SEDAR

Southeast Data, Assessment, and Review

SEDAR 84

US Caribbean Stoplight Parrotfish – St. Croix

SECTION II: Data Workshop Report

April 2024

SEDAR
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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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Carlos Farchette .... Stakeholder - STX
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Wilfredo ....

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. Stoplight Parrotfish life history data were provided in Shervette et al. (2024).

2.2 Stock Definition and Description

The Stoplight Parrotfish stock was defined by the CFMC Island-based Fishery Management Plan. The St. Croix stock is defined as the population within the U.S. Virgin Island's territorial waters; i.e., the island platform of St. Croix and the adjacent EEZ.

2.3 Meristic & Conversion factors

The length-length and length-weight relationship equations with parameters for Stoplight Parrotfishes collected 2013-2023 for the combined sexes (Shervette et al. 2024) are shown 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. (2012) 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

Stoplight Parrotfish are sequential protogynous hermaphrodites; dominant reproductive mode is to start out life as female with the capacity to transition to male later in life; reproductive data were provided in Rivera-Hernandez and Shervette (2024).

Table 2.3 shows a summary of Stoplight Parrotfish samples from the U.S. Caribbean with reproductive phase information in Table 2.4 and Figure 2.1 shows length and ages of fish associated with information on sex and color transitions (Rivera-Hernandez and Shervette 2024).

A total of 1,765 Stoplight Parrotfish gonads provided information on sexual maturity and reproductive phase. A high proportion of both females and males were in the spawning capable phase during every month of the year indicating year-round spawning activity (Figure 2.2).

Spawning fraction overall for stoplight females was 0.52. Overall spawning interval, defined as the number of days between spawning events in a female, was 1.9 d (Table 2.5). When examining trends in spawning fraction, interval and frequency by length, spawning frequency increased with increasing length class; females in the smallest FL class had an estimated spawing frequency of 33 times a year, while females in the second to largest FL class had an estimated spawning frequency of 332 times a year (Table 2.5). Similar increases in spawning frequency occurred when examined by age classes.

2.6 Age and Growth

Table 2.6 provides the results of fitting the von Bertalanffy (VB) growth parameters for various length variables (Shervette et al. 2024) and Figure 2.3 show the VB graph fitted to samples.

Mean length of males (304 mm FL) was significantly larger than mean length of females (259 mm FL) and transitioning individuals (258 mm FL). Mean age of males (5.7 y) was significantly older than females (5.2 y), but only by 0.5 y; mean ages of males and females were significantly older than transitioning individuals (4.5 y). Females attained an older maximum age (20 y) compared to males (16 y)

2.7 SEDAR Panel Discussions on Use of Life History Data for Assessment Analyses

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.
- Develop sex-specific length-age curves.

Rationale:

- We are tentatively accepting 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 (from SEDAR46 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
A	Weight-length scalar	a	wla	dimensionless
B	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 U.S. Caribbean Stoplight Parrotfish length-length and length-weight conversion relationships derived from regression analyses.

Category	n	Regression equation	R^2
SL→Wt	1488	$W = (2\times10^{-4})\ SL^{2.69}$	0.93
FL→Wt	1716	$W = (4\times10^{-5})\ FL^{2.90}$	0.95
TL→Wt	1706	$W = (3\times10^{-4})\ TL^{2.51}$	0.95
FL→SL	1488	SL= 0.90FL - 14.11	0.98
FL→TL	1711	TL= 1.28FL – 47.38	0.97
TL→SL	1488	SL= 0.70TL + 22.33	0.97

Table 2.3 Sample summary of Stoplight Parrotfish across the main islands of the U.S. Caribbean.

	Overall	Puerto Rico	St. Thomas	St. Croix
Total fish sampled	1801	627	500	674
Fisheries-dependent	1592	511	431	650
Initial color phase	769	237	166	366
Transition color phase	4	-	4	-
Terminal color phase	819	274	261	284
Female	667	208	120	339
Transition	62	3	36	23
Male	846	291	270	285
Unknown	16	9	4	3
Fisheries-independent	209	116	69	24
Initial color phase	146	68	56	22
Terminal color phase	63	48	13	2
Female	124	64	39	21
Transition	11	1	9	1
Male	70	49	19	2
Unknown	4	2	2	-

Table 2.4 Summary of fork length (FL) and standard length (SL), and age information obtained from U.S. Caribbean Stoplight Parrotfish samples ("All fish") by sex, and by color phase x sex. Samples of unknown sex were not included beyond "All fish" group.

Species	Group	N measured/ aged	FL range (mean) mm	SL range (mean) mm	Age range (mean) y
	All fish	1801/1714	73-433 (281)	60-376 (240)	0-20 (5.4)
Sex	Female	791/754	73-433 (259)	60-376 (218)	0-20 (5.2)
	Male	917/874	127-399 (304)	103-355 (261)	1-16 (5.7)
	Transition	73/70	183-366 (258)	148-315 (217)	2-15 (4.5)
	Unknown	20/16	135-293 (241)	114-237 (199)	2-9 (5.0)
Initial Phase	All	917/869	73-433 (258)	60-376 (217)	0-20 (5.1)
	Female	791/754	73-433 (259)	0-376 (218)	0-20 (5.2)
	Male	34/30	127-298 (238)	103-241 (198)	1-7 (4.2)
	Transition	72/69	183-366 (258)	148-315 (217)	2-15 (4.5)
	Unknown	20/16	135-293 (241)	114-237 (199)	2-9 (5.0)
Transitioning Color Phase	All	4/4	250-318 (290)	213-282 (247)	4-8 (5.5)
	Male	3/3	291-318 (303)	242-282 (258)	5-8 (6.0)
	Transition	1/1	250	213	4
Terminal Phase	Male	880/841	210-399 (306)	175-355 (264)	2-16 (5.7)

Table 2.5 Female Stoplight Parrotfish estimates for spawning fraction, spawning interval, and spawning frequency summarized overall, by length classes, and age by classes. Spawning fraction is the proportion of actively spawning females relative to the total number of mature females. Spawning interval is the estimated number of days between spawning events. Spawning frequency was computed to estimate the number of times females could spawn within a year.

Group	N of mature females	Spawning fraction	Spawning interval	Spawning frequency
Overall	732	0.52	1.9 d	190/y
FL class (mm)				
≤ 200	23	0.09	11.1 d	33/y
201 – 250	226	0.43	2.3 d	157/y
251 – 300	359	0.56	1.7 d	204/y
301 – 350	115	0.71	1.4 d	332/y
≥ 351	4	0.50	2.0 d	183/y
Age class (y)				
≤2	20	0.05	20 d	18/y
3-4	264	0.46	2.1 d	168/y
5-6	274	0.57	1.7 d	209/y
7-8	84	0.65	1.5 d	237/y
9+	56	0.70	1.4 d	261/y

Table 2.6 Von Bertalanffy Growth Function parameter estimate results for Stoplight Parrotfish.

Model	N	L_∞ (mm)	K	t_0
FL mm t_0-fixed	1649	332 (328 - 335)	0.39 (0.35 - 0.41)	-0.06*
FL mm	1649	338 (328 - 335)	0.33 (0.31 - 0.36)	−0.52 (−0.72 - −0.35)
SL mm t_0-fixed	1649	287 (282-290)	0.38 (282-290)	-0.06*
SL mm	1649	297 (286-300)	0.33 (0.31-0.36)	−0.40 (−0.59 - −0.23)

2.9 Life History Figures

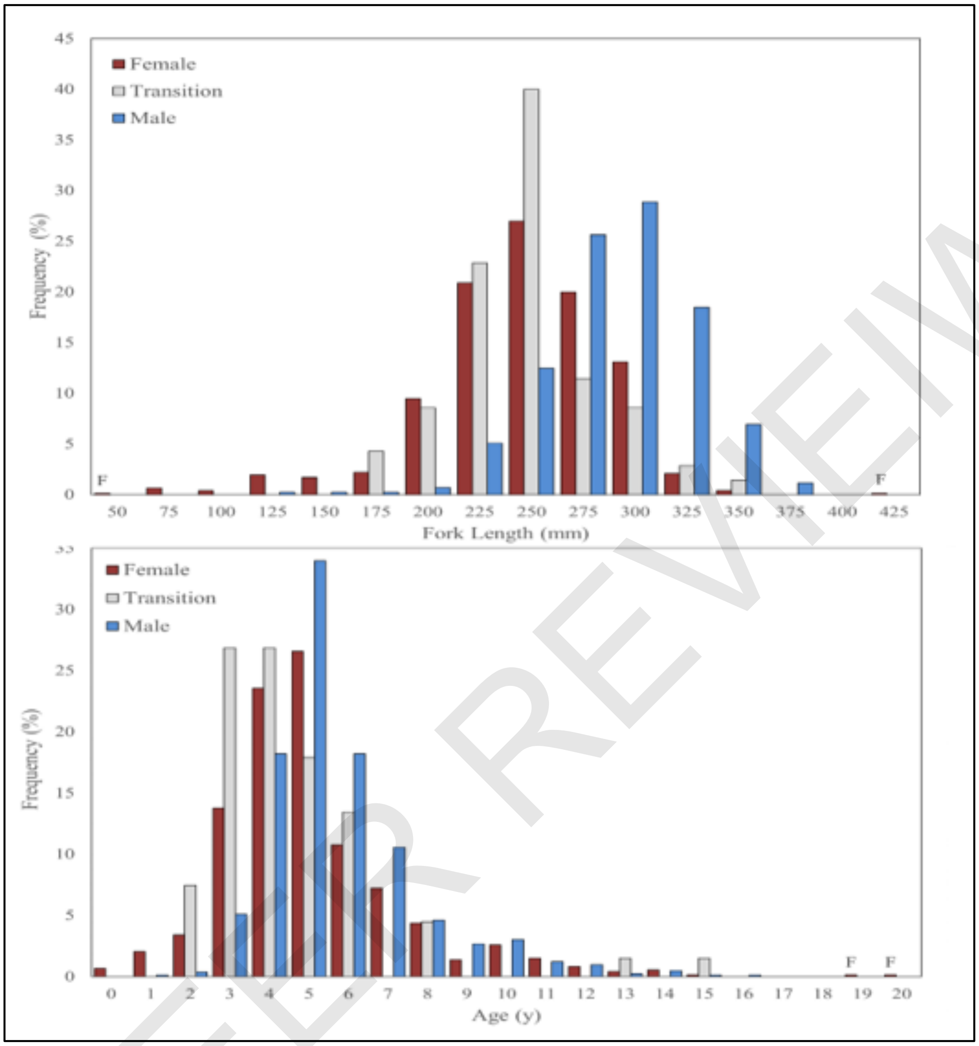

Figure 2.1 Length frequencies (top) and age frequency distributions of Stoplight Parrotfish females, transitioning individuals, and males.

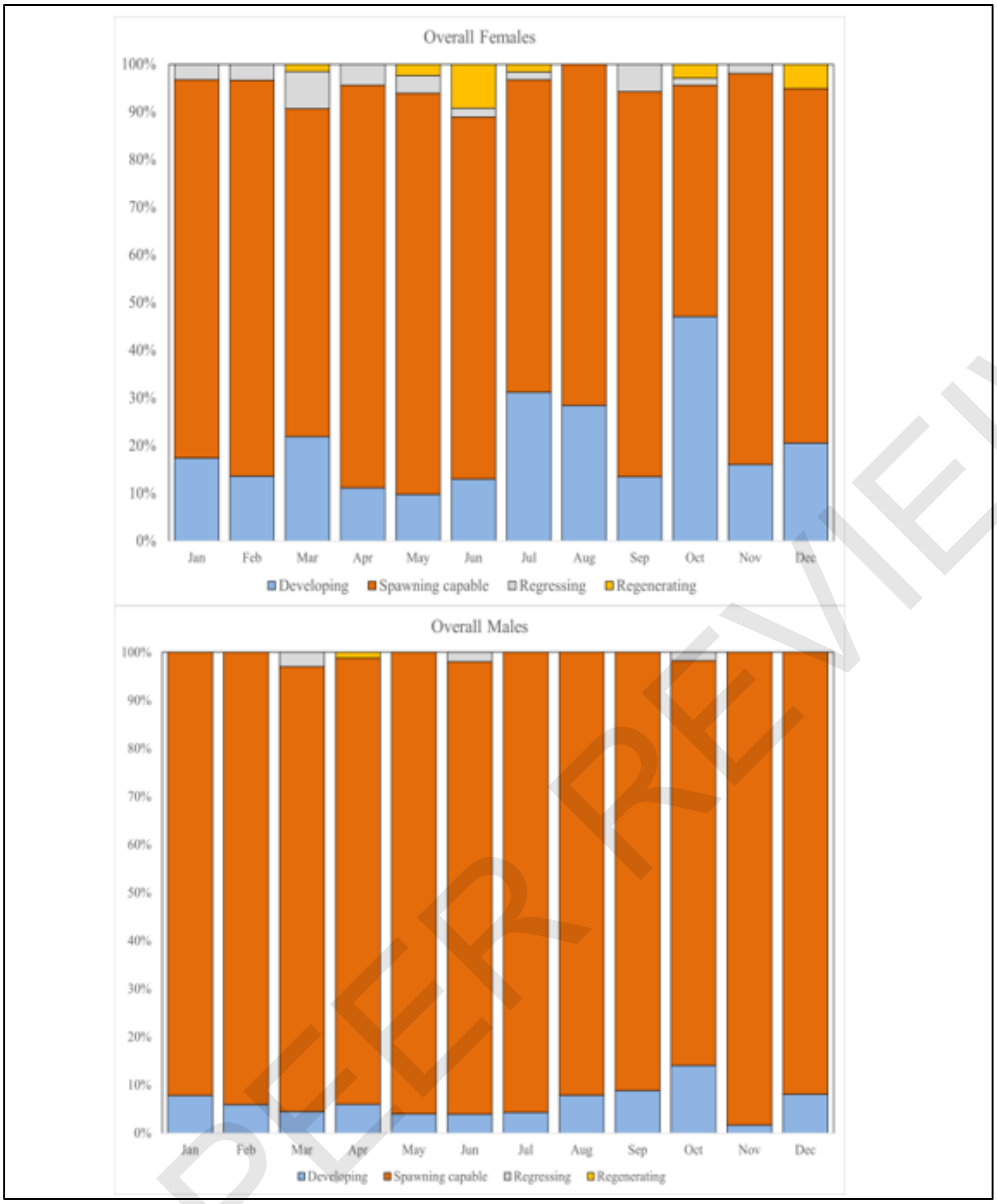

Figure 2.2 Reproductive seasonality for Stoplight Parrotfish females (top) and males in the U.S. Caribbean. Monthly percentages of individuals in each reproductive phase are presented.

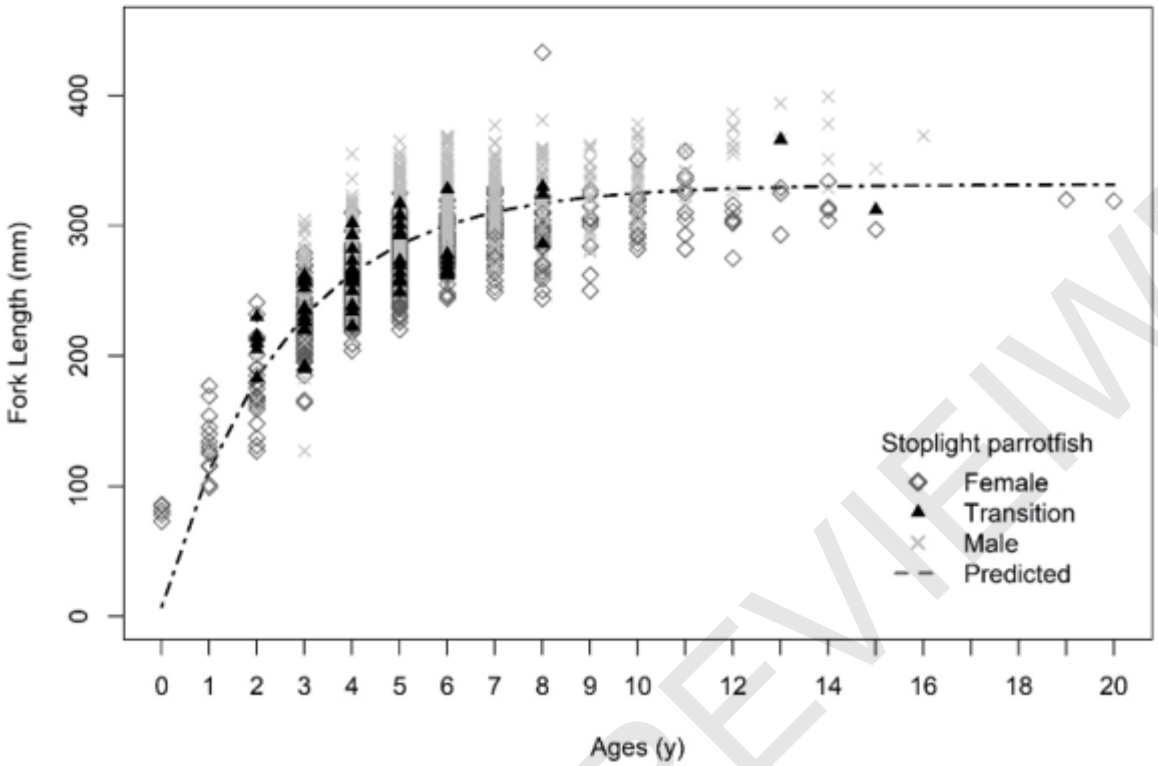

Figure 2.3 Von Bertalanffy growth and sized-at-age for Stoplight Parrotfish from waters of the U.S. Caribbean.

3 Commercial Fishery Statistics

3.1 Commercial Landings

3.1.1 Overview

Commercial fishery landings in St. Croix (STX) were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL). Reporting of Stoplight Parrotfish by species and fishing gear did not begin until July 2011 in the U.S. Virgin Islands, therefore, the first complete year of species-specific data is 2012 (changes to reporting forms are usually implemented in July).

Logbook data are recorded by fishing year, which runs from July 1 through June 30 of the following year. However, data in this report are recorded in calendar year. Commercial fishery landings data for Stoplight Parrotfish in STX were available for the calendar years 2012-2022. Commercial landings of Stoplight parrotfish were compiled from 2012 to 2022. The commercial landings were produced in pounds by year and fishing gear (Table 3.1.1).

3.1.2 Outlier Removal

Outlier removal was conducted by using a mean and standard deviation method. If the landings of Stoplight Parrotfish reported on a trip were greater than three standard deviations from the mean (i.e., 99.73% quantile), they 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, and Method 2 , the values to define outliers were calculated by year and gear group (Table 3.1.2). Due to the outlier removal, the yearly commercial landings for Stoplight Parrotfish compiled in SEDAR84 may not match landings provided for previous SEDARs.

3.1.3 Parrotfish Fishery

Beginning in 1996, part of the commercial landings were reported by species group (e.g., snappers, groupers, parrotfishes, surgeonfishes, etc.), and by gear (hook and line, gill net, SCUBA, trap, etc.). All commercial fishery data reports included species groups beginning in 1998. In July of 2011, commercial landings were reported by species and gear. The parrotfish complex (1996-2011) and species-specific snapper (2011-2022) landings are summarized in Table 3.1.3 and Figure 3.1.1. Note that landings prior to 1998 may be incomplete.

3.2 Commercial Discards

Species-specific commercial discard reporting started in 2016 in STX for Stoplight Parrotfish (Martinez et al 2024). Commercial discards reported by calendar year were not significant.

3.3 Commercial Effort

Commercial trips with reported Stoplight Parrotfish landings per year and gear group were compiled from 2012 to 2022 (Table 3.3.1).

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).

3.4.2 Length Composition Sampling Intensity

The TIP data pertaining to Stoplight Parrotfish in St. Croix comprises 29,582 length observations across 1,028 unique port sampling interviews. Of the Stoplight Parrotfish measured, 29,048 are fork lengths (98.2%). Figure 3.4.1 displays the sample availability by year and gear. Plots and summary statistics of the currently available length frequency data of Stoplight Parrotfish sampled from the predominant gears in St. Croix are included in the working paper (Godwin et al. 2024).

3.4.3 Length Distributions

A variety of fishing gears were used by St. Croix commercial fishers to catch Stoplight Parrotfish. An analysis was conducted to establish gear groups among the many commercial fishing gears with groups based upon Stoplight Parrotfish 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

2012 to 2022 (the years corresponding to species specific reporting of commercial landings data) are 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 plots of Stoplight Parrotfish fork lengths collected across three or more unique interviews per gear groups across the time series 1983-2022 (years with species specific commercial landings data) are summarized for all gears combined in Figure 3.4.2. Aggregated density plots of gears representing 2% or more of the samples are summarized in Figure 3.4.3.

3.4.4 Adequacy of Size Composition Data for Characterizing Catch

Due to low levels of available data after 2012, the decision by the panel is to combine TIP data across all years and use it to inform commercial fleet selectivity, not annual population trends. The landings data collected before 2012 were not species-specific, and current model configurations only require length composition data after the first year of landings data. However, access to the complete TIP time series of Stoplight Parrotfish length composition data allows the analytical team to investigate additional analyses.

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)

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 data (including before 2012 and hindcast partitioning of landings recorded as species groups).
- Only use data starting in 2012, the first full year of species-specific reporting of the parrotfish group.

Decision:

- Refrain from hindcasting the landings data before 2012.
- Provide a full-time series associated with the total landings of the parrotfish group over all years of available landings data.

Rationale:

- Due to the prohibition of some species and comprehensive regulatory changes before 2012, analysis cannot determine a consistent percentage of Stoplight Parrotfish within the parrotfish grouping.

Issue 2: 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. For example, the significant jump in outliers for 2022 can be attributed to the new style of fishing, indicating that these outliers are still valid trips.

Issue 3: What should the gear fleets be for the commercial landings data?

Options:

- Retain identified gear groups with landings from "other" gears apportioned to those groups.
- Compile landings from "other" gears into another gear group.

Decision:

- Utilize the various diving gears to establish a SCUBA gear group. Provide a plot of the gears associated with gear groups classified as other, particularly fish traps *Rationale:*
- The SCUBA gear group makes up most of the landings. However, communicating an overview of the gear that makes up each gear group over time provides context for emerging or historical gears.

3.5.2 Discard and Discard Mortality Data

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

Options:

- Use self-reported discards by gear from 2016-2022.
- Assume discards are negligible.

Decision:

- Assume commercial discards of Stoplight Parrotfish in St. Croix are negligible.

Rationale:

- Due to the nature of spearfishing, discards from this gear are considered zero. The lack of commercial discard data is partly due to the underreporting of discards in the trap fishery. However, regarding discard mortality, the panel agreed that we can assume that most discarded fish live. Smaller fish would swim out of the pot. Larger fish would survive as this species is hearty, and fishing occurs in shallower waters (50-110 feet).

3.5.3 Adequacy of Length Composition Data

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

Options:

- Use filtered TIP lengths available by year from 1983 to 2022.
- Use filtered TIP lengths available by year from 2012 to 2022.
- Use filtered TIP lengths combined across years from 2012 to 2022 to inform selectivity.
- Do not recommend using TIP lengths for any year.

Decision:

- Supply complete TIP time series for SEDAR 84 investigations.
- Utilize TIP lengths from 2012 to 2022 to inform commercial fleet selectivity.
- Apply outlier filtering based on the condition factor

Rationale:

- Due to low levels of available data after 2012, combine TIP data across all years and use it to inform commercial fleet selectivity, not annual population trends.
- The landings data collected before 2012 were not species-specific, and current model configurations only require length composition data after the first year of landings data. However, access to the complete TIP time series allows the analytical team to investigate other analyses.

3.6 Commercial Statistics Tables

Table 3.1.1 Commercial landings (in pounds) of Stoplight Parrotfish reported in St. Croix from 2012-2022.

Year	Other	Scuba	Total Landings
2012	1,101	40,768	41,869
2013	643	33,130	33,773
2014	2,795	18,979	21,774
2015	7,926	16,882	24,808
2016	10,193	14,288	24,481
2017	7,514	16,019	23,533
2018	746	6,516	7,262
2019	1,537	6,003	7,540
2020	6,297	15,586	21,883
2021	2,412	22,000	24,412
2022	4,240	12,158	16,398

Table 3.1.2 Comparison of commercial landings in pounds of Stoplight Parrotfish reported in St. Croix from 2012-2022 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)
2012	41,869	41,869	41,169	0%	-2%
2013	33,773	33,073	32,929	-2%	-2%
2014	21,774	21,774	21,604	0%	-1%
2015	24,808	24,328	24,328	-2%	-2%
2016	24,481	24,481	23,981	0%	-2%
2017	23,533	22,011	23,338	-6%	-1%
2018	7,262	7,262	7,124	0%	-2%
2019	7,540	7,540	7,181	0%	-5%
2020	21,883	21,883	21,515	0%	-2%
2021	24,412	24,412	24,412	0%	0%
2022	16,398	14,804	15,986	-10%	-3%

Table 3.1.3 Commercial landings of all parrotfish species reported in St. Croix from 1996-2022 by year. Note that landings prior to 1998 may be incomplete.

Year	Landings (lbs)
1995	4,717
1996	65,583
1997	181,649
1998	213,537
1999	235,864
2000	260,473
2001	290,498
2002	307,591
2003	262,474
2004	319,246
2005	376,385
2006	433,095
2007	414,904
2008	354,997
2009	315,787
2010	162,624
2011	154,533
2012	118,868
2013	107,435
2014	75,442
2015	86,345
2016	90,062
2017	69,597
2018	17,988
2019	21,111
2020	61,060
2021	52,090
2022	54,882

Table 3.3.1 Commercial trips that reported Stoplight Parrotfish landings in St. Croix from 2012-2022 by year and gear group.

Year	Other	Scuba	Total Trips
2012	1,101	40,768	41,869
2013	643	33,130	33,773
2014	2,795	18,979	21,774
2015	7,926	16,882	24,808
2016	10,193	14,288	24,481
2017	7,514	16,019	23,533
2018	746	6,516	7,262
2019	1,537	6,003	7,540
2020	6,297	15,586	21,883
2021	2,412	22,000	24,412
2022	4,240	12,158	16,398

Table 3.4.1 Generalized linear mixed model (GLMM) analysis summary results for the TIP data of Stoplight Parrotfish fork lengths in St. Croix from 2012 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. Gears that make up less than 2% are shaded in gray.

Gear	Mean	Estimated Marginal Mean	LCL	UCL	Group	Fish (n)	Interview (n)	Percentage	Gear Group
SPEARS; DIVING	27.69	3.33	3.29	3.38	1	984	63	93.54	Spears or Fish Traps
BY HAND; DIVING GEAR	26.76	3.29	3.05	3.52	1	49	3	4.66	Spears or Fish Traps
POTS AND TRAPS; FISH	30.26	3.30	3.15	3.46	1	19	4	1.81	Spears or Fish Traps

3.7 Commercial Statistics Figures

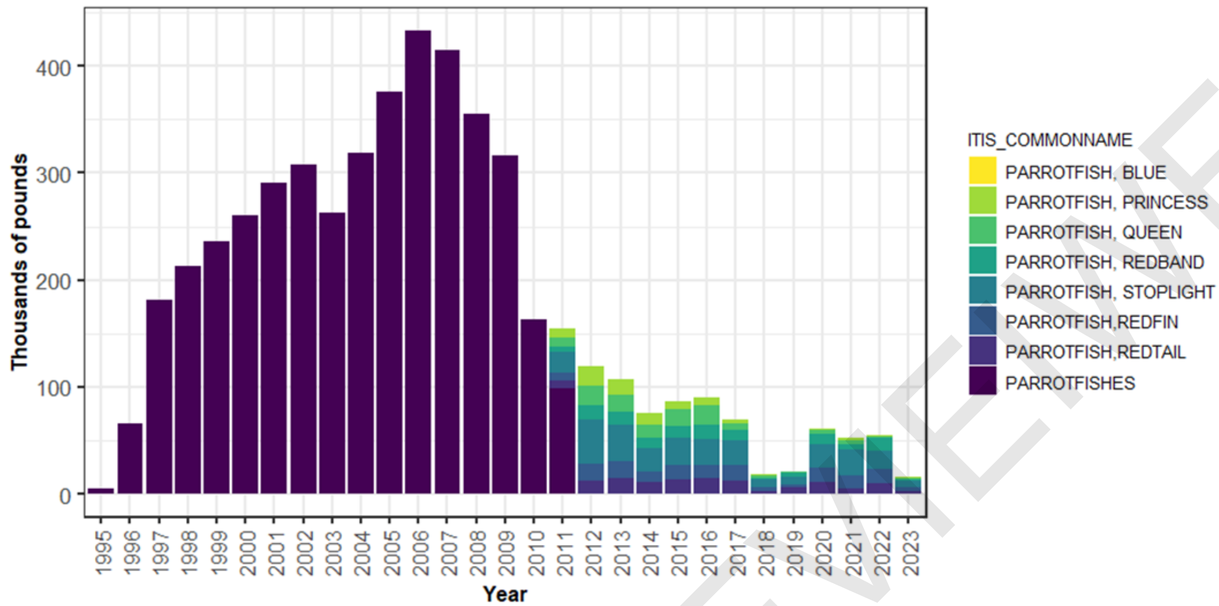

Figure 3.2.1 Commercial landings of all parrotfish species reported in St. Croix from 1996-2022 by year. Note that landings prior to 1998 may be incomplete.

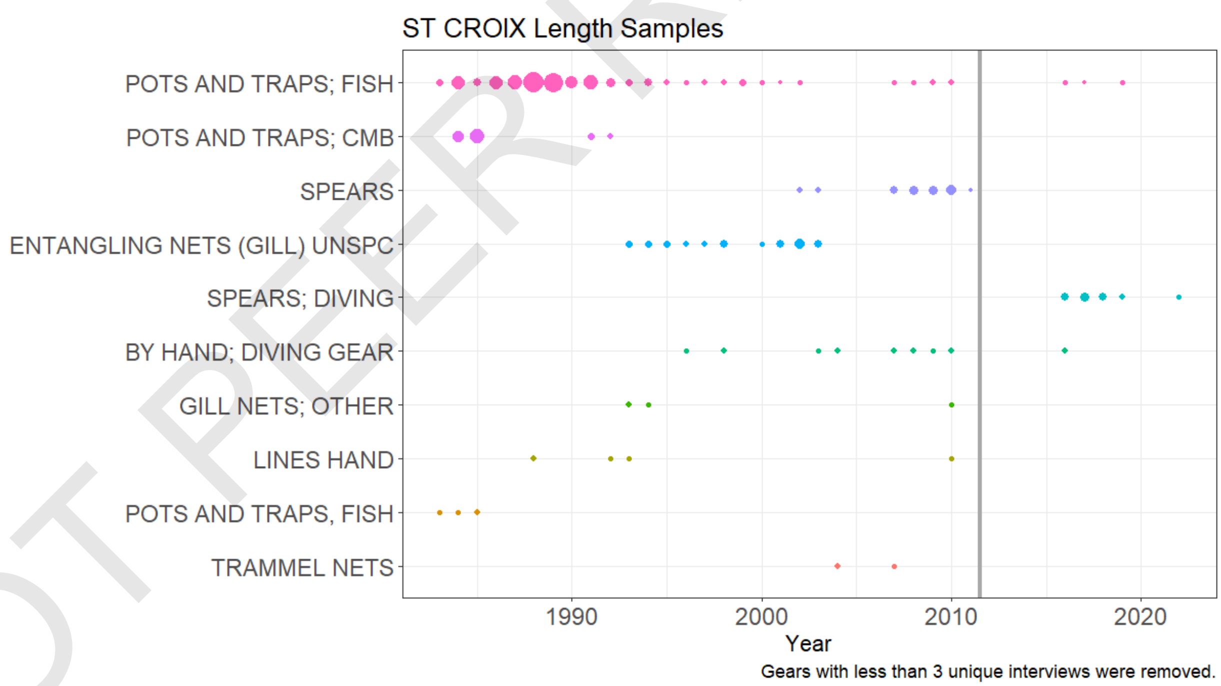

Figure 3.4.1 Plot showing relative number of Stoplight Parrotfish lengths collected in St. Croix over time. Each point is color specific to the gear it represents. Gears are arranged from largest to smallest sample size of individual recorded lengths. Gray vertical line denotes the beginning of the truncated time series in 2012 2012 (those years with species specific commercial landings data).

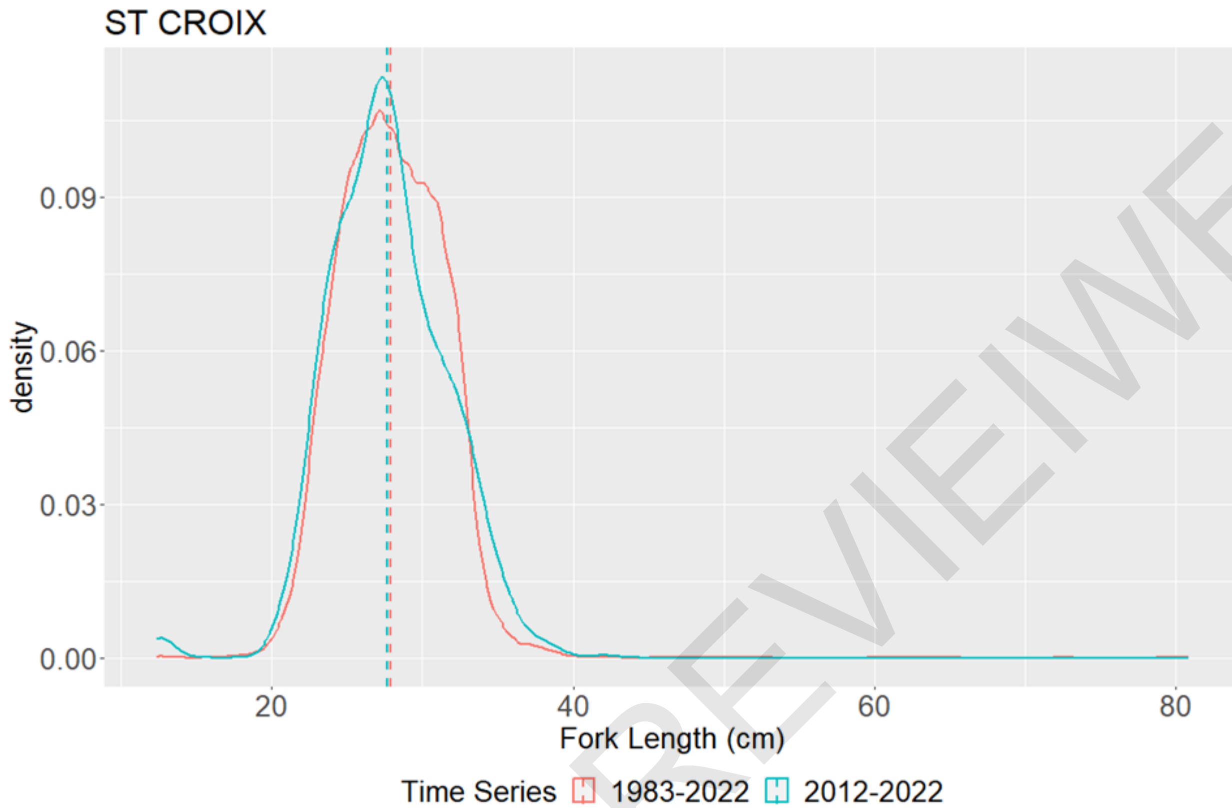

Figure 3.4.2 Aggregated density plot of lengths(cm) of Stoplight Parrotfish in St. Croix, all gears combined. Dotted line represents mean length. The period 1983-2022 includes all years with TIP data. The period 2012-2022 includes those years with corresponding species-specific commercial landings data.

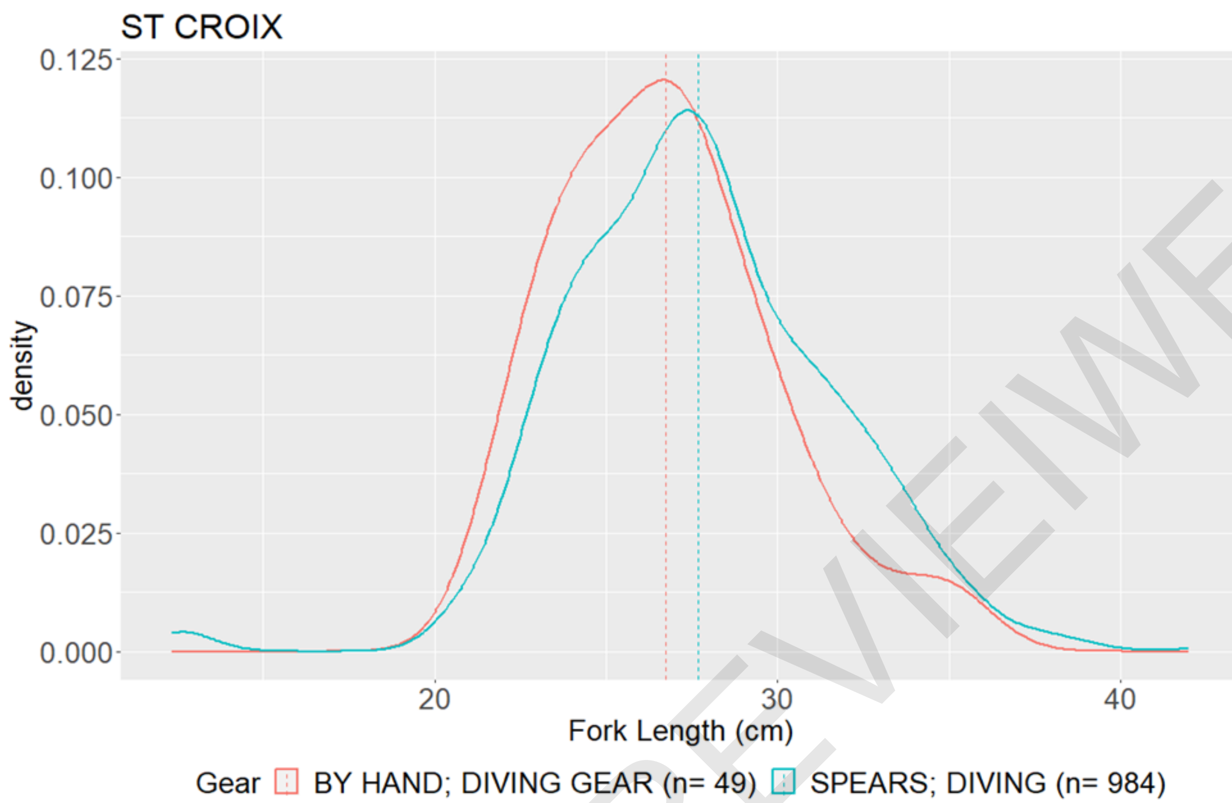

Figure 3.4.3 Aggregated density plot of lengths (cm) by gears with greater than 2% of total samples for Stoplight Parrotfish in St. Croix from 2012 to 2022. Dotted line represents mean length.

4 Recreational Fishery Statistics

4.1 Overview

U.S. Virgin Islands fishing tournament data were collected by the USVI Department of Planning and Natural Resources, Division of Fish and Wildlife staff serving as official weighmasters. Data collected includes tournament name, date, vessel name, captain name, length of tournament, species landed, species weight, and species length.

The available time series for St. Croix tournament data runs from 2003-2022, however no data from tournaments was collected between 2005-2015, in 2017, and in 2019. There are no records of Stoplight Parrotfish landings for St. Croix from tournaments and there are no recreational tournaments that target parrotfish in St. Croix.

4.2 SEDAR Panel Discussion of Recreational Landings Data for Assessment Analyses

As no data for Stoplight Parrotfish were available from recreational fishing tournaments, no discussion of recreational tournament data was required.

5 Measures of Population Abundance

5.1 Overview

Several fisheries dependent and fisheries independent data sources to be considered as measures for population abundance were explored during the SEDAR 84 DW.

5.2 Review of Working Papers

SEDAR84-DW-14 (Grove et al. 2024): NCRMP FI Survey of Stoplight Parrotfish (*Sparisoma viride*) in St. Croix, summarized NCRMP survey data for Stoplight Parrotfish from 2014 to 2022.

5.3 Fishery Independent Surveys -NCRMP

5.3.1 Methods, Gears, and Coverage (Map Survey Area)

This document outlines the data and methodologies used to estimate density and abundance-at-length compositions for the SEDAR84 Stoplight Parrotfish Assessment for St. Croix.

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 samples were reduced in St. Croix in 2021 to 148 as a result of weather (Figure 5.3.1)

Two levels of calibration were needed to incorporate historical transect data. First, we analyzed the regionally restricted transect data from 2001 to 2011 in Buck Island Reef National Monument. 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 (2017–2021). 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, ±1). 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 Stoplight Parrotfish surveyed, 2) pre-exploited density estimates filters sizes to only include those that are less than minimum size limit (9 inches FL), set by management, and 3) exploited density estimates filters sizes to include all sizes greater than or equal to 9 inches FL (or, 23cm FL).

5.3.2 Sampling Intensity – Time Series

Sampling Intensity and the time series of the NCRMP reef survey in St. Croix is illustrated in Table 5.3.1. Sampling began in 2001 and was conducted every year from 2001 to 2012 and then from 2015 onwards every other year. 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 Stoplight Parrotfish and the number of lengths measured, each by year.

5.3.3 Size Data

Length size frequency distribution of Stoplight Parrotfish on St. Croix are shown for 2017, 2019, and 2021 in Figure 5.3.2. Notable are the greater proportion of the smaller size classes seen in 2019.

5.3.4 Catch Rates in Numbers per Area Sampled

The time series of estimated mean Stoplight Parrotfish population density in numbers per sampled area; i.e.,178 m^2 +/- SE, is shown Figure 5.3.3. 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 5.3.4.

5.4 Fishery-Dependent Measures

5.4.1 Overview

US Caribbean commercial logbook (CCL) landings and effort were used to construct nominal indices of abundance. CCL data are self-reported. Species specific reporting in the US Virgin Islands landings started in 2012 (1st full year) and the time series from 2012-2022 was considered. After calculating the proportion positive Stoplight Parrotfish trips by gear group (Table 5.4.1) and examining the reported landings by gear group (Table 3.1.1), only dive gear (labeled SCUBA in Table 3.1.1) had sufficient data to explore the construction of an index of abundance.

5.4.2 Methods of Estimation

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

- Hours fished
- Dives count
- Divers count

The following units of effort considered

- Hours fished (hours fished * divers count * dives count)

- Diver hours fished (hours fished * diver count)
- Diving hours fishing (hours fished * dives count)
- Hours fished (hours fished)

Based on the exploratory analysis of the relationship between CPUE (calculated as pounds of landed Stoplight Parrotfish/unit of fishing effort; e.g., diver hours fished) and effort (Figure 5.4.1), diver hours was deemed as the most appropriate effort measure to calculate CPUE.

5.4.3 Sampling Intensity

All commercial fishers are required to report landings and effort to CCL. CCL reporting is therefore considered to be census of commercial landings and fishing effort. Any underreporting has not been quantified.

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 through the time series in pounds per dive hours fished in shown in Figure 5.4.2.

5.4.6 Uncertainty and Measures of Precision

Coefficients of variance (CV) around the nominal CPUE index were large throughout most of the time series (Figure 5.4.2).

5.5 SEDAR Panel Discussion of Indices Data for Assessment Analyses

5.5.1 Fishery Independent – NCRMP

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

Options:

- Use the density estimates and length composition data from 2012 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 only collected around Buck Island, which may impact size distribution due to fishing restrictions.

Decision:

- Use the NCRMP Stoplight Parrotfish data for STX from 2012 to 2022.
- Ensure the length at first capture used to define the exploited population aligns with the lengths observed in the port sampled data.

Rationale:

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

Issue 2: Should the fishery-dependent information from commercial logbooks be considered to conduct abundance indices?

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

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

Rationale:
- No adequate unit of effort was identified at this time. For example, the hours on the water is not a good measure of effort. It is difficult to determine if the information reflects abundance or how effective the fisherman is at harvesting Stoplight Parrotfish.

5.6 Measure of Population Abundance Tables

Table 5.3.1.-Number of reef fish visual survey sites by hard-bottom strata and depth categories per year from the reef fish visual surveys in the St. Croix 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	12		14	35	12			9	2	2	**86**	**376**
2002	7		15	21	10			8	14	1	**76**	**318**
2003	38	6	13	72	7	3		3	21	2	**165**	**455**
2004	23	4	14	46	9	2		4	7	5	**114**	**413**
2005	43	4	17	46	11	9	1	7	25	7	**170**	**485**
2006	34	2	18	48	20	6		13	38	6	**185**	**400**
2007	13	1	14	23	5	1		7	24	2	**90**	**230**
2008	16		27	62	3	5		12	35	7	**167**	**344**
2009	15		23	61	9	4		8	32	5	**157**	**277**
2010	17		15	38	5	3		2	33	5	**118**	**344**
2011	3			19					17	2	**41**	**86**
2012	15	5	13	64	6	35		19	79	26	**262**	**492**
2015	15	4	14	47	17	33		19	75	15	**239**	**444**
2017	11	1	14	33	5	46		19	47	5	**181**	**810**
2019	29	8	32	46	10	74		35	72	8	**314**	**1116**
2021	14		19	19	2	43		12	35	4	**148**	**694**

5.7 Measure of Population Abundance Figures

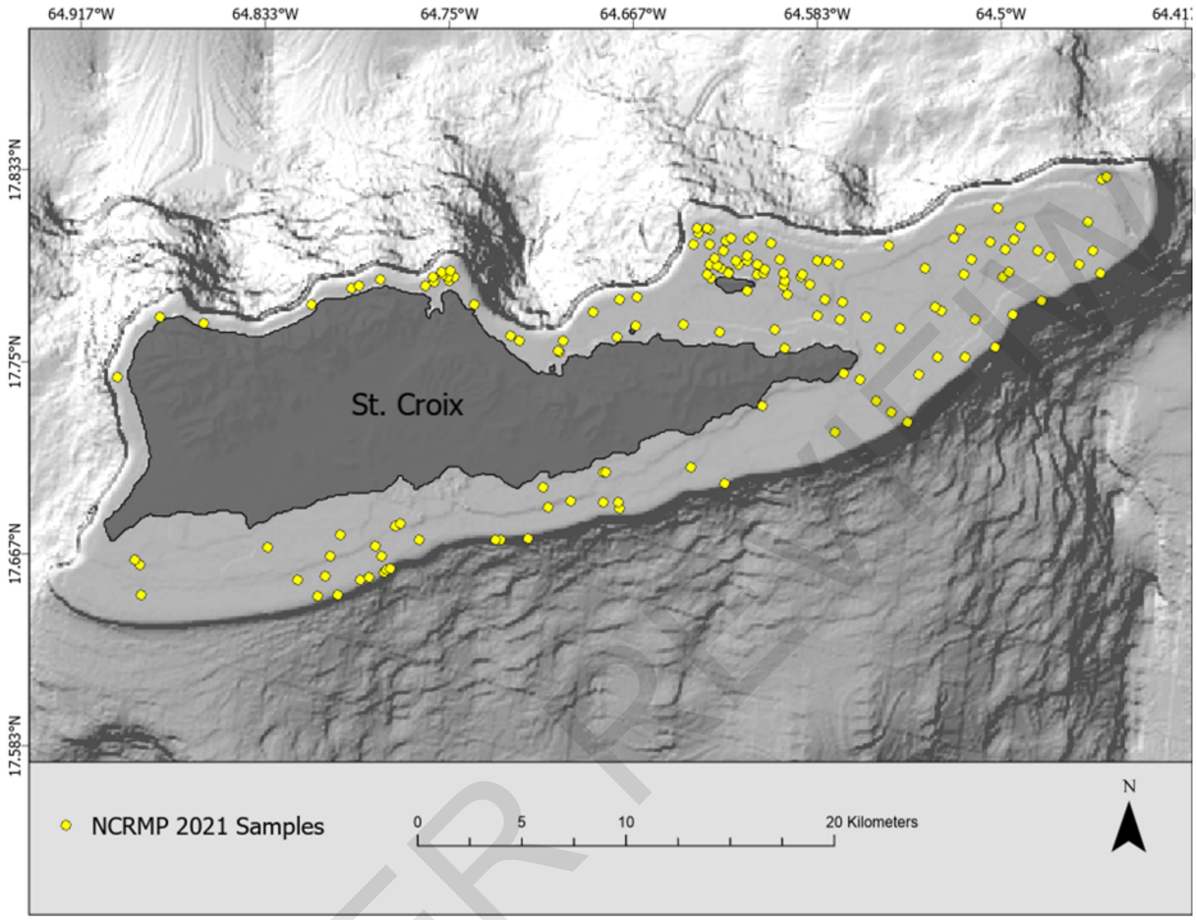

Figure 5.3.1 St. Croix NCRMP sampling sites 2021 (n = 148).

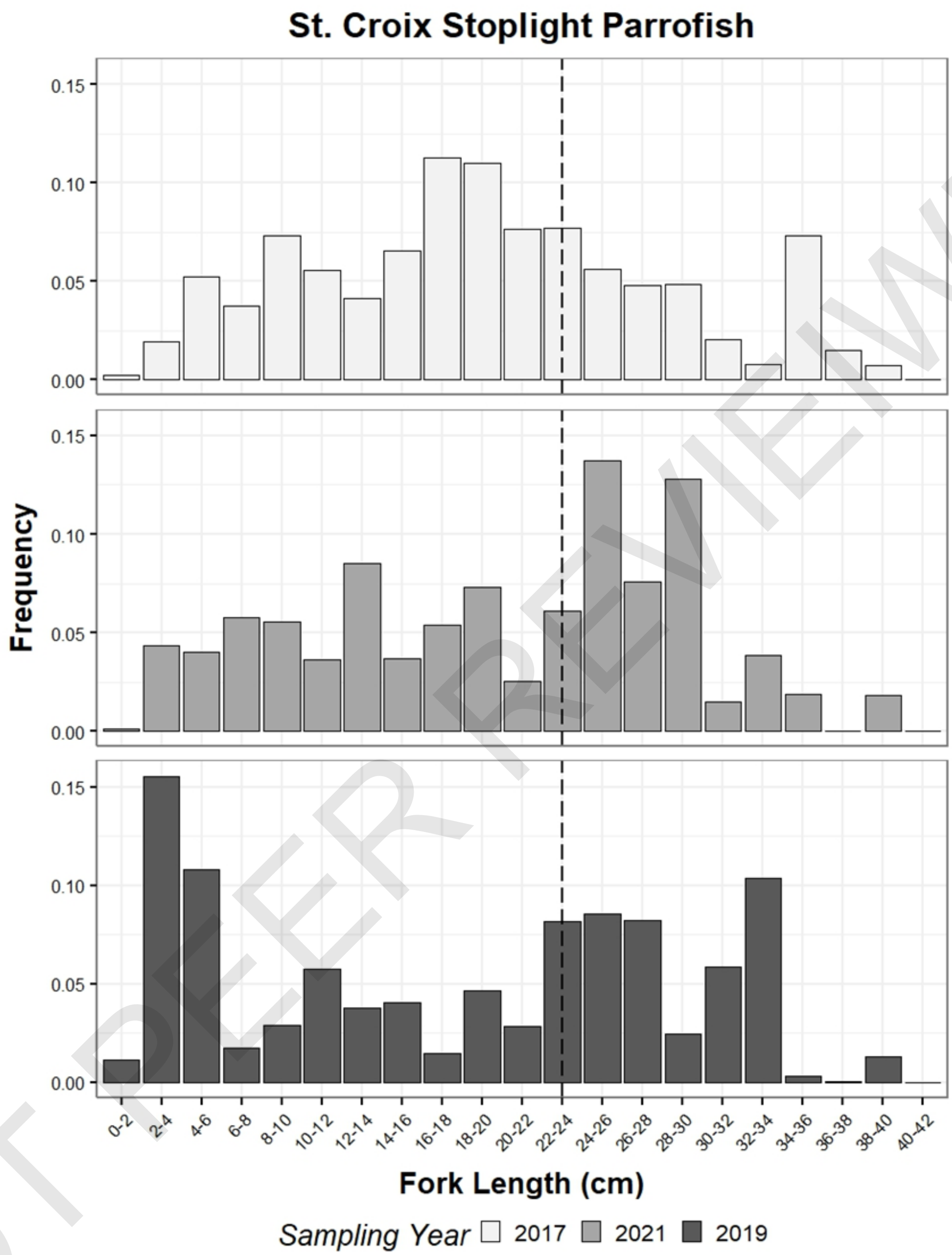

Figure 5.3.2 Stoplight parrotfish population size-frequency distribution at 2-cm bins from the 2017 - 2021 NCRMP RVC-SPC St. Croix surveys. Vertical dashed line is length at capture (23.0 cm fork length).

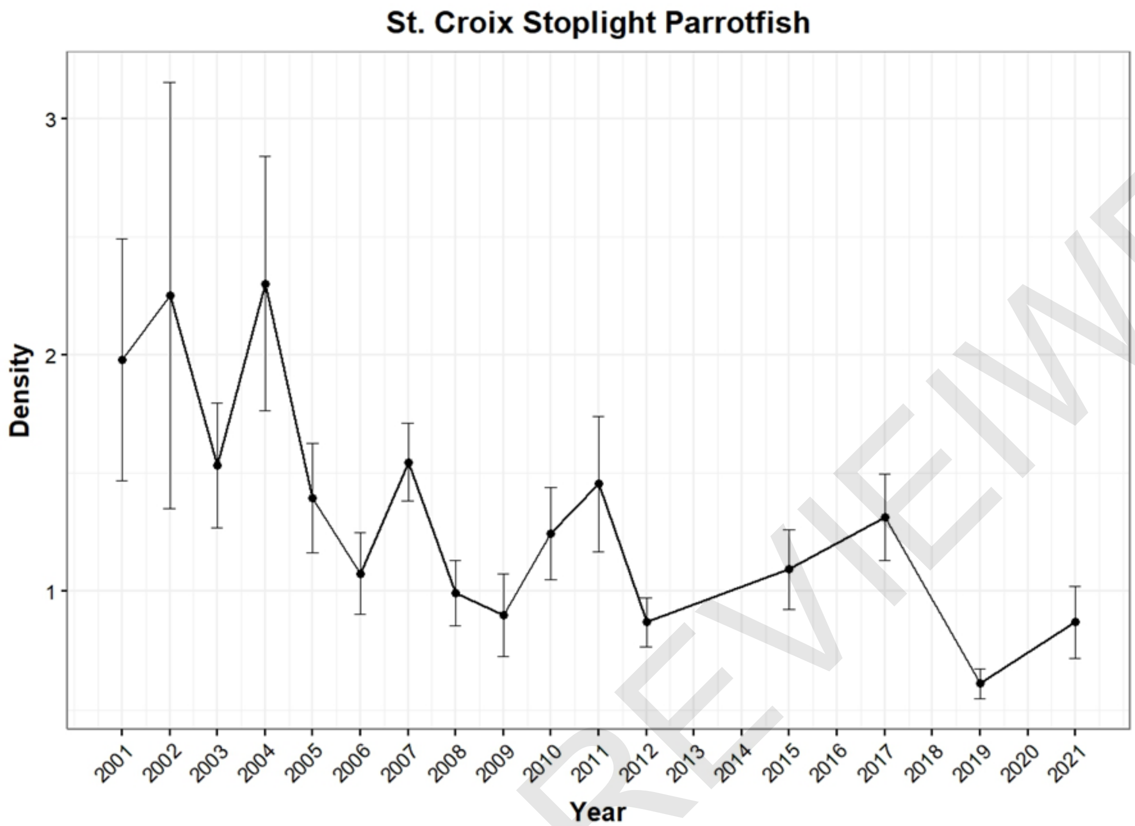

Figure 5.3.3 Time series (2001–2021) of Stoplight Parrotfish (Sparisoma viride) mean population density (number per 178 m2, ± SE) from the reef fish visual surveys in the St. Croix coral reef ecosystem.

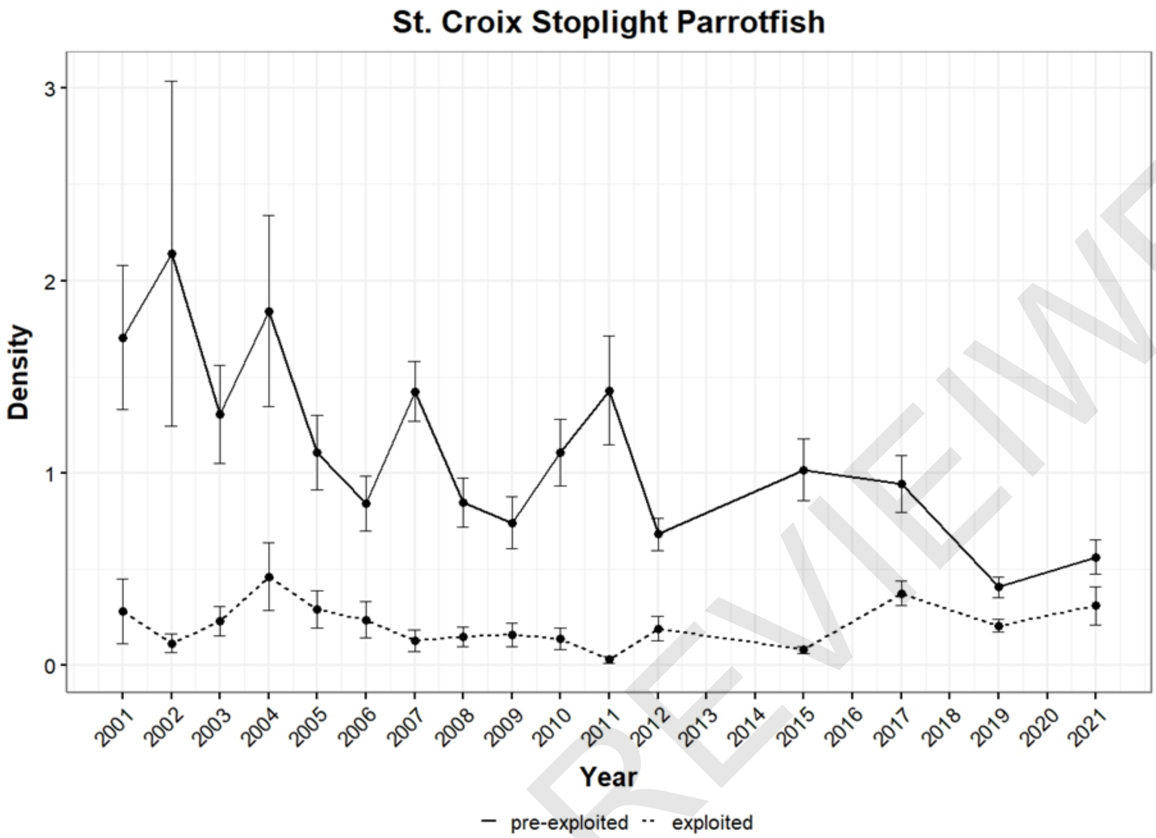

Figure 5.3.4 Time series (2001–2021) of pre-exploited (solid line, < 25 cm) and exploited (dotted line, ≥ 25 cm) Stoplight Parrotfish mean population density (number per 178 m2, ± SE) from the reef fish visual surveys in the St. Croix coral reef ecosystem.

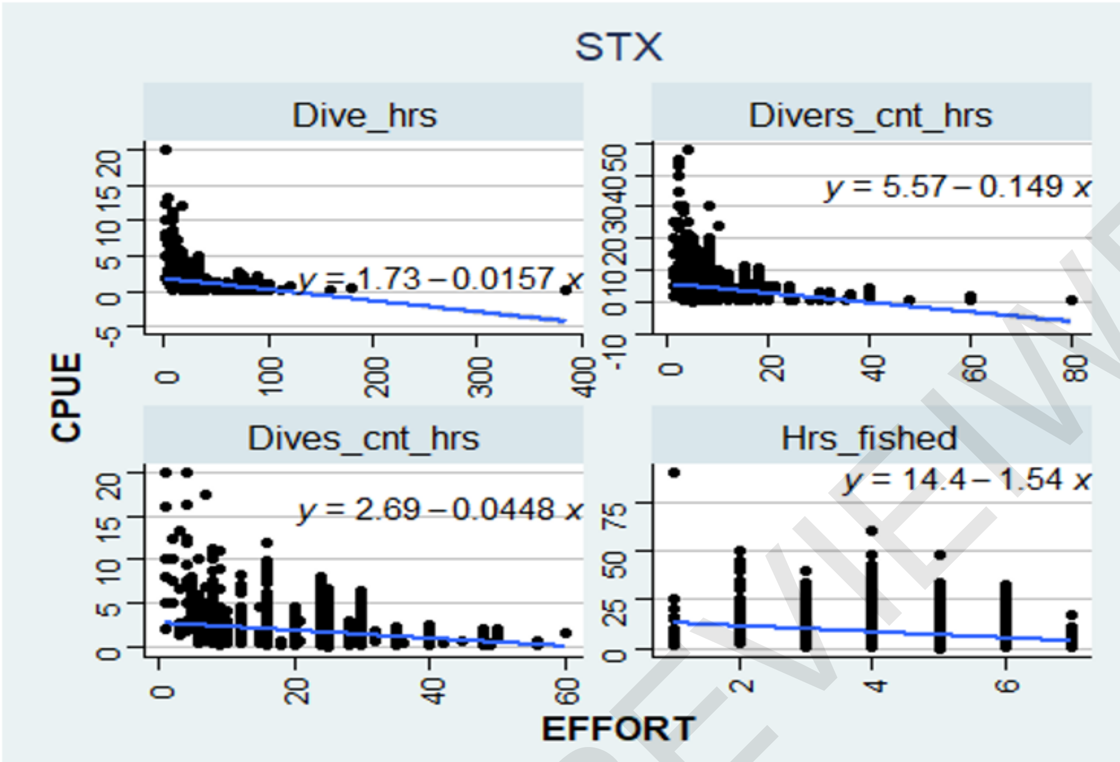

Figure 5.4.1 Exploratory analysis of different variables for suitability as a measure of effort. Dive hours on the top left was chosen due to the minimal change in CPUE over increasing effort (diver hours); i.e., slope of the line is lowest (-0.0157).

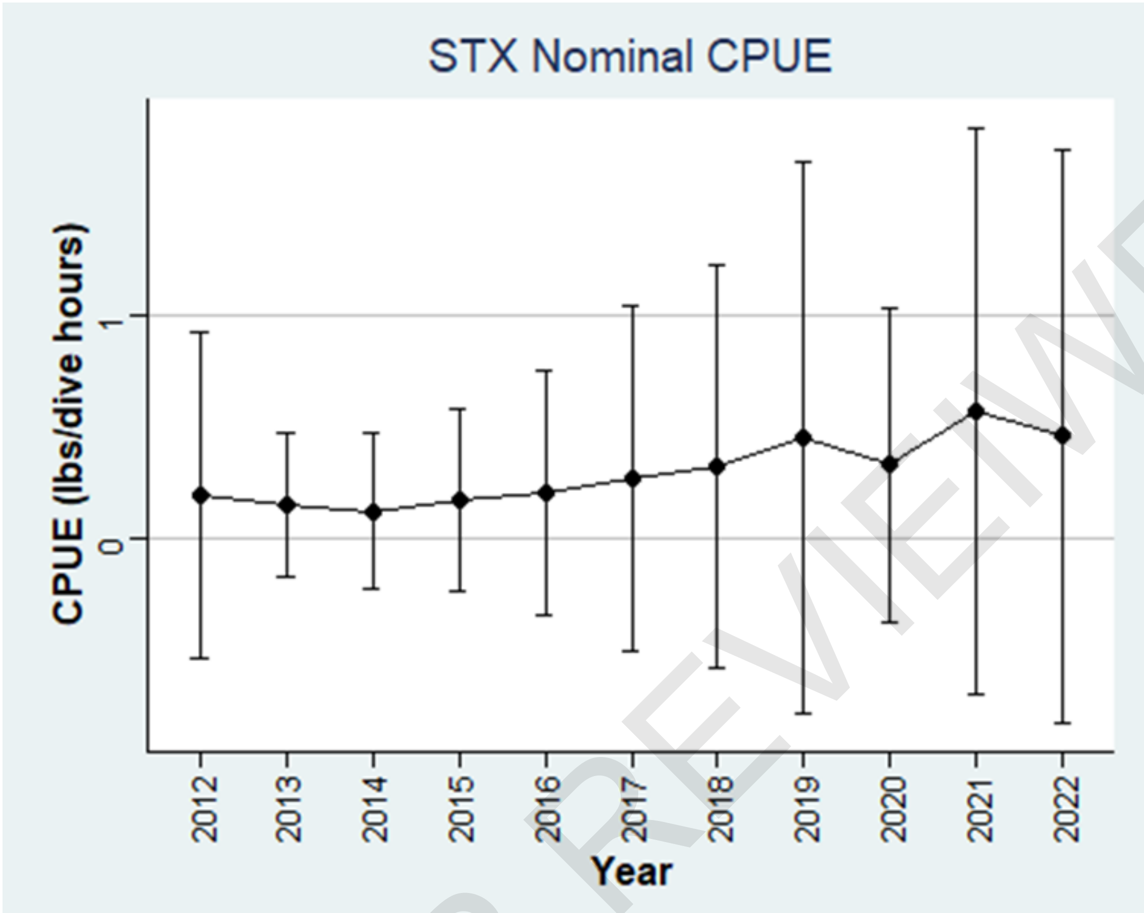

Figure 5.4.2 **N**ominal CPUE index in pounds per diver hours landed for the commercial Stoplight Parrotfish fishery in the St. Croix from 2012 to 2022.

6 Research Recommendations

6.1 Life History Research Recommendation

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

6.2.1 Commercial Landings Research Recommendations

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

- Investigate trends in effort, significant socioeconomic and environmental events, and associated effects on the demographics, gears used, and species landed.
- Increased port sampling is needed in St. Croix to enable analyses required for quantifying removals.
- Conduct recreational fishery port sampling surveys to determine removals due to recreational fishing.
- Investigate the applicability of hindcasting for all parrotfish combined or other applicable future assessments.

Issue 2: Should data outliers in the commercial landings be flagged for additional investigation?

- Operationalize an outlier flagging process for future SEDAR assessments.

Issue 3: What should the gear fleets be for the commercial landings data?

- Operationalize a gear grouping process for future SEDAR assessments.

6.2.2 Length Composition Research Recommendations

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

- 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).
- Operationalize an outlier flagging process for future SEDAR assessments.
- Develop a data management system to link TIP to CCL. A linked system would require changing the overarching structure of collecting fishery-dependent data. A fishery information network system for the US Caribbean could comprehensively resolve this issue.

- 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.

6.2.3 Discards and Discard Mortality Research Recommendations

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

- As shark depredation could play an increasing role in discard mortality, additional research is needed to quantify discards better.
- Promote, through outreach and education, increased reporting of discards.

6.3 Indices Research Recommendations

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

- Use the NCRMP data to investigate what has occurred in regions consistently sampled since 2001 (e.g., Buck Island). Doing so may require combining data across years.
- Investigate the potential impact of changes in habitat on the surveys.
- There is an association between the habitat and fish, but we should consider whether the habitat changes the spatial distribution of fish.
- Investigate highly turbid areas that are currently not surveyed.
- Expand fishery-independent surveys to seagrass/mangrove habitats since these areas are essential for recruitment.

Issue 2: Should the fishery-dependent information from commercial logbooks be considered to conduct abundance indices?

- For future SEDARs, consider an ecosystem-based perspective by investigating what species groups and associated species commercial fishers target to understand species complexes better.
- For future assessments, filter out trips that report only lobster or conch to understand the targeted effort better.
- Investigate the relationship between the catch and effort of the diving data to document the disconnect between time diving and species-specific targeted effort for species considered bycatch or opportunistically targeted.

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