

U.S. Caribbean Stoplight Parrotfish St. Croix, USVI



I. Introduction & Background

- Maps
- Current Management
- Management History
- Stock Complexes
- Assessment History



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Current Management

- Island-based fishery management plans effective as of October 2022
 - [St. Croix Fishery Management Plan](#)
 - [Annual Catch Limits for Stocks and Stock Complexes](#)
- 2022 ACL for St. Croix Parrotfish 2— 72,365 lbs
 - *2000-2010 reference; 2012-2016 ratio*
 - Based on commercial landings but applies to all harvest
 - Landings of indicator stocks are combined to monitor compliance
 - Accountability measures apply to all stocks in the complex if ACL is exceeded

Management History

- Federal Waters
 - 2005 [FMP comprehensive amendment](#) and ban of gillnets and trammel nets
 - 2012 Prohibited Blue, Midnight, and Rainbow parrotfish
 - 2012 ACL for St. Croix Parrotfish 240,000 lb (*1999-2005 reference*)
 - 2013 9-inch size limit for parrotfishes, except redband
- Territorial Waters
 - 2008 [Buy-back/ban](#) of gillnets and trammel nets

Stock Complexes

- Parrotfish 1— Blue, Midnight, and Rainbow parrotfish
Prohibited 2012
- Parrotfish 2— Princess, Queen, Redband, **Redfin**, Redtail, **Stoplight**, Striped parrotfish



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PROTECT THE PARROTFISH!

Remember that none of the following parrotfish species may be caught in the United States Caribbean Economic Exclusive Zone:

Parrotfish serve an important ecological role in US Caribbean reefs. These fish eat algae, which compete for space on several coral species, including *Acropora palmata* and *Acropora cervicornis*, both of which are listed in the Endangered Species Act. These coral species' habitat has been designated as a critical habitat, and the essential characteristics of a critical habitat include the availability of substrate free of macroalgae at certain depths.



Blue parrotfish
Scarus coeruleus



Midnight parrotfish
Scarus coelestinus



Rainbow parrotfish
Scarus guacamaia

Parrotfishes are also considered a cultural dietary component in the US Caribbean, particularly in St. Croix. These three parrotfish species tend to grow slowly and have relatively long timeframes in which to repopulate in comparison to other parrotfish species, which makes them susceptible to overfishing.

Assessment History

- A 2016 assessment ([SEDAR 46](#)) used data-limited methods but was not used for management advice

February 2016

U.S. Caribbean Data-limited Species

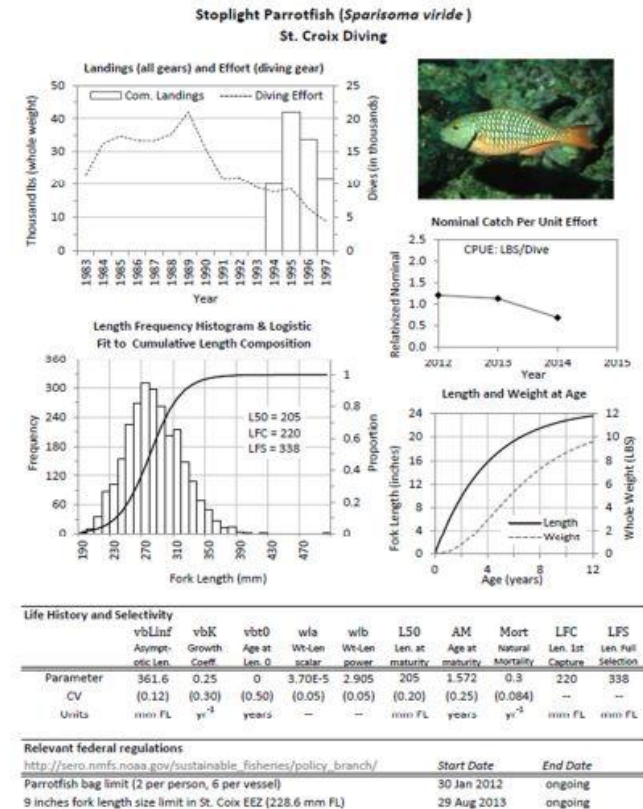


Figure 3.1.6 Summarized information available for stock evaluation of St. Croix stoplight parrotfish using the DLMtool modeling framework.

II. Data & Methods

- Data Sources Overview
- Data Workshop Outcomes
- Post-Data Workshop Outcomes
- Modeling Approach
- Assessment Methodology
- Assessment Overview
- Data Sources



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Data Sources Overview

1. **Landings** from self-reported commercial fisher logbooks
2. **Length compositions** from shore-based port sampling
3. **Length compositions** from a fishery-independent survey of reef fish
4. **Index of abundance** from a fishery-independent survey of reef fish
5. **Life history information** from otolith analysis and gonad histology

Data Workshop Outcomes

- Use life history data made available in SEDAR working papers.
- Only use commercial landings data starting in 2012.
- Identify and flag outliers.
- Utilize the various diving gears to establish a SCUBA gear group.
- Assume commercial discards are negligible.
- Utilize TIP lengths from 2012 to 2022 to inform selectivity.
- Use the NCRMP Stoplight Parrotfish data for STX from 2012 to 2022.
- Do not consider the fishery-dependent information for an abundance indices.

Post-Data Workshop Outcomes

- Life history working paper finalized ([SEDAR84-AP-01](#))
- Assessment panel accepted landings outliers retained as valid trips



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Modeling Approach

- [Stock Synthesis](#) V3.30.22 was the modeling approach applied in the current SEDAR 84 assessment because of compatibility with the available data and consistency with standard practices.
- 40% SPR used as a proxy for MSY.
- Tools for working with Stock Synthesis
 - [r4ss](#): Create plots and tables of Stock Synthesis output and functions to work with Stock Synthesis in R.
 - [ss3diags](#): Run advanced diagnostics for Stock Synthesis models.
 - [Stock Assessment Continuum Tool](#) (previously the SS-DL-tool) a shiny app that includes Extended Simple Stock Synthesis and Simple Stock Synthesis in its functionality.

Assessment Method

- Began with data-limited models using super-period length compositions
 - Steepness fixed at 0.99
 - Sigma R fixed at 0.7
- Model progression tracked biological/data complexities:
 - m1: Hermaphroditism
 - m2: Continuous recruitment
 - m3: Increased catch uncertainty
- Progressed to data-moderate models incorporating:
 - Abundance indices
 - Annual fishery-independent length compositions
 - Recruitment deviations



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Assessment Overview

- Stock Assessment Continuum Tool used to build initial models
- Models configured with 1 area, 1 fleet, and 1 survey; 2012—2022
- Sensitivities tested using:
 - Longevity-based natural mortality
 - Growth variability (CV on growth)
 - Hermaphroditism parameterization
 - Uncertainty in initial equilibrium catch
- Diagnostics included:
 - Gradients, residuals, likelihood profiles
 - Retrospectives and jitter analyses



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Model Development

Stage	Code	Sequential modeling steps
Initial	ct	model initialized with continuum tool (ct)
Initial	m1	ct + hermaphroditism and adjusted length at age zero
Initial	m2	m1 + continuous recruitment
Initial	m3	m2 + catch uncertainty
Scenario	null	catch and super-year length data
Scenario	a	index
Scenario	b	annual fishery-independent length data
Scenario	v1	index + annual fishery-independent length data
Scenario	v3	index + recruitment deviations
Scenario	v7	index + annual fishery-independent length data + recruitment deviations
Sensitivity	s1	higher CV on growth young
Sensitivity	s2	higher age and lower m
Sensitivity	s3	one sex (age-based fecundity = maturity * weight * sex ratio)
Sensitivity	s4	higher catch uncertainty
Sensitivity	s5	s2 + s4
Sensitivity	s6	s2 + s3 + s4

model runs developed under the direction of the Review Workshop Panel to explore data use and model behavior

Model	Description
STX_RW_1	Single Sex, F method 2, Catch SE = 0.3, and Corrected Survey SE
STX_RW_2	STX_RW_1 + Catch SE = 2 and Estimated Growth



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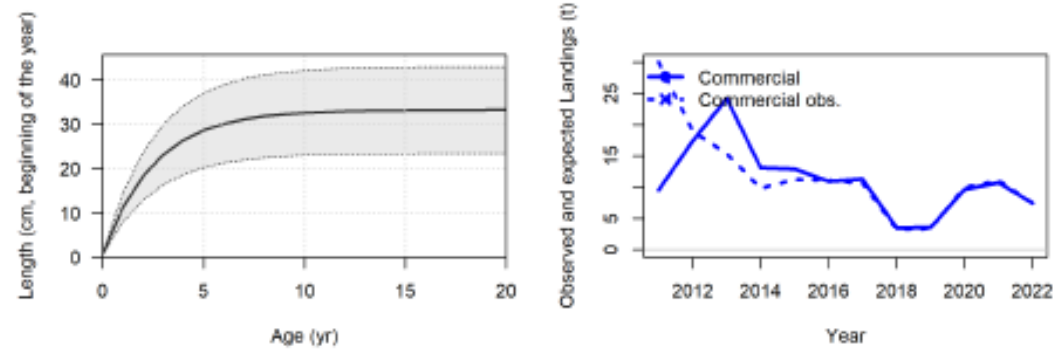
S84 Addendum

- The models remain preliminary and sensitive to consequential assumptions (e.g., initial equilibrium catch, recruitment steepness, selectivity).
- Further work is required to address these uncertainties and develop models more robust for informing management advice.
- These models do not represent final scientific advice. They are intermediate steps in an iterative review process leading to future model development, SSC review, and eventual management consideration.

CIE Review

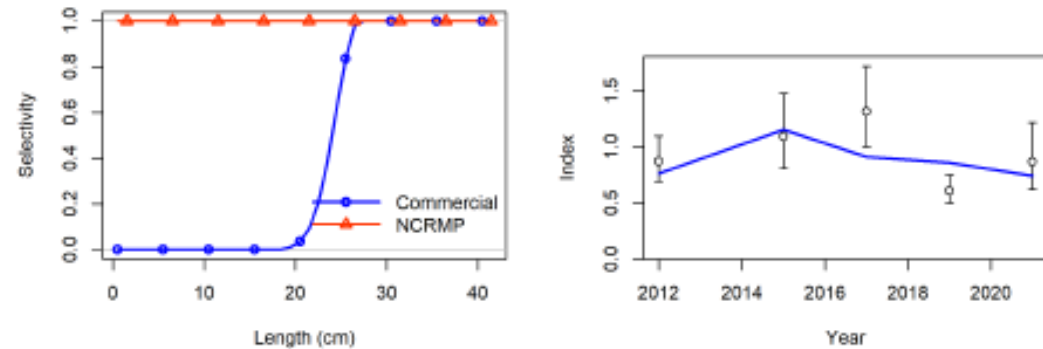
- Although SS3 was implemented correctly, the quality and availability of the data were not robust enough to fully support such a complex model. Diagnostics and the additional model runs revealed sensitivities to assumptions about catch uncertainty (fits to the catch vs index data) and estimation of growth.
- The RP recommended further data collection, consideration of alternative modeling approaches, and reintegration of historical information.

SEDAR 84 SAR SECTION VI - Addendum



(a) Size at age

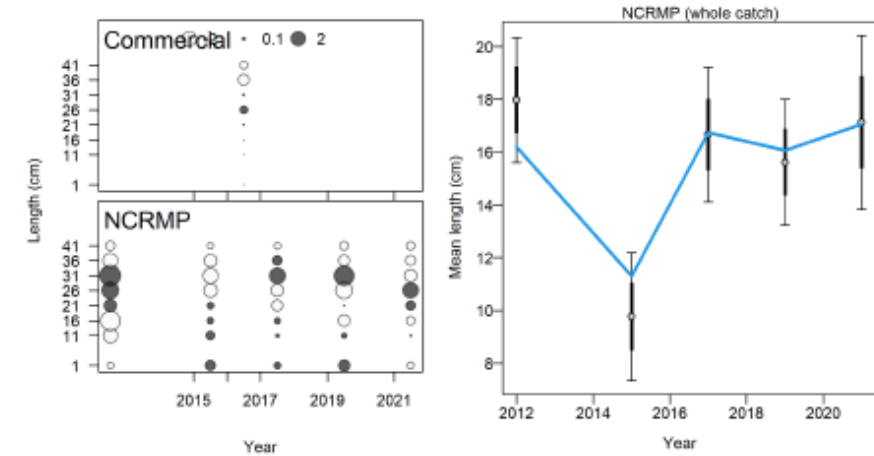
(b) Observed and expected landings



(c) Selectivity

(d) Index NCRMP

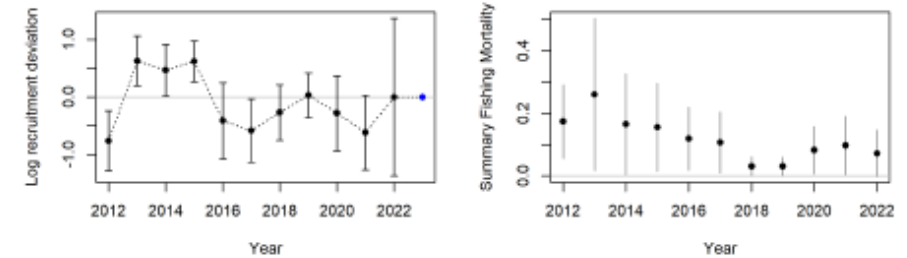
Figure 1: St. Croix Stoplight Parrotfish Review Workshop Model STX_RW_1. (a) Length at age in the beginning of the year (or season) in the final year of the model. Shaded area indicates 95% distribution of length at age around estimated growth curve; (b) observed and expected landings; (c) selectivity at length by fleet; and (d) Fit to index data for the NCRMP survey.



(a) Length fit

(b) Mean length NCRMP

Figure 3: St. Croix Stoplight Parrotfish Review Workshop Model STX_RW_1. (a) Pearson residuals, comparing across fleets. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected); and (b) mean length for the NCRMP survey with 95% confidence intervals.



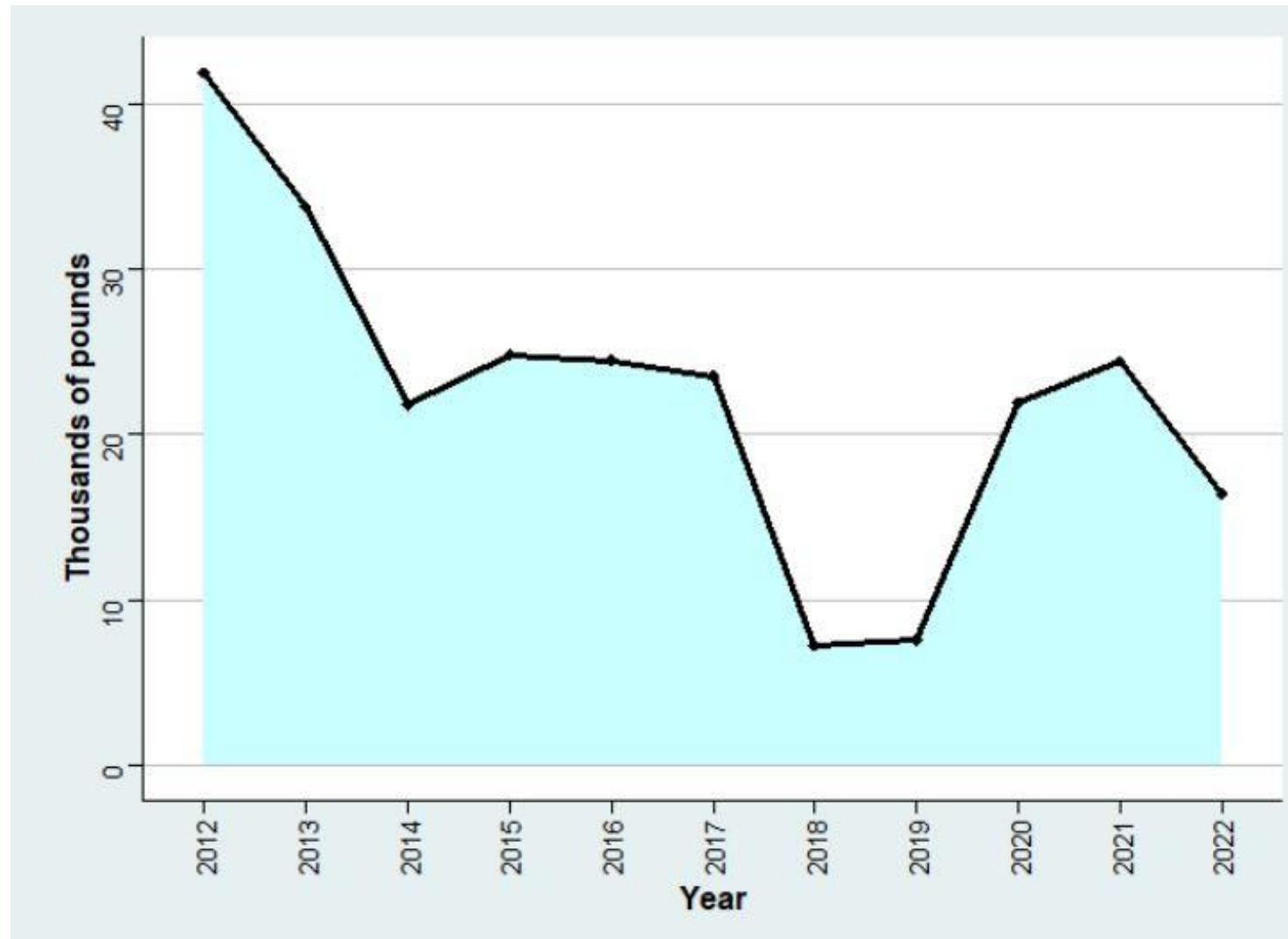
(a) Recruitment deviations

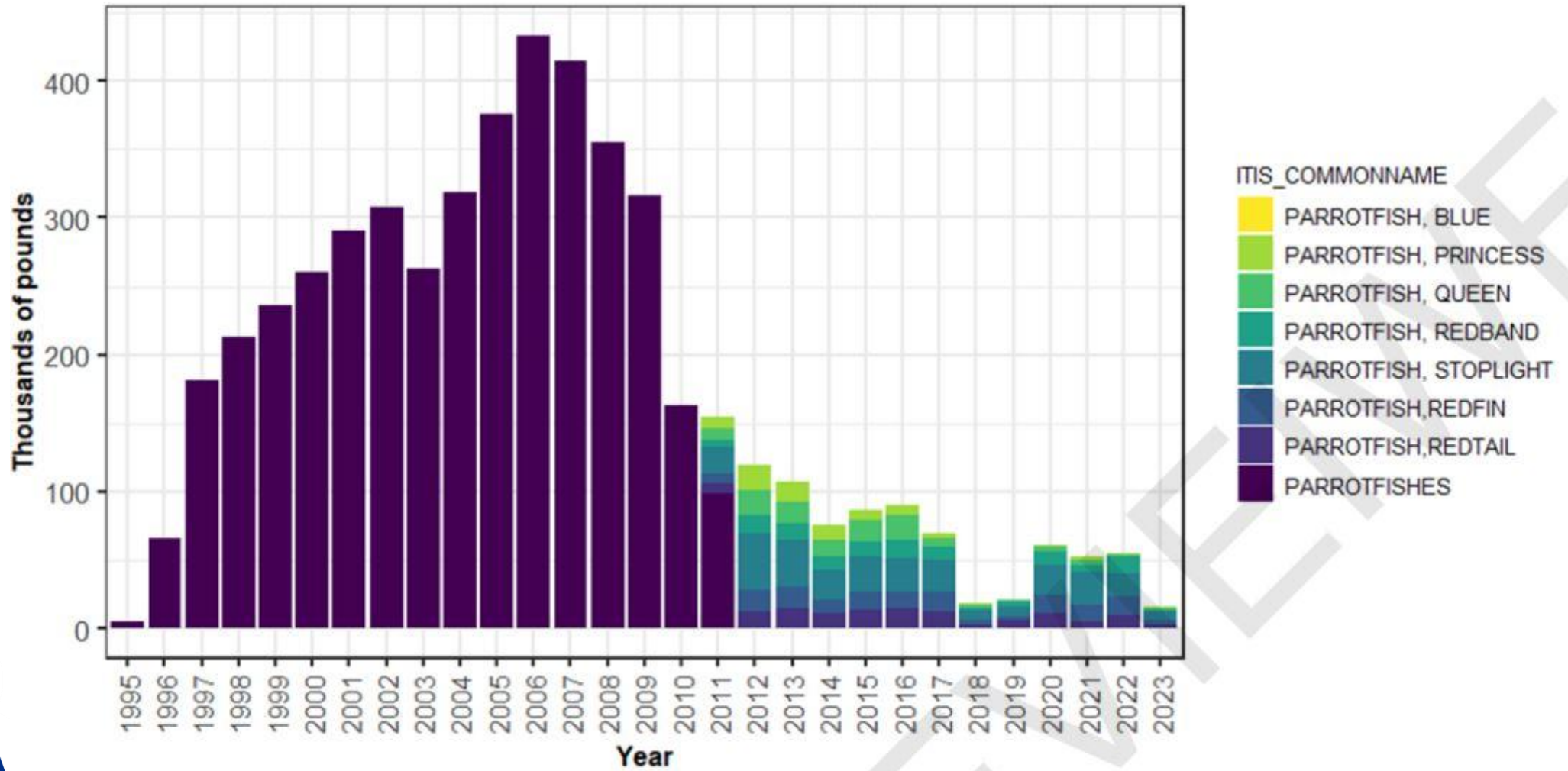
(b) Fishing Mortality

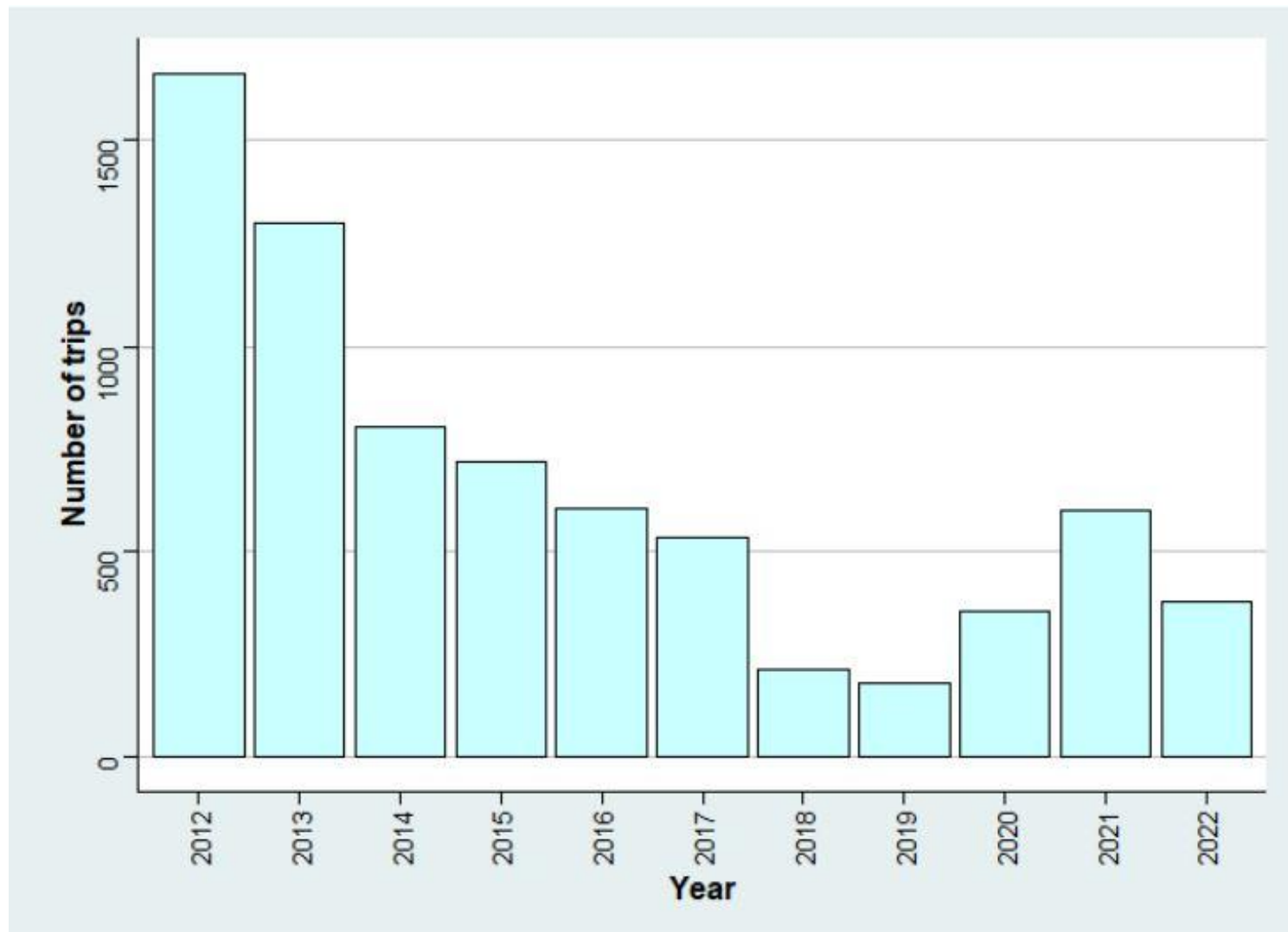
Figure 4: St. Croix Stoplight Parrotfish Review Workshop Model STX_RW_1. (a) Recruitment deviations with 95% intervals; and (b) fishing mortality (total biomass killed / total biomass).

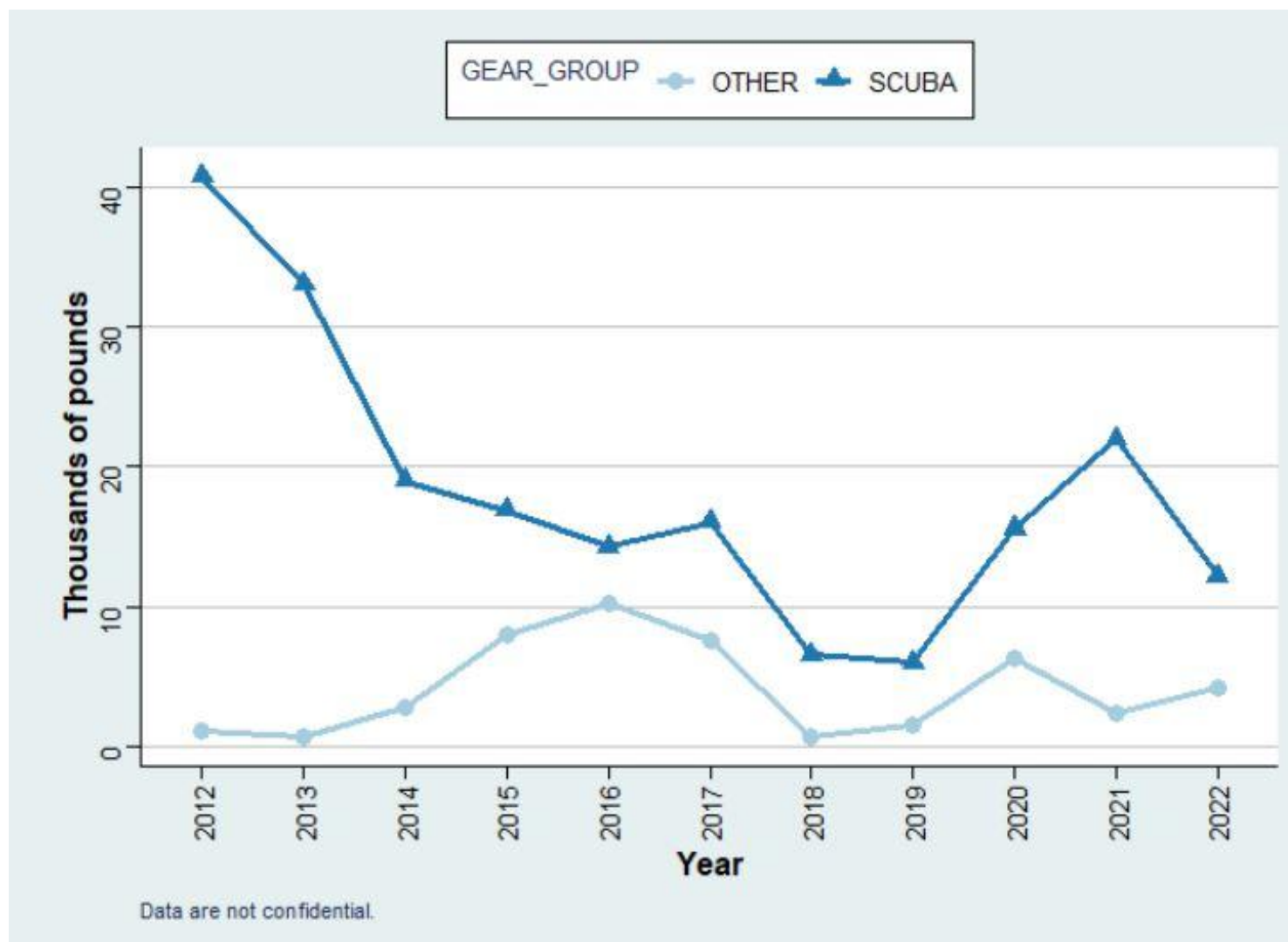
1. Landings from self-reported commercial logbooks

Caribbean Commercial Logbook Program







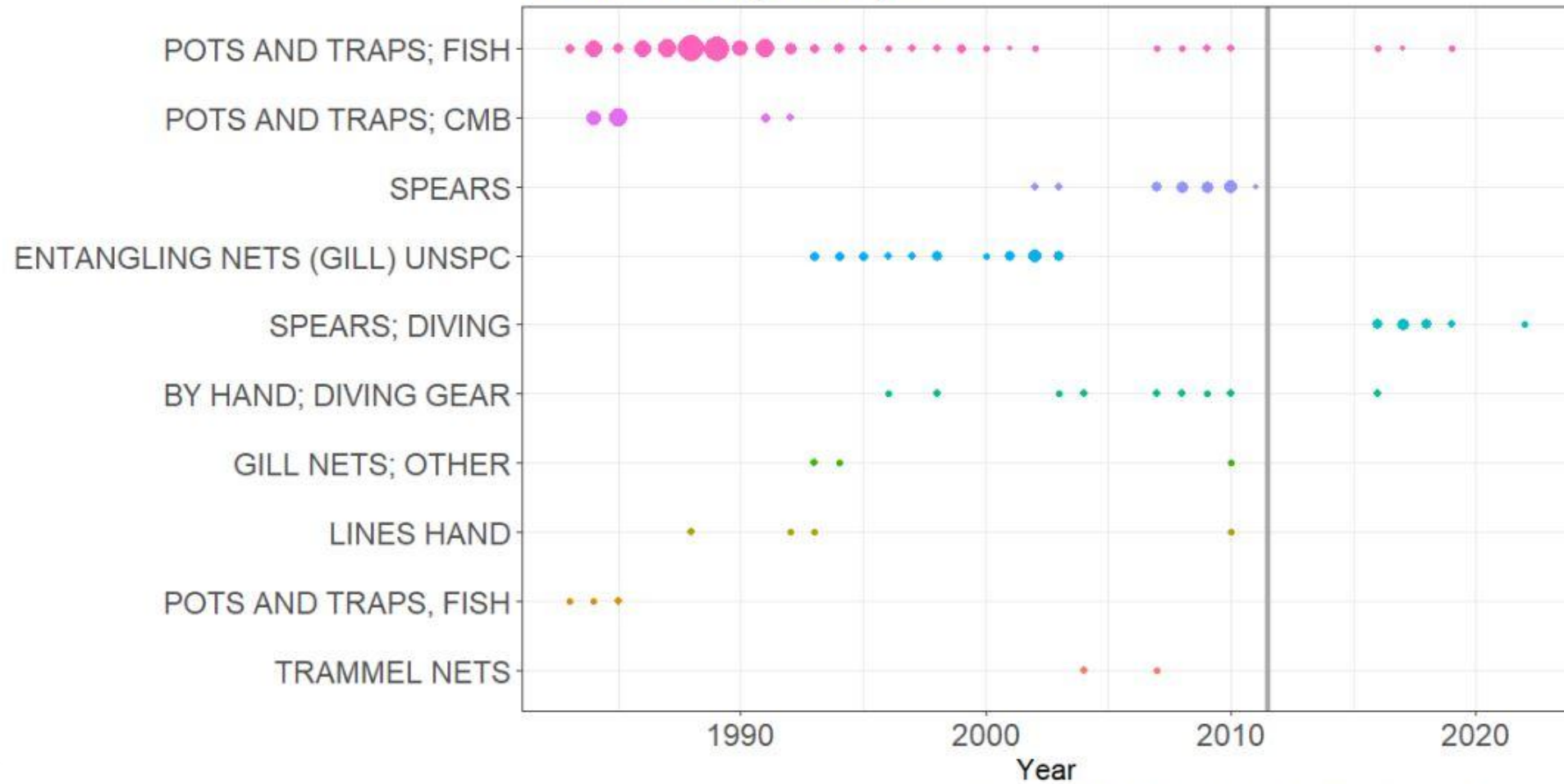


2. Length compositions from shore-based port sampling

Trip Interview Program

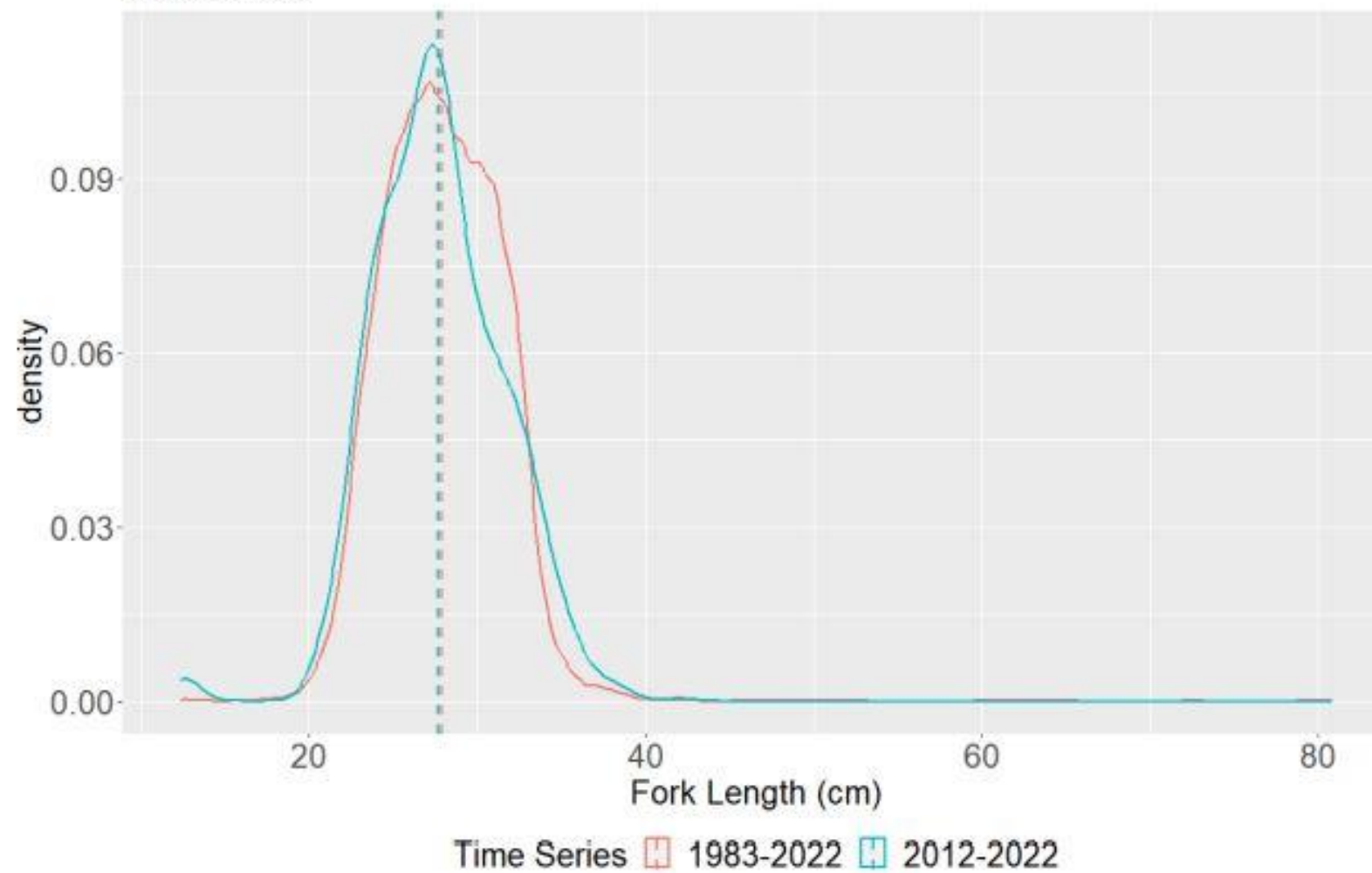
- 98% of TIP length data (2012–2022) came from diving gear.
 - 1,033 length measurements from 66 trips.
- Used to inform length-based selectivity for the commercial fleet.
- Multiple lengths per trip; non-independent observations.
- Model weighting based on number of sampled trips.

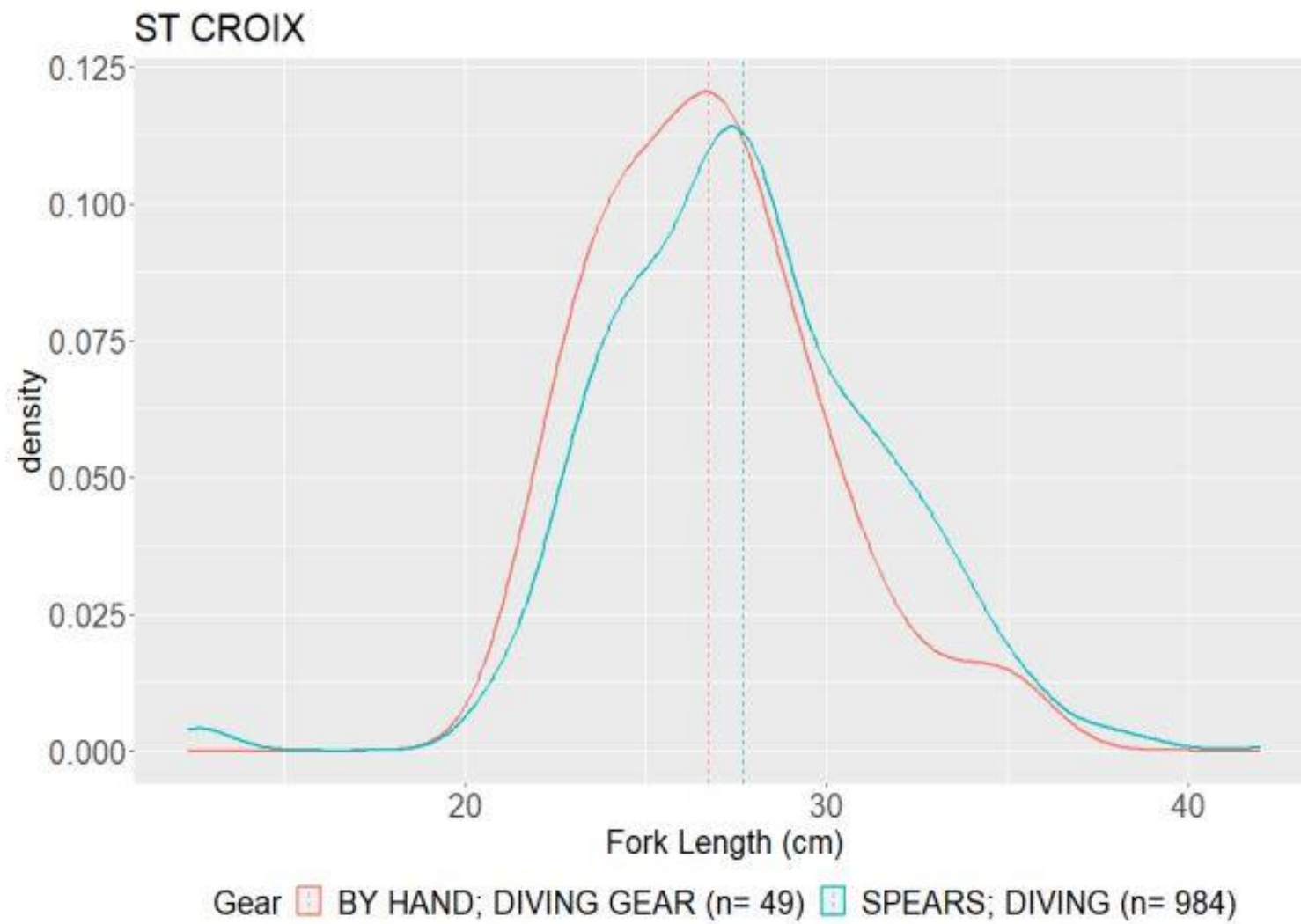
ST CROIX Length Samples



Gears with less than 3 unique interviews were removed.

ST CROIX





3. Length compositions from a fishery-independent survey of reef fish

National Coral Reef Monitoring Program

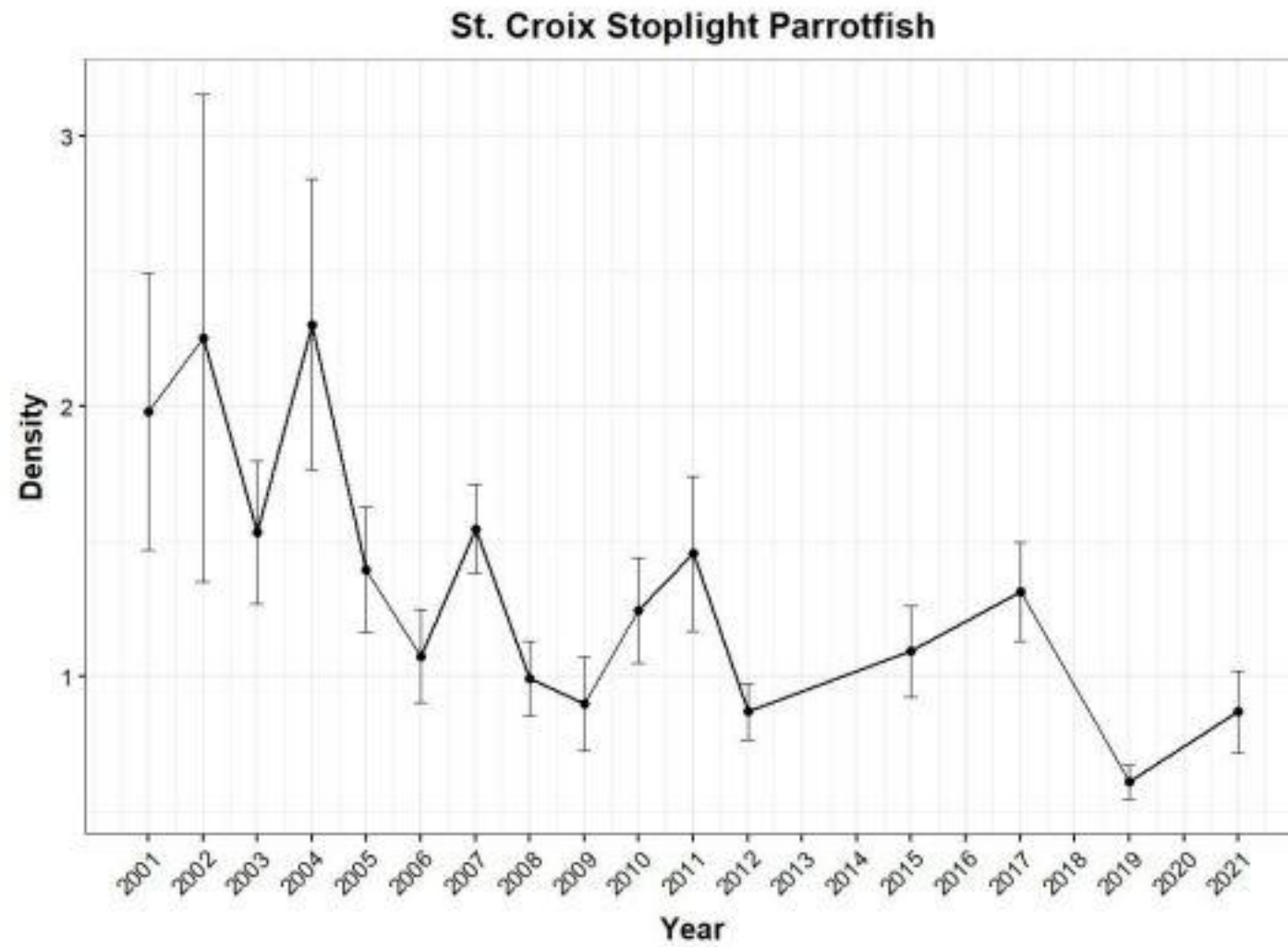
- Regionally restricted transect data from 2001 to 2011.
- Belt transect (2001–2015); Stationary point count (2017–2021).
- Multiple lengths per dive; non-independent observations.
- The relative model weighting based on the number of paired dives.

	0 - 12 meters					12 - 30 meters					Site Total	Length Total
Year	Aggregate	Bedrock	Patch	Pavement	Coral/Rock	Aggregate	Bedrock	Patch	Pavement	Coral/Rock		
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



	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
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2004	23	4	14	46	9	2		4	7	5	114	413
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2019	29	8	32	46	10	74		35	72	8	314	1116
2021	14		19	19	2	43		12	35	4	148	694

4. Index of abundance from a fishery-independent survey of reef fish



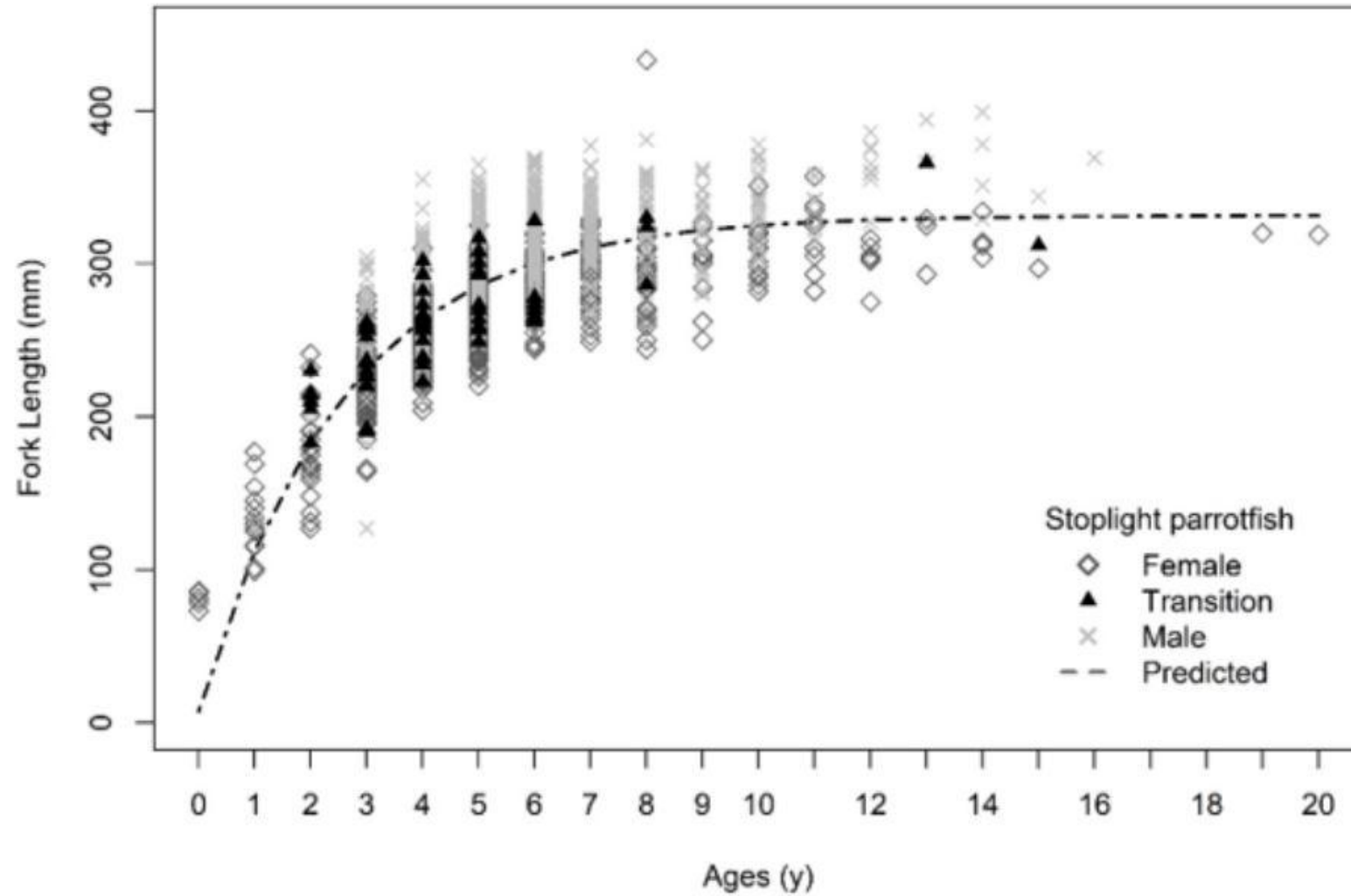
5. Life history information

- Lengths
 - 1,801 samples from 2013-2023 and across the U.S. Caribbean
 - Males (304 mm FL) were significantly larger than females (259 mm FL) and transitioning (258 mm FL)
 - Very few females greater than 351 mm FL
 - Maximum length 433 mm FL
- Ages
 - 1,649 aged fish
 - Oldest fish (20 y) female

5. Life history information

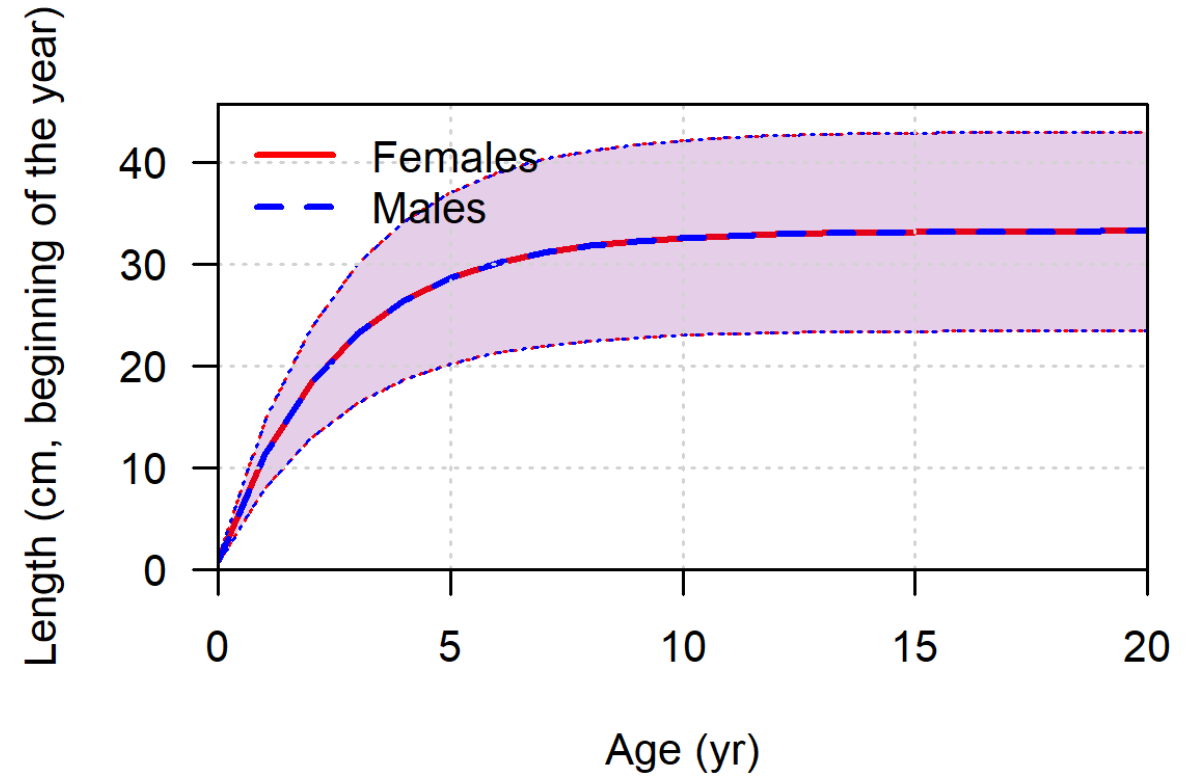
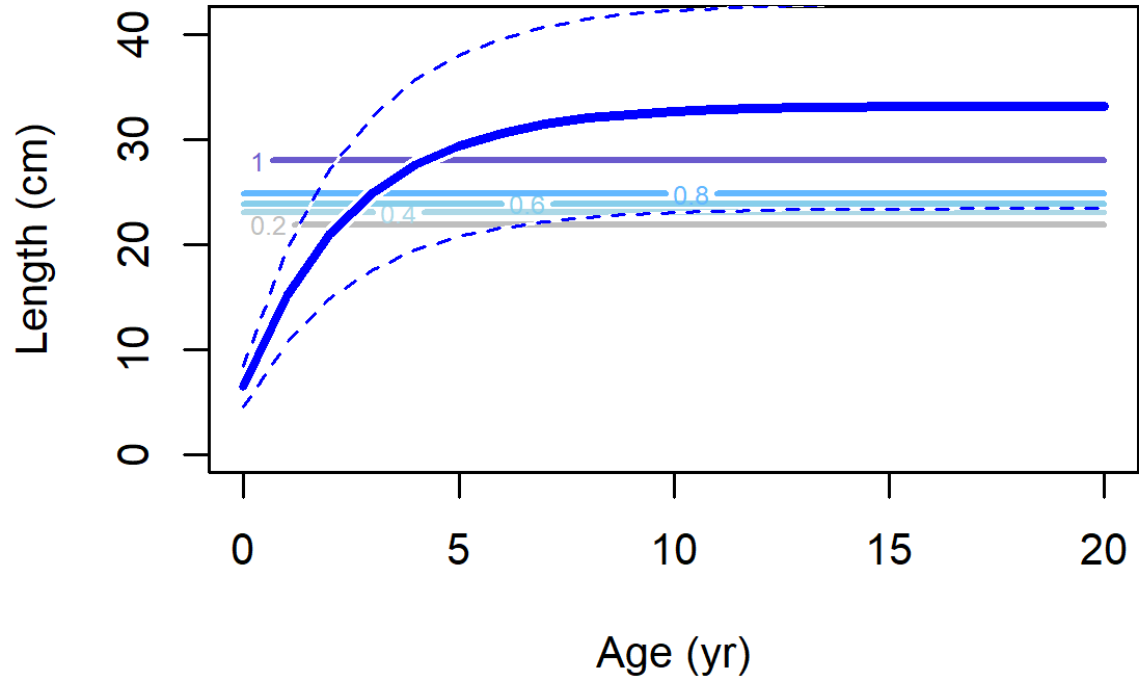
- Sexual maturity and reproductive phase
 - 1,765 stoplight parrotfish gonads
 - Females and males spawning capable year-round
 - Not all females appear to transition to males
 - Females are more dominant through age-3
 - Similar proportions of females and males ages 4-15

Growth



Growth

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)

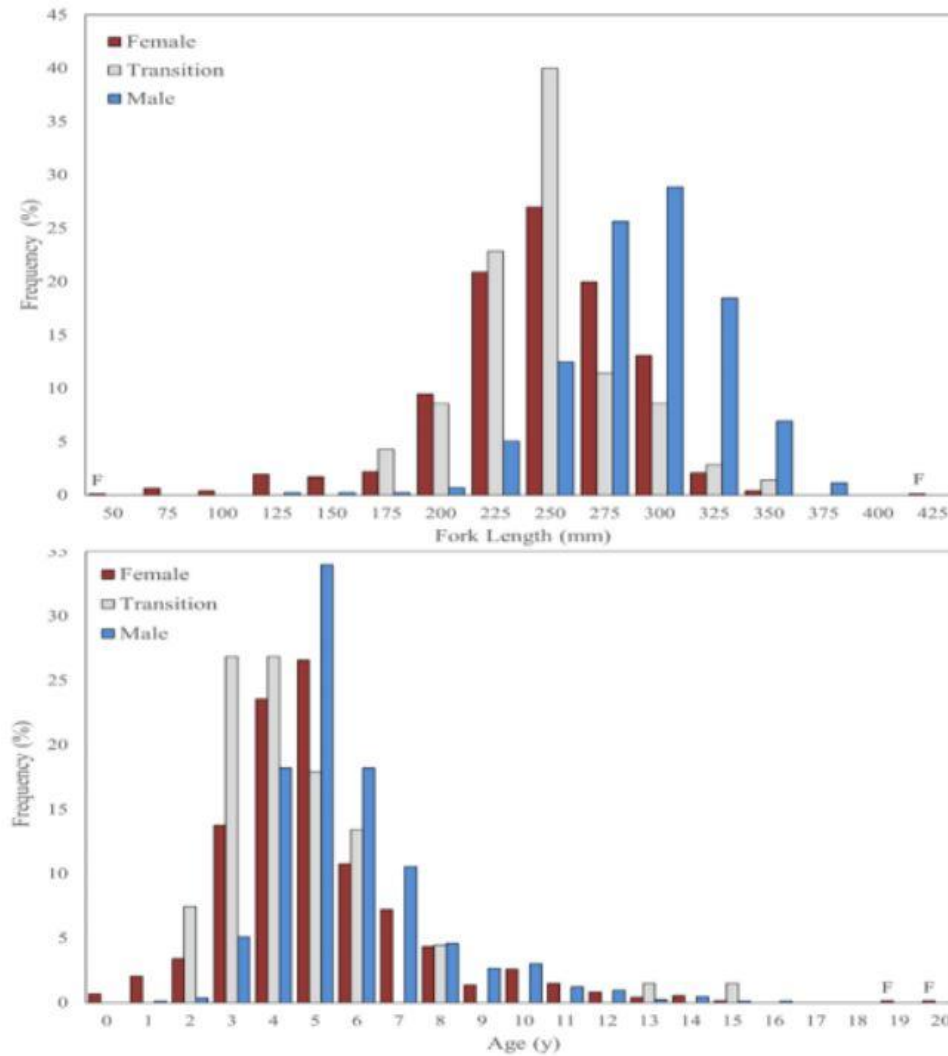


Maturity and Hermaphroditism

Parameter	n	Estimate
Sexual Maturity		
LM ₅₀	768	153 (140 - 165)
AM ₅₀	731	1.6 (1.4 - 1.9)
Transition		
LT ₅₀	1637	279 (275 - 282)
AT ₅₀	1558	4.5 (3.4 - 5.3)



Maturity and Hermaphroditism



Natural Mortality

Input Source	Input Type	Input	M	Method
Survival curve	Maximum age	30	0.180	Hamel_Amax
SEDAR84-AP-01	Maximum age	20	0.270	Hamel_Amax
Meta-analysis	Scientific name	<i>Sparisoma viride</i>	0.397	FishLife
Choat et al. (2003)	Maximum age	12	0.450	Hamel_Amax
Choat et al. (2003)	Maximum age	9	0.600	Hamel_Amax
SEDAR84-AP-01	Growth (k)	0.39	0.604	Hamel_k
SEDAR84-AP-01	Growth (k)	0.39	0.585	Jensen_k 1
SEDAR84-AP-01	Growth (k)	0.39	0.624	Jensen_k 2
SEDAR84-AP-01	Growth (L_{∞} , k)	33.2, 0.39	0.576	Then_VBGF
SEDAR84-AP-01	Growth (k)	0.33	0.512	Hamel_k
SEDAR84-AP-01	Growth (k)	0.33	0.495	Jensen_k 1
SEDAR84-AP-01	Growth (k)	0.33	0.528	Jensen_k 2
SEDAR84-AP-01	Growth (L_{∞} , k)	33.8, 0.33	0.573	Then_VBGF
SEDAR84-AP-01	Age at 50% maturity	1.6	1.030	Jensen_Amat
SEDAR84-AP-01	Age at 50% maturity	1.6	0.924	Ri_Ef_Amat



III. Assessment Results

Model Scenario m3_v7

1. Convergence - OKAY
2. Correlation Analysis - OKAY
3. Variance - OKAY
4. Jitter Analysis - OKAY
5. Residual Analysis
6. Retrospective Analysis
7. Likelihood Profiles (3)
8. Sensitivities (6)

5. Residual Analysis

- Catch
- Indices
- Length Compositions

IV. Discussion & Uncertainties

- Assessment uses a stepwise, scenario-based framework to explore uncertainty
- Natural mortality and initial catch are highly influential in model outcomes
- Short time series (2012-2022) and coarse length bins (2012 & 2015)
- Recruitment deviations are uncertain but improved by fishery-independent data

Key Findings

- Model indicates no overfishing and not overfished
- Only one sensitivity (m3_s6) showed potential overfishing status
- Initial catch conditions are a major source of uncertainty
- Results are robust across models but limited by low-contrast data

Assessment Research Recommendations

- Reevaluate use of combined indicator species for setting ACLs
- Consider larger-scale stock definitions due to high larval connectivity
- Expand modeling to reflect regional metapopulation dynamics
- Continue long-term monitoring with 1-cm length resolution
- Decouple initial condition from long-term sustainable yields
- Support development of ensembles to capture uncertainty
- Promote scenario testing for other Caribbean species

Data Workshop Research Recommendations

Life History

- Optimize sample sizes
- Ensure adequate coverage of small and large fish

Length Composition

- Increase TIP sample size and improve trip coverage (e.g., night fishing)
- Link TIP and CCL via integrated data system
- Investigate weight-at-length trends and trip-level representativeness
- Develop a more holistic sampling strategy

Data Workshop Recommendations (cont.)

- Commercial Landings
- Investigate trends in effort, gear, and environmental drivers
- Explore hindcasting and develop gear grouping and outlier flagging tools
- Discards & Mortality
- Quantify **shark depredation** and discard mortality
- Promote discard reporting through outreach and education

Data Workshop Recommendations (cont.)

- Fishery-Independent (NCRMP)
 - Investigate changes across consistent sites (e.g., Buck Island);
 - Investigate habitat change and expand to seagrass/mangrove areas
 - Explore unsurveyed turbid regions
- Fishery-Dependent Indices
 - Apply ecosystem lens to fisher targeting behavior
 - Filter out lobster/conch-only trips
 - Examine effort vs. catch disconnect in dive data

The End

