# SSC Report to the 187th CFMC Meeting

August 12-13, 2025

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Chairman

Scientific and Statistical Committee

# SEDAR 84

SEDAR 84 US Caribbean Yellowtail Snapper and Stoplight Parrotfish:

Stock Assessment

# Review Workshop

July 15 – July 18, 2025, Ft. Lauderdale, Florida, USA.

# SEDAR 84

## SEDAR is organized within three workshops: 5 steps

**First is the Data Workshop**, during which fisheries dependent and indepebdent monitoring (FDD and FID), and **life history data** of a fish stock are reviewed and compiled.

**Second Workshop is the Assessment Process** during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop.

**Third step is the Review Workshop**, (which is the subject of this report) during which independent experts review the input data, assessment methods, and assessment products.

**Fourth** The final **Completed Assessment** includes the reports of all 3 aforementioned stages and of all supporting documentation.

**Fifth** The **Completed Assessment Report** is then forwarded to the **Council SSC** (in this case the CFMC/SSC) for certification as 'appropriate for management' and development of specific management recommendations.

# SEDAR 84

- The **Review Panel** consisted of six (6) panel members: two CFMC/SSC members and four (4) from other institutions (i.e. USVI, MSU, IFC, and COV).

- The **Analytic Team** consisted of two (2) members, both from the SEFSC (NMFS).

- The **Appointed Observers** There were four (4**)** : three (3) from the CFMC District Advisory Panel of St. Croix (USVI) and one (1) from the CFMC District Advisory Panel of St. Thomas/St. John (USVI).

- The **Additional Observers** (*via* Webinar) Fourteen (14also participated, which included, among others, three (3) from NOAA, two (2) from the regional office (SERO) and two Science Centers (SEFSC, and SWFSC). Two Staff Members (1 from SEDAR and 1 from the CFMC) and one (1) Workshop Observer (from the SEFSC) participated in person.

# SEDAR 84

SEDAR 84 addressed the stock assessments of **two** U.S. Caribbean data-limited species:

1) the Yellowtail snapper (*Ocyurus chrysurus*) and,

2) the Stoplight Parrotfish (*Sparisoma viride*).

- The Caribbean Yellowtail snapper stock has been addressed in two previous SEDAR stock assessment processes (i.e. **SEDAR 8** and, in **SEDAR 46**).

- In the latter (**SEDAR 46**) the Stoplight parrotfish stock was also previously included.

- Both of these taxa at present are classified as reef fish FMUs and managed under their respective Island Based Fisheries Management Programs as data-limited species.

# SEDAR 84

## ABOUT THE SPECIES

1. both species are reef fish units,
2. they are very different in their systematics, different in their life histories
3. the Yellowtail snapper is dioecious, having separate sexes
4. the Stoplight parrotfish is protandrous, a sequential hermaphrodite with three sexes).
5. their  feeding habits, their behavior,  and their ecological functions differ:
6. the Yellowtail snapper is carnivorous and preys on the water column (e.g. on small fish and squids) as well as on benthic reef invertebrates (e.g. on decapod crustaceans).
7. The Stoplight parrotfish is a macroalgal grazer (herbivorous) and feeds almost exclusively on algae: large and sparse turfs growing, and endolithic algae (Bruggemann, J. H., van Oppen, MJH., & Breeman, A. M. (1994).

# SEDAR 84

During the SEDAR 84 stock assessment process of the US Caribbean Yellowtail snapper (*Ocyurus chrysurus*) and the Stoplight Parrotfish (*Sparisoma viride*) four stock assessment **MODELS** were used:

1. MODEL 1:  for 1) St. Croix, 2) St. Thomas/St. John, 3) Puerto Rico, and for 4) Puerto Rico/St. Thomas/St. John.

2. MODEL 2: for 1) St. Croix, 2) St. Thomas/St. John, 3) Puerto Rico; and for 4) Puerto Rico/St. Thomas/St. John.

3. MODEL 3: for 1) St. Thomas/St. John, and 2) for Puerto Rico.

4. MODEL 4: for 1) Puerto Rico (test for model convergence).

For each model, among other parameters (listed below), key Spawning Potential Ratio (SPR) plots are provided with horizontal red lines indicating the MSY proxy of 40% SPR.

# SEDAR 84

## POPULATION PARAMETERS PLOTTED FOR EACH MODEL

1. **Size at Age**,
2. Observed and Expected Landings,
3. Size Selectivity,
4. SPR,
5. SPR Phase,
6. SPR Ratio,
7. Length Fit aggregated across time,
8. Length Fit,
9. Mean Length (NCRMP),
10. Recruitment Deviations,
11. Unfished Ratio,
12. Fishing Mortality,
13. Parameters,
14. Length Composition, and,
15. **Index of NCRMP**.

# SEDAR 84

Under SEDAR 84  Caribbean Yellowtail Snapper and Stoplight Parrotfish SECTION V, a Review Workshop Report was submitted in July 17, 2025. The Review Panel Report  submitted responded to the **eight (8) mandated Terms of Reference (T**OR).

# SEDAR 84

***TOR1. Evaluate the DATA***

## St. Thomas/St. John and Puerto Rico Yellowtail Snapper

1. The panel recommended that for the yellowtail snapper model, the stock unit should have been explored further and needs to reflect the biology of the species and its dynamics

2. The panel also believed that the time series for the St Thomas/St, John fishery is too short for this species, as longevity is **20-30 years but the time series is 12 years**. In Puerto Rico, the decision to drop the initial NCRMP survey time series was thought to be premature.

3. **Uncertainties** were acknowledged such as: 1) **short time series** in landings reports, 2) difficulty in quantifying fisher **CPUE**, 3**) distrust in landings report data**, 4) **limited samples** of fisheries dependent (TIP) length composition data, 5) incomplete datasets (e.g., not capturing juvenile trends), and, 6) uncertain connectivity.

4. Other uncertainties were not acknowledged such as the Uncertainties in the NCRMP seasonality and the limitations of NCRMP in capturing indices of abundance for large yellowtail snapper or juvenile parrotfish.

5. The panel agreed that based on the model requirements, the best available data used was appropriately applied.

# SEDAR 84

***TOR1. Evaluate the DATA***

## St. Croix Stoplight Parrotfish

1. The panel did not agree that the because of the **short time series** for parrotfish catch reports (2009-2024). input data series for the St. Croix Stoplight Parrotfish is reliable and sufficient to support the assessment approach and findings
2. Furthermore, the panel is concerned about the **very limited TIP length composition data** and an overall **distrust in the catch report data.**
3. The panel also believed that there are **biases associated with the index data** used for the model which include the seasonality of **NCRMP** data collection (2 weeks in June or July every two years) potentially missing seasonal or environmental changes in parrotfish abundance, and,
4. **NCRMP** methodology that certainly **misses a significant proportion of young of the year** stoplight parrotfish, which recruit to the reef at settlement.

# SEDAR 84

***TOR1. Evaluate the DATA***

## St. Thomas/St. John Yellowtail Snapper

1. The **input data series** for the **St. Thomas/St. John Yellowtail Snapper** is **unreliable** and **insufficient** to support the assessment approach and findings.
2. The reason for this disagreement is that the **historic landings data used is only 12 years** in the series, for a fish, that lives 20-20 years.
3. In addition, the panel believes that the fisheries independent index data used for the model **include the seasonality of NCRMP data collection** (2 weeks in August every two years) potentially misses seasonal or environmental changes in yellowtail abundance, and misses larger, older fish that are found in highest abundance.
4. The Panel also believes that the DCRMP data is helpful in capturing this subset, but, the **DCRMP time series and sample size is small.**

# SEDAR 84

***TOR1. Evaluate the DATA***

## Puerto Rico Yellowtail Snapper

1. The input data series for the **Puerto Rico Yellowtail Snapper** is **unreliable** and **insufficient** to support the assessment approach and findings.

2. The reasoning behind this disagreement are:

    1)There is **no recreational data available** in Puerto Rico,

    2) the recreational fishing for yellowtail snapper is significant around the island,

    3) that there are biases associated with fisheries independent index data used for the model, and,

    4) the **NCRMP methodology misses larger, older fish** that are found *(in highest abundance in areas of upwelling and turbulence, generally near the shelf edge (VPV???).*

# SEDAR 84

***TOR2. Evaluate the methods used to assess the stock, taking into account the available data.***

1. The Panel agreed that the Stock Synthesis (SS3) was correctly applied for all three stock assessments (St. Croix Stoplight Parrotfish, St. Thomas/St. John Yellowtail Snapper, and Puerto Rico Yellowtail Snapper).
2. The configurations and assumptions of the models (e.g., fixed vs estimated parameters, which options were selected within SS3, etc) were not all documented in the Assessment Workshop report. For all three assessments, there were a few changes in the configuration and inputs of SS3 during the Review Workshop:

# SEDAR 84

***TOR2**. Evaluate the **methods***

## St. Croix Stoplight Parrotfish

1. The standard deviations around the estimate of fishing mortality were really high, indicating that **the model was not able to estimate fishing mortality well**.
2. This could either be an indication of model misspecification or data quality issue (i.e., there is not enough contrast in the length composition data to effectively estimate fishing mortality).
3. There was also **poor convergence of $F_{MSY}$ in both model runs** (STX_RW_1 and STX_RW_2), which could also be an indication of model miss-specific or data quality issues.

# SEDAR 84

***TOR2**. Evaluate the **methods***

## St. Thomas/St. John Yellowtail Snapper

1. The use of **dome-shaped selectivity** for the two fishery-independent surveys (**NCRMP and DCRMP**) was **questioned** as this assumption has strong implications for the representation of large fish in the population and the fishery.

2. **The Analyst Team found no differences between the two plus group configurations**, and the shape of selectivity for NCRMP and DCRMP remained unchanged.

3. As a result, **the plus group configuration of 26+ and dome-shaped selectivity were retained** for Yellowtail Snapper (including the Puerto Rico Yellowtail Snapper).

4. **After the Review Workshop, it remained unclear if other model configurations were correctly specified based on the diagnostics, or issues were related to data quality (see more details in TOR 4). Similar issues to those observed with the St. Croix Stoplight Parrotfish model were evident for this model as well, including high uncertainty around fishing mortality and recruitment estimates and poor convergence of $F_{MSY}$.**

# SEDAR 84

***TOR2. Evaluate the methods***

## Puerto Rico Yellowtail Snapper

1. The Review Panel raised **concerns about the use of dome-shaped selectivity for the NCRMP survey** and the choice of age 26+ as the plus group. These choices were retained based on the tests and additional model runs from the St. Thomas/St. John model.
2. **After the Review Workshop, it remained unclear if other model configurations were correctly specified based on the diagnostics** (see more details in TOR 4).
3. Although this assessment included longer time series than the St. Thomas/St. John assessment, **the high uncertainty around fishing mortality and recruit estimates** suggests that the data may not be able to differentiate between these two processes, indicating a potential data quality issue.
4. Similar issues to those observed with the St. Croix Stoplight Parrotfish and St. Thomas/St. John Yellowtail Snapper models were evident for this model as well, including **high uncertainty around fishing mortality and recruitment estimates and poor convergence of $F_{MSY}$.**

# SEDAR 84

***TOR2. Evaluate the methods***

## St. Croix Stoplight Parrotfish

1. The Review Panel **was concerned about the short time series** (commercial catch, length composition, index of abundance). While SS3 is a flexible and powerful stock assessment model, its performance depends on having sufficient data to inform the model.
2. In this case, **data appears insufficient to support the model's complexity** even with data-limited/moderate settings. There are too many uncertainties about key parameters (e.g., initial equilibrium catch, natural mortality, steepness, etc.) and population processes (e.g., growth, recruitment).
3. Additionally, **only five years of survey index were available**, along with one super year period that includes just 66 Trip Interview Program trips over 11 years for commercial length composition (with no age composition).
4. Even though SS3 allows length composition only configurations, **SS3 is still ultimately an age-structured model that converts lengths to ages**, which **this assessment does not have enough information or data for**.
5. Sensitivity analyses (STX_RW_1 and STX_RW_2) conducted during the Review Workshop also showed how **sensitive the model outputs were to the trade-off of fits between the commercial catch and NCRMP survey and estimation of growth parameters.**
6. **The two model runs also showed opposite signals in overfishing and overfished statuses**, also indicating the sensitivity of the model and how SS3 may not be suitable for these data limitations. The data was not sufficient enough for them to produce a final assessment model.

# SEDAR 84

***TOR2. Evaluate the methods***

## St. Thomas/St. John Yellowtail Snapper

1. Similar to the St. Croix Stoplight Parrotfish stock assessment, **the Review Panel was concerned about the short time series** and the **data appears insufficient to support the complexity of SS3**.
2. **There are too many uncertainties about key parameters** (e.g., initial equilibrium catch, natural mortality, steepness, etc.) and population processes (e.g., growth, recruitment). Only 3-5 years of fishery-independent survey and length composition data (NCRMP and DCRMP) were available, along with one super period for commercial length composition (due to low sample sizes).
3. Even though SS3 allows length composition only configurations, **SS3 is still ultimately an age-structured model that converts lengths to ages, which this assessment does not have enough information or data for.**
4. Sensitivity analyses (STTJ_RW_1, STTJ_RW_2, and STTJ_RW_3) conducted during the Review Workshop also showed how **sensitive the model outputs were to the trade-off of fits between the commercial catch and NCRMP + DCRMP surveys and estimation of growth parameters**. The data was not sufficient enough for them to produce a final assessment model.

# SEDAR 84

***TOR2. Evaluate the methods***

## Puerto Rico Yellowtail Snapper

1. While longer time series data were available for the Puerto Rico Yellowtail Snapper stock assessment, model diagnostics (e.g., standard deviations on key parameters, parameters hitting bounds, poor convergence in $F_{MSY}$) **indicate that either the model was not configured correctly or SS3 may still be too complex given the data quality.**

2. Although SS3 allows length composition only configurations, it is still ultimately an age-structured model that converts lengths to ages.

3. Sensitivity analyses (PR_RW_1, PR_RW_2, PR_RW_2, PR_RW_3, PR_RW_4) conducted during the Review Workshop showed how **sensitivity model outputs were to the trade-off of fits between the commercial catch and NCRMP + NCRMP La Parguera surveys** (the latter covering an older, smaller NCRMP survey domain time series from 2002-2012) and estimation of growth parameters.

4. The Reviewer Panel suggested that the Analyst Team **investigate combining the St. Thomas/St. John and Puerto Rico Yellowtail Snapper assessments instead of further revising the Puerto Rico assessment.**

5. **Given that it is unclear if the model is sensitive because of model misspecification or data quality issues, and considering the sufficient length of data, it remains uncertain if SS3 is the appropriate model for this assessment.**

# SEDAR 84

**St. Thomas/St. John Yellowtail Snapper Puerto Rico Yellowtail Snapper**

*Is it likely the stock is overfished? What information helps you reach this conclusion?*

- **Unknown**, the results are too sensitive to model assumptions to allow for a conclusion about this topic. See above.

*Is it likely the stock is undergoing overfishing? What information helps you reach this conclusion?*

- **Unknown**, the results are too sensitive to model assumptions to allow for a conclusion about this topic. See above.

# SEDAR 84

***TOR4. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods. Ensure that the implications of uncertainty in technical conclusions are clearly stated.***

1. Stock Synthesis (SS3) includes a set of standard approaches to investigate uncertainties. These tools were applied to the assessment, and a standard set of diagnostics was used to evaluate model stability for the three stocks.
2. These diagnostics included checks for convergence, correlation analysis, variance evaluation, jitter analysis, residuals analysis, retrospective analysis, and likelihood profiles.
3. Additionally, sensitivity runs were conducted. The base models from the AW were changed during the RW due to some mistakes detected in the configurations.
4. The new based model and sensitivity runs are documented in the Anex 1. Note that these full set of diagnostics **were not updated for the new base model agreed upon during the RW**.

# SEDAR 84

## TOR 4 uncertainty

# Stoplight Parrotfish

- During the meeting, the model **m3_v7** was presented as the base model, and the **methods used to evaluate uncertainty were appropriately applied and explained**. However, the model was found to be highly sensitive and not found appropriate to use as a basis for advice, making it difficult to isolate and clearly identify the most influential sources of uncertainty.
- **Several key uncertainties were identified during the Review Workshop (RW),** particularly concerning initial equilibrium catch, natural mortality (M), and steepness. The model showed strong sensitivity to these parameters. A full set of diagnostics was presented.
- Although the model converged successfully and the jitter analysis appeared satisfactory, other diagnostics revealed structural and data-related concerns. A strong correlation was observed between commercial selectivity parameters, which may be biologically plausible given the logistic shape of selectivity. The retrospective pattern showed poor performance, and the likelihood profiles indicated a conflict between the equilibrium catch and the length composition data.
- The model struggled to reliably estimate equilibrium catch, suggesting that the data may provide limited information on this parameter. While the fits to the length composition data were reasonably good, the model was unable to simultaneously fit both the commercial catch data and the survey index of abundance well.
- During the RW, efforts were made to clarify assumptions related to population dynamics and model configuration, which had been unclear in earlier documentation. The Review Panel recommended several sensitivity analyses, particularly focusing on assumptions around catch standard errors, growth parameters, and selectivity formulations. These were appropriate steps for testing the model; however, time constraints limited exploration of additional uncertainties, such as estimating fixed parameters (e.g., catchability) or testing alternative model structures.
- The new base model agreed upon during the RW, including the modifications described in the sections above TOR 2 (a single-sex structure, Fmethod 2, and corrected survey SE )still showed high sensitivity to assumptions about catch uncertainty and the estimation of von Bertalanffy growth parameters. The model was sensitive to assumptions about growth and the estimation of length at age, probably due to the absence of age composition data. Notably, estimates of stock status differed across sensitivity runs (indicating overfished vs. underfished conditions), which further complicates interpretation.

In summary, while appropriate diagnostics and sensitivity runs were conducted, the combination of model instability and interacting uncertainties made it difficult to confidently attribute outcomes to specific sources. This makes it difficult to reach clear conclusions due to the various sources of uncertainty. Further investigation of model assumptions, alternative parameterizations, and potential data conflicts is necessary.

# SEDAR 84

**TOR 4 uncertainty**

## Puerto Rico Yellowtail Snapper

1. As for the STSJJ Yellowtail Snapper concerns on the model configurations were detected previous to the RW and the same changes to the base model were requested.

2. The new base model was presented as the base model. However, the model was found to be highly sensitive and not find appropriate to use as basis for advice, making it difficult to isolate and clearly identify the most influential sources of uncertainty.

3. Also several key uncertainties were identified during the Review Workshop (RW), in key parameters concerning initial equilibrium catch, natural mortality (M), and steepness and population processes (growth, recruitment).

4. The full set of diagnostic is found in the assessment report for the initial base model m3_v31, indicating incorrect configuration of the model or problems with the quality of data.While the model converged, jitter analysis show instability, the likelihood profiles show instability in the total and equilibrium catch and the retrospective reavealed some different patterns at the terminal year estimates.

5. Four different sensitivity analysis detailed in Annex 1 were conducted and presented during the RW. Although the time series was extended, the older survey data were excluded, and the only the series 2014-2022 was retained

6. A key suggestion was to reintroduce the historical time series (as a separate survey since the coverage was different) however, that sensitivity run failed to converge. Overall, the sensitivity runs showed high sensitivity in models outputs. Additionally , strong correlation among growth parameters was found, indicated that growth could not be reliably estimated.

7. In summary, the combination of model instability and interacting uncertainties made it difficult to confidently attribute outcomes to specific sources. As a result, drawing clear conclusions remains challenging. To address this, improvements in data quality, increased data collection, extension of the time series and combining this stock with St. John’s/St.Thomas are recommended.

# SEDAR 84

**TOR 4 uncertainty**

## TOR 4 Combined St.Thomas/St John/Puerto Rico Yellowtail Snapper

1. Due to **uncertainties in the model structure** , the recognition that the **stocks from PR and STSJ are part of a larger populations**, the short time series available for the stock in St Johns/St Thomas, and looking into the survey índices that peaked in 2012 in PR and in 2013 in STSJ.
2. The RP recommended to build a **combined model using data from both PR and STSJ.** Efforts were initiated, presented and discussed during the RW. While the first combined model run (PR_STTJ_RW_1) did not converge, **a second attempt (PR_STTJ_RW_2) successfully converged and provided a basis for further research.**

# SEDAR 84

## TOR 5 RECOMMENDATIONS St. Croix Stoplight Parrotfish

1. **Population structure** studies could be conducted through genetics, tagging, fish larvae, otolith microchemistry, or modelling.
2. To consider **increasing the time series** with data available back in time. For e.g. the proportion of stoplight parrotfish could be investigated from 2012, and a mean of that proportion could be applied to split the catches prior to the species-specific split.
3. To **increase the sample size** of the length composition.
4. **To continue the efforts** of conducting the survey and to **explore alternative survey sampling designs** that could better capture the whole size distribution.
5. **Re-evaluate assumptions** of steepness and SR.
6. **Alternative methods for estimating M** (MORTALITY)
7. To **improve otolith samples** and try to convert length compositions into ages if enough available samples. The conditional age-at-length approach in SS3 allows to incorporate length and age data whenever available.

# SEDAR 84

**TOR 5 RECOMMENDATIONS St. Thomas/St. John and Puerto Rico Yellowtail Snapper**

1. Further investigate the **population structure** of those two stocks.
2. Alternative methods for **estimating M**.
3. To **increase sample size** for commercial length compositions.
4. To collect data from the **recreational fleet** (Puerto Rico).
5. Models were very sensitive to growth and length at age. It is recommended **to increase otoliths readings** and try to produce age-length keys for some year to try to feed the model.

# SEDAR 84

***TOR6. Provide guidance on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.***

## US Caribbean Stoplight Parrotfish

1. To consider increasing the time-series
2. To consider the use of data-limited methods to provide advice

## Yellowtail Snapper

1. 2 area/unit model recommendation
2. Model-based survey estimated: explore spatial-temporal models that could combine the NCRMP indices from both islands.

# SEDAR 84

***TOR7. Provide recommendations on possible ways to improve the SEDAR process.  ???***

***TOR8. Prepare a Peer Review Summary summarizing the Panel's overall conclusions and recommendations.???***

**Compiled by Review Panel**

# SEDAR 84

Appendix 1

Table A1. List of stock assessment model runs developed during the SEDAR 84 Review Workshop (RW).

| Model Name | Description |
|---|---|
| STX_RW_1 | single sex + F method 2 + catch standard error = 0.3 + corrected survey standard error |
| STX_RW_2 | STW_RW_1 + catch standard error = 2 + estimated growth |
| STTJ_RW_1 | single sex + F method 2 + catch standard = 0.3 + corrected survey standard error |
| STTJ_RW_2 | STTJ_RW_1 + catch standard error = 2+ estimated growth |
| STTJ_RW_3 | STTJ_RW_1 + plus group = 12+ |
| PR_RW_1 | Single sex + F method 2 + catch standard error = 0.3 + corrected survey standard error |
| PR_RW_2 | PR_RW_1 + catch standard error = 2 + estimated growth |
| PR_RW_3 | PR_RW_1 + La Paraguera survey + selectivity spline |
| PR_RW_4 | PR_RW_3 + estimated growth |
| PR_STTJ_RW_1 | PR_RW_3 + STTJ fleet and STTJ survey |
| PR_STTJ_RW_2 | PR_STTJ_RW_1 + estimated length at maximum age + fixed selectivity + steepness = 0.8 |

# SEDAR 84



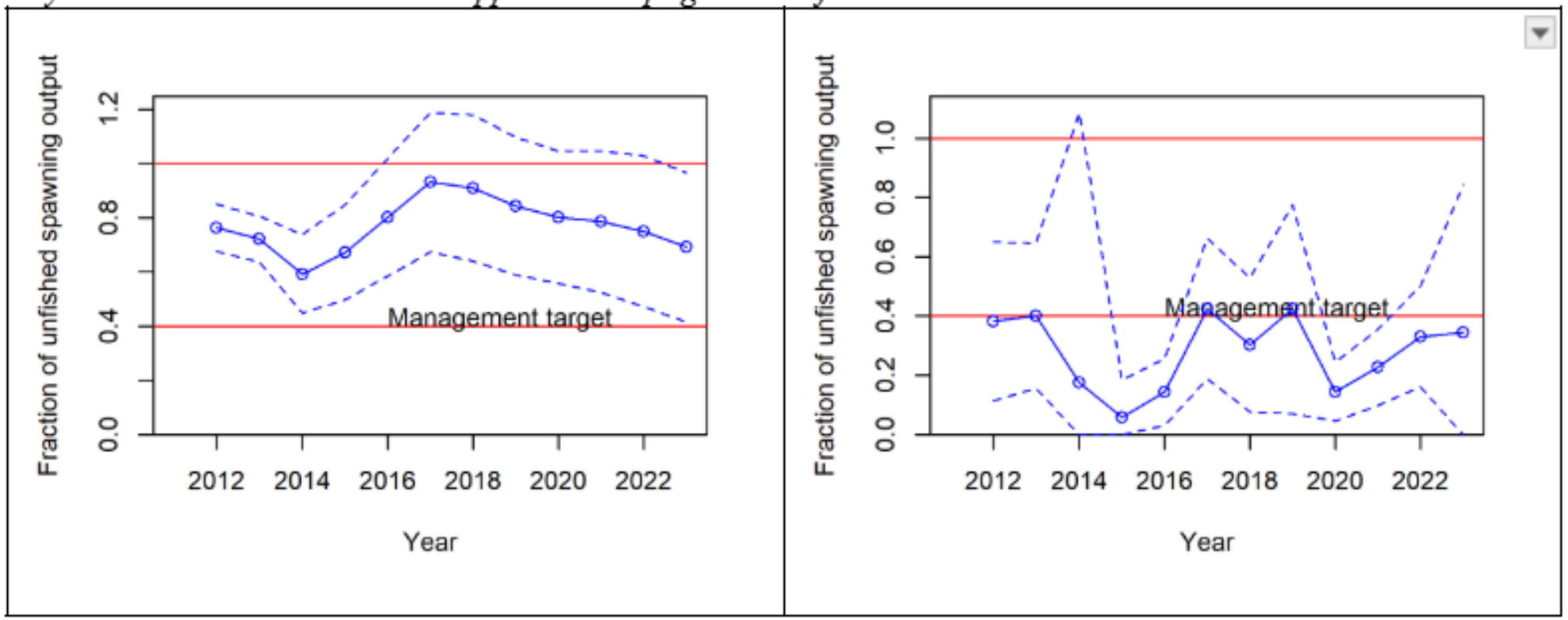


Figure 1 - Depletion level (i.e., fraction of unfished spawning output) estimated by the base run (STX_RW_1; left) and sensitivity run (STX_RW_2; right).

# SEDAR 84

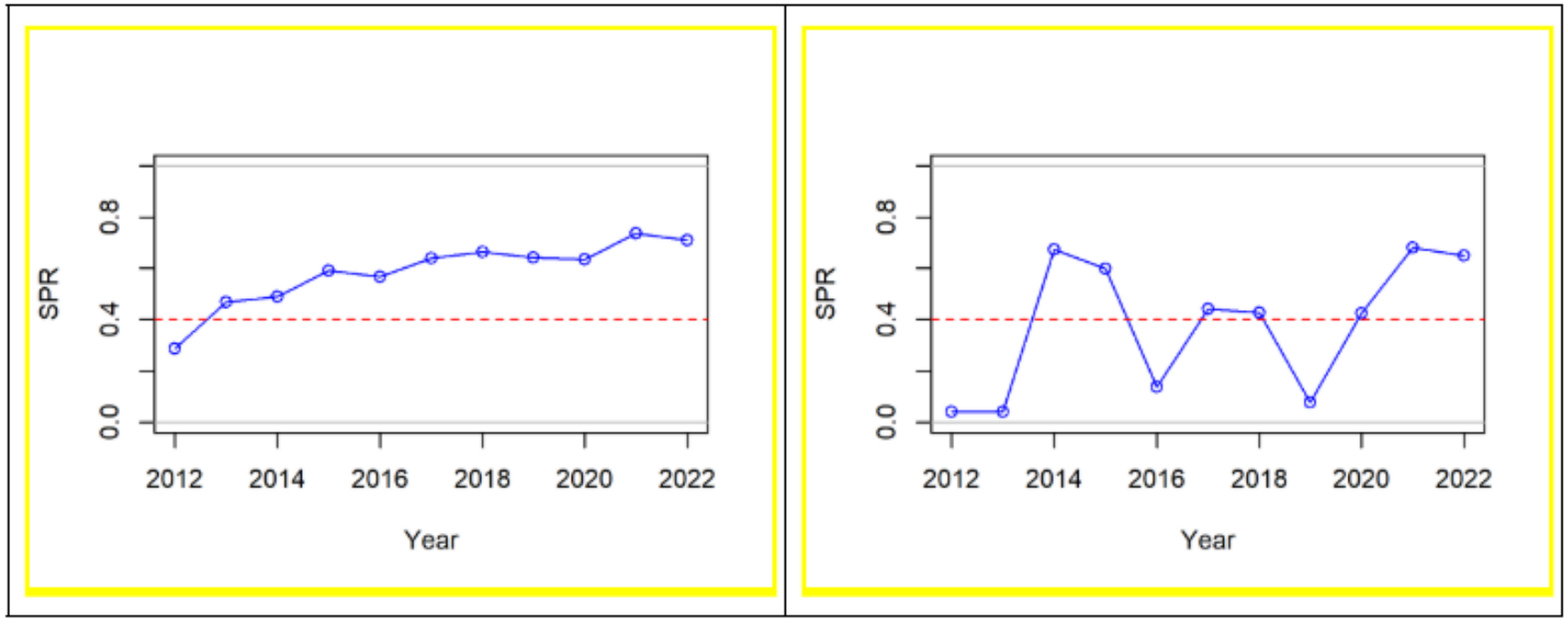


Figure 2 - Spawning Potential Ratio (SPR) estimated by the base run (STTJ_RW_1; left) and sensitivity run (STTJ_RW_2; right) .

Given these limitations, the assessment results are not sufficiently robust to support the development of reliable annual catch limits or other management measures for the U.S. Caribbean region.

# SEDAR 84

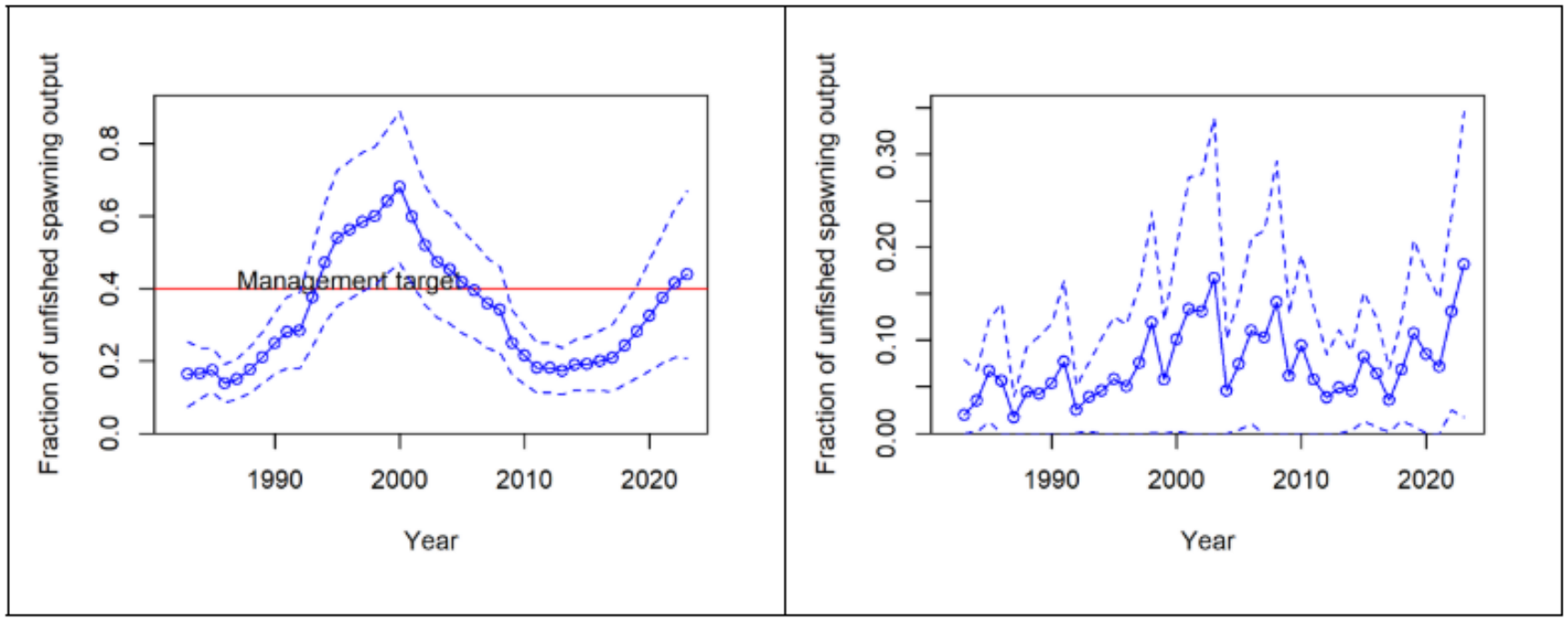


Figure 3 - Depletion level (i.e., fraction of unfished spawning output) estimated by the base run (PR_RW_1; left) and sensitivity run (PR_RW_2; right)

Overall, the combination of model sensitivity to assumptions, data conflicts, and uncertain historical trends limits the assessment's utility for informing robust, science-based management measures.

# Next SSC Meeting to discuss

- 1. **SEDAR 91 SSC REVIEW**
- **2. SEDAR 84 SSC REVIEW**
- **3. OTHERS CFMC 187$^{th}$ MEETING**
- **4. Species Matrix: Ecosystem components**
  - **Criteria: Apply the Keystone Species Concept (R.T. Paine); Evaluate Ecological functions (e.g. production of Bioherm habitats, stabilization of unconsolidated substrates, ability to adapt to climate changes, primary production etc.**