SEDAR

Southeast Data, Assessment, and Review

SEDAR 84

US Caribbean Yellowtail Snapper
Puerto Rico

SECTION II: Data Workshop Report

April 2024

SEDAR
4055 Faber Place Drive, Suite 201
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1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 84 Data Workshop was held January 23-25, 2024, in San Juan, Puerto Rico. In addition to the in-person workshop, a series for webinars were held before (July and December 2023) the meeting.

1.2 TERMS OF REFERNCE

Data Workshop Terms of Reference:

1. Develop a stock assessment model for Puerto Rico and St. Thomas/St. John Yellowtail Snapper and St. Croix Stoplight Parrotfish stocks using an appropriate approach.
2. Review available data inputs and provide tables and figures including, but not limited to:
   a. Commercial and recreational catches and/or discards.
   b. Length/age composition data
   c. Life history and ecological information
   d. Indices of abundance
3. Construct a stock assessment model that is appropriate for the available data.
4. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on research goals, data to be collected, and how the research will inform stock assessment.

5. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Data Workshop Participants

Adyan Rios (Lead Analyst) .... NMFS/SEFSC
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1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR84-DW-01	Radiocarbon Age Validation for Caribbean Parrotfishes	Jesus Rivera Hernández and Virginia Shervette	9 January 2024 Updated: 5 March 2024
SEDAR84-DW-02	SEDAR 84 Commercial fishery landings of Yellowtail Snapper (*Ocyurus chrysurus*) in St. Thomas and St. John, US Caribbean, 2012-2022	Stephanie Martínez Rivera, Kimberley Johnson, and M. Refik Orhun	18 January 2024 Updated: 21 February 2024
SEDAR84-DW-03	SEDAR 84 Commercial fishery landings of Stoplight Parrotfish (*Sparisoma viride*) in St. Croix, US Caribbean, 2012-2022	Stephanie Martínez Rivera, Kim Johnson, and M. Refik Orhun	18 January 2024 Updated: 21 February 2024

SEDAR84-DW-04	Analysis of SEAMAP-C hook and line survey data for yellowtail snapper in Puerto Rico (1992-2020)	Walter Ingram, Refik Orhun, and Carlos M. Zayas Santiago	19 January 2024
SEDAR84-DW-05	Summary of Management Actions for Stoplight Parrotfish (*Sparisoma viride*) from St. Croix (1985 - 2021) as Documented within the Management History Database	G. Malone	22 January 2024 Updated: 21 February 2024
SEDAR84-DW-06	Summary of Management Actions for Yellowtail Snapper (*Ocyurus chrysurus*) from Puerto Rico and St. Thomas/St. John (1985 - 2021) as Documented within the Management History Database	G. Malone	22 January 2024 Updated: 21 February 2024
SEDAR84-DW-07	Addressing Critical Life History Gaps for U.S. Caribbean Yellowtail Snapper: Bomb radiocarbon of age estimation method and a summary of the regional demographic patterns for size, age, and growth	Virginia Shervette, Jesus Rivera Hernandez, Sarah Zajovits	22 January 2024 Updated: 15 February 2024
SEDAR84-DW-08	U.S. Caribbean Yellowtail Snapper Population Demographics, Growth, and Reproductive Biology: Addressing Critical Life History Gaps	Virginia Shervette, Jesus Rivera Hernandez, Noemi Pena Alvarado	18 February 2024
SEDAR84-DW-09	SEDAR 84 Trip Interview Program (TIP) Size Composition Analysis of Yellowtail Snapper (*Ocyurus chrysurus*) in Puerto Rico, U.S. Caribbean, 1983-2022	Katherine Godwin, Adyan Rios, Kyle Dettloff	21 February 2024
SEDAR84-DW-10	SEDAR 84 Trip Interview Program (TIP) Size Composition Analysis of Yellowtail Snapper (*Ocyurus chrysurus*) in St. Thomas/St. John, U.S. Caribbean, 1983-2022	Katherine Godwin, Adyan Rios, Kyle Dettloff	21 February 2024
SEDAR84-DW-11	SEDAR 84 Trip Interview Program (TIP) Size Composition Analysis of Stoplight Parrotfish (*Sparisoma viride*) in St. Croix, U.S. Caribbean, 1983-2022	Katherine Godwin, Adyan Rios, Kyle Dettloff	21 February 2024
SEDAR84-DW-12	SEDAR 84 Commercial fishery landings of Yellowtail Snapper	Stephanie Martínez Rivera, Kimberley	21 February 2024

	(Ocyurus chrysurus) in Puerto Rico, US Caribbean, 2012-2022	Johnson, and M. Refik Orhun	
SEDAR84-DW-13	Length-Frequency Snapshot of Yellowtail Snapper from Image Analysis in Puerto Rico	Derek Soto, Alejandro Carrera Montalvo, Todd Gedamke	22 February 2024
SEDAR84-DW-14	Fishery-Independent Reef Fish Visual Survey Population Density and Length Composition for Stoplight Parrotfish in the St. Croix	Laura Jay W. Grove, Jeremiah Blondeau, and Jerald S. Ault	16 February 2024
SEDAR84-DW-15	Fishery-Independent Reef Fish Visual Survey Population Density and Length Composition for Yellowtail Snapper in the Puerto Rico	Laura Jay W. Grove, Jeremiah Blondeau, and Jerald S. Ault	16 February 2024
SEDAR84-DW-16	Fishery-Independent Reef Fish Visual Survey Population Density and Length Composition for Yellowtail Snapper in St. Thomas/John	Laura Jay W. Grove, Jeremiah Blondeau, and Jerald S. Ault	16 February 2024
Reference Documents			
SEDAR84-RD01	Selectividad Pesquera del Buche (Seno) en Chinchorros de Playa con mallas de 2.5, 2.0 y 1.0 pulgadas, a lo largo de la costa Oeste y Noreste de la Isla de Puerto Rico	Edgardo Ojeda Serrano, Omayra Hernandez Vak, and Samuel Garcia Vazquez	
SEDAR84-RD02	Monitoring of Mesophotic Habitats and Associated Benthic and Fish/Shellfish Communities from Abrir la Sierra, Bajo de Sico, Tourmaline, Isla Desecheo, El Seco and Boya 4, 2018-20 Survey	Jorge R, Garcia-Sais, Stacey Williams, Evan Tuohy, Jorge Sabater-Clavell and Milton Carlo	
SEDAR84-RD03	Population Size, Growth, Mortality and Movement Patterns of Yellowtail Snapper (*Ocyurus chrysurus*) in the U.S. Virgin Islands Determined Through a Multi institutional Collaboration	St. Thomas Fishermen's Association	

SEDAR84-RD04	S8-DW-09: An Update on the Reported Landings, Expansion Factors and Expanded Landings for the Commercial Fisheries of the United States Virgin Islands (with Emphasis on Spiny Lobster and the Snapper Complex)	Mónica Valle-Esquivel and Guillermo Díaz
SEDAR84-RD05	SEDAR68-DW-13: Marine Recreational Information Program Metadata for the Atlantic, Gulf of Mexico, and Caribbean regions	Vivian M. Matter and Matthew A. Nuttall
SEDAR84-RD06	Nearshore habitats as nursery grounds for recreationally important fishes, St. Croix, U S. Virgin Islands	Ivan Mateo
SEDAR84-RD07	Seasonal Patterns of Juvenile Fish Abundance in Seagrass Meadows in Teague Bay Bank Barrier Reef Lagoon, St. Croix, U.S. Virgin Islands	Ivan Mateo and William J. Tobias
SEDAR84-RD08	The Distribution of Herbivorous Coral Reef Fishes within Fore-reef Habitats: the Role of Depth, Light and Rugosity	Michael Nemeth and Richard Appeldoorn
SEDAR84-RD09	The Use of Vertical Distribution Data in the Identification of Potential Spawning Sites and Dispersal Pathways for Parrotfish (Genera *Sparisoma* and *Scarus*) within Territorial Waters of the U.S. Virgin Islands	Kristen A. Ewen
SEDAR84-RD10	Evaluating the impact of invasive seagrass *Halophila stipulacea* on settlement, survival, and condition factor of juvenile yellowtail snapper, *Ocyurus chrysurus*, in St. Thomas, USVI	Sophia Victoria Costa

2 Life History

2.1 Overview

Table 2.1 provides a summary of parameters, definitions, nomenclature, and units for the life history parameters included within this report (SEDAR 46 SAR v2). Yellowtail Snapper life history data were provided in Shervette et al. (2024a).

2.2 Stock Definition and Description

The Yellowtail Snapper stock was defined by the CFMC Island-based Fishery Management Plan. The Puerto Rico stock is defined as the population within the Puerto Rico territorial waters and the adjacent EEZ.

2.3 Meristic & Conversion factors

The length-length and length-weight relationship equations with parameters for Yellowtail Snappers collected 2013-2023 for the combined sexes (Shervette et al. 2024) are shown are in Table 2.2.

2.4 Natural Mortality

The DW panel recommended that the assessment team explore various methods of estimating natural mortality (M) based on life history parameters. This may include methods that apply one point estimate to the entire age range of the fish, such as Hewitt and Hoenig (2005) or Then et al. (2015). Additional, and perhaps preferred methods, include using the methods of Charnov et al. (2013) which features age-varying natural mortality as a function of size of the fish. The age specific M may be calculated using the von Bertalanffy population growth parameters, $L\infty$ and K, and the predicted fork length at the mid-point of each age. The mid-point of each year class can be used to represent the mean size of the fish in a calendar year.

2.5 Reproduction

Yellowtail Snapper reproductive data were provided in Shervette et al. (2024). The overall male to female sex ratio was estimated to be 1:1.04. A total of 892 mature female and 856 mature male Yellowtail Snapper had reproductive phase information. The months with the greatest proportion of spawning capable females were March and April. Males with testes in the spawning capable phase occurred in all months of the year. Yellowtail snapper from the U.S. Caribbean exhibit year-round spawning.

A total of 454 female Yellowtail Snapper samples were evaluated for maturity and indicators of active spawning to estimate spawning fraction, spawning interval, and spawning frequency. Female Yellowtail Snapper spawning fraction overall was 0.13; overall spawning interval, defined as the number of days between spawning events in a female, was 7 days, indicating that a female spawns approximately 49 times over the estimated ~365-day spawning season.

When examining trends in spawning fraction, interval and frequency by length, spawning frequency increased with increasing length class. Females in the smallest fork length (FL) class had an estimated spawning frequency of six times over the spawning season, while females in the largest FL class had an estimated spawning frequency of 69 times over the spawning season. Similar increases in spawning frequency occurred when examined by age classes. Females in the oldest age class (13+ y) spawned approximately 85 times a year.

A total of 949 U.S. Caribbean Yellowtail Snapper samples with length, age, and sexual maturity information were used to obtain estimates of length and age at 50, 90, and 95% maturity (Shervette et al. 2024). Results are shown in Tables 2.3a (length at maturity) and 2.3b (age at maturity).

2.6 Age and Growth

Table 2.4 provides the results of fitting the von Bertanlanffy (VB) growth parameters for various length variables (Shervette et al. 2024). Figure 2.1 shows the fishery-dependent (FD) and fishery independent (FI) length-at-age data and the predicted overall VB growth curve. A summary list of available life history inputs is provided in Table 2.5; from Shervette et al. (2024).

2.7 SEDAR Panel Discussions of Life History Data for Assessment Analyses

Table 2.6 shows the life history parameters used in SEDAR 46 and those provided in Shervette et al. (2024).

Issue 1: Are sufficient life history data available?

Options:

- Use recent and regionally relevant life history data made available in SEDAR working papers.
- Use previously established life history parameters obtained from literature reviews.

Decision:

- Tentatively accept the life history parameters presented. The life history team will work with the assessment team to finalize the working paper.
- Aggregate the maturity data from USCA and SEAMAP-C.

Rationale:

- Both datasets (USCA and SEAMAP-C) show a reproduction peak from March to June, suggesting that the data can be combined.
- Tentatively accept the life history parameters provided. Providing the submission of the working paper, the team will review the results.

2.8 Life History Tables

Table 2.1 Summary of parameters, definitions, nomenclature and units for model parameters included within this report (SEDAR 46 Table 2.2.1).

Parameter	Definition	Management Strategy evaluation Stock Input	Real world data input	Units
L∞	Asymptotic length	Linf	vbLinf	mm FL
K	Brody growth coefficient	K	vbK	year $^{-1}$
t0	Theoretical age at length 0	t0	vbt0	years
α	Weight-length scalar	a	wla	dimensionless
β	Weight-length power	b	wlb	dimensionless
W∞	Asymptotic weight	--	--	g
Lm	Length at maturity	L50	L50	mm FL
tm	Age at maturity	--	--	years
tλ	Maximum age	Max. age	Max. Age	years
Lλ	Mean length of Max age	--	--	mm FL
M	Natural mortality	M	Mort	year $^{-1}$
Sλ	Survivorship to Max age	--	--	dimensionless

Table 2.2 Regression equations for U.S. Caribbean Yellowtail Snapper length-length and length-weight relationship. n = number of fish

Variables X	y	n	Equation	R^2
SL	FL	1538	y= 1.1156x+7.9985	0.9974
SL	TL	1520	y = 1.4435x - 69857	0.9917
SL	Wt	1532	$y = 0.00008x^{2.7772}$	0.9842
FL	SL	1538	y = 0.8694x- 6.4783	0.9974
FL	TL	1530	y= 1.2937x-17.299	0.9944
FL	Wt	1542	y = 0.00004x2.8642	0.9882
TL	SL	1520	y = 0.687x- 6.92	0.9917
TL	FL	1530	y = 0.7686x + 14.945	0.9944
TL	Wt	1524	$y = 0.00005x^{2.7185}$	0.9839

Table 2.3a, b Caribbean Yellowtail Snapper a) lengths (mm FL) and b) ages (years) as sexual maturity. Values in parentheses are 95% prediction intervals.

a)

Variable	**Sexes Combined**	**Female**	**Male**
Number of samples	1,876	922	954
L50	194 (189 - 199)	207 (202 - 211)	182 (174 - 190)
L90	238 (233 - 242)	244 (238 - 249)	229 (221 - 235)
L95	253 (246 - 258)	256 (248 - 264)	245 (235 - 253)

b)

Variable	**Sexes Combined**	**Female**	**Male**
Number of samples	949	482	464
A50	1.5 (1.4 - 1.6)	1.5 (1.3 - 1.9)	1.6 (1.4 - 1.7)
A90	2.2 (2.0 - 2.3)	2.1 (1.9 - 2.3)	2.3 (2.0 - 2.6)
A95	2.4 (2.2 - 2.6)	2.3 (2.0 - 2.6)	2.5 (2.2 - 2.9)

Table 2.4 U.S. Caribbean Yellowtail Snapper von Bertanlanffy (VB) growth function (VBGF) results. Parameter estimates are provided using fork length (FL) and total length (TL). Also provided are computed parameter estimates using theoretical age at length 0 (t_0) = -0.96 for comparison with the Caribbean study by Manooch and Drennon (1987) and using (t_0) = -1.93 for comparison with growth parameter estimates for Southeastern U.S. Yellowtail Snapper as reported in SEDAR 64.

Model	L∞ (mm)	K	t0	R2
FLmm	508 (479-547)	0.12 (0.10-0.14)	-2.73 (-3.29- -2.26)	0.70
TLmm	653 {635-648)	0.11 (0.10-0.13)	-2.67 (-3.18- -2.18)	0.70
FL mm to-fixed Carib	424 (415-434)	0.23 (0.22-0.24)	-0.96	0.68
FL mm to-fixed Fla	467 (454-481)	0.16 (0.15-0.18)	-1.93	0.70

Table 2.5 Summary of Yellowtail Snapper studies focused on estimating growth parameters. * indicates that a fixed t_0 value of -0.96 was used so that other growth parameters results from the Shervette et al, 2024 study could be compared to results from Manooch and Drennon (1987) ** indicates that a fixed t_0 value of -1,93 was used so that other growth parameter results from the Shervette et al, 2024 study could be compared to results from Florida (SEDAR 64/Stevens et al. 2019).

Study Area Study Citation	Time period (n) sample source	Size range (mean) mm	Age range (mean) y	$L_\infty/K/t_0$ Opaque zone formation	Comments
U.S. Caribbean Current study	2013-2023 (1554) FI + FD	FL: 28-572 (291)	0-26 (5)	FL: 508/0.12/-2.73 424/0.23/-0.96* 467/0.16/-1.93** Mar-Jun	Age validation via radiocarbon
U.S. Caribbean Manooch and Drennon 1987	1983-1984 (468) FD	FL: 140-590	1-17	FL: 503/0.14/-0.96 Mar-May	Used back-calculated size-at-age
Cuba Claro 1983	1972-1974 (3593) FD	FL: 160-460	0-6	FL: 681/0.16/-0.85 Mar-Jun	No validation of age estimates; otoliths read whole
FL east coast Allman et al. 2005	1980-2002 (6679) FI + FD	FL: 115-605 (312)	1-17 (4)	FL: 410/0.27/-2.03 Feb-May	
Southeast FL Garcia et al. 2003	1994-1999 (1528) FD	FL: 220-561	1-13	FL: 484/0.17/-1.87 Mar-May	
Southeast FL Johnson 1983	1979-1980 (807) FD	FL: 134-567	1-14	FL: 451/0.28/-0.36	
Florida SEDAR 2020	1980-2017 (42,985) FD (<1% FI)	FL: 100-600*	0-28	FL: 426/0.20/-1.93 Mar-Jun	Growth model accounted for truncated size-at-age

Table 2.6 Life history parameter values for Yellowtail Snapper provided by Shervette et al, 2024 and those used in SEDAR46 (S46 report Table 2.2.2). Values provided include the mean and CVs. Units are defined in Table 2.1 Asterisks denote values where the CV was not reported in the literature and instead imputed by SEDAR 46 Life History Working Group.

Parameter	Yellowtail Snapper (Shervette et al, 2024)	Yellowtail Snapper (Sedar 46)
vbLinf	508	502.5 (0.05)
vbK	0.12	0.139 (0.16)
vbt0	-2.73	−0.96 (0.45)
wla	4.0E-05	3.45E-05 (0.05*)
wlb	2.8642	2.859 (0.05*)
W∞		1,870
L50	194	248 (0.15*)
tm		3.939 (0.25*)
Lλ		471.1
Max. Age	26	19
Mort (M)		0.189 (0.083*)
Sλ		0.0276

2.9 Life History Figures

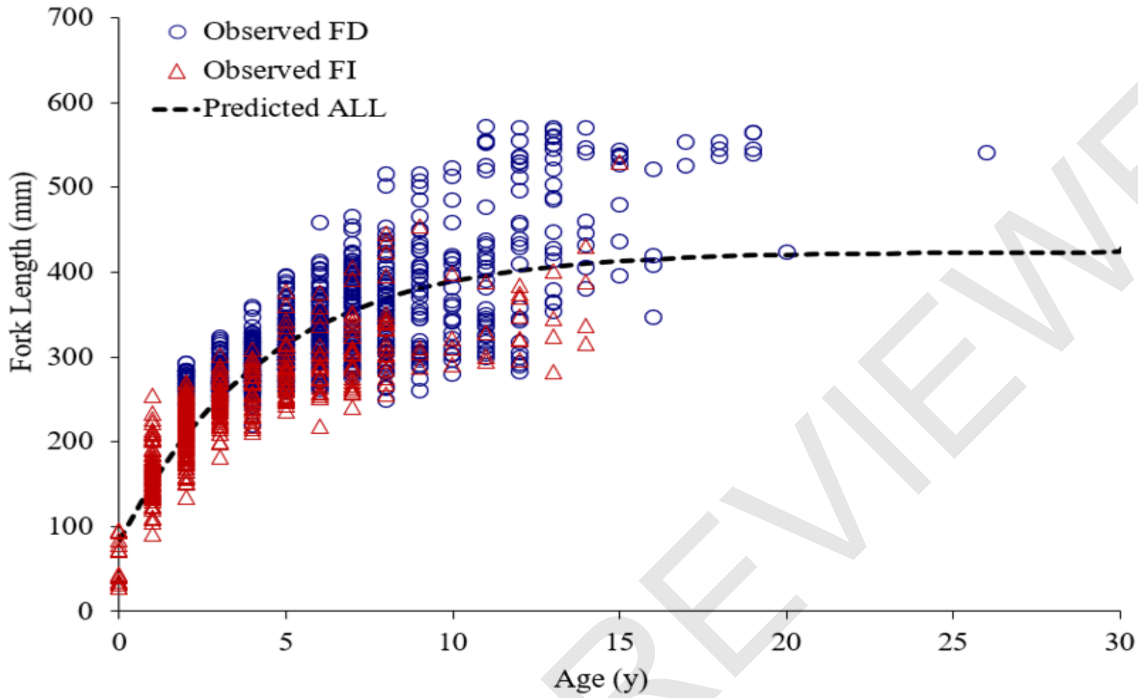

Figure 2.1 U.S. Caribbean Yellowtail Snapper length-at-age for FD and FI samples and von Bertalanffy growth based on $t_0 = -0.93$.

3 Commercial Fishery Statistics

3.1 Commercial Landings

3.1.1 Overview

Commercial fishery landings in Puerto Rico were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL) the fishers mail or deliver monthly to the Puerto Rico Department of Natural and Environmental Resources. A proportion of fishers are reporting to an e-reporting system that began in January 2020.

Commercial landings were reported by species, fishing gear, and the fishing center where the catch was landed. Puerto Rico commercial landings have been incompletely reported throughout the available time series (Caribbean Fisheries Data Evaluation Final Report, 2009) and correction factors have been used to estimate total landings. Commercial fishery landings data for Yellowtail Snapper in Puerto Rico were available for the years 1983-2022. The commercial landings were produced in pounds by year and fishing gear (Table 3.1.1 and Figure 3.1.1).

3.1.2 Correction factors and Calculation of Commercial Landings

Compilation of commercial fishery landings of 1983-2002 (see Appendix 1 of working paper on Puerto Rico commercial landings, Martinez et al 2024) used a single, island-wide, correction factor. For the years 2003 to 2022, correction factors were coast-specific (north, south, east, west). Reported landings were assigned to a coast based upon the fishing center reported for a trip. Over the years, there have been a few examples where the correction factor was adjusted. Refer to the working paper for these years along with the reasoning and solution behind the deviation. Total landings were estimated as the reported landings (island-wide or coast specific, as appropriate) divided by the correction factor (correction factors are less than one and reported landings are a fraction of the actual landings).

3.1.3 Outlier removal

Outlier removal was conducted by using a mean and standard deviation method. In Puerto Rico, fishers combined landings from multiple trips in single logbook reports in several years. In those cases when multiple trips combined in a single report, we used reported landings (not expanded landings) divided by the number of trips to estimate landings per trip for the outlier analysis. If the landings of Yellowtail Snapper reported on a trip were greater than three standard deviations from the mean (i.e., 99.73% quantile), the report was assumed to be in error and those data were removed from the dataset. Two methods were used to identify outliers: Method 1, the values to define outliers were calculated by gear group across all years (Table 3.1.2), and Method 2, the values to define outliers were calculated by year and gear group (Table 3.1.2).

3.2 Commercial Discards

Commercial discards are not reported in Puerto Rico fisher logbook data.

3.3 Commercial Effort

Commercial trips with reported Yellowtail Snapper landings per year and gear group were compiled from 1983 to 2022 (Table 3.3). No correction factors for estimating total trips were available for Puerto Rico; correction factors were designed to more accurately estimate total landings.

3.4 Biological Sampling

3.4.1 Overview

The NOAA Fisheries, Southeast Fisheries Science Center Trip Interview Program (TIP) collects length and weight data from fish landed by commercial fishing vessels, along with information about fishing area and gear. Data collection began in 1983 with frequent updates in best practices; the latest being in 2017. Data are collected by trained shore-based samplers (Beggerly, Stevens, and Baertlein 2022).

Additional length composition data from the commercial fishery in Puerto Rico were collected by MER Consultants during the period 2017-2019 with additional sampling in 2023 using image analysis (Soto et al. 2024).

3.4.2 Length Composition Sampling Intensity

The TIP data pertaining to Yellowtail Snapper in Puerto Rico consists of 103,730 length observations across 5,159 unique port sampling interviews (Figure 3.4.1). Of the Yellowtail Snapper measured, 103,520 were fork length observations (99.8%). Plots and summary statistics of the currently available length frequency data of Yellowtail Snapper sampled from the predominant gears in Puerto Rico are included in the working paper (Godwin et al. 2024).

The MER Consultants data set included more than 20,000 images taken, of which 2,484 were Yellowtail Snapper measurements provided for SEDAR 84. Samples were collected from locations throughout Puerto Rico.

3.4.3 Length Distributions

A large variety of fishing gears were used by Puerto Rico commercial fishers to catch Yellowtail Snapper. An analysis was conducted to establish gear groups among the many commercial fishing gears with groups based upon Yellowtail Snapper size composition differences among the gears. The resulting groups are recorded in Table 3.4.1. Summary statistics produced by a generalized linear mixed model (GLMM) analysis of the available length frequency data from 1983 to 2022 are also found in Table 3.4.1. Gear groups were identified based on GLMM analysis using a gamma-distributed dependent variable and a covariate to account for changes in mean size over time. Random effects for interview ID and categorical year were included to account for non-independence of observations.

The aggregated density plot for all gears combined of Yellowtail Snapper fork lengths collected across three or more unique interviews per gear group across the time series 1983-2022 are summarized in Figure 3.4.2. Aggregated density plots of Yellowtail Snapper landed by gears with 2% or more of the samples are summarized in Figure 3.4.3.

MER Consultant samples were collected from locations throughout Puerto Rico (Fig. 3.4.4). A histogram of Yellowtail Snapper fork lengths for all years is shown in Table 3.4.5. Histograms of Yellowtail Snapper fork lengths for 2017-2018 and 2023, plotted separately, are provided in Figure 3.4.6. Density plots of Yellowtail Snapper fork lengths are shown in Figure 3.4.7 for 2017-2019 and 2023 (plotted separately).

3.4.4 Adequacy of Size Composition Data for Characterizing Catch

Due to reasonable levels of available data throughout the time series, TIP data can be considered to inform selectivity and annual population trends in the SEDAR 84 assessment. A high number of length and weight pairs flagged as possible outliers and further investigation into the filtering process will need to be executed to understand the reason those data were identified as outliers (Godwin et al 2024).

As necessary, the analysts will communicate the high uncertainty across the measurement units associated with the TIP data for Yellowtail Snapper. Additionally, further investigation into how the length-weight relationship varies by month and year (reflecting seasonality and variability in reproduction) is suggested.

The MER Consultants Yellowtail Snapper data in Puerto Rico reflects the size composition of fish landed in the commercial fishery and may be combined with TIP data.

3.5 SEDAR Panel Discussion of Commercial Statistics Data for Assessment Analyses

3.5.1 Adequacy of Commercial Landings Data

Issue 1: Are analysis-ready commercial landings data available for SEDAR 84?

Options:
- Use all available expanded landing data (starting in 1983) and using newly calculated 2020-2022 expansion/correction factors.
- Use all available expanded landing data (starting in 1983) and using coast-specific expansion factors averaged across the years 2014-2019 as proxy expansion factors to calculate 2020-2022 commercial landings.
- Truncate the time series if electronic logbook data are not available

Decision:
- Move forward using all available landings data and using coast-specific expansion factors averaged across the years 2014-2019 as proxy expansion factors to calculate 2020-2022 commercial landings.
- Acquire reports from the 1950s to the 1970s. Those reports may include additional species-specific information.

Rationale:
- These data represent the best and most complete information available.

Issue 2: How uncertain are the commercial landings?

Options:
- Consider uncertainty around the landings. (e.g. +/- 5%)
- Consider directional bias. (e.g. + 5%)

Decision:
- Consider uncertainty around the landings.

Rationale:
- This decision was based on the opinion of panel members.

Issue 3: Should data outliers in the commercial landings be flagged for additional investigation?

Options:
- Identify and flag outliers.
- Do not identify and flag outliers.

Decision:
- Conduct outlier analysis flagging by year and gear.

Rationale:
- Through the flagging process, we can identify outliers to investigate further, allowing us to understand the situations occurring within the fishery and their potential impact.

3.5.2 Adequacy of Discard and Discard Mortality Data

Issue 1: Do we have estimates of commercial discards and estimates of discard mortality?

Options:
- Identify a data source quantifying commercial discards.
- Do not consider discards.

Decision:
- Do not consider discards.

Rationale:
- Discard mortality was deemed negligible. Anecdotally, discard quantities are small, and most discarded fish survive.

Issue 2: Do we have estimates of recreational discards and estimates of discard mortality?

Options:
- Investigate the data further for consideration at the SEDAR 84 Assessment Workshop.
- Do not consider recreational discard data.

Decision:
- The assessment team and contributors will present the results of this investigation at the assessment workshop.

Rationale:
- It is crucial to explore the little available information.

3.5.3 Adequacy of Length Composition Data

Issue 1: Can the TIP size data be used for SEDAR 84 to inform selectivity?

Options:
- Use filtered TIP lengths available by year from 1983 to 2022.
- Do not use the data to inform SEDAR 84.

Decision:
- Consider TIP data to inform selectivity and annual population trends in the SEDAR 84 assessment.
- Apply filtering based on the condition factor.
- Supply complete TIP time series for use in SEDAR 84 investigations.

Rationale:
- Use the TIP data since there were reasonable levels of available data.
- Investigate the filtering process further. The high number of flagged pairs of length and weights need to be better understood. Alternatively, communicate high uncertainty across the measurement units associated with the TIP data for Yellowtail Snapper.

Issue 2: Are the pilot Yellowtail Snapper length-frequency image analysis data available for consideration in SEDAR 84?

Options:
- Do not consider the image analysis data in SEDAR 84.
- Combine image analysis data with TIP data for length frequency and size composition analysis.

Decision:
- Obtain the image analysis data so that it can be combined with TIP data for length frequency and size composition analysis.

Rationale:
- The image analysis data of Yellowtail Snapper in Puerto Rico data reflects the size composition of fish landed in the commercial fishery. Including this data with the TIP data would be entirely appropriate.

Issue 3: Are the seine net study data available for consideration in SEDAR 84?

Options:
- *Use the data in the size composition analysis.*
- *Do not use the data in the size composition analysis.*

Decision:
- Using the seine net data to investigate length-weight relationships to identify trends over time.

Rationale:
- The seine net data may also help inform the TIP outlier identification.

Issue 4: Should length composition analysis be performed on available recreational data?

Options:

- Consider this information.
- Do not consider this information.
- Investigate the dataset further.

Decision:

- Investigate the dataset further.

Rationale:

- It is crucial to explore the little available information.

3.6 Commercial Statistics Tables

Table 3.1.1 Commercial landings of Yellowtail Snapper in Puerto Rico from 1983-2022 reported in pounds by year and gear group.

Year	Lines	Seines	Traps	Other	Total landings
1983	149,406	25,970	86,535	12,731	274,642
1984	131,087	26,058	58,738	11,551	227,434
1985	144,349	12,145	70,487	23,561	250,542
1986	62,075	5,455	26,006	31,456	124,992
1987	73,055	1,856	24,742	23,371	123,024
1988	90,913	2,553	21,402	22,997	137,865
1989	123,814	13,088	23,140	18,500	178,542
1990	158,339	15,525	23,957	12,152	209,973
1991	224,461	11,469	38,528	16,816	291,274
1992	188,932	10,375	27,955	21,243	248,505
1993	236,203	18,335	30,267	20,143	304,948
1994	216,496	19,672	34,091	20,705	290,964
1995	351,076	8,930	30,454	18,991	409,451
1996	298,343	5,103	38,889	40,440	382,775
1997	277,622	5,512	34,534	32,134	349,802
1998	273,493	3,554	25,614	19,860	322,521
1999	300,224	5,277	29,267	21,774	356,542
2000	539,669	15,409	38,101	39,279	632,458
2001	380,300	17,982	33,130	33,715	465,127
2002	268,390	11,666	33,567	24,396	338,019
2003	222,036	19,559	25,663	14,943	282,201
2004	274,280	13,494	32,804	23,940	344,518
2005	232,924	3,771	15,780	9,601	262,076
2006	248,891	196	16,006	9,500	274,593
2007	189,707	132	8,711	7,887	206,437
2008	354,259	183	7,138	12,030	373,610
2009	196,272	1,935	17,915	6,470	222,592
2010	194,288	2,491	13,963	4,057	214,799
2011	127,667	1,383	10,434	10,105	149,589
2012	173,240	2,006	18,550	14,356	208,152
2013	111,739	2,079	12,363	5,086	131,267
2014	169,273	2,689	14,905	5,941	192,808
2015	156,712	2,216	14,652	4,011	177,591
2016	168,254	1,863	12,885	5,119	188,121
2017	109,539	2,029	8,768	5,002	125,338
2018	127,408	895	12,479	8,417	149,199
2019	142,782	336	11,913	9,262	164,293
2020	97,231	462	9,145	17,347	124,185
2021	113,007	132	12,699	23,143	148,981
2022	136,046	1,162	13,132	24,596	174,936

Table 3.1.2 Comparison of commercial landings of Yellowtail Snapper in Puerto Rico from 1983-2022 in relation to the outlier removal methods.

Year	Landings (no outlier removal)	Landings (outlier removal method 1)	Landings (outlier removal method 2)	Diff (method 1)	Diff (method 2)
1983	274,642	272,354	268,303	-1%	-2%
1984	227,434	225,728	223,160	-1%	-2%
1985	250,542	249,476	241,602	0%	-4%
1986	124,992	115,866	119,388	-7%	-4%
1987	123,024	110,585	116,893	-10%	-5%
1988	137,865	131,922	133,256	-4%	-3%
1989	178,542	170,217	171,512	-5%	-4%
1990	209,973	205,342	202,956	-2%	-3%
1991	291,274	285,211	282,720	-2%	-3%
1992	248,505	233,250	235,594	-6%	-5%
1993	304,948	283,662	290,127	-7%	-5%
1994	290,964	275,370	280,661	-5%	-4%
1995	409,451	389,674	391,947	-5%	-4%
1996	382,775	372,211	371,393	-3%	-3%
1997	349,802	328,188	335,542	-6%	-4%
1998	322,521	299,913	308,796	-7%	-4%
1999	356,542	336,897	343,957	-6%	-4%
2000	632,458	596,566	607,693	-6%	-4%
2001	465,127	433,541	446,612	-7%	-4%
2002	338,019	325,605	325,872	-4%	-4%
2003	282,201	275,807	272,098	-2%	-4%
2004	344,518	330,700	324,337	-4%	-6%
2005	262,076	253,478	251,652	-3%	-4%
2006	274,593	271,765	269,411	-1%	-2%
2007	206,437	203,520	201,544	-1%	-2%
2008	373,610	373,060	365,904	0%	-2%
2009	222,592	221,852	219,382	0%	-1%
2010	214,799	213,999	209,141	0%	-3%
2011	149,589	149,258	145,412	0%	-3%
2012	208,152	207,631	202,538	0%	-3%
2013	131,267	131,267	128,245	0%	-2%
2014	192,808	192,808	188,385	0%	-2%
2015	177,591	177,591	173,347	0%	-2%
2016	188,121	186,624	183,166	-1%	-3%
2017	125,338	124,004	121,405	-1%	-3%
2018	149,199	147,998	144,098	-1%	-3%
2019	164,293	161,539	159,455	-2%	-3%
2020	124,185	124,185	121,694	0%	-2%
2021	148,981	147,010	144,751	-1%	-3%
2022	174,936	174,936	170,123	0%	-3%

Table 3.3 Commercial trips with reported Yellowtail Snapper landings in Puerto Rico 1983-2022.

Year	Lines	Other	Seines	Traps	Total Trips
1983	3,785	378	390	4,359	8,912
1984	4,154	455	288	4,328	9,225
1985	5,277	1,077	286	4,540	11,180
1986	2,085	973	128	1,762	4,948
1987	1,753	368	31	1,246	3,398
1988	1,672	364	44	756	2,836
1989	2,836	244	118	998	4,196
1990	3,420	456	75	1,443	5,394
1991	5,219	557	232	2,495	8,503
1992	4,510	555	105	1,516	6,686
1993	5,661	733	149	1,960	8,503
1994	6,099	869	147	1,830	8,945
1995	12,496	1,551	343	3,757	18,147
1996	11,480	2,771	219	5,116	19,586
1997	11,719	2,550	342	4,115	18,726
1998	9,109	1,438	79	2,805	13,431
1999	11,686	2,351	171	3,839	18,047
2000	11,102	2,915	169	3,342	17,528
2001	10,750	2,572	219	3,221	16,762
2002	10,560	2,399	236	3,502	16,697
2003	4,130	712	93	1,367	6,302
2004	3,167	553	84	1,125	4,929
2005	2,918	368	27	781	4,094
2006	2,497	310	8	709	3,524
2007	2,117	374	13	419	2,923
2008	1,869	354	15	425	2,663
2009	1,761	352	36	514	2,663
2010	1,744	269	40	444	2,497
2011	2,042	349	23	408	2,822
2012	2,179	417	14	581	3,191
2013	2,596	241	12	724	3,573
2014	3,025	277	28	924	4,254
2015	2,885	250	52	936	4,123
2016	2,626	291	47	803	3,767
2017	1,729	219	29	519	2,496
2018	1,736	331	20	528	2,615
2019	2,422	323	21	721	3,487
2020	1,606	336	10	521	2,473
2021	2,120	431	6	661	3,218
2022	2,527	533	14	656	3,730

Table 3.4.1 Generalized linear mixed model (GLMM) analysis summary results for Puerto Rico TIP Yellowtail Snapper fork lengths (cm) from 1983 to 2022. The column "group" indicates the group(s) where mean lengths are not statistically different from other gears with matching group number(s). The "n" column indicates the number of unique lengths recorded for each gear. The "Percentage" column indicates the percent of the total recorded lengths for each gear. Shaded rows indicate gears with less than two percent of the total recorded lengths.

Gear	Mean	Estimated Marginal Mean	LCL	UCL	Group	Fish (n)	Interview (n)	Percentage	Gear Group
LINES HAND	30.03	3.38	3.37	3.40	5	79,750	2,644	76.50	Hand Line
HAUL SEINES	25.13	3.18	3.14	3.21	1	7,214	212	6.92	Haul Seine
POTS AND TRAPS; FISH	25.05	3.22	3.21	3.24	1,2	6,995	1,282	6.71	Haul Seine or Trap
BOTTOM LINE	29.70	3.38	3.35	3.42	5	4,776	204	4.58	Hand Line
ENTANGLING NETS (GILL) UNSPC	26.28	3.28	3.24	3.31	2,3,4	1,338	123	1.28	Trap, Net, or Diving
TRAMMEL NETS	27.55	3.31	3.28	3.33	3,4	1,005	224	0.96	Net or Diving
LINES LONG SET WITH HOOKS	27.59	3.35	3.30	3.40	3,4,5	634	61	0.61	Net, Diving, or Hand Line
BY HAND; DIVING GEAR	30.18	3.36	3.32	3.39	4,5	557	117	0.53	Diving or Hand Line
LINES POWER TROLL OTHER	30.29	3.39	3.32	3.45	3,4,5	419	36	0.40	Net, Diving, or Hand Line
FISH POT	25.09	3.25	3.21	3.29	1,2,3	369	99	0.35	Haul Seine, Trap, or Net
ROD AND REEL	27.61	3.35	3.28	3.42	2,3,4,5	366	32	0.35	Trap, Net, Diving, or Hand Line

POTS AND TRAPS; SPINY LOBSTER	28.56	3.31	3.20	3.42	1,2,3,4,5	235	14	0.23	Haul Seine, Trap, Net, Diving, or Hand Line
BEACH SEINE	27.96	3.24	3.09	3.39	1,2,3,4,5	177	7	0.17	Haul Seine, Trap, Net, Diving, or Hand Line
LONGLINE	31.30	3.34	3.23	3.46	1,2,3,4,5	78	10	0.07	Haul Seine, Trap, Net, Diving, or Hand Line
SCUBA DIVING	29.52	3.32	3.25	3.39	1,2,3,4,5	48	29	0.05	Haul Seine, Trap, Net, Diving, or Hand Line
TRAMMEL NET	27.50	3.35	3.24	3.46	1,2,3,4,5	45	11	0.04	Haul Seine, Trap, Net, Diving, or Hand Line
LOBSTER POT	23.34	3.19	3.07	3.31	1,2,3,4,5	28	10	0.03	Haul Seine, Trap, Net, Diving, or Hand Line
GILL NET	27.57	3.31	3.15	3.47	1,2,3,4,5	22	5	0.02	Haul Seine, Trap, Net, Diving, or Hand Line
NOT CODED 000	24.20	3.21	3.05	3.38	1,2,3,4,5	23	4	0.02	Haul Seine, Trap, Net, Diving, or Hand Line
SKIN DIVING	31.04	3.40	3.20	3.59	1,2,3,4,5	18	4	0.02	Haul Seine, Trap, Net, Diving, or Hand Line
TROLL LINE	24.86	3.29	3.10	3.48	1,2,3,4,5	16	3	0.02	Haul Seine, Trap, Net, Diving, or Hand Line

3.7 Commercial Statistics Figures

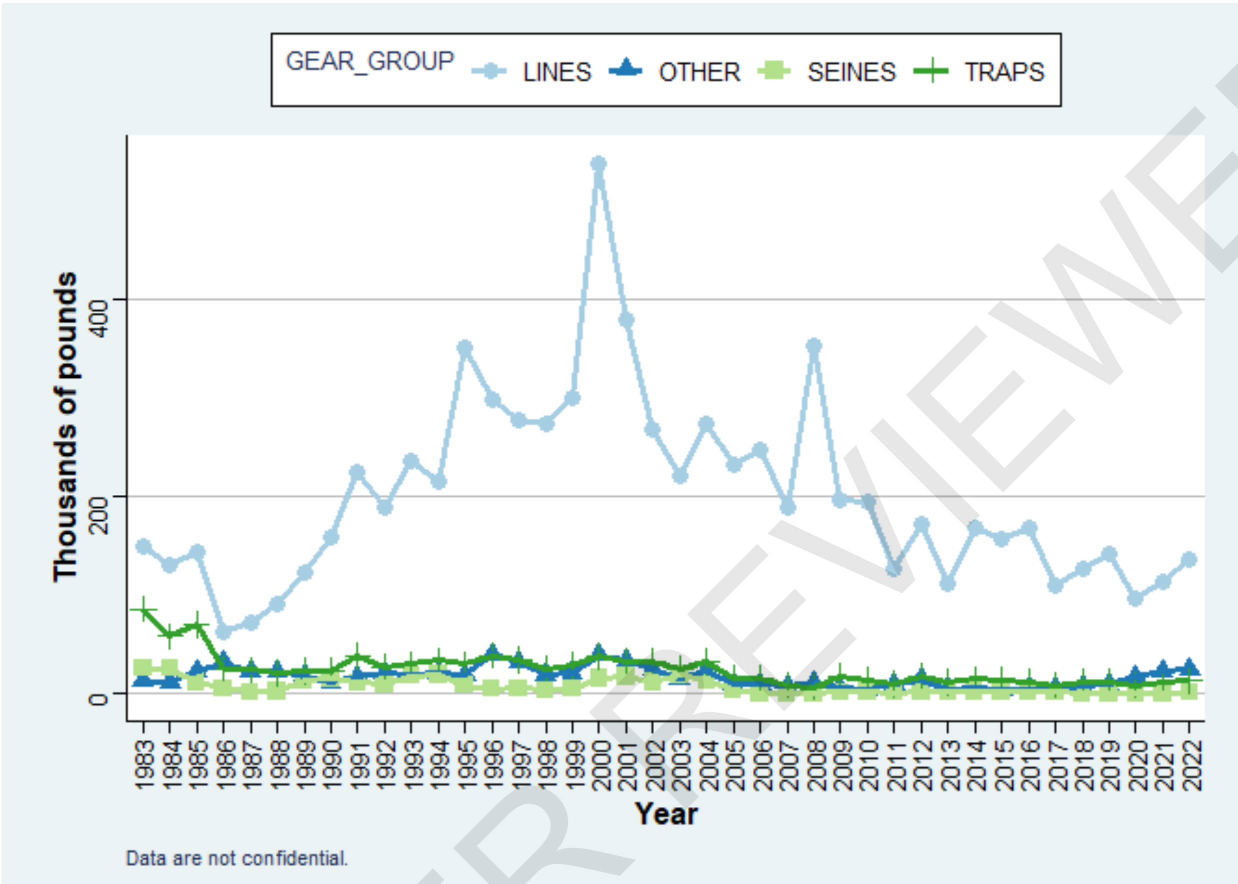

Figure 3.1.1 Commercial landings in pounds of Yellowtail Snapper by year and gear group in Puerto Rico.

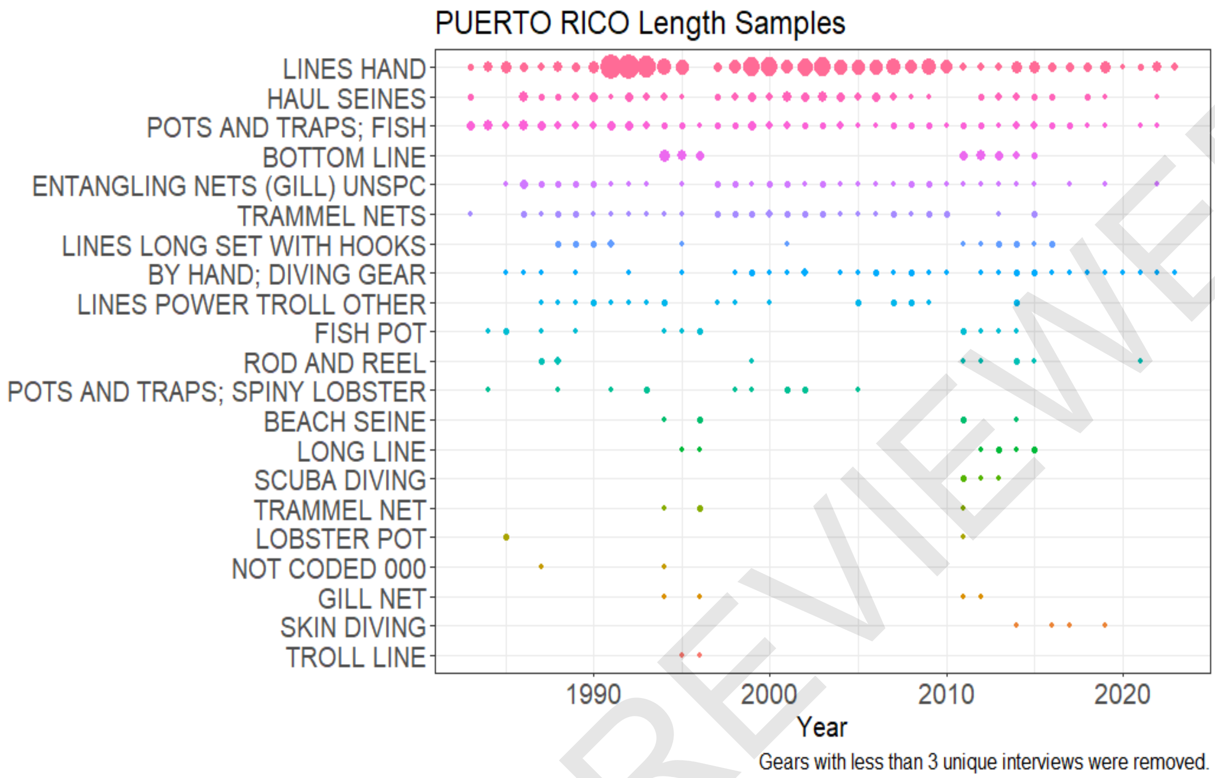

Figure 3.4.1 Plot showing relative number of Yellowtail Snapper lengths in Puerto Rico across time collected. Each point is color specific to the gear it represents. Gears are arranged from largest to smallest sample size of individual recorded lengths.

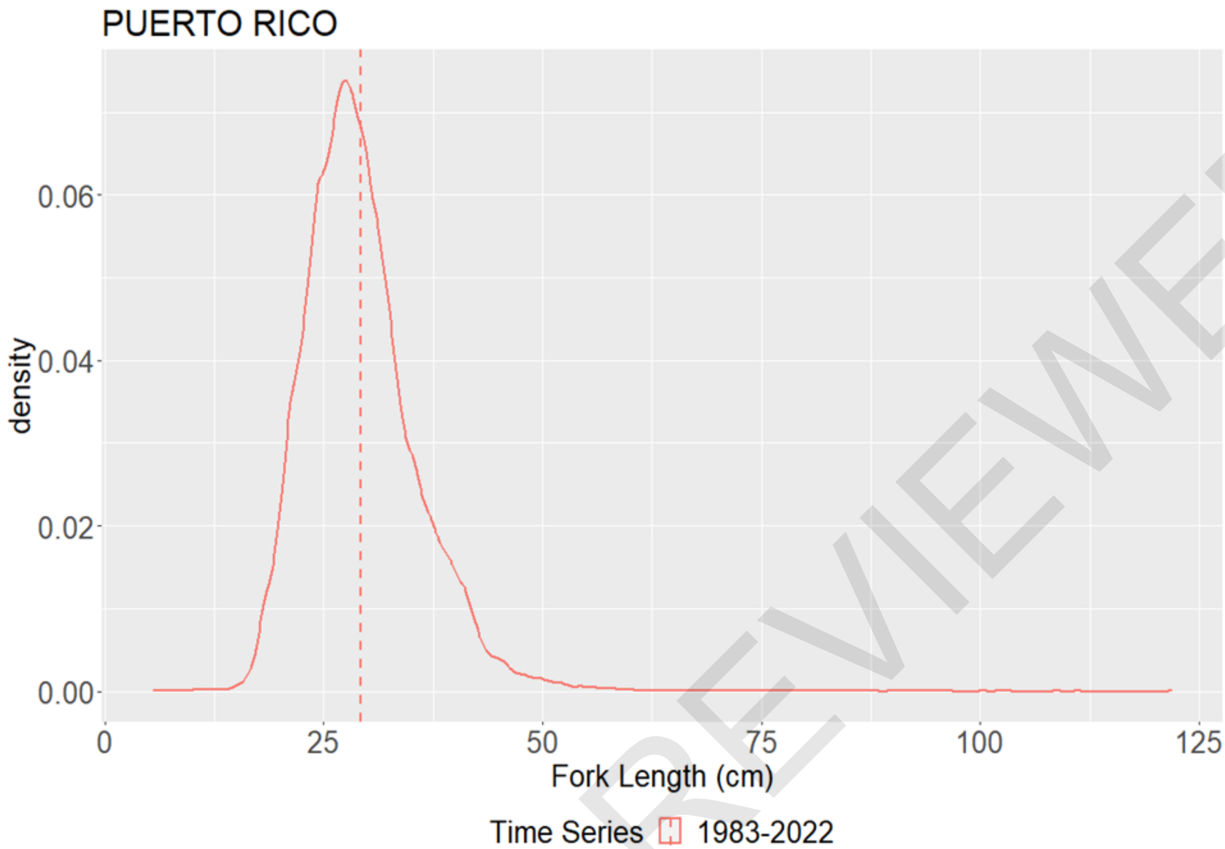

Figure 3.4.2 Aggregated density plot of lengths (cm) of Yellowtail Snapper in Puerto Rico, all gears combined. Dotted line represents mean length (29.22cm).

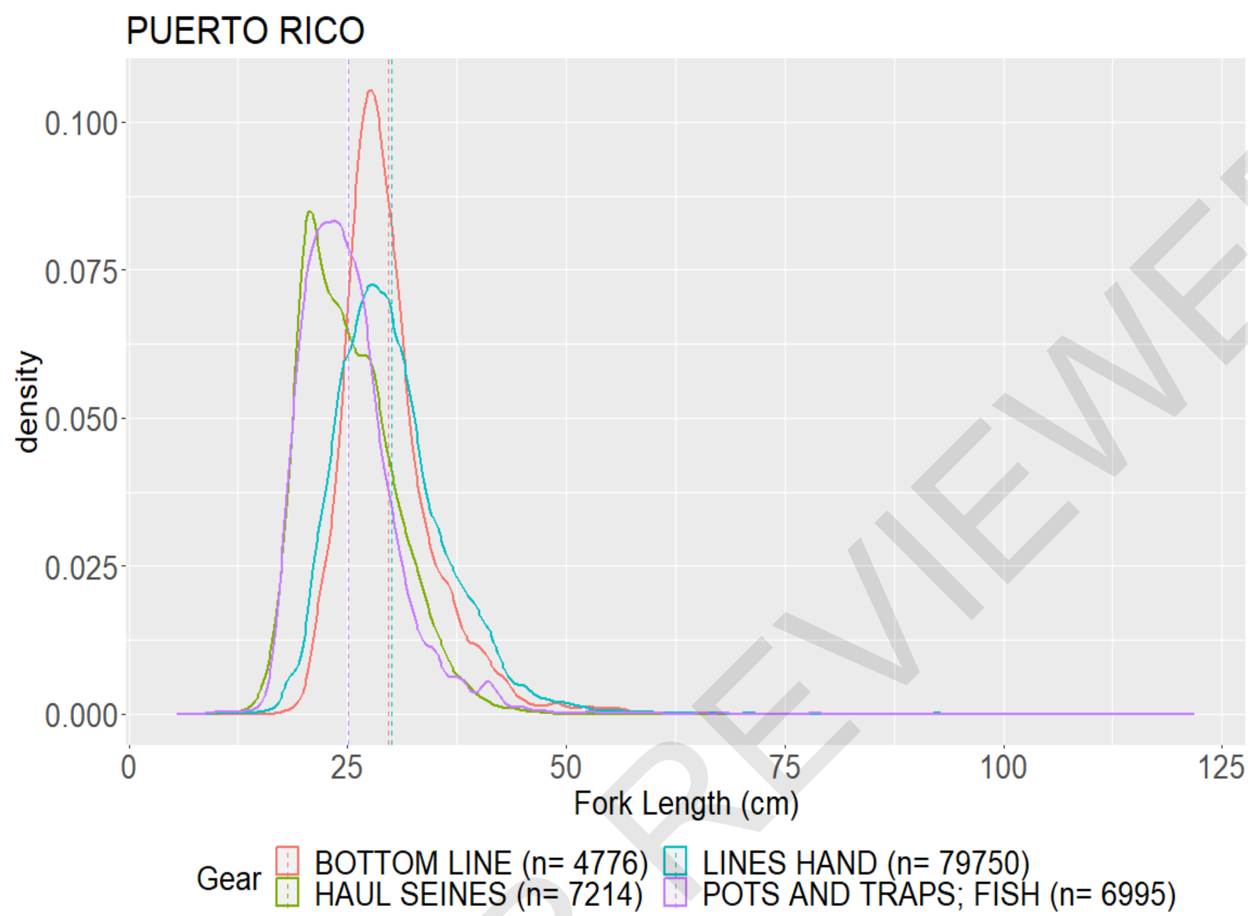

Figure 3.4.3 Aggregated density plot of lengths (cm) by gears with greater than 2% of total samples of Yellowtail Snapper in Puerto Rico from 1983 to 2022. Dotted line represents mean length. Mean lengths by gear can be found in Table 3.4.1.

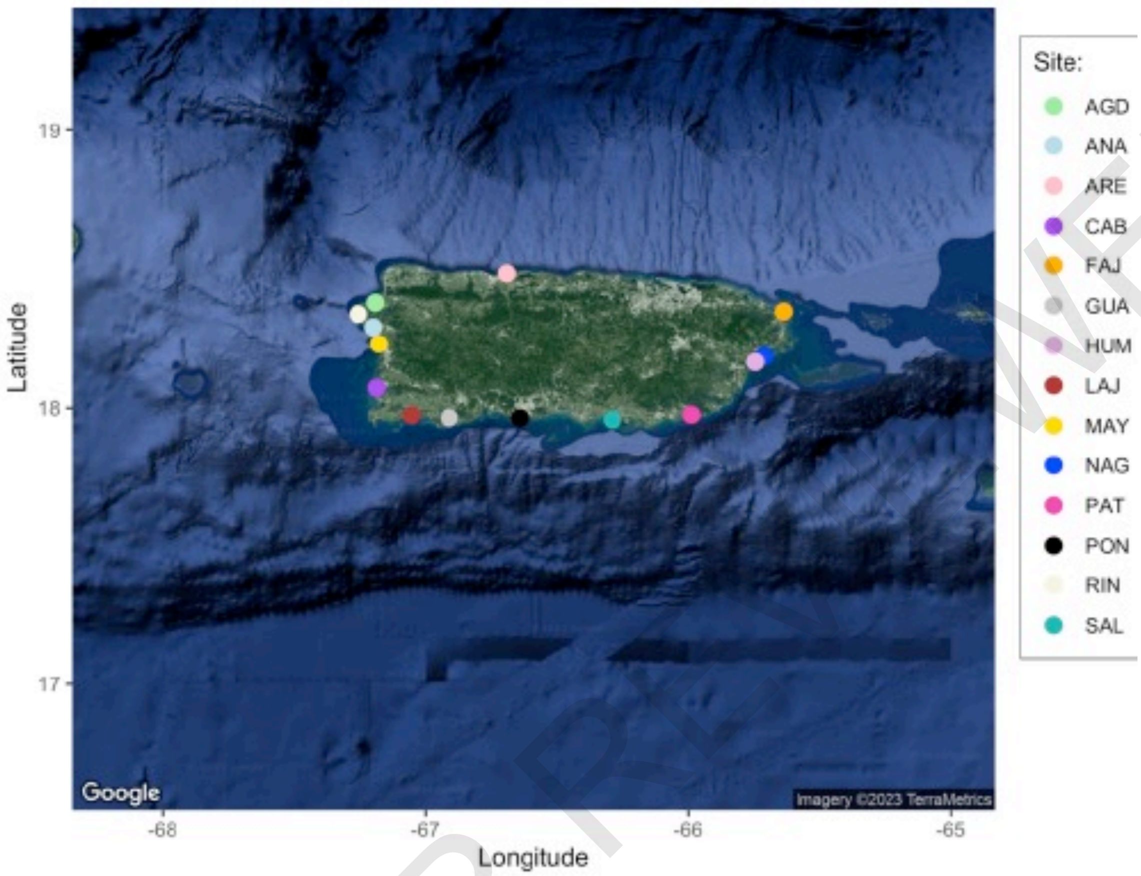

Figure 3.4.4 Map of the MER Consultant 2023 port sampling study.

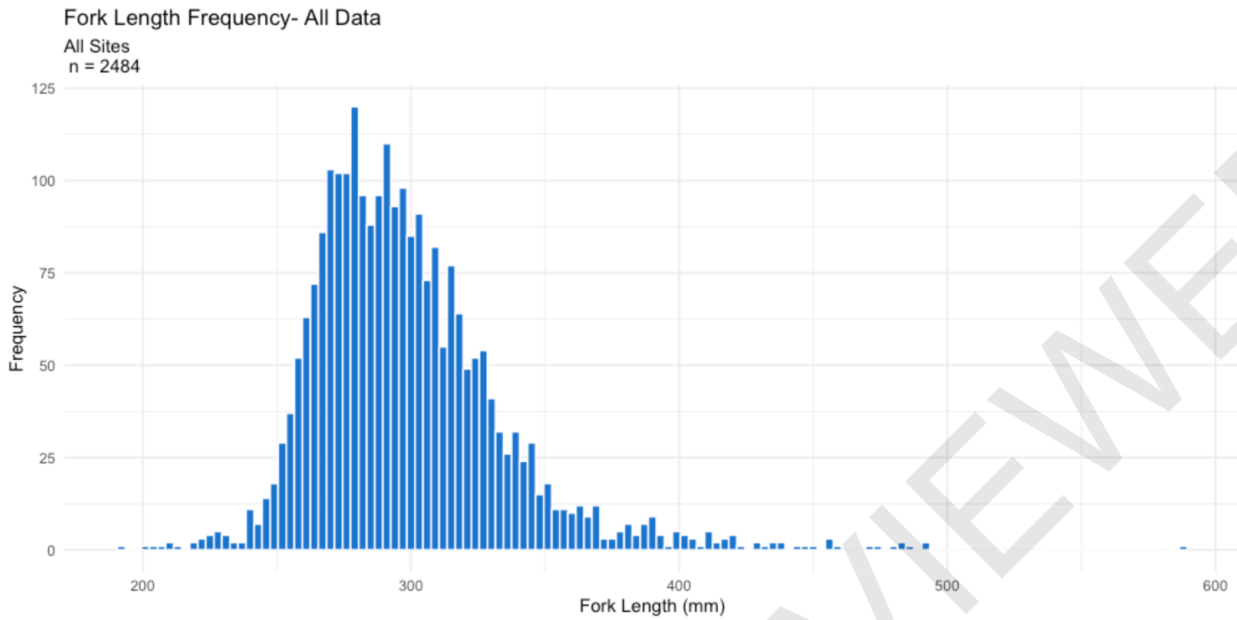

Figure 3.4.5 Digitally measured fork length frequency histogram of Yellowtail Snapper for 2023 and 2017-2019 datasets.

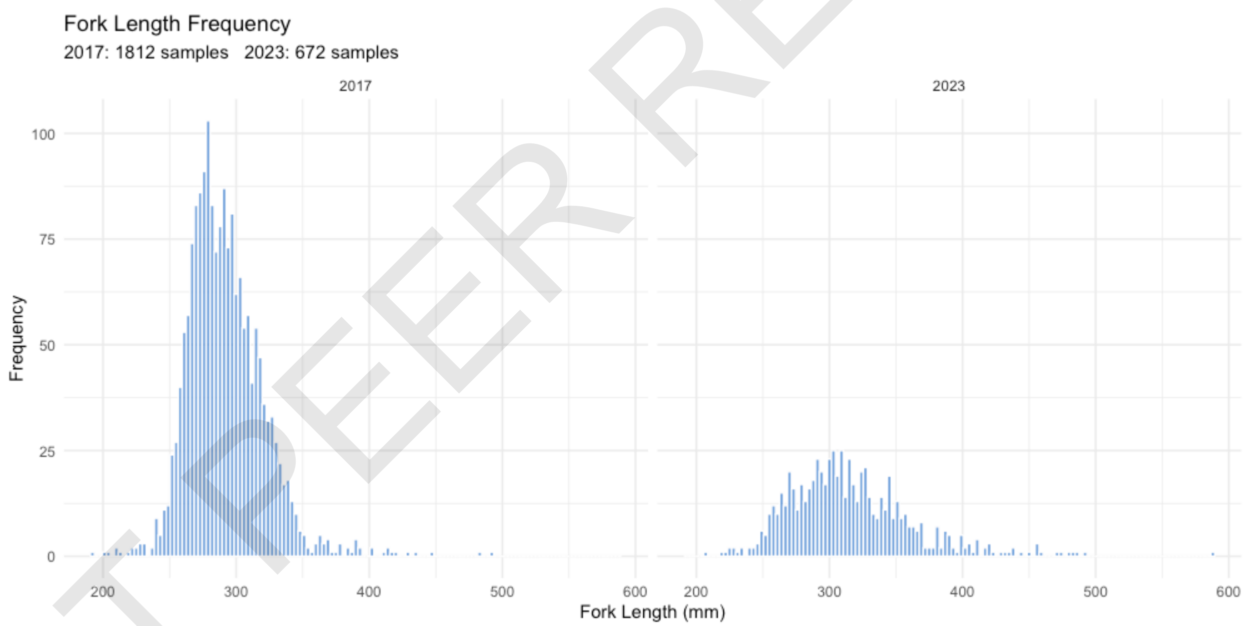

Figure 3.4.6 Digitally measured fork length frequency histogram of Yellowtail Snapper for 2023 and 2017-2019 datasets. Note: plot labeled 2017 includes data from 2017-2019.

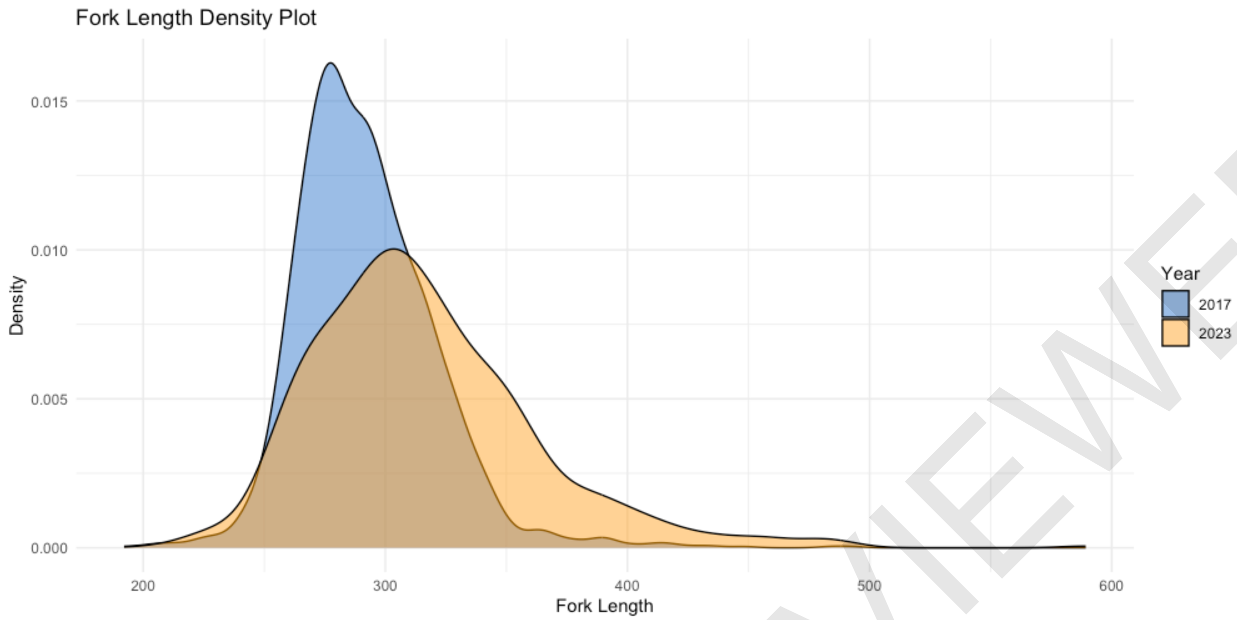

Figure 3.4.7 Density plot of Yellowtail Snapper fork lengths by subsets. Note: plot labeled 2017 includes data from 2017-2019.

4 Recreational Fishery Statistics

4.1 Overview

Overview of Yellowtail snapper (*Ocyurus chrysurus*) available for SEDAR 84 collected in the Department of Natural and Environmental Resources' Marine Recreational Fisheries Statistics Program.

4.2 Summary

The Puerto Rico Marine Recreational Fisheries Statistics Program has been collecting information on fishing tournaments since 2000. The goal is to estimate tournament landings and/or releases by kilogram and catch per unit effort of marine recreational anglers. These data are utilized to examine biostatistical and socioeconomic statistics, as well as on-site effort, landings, and/or release data, all of which are useful for Puerto Rico fishery management. Tournament surveys cover pelagic, reef, and shore fishing competitions.

4.3 Methodology

Then, project staff attended each tournament and collected the landings and/or releases data as well as total effort information from records (logbooks) and collected biometrical data. These include information on sex (whenever possible), length, weight, and species identifications as a minimum.

From the period of 2000-2022 a total of 824 fishing tournaments have been visited by project staff, of those 63 had yellow tail snapper reported as catch (Table 4.1, Figure 4.1). It should be noted that Yellowtail Snapper is not the target species in any fishing competitions.

Among the tournament fishing modes that were sampled, Yellowtail Snapper was mentioned in the reports from shore and kayak fishing competitions. It's important to note that these shore-based competitions are mostly catch-and-release affairs with an emphasis on youth participation (Figure 4.2).

Available MRIP data are still being analyzed and the SEDAR DW Panel recommended that those MRIP data for Puerto Rico be fully reviewed at the Assessment Workshop.

4.4 SEDAR Panel Discussions on Use of Recreational Landings Data for Assessment Analyses

Issue 4: Are analysis-ready recreational landings data available for SEDAR 84?

Options:

- Investigate the MRIP and Puerto Rico Marine Recreational Statistics Program data further for consideration at the SEDAR 84 Assessment Workshop.
- Do not use the recreational landings data.

Decision:

- The assessment team and contributors will present the results of this investigation at the assessment workshop.

Rationale:

- It is crucial to explore the little available information

4.5 Recreational Landings Tables

Table 4.1 List of marine fishing tournaments that reported Yellowtail Snapper *(Ocyurus. chrysurus*) as catch.

Year	Number of tournament	Total number of fish reported	Number of Yellow tail snapper fish mearsured	Number of yellow tail weight
2000	1	10	10	10
2005	1	4	0	4
2009	2	23	23	19
2010	2	6	6	5
2011	3	20	20	18
2012	5	17	17	15
2013	5	48	16	42
2014	9	33	16	24
2015	8	67	56	13
2016	5	33	24	9
2017	9	42	41	5
2018	1	7	5	6
2019	7	48	41	34
2021	2	2	0	2
2022	3	6	7	2
Total	**63**	**366**	**282**	**208**

4.6 Recreational Landings Figures

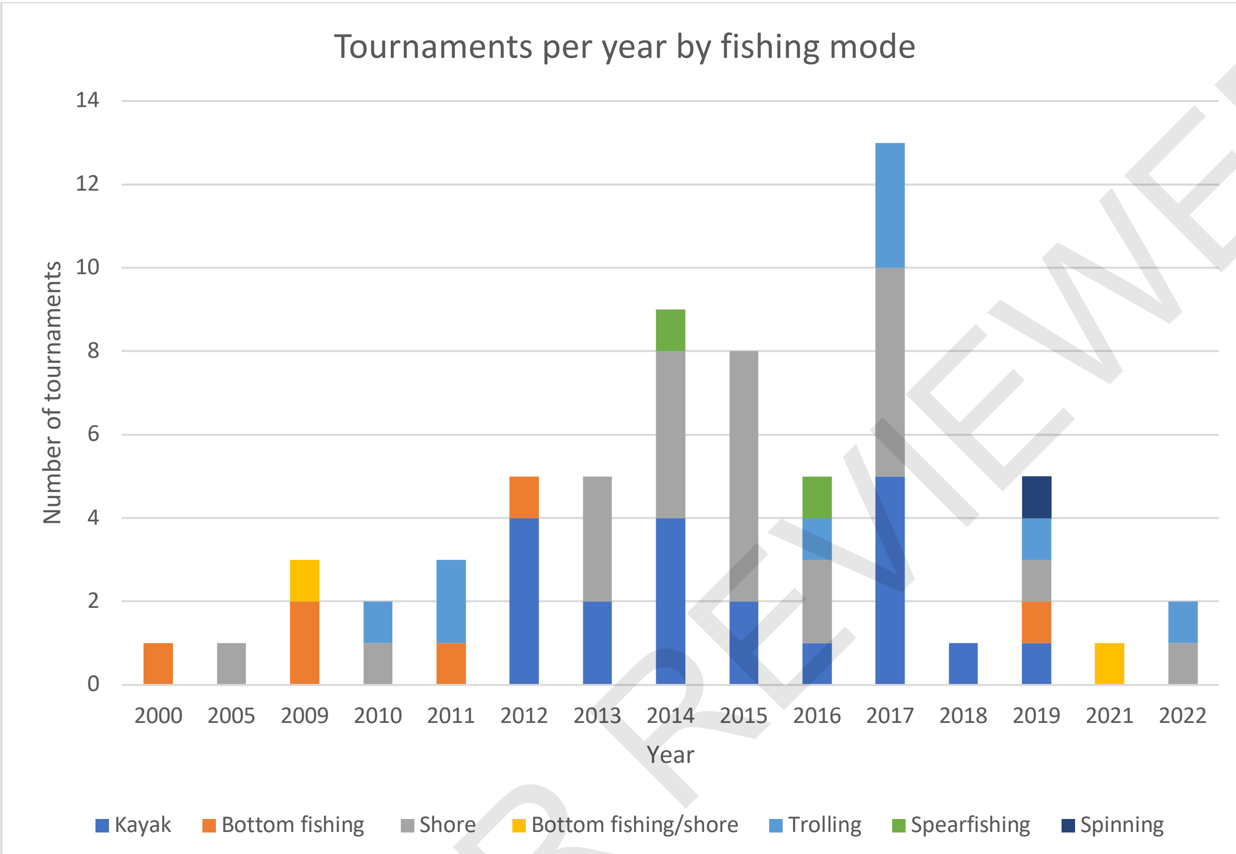

Figure 4.1 Fishing tournament type by year where Yellowtail Snapper (*Ocyurus. chrysurus)* was reported as catch.

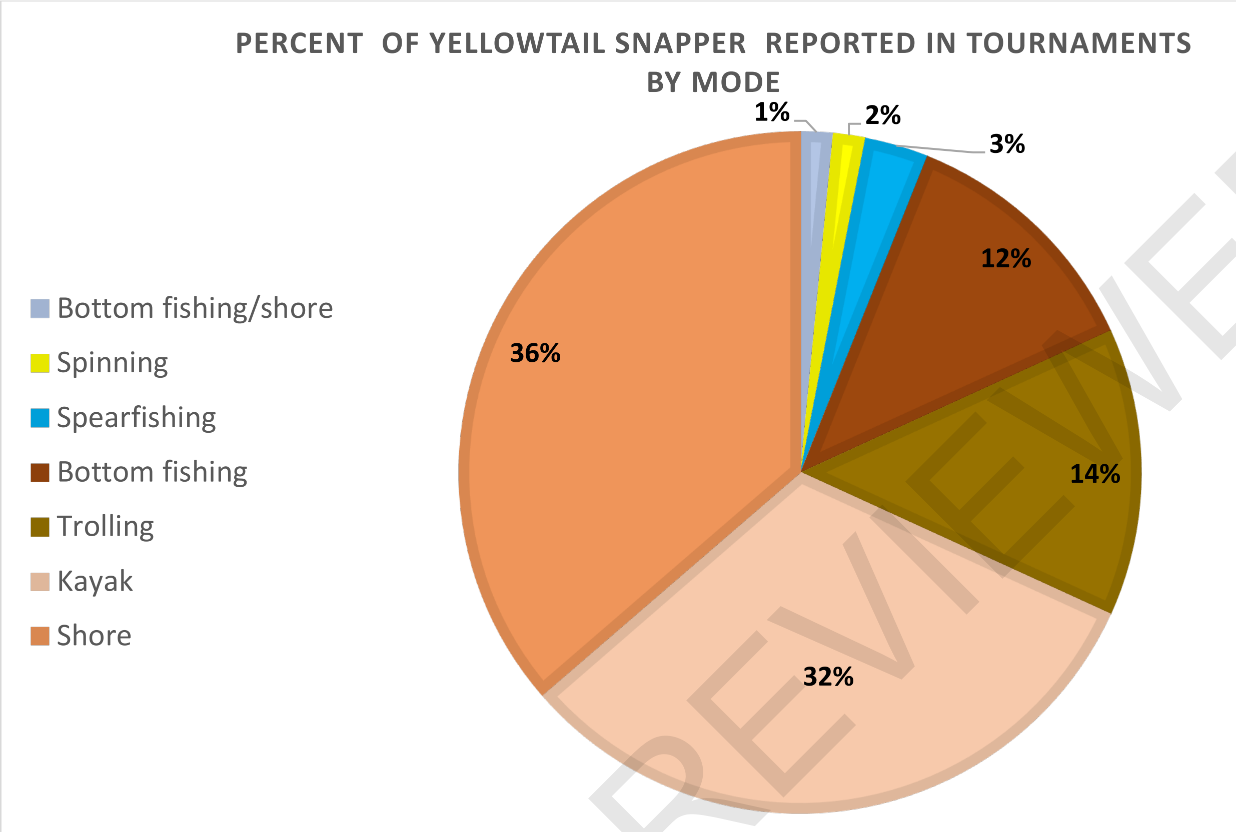

Figure 4.2 Percent of Yellowtail Snapper Reported in tournaments by fishing mode.

5 Measures of Population Abundance

5.1 Overview

The SEDAR 84 DW Panel reviewed several measures of abundance from both fishery independent and fishery dependent data sources during the workshop. The following sections briefly summarize those data or provide references that summarize the methods and data

5.2 Review of Working Papers

SEDAR84-DW-15 (Ingram et al 2024): Analysis of SEAMAP-C hook and line survey data for Yellowtail Snapper summarized the analysis of the fishery independent SEAMAP-C hook & line survey data for Yellowtail Snapper in Puerto Rico from 1992 through 2020.

SEDAR84-DW-16 (Blondeau et al 2024): NCRMP FI Survey of Yellowtail Snapper (*Ocyurus chrysurus*) in USVI U.S. Caribbean summarized NCRMP survey data for Yellowtail Snapper in Puerto Rico from2014 to 2022.

5.3 Fishery Independent Surveys

5.3.1 Analysis of SEAMAP-C Hook and Line survey

The Southeast Area Monitoring and Assessment Program Caribbean Survey (SEAMAP-C) is aimed at determining abundance and seasonal fluctuations of commercially exploited species in selected areas.

Recently, all the available SEAMAP-C finfish data from the U.S. Virgin Islands and Puerto Rico since its inception in 1989 through 2022 have been archived into a "Gold Copy." These fishery-independent data were collected through survey methods that include trap fishing and hook and line data. These SEAMAP-C data were analyzed to determine if there are trends that exist in abundance for Yellowtail Snapper (YTS) in eastern and western Puerto Rico and both areas combined.

The analyses focused on hook and line survey data, since it contained the largest number of samples of the longest series of time. The SEAMAP-C data for Puerto Rico consisted of five Sampling Programs extending from 1992-2020. During each of these Sampling Programs, hook and line methodologies differed to align with the different priorities of each program.

The reef fish survey officially began in 1992 as a SEAMAP survey in Puerto Rico. Until 2004, sampling was conducted using two gears: hook-and-line and fish traps. The use of fish traps ceased in 2006, and hook-and-line is now the primary gear used for this survey. In 2016, the reef fish survey was revamped and expanded to include video and bottom longline to complement the hook-and-line gear.

The Sampling Programs used differing numbers of lines, numbers of hooks per line, numbers of gear immersions, total sampling time, and hook types. Also, during early Sampling Programs the vessel was set to drifting, while later the vessels were anchored during sampling. During the earlier Sampling Programs, stations were randomly selected from of 2 x 2 nautical miles quadrats off the west and east insular shelves. During later Sampling Programs, sample site selection included a two-factor random stratified sampling design based on depth and benthic habitat type within the 50-fathom contour of eastern and western Puerto Rico. During all Sampling Programs, all YTS were counted, weighed and measured.

In order to calculate the CPUE of YTS collected by hook and line surveys from Puerto Rico, the number of YTS were divided by the product of the number of lines per vessel, the number of hooks per line, and the time spent sampling. Due to the differences in methodologies and research focus between Sampling Programs, resulting effort estimations were very different. In addition, these differing methodologies are confounded in time. The CPUE data were standardized before employing the delta-lognormal model, by first calculating the CPUE as above, and then standardize that CPUE to a mean of one within each Sampling Program. The variables employed in the delta-lognormal model included year, quarter, position method (i.e., anchored or drifting), hook type (J or C) and survey area (east or west Puerto Rico) for the combined model. Models were constructed using a backward selection procedure, based on Type 3 tests of significance, and residual analyses were used to determine model performance. Finally, length frequencies for all specimens combined, by gear year (i.e., hook and line, longline, and trap), by year, and by gear and are provided.

Figure 5.3.1 is a chart of all hook and line survey stations used in this analysis. Figure 5.3.2 and Table 5.3.1 summarize the time series of hook and line indices for eastern and western Puerto Rico combined. Due to the changes in methodologies and research focus between Sampling Programs being confounded in time, the standardization technique of scaling the CPUE to a mean of one within each Sampling Program could mask changes in abundance trends. It was decided that it would be best to use an index based on the NCRMP data rather than the SEAMAP-C data, since the data provided with NCRMP are more stable and consistent in terms of methodology.

5.3.2 National Coral Reef Monitoring Program (NCRMP)

Methods, Gears, and Coverage (Map Survey Area)
This section outlines the data and methodologies used to estimate density and abundance-at-length compositions for the SEDAR84 Yellowtail Snapper Assessment for Puerto Rico.

For more background details about the reef visual survey program (historic and NCRMP), methodology, data, and sampling coverage including maps of all survey sites completed by year (2001–2019) in each U.S. Caribbean sampling domain (Puerto Rico, St. Thomas/St. John, and St. Croix) see SEDAR80-WP-02 (Grove et al. 2021). Sampling in 2021 had similar island-wide coverage for each of the island assessments as previous NCRMP surveys. Total sample sites in Puerto Rico 2021 was 234 (Figure 5.3.3)

Two levels of calibration were needed to incorporate historical transect data. First, we analyzed the regionally restricted transect data from 2001 to 2013 in La Parguera in Puerto Rico. We determined that similar density distributions existed within strata between the regional data and whole island-wide data, and that each strata was represented in the sampling for proper area weighting. Secondly, a robust method calibration was conducted to convert belt transect (BT) densities (2001–2015) to RVC stationary point count (RVC-SPC) densities (2016–2021). In short, paired BT and RVC-SPC sampling was conducted a number of times within each survey strata. Density and occurrence were modeled in a two-stage GLM regression using a "delta" framework for estimation of the gear correction (method calibration) factors. The method calibration factor was then applied to the BT dataset prior to any domain level estimations (Ault et al. 2020). For more details, see Grove et al. 2022 Appendix I.

Domain-wide density and variance estimates were calculated using standard stratified random design-based principles (Smith et al. 2011). Metric estimates and associated variance were computed in each strata and multiplied by the stratum weighting factor. Area weighted stratum density and variance was then summed across all strata for the final domain wide estimate. All density data are presented as reef visual census stationary point count (RVC-SPC) estimates (number per 178 m2, ± SE). For more details, see Grove et al. 2022 Appendix II. Three different time series estimates of density are presented in this working paper and made available as complete datasets; 1) population-level estimates include all sizes of Yellowtail Snapper surveyed, 2) pre-exploited density estimates filters sizes to only include those that are less than minimum size limit (12 inches TL), set by management, in federal waters and 3) exploited density estimates filters sizes to include all sizes greater than or equal to 12 inches TL (or, 25cm FL).

Sampling Intensity – Time Series

Sampling Intensity and the time series of the NCRMP reef survey in Puerto Rico is illustrated in Table 5.3.2. Sampling began in 2001 and was conducted every year from 2001 to 2012 and then from 2014, 2016, 2019 and 2021. Samples were divided to 0-12m and the 12-30m strata. Sampling was only conducted on hard-bottom strata which were distinguished into five categories (shown in alphabetical order)

- Aggregate
- Bedrock
- Patch
- Pavement
- Coral/Rock

Additional information of sampling intensity consisted of total number observations of Yellowtail Snapper and the number of lengths measured, each by year.

Size Data

Length size frequency distribution of Yellowtail Snapper on Puerto Rico are shown for 2016, 2019, and 2019 in Figure 5.3.4.

Catch Rates in Numbers per Area Sampled

The time series of estimated mean Yellowtail Snapper population density in numbers per sampled area, i.e. per 178 m^2 +/- SE, is shown Figure 5.3.5. In addition, a time series of estimated population density of the pre-exploited phase. i.e., fish <25cm fork length, was constructed and compared to that of the exploited phase fish, i.e., > 25cm, in Figure 5.3.6.

5.4 Fishery-Dependent Measures

5.4.1 Overview

U.S. Caribbean commercial logbook (CCL) landings and effort were used to construct nominal indices of abundance. CCL data are self-reported. The time series for a Puerto Rico fishery dependent index of abundance include the years 1991 through 2019. Due to inconsistencies between databases that require exploration, the years 2020-2022 are not included in the analysis. Data years prior to 1991 were excluded due to changes in minimum size regulations.

Based on the generalized linear mixed model analysis of TIP size composition data (Table 3.4.1), data from the gears bottom_line, long_line_ rod_reel, and hand_line were combined into a single gear, Lines, and a nominal index was constructed.

5.4.2 Methods of Estimation

Effort variables explored for constructing a nominal index of abundance included,

- Numbers of trips
- Gear hours
- Gear quantity

The variable gear hours had sufficient data to calculate CPUE as: pounds of Yellowtail Snapper landed/gear hours fished. Gear quantity data were insufficiently reported over time to calculate CPUE. Trips as an effort measure was considered to lack sufficient detail to provide a meaningful effort measure. A plot of CPUE (as calculated using gear hours) over effort is shown in Figure 5.4.1. CPUE should not be affected by increasing effort (although catch likely will);

i.e., the slope should be zero. The very small negative slope of CPUE based upon gear hours plotted over effort suggests that gear hours is an appropriate effort measure.

5.4.3 Sampling Intensity

All commercial fishers are required to report landings and effort to CCL. CCL reporting is therefore considered to be a census of commercial landings and fishing effort, however underreporting and misreporting are known issues in Puerto Rico.

5.4.4 Size/Age data

CCL includes only landed fish, therefore TIP data provides size composition data for this index

5.4.5 Catch Rates – Number and Biomass

Catch rates throughout the time series in pounds per gear hour fished are shown Figure 5.4.2. Nominal catch rates are shown; i.e., this CPUE series has not been standardized to account for fishing practice and other effects that may mask true trends in abundance.

5.4.6 Uncertainty and Measures of Precision

Coefficients of variance (CV) around the nominal CPUE index were large, particularly prior to 2012 (Figure 5.4.1).

5.5 SEDAR Panel Discussions of Indices Data for Assessment Analyses

Issue 1: Should the fishery-independent density estimates from SEAMAP-C be used in SEDAR 84?

Options:
- Use the SEAMAP-C data.
- Do not use the SEAMAP-C data.

Decision:
- Do not use the SEAMAP-C data.

Rationale:
- The data provided with NCRMP are more stable and consistent regarding methodology. It is best to use the NCRMP data rather than the SEAMAP-C data.

Issue 2: Should the fishery-independent density estimates from NCRMP be used in SEDAR 84?

Options:
- Use the density estimates and length composition data from 2014 forward, which includes years calibrated to account for the transition from belt transect to cylinder survey method.
- Use all years of data, 2001-2022, with the caveat that data from 2001-2011 was not an island-wide survey.
- Do not use NCRMP data for constructing an index of abundance.

Decision:
- Start the index at the domain-wide (island-wide) survey beginning in 2014.

Rationale:
- The NCRMP survey is the most consistent island-wide survey available.

Issue 3: Should the commercial fishery-dependent data be used to conduct an index?

Options:
- Consider this information.
- Do not consider this information.
- Investigate the dataset further.

Decision:
- Do not consider this information for an abundance index.

Rationale:
- Concerns with the commercial fishery-dependent data set include questionable data values and incomplete effort units. The data are inconsistent across years. Additionally, the panel has recommended the fishery-independent data for an index.
- Time spent fishing does not necessarily translate to nominal CPUE, equating to where you could look at patterns over time. Experienced commercial fishers know how to target the species effectively, which may differ from inexperienced fishers. Therefore, we must include other aspects within the index to make it more representative.

Issue 5: Can the recreational data be used to develop an abundance index?

Options:
- Explore constructing an abundance index.
- Do not explore an abundance index using recreational data.

Decision:
- Do not explore an abundance index using recreational data.

Rationale:
- Data are insufficient (sample sizes too low) for index construction.

5.6 Measures of Population Abundance Tables

Table 5.3.1 SEAMAP-C sample size modeled index (with 95% CL), nominal index, nominal frequency, and CV by year for eastern and western Puerto Rico combined.

Year	N	Nominal Frequency	Nominal Index	Index	LCL	UCL	CV
1991	35	0	0	0	0	0	
1992	111	0.02703	0.02402	0.01285	0.00336	0.04922	0.75477
1993	141	0.04965	0.04413	0.02555	0.00971	0.06717	0.51305
1994	120	0.04167	0.04444	0.02099	0.00691	0.06373	0.60114
1995	35	0.08571	0.07619	0.058	0.01521	0.22115	0.75157
1996	0						
1997	56	0.01786	0.01587	0.00474	0.00068	0.03291	1.2477

1998	13	0	0	0	0	0	
1999	9	0.11111	0.09877	0.06296	0.00936	0.42329	1.21611
2000	33	0.18182	0.26936	0.10686	0.03743	0.30508	0.56276
2001	29	0.06897	0.0613	0.04614	0.00974	0.21867	0.91185
2002	0						
2003	0						
2004	15	0	0	0	0	0	
2005	59	0.0678	0.0678	0.04369	0.01315	0.14515	0.65873
2006	16	0.0625	0.125	0.07791	0.01137	0.53391	1.23481
2007	0						
2008	0						
2009	88	0.25	0.01244	0.01005	0.00575	0.01755	0.28428
2010	100	0.39	0.49366	0.15251	0.09907	0.23477	0.21822
2011	37	0.51351	0.67387	0.55166	0.3065	0.99293	0.30032
2012	66	0.33333	0.4612	0.76174	0.45029	1.2886	0.26746
2013	165	0.31515	0.31593	0.23	0.15453	0.34232	0.20082
2014	58	0.39655	0.35584	0.16145	0.09269	0.28124	0.28292
2015	15	0.73333	0.90204	1.30665	0.71291	2.39491	0.31002
2016	52	0.38462	0.21627	0.0758	0.03795	0.15139	0.35648
2017	230	0.36087	0.39005	0.58618	0.39701	0.86549	0.1967
2018	88	0.13636	0.15593	0.02062	0.0085	0.05	0.4656
2019	254	0.08268	0.07458	0.05096	0.02684	0.09673	0.32889
2020	35	0.22857	0.2381	0.49542	0.21606	1.13598	0.43344

Table 5.3.2 Number of reef fish visual survey sites by hard-bottom strata and depth categories per year from the reef fish visual surveys in the Puerto Rico coral reef ecosystem (2001–2021). Empty cells indicate zero samples. Length totals represent the number of individual length observations recorded.

	0 - 12 meters					**12 - 30 meters**						
Year	**Aggregate**	**Bedrock**	**Patch**	**Pavement**	**Coral/Rock**	**Aggregate**	**Bedrock**	**Patch**	**Pavement**	**Coral/Rock**	**Site Total**	**Length Total**
2001	15		6	5		2		5	3		**36**	**42**
2002	21		11	9	1	5		8	15	1	**71**	**93**
2003	18		16	3	2	8		15	20		**82**	**90**
2004	16		12	7	5	17		13	11	2	**83**	**66**
2005	17		7	5	1	20		14	24	7	**95**	**72**
2006	10		5	10		42		9	21	3	**100**	**155**
2007	21		18	28	1	46		14	36	9	**173**	**288**
2008	7		4	8		30		7	25	5	**86**	**92**
2009	18		12	8		42		5	24	7	**116**	**244**
2010	13		1	14		12		10	16	8	**74**	**116**
2011	6		3	9	1	3		5	19	5	**51**	**138**
2012	1		1	8		11		2	12		**35**	**165**
2014	31	14	19	36	6	42	4	20	37	14	**223**	**522**
2016	24	7	14	38	8	48	2	27	57	15	**240**	**670**
2019	38	10	16	28	9	42	1	16	27	16	**203**	**872**
2021	29	8	14	46	4	48	2	28	43	12	**234**	**1,238**

5.7 Measures of Population Abundance Figures

Figure 5.3.1 SEAMAP-C Hook and line survey sampling positions around Puerto Rico.

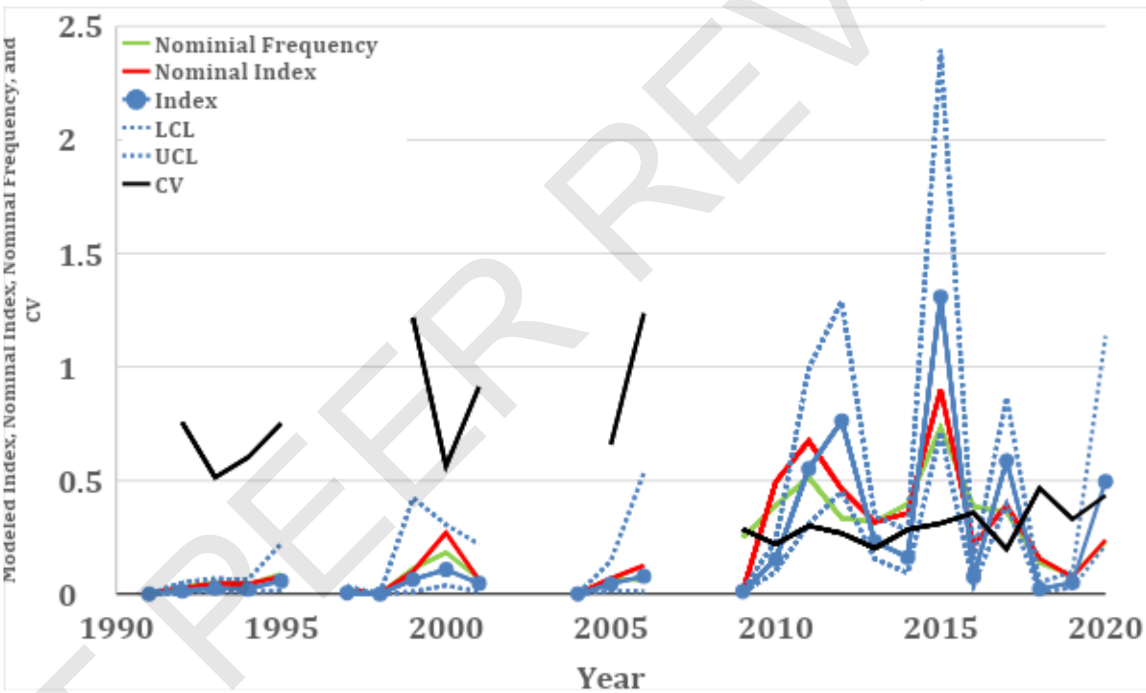

Figure 5.3.2 The modeled index (with 95% CL), nominal index, nominal frequency, and CV plotted by year for eastern and western Puerto Rico combined based on SEAMAP-C data.

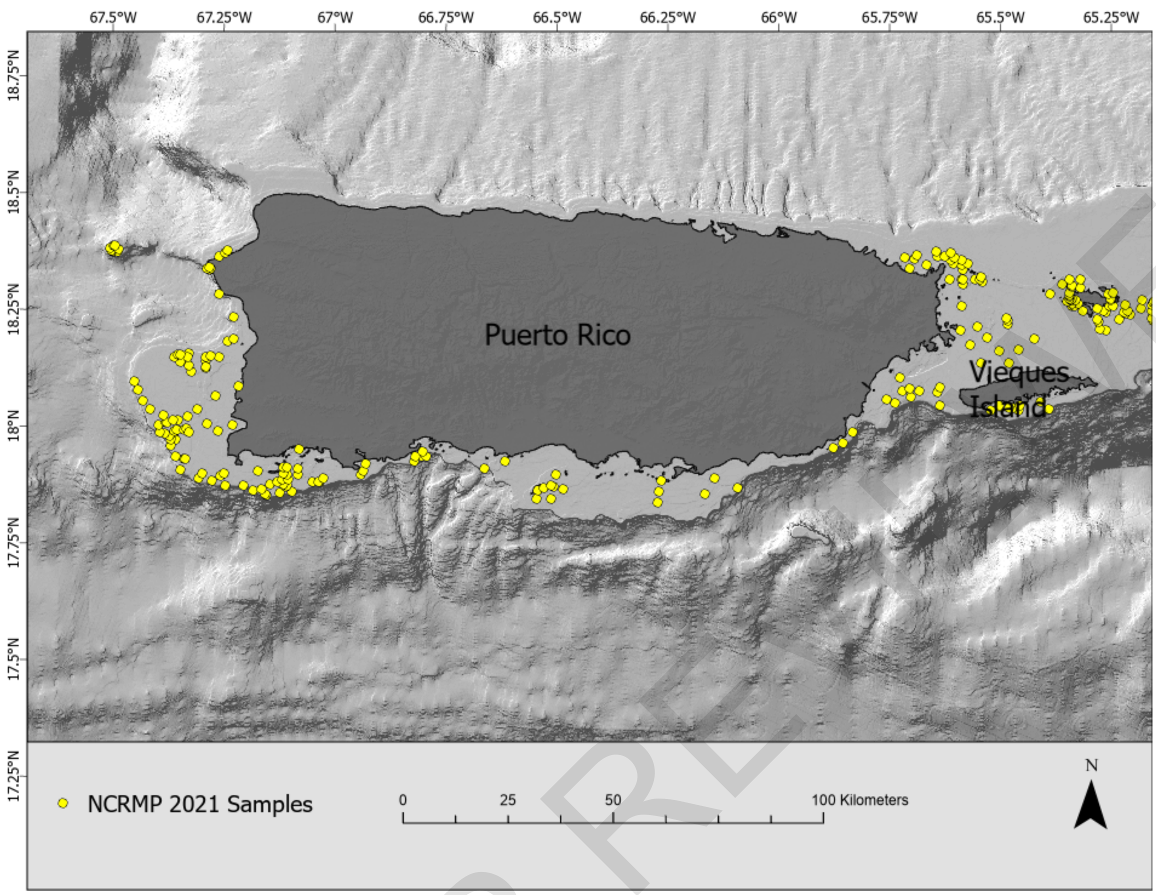

Figure 5.3.3 Puerto Rico NCRMP sampling sites 2021 (n = 234).

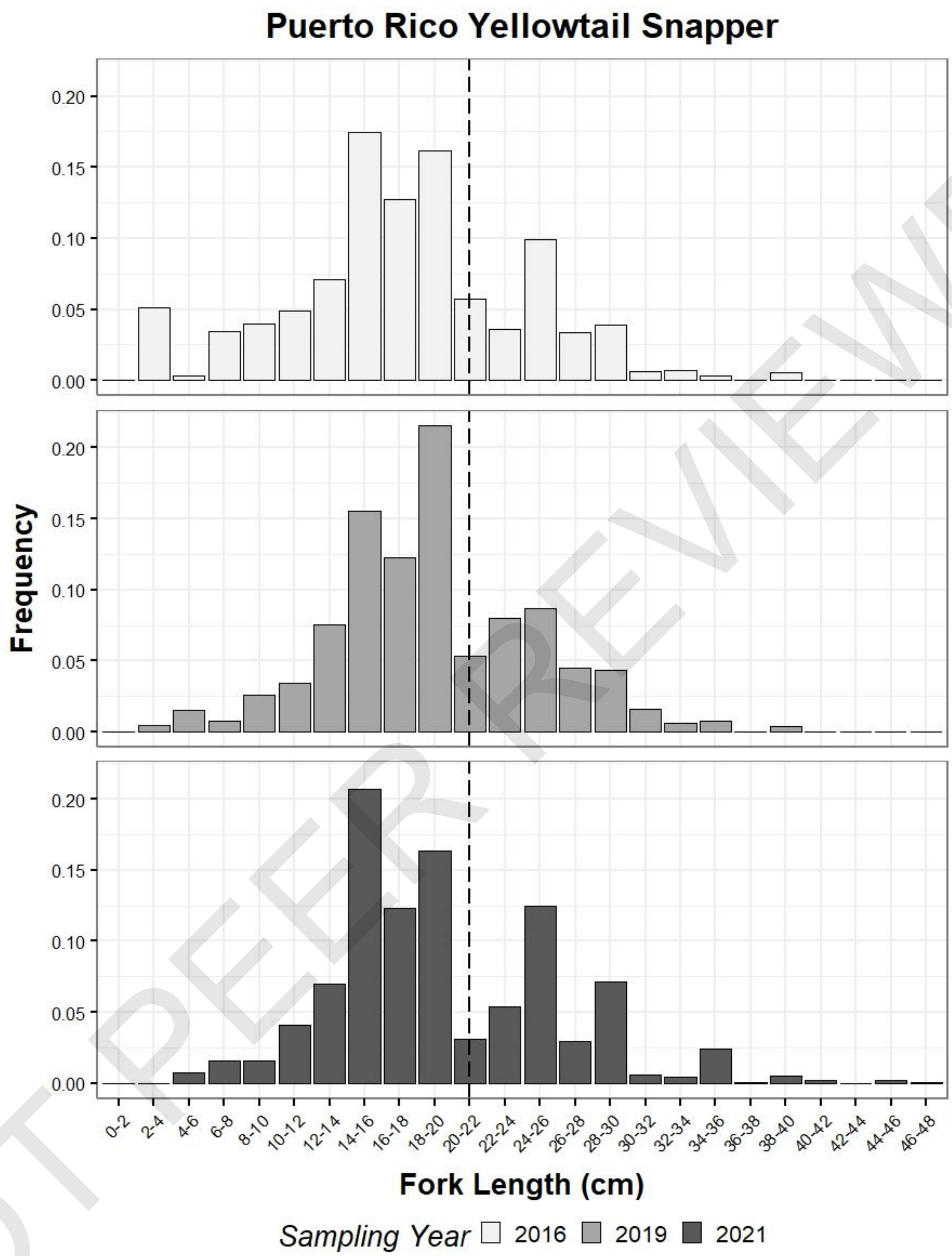

Figure 5.3.4 Yellowtail Snapper population size-frequency distribution at 2-cm bins from the 2016 - 2021 NCRMP RVC-SPC Puerto Rico surveys. Vertical dashed line is length at capture (25.0 cm fork length; i.e., minimum size regulation).

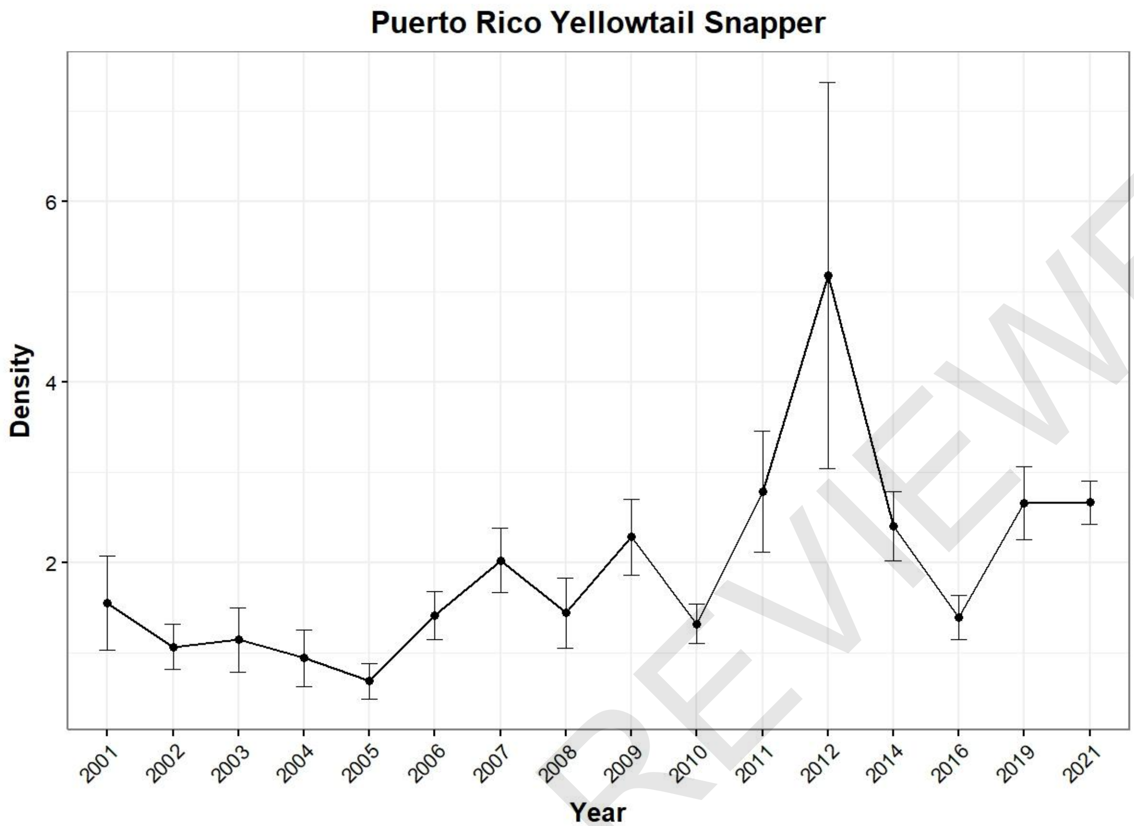

Figure 5.3.5 Time series (2001–2021) of Yellowtail Snapper (*Ocyurus chrysurus*) mean population density (number per 178 m2, ± SE) from the reef fish visual surveys in the Puerto Rico coral reef ecosystem

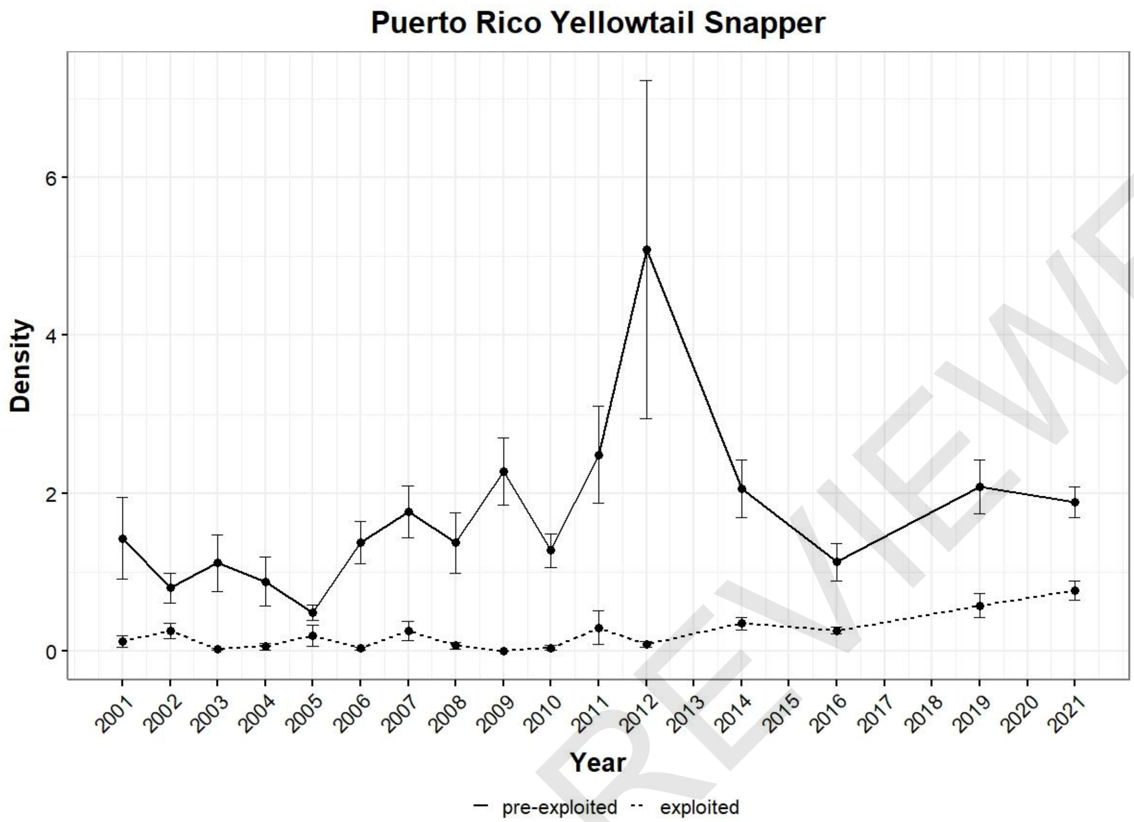

Figure 5.3.6 Time series (2001–2021) of pre-exploited (solid line, < 25 cm) and exploited (dotted line, ≥ 25 cm) Yellowtail Snapper mean population density (number per 178 m2, ± SE) from the reef fish visual surveys in the Puerto Rico coral reef ecosystem.

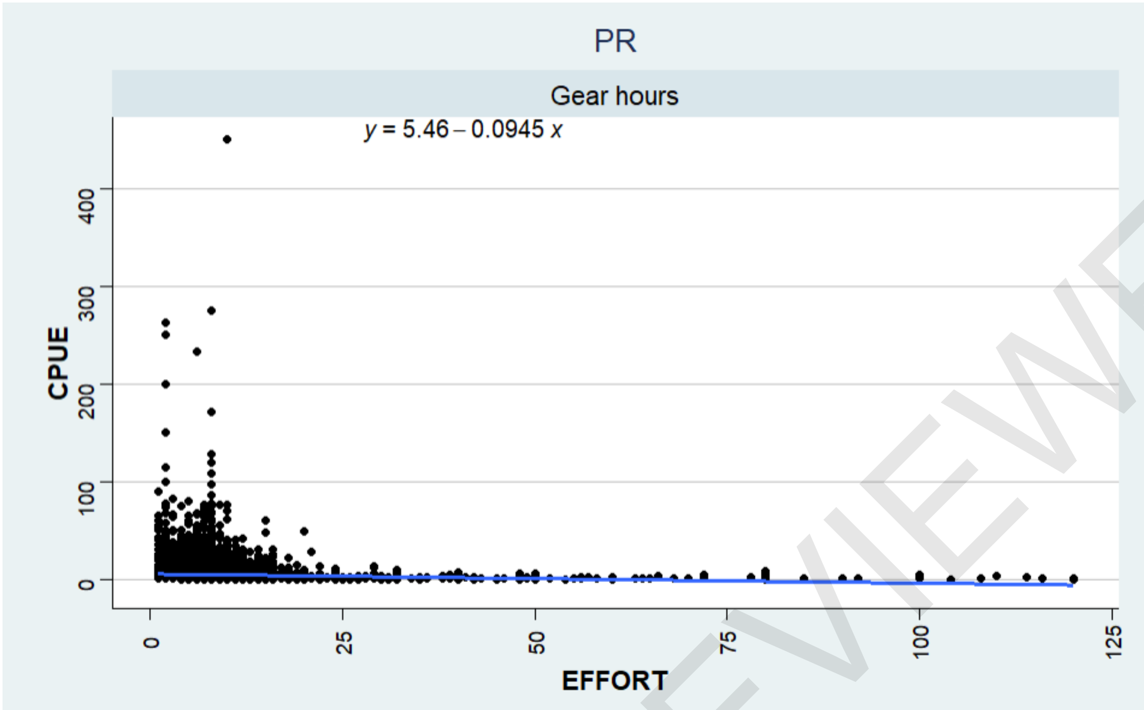

Figure 5.4.1 Catch per unit effort (CPUE) as a function of gear hours for the commercial Yellowtail Snapper fishery in Puerto Rico 1991-2019.

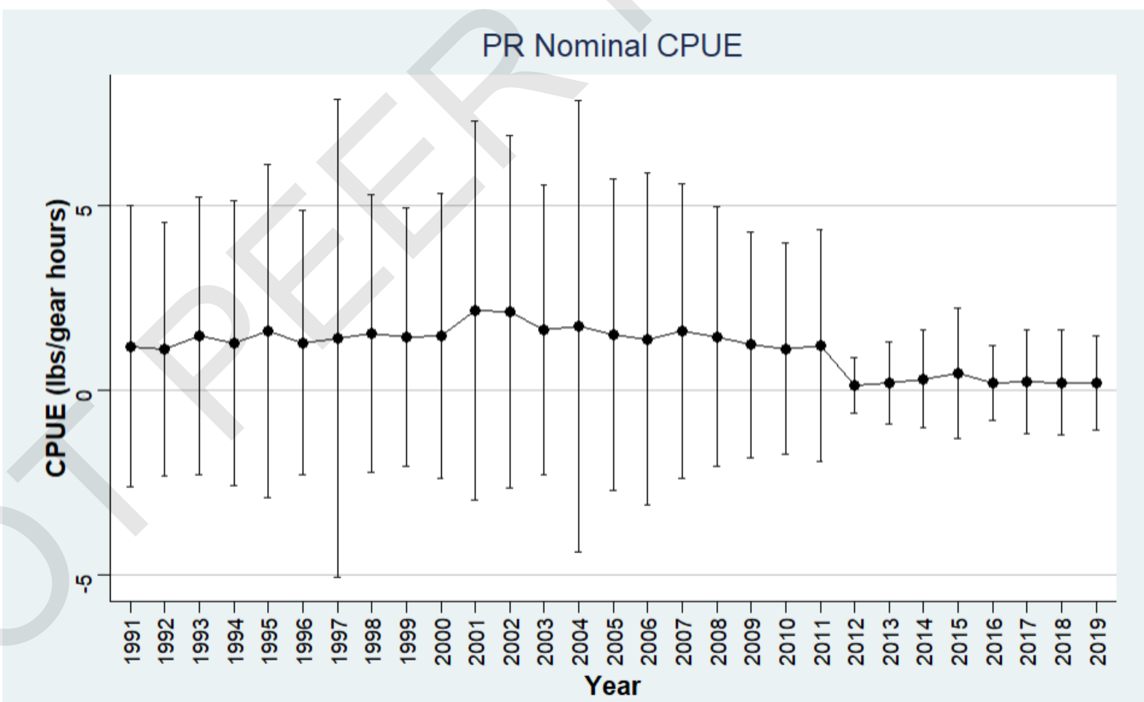

Figure 5.4.2 Nominal CPUE index in pounds per gear hours landed for the commercial Yellowtail Snapper fishery in Puerto Rico from 1991 to 2019,

6 Research Recommendations

6.1 Life History Research Recommendations

Issue 1: Are sufficient life history data available?

- Life history sampling should be done with statisticians to ensure more efficient collection programs (e.g., optimizing sample sizes within size bins).
- Ensure statistically robust sample sizes of small and large size classes of fish.

6.2 Commercial Statistics Research Recommendations

6.2.1 Commercial Landings Research Recommendations

Issue 1: Are analysis-ready commercial landings data available for SEDAR 84?

- Investigate trends in effort, major socioeconomic and environmental events, and associated effects on the demographics, gears used, and species landed.
- Increased port sampling is needed to enable analyses required for quantifying removals.

Issue 2: How uncertain are the commercial landings?

- Increase efforts towards landings validation, e.g., port sampling to estimate landings for comparison with CCL landings.

Issue 3: Should data outliers in the commercial landings be flagged for additional

- Operationalize an outlier flagging process for future SEDAR assessments.

Issue 4: Are analysis-ready recreational landings data available for SEDAR 84?

- Conduct recreational fishery port sampling surveys to determine removals from recreational fishing.
- Identify and obtain additional recreational data sources. Obtain data from economic surveys.

6.2.2 Length Composition Research Recommendations

Issue 1: Can the TIP size data be used for SEDAR 84 to inform selectivity?

- Look at the representativeness of where sampling occurs and where samples are coming from.
- Make hard copies of TIP PR data forms before 2010 available to help investigate flagged TIP data.
- Increase collection efforts to increase sample size in TIP.
- Work with port samplers and fishers to implement the trip interview program better and ensure critical fishing times are captured adequately (e.g., at night).
- Develop a data management system to link TIP to CCL. A linked system would require changing the overarching structure of collecting fishery-dependent data.
- Develop a fishery information network system for the US Caribbean.

- Operationalize an outlier flagging process for future SEDAR assessments.
- Investigate if relative weight at a given length has changed across years or clusters of years.
- Examine the number of trips when considering the representativeness of TIP samples; do not limit the investigation to the number of fish or the weight of the catch, samples, and trips.
- Going forward, we need a recommendation on how to do a new sampling strategy that is more holistic.
- Investigate how the length-weight relationship varies by month and year (seasonality and reproduction). And the fact that they are fed lots of bait during fishing (anchored) which could increase the weight of a fish over what is expected.

6.2.3 Discards and Discard Mortality Research Recommendations

Issue 1: Do we have estimates of commercial discards and estimates of discard mortality?

- Investigate release mortality further.

6.3 Recreational Statistics Research Recommendations

Issue 1: Are analysis-ready recreational landings data available for SEDAR 84?

- Conduct recreational fishery port sampling surveys to determine removals from recreational fishing.
- Identify and obtain additional recreational data sources. Obtain data from economic surveys.

6.4 Measures of Population Abundance Research Recommendations

Issue 1: Should the fishery-independent density estimates from SEAMAP-C be used in SEDAR 84?

- Professional fishers should be trained to support the methodologies of fishery-independent study designs. Trained fishers would improve the knowledge transfer between both sides of the process (fishers and scientists).
- Allocate funding towards new generalized survey methods optimized to target and capture this species more effectively than current surveys.
- Consider a cooperative scientific survey for Yellowtail Snapper designed in collaboration with fishers.

Issue 2: Should the fishery-independent density estimates from NCRMP be used in SEDAR 84?

- Work with fishers to improve methodologies to access areas that are not currently accessible with the SCUBA surveys.

Issue 3: Should the commercial fishery-dependent data be used to conduct an index?

- Further investigate logbook data and their utility for constructing an index
- Change in targeting multi-species

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