The Commercial Yellowtail Snapper fishery off Puerto Rico, 1983-2003

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ABSTRACT

The commercial yellowtail snapper, *Ocyurus chrysurus,* fishery off Puerto Rico is discussed. Commercial landings of yellowtail snapper ranged from 77,000 pounds to 363,000 pounds from 1983 - 2003. Landings peaked in 2000. Both observed and GLM standardized CPUE showed an unvarying trend over the study period. Temporal and spatial trends in landings are presented and changes in the multi-species multi-gear nature of the reef fish fishery off Puerto Rico are discussed.

KEY WORDS: Yellowtail snapper, commercial fishery, catch per unit of effort, Puerto Rico

Las Pesquerías Comerciales de la Rabirrubia en Puerto Rico entre 1983-2003

Se discuten las pesquerías comerciales de la Rabirrubia *Ocyurus chrysurus*, presentándose estadísticas de capturas de los desembarcos anuales y capturas por unidad de esfuerzo estandarizadas. Se muestran las tendencias temporales y espaciales de la pesquería, así como el análisis de los cambios en una pesquería multiespecífica, donde se usan diferentes artes de pesca como lo es la pesquería de peces de arrecifes en Puesto Rico

PALABRAS CLAVES: *Ocyurus chrysurus*, las pesquerías comerciales

INTRODUCTION

The yellowtail snapper, *Ocyurus chrysurus* (Bloch 1791), is a common reef fish species found extensively throughout the tropical and subtropical western Atlantic shelf and coastal waters. Because of the excellent taste and common occurrence, this species is highly sought after by recreational and commercial fishers off the southeastern U.S. (Florida), Cuba, and in the Caribbean (Piedra 1969, Johnson 1983, Manooch and Drennon 1987). In the western Caribbean, especially off Puerto Rico and the U.S. Virgin Islands, yellowtail snapper comprises a major component of the commercial fishery landings along with lane, mutton, and silk snapper (Matos-Caraballo 2000). The rarity of parasites, common in many marine food fishes, makes this species very desirable among consumers (Collins 1984).

The focus of this report is to provide information on the commercial yellowtail snapper fisheries off Puerto Rico. Data on commercial landings and catch per unit of effort (CPUE) are needed by managers to evaluate the condition of the population. Matos-Caraballo (2002) emphasized the need to evaluate whether over fishing was occurring in the fish stocks off Puerto Rico given the recent observed changes in the commercial fishery during the 1990s. The yellowtail snapper has historically been an important component of the Puerto Rico commercial landings, on average contributing about 5% of the total combined shellfish and finfish landings by weight and about 10% of the annual landings of reef fish (Matos-Caraballo 2004, 2002, 2001, 1998). Detailed information on historical levels of recreational landings is not presented in this report, however it is believed that this species is frequently sought after by many recreational anglers.

FISHERY BACKGROUND

Fishing is known to have occurred off Puerto Rico since the late 1800's. Prior to the early 1900's fishing activities off Puerto Rico are thought to have been mainly for subsistence reasons (Wilcox 1899, 1900). Written accounts indicate commercial fishing was being carried out since around 1930 (see Wilcox 1899, 1900, Jarvis 1932, Matos-Caraballo 2003a). Jarvis (1932) described the 1931 survey conducted by the U.S. Department of Commerce, Bureau of Fisheries to document marketing and economic aspects of the commercial fisheries off Puerto Rico. Between 1941 and 1958, the Puerto Rico Department of Agriculture initiated a program to improve commercial fishing practices through exploratory fishing, development of new gears and fisher training,, conducting marketing and processing studies, and establishing fishery equipment centers. Between 1967 and 1972 the United States Department of the Interior and the Department of Agriculture, Commonwealth of Puerto Rico carried out a project entitled "Exploratory Fishing, Gear Tests and Demonstration" in the coastal waters of Puerto Rico and adjacent islands of Culebra and Vieques. The focus of the exploratory surveys was:

i) To determine and identify potential fishing grounds having commercial concentrations,
ii) Test and demonstrate improved fishing gear (e.g., larger steel frame pots and floats of 25-30 pounds buoyancy to compensate for the strong currents) and vessels (modified Florida lobster boat with davits for pot hauling), and
iii) To evaluate the potential of fishing beyond 40 m (Juhl 1972).

Prior to this time, the majority of commercial fishing was done in the near shore coastal areas. From 1972-1975, a program entitled the "Commercial Fisheries Survey and Development Project" carried out further commercial fisheries investigations. The primary focus of the latter project included:

i) Continued evaluation of the feasibility of commercial fishing beyond 40 m,
ii) Further test fishing of deep water pots, and
Iii) Evaluating the efficiency of the Antillean fish trap (Cole 1976).

Puerto Rico's commercial fisheries have been monitored only since 1967 by the Puerto Rico Department of Natural and Environmental Resources (DNER) Fisheries Research Laboratory (FRL), Fisheries Statistics Project (FSP). This program provides quantitative data on the fishery resources in the territorial sea of the commonwealth of Puerto Rico and contiguous federal fishery conservation zone waters (Matos-Caraballo 1997). The collection of detailed information on the health of the marine resources off Puerto Rico is required for proper long term management.

Recent studies of the commercial fisheries off Puerto Rico have raised concern as to the condition of several species or species groups commonly reported in these fisheries including several snappers and groupers. Declining landings from pots off Puerto Rico (Matos-Caraballo and Sadovy 1990, and 1991, Matos-Caraballo 1992, 1993, 1995, 1997, 2002) and increasing landings from hand lines, gill nets, and diver operations have been reported (Matos-Caraballo, 2002 and Collazo and Calderon 1988). Matos-Caraballo (2002) also reported declines in total landings from the west coast of Puerto Rico and, for the first time since 1972 a trend of increasing landings from the south coast of Puerto Rico.

MATERIALS AND METHODS

Reported Commercial Landings and Economic Value

Statistics for Puerto Rico's commercial fisheries were collected by the Puerto Rico DNER, FRL, FSP since 1967. Prior to the FSP program that began in 1967, annual landings were estimated by port agents who visited the fishing port. Port samplers visited the 42 coastal municipalities including, the islands of Vieques and Culebra and the 88 identified fishing centers and collected landings data from voluntary fishers, fish buyers and fishing associations (Figure 1). Usually information was recorded on landings sales records (referred to as fish tickets); each ticket included data on: fishing date, name of buyer, fisherman and/or helper, municipality of sale, fishing center landing area, number of trips, gear used, amount of time expended fishing (hours usually), weight in pounds by species sold, and price per pound. On some trips, information was also recorded on the maximum and minimum depth of fishing and also the fishing area was identified. Fish were usually landed in the round (not gutted) except deepwater snappers and large groupers that were gilled and gutted. Prior to about 1970, landings were categorized as one of four classes of fish (first, second, third and "trash"). Although landings data were collected by species since about 1970, computerized data existed for use in this report for only 1983 - 2003. In addition, because the reporting of landings by fishers and/or associations was voluntary during this period, not all landings were always reported as sometimes fisher cooperation was not 100%. Cummings and Matos-Caraballo (2003) reported that over the period, cooperation ranged from 51% -86%.

The landings data were entered into a database using Microsoft FoxPro and DBASE III+ computer software and checked for errors against the original sales tickets. A copy of the database was obtained by the author from the Puerto Rico, DNER, FRL, FSP and the landings data analyzed using Fortran and SAS Computer Software.

Figure 1. Puerto Rico fishing center locations used by the Puerto Rico, DNER, CSP, FSP in data recording. [Landing site location, GIS shape file, compliments of Holly Stone, NMFS, SEFSC, Economics Division].

The economic value, measured in U.S. dollars ($), of yellowtail snapper sold by year, month, and gear was calculated using the reported fish tickets for 1983 - 2003. The average value of yellowtail snapper sales measured as dollars per pound (US) was calculated by year and by fishery.

Catch Per Unit of Effort

CPUE of yellowtail snapper landed and sold in Puerto Rico was examined using the individual fish tickets recorded by the fishers and/or fishing associations. Matos-Caraballo (2002) presented CPUE information for 1998 - 2001, using sub-sampling of the raw data by month, including only sales records that clearly indicated representing a single trip. For this report two types of calculations of CPUE were made, Nominal unadjusted CPUE and Standardized CPUE. For both sets of CPUE calculations the complete set of landings sales records for yellowtail snapper was used.

Nominal CPUE — First, a dataset was constructed containing only observations where the 'number of trips' variable was recorded as 'ntrips' = 1 and a second data set was constructed of the sales records in which the 'ntrips' data variable was recorded as 'ntrips ≤ 7'. It seemed logical to assume that fishers would not retain more than a week of catch to be later sold and still receive a reasonable price per pound. A third data set was formed of all the observations disregarding the 'ntrips' variable as a data selection criterion. The unit of effort was a trip. CPUE for each sale was computed as total pounds divided by the total number of trips. For each CPUE observation data set ('ntrips' = 1,'ntrips' ≤ 7, all trips) nominal unadjusted CPUE was calculated for each year in the data, 1983 - 2003, combining the data across all possible classifications of municipalities of sale (i.e., gears used, month of sale, municipality of sale, and fisherman id). Next, nominal CPUE was computed by year for each major fishing gear used to capture yellowtail snapper (hook and line, pot, net, seines and other) again for each data set ('ntrips' = 1, 'ntrips' ≤ 7, all trips).

Standardized CPUE — General linear modeling (GLM) methods (Robson 1966) were used to calculate abundance indices adjusted for the variation in CPUE traditionally believed to be affect CPUE (i.e., area of fishing, time of year, geographical region). Three data sets were constructed using similar logic for treating the 'ntrips' data variable as done above for nominal CPUE. The first set contained only observations where the 'ntrips' data variable was recorded as 'ntrips' = 1. A second data set was formed by only including CPUE observations from sales where 'ntrips' was recorded as 'ntrips' ≤ 7. A third data set of all the yellowtail snapper CPUE observations was also formed. For each data set a GLM model was fit which contained auxiliary terms for: year, month of sale, municipality as a proxy for general area of catch, and gear used in the capture. The model fit was:

$$\ln CPUE_i = B_i + E_i$$

where, $CPUE_i$ = pounds landed / number of trips and , B is a log transformed function of the independent variables (month, gear type, municipality) included in the model and the E_i's are the errors within each class variable (i.e. year, month, gear).

RESULTS

Commercial Landings of Yellowtail Snapper

Individual fisher reported observations of reported commercial sales (landings) of yellowtail snapper in Puerto Rico were available for 1983 through 2003. Total reported landings varied from 77,232 pounds (1988) to 363,037 pounds (2000) (Figures 2). The number of individual fisher sales (fish tickets) of yellowtail snapper varied over the 21 year period from 2,024 (1984) sales to 7,694 (2001)

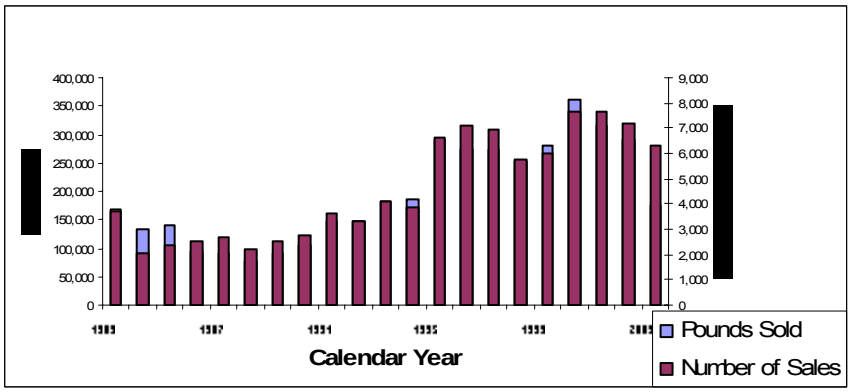

Figure 2. Total Reported Pounds of Yellowtail Snapper sold annually in Puerto Rico, 1983-2003 (unadjusted for under-reporting) and Number of Individual Sales (fish tickets).

sales (Figure 2). Peak years of landings of yellowtail snapper and the number of individual fisher sales were 2000 and 2001 respectively (Figure 2). These data suggest an increasing trend of fisher sales of yellowtail snapper pounds in Puerto Rico from 1984 continuing through 1995 (Figures 2). From 1995 through 2000, fisher sales of this species varied without trend. After 2000, the data do not reveal a strong declining or increasing trend in yellowtail snapper fisher sales through 2002. The 2003 data are considered preliminary in all subsequent discussions. \

Trends in Commercial Sales by Major Gear Category

The landings reports indicate that yellowtail snapper were caught mainly using lines (e.g., rod and reel, hand line, bottom line, silk haul) or were caught mainly with pots (Figure 3). Lines contributed from about 50% to 85% by weight of the total annual sales of this species from 1983 - 2003 (Figure 3). On average, the percentage by weight that pots contributed ranged from about 8% to 30% (Figure 3). The annual percentage contribution of yellow-tail sales by pot gear declined from 1983 to 1992 and remained stable thereafter as did total landings (Figures 2 and 3). Other gears that fishers reported using to catch yellowtail snapper off Puerto Rico were: cast nets, seines, vertical lines, and diving (scuba, skin diving, spear) however on average these gears contributed less than ten percent of the annual total weight landed of yellowtail snapper. Seines, followed by nets of various types were the main gears in the "minor" gears involved in capture of this species.

Temporal Trends of Commercial Sales

Sales of yellowtail snapper in Puerto Rico by month ranged from about 7 to 11% in general not revealing any strong seasonality across the entire period from 1983 through 2003 (Figure 4). For some years, a small increase in sales was evident around February-March and also around August and September however this was not consistently observed in all years (Figure 4). Some researchers have reported increases in observations of ripe fishes during this same time. These type observations were reported on in more detail in the review of the biology of this species by Cummings (2004).

Spatial Trends in Yellowtail SnapperLandings

The tabled summary data were organized beginning from the most northeast located municipality (Isabela) moving eastward along the north coast to the municipality of Ceiba, then along the east coast of Puerto Rico to Humaco off the southeast coast, then southwest to Cabo Rojo and finally to the last municipality at the northwest coast of Aquadilla (Figure 1). In this study, municipality was considered as a very general proxy for approximate fishing location.

The 21 year time series of fisher sales statistics from 1983 - 2003, indicates that yellowtail snapper have been caught and landed in all of the major island municipalities in Puerto Rico in nearly all years (Table 1). Historically, only six of the municipalities have contributed five percent or more of the landings over all years and the remaining municipalities on average contributed about 1 - 2% of the annual sales (Table 1). The major fishing centers were located in the municipalities of San Juan (northeast),

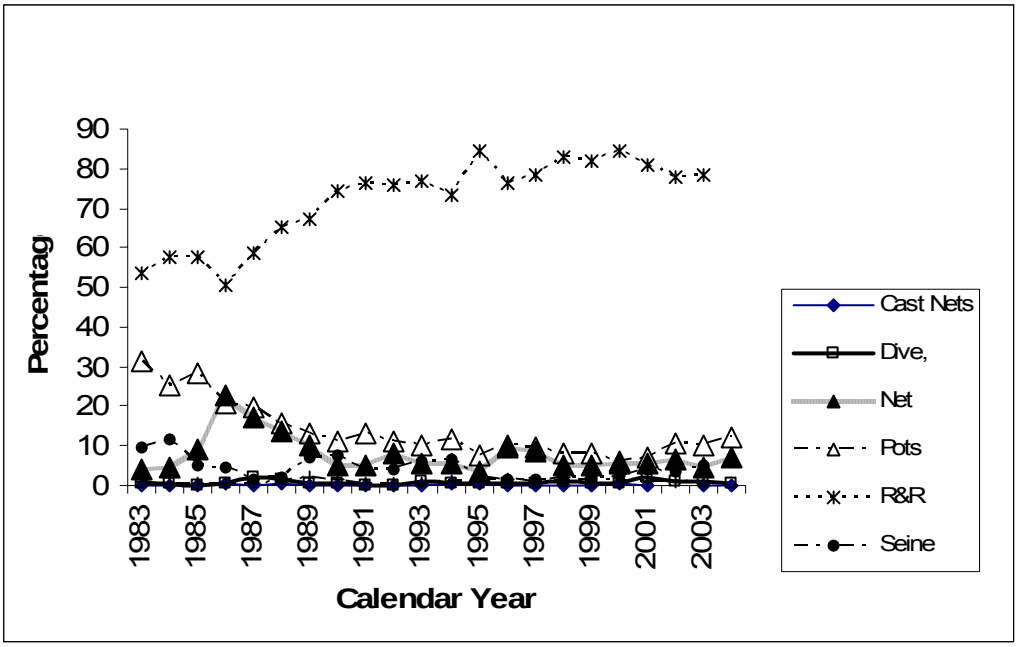

Figure 3. Total Reported Pounds of Yellowtail Snapper sold in Puerto Rico, 1983 - 2003 by gear category (unadjusted for under-reporting).

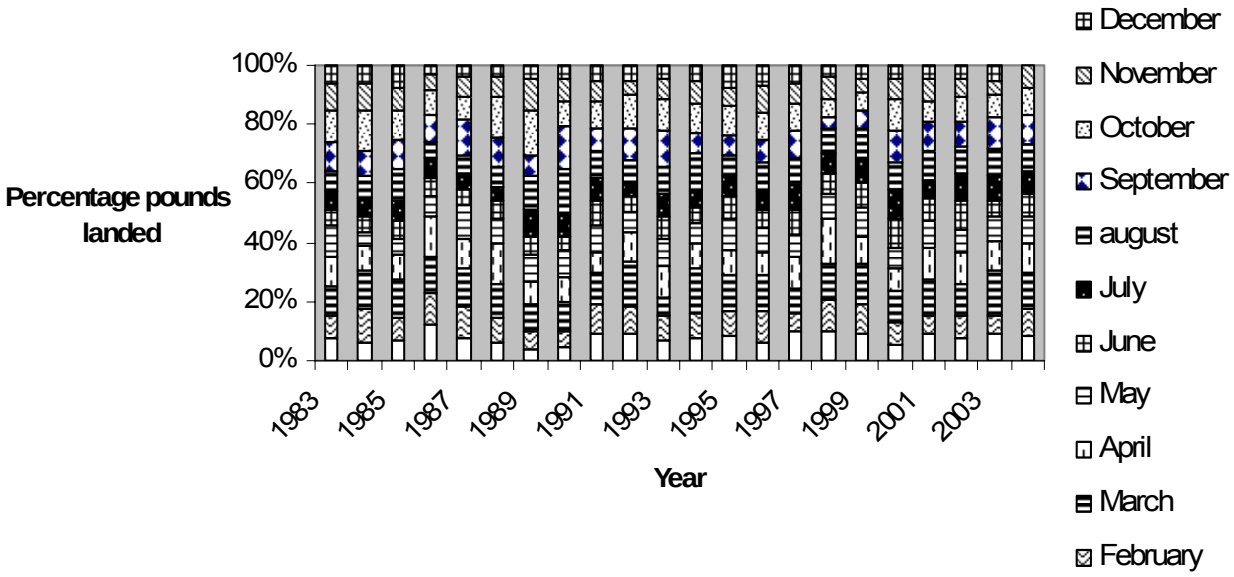

Figure 4. Total Reported Pounds of Yellowtail Snapper sold in Puerto Rico, 1983 - 2003 by month.

Fajardo and Humacao (east and southeast coast) and in Guanica, Cabo Rojo, and Mayaguez) off the southwest and west coasts of Puerto Rico (see Figure 1). Of these six municipalities, those from the northeast and east coast (San Juan, Fajardo), and the southwest coast (Guanica) contributed more than 10% of the long term landings. The municipality of Cabo Rojo showed a decline in sales of yellowtail from a steady 20% in 1983 to about 5% in 1993, that trend not varying since then. Similarly the municipality of San Juan in the northeast contributed about 20% annually from 1983 - 1990 declining thereafter to about 10% of the annual yellowtail sales. Trend comparisons are made here in reference to the "All Years Combined" column of Table 1.

There were a few noteworthy differences when the data were partitioned by gear. Sales of yellowtail snapper from lines (rod and reel gear) were mainly from four municipalities representing three regions of the coasts. These were the San Juan district on the northeast, Fajardo on the east coast, and Guanica and Mayaguez on the southwest coast. The remaining municipalities contributed 3% or less, usually to the total annual sales of yellowtail snapper by lines. Yellowtail snapper were caught by pots and sold in numerous municipalities within these same regions (northeast, east, southeast and southwest coast). In general there were many municipalities which contribute 3-5% or more of the annual pot landings of yellowtail snapper. Sales from pots also showed more inter-year variability than did sales of yellowtail from lines. As noted, above trend comparisons across municipalities mainly refer to the 'All Years' column.

Value of Yellowtail Snapper Sold in Puerto Rico

The reported total value of the landings and sales of yellowtail snapper from all gears ranged from $ 119,351 in 1988 to $ 699,582 in 2000 (Figure 5). The reported value is considered an under estimate of the actual value of this fishery because of under-reporting by fishers. The percentage of cooperating fisheres is believed to have ranged from 51% - 86% over the 21 year period, 1983-2003 (Cummings and Matos-Caraballo 2003b, Matos-Caraballo 2004). The average price per pound of yellowtail snapper caught and sold in Puerto Rico by all gears varied from $1.26 per pound (1983) to $2.20 per pound (2002) over the period (Figure 6). In general, total annual revenue of yellowtail snapper in Puerto Rico has increased along with increases in landings and increases in price per pound particularly between 1984 and 2000 (Figures 2 and 5). Yellowtail snapper caught by rod and reel gear received a higher price per pound than fish caught in pots or other gears (Figure 6). Yellowtail snapper caught by rod and reel gear ranged in value from $1.45 per pound (1983) to $2.25 per pound (2003). Yellowtail snapper landed from pot gear received an average of $1.05 per pound to $2.25 per pound over the study period. As observed in total landings, line gear and pots contributed most to the total value of yellowtail snapper sold. The average reported price per pound of yellowtail landed in cast nets showed large variation over the 21 year period, ranging from about $1.10 per pound (1984) to $2.42 per pound. It was not possible to determine the validity of these prices nor the accuracy of the gear recorded for these sales records for this report. Since the primary 'major' gears involved in the yellowtail snapper landings are lines and pots and the primary 'minor' gears are nets, followed by seines, total value and price variation for these gears should be given most attention (Figure 7).

Table 1. Percentage of commercial sales of yellowtail snapper, *Ocyurus chrysurus,* sold in Puerto Rico from 1983-2003 by major municipality of sale. All gears combined. 2003 considered preliminary.

	Year																					
Center	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**All**
Isabela	0.3	0.2	0.3	0.1		0	0.2	0.2	0.3	0.4	0.6	0.3	0.5	0.4	0.5	0.3	0.1	0	0.1	0.5	0.1	0.3
Camuy	0.3	0.4	0.4	0.6	0.1	0.2	0.1		0.1	0.3			0.1	0.1	0.5	1.5	0.6	0.4	0.3	0.3	0.2	0.3
Hatillo	0.7	1.1	1.3	0.3	0.8	1.2	1.5	0.4		0.5	0.5	0.4	0.4	0.5	0.8	0.2	0.5	0	0.1	0	0.1	0.4
Arecibo			0				0.1	0.3	0.1	0	0.1	0.5	0	0.5	0.8	0.5	0.3	0.6	1.3	0.6	0.6	0.4
Barcelo-neta	1.7	1.3	0.4	1	0.3		1.2	0.6	1.1	0.3	0.4	0.7	0.4	0.1	0.5	0.5	0.2	0.3	0.7	0.1	0.3	0.5
Manati	0	0	0	0.2				0	0.1	0.1	0.1	0.1	0.3	0	0.2	0.3	0.2	0.1	0.2	0.2	0	0.1
Vega Baja	0.2	0.1	0.9	1.1	0.1	0			0.4	0.1	0	0	0.1	0.1	0.2	0.4	0.2	0.4	0.8	0.7	0	0.3
Vega Alta	0.1	0	0.1	0.3	0.1	0	0			0.1	0.2	0.1	0.2	0.2	0.2	0.4	0.1	0.2	0.3	0.1	0.1	0.2
Dorado	0	0	0	0		0	0.1	0	0.2	0	0.1	0.7	0.3	0.4	0.3	0.2	0.3	0.1	0.4	0.4	0.8	0.3
Toa Baja		0	0	0.1	0				0				0				0	0	0			0
Catano	0.8	1	0.4	0.8	0.4	0.4	0.8	1.5	4.8	3.6	2.3	4.1	4.1	1.7	2.6	1.5	1.2	0.6	0.5	0.6	1.1	1.7
San Juan	19.3	15.1	15.5	15.9	18.5	22.3	8.8	18.6	16.4	17.5	11.2	14.6	11.4	5.9	8.6	10	12.3	9.4	10.8	9.4	12.3	12.2
Carolina	0.3	0.1	0.3	0	0.5	1.1	2.5	0.4	0.2	1.2	0.3	0.5	0.5	1	0.9	0.5	1	0.8	2	0.4		0.7
Loiza	0.5	0.2	0.1	0.3	0.4	0.7		0.3	1.8	1.1	0.7	1.3	1.6	2.5	2.6	1.3	0.4	0.2	1	2	1.8	1.2
Rio Grande	1.3	1.3	0.7	0.4	0.3	0.1		0.1	0.3	0.3	0.5	0.9	1.2	0.7	0.8	1	1.1	0.8	1.3	2	1.6	0.9
Luquillo	0.9	0.4	0.5	0.6	1	0.8	0.4	0.1	0.9	1.2	0.1	0	1	0.6	0.9	0.3	0.2	0.2	0	0.6	0	0.5
Fajardo	12.7	9.8	15.7	8.8	12.3	11.6	8.4	9.5	1.9	8.3	9	8.2	19.4	13.2	13.8	15	14.4	10.1	16.7	12.8	14.2	12.5
Ceiba	1.4	0.9	1.4	2.3	6	1	0.1	0.4	1.4	0.5	0.1	0.3	1.7	1.9	1.4	1.2	1.2	1	1.5	1.8	1.3	1.3
Naguabo	3.8	3.3	2.1	2.2	2.7	0.5	0.6	0.1		0.1	0.4	1.6	0.9	0.4	1.1	0.7	1.2	1.5	2	1.5	1.9	1.3
Humacao	4	1.8	6.6	7.5	7.4	5	3.8	6.6	6.2	4.4	5.8	6.4	5.4	4.8	4.7	2.9	4.1	2.5	4.7	4	5	4.6
Yabucoa	0.6	0.4	0.6	1.2	1.5	0.8	1.2	3.5	2.6	0.4	2.8	1.8	1.7	2	2.6	0.7	1.5	1.6	2.1	2.8	2.2	1.7
Maunabo	0.2	0.4	0.2	0.9	0.3	0.3	0.2	1.2	1.2		0.1	0.1	0.2	0.6	0.9	0.4	1.1	0.5	0.6	0.4	0.1	0.5
Culebra	1.6	1.4	3.5	5	4.2	3.2	3.5	1.9	2.1	2.2	1.4	1.8	1.6	0.4	0.1		1	1.4	0.4	1	2.6	1.5
Vieques	4	5.6	2.6	2.6	4.9	6.1	3.2	1	0.8	1.9	1.8	0	0.9	3.3	2.4	4.1	1.4	0.9	9.3	10.9	4.7	3.6
Patillas	0.1	0.4	2.9	2.1	1.2	2.6	1.4	0.7	5.3	1.5	1.6	2.9	4.2	1	2.6	0.9	0.9	1.1	1.2	1	1.4	1.7
Arroyo	1.7	2.4	1.7	0.1	0		0	0.5	1	0	0	0.5	1.4	1.8	1	0.5	0.3	0.2	0.2	0.2	0.3	0.7
Guayama	1.8	3.1	1.6	1.3	0.9	1.1	1.4	0.5	0.6	2.5	2.2	2.1	1.3	2.3	3.2	2	2.5	0.8	0.7	1.4	2.1	1.7
Salinas	1	0.5	1.3	1.1	0.3	1.1	0.4	0.6	0.9	0.7	2.2	3.6	2.7	3.9	2.9	2.8	2.3	2.3	1.9	2.6	2.9	2.1
Santa Isabel	0.2	0				0.1	2.1	0.2	0.5	0.1	0.2	1.8	1.9	3.1	2.2	1.7	1.3	1.8	1.5	1.4	1.4	1.3
Juana Diaz	3	2.5	1	0.1	0.9	0	0.4	0	0	0		0.4	0.3	1	1.2	0.7	0.4	0.8	1.1	1	0.6	0.8
Ponce	0.2	0.2	0	0.2	0				0.2	0.3	1.2	6.4	4.4	7	4.7	10.8	10.3	9.1	6.6	5.2	11.4	5
Penuelas	0.3	0.1	0.1	0	0.2	0.2	0.1	0	0	0.1	0	0.1	0	0	0	0.1	0.1	0.1	0.3	0.5	0.1	0.1
Guayamilla	2.5	2.4	2.9	2.1	0.2	0.2	0.6	0.3	0.1	0.2		0.1	0.9	1.1	1	0.5	1.4	2.1	0.9	1.4	0.5	1.1
Guanica	4.2	14.7	5.8	5.5	9.1	5.9	14.3	14.6	8.3	14.2	10.2	12.2	10	11.8	9.1	9.6	11.4	28.7	6.8	6.8	4.2	11.1
Lajas	4.1		2.5	6.5	2.3	4.2	1.5	2.7	3.8	4.7	2.6	2.5	2.8	4.4	4.4	7.6	7.5	5	5.3	9.1	4.1	4.6
Cabo Rojo	17.1	21.5	18.9	19.3	13.2	15.4	18.1	7.2	12	9.7	4.3	2.9	2.8	5.2	5.1	3.6	2.8	4.2	5.4	4.4	6.6	7.5
Mayaguez	7	6.2	5.8	4.1	4.7	5.8	6.2	9.6	18.8	15.1	27.2	12.3	7.7	11.7	9.5	9.7	9.8	6.7	6.7	8	9.3	9.7
Anasco		0	0.2	0.1	0.1	0.1	0.3	0.2	0.5	0	0	0	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Rincon	0.3	0.1	0.1	0.1	0.3		0.1	0.5		0.3	0.4	0	0.2	0.1	0.1	0	0.1	0.1	0.6	0.2	0.4	0.2
Aguada	0.2	0.3	0.5	3.6	0	0.6	5.5	7.6	0.9	2.2	5	4.9	0.6	1.5	1.2	1	0.9	1	1.8	1.1	1.5	1.7
Aguadilla	1.6	0.7	1.2	1.6	4.8	7.3	10.6	8.2	4.2	4	4.3	2.6	4.5	2.2	4	4.6	3.2	2.5	1.6	2.6	2.1	3.3
All	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

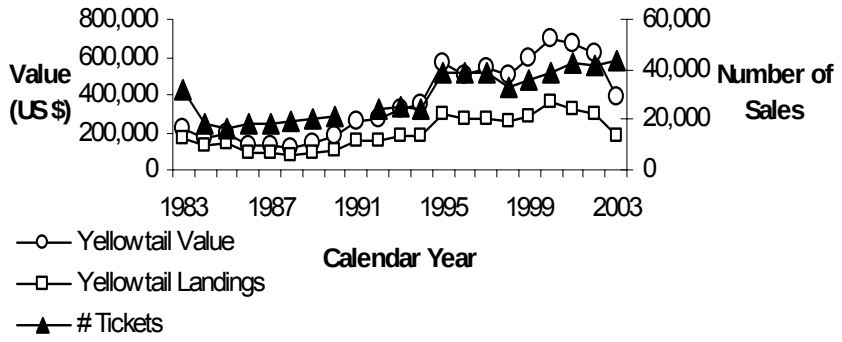

Figure 5. Total Annual landings (sales) and values (US $) of yellowtail snapper sold in Puerto Rico, 1983 - 2003 (unadjusted for under-reporting)

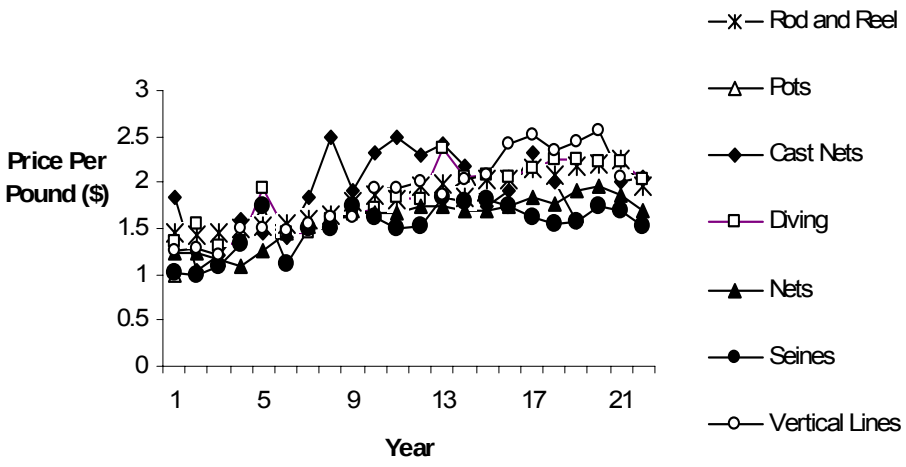

Figure 6. Average annual Price Per Pound of yellowtail snapper sold in Puerto Rico by gear, 1983 - 2003

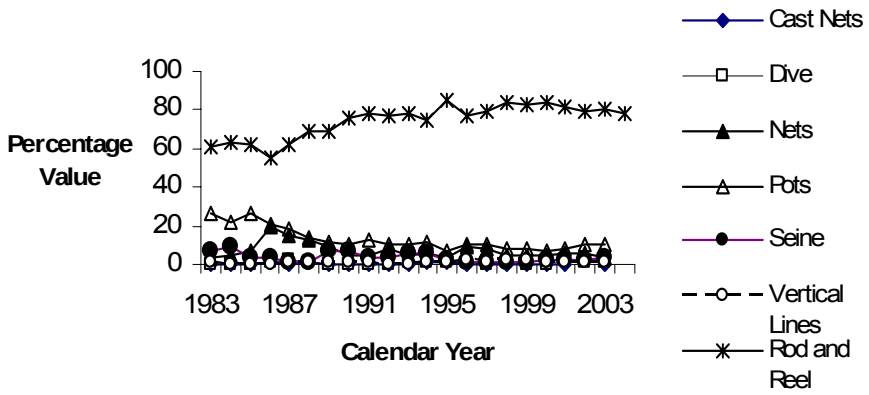

Figure 7. Percentage value of yellowtail snapper commercial sales in Puerto Rico 1983 - 2003 by fishery

Catch Per Unit of Effort of Yellowtail Snapper in Puerto Rico

The number of fishing trips variable, 'ntrips', was used as a criterion for data exclusion in the CPUE analyses. Although, an objective of the FSP data collection program was to collect trip specific landings data, often fishers recorded as many as up to 95 trips on the fish tickets, clearly anomalous entries. There were a total of 99,668 individual fisher sales records identified as yellowtail snapper from the 1983 - 2003 Puerto Rico landings data. Of these observations, the 'ntrips' variable was coded as zero ('0') for 17% of the data records; these records were excluded from subsequent calculations of CPUE. The remaining data records were further reviewed to determine an appropriate cutoff value for the 'ntrips' variable. Mean CPUE, calculated as total pounds per trip divided by the number of trips (i.e., 'ntrips') and the standard deviation of mean CPUE (stddev) were calculated (Figure 8). The stddev variable visually shows the between sale variation in nominal CPUE (i.e., pounds per trip).

The majority of fishers (71% or 57,900) landing yellowtail snapper, reported making a single trip ('ntrip' = 1) on the sales forms with 95% (n = 78,112 observations) recording ntrips ≤ 9. The standard deviation (stddev) of mean CPUE increased nearly five fold from fish tickets indicating that the total weight sold represented ≥10 trips (see Figure 8). It seemed logical that the stddev of the catch would decline as 'ntrips' increases. From an operational view, it also seemed impractical that fishers would conduct repeated fishing trips, of a week or more, in sequence and retain that catch prior to processing. Most shallow water snapper fishing trips are conducted during in a single day in Puerto Rico. Retaining catches over multiple days could conceivably adversely affect the product quality and the resulting price obtained at market. A cutoff value of 'ntrips' ≤ 7 (i.e., one week) was adopted in forming the second CPUE data set. Thus, two data set were formed 1) of only observations indicating the 'ntrips' = 1 and 2) one containing only landings observations indicating the 'ntrips' data variable was ≤ 7 (one week). For each data set nominal un-adjusted CPUE of yellowtail snapper was calculated and is presented by year and each major (rod and reel, pot) and also the minor gears (nets, seines, dive, cast nets, other).

Nominal CPUE of Yellowtail Snapper — For the 'ntrips' = 1 data set, yellowtail snapper commercial CPUE from lines (rod and reel) varied without trend from 1985-2003 from about 31 to 54 pounds per trip and was 34 pounds per trip in 2003 (Figure 9). The very high CPUE calculation in 1984 observed in the rod and reel nominal CPUE was evident in all gear categories. Pot CPUE of yellowtail snapper varied from about 15 pounds per trip to 31 pounds per trip over the 21 year period and was 13 pounds per trip in 2003 (Figure 9). CPUE observations from pots and line gear contributed 88 % to the total all gear CPUE data set. The 1984 data points are excluded from this discussion as it appears to be aberrant in all gear and closer inspection of all the data for 1984 is recommended for future analyses.

For the 'ntrips' ≤ 7 CPUE data set, yellowtail snapper CPUE from line gear varied from about 21 pounds per trip to 42 pounds per trip and was 34 pounds per trip in 2003, again varying without strong trend over the 21 year period (Figure 10). Pot CPUE of yellowtail from the 'ntrips' ≤ 7 data set varied from around 10 pounds per trip to 18 pounds per trip and was 14 pounds per trip in 2003. The lower mean value from pot fishers in the 'ntrips ≤ 7' data set could indicate pot fishermen are checking their gear more than once per day and counting each trap set haul as a trip.

In general, over the 21 year period, 1983-2003, nominal CPUE of yellowtail snapper varied without major trend in nearly all fisheries. Graphical comparisons of line and pot CPUE for yellowtail snapper are shown in Figure 11 for the data set using all the observations. CPUE from all gears combined ranged from 17 pounds per trip to 38 pounds per trip over the period and was 8 pounds per trip in 2003 (Figure 11).

Standardized CPUE of Yellowtail Snapper — Results of applying general linear models to adjust the raw CPUE data for variation due to the year, month, fishing center (as a proxy for catch location), and gear are presented in Figures 12-14. As with the nominal CPUE calculations two data sets were formed first: 1) one of all landings observations in which the 'ntrips' data variable was equal to one and 2) a set of the data where the 'ntrips' data variable was recorded as ≤ 7. A separate GLM model was fit to all the data. The same general linear model was fit to each data set and contained auxiliary terms for year, month, gear, and fishing center. CPUE was calculated as total pounds per trip as done for nominal CPUE calculations.

Annual patterns for standardized CPUE results were very similar to the unadjusted CPUE trends and generally showed a similar unvarying pattern over the time period. In addition, CPUE estimates for 1984 appear somewhat out of line with surrounding years and all comparisons are made from the 1985 year and later. Standardized CPUE of yellowtail snapper across all gears from the 'ntrips' = 1dataset varied from about 12 pounds per trip to 18 pounds per trip (Figure 12). Current CPUE was 14 pounds in 2003. The total percent of variation in the data explained with this model was 30%.

Standardized CPUE of yellowtail across all gears form the 'ntrips' ≤ 7 dataset varied from 10 pounds to 14 pounds per trip and current CPUE in 2003 for this data set was 14 pounds per trip (Figure 13). The total percent of variation in the data explained with this model was 29%.

Standardized CPUE of yellowtail snapper from the 'all fishing trips' data set ranged from 10 pounds to 14 pounds

per trip over the 21 year period across all gears. Current CPUE in 2003 was 14 pounds per trip (Figure 14). The total percent of variation in the data explained with this model for the 'all observations data set' was 30%. CPUE ranged from 9 pounds per trip to 16 pounds per trip for lines and from 7 pounds to 16 pounds per trip for pots Current CPUE in 2003 was 16 and 11 pounds per trip respectively for lines and pot. The total percent of variation in the data explained with the model for these two data sets was 25% and 19%, respectively.

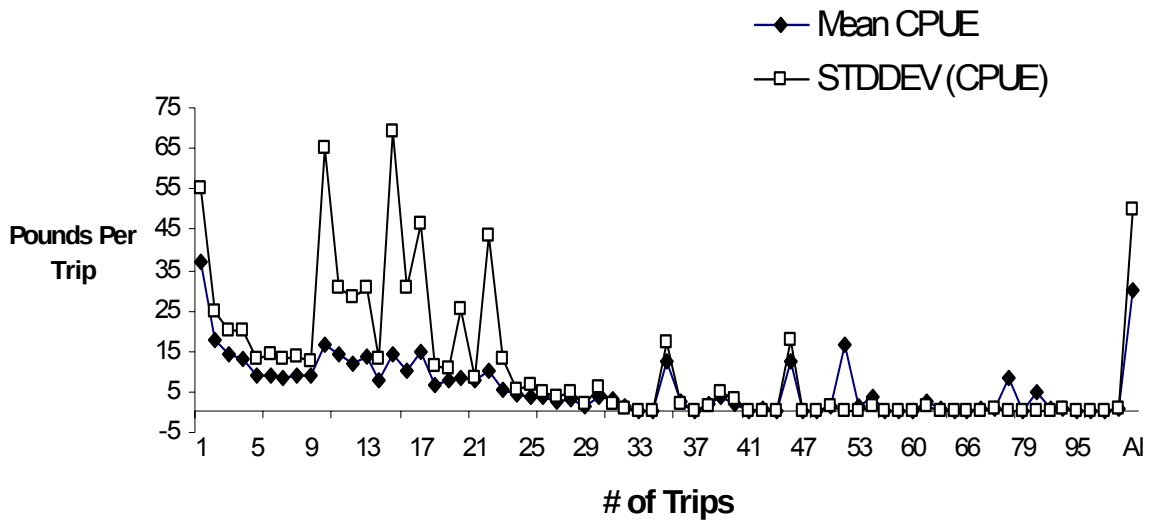

Figure 8. Mean CPUE and Standard deviation of CPUE for yellowtail snapper for commercial sales in Puerto Rico, 1983 - 2003.

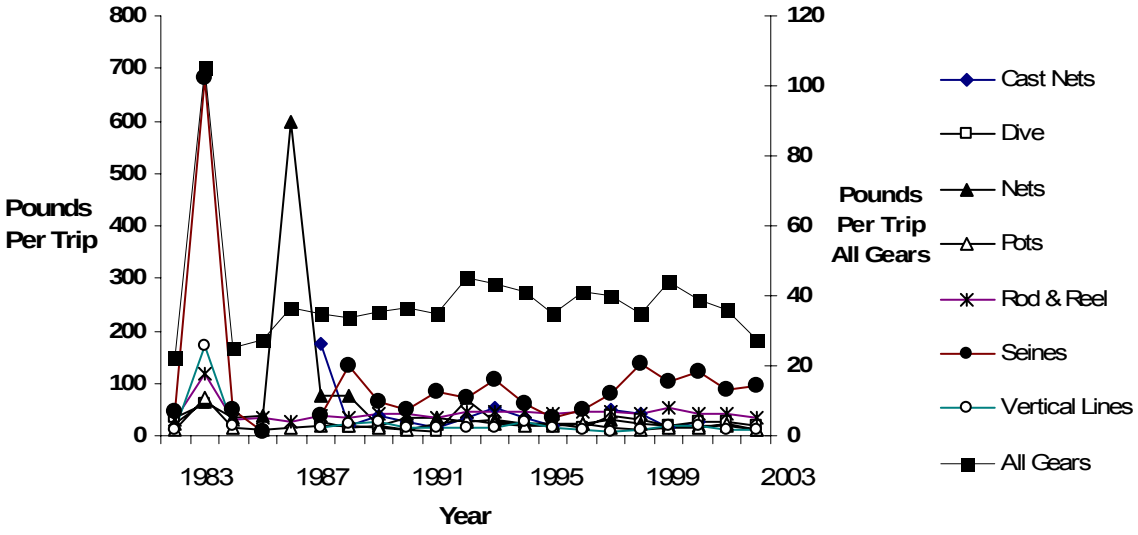

Figure 9. Yellowtail snapper nominal commercial CPUE (pounds per trip) for 'ntrips' = 1 data variable, 1983-2003, by gear and year.

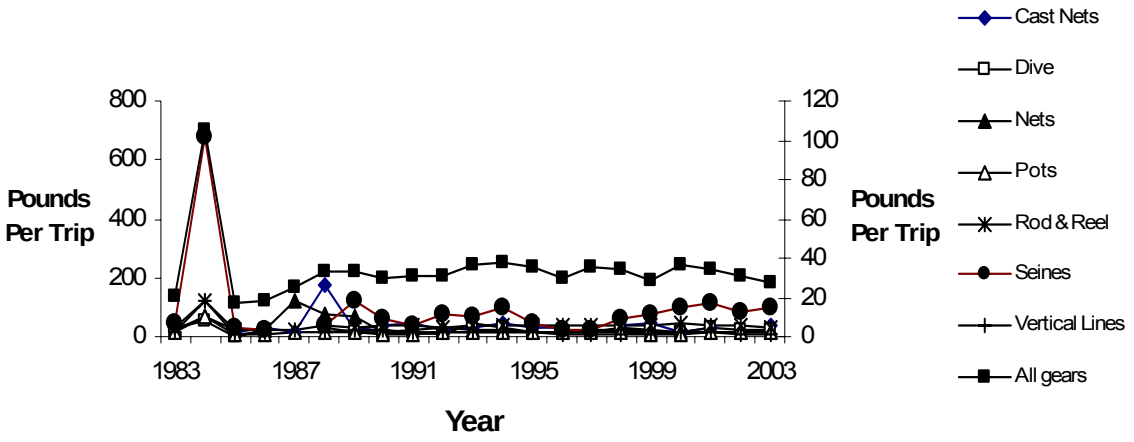

Figure 10. Yellowtail snapper nominal commercial CPUE for 'ntrips' ≤ 7 data variable, 1983 - 2003, by gear and year

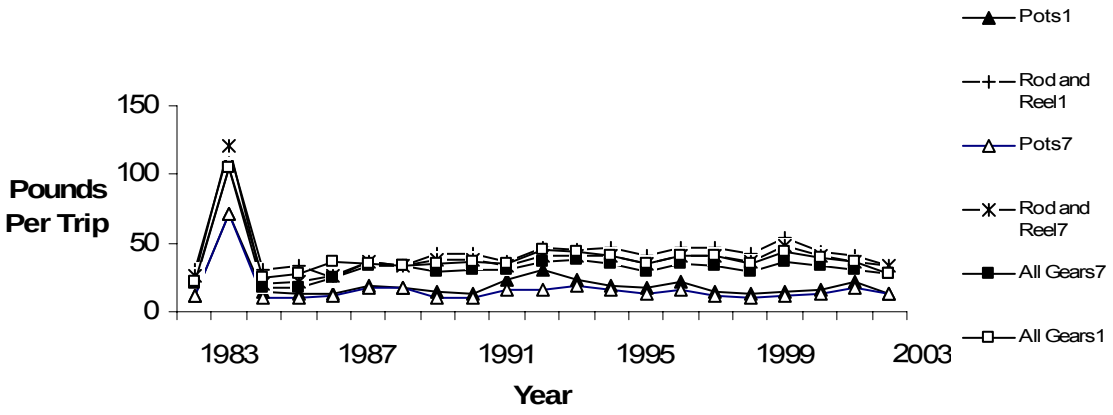

Figure 11. Yellowtail snapper nominal Commercial Nominal CPUE for all trips, 1983 - 2003, pots, line gear and all gear

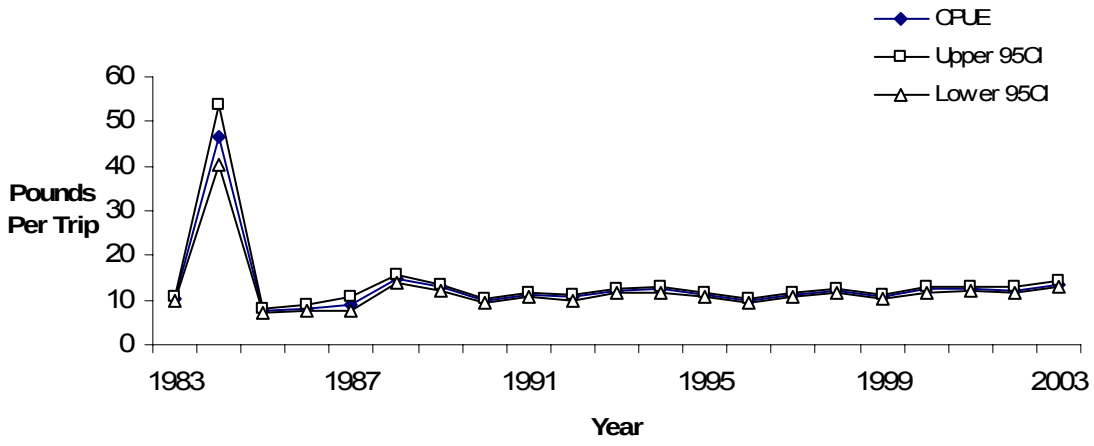

Figure 12. Yellowtail snapper standardized commercial CPUE for 'ntrips' = 1 data variable, 1983-2003, by gear and year

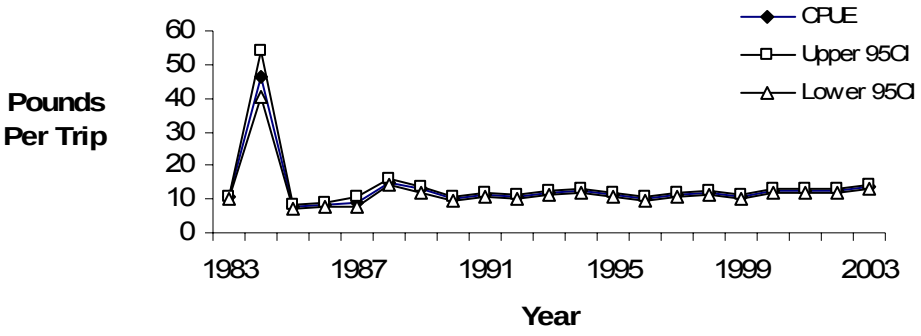

Figure 13. Yellowtail Snapper standardized commercial CPUE for 'ntrips' ≤ 7 data variable, 1983 - 2003, by gear and year

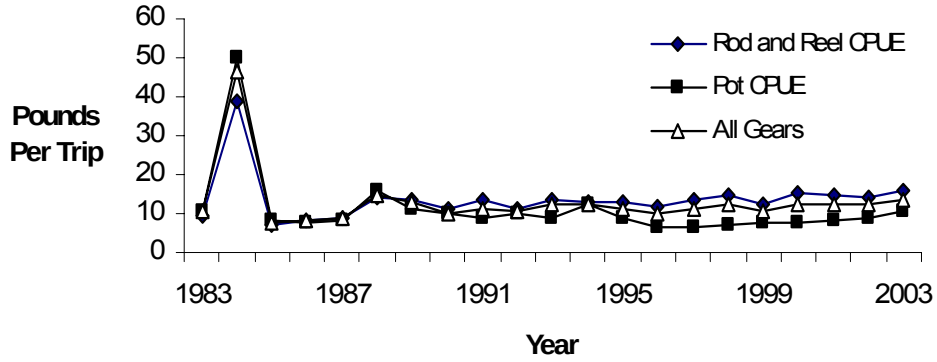

Figure 14. Yellowtail Snapper standardized commercial CPUE for all trips, 1983 - 2003

ACKNOWLEDGEMENTS

The information presented in this report was the collaborative result of the many persons efforts. Thanks are extended to the Puerto Rico Department of Natural and Environmental Resources Fisheries Research Laboratory Staff and Fisheries Port Agents who collected and computerized the fishery data. Special thanks are extended to Ms. Aida Rosario and Daniel Matos-Caraballo who collaborated in the original analyses conducted for the Southeast Data and Assessment Review (SEDAR) stock assessment workshops. Additional thanks are extended to Joshua Bennett of NMFS, SEFSC Miami Florida for assistance in obtaining the raw data and to S. Saul for editorial suggestions.

LITERATURE CITED

Bloch, M.E. 1791. Naturgeschichte der ausländischen Fische. Berlin. Naturg. Ausl. Fische i-viii + 1-152 cited in Fishbase.

Cole,J.S. 1976. Annual report fishcal year 1972-1973 Project 2-183-R, "Commercial fisheries survey and development" submitted to National Marine Fisheries Service. Unpubl. MS.

Collazo, J. and J.A. Calderon. 1988. Status of the Fisheries in Puerto Rico 1979-1982. Technical Report. CODREMAR **1982**:1-30.

Cummings, N.J. and D. Matos-Caraballo. 2003a. Summary information on commercial fishing operations in Puerto Rico from 1969-2001 and reporting rates needed to adjust commercial landings. U.S. DOC, NOAA, NMFS, SFSC, SFD SFD, 2003-0023, 14 pp. SEDAR 4 Doc-5.

Cummings, N.J. and D. Mato-Caraballo. 2003b. Summary information on the Commercial Fishing Operations in Puerto Rico from 1969 - 2001 and Reporting rates needed to adjust commercial landings.

Jarvis, N.D. 1932. *The fisheries of Puerto Rico*.U.S. Department of Commerce, *Bureau of Fisheries Investigation Report 13*. 41 pp.

Froese, R. and D. Pauly (eds.). 2004. FishBase. World Wide Web electronic publication. www.fishbase.org, Version 09/2004.

Johnson, A.G. 1983. Age and growth of yellowtail snapper from South Florida. *Transactions of the American Fisheries Society* **112**:173-177.

Juhl, R. 1969. Exploratory fishing surveys and gear tests in Puerto Rico. Contrib. Agrop. Pesq. Serv. Aux. Cent. Dept. Agric., **1**(1):1-39.

Juhl, R. 1972. *A report on exploratory fishing and gear tests in Puerto Rico*. Cont. Agrop. Pesq. Serv. Aux. Cent. Dept. Agric. **4**(3):1-63.

Manooch, C.S. III and C.L. Drennon. 1987. Age and growth of the yellowtail snapper and queen triggerfish collected from the U.S. Virgin Islands and Puerto Rico. *Fisheries Research* **6**:53-68.

Matos-Caraballo, D. 2004. Collection of Puerto Rico commercial landings data,. April 2001-2004. Job 1 and 2. [In: Puerto Rico/NMFS Cooperative Fisheries Statistics Program April 2001- March, 2004. Puerto Rico, DNER, Mayaguez Puerto Rico, Contract Report No. NA17FT1006]. 50 pp.

Matos-Caraballo, D. 2004. Comprehensive census of the marine fishery of Puerto Rico, 2002. Job 3 Pages 51—85 in: Puerto Rico/NMFS Cooperative Fisheries Statistics Program April 2001-March 2004. Puerto Rico, DNER, Mayaguez Puerto Rico, Contract Report No. NA17FT1006].

Matos-Caraballo, D. 2002. Overview of Puerto Rico's small-scale fisheries statistics 1998-2000. *Proceedings of the Gulf and Caribbean Fisheries Institute* **55**:

Matos-Caraballo, Daniel 2001. Overview of Puerto Rico's small-scale fisheries statistics 1998-2001. *Proceedings of the Gulf and Caribbean Fisheries Institute* **52**: 197-203.

Matos-Caraballo, 2000. A Puerto Rico census 1995-1996. *Proceedings of the Gulf and Caribbean Fisheries Institute* **51**:258-270.

Matos-Caraballo, D. 1998. Commercial fisheries statistics: Puerto Rico/NMFS Cooperative Fisheries Statistics Program 1997-2000. PR, DNER, Final Report to the NMFS. 73 pp.

Matos-Caraballo, D. and Y. Sadovy. 1990. Overview of Puerto Rico small-scale fisheries statistics 1988—1990. Technical Report. CODREMAR. 1(4): 1- 17.

Matos-Caraballo, D. and Y. Sadovy. 1991. Commercial Fisheries Statistics: Puerto Rico/State Federal Cooperative Fisheries Statistics Program. Department of Natural Resources Annual Report to the National Marine fisheries Service. 53pp.

Piedra, G. 1969. Materials on the biology of the yellowtail snapper (*Ocyurus chrysurus* Black). Pages 251-269 in: A. S. Bogdanov (ed.) *Soviet-Cuban fishery research*. Translated from Russian: Israel Program for Scientific Translations, Jerusalem, Israel.

Robson, D.S. 1966. *Estimation of the relative fishing power of individual ships*. *ICNAF Research Bulletin* **3**:5-15.

Wilcox, William A. 1899. Notes on the foreign fishery trade and local fisheries of Porto Rico. Pages 1 - 34 in: *Investigations of the Aquatic Resources and Fisheries of Porto Rico by the U.S. Fish Commission Steamer Fish Hawk in 1899*.

Wilcox, William A. 1900. The fisheries and fish trade of Porto Rico. Pages 27 - 48 in: *Investigations of the Aquatic Resources and Fisheries of Porto Rico by the U.S. Fish Commission Steamer Fish Hawk in 1899*.