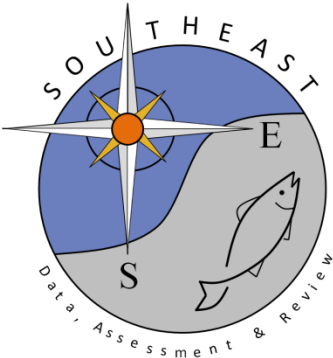


Portrait of the commercial fishery of red hind, *Epinephelus guttatus*, in
Puerto Rico during 1988-2001

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ABSTRACT

The Puerto Rico Department of Natural and Environmental Resources (DNER) is responsible for the conservation and management of 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. During the 1980s, it was observed that the 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).

Groupers (Serranidae) are an important resource in Puerto Rico's commercial fishery. Grouper species share a number of life history characteristics believed to render them particularly vulnerable to human exploitation. Several groupers species in the Caribbean and Western Atlantic are known to aggregate for spawning at specific times and locations. The fishing activity of these resources during their aggregation periods make these groupers very vulnerable to being overexploited.

The red hind, *Epinephelus guttatus*, has become the most important species of grouper taken commercially in Puerto Rico. *E. guttatus* is a protogynous hermaphrodite and forms spawning aggregations. However, this species is also heavily fished during the spawning aggregation. During the last 12 years there are many studies reporting red hind as an overfished species. Since 1995, three spawning aggregation sites of the red hind in the west coast of Puerto Rico have been closed to all fishing activity. The Caribbean Fishery Management Council and the DNER work together to enforce this action.

The objective of this study is to describe the fishery of red hind through the data collected by the CFSP (landings and biostatistics data) during 1988 - 2001. Length frequency distributions (LFD) of this species by years, fish traps, SCUBA diving, and bottom lines were compared.

KEY WORDS: Biostatistics data, commercial fishery, red hind, Puerto Rico

Un Retrato de la Pesquería de *Epinephelus guttatus* 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).

Los meros (Serranidae) son un recurso importante en la pesca comercial de Puerto Rico. Los meros comparten un número de características que los hacen vulnerables a la explotación por el ser humano. Varias especies de mero en el Caribe y el Atlántico Occidental se agregan para aparearse en un tiempo y un lugar específico. La pesca de estos recursos durante periodos de agregación hace muy vulnerables a ser sobre explotados.

La cabrilla, *Epinephelus guttatus*, se ha convertido en la especie de mero más importante capturada comercialmente en Puerto Rico. El mero cabrilla es hermafrodita protógineo y forma agregaciones para aparearse. No obstante esta especie ha sido fuertemente pescada durante las agregaciones para aparearse. Durante los últimos 12 años muchos estudios reportan a *E. guttatus* como una especie sobre pescada. Desde 1995, tres lugares de agregación para aparearse de la cabrilla, en la costa oeste de Puerto Rico, han sido cerrados a toda actividad pesquera. El Consejo de Pesca del Caribe y el DRNA trabajan en conjunto para hacer cumplir esta acción.

El objetivo de este estudio es describir la pesquería de *E. guttatus* utilizando los datos recolectados por el PEP (desembarcos y datos bioestadísticos) durante 1988-2001. Se comparó la distribución de frecuencia de tallas de esta especie por año y arte de pesca (nasa, buceo y línea).

PALABRAS CLAVES: Datos de bioestadísticas, pesca comercial, mero cabrilla, Puerto Rico

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 (in press a and b) mentioned that during the 1980s decade, it was observed that the 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). Species considered in the market as trash during the 1970s, today have been considered a second class market species (Matos-Caraballo in press a and b).

Groupers (Serranidae) are an important resource in the Puerto Rico's commercial fishery. Grouper species share a number of life history characteristics believed to render them particularly vulnerable to human exploitation (Mannoch 1987). Sadovy (1994) mentioned that groupers are carnivores, have relatively long life span, large size of sexual maturation, slow growth, and

appear to be relatively easy to catch, being susceptible to a wide range of sizes and types of fishing gear. Many species of groupers exhibit adult sex change. Several groupers species in the Caribbean and Western Atlantic are known to aggregate for spawning at specific times and locations. The fishing activity of these resources during their aggregation periods make these groupers very vulnerable to overexploitation. The Nassau grouper, *Epinephelus striatus*, was the main grouper species landed in Puerto Rico by commercial fishers from 1900 to the 1970s (Everman 1900, Suárez-Caabro 1970). This species was heavily fished during spawning aggregations resulting in a gradual decrease of landings. Since the mid-1980s, this species has been considered extinct for commercial fishery purposes (Sadovy 1996).

The red hind, *Epinephelus guttatus*, has become the most important species of grouper taken commercially in Puerto Rico, following the decline of *E. striatus* (Matos-Caraballo and Sadovy 1990, Sadovy 1993, Matos Caraballo 1999). Red hind is a protogynous hermaphrodite and forms spawning aggregations. However, this species is also heavily fished during the spawning aggregation. The result of this activity would cause the same fate as that of *E. striatus*. During the last 12 years there are many studies reporting red hind as an overfished species (Appeldorn et al. 1992, Sadovy and Figuerola 1992, Rosario 1996, Matos-Caraballo 2002). *Epinephelus guttatus* forms spawning aggregations around the full moon of December, January, and February. Since 1995, three spawning aggregation sites for *E. guttatus* along the west coast of Puerto Rico have been closed to all fishing activity (Tourmaline Bank, Abrir La Sierra Bank, and Bajo de Sico Bank). The Caribbean Fishery Management Council and the DNER worked together to enforce this action. Matos-Caraballo (2000), discussed how the mentioned regulation significantly improved the red hind population.

The objective of this study is to describe the fishery of red hind through the data collected by the CFSP (landings and biostatistics data) during 1988 - 2001. Length frequency distributions (LFD) of this species by years, fish traps, SCUBA diving, and bottom lines were compared.

METHODS

This report will discuss the red hind fishery using two types of dependent data collected by CFSP thru 1988-2001. First, the landings data were collected by CFSP's port samplers. The commercial fishers and/or fish houses reported their catch using a ticket. Unfortunately, some reports of this species had been reported as groupers or first class fishes.

The second type of data used in this study was biostatistics. That 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 fishes' fork length (FL) in mm. If possible, the entire catch was individually measured and sex was also registered. CFSP's port samplers collected catch per unit effort data (CPUE) when they did the biostatistics sampling. The total landings by trip and by gear, number of traps hauled, and nets length in fathoms were recorded.

Port samplers delivered the landings and biostatistics data to CFSP and statistical clerks edited and entered 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 diving, and bottom line. LFD for both species by years and by gears were analyzed. Kolmogorov-Smirnov Two Sample Test, $p \leq 0.05$ (Sokal and Rohlf, 1981) was used to know if there is any significant difference among the LFD's.

RESULTS

Landings data show that a total of 680,601 pounds of red hind were reported to the CFSP during 1988 - 2001 (Figure 1). During the late 1980s, a process was initiated to educate commercial fishers about reporting red hind landing. This fact explains the significant increase in reported landings during 1988 - 1991. Figure 1 includes the grouper category because many fishers reported red hind in the grouper category; besides red hind was the main grouper caught in Puerto Rico during the time period of this study. The number of pounds reported of red hind represented a 1.7% from the total catch reported during the mentioned period. However, it is known by the CFSP personnel that a significant percentage of the pounds reported as first class fish were also red hind. For this paper, only the red hind data were used. During 1988 - 1994, red hind reported represented 1.7% of the total pounds reported of fish and shellfish. During 1995 - 2001, red hind reported represented a total of 2.0% of the total pounds reported of fish and shellfish. During 1988 - 2001, red hind reported represented 1.9% of fishes. For this period the red hind was

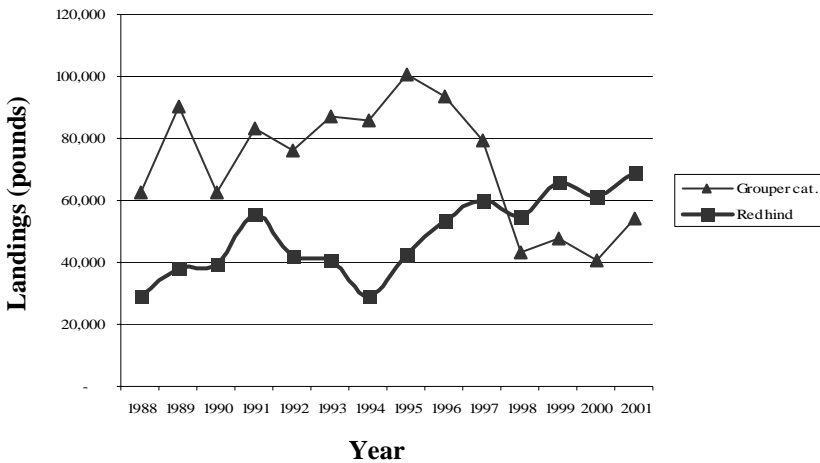


Figure 1. Landings reported of grouper category and red hind in Puerto Rico during 1988 - 2001.

Figure 2 shows the trend of landings reported by fish traps, bottom lines and SCUBA divers during 1988 - 2001. Landings reported by the mentioned gears show that fish traps caught 33% of the 680,601 pounds of red hind reported during 1988 - 2001. For the same period, bottom lines caught 47%, and SCUBA divers caught 14% of the total landed pounds of red hind reported. Figure 2 shows that fish trap landings decreased from those reported from 1995 - 2001. On the other hand, bottom line and SCUBA divers show an increase in landings reported during 1995 - 2001. Biostatistical data show that from 1988 - 2001, a total of 8,861 individuals of red hind were measured by CFSP's port samplers. Red hind measured during 1988 - 1994, had a FL mean of 306.5 mm (Figure 3) and during 1995 - 2001 was 318.5 mm (Figure 4). Kolmogorov-Smirnov Test shows a significant difference in the LFD among both periods of time ($D_{max} = 0.0981$).

The mean FL for red hind caught by fish traps during 1988 - 2001 was 291 mm (Figure 5). For the same period red, hind caught by hook and line had a mean FL of 313 mm (Figure 6). Kolmogorov-Smirnov Test shows a significant difference in the red hind LFD among fish traps and hook and line during 1988 - 2001 ($D_{max} = 0.1321$). The mean FL for red hind caught by SCUBA divers during 1988 - 2001 was 336 mm (Figure 7). Kolmogorov-Smirnov Test shows a significant difference in the red hind LFD among hook and line and SCUBA divers during 1988 - 2001 ($D_{max} = 0.1163$).

A total of one-hundred biostatistics interviews were randomly selected to obtain red hind CPUE estimates for data analysis. All interviews include reports of red hind and other reef fishes. However, the red hind was significant in number of individuals and weight in the catch composition. CFSP data show that during 1988 - 1994, the fish traps had an average catch of 62.8 pounds/trip. During this period, fishing trips had an average of hauling 28.5 fish traps and the average soak time was 5.6 days. It was estimated that every fish trap caught 0.40 pounds/day. On the other hand, for the period of 1995 - 2001, fish traps show a landings increase, averaging 78.7 pounds/trip. During this period, fish traps fishing trips had an average of hauling 41.4 fish traps and the average soak time was 5.4 days. It was estimated that every fish trap caught 0.37 pound/days. Bottom lines CFSP data show that during 1988 - 1994, had an average catch of 44.2 pounds/trip. During this period of time fishing trips had an average of 6.5 hooks, and the average fishing time was 8.5 hours. It was estimated that bottom lines caught 0.80 pounds/hook/hour. On the other hand, for the period of 1995 - 2001, landings from bottom lines increased, obtaining an average of 64.8 pounds/trip. During this period, reef fishes fishing trips had an average of 7.0 hooks/trip and the average fishing time was 9.5 hours. It was estimated that bottom lines catch 0.97 pound/hook/hour. CFSP SCUBA divers data shows that during 1988 - 1994, had an average catch of 31.4 pounds/trip. During this period, fishing trips had an average of 1.8 divers with an average fishing time of 3.9 hours. It was estimated that a diver caught 8.1 pound/hour. On the other hand, for the period of 1995 - 2001, SCUBA divers shows a landings increase, obtaining an average of 44.7 pounds/trip. During this period, reef fishes fishing trips had an average of 1.37 SCUBA divers per trip, and the average fishing time was 3.5 hours. It was estimated that SCUBA divers caught 12.8 pounds/hour.

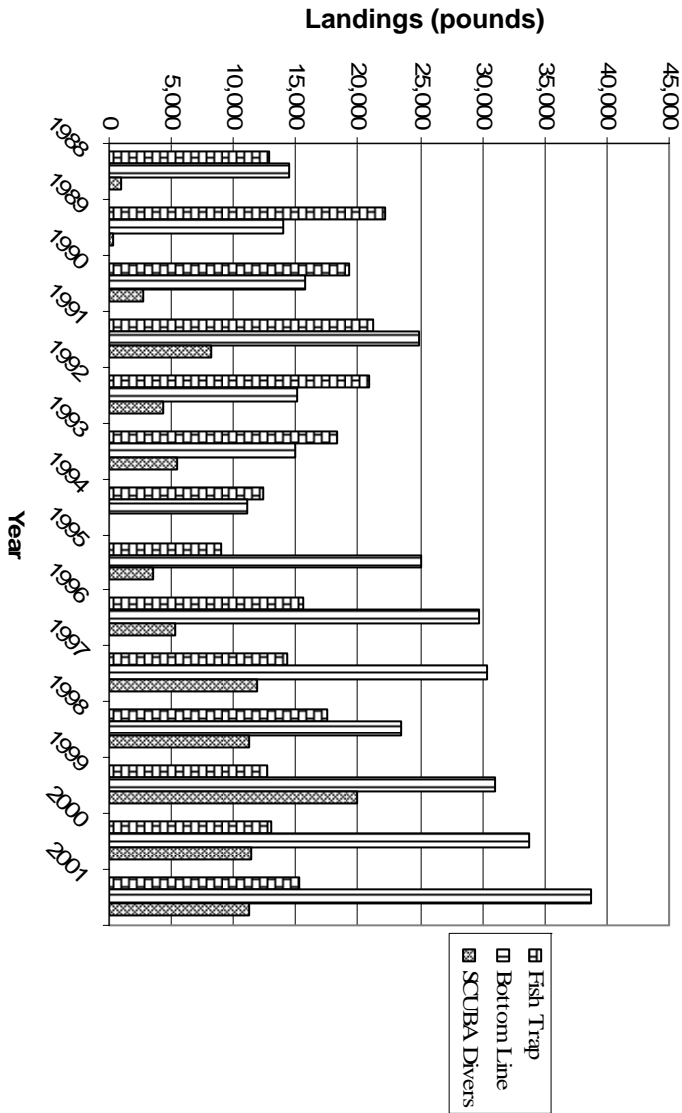


Figure 2. Landings reported of red hind by fish trap, bottom line and SCUBA divers in Puerto Rico during 1988 - 2001.

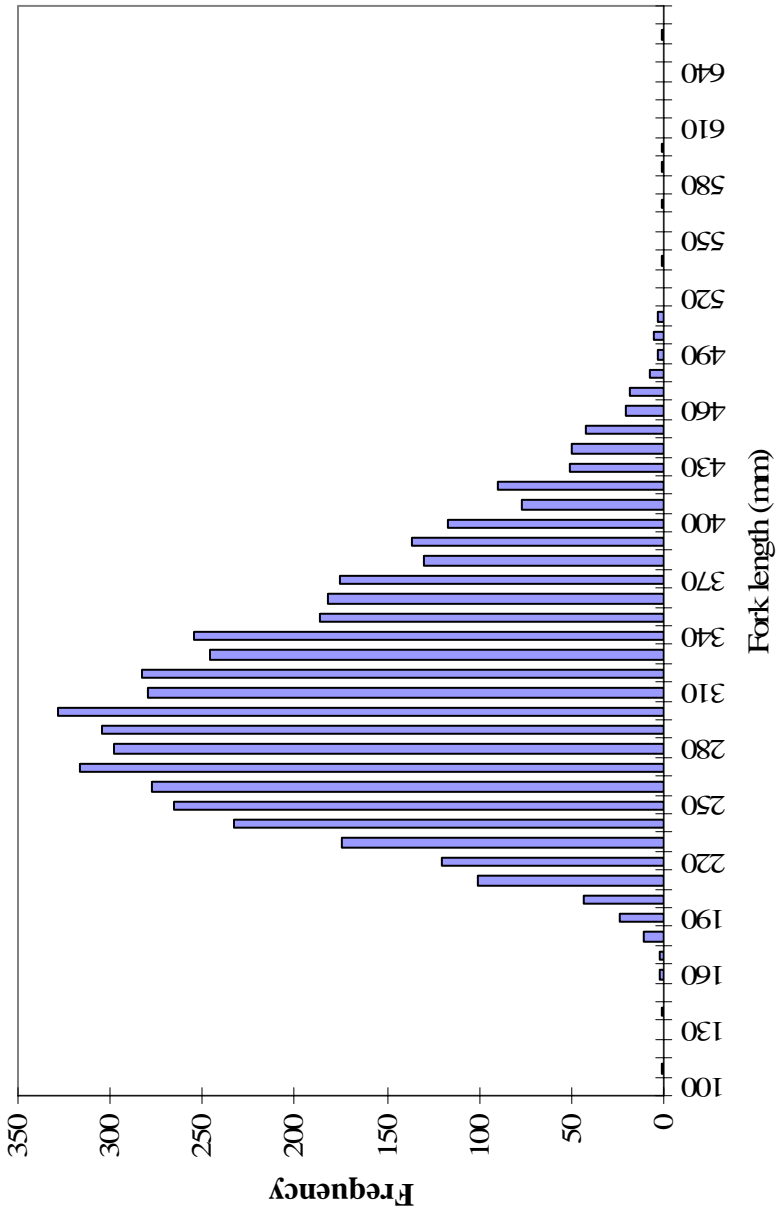


Figure 3. Length frequency distribution for red hind caught in Puerto Rico during 1988 - 1994.

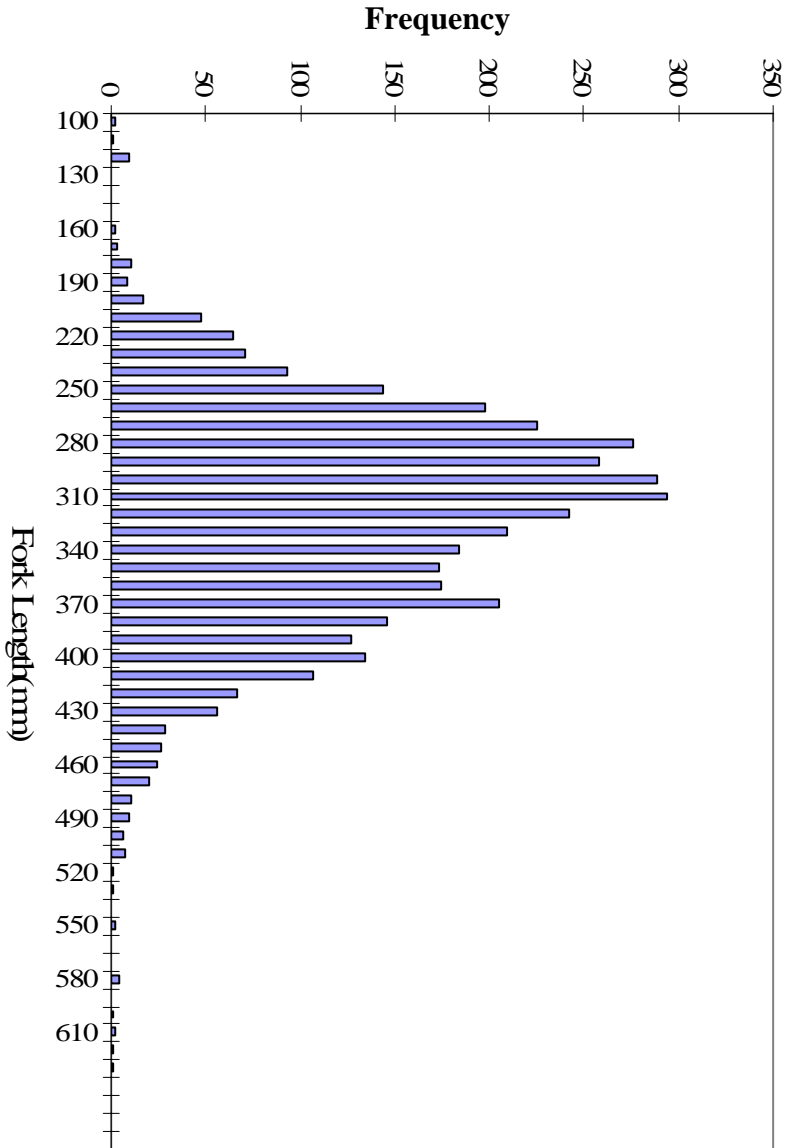


Figure 4. Length frequency distribution for red hind caught in Puerto Rico during 1995 - 2001.

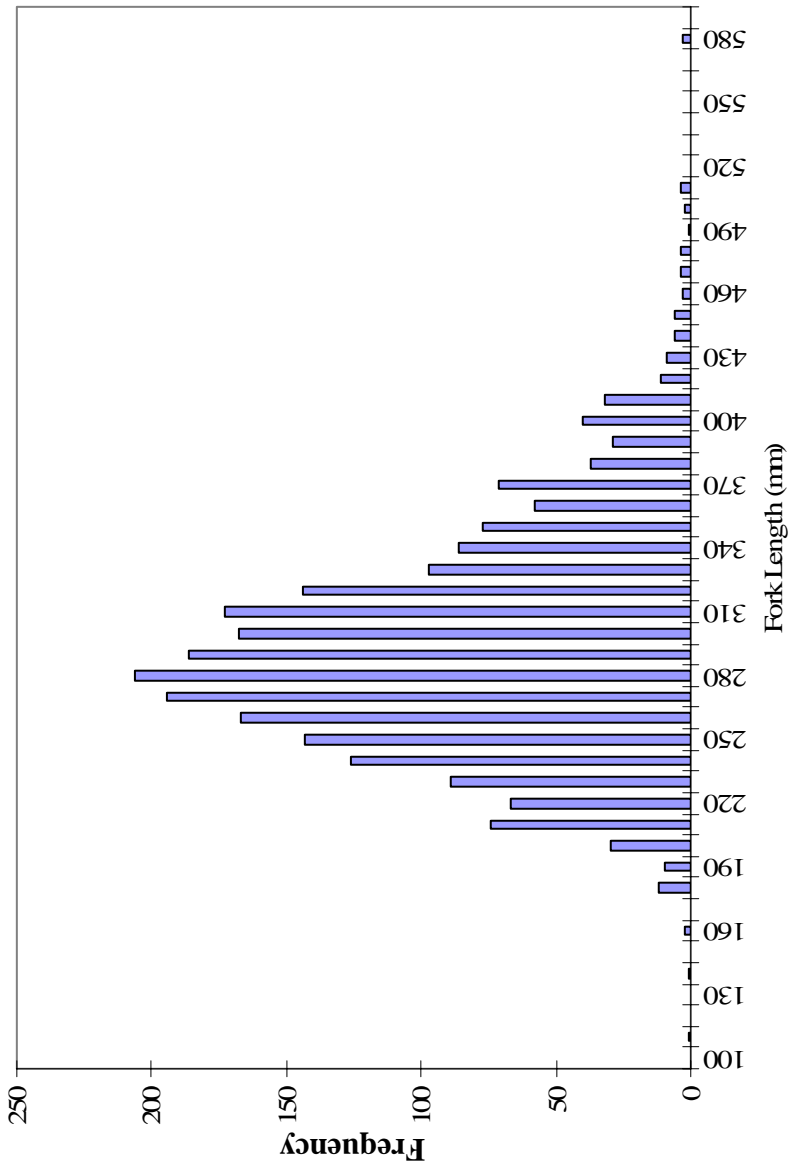


Figure 5. Length frequency distribution for red hind caught in Puerto Rico by fish trap during 1988 - 2001.

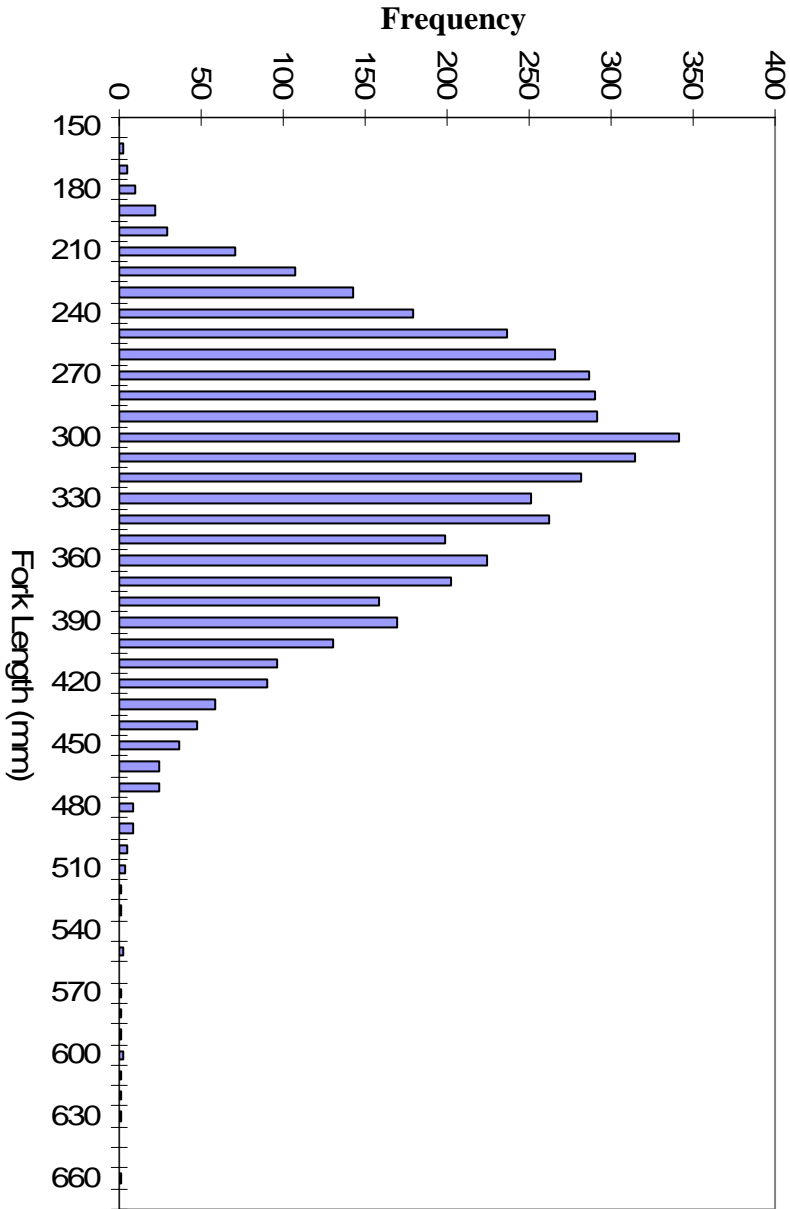


Figure 6. Length frequency distribution for red hind caught in Puerto Rico by bottom line during 1988 - 2001.

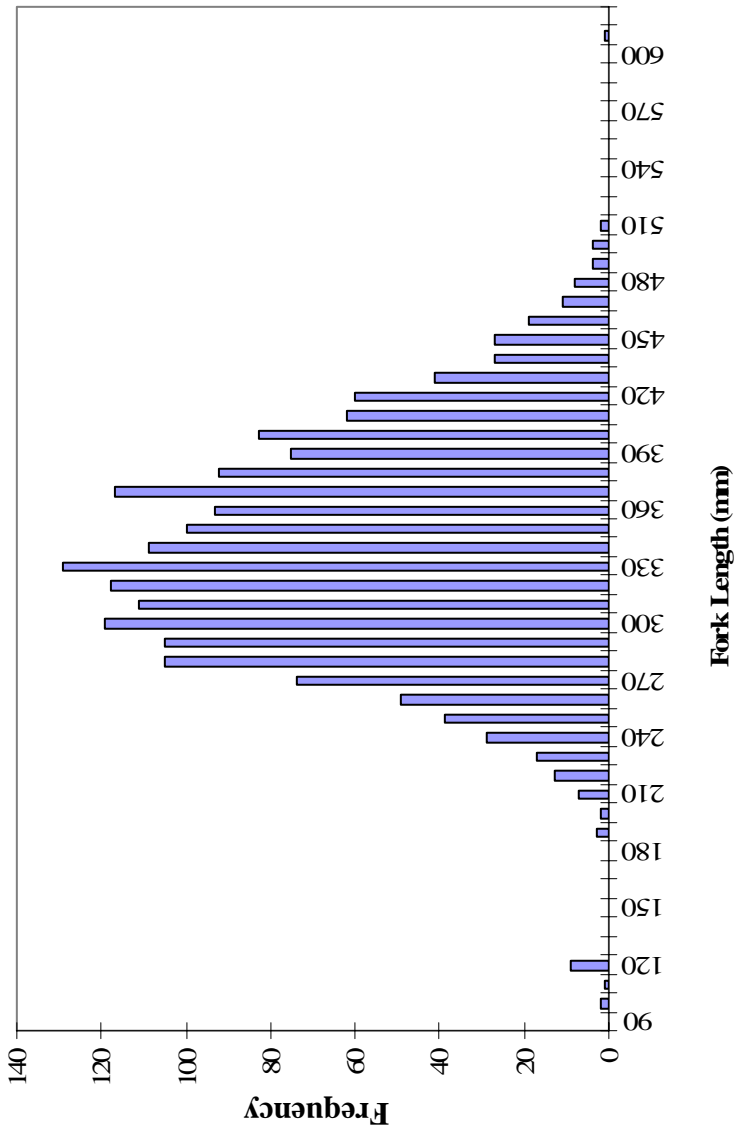


Figure 7. Length frequency distribution for red hind caught in Puerto Rico by SCUBA divers during 1988 - 2001.

DISCUSSION

Puerto Rico's commercial fishery of red hind has shown that marketing and demand for this species continues to be one of the most important during the last 15 years. The data analyzed in this report show that a high fishing pressure occurred on red hind during 1988 - 2001. The landings data show an increasing trend in landings for red hind during 1995-2001. However, before 1987, red hind was reported in the grouper category. It is assumed that during 1988 - 1989, most fishers probably still reported red hind in the grouper category. Beginning in 1995, three red hind spawning aggregation areas were closed in Puerto Rico's west coast. Matos-Caraballo (2002) mentioned that during 1995 - 1998, increased landings of red hind were reported, also larger individuals were caught compared to 1992 - 1994. The CPUE data also confirms the increase in the fishery pressure for red hind. Bottom lines are the most efficient gear for catching red hind (47%), followed by fish traps (33%) and SCUBA divers (14%). However, fish traps landings decreased during 1989 - 1995, and during this time a decrease in fish traps gear was also observed (Matos-Caraballo 2005). Also it is interesting to observe that the Puerto Rico's Fishery Census 2002 shows an increase in bottom line gears and SCUBA divers in Puerto Rico's commercial fishery (Matos-Caraballo 2005).

Matos-Caraballo (2002) mentioned that individuals of red hind were significantly larger in their LFD for 1988 than for 1992. In this study, the red hind caught were larger during 1995 - 2001 than 1988 - 1994. It is very probable that the closed areas to protect the spawning aggregations in the west coast help to improve the fishery resource (Matos 1999, 2002). The DNER fishing regulation established a closed season for red hind during December 1st to February 28th of every year. This closed season will help to improve the fishery population of red hind.

Sadovy and Figuerola (1992) reported that red hind has a minimum size of sexual maturation (MSSM) of 215 mm FL. The data analysis shows that only 2% of red hind were caught before reaching the MSSM during 1988 - 2001. Biostatistics data shows that 5% of red hind caught by fish traps were caught before they reached MSSM during 1988 - 2001. In contrast, the bottom lines caught only 2.6% of red hind before reaching the MSSM and 0.3% for SCUBA divers. This evidence suggests that the juvenile mortality for this species is very low. However, it is necessary to mention the need for bycatch data for these gears.

The landings data and biostatistics data presented in this study show that red hind can be considered as an overfished resource when it is compared with the 1970s data (Sadovy and Figuerola 1992). However, the data presented during 1988 - 2001, show that red hind populations have not changed significantly. Due to the fact that red hind it is a very important component of Puerto Rico's commercial fishery and also is a fragile species because it is a protogynous hermaphrodite species, the CFSP must continue monitoring this species.

The average number of fish traps increased from 28.5 in 1988 - 1994 to 41.4 in 1995 - 2001. Bottom lines also showed an increase in the number from 1988 - 1994 (6.5 hooks) to 1995 - 2001 (7.0 hooks). Also, an average one hour

increase from the same two periods 8.5 hours to 9.5 hours. The CPUE increased from 1988 - 1994 to 1995 - 2001. Again, it is probable that the closed spawning aggregation on the west coast helped the red hind population to recover from fishing pressure.

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