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#### ABSTRACT

The Puerto Rico Department of Natural and Environmental Resources (DNER) is responsible for the conservation and management of the Island's natural resources, including the fishery resources. The DNER's Commercial Fisheries Statistics Program (CFSP) collects and analyzes the dependent fisheries data. The CFSP has been collecting data since 1971. During the 1980s, Puerto Rico's commercial fishery resources had shown overfishing symptoms (e.g. decrease in landings pounds, change in catch composition, decrease in the size of some important species).

Spiny lobster, *Panulirus argus*, is a very valuable exploited marine crustacean in the shallow water of the Caribbean Islands. During the 1950s, the fishery and economic of the spiny lobster started to increase. Spiny lobster has been the most important shellfish by landed weight and price per pound in Puerto Rico's fishery since the 1970s to 2001. Spiny lobster showed symptoms of overfishing during the 1980s. Since 1985, then the Caribbean Fishery Management Council (CFMC) and the DNER have regulations to protect the spiny lobster. These include a minimum legal size (MLS) of 89 mm carapace length (CL), forbidden to take egg-bearing females, forbidden the use of gaff to catch lobsters, and all spiny lobster must be landed whole. Despite these fishing regulations, CFSP personnel observed that very little or no enforcement occurred until 1995. During 1989 - 1991, more than 50% of the spiny lobsters were caught before reaching the MLS. Since 1995, the DNER's rangers started to enforce the spiny lobster regulations, with the result that during 1998, only 24% were caught before MLS.

The objective of this study is to describe the fishery of the spiny lobster thru the data collected by the CFSP (landings and biostatistics data) during 1988 - 2001. Length frequency distributions (LFD) of this species by years, fish traps and SCUBA diving have been analyzed.

**KEY WORDS:** Biostatistics data, commercial landings, Puerto Rico, spiny lobster

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## Un Retrato de la Pesquería de Langosta, *Panulirus argus*, en Puerto Rico durante 1988-2001

El Departamento de Recursos Naturales y Ambientales de Puerto Rico (DRNA) es el responsable de conservar y administrar todos los recursos naturales de la Isla, incluyendo los recursos pesqueros. El Programa de Estadísticas Pesqueras (PEP) del DRNA se encarga de recolectar y analizar los datos dependientes de la pesca. El PEP ha estado recolectando datos desde 1971. Estos datos muestran que durante la década de 1980, la pesca comercial en Puerto Rico mostraba indicios de sobre pesca (Ej. disminución en las libras desembarcadas, cambios en la composición de la captura, disminución en el tamaño de especies importantes).

La langosta espinosa, *Panulirus argus* es un crustáceo marino explotado en las aguas someras de las islas caribeñas. Durante los años 50 la pesquería y la economía de la langosta espinosa aumentaron. La langosta espinosa ha sido el marisco más importante por libras desembarcadas y por precio por libra en la pesquería de Puerto Rico desde 1970 hasta 2001. La langosta espinosa mostró indicios de sobre pesca durante los años 1980. Desde 1985, el Consejo de Pesca del Caribe (CFMC) y el DRNA tienen reglamentaciones para proteger a la langosta espinosa. Estas reglamentaciones incluyen un tamaño mínimo legal de 89mm del largo del carapacho, la prohibición de capturar hembras con huevos, el uso de bichero para capturarlas, y todas las langostas espinosas deben estar completas al momento del desembarco. A pesar de estas reglamentaciones el personal del PEP observó que no se hicieron cumplir las mismas hasta el 1995. En el periodo de 1989-91, más del 50% de las langostas espinosas eran capturadas antes de alcanzar el tamaño mínimo legal. A partir de 1995, los vigilantes del DRNA comenzaron a hacer cumplir las reglamentaciones de la langosta espinosa, dando como resultado para el año 1998, sólo el 24% fue capturado antes de alcanzar el tamaño mínimo legal.

El objetivo de este estudio es describir la pesquería de la langosta espinosa utilizando los datos recolectados por el PEP (desembarcos y datos bioestadísticas) durante 1988-2001. Se analizó la frecuencia de tallas (LFD) de esta especie por año, nasas y buceo.

**PALABRAS CLAVES:** Datos de bioestadísticas, desembarcos comerciales, Puerto Rico, langosta espinosa

### INTRODUCTION

The Puerto Rico Department of Natural and Environmental Resources (DNER) is responsible to conserve and manage all the Island's natural resources, including the fishery resources. The DNER's Commercial Fisheries Statistics Program (CFSP) collects and analyzes the dependent fisheries data. The CFSP has been collecting data since 1971. Matos-Caraballo (2005, 2004) mentioned that during the 1980s Puerto Rico's commercial fishery resources had shown over fishing symptoms (e.g. decrease in landings pounds, change in catch composition, decrease in the size of some important species). Species considered in the market as trash during the 1970s, today have been considered

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a second class market species (Matos-Caraballo 2005, 2004).

Spiny Lobster *Panulirus argus* it is a very valuable marine crustacean in the shallow water of the Caribbean Islands (Mateo and Die 2004). Jarvis (1932) mentioned that in early 1930s fishermen frequently caught spiny lobsters, although they did not have a good market. Old commercial fishers report to CFSP that until early 1950s most lobsters were used as fish trap baits (Matos-Caraballo 2001). Mattox (1952) and Feliciano (1958) described how the fishery and economy of the spiny lobster started to increase during the 1950s. Spiny lobster has been the most important shellfish by landed weight and price per pound in the Puerto Rico's fishery since the 1970s to 2001 (Suárez-Caabro 1979, Matos-Caraballo 2005, 2004, 2001). Spiny lobster showed symptoms of overfishing during the 1980s, and since that time the Caribbean Fishery Management Council (CFMC) and the DNER have enacted regulations to protect the spiny lobster. The mentioned regulations includes a minimum legal size (MLS) of 89 mm carapace length (CL), forbidden to take egg-bearing females, forbidden the use of gaff to catch lobsters, and all spiny lobster must be landed whole. Although the mentioned fishing regulations CFSP personnel observed that very little or none enforcement occurred until 1995 (Matos-Caraballo 2001). During 1989 - 1991, more than 50% of the spiny lobster were caught before reaching the MLS. Since 1995, the DNER's rangers started to enforce the spiny lobster regulations, with the result that during 1998, only 24% were caught before MLS.

The objective of this study is to describe the fishery of spiny lobster thru the data collected by the CFSP (landings and biostatistics data) during 1988-2001. Length frequency distributions (LFD) of this species by year, fish traps, and SCUBA divers have been analyzed.

## METHODS

This report will discuss the spiny lobster fishery using two types of dependent data collected by CFSP through 1988 - 2001. First, the landings data were collected by CFSP's port samplers. The commercial fishers and/or fish houses reported their catch in a ticket.

The second type of data used in this study was biostatistics. This data were also collected by CFSP's port samplers. They visited the fishing centers and randomly selected commercial landings. Then they proceeded to identify by species all the catch to obtain data about composition. Then port samplers measured CL in mm. If it was possible, the whole catch was individually measured and sexed. CFSP's port samplers collect catch per unit effort data (CPUE) *in situ* when they do the biostatistics sampling. The total landings by trip and by gear, number of traps hauled, and net lengths in fathoms were recorded.

Port samplers delivered the landings and biostatistics data to CFSP and statistical clerks edited and entered it in computers using Microsoft FoxPro and NMFS Trip Interview Program (TIP). The data were analyzed using length frequency distribution (LFD) of this species by years, fish traps, SCUBA divers, and lobster traps. LFD for both species by years and by gears were analyzed. Kolmogorov-Smirnov Two Sample Test,  $p \leq 0.05$  (Sokal and Rohlf

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1981) was used to know if there is any significant difference among the comparisons.

## RESULTS

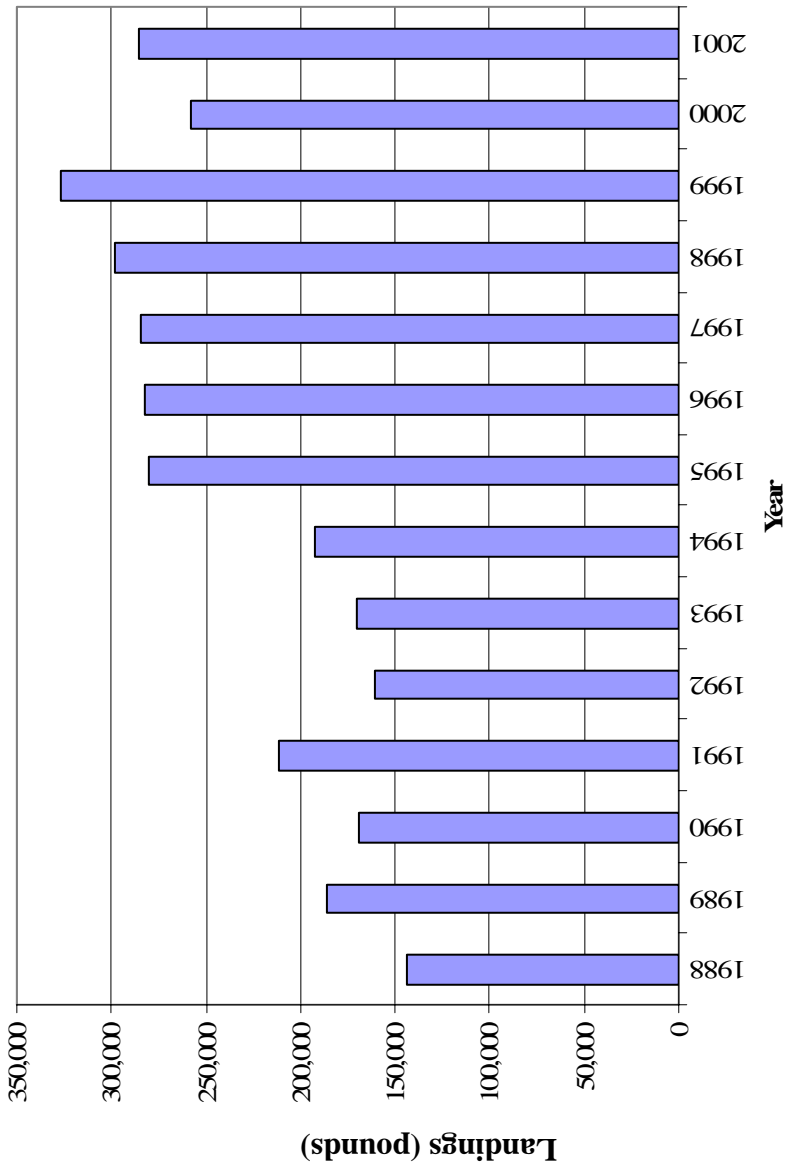
Landings data indicate that a total of 3,238,755 pounds of spiny lobster were reported to the CFSP during 1988 - 2001 (Figure 1). An increase is observed in the spiny lobster reported during the period of 1988 - 1994 (1,228,856 pounds), compared to 1995 - 2001 (2,009,899). The spiny lobster landings increase coincides with the higher participation in the number of commercial fishers (Matos-Caraballo 2004). During 1988 - 2001, spiny lobster reported represented approximately 8% of the total pounds reported for fish and shellfish. The spiny lobster continues to be the most important shellfish in pounds and traps in Puerto Rico's fishery. Also, spiny lobster is one of the top five species of fish and shellfish in Puerto Rico's landings.

Figure 2 shows the trend of landings reported by fish trap, lobster trap, gill net, trammel net, and SCUBA divers during 1988 - 2001. Landings reported by these gears show that fish traps caught 42% of the 3,238,755 spiny lobster pounds during 1988 - 2001. For the same period, lobster traps caught 9.4%, gill nets caught 1.0%, trammel nets caught 5.1%, and SCUBA divers caught 42.4% of the total landed pounds reported. Figure 2 shows that SCUBA divers and fish traps were the most productive gears in this fishery.

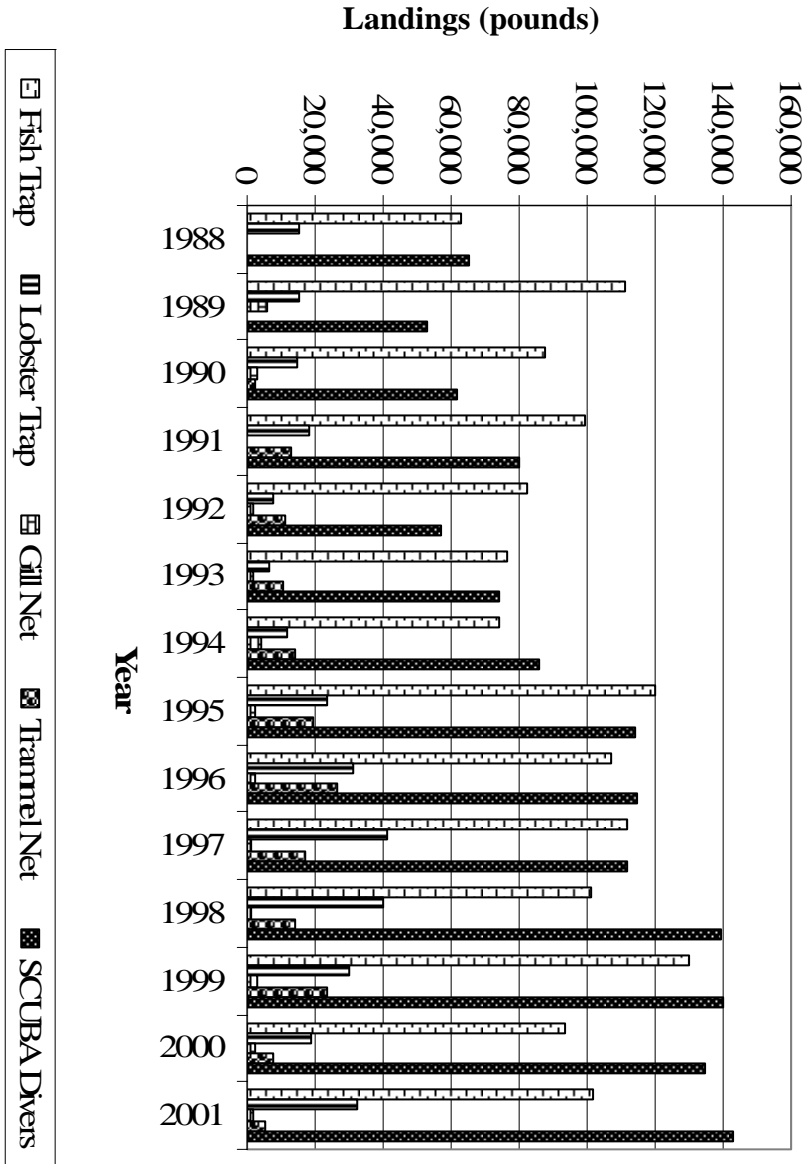
Biostatistics data from 1988-2001, shows that a total of 13,418 spiny lobsters were measured by CFSP (Figure 3). The spiny lobster caught during 1988 - 94, had an average of 93 mm CL (Figure 4). On the other hand, the spiny lobster caught during 1995 - 2001 had an average of 99 mm CL (Figure 5). Kolmogorov-Smirnov test shows that the LFD for 1995 - 2001 were significantly larger than the LFD 1988 - 1994 ( $D_{max} = 0.1799$ ).

Spiny lobster males caught during 1988-94 had an average of 96 mm CL (Figure 6). During 1995 - 2001 the average was 101 mm CL (Figure 7). The trend observed in males was observed also in the females LFD for the same periods of time. Spiny lobster females caught during 1988 - 1994 had an average of 90 mm CL (Figure 8) and during 1995 - 2001 the average was 96 mm CL (Figure 9). The females caught during 1988 - 1994 were significantly smaller than the females caught during 1995 - 2001 ( $D_{max} = 0.1859$ ).

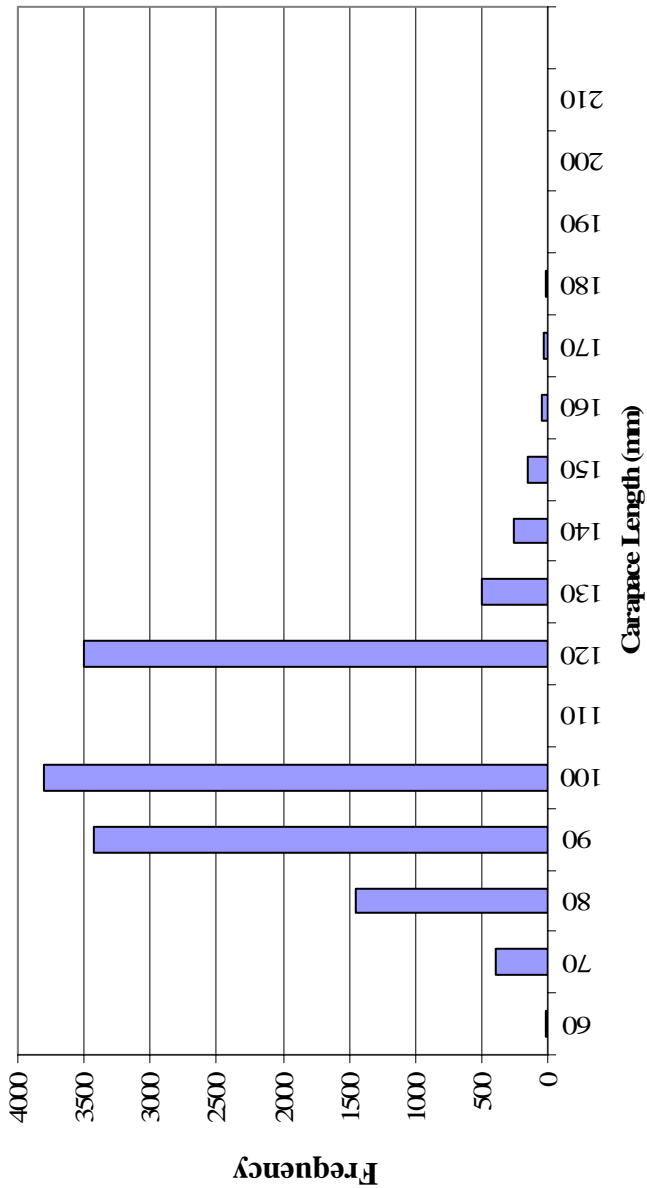
A total of 1,492 individuals of spiny lobsters caught by fish traps were measured by CFSP's port samplers during 1988 - 2001 (Figure 10). Length frequency distribution shows that 471 (31%) individuals were caught before reaching the MLS of 89 mm CL. On the other hand, 9,766 spiny lobster caught by SCUBA divers were sampled by CFSP. From this total 2,434 (25%) were caught before reaching the MLS (Figure 11). The lobster trap caught only 18% of the individuals before reaching the MLS (Figure 12).



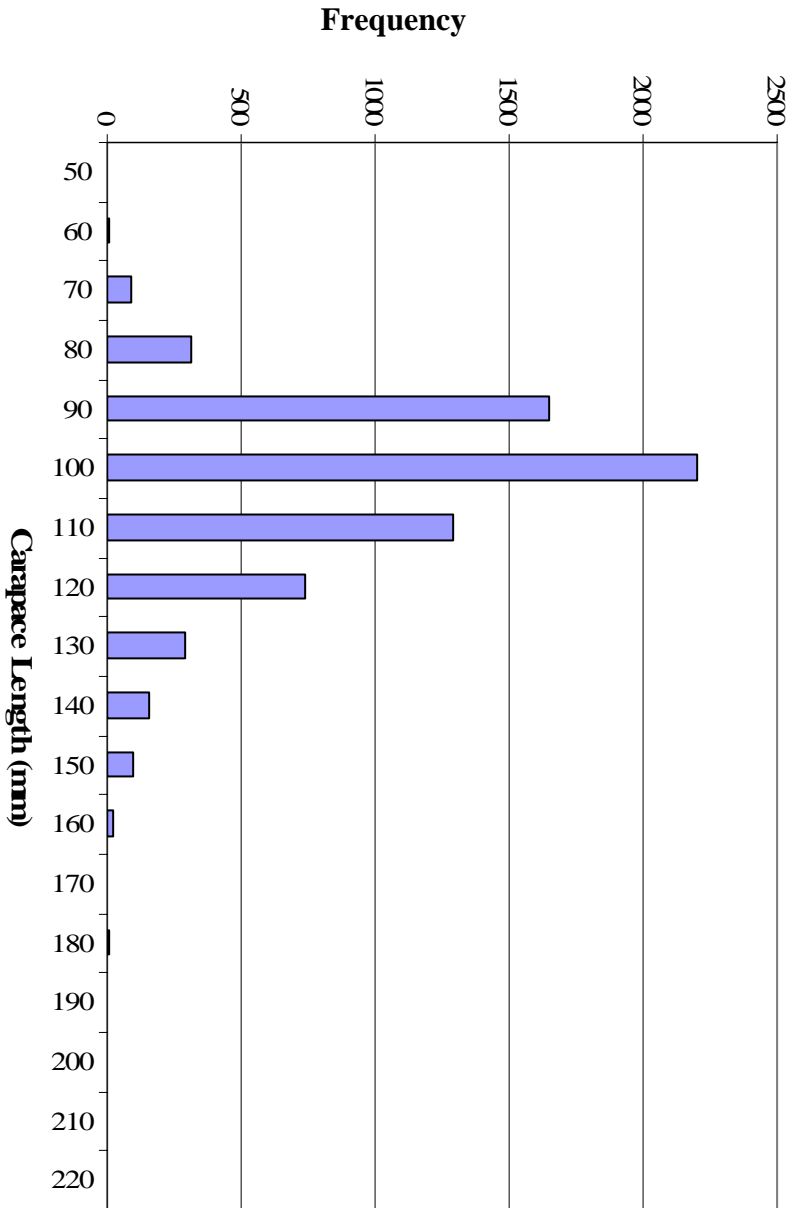
**Figure 1.** Landings reported of spiny lobster in Puerto Rico during 1988 - 2001.



**Figure 2.** Landings reported for spiny lobster by fish trap, lobster trap, gill net, trammel net, and SCUBA divers in Puerto Rico during 1988 - 2001.

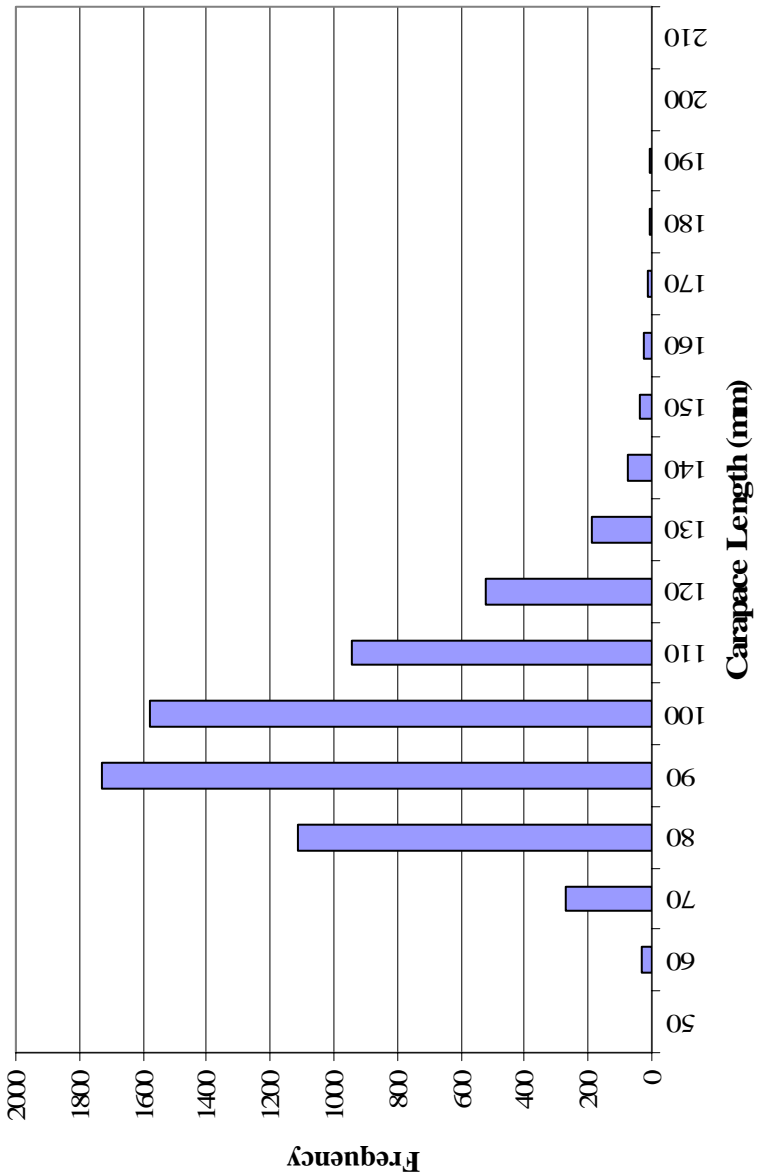


**Figure 3.** Length frequency distribution for spiny lobster caught in Puerto Rico during 1988 - 2001.

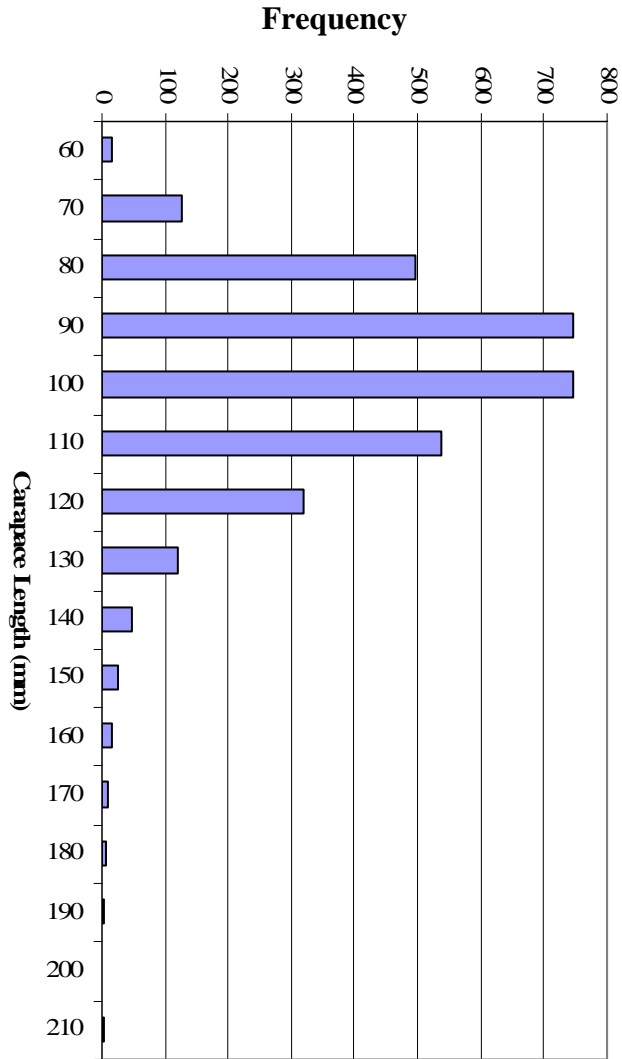


**Figure 4.** Length frequency distribution for spiny lobster caught in Puerto Rico during 1988 - 1994.

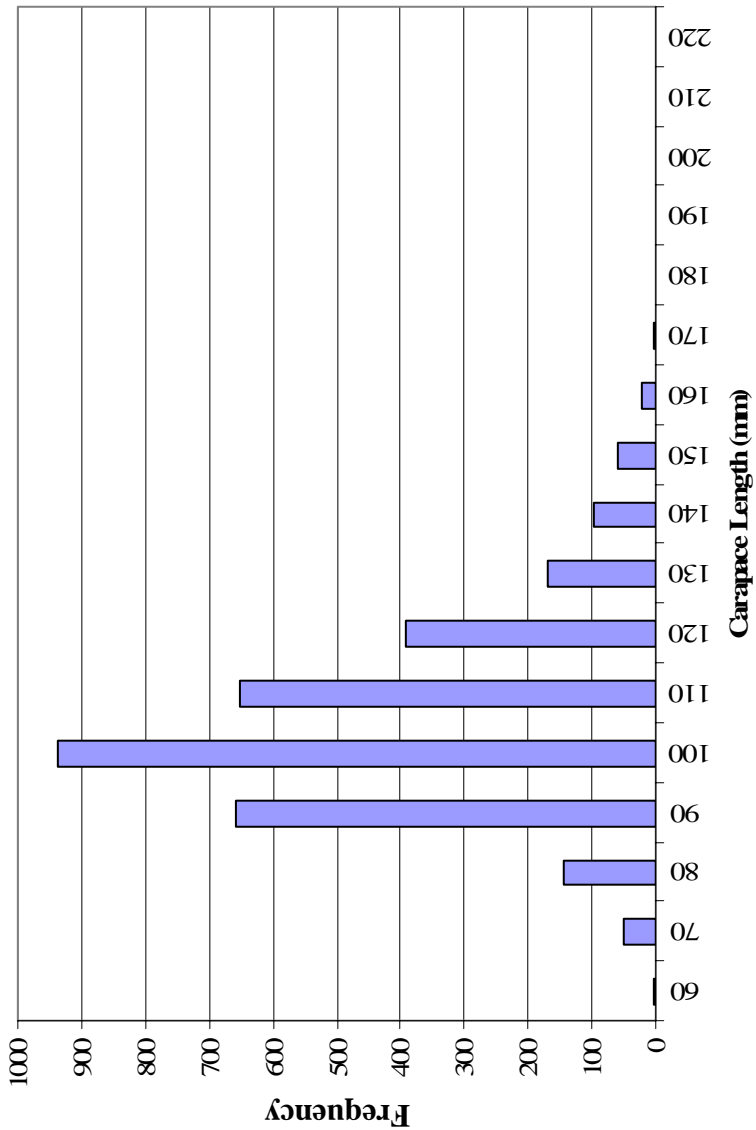




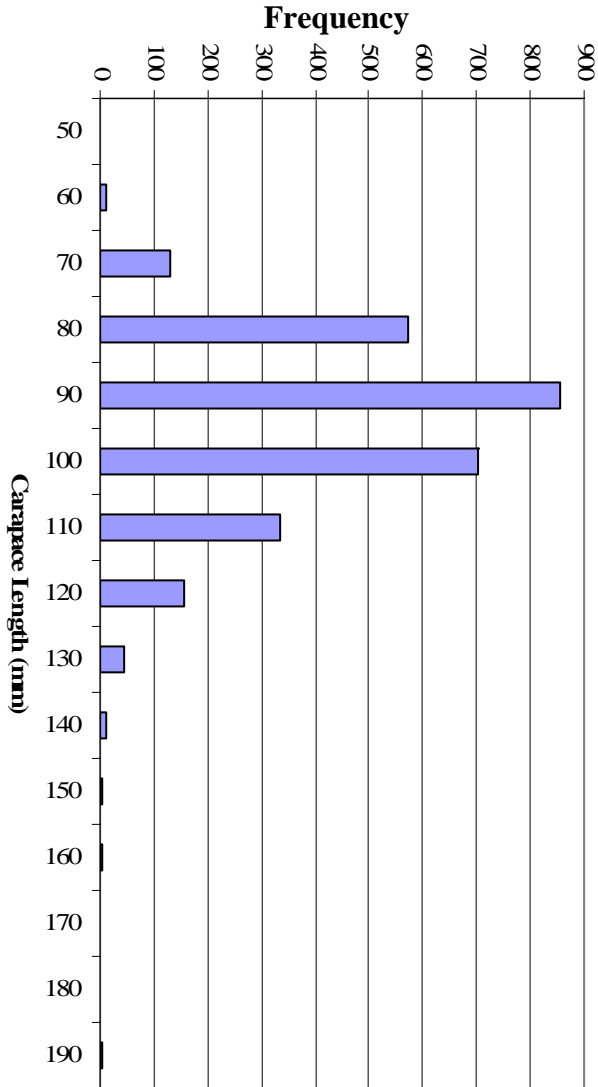
**Figure 5.** Length frequency distribution for spiny lobster caught in Puerto Rico during 1995 - 2001.



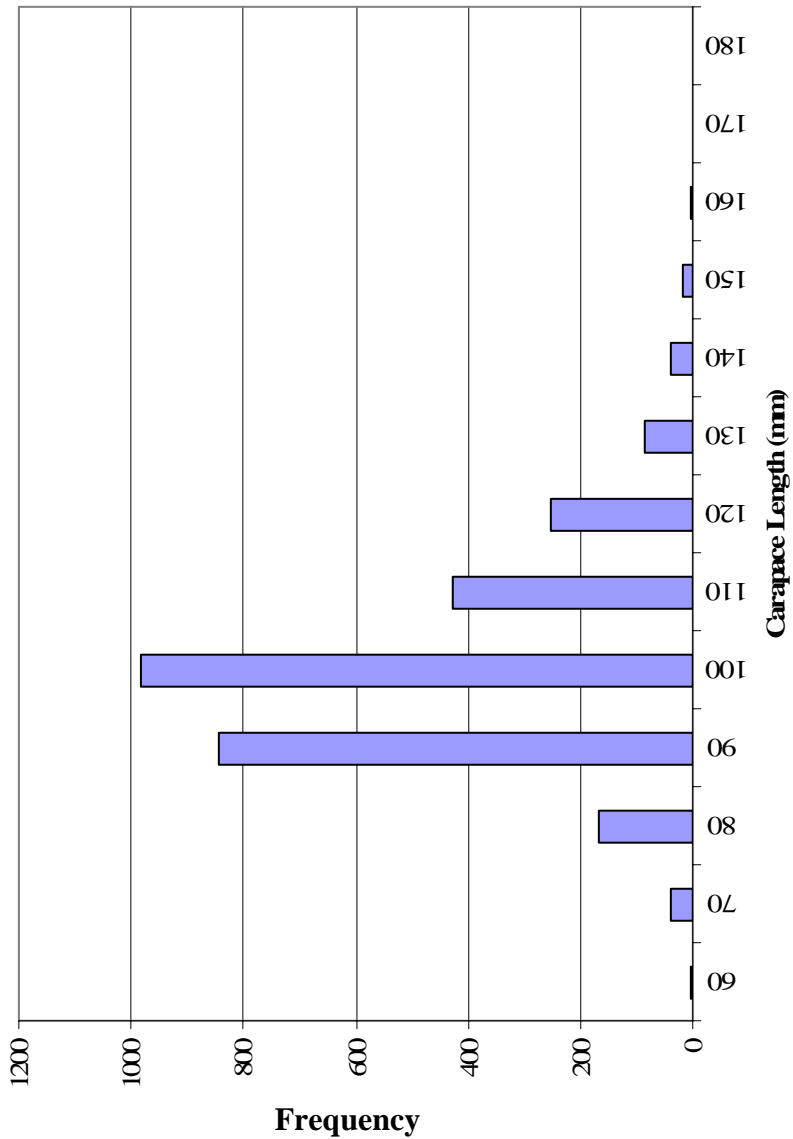
**Figure 6.** Length frequency distribution for spiny lobster males caught in Puerto Rico during 1988 - 1994.



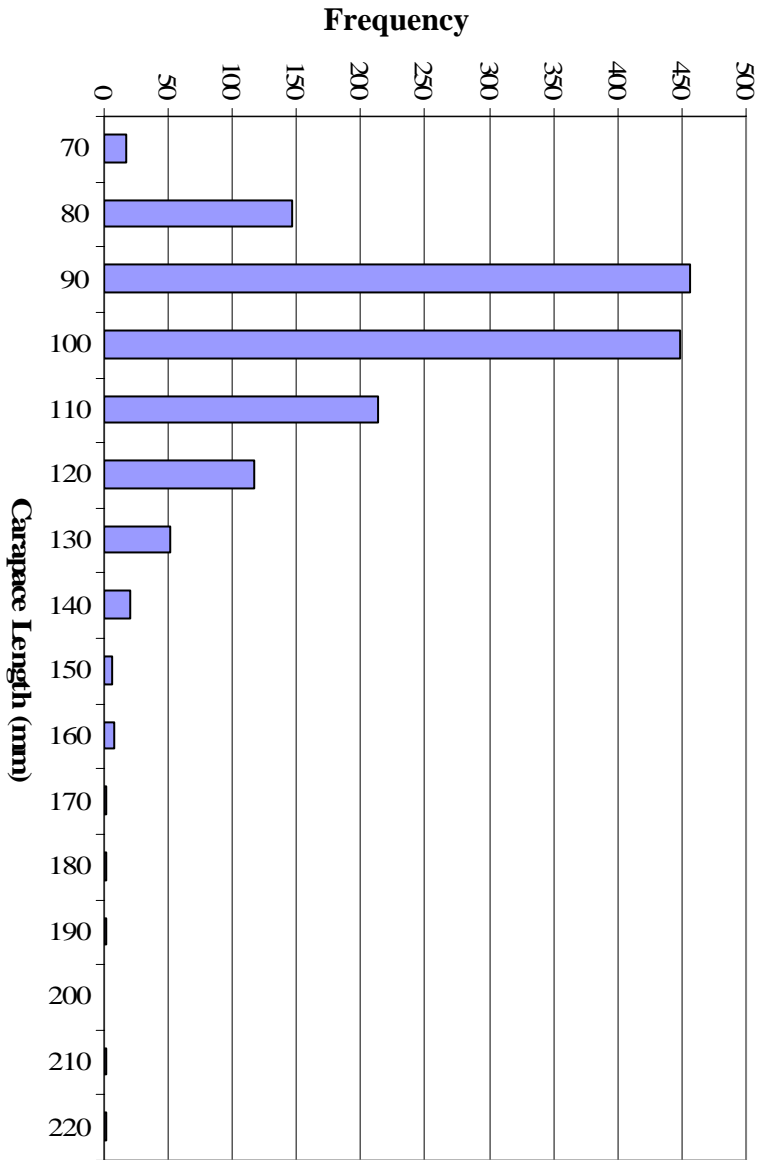
**Figure 7.** Length frequency distribution for spiny lobster males caught in Puerto Rico during 1995 - 2001.



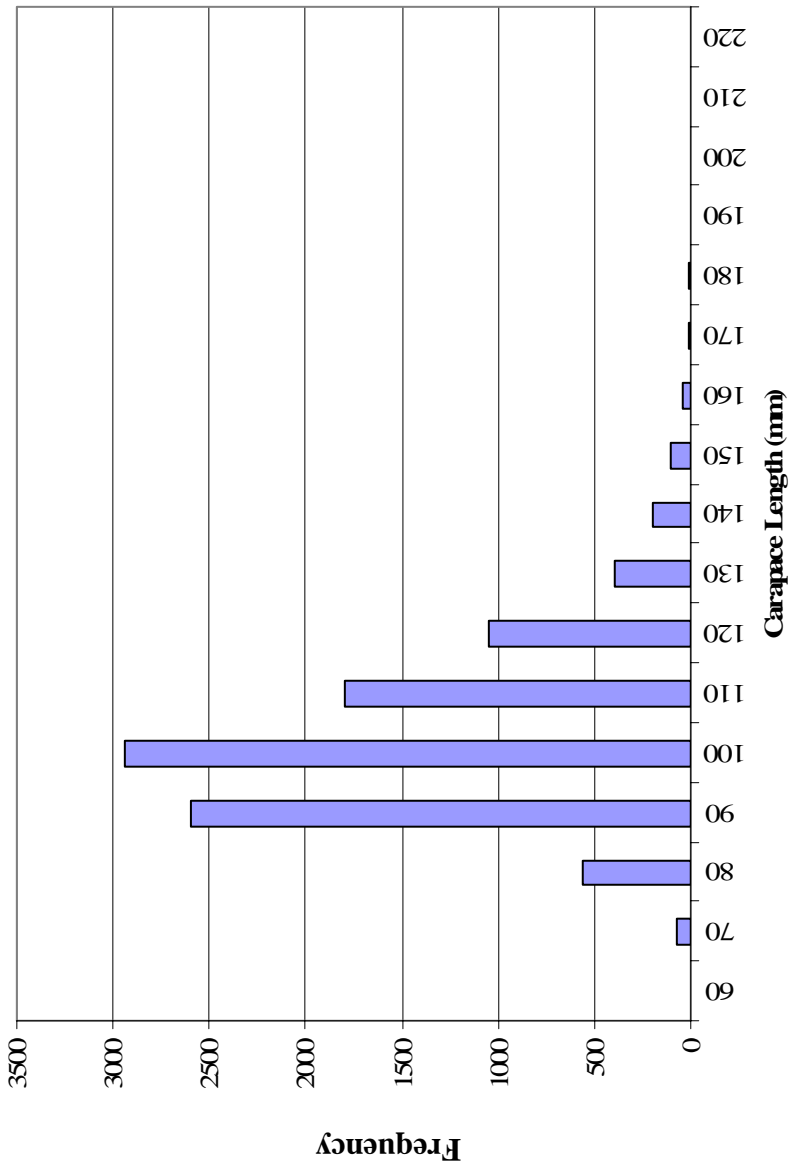
**Figure 8.** Length frequency distribution for spiny lobster females caught in Puerto Rico during 1988 - 1994.



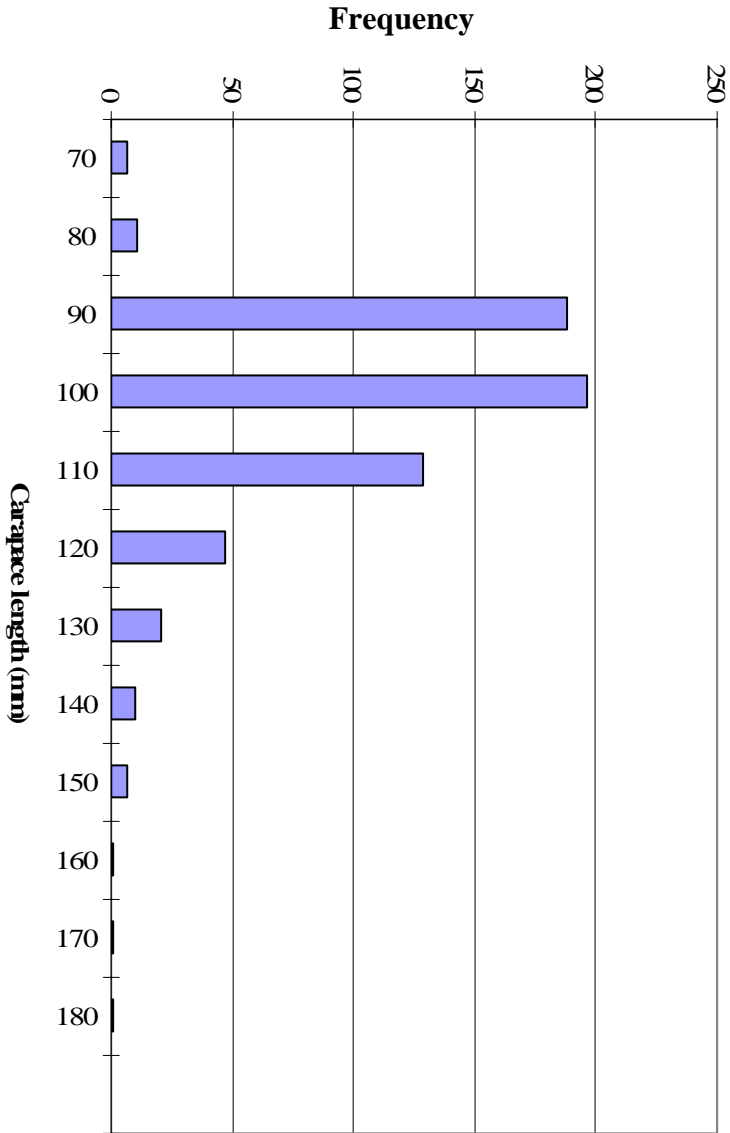
**Figure 9.** Length frequency distribution for spiny lobster females caught in Puerto Rico during 1995 - 2001.



**Figure 10.** Length frequency distribution for spiny lobster caught in Puerto Rico by fish traps during 1988 - 2001.



**Figure 11.** Length frequency distribution for spiny lobster caught in Puerto Rico by SCUBA divers during 1988 - 2001.



**Figure 12.** Length frequency distribution for spiny lobster caught in Puerto Rico by lobster traps during 1988 - 2001.



A total of one-hundred biostatistics interviews were randomly selected to obtain spiny lobster CPUE estimates data analysis. Most of the interviews included reports of spiny lobsters, conch, and other reef fishes. However, the spiny lobster was significant in number of individuals and weight in the landings interviews. CFSP data showed that during 1988 - 1994, the fish traps had an average catch of 48 pounds/trip. During this period, fishing trips had an average of hauling 27.5 fish traps, and the average soak time was 4.6 days. It was estimated that every fish trap caught 0.39 pounds/trap/day. On the other hand, for the period of 1995 - 2001, fish traps showed a landings increase, obtaining an average of 57 pounds/trip. Fishing trips showed an increase in the average of fish traps hauled to 32.0, and the average soak time increased to 5.3 days. For this period, it was estimated that every fish trap caught 0.33 pounds/trap/day. During 1988 - 1994, SCUBA divers' fishing trips had an average of 44 pounds/trip. During this period, fishing trips had an average of 1.7 divers, and the average diving time was 3.6 hours. It was estimated that SCUBA divers caught 7.23 pounds/diver/hour. On the other hand, for the period of 1995 - 2001, SCUBA divers showed a landings increase, obtaining an average of 47 pounds/trip. During this period, reef fishes fishing trips had an average of 1.33 divers per trip, and the average diving time was 4.3 hours. It was estimated that SCUBA divers caught 8.18 pounds/diver/hour.

## DISCUSSION

Puerto Rico's commercial fishery of spiny lobster has shown that market demand for this species continues to make it one of the most important resources during the last 15 years. The data analyzed in this report showed that a high fishing pressure occurred on spiny lobster during 1988 - 2001. The landings data showed increasing landings in spiny lobster during 1995 - 2001. Two facts would explain this increase. First, starting in 1995, more fishers participated in the CFSP (Matos-Caraballo 2002). Second, many fish traps users mentioned to CFSP's principal investigator that due to the profit, they targeted mostly their gear to catch spiny lobster. This fact is supported by the CPUE landings by trip data analysis that shows an increase in the fishing pressure on the spiny lobster for SCUBA divers. Also, fish traps increased the average number of fish traps hauled per trip and the average number of soak days.

SCUBA divers and fish traps were more efficient gears to catch spiny lobster. Due to regional tradition, the lobster trap is used only in three or four south coast municipalities and in the east coast. The trammel net is used to catch spiny lobster during the season of strong wave surges in November-February along the western coast. Fishers mentioned that spiny lobsters migrate together, and trammel nets are able to catch hundreds of pounds of this species in a single day. Unfortunately, a significant part of these catch were not reported to CFSP.

This study shows that the spiny lobsters caught during 1995 - 2001 were significantly larger than during 1988 - 1994, for all individuals, males and females. These results indicate that the spiny lobster fishing regulation enforcement has been working to conserve the resource (Matos-Caraballo,

2001).

LFD data shows that fish traps caught a higher percent of spiny lobster before reach LMS, follow by SCUBA divers and lobster trap. However, after 1995, the catch of individuals before reaching the MLS, decreased for all gears.

Effort by gear data shows an increase in the effort to catch spiny lobster by fish traps and SCUBA divers. Again, these facts reflect an increasing fishing pressure on this resource. The landings, biostatistics, and CPUE data showed that spiny lobsters were subject to high fishing pressure. Although spiny lobster landings decreased occurred from the 1970s to the 1980s, during 1988 - 2001 the landings have been steady (Mateo and Die 2004). Spiny lobsters were caught significantly larger during 1995 - 2001, probably due to the enforcement of the fishing regulations. Due to the high fishing pressure on this resource, it is necessary to continue the enforcement action in order to diminish or eliminate from the landings those individuals that are below the MLS. Also, it is essential to continue the monitoring of the landings, biostatistics, and CPUE data by the CFSP.

#### ACKNOWLEDGEMENT

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