

# **SEDAR 84**

Southeast Fisheries Science Center

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# Executive Summary

The SEDAR 84 St. Croix Stoplight Parrotfish stock assessment process consisted of four webinars between April 2024 and October 2024. The data available for the assessment included:

- An annual species-specific catch time series from a commercial logbook program
- Fishery-dependent length compositions from a commercial port-sampling program
- Fishery-independent length compositions from a stratified random sampling survey of reef fish
- A fishery-independent index of abundance from a stratified random sampling survey of reef fish
- Life history information from otolith analysis and gonad histology

The assessment used Stock Synthesis, a statistical catch-at-age model (Methot et al.). Stock Synthesis models were initially configured using an annual catch time series and compositions that were aggregated across the available years for each source of length data. Model development proceeded stepwise from the simplest configuration to those of moderate complexity. Those sequential steps included the inclusion of the index of abundance and annual fishery-independent length compositions. Models were run with and without the estimation of recruitment deviations. Finally, the sensitivity of the assessment outcomes was investigated using alternative inputs for longevity-informed natural mortality, parameterization of hermaphroditism, and reweighting of the effective sample size associated across each source of the length composition data.

All of the configurations resulted in inconclusive results, evidenced by high correlations between the scale of the average recruitment and the fishing mortality rate associated with an assumed initial equilibrium state. Likelihood profile diagnostics further indicate that the configurations explored could not reliably estimate the stock status. Thus, the overfished status of the St. Croix Stoplight Parrotfish stock remains unknown. However, the available data do not indicate a decline in the abundance index concurrent with a decrease in landings and show constant trends in size composition quarantines. These findings suggest that the St. Croix Stoplight Parrotfish is not likely to be undergoing overfishing in 2022.

# 1 Background

The Stoplight Parrotfish (*Sparisoma viride*) is a sequential protogynous hermaphrodite that inhabits coral reefs in the Caribbean Sea, Florida, Gulf of Mexico, Bermuda, and Brazil. It is an herbivorous species that is targeted in reef fish fisheries throughout much of the Caribbean, including St. Croix, USVI.

## 1.1 Management

St. Croix Stoplight Parrotfish is managed under the St. Croix Fishery Management Plan (Crabtree). In 2023, the Caribbean Fisheries Management Council transitioned from species-based to island-based fisheries management (Figure 1.1). The management measures in the new island-based fishery management plans became effective on October 13, 2022. The Parrotfish 2 stock complex includes two indicator stocks and five other species. The indicator species are Redtail Parrotfish and Stoplight Parrotfish. The allowable biological catch for the complex was established using tier 4a of the 4-tired ABC control rule. The complex has an ABC of 85,135 and an ACL of 72,365 pounds whole weight (32,824.2 kg).

The Southeast Fisheries Science Center provided a SEDAR 84 Data Workshop working paper summarizing federal management actions for Stoplight Parrotfish in St. Croix. On August 29, 2013, a 9-inch federal size limit was instituted by Final Regulatory Amendment 4. The size limit only applies in the U.S. EEZ surrounding St. Croix, defined as the federal waters ranging from 3 to 200 nautical miles (nm) (5.6 – 370 kilometers [km]) from the nearest coastline point of the U.S. Virgin Islands (Figure 1.2).

## 1.2 Assessment History

Before the current assessment, only one St. Croix Stoplight Parrotfish stock assessment had been conducted (SEDAR, *SEDAR 46 Caribbean Data-Limited Species Stock Assessment Report*). The SEDAR 46 evaluations were performed using the Data-Limited Methods Toolkit (Carruthers and Hordyk). The approach applied data-limited stock assessment models and management procedures. Ultimately, the results were not used for management advice.

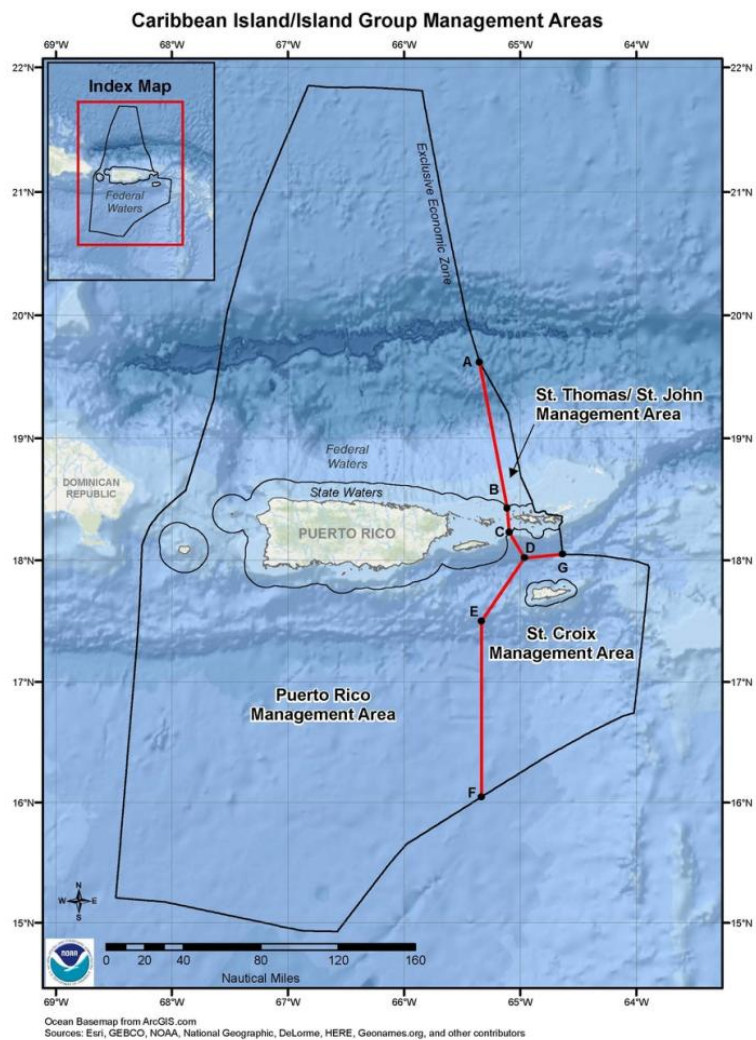


Figure 1.1: Jurisdictional boundaries of the Caribbean Fishery Management Council.

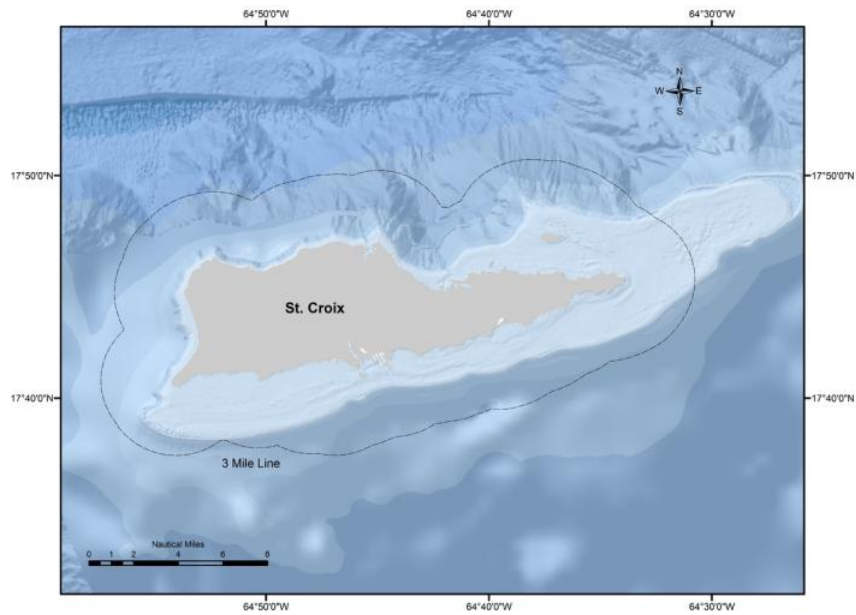


Figure 1.2: The U.S. EEZ is defined as the federal waters ranging from 3 to 200 nautical miles (5.6 – 370 kilometers) from the nearest coastline point of the US Virgin Islands.

## 2 Modeling Framework

**Stock Synthesis was the modeling approach applied in this assessment because of its compatibility with the available data and consistent with standard practices.**

Stock Synthesis is a statistical catch-at-age model that uses a population model, an observation model, and an estimation model and applies a likelihood function in the estimation process (Methot et al.). Stock Synthesis, commonly referred to as SS3, has been applied extensively worldwide for stock assessment evaluations (Methot and Wetzel). It has also been used for previous data-limited and data-moderate SEDAR assessments, including the SEDAR 57 assessments and subsequent updates for Caribbean Spiny Lobster, and the SEDAR 80 assessments for Queen Triggerfish (SEDAR, *SEDAR 57 Stock Assessment Report u.s. Caribbean Spiny Lobster*; SEDAR, *SEDAR 80 – US Caribbean Queen Triggerfish – Puerto Rico Final Stock Assessment Report*).

The Stock Synthesis modeling framework is a compatible tool for SEDAR stock assessments in the U.S. Caribbean because it can accommodate a wide range of model complexities, from data-limited to highly detailed assessments (Cope). Stock Synthesis allows for the characterization of stock, fishing fleet, and survey dynamics through various parameters, which can be either fixed based on external data or estimated when sufficient assessment data are available. Additionally, it can incorporate complex biological dynamics, such as hermaphroditism and continuous recruitment, which are critical for accurately assessing St. Croix Stoplight Parrotfish.

Finally, R packages such as *r4ss* and *ss3diags* facilitate critical evaluations of model reliability and model comparisons (Taylor et al.; Carvalho et al.). For example, *R4SS* provides visualization and diagnostic tools to summarize and interpret fit, convergence, and key output metrics. *SS3diags* focuses on retrospective analyses, hind-casting, and residual pattern evaluations. The integration of these tools allows rigorous uncertainty analysis, streamlined sensitivity analyses, and enhanced transparency in decision-making.

## 3 Available Data

The data available for use in the current assessment are summarized in the SEDAR 84 US Caribbean Stoplight Parrotfish St. Croix Data Workshop Report (SEDAR, *SEDAR 84 US Caribbean Stoplight Parrotfish St. Croix Data Workshop Report*). Additional details are provided across the respective references identified below:

1. Landings from self-reported commercial fisher logbook data (Martínez Rivera et al.)
2. Length compositions from shore-based port-sampling of commercial landings (Godwin et al.)
3. Length compositions from a fishery-independent stratified random sampling survey of reef fish (Grove et al.)
4. Index of abundance from a fishery-independent stratified random sampling survey of reef fish (Grove et al.)
5. Life history information from otolith analysis and gonad histology (Rivera Hernández and Shervette)

**Based on the available data, the assessment was configured with one diving fleet and one fishery-independent survey.**

The remainder of this section documents the input data, assumptions, configurations, and equations explored using Stock Synthesis based on the available data.

### 3.1 Commercial Dive Fleet

#### 3.1.1 Catch Data

The catch inputs for diving fleet came from the Caribbean Commercial Logbook data.

The years of the available species-specific logbook data determined the start and end years of the Stock Synthesis models. They were 2012 and 2022, respectively. Based on discussions at the data workshop characterizing the diver fleet, the assessment assumed no discarding nor discard mortality associated with the dive fleet. - The catch was treated as if it as the available



### 3.1.2 Size Composition Data

Corresponding gear-specific size compositions came from the Trip Interview Program. Since multiple fish can be obtained from a single sampled trip, the lengths are not independent observations. Therefore, the relative model weighting of the dive fleet length compositions was based on the number of trips sampled.

**Due to low sample sizes, the fishery-dependent commercial dive fleet length composition data were collapsed across all years and used in the model to inform the fleet selectivity.**

Additional fleet-fleet inputs required for the Stock Synthesis model included an input standard error for the landings and an equilibrium catch value. Since the data-limited implementation of Stock Synthesis is conditioned on landings, the input standard error for the landings was set to 0.01. Although the data-limited implementation of SS3 will inherently nearly exactly fit the annual landings time series, a higher CV of 0.3 was explored via sensitivity analysis (see [?@sec-methods-sensitivity](#)).

It is important to note that the stock was not at an unexploited equilibrium at the start year of the available time series. The fishery had been ongoing for decades, and the total fishing effort in St. Croix in 2012 was undergoing a meaningful decline; thus, an initial  $F$  was estimated for the Commercial undefined fishery, and an initial equilibrium catch was input as 30 metric tons, a little over twice the geometric mean of the catches from 2012-2014. The initial equilibrium catch was explored via likelihood profiling.

One fishery-independent survey was modeled with an abundance index and associated length compositions for 2012, 2015, 2017, 2019, and 2021. The data were from the National Coral Reef Monitoring Program (NCRMP) Reef Visual Census (Grove et al.). The relative model weighting of the NCRMP survey length compositions across years was based on the number of paired dives.

Although the three most recent years of the NCRMP survey provided counts by individual lengths measured to the nearest centimeter, the data in St. Croix before 2017 were collected in 5-centimeter bins. Therefore, the length data inputs for both the dive fleet and the three most recent years of the NCRMP survey 1-centimeter length measurements were binned to match the NCRMP 2012 and 2015 5-centimeter bins accordingly. Further, due to the large proportion of small fish observed in the NCRMP survey, the smallest two bins, [1-6) and [6-11), were collapsed into a single bin [1-11). Note that SS3 allows the length bins of the data inputs to be larger than the bins used in the population model. Although the size bins of all the length data inputs were large ( $\geq 5$  centimeters), the model's simulated population bin size was 1-centimeter bins, with a plus group for the largest bin, greater than or equal to 41 centimeters fork length. Although the population is modeled at a higher resolution concerning bin size, the likelihood function, which aims to match the observed data inputs and the simulated population estimates, operates at the resolution of the data inputs ( $\geq 5$  centimeters).

## 3.2 Life History

The life history data used in the assessment included longevity-informed natural mortality, growth (length-age), length-weight, maturity, and sex ratios obtained from 1,801 samples of Stoplight Parrotfish collected across the U.S. Caribbean from 2013 to 2023 (Rivera Hernández and Shervette).

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