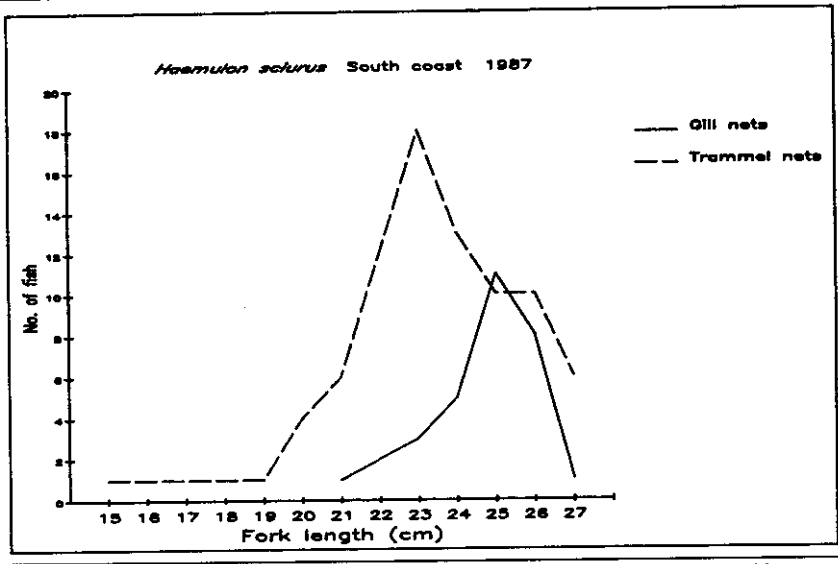

Figure 15. Length frequency distributions of *Haemulon sciurus* captured by gillnets and trammel nets for the South and West coast of Puerto Rico during 1987.

and from 0.5 to 4 in., respectively (Torres-Rosado *et al.*, 1988). A more detailed analysis of the size distribution caught by gillnets in both areas was not possible due to the lack of information for each sample concerning the design of the gillnets used.

The limited number of samples per month made the length -frequency analysis by species difficult. Despite this problem the data were useful for characterizing the size distributions for the more abundant species. Length-frequency distribution results show a general pattern of smaller fish being landed on the south coast. Data from this database show that the mean size of capture of *Ocyurus chrysurus* for the two gears analyzed was less than 12 in. (30.4 cm), which is below the minimum legal size of capture for this species in federal waters. Also, there was a drop in the percentage of yellowtail snapper caught by beach seines in 1987 compared to 1986. The reason for this is unknown; it may be attributed to differences in the number of samples and sampling periods between 1986 and 1987.

The species composition generated for each fishing gear from the CODREMAR database can only be considered a partial list since species which are abundant in Puerto Rico, such as mackerels (Scombridae), barracudas (Sphyraenidae), mullets (Mugilidae), and sharks (Carcharinidae), were not reported. The reason for under-reporting species can be attributed to the systematic collection of only a particular subset of the catch:the target species. Also, due to inconsistent sampling effort, the species composition found, may not represent the true composition. Incomplete data also limits the assessment of seasonal variability.

The lack of information on depth and fishing grounds does not permit the examination of the relationship between the size of fish and depth. At the same time, the lack of information in the design of the gear, such as net dimensions and mesh size, does not allow for the calculation/determination of selectivity curves for individual species.

The use of the Kolmogorov-Smirnov two sample test for the analysis of frequency distributions can be a good tool for management purposes, especially for comparing fished and unfished areas (Bell *et al.*, 1985). In this paper its application is limited due to poor data, but its application in testing different distributions by fishing gear can be very valuable.

Bohnsack *et al.* (1986) found similar limitations in the biostatistical database for 1985, and they made some recommendations of how to improve it. However, similar limitations are found in the biostatistical data from 1986-87.

The system of collecting biostatistical data needs to be improved in order to obtain satisfactory information for management purposes. Data collection should involve standardization of the sampling effort by month and by fishing gear type and should include information on:

1. Species composition of the landings.
2. Fishing effort for each gear.
3. Description of the design of the fishing gear (especially in the case of nets).
4. Description of the depth and the type of bottom fished.
5. Continuous monitoring of the data collection in order to establish and maintain data quality.

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Appendix 1. Species(percent by number) represented in the biostatistical data for gilnet, trammel net and beach seine at the South West coast Puerto Rico during 1986 and 1987.

	Gillnet		Trammel Net		Beach Seine	
	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*
Sparisoma viride	22.0 *7.2*	46.0 *4.9*	43.5 *< 1%*	11.1 *26.5*		
Haemulon plumieri	18.0 *20.7*	19.9 *38.4*	7.1 *11.7*	18.6 *22.1*	17.6 *12*	15.3
Haemulon carbonarium		5.4				
Ocyurus chrysurus	11.5 *5.9*	*3.5*	1.7 *17.1*	7.6 *< 1%*	48.2 *17.5*	36.6
Apsilus dentatus		3.7				
Caranx ruber	9.1 *10.3*	4.6	4.1 *2.9*	11.1 *3.7*	1.3 *3.0*	6.7
Calamus pennatula	7.2 *22*	< 1%	4.6 *30.3*	1.5 *1.8*	17.6 *33*	10.3
Calamus bajonado	6.6 *< 1%*	1.3 *< 1%*	*3.9*		4.0 *4.0*	< 1%
Haemulon sciurus	3.5 *7.1*	7.7 *22.5*	20.9 *< 1%*	21.5 *11.5*	1.8 *< 1%*	2.4
Lutjanus synagris	5.7 *5.5*	< 1%	< 1%	< 1% *< 1%*	5.8	12.1

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*
Epinephelus fulvus	2.8 *< 1%*	< 1% *< 1%*	1.7	1.9 *< 1%*		
Scarus vetula	1.1					
Caranx bartholomaei		1.3		2.3	< 1% *7.0*	
Lutjanus analis	< 1%	< 1%	*6.8* *5.3*		< 1% *5.5*	5.4
Scianidae	< 1%				1.9	
Lutjanus apodus	< 1% *3.6*	*4.9*	4.4	9.2 *1.2*	< 1%	< 1%
Epinephelus guttatus	< 1%	< 1%	< 1%	< 1% *< 1%*		
Lutjanus griseus	< 1%	< 1%				
Balistes vetula	< 1%	*2.8*	1.7 *< 1%*	< 1% *< 1%*	< 1% *< 1%*	
Ecinostomus gula	< 1%					
Lutjanus vivanus	< 1%					

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South	West	South	West	South	West
	1986	1986	1986	1986	1986	1986
	1987	*1987*	*1987*	*1987*	*1987*	*1987*
Pseudupeneus malaculatus	< 1%				< 1%	< 1%
	< 1%			*< 1%*	*< 1%*	
Mulloidichthys martinicus	< 1%	< 1%	< 1%	< 1%	< 1%	
			2.9		*3.0*	
Anisotremus virginicus	< 1%	1.7	1.2	1.3	1.1	
	< 1%	*6.3*		*4.9*		
Epinephelus cruentatus	< 1%					
Lachnolaimos maximus	< 1%	1.9		1.5		
	< 1%			*< 1%*		
Epinephelus inermis	< 1%					
Lutjanus cyanopterus	< 1%					
	< 1%					
Lutjanus jocu	< 1%	< 1%				
Sparisoma aurofrenatum	< 1%			< 1%		< 1%
				< 1%		
Scomberomorus regalis	< 1%					
Mycteroperca venenosa	< 1%		< 1%			

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*
Pomadasys croco	< 1%					
Mugil curema	< 1%					
Epinephalus striatus	< 1%			< 1%		< 1%
Epinephelus mystacinus	< 1%				< 1%	
Haliochoeres radiatus	< 1%					
Lutjanus mahogoni	< 1%					
Gerres cinereus	< 1% *< 1%*	*1.4*	*< 1%*			*1.0*
Holocentrus adscensionis		< 1%	< 1%	< 1% *< 1%*		
Haemulon macrostomun		< 1%				
Haemulon album		< 1%				

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*
Bodianus rufus		< 1%				
Epinephelus adscensionis	*< 1%*	*< 1%*	< 1%			
Lactophrys bicaudalis	< 1%					
Lactophrys trigonus				< 1%	< 1%	
Lactophrys triqueter	< 1%					
Lactophrys polygonia	*1.7*					
Lactophrys quadricornis	*< 1%*	< 1%	< 1%			
Anisotremus surinamensis	*< 1%*			*< 1%* < 1%		
Epinephelus afer				< 1%	< 1%	
Trachinotus goodei				< 1%		
Sparidae					1.0	

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*	South 1986 *1987*	West 1986 *1987*
Kyphosus incisors					< 1%	
			7.3		*7.5*	
Haemulon parrai	< 1%				< 1%	
					< 1%	< 1%
Haemulon flavolineatus				*1.5*		
	< 1%					< 1%
Haemulon bonariensis						
	< 1%				< 1%	
Gymnothorax funebris						
					< 1%	
Selar crumenophthalmus						
					< 1%	
Caranx latus						
						1.6
Calamus calamus						
Calamus penna						
	2.1					< 1%
Coryphaena equisetis						

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South	West	South	West	South	West
	1986	1986	1986	1986	1986	1986
	1987	*1987*	*1987*	*1987*	*1987*	*1987*
Acanthurus chirurgus						
Acanthurus bahianus		*6.3*				
Equetus punctatus						
Chaetodipterus faber		*< 1%*				
Priacanthus arenatus		*< 1%*				
Scarus guacamaia		*< 1%*				
Malacanthus plumieri			3.4	5.4		
Archosargus rhomboidalis			< 1%	*11.8*		
Auxis spp.			3.9	*1.1*		
Sparisoma chrysopterum	< 1%					
				< 1%		
						1.0
						4.0
				< 1%		
				2.7		< 1%
				8.3		

Appendix 1. (continued)

	Gillnet		Trammel Net		Beach Seine	
	South	West	South	West	South	West
	1986	1986	1986	1986	1986	1986
	1987	*1987*	*1987*	*1987*	*1987*	*1987*
Pomacanthus arcuatus				*< 1%*		
Scarus teaniopterus	< 1%			*< 1%*		
Sparisoma rubripinne				*< 1%*		
Scarus coelestinus		*2.2*				