Summary of Puerto Rico Yellowtail Snapper SEDAR 84 Additional Sensitivity Runs: Exploring Parameter Space and Including 2024 Terminal Year

Caribbean Fisheries Branch
Sustainable Fisheries Division, Southeast Fisheries Science Center

Executive Summary

SEDAR 84 included a Benchmark stock assessment for Caribbean Yellowtail Snapper in Puerto Rico (SEDAR 2025b). The SEDAR 84 Data Workshop was held in January 2024. The Assessment Process was a series of webinars held in 2024 and the Review Workshop held July 15th-18th, 2025. The CIE review process identified that the Puerto Rico Yellowtail Snapper model was deterministic and sensitive to fixed assumptions. In response, the Caribbean Fisheries Branch conducted a phased exploration of the parameter space, including a data update through 2024. While the model remains sensitive to fixed inputs (specifically maximum length, terminal dome selectivity, and steepness), the current suite of sensitivity runs suggests that current catches are likely sustainable in the short term, as scenarios that converged on plausible stock dynamics indicated an increasing trend in Spawning Stock Biomass over the last decade.

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1 Background and Objectives

Following the SEDAR 84 Review Workshop, the CFMC SSC requested supplemental sensitivity runs for the Puerto Rico (PR) Yellowtail Snapper stock. These runs incorporate an additional two years of data, extending the terminal year from 2022 to 2024. Furthermore, these analyses address concerns regarding model rigidity raised during the CIE Review by investigating alternative parameterizations for steepness, average length at maximum age (L_∞), and the degree of dome-shaped selectivity for the NCRMP fishery-independent survey.

- Average Length at Maximum Age: To evaluate sensitivity to the L_∞ value of 42.2 cm used in the base SEDAR 84 model, an alternative value of 50.8 cm was tested. Both values are derived from fits to length-and-age data reported by Shervette et al., (2024).
- Steepness (h): In addition to the SEDAR 84 assumed value of 0.99, an alternative steepness of 0.8 was explored. This value is informed by stock assessments of Southeastern U.S. Yellowtail Snapper, which estimated steepness at 0.808 and 0.767, respectively (SEDAR 2020, 2025a). Sensitivity runs were conducted using $h = 0.99$, $h = 0.8$, and configurations where the parameter was freely estimated.
- Selectivity: The SEDAR 84 base model assumed dome-shaped selectivity for the NCRMP fishery-independent survey, utilizing a double-normal function to estimate terminal selectivity. Dome-shaped patterns are typically applied when larger individuals are less available to a survey due to gear avoidance or spatial distributions. To test the robustness of this assumption, sensitivity runs were performed with -1.9 and a higher terminal selectivity of -1 (logit space), which corresponds to the descending limbs of the double-normal curve reaching probabilities of approximately

0.27 and 0.13, respectively. The value of -1 is the higher selectivity (more fish expected to be seen) compared to -1.9. Selectivity was evaluated with terminal parameters fixed at -1.9 and -1 (logit space), as well as runs where the parameter was estimated.

2 Key Model Improvements and Data Corrections

1. **Landings Correction**: A data entry error was identified and corrected. Recreational landings in metric tons were previously input as 80% of commercial vertical line landings; the corrected value is 7.78%, derived from 2012–2016 MRIP comparisons, representing a tenfold reduction in estimated recreational removals (Figure 1 and 2). Comparison of the corrected model runs against the previous model runs that included the uncorrected landings showed that the model behavior is nearly identical in all respects except for the scale of the unfished recruitment parameter (Figure 4). Because this correction acted as a consistent scalar across the entire time series, correction of the landings adjusted the estimated absolute population size without fundamentally altering the relative trends in spawning stock biomass, fishing mortality, and recruitment.
2. **Terminal Year Update**: The model now incorporates landings and length data through 2024 and the NCRMP index through 2023. The terminal year of the data had been 2022. It is important to note that the model does not yet account for the 2025 NCRMP index data, which shows an increasing trend in abundance and may signal a relative recruitment pulse (Figure 3).
3. **Simplification**: To isolate the effects of key parameters, the model was simplified to a single annual settlement event, and the smallest length bins were collapsed into a single bin for individuals under 12 cm. The growth curve was also modified by increasing the CV for young fish—while fixing the growth curve to begin at a settlement age of 1—and decreasing the CV for older fish. Finally, the natural mortality was adjusted to a Lorenzen curve by age. These adjustments allowed the model improved the fit to the high selectivity of small fish observed in the NCRMP survey length compositions.

3 Exploration of Model Rigidity

We implemented an 8-step model development process to systematically deconstruct the model's sensitivity and address the deterministic nature of the SEDAR 84 stock assessment for Puerto Rico Yellowtail Snapper:

a. Landings Correction: A correction of the recreational catch ratio (from 80% to 7.78% of commercial vertical line landings). This correction acted as a consistent scalar across the entire time series, adjusting absolute biomass without altering relative stock trends (Figure 4).

b. Removal of Recruitment Deviations: Initially, in the SEDAR 84 Review Workshop models, recruitment was estimated for each year. By removing these deviations, we identified a fundamental conflict. The model struggles to reconcile length compositions with catch data unless the CV on catch is reduced (Figures 5 8). This highlights how estimating recruitment deviations across all years was previously absorbing model misspecification.
c. Terminal Year Update: Incorporated landings and length data through 2024 and the NCRMP index through 2023 as model inputs (Figures 10 - 13).
d. Structural Simplification and Adjusted Biological Inputs: Adopted a single settlement event to simplify model dynamics. To better represent how the biological dynamics of yellowtail snapper were modeled, natural mortality settings were updated to use a Lorenzen mortality curve, as recommended by the CIE review. Additional simplifications involved collapsing the smallest 3-cm length bins into a single bin for individuals under 12 cm, adjusted growth CVs, and increasing the settlement age from 0 to 1 (Figure 9). The CV on growth was increased from 0.15 to 0.3 for young fish, and decreased from 0.15 to 0.1 for old fish. These changes improved the fit to small fish in the NCRMP survey (Figures 10 - 13). Furthermore, the simplified structure facilitated isolating the effects of key parameters.
e. Single-Factor Sensitivity: Tested individual factors from the parameter grid (steepness, average length at maximum age, and dome selectivity) to isolate their independent effects on model results (Table 4 - 7).
f. Multiple Factor Sensitivity: Tested combinations of individual factors to identify interactions that lead to divergent stock status conclusions (Table 4 - 7).
g. Recruitment Estimation (2014–2022): Reintroduced recruitment deviations only for the years with the NCRMP abundance index (Figures 14 - 17). This ensures recruitment pulses are informed by observed abundance signals rather than just noise or targeting changes in the fishery-dependent length data. By estimating recruitment deviations this allowed the model to be dynamic rather than a static model and better fit the NCRMP index (Figure 17). However, estimating annual recruitment deviations is only recommended for years with data reflecting abundance signals, such as that from the NCRMP survey.
h. Characterization of Implausible Scenarios: Sensitivity analyses identified specific parameter combinations that result in an extreme depletion scenario (Table 4). However, this scenario represents a completely implausible scenario, as the stock did not have enough biomass to support recent landings. Despite this, the scenario provides a useful boundary for understanding the parameter ranges under which the model maintains consistent trends in recent years. Given the model's sensitivity to strong assumptions, future improvements should prioritize expanding data collection for yellowtail snapper beyond the current NCRMP sampling domain to better define the survey's selectivity, and implementing internal growth estimation within Stock Synthesis to refine fits to length-at-age data.

3.1 Refining the Super-Year Concern

Initially in SEDAR 84, Super-Years were used to pool commercial length data and address concerns that fishery-dependent sizes reflect shifting targeting effort rather than true population pulses. While this concern persists, it is mitigated in the current model runs by the handling of recruitment. By either running the model under average recruitment (no deviations) or restricting recruitment estimation to years supported by the fishery-independent NCRMP index, we prevent the model from overfitting artificial pulses in the commercial length data. This improves the model by taking it from a static to a dynamic structure, while ensuring that predicted recruitment trends are grounded in data of abundance signals rather than potential shifts in fishing behavior.

4 Findings and Management Implications

In the vast majority of the key model runs, the stock shows a sustained increase in SSB over the recent decade. The increasing trend in spawning stock biomass suggests that the stock is likely not undergoing overfishing at current catch levels.

Overall, the updated configurations for SEDAR 84 represent a transition from a rigid, deterministic framework toward a model that more effectively characterizes uncertainty in key assumptions, specifically growth (L_∞), steepness (h), and survey selectivity. The results of the sensitivity analyses consistently indicate a stable or increasing biomass trend under current management remains the most likely scenario.

Given the inherent uncertainty in the spawner-recruit relationship and its sensitivity to the degree of dome-shaped selectivity, an $SSB_{40\%}$ proxy for MSY was utilized for all model runs (Tables 6). This serves as a most likely proxy for MSY.

While the SEDAR 84 sensitivities explored do not yet provide a comprehensive characterization of uncertainty, integrated across all fixed inputs, the results suggest that current management measures are appropriate. This conclusion is further supported by the fact that recent landings have remained consistently below the Annual Catch Limit of 143 metric tons (315,806 LBS), along with the high density of yellowtail snapper observed in the NCRMP survey in 2025 (Figure 3).

5 Tables

Table 1: Parameter values used in the sensitivity analysis. The first column of values represents the baseline fixed parameters used in the simplified model. The second column of values represents alternative fixed values explored during the single and multi-factor sensitivities. Parameters that were estimated within the Stock Synthesis model in some of the sensitivity runs are also identified.

Parameters	Simplified Parameters	Alternate Values	Estimated
L Max	42.2	50.8	no
End NCRMP Dome Sel.	-1.9	-1	yes
Steepness	0.99	0.8	yes
Rec Devs	Off	Off	yes; 2014-2022

Table 2: Summary of the first five stages of the model development for SEDAR 84 Yellowtail snapper sensitivity runs starting with the model developed during the Review Workshop.

Stage	**Scenario**	**Label**
Review workshop	1_23_rw_re	Review Workshop (1)
Correction to catch	2_23a_rw_re	Corrected Catch Units (2)
Removal of Recruitment Deviations	3_23b_c1	No Rec. Dev. (3)
	4_23b_c2	Catch CV 0.2 (4)
	5_23b_c3	Catch CV 0.15 (5)
	6_23b_c4	Catch CV 0.1 (6)
Terminal Year Update	7_24b_c4	End Year 2024 (7)
Structural Simplification	8_24c_p1	Lorenzen m (8)
	9_24c_p2	Adjusted growth (9)
	10_24c_p3	One settlement (10)
	11_24c_p4	Bin <= 12 cm (11)
	12_24c_p5	Adj. m, growth, settlement, and bin (12)
	13_24c_p6	Adj. m, growth, and bin (13)
	14_24c_p7	Fix selectivity (14)
	15_24c_p8	Simplified (15)

Table 3: Summary of the SEDAR 84 Yellowtail snapper sensitivity runs.

Stage	Scenario	Label
Single-Factor Sensitivity	16_24d_l1	Alt. length (16)
	17_24d_se	Est. sel. (17)
	18_24d_s1	Alt. sel. (18)
	19_24d_he	Est. h (19)
	20_24d_h1	Alt. h (20)
Multiple Factor Parameter Grid	21_24e_l1se	Alt. L, Est. sel. (21)
	22_24e_l1s1	Alt. L, Alt. sel. (22)
	23_24e_l1he	Alt. L, Est. h (23)
	24_24e_l1h1	Alt. L, Alt. h (24)
	25_24e_hese	Est. h, Est. sel (25)
	26_24e_hes1	Est. h, Alt. sel (26)
	27_24e_h1se	Alt. h, Est. sel (27)
	28_24e_h1s1	Alt. h, Alt. sel (28)
	29_24e_l1hes1	Alt. L, Est. h, Est. sel (29)
	30_24e_l1hese	Alt. L, Est. h, Alt. sel (30)
	31_24e_l1h1se	Alt. L, Alt. h, Est. sel (31)
	32_24e_l1h1s1	Alt. L, Alt. h, Alt. sel (32)
Recruitment Estimation	33_24f_re	2014-2022 Rec. Dev. (33)
	34_24f_se_re	Estimate NCRMP end Sel. (34)
	35_24f_hese_re	Estimate h and NCRMP end Sel. (35)

Table 4: Number of parameters, total likelihoods, and 2024 ratios for the first five stages of the model development for SEDAR 84 Puerto Rico Yellowtail Snapper sensitivity runs, starting with the model developed during the Review Workshop.

Label	Parameters	Likelihood	SSB Ratio 2024	F Ratio 2024
Review Workshop (1)	91	166.9	1.08	0.87
Corrected Catch Units (2)	91	166.125	1.1	0.87
No Rec. Dev. (3)	51	235.561	1.18	0.83
Catch CV 0.2 (4)	51	264.324	1.31	0.78
Catch CV 0.15 (5)	51	284.146	1.41	0.73
Catch CV 0.1 (6)	51	311.723	1.47	0.73
End Year 2024 (7)	53	361.261	1.64	0.39
Lorenzen m (8)	53	397.066	1.03	0.75
Adjusted growth (9)	53	400.248	1.49	0.45
One settlement (10)	53	455.299	1.64	0.39
Bin <= 12 cm (11)	53	325.599	1.64	0.39
Adj. m, growth, settlement, and bin (12)	53	401.993	1.44	0.52
Adj. m, growth, and bin (13)	53	376.089	1.04	0.74
Fix selectivity (14)	54	340.132	1	0.74
Simplified (15)	54	327.997	1.42	0.52

Table 5: Number of parameters, total likelihoods, and 2024 ratios for the SEDAR 84 Puerto Rico Yellowtail Snapper sensitivity runs. Scenarios where the parameter combinations result in an extreme depletion scenario are shown in red.

Label	Parameters	Likelihood	SSB Ratio 2024	F Ratio 2024
Alt. length (16)	54	372.402	0.88	1.02
Est. sel. (17)	53	316.67	1.49	0.46
Alt. sel. (18)	54	370.083	1.24	0.68
Est. h (19)	55	315.413	1.53	0.4
Alt. h (20)	54	318.174	1.51	0.4
Alt. L, Est. sel. (21)	53	362.205	1.04	0.77
Alt. L, Alt. sel. (22)	54	401.295	0.63	1.52
Alt. L, Est. h (23)	55	305.459	0.05	6.43
Alt. L, Alt. h (24)	54	308.892	0.05	6.08
Est. h, Est. sel (25)	54	302.589	1.63	0.4
Est. h, Alt. sel (26)	54	327.045	0.21	2.53
Alt. h, Est. sel (27)	53	306.792	1.67	0.34
Alt. h, Alt. sel (28)	54	342.174	1.04	0.68
Alt. L, Est. h, Est. sel (29)	54	298.604	0.05	6.55
Alt. L, Est. h, Alt. sel (30)	54	297.799	0.04	7.04
Alt. L, Alt. h, Est. sel (31)	53	302.767	0.04	6.63
Alt. L, Alt. h, Alt. sel (32)	53	302.739	0.04	6.57
2014-2022 Rec. Dev. (33)	63	315.208	1.37	0.52
Estimate NCRMP end Sel. (34)	62	306.687	1.32	0.52
Estimate h and NCRMP end Sel. (35)	63	292.236	1.47	0.4

Table 6: Equilibrium catch and MSY Proxy (based on $MSY_{SPR\ 40\%}$) for the first five stages of the model development for SEDAR 84 Puerto Rico Yellowtail Snapper sensitivity runs, starting with the model developed during the Review Workshop.

Label	Equilibrium Catch	MSY Proxy	SD	CV	MSY Proxy in Pounds
Review Workshop (1)	182.805	170.17	18.28	0.11	375,154
Corrected Catch Units (2)	120.886	112.56	12.13	0.11	248,143
No Rec. Dev. (3)	130.494	119.48	7.63	0.06	263,404
Catch CV 0.2 (4)	137.438	125.78	6.28	0.05	277,295
Catch CV 0.15 (5)	145.235	135.24	5.94	0.04	298,151
Catch CV 0.1 (6)	151.263	144.4	5.13	0.04	318,354
End Year 2024 (7)	152.881	146.72	5.26	0.04	323,456
Lorenzen m (8)	130.036	127.84	3.79	0.03	281,835
Adjusted growth (9)	152.557	134.62	4.86	0.04	296,788
One settlement (10)	152.769	146.65	5.26	0.04	323,308
Bin <= 12 cm (11)	152.82	146.63	5.26	0.04	323,262
Adj. m, growth, settlement, and bin (12)	166.8	129.86	4.53	0.03	286,286
Adj. m, growth, and bin (13)	145.838	121.37	3.81	0.03	267,577
Fix selectivity (14)	143.455	119.18	3.54	0.03	262,751
Simplified (15)	164.699	128.29	4.32	0.03	282,842

Table 7: Equilibrium catch and MSY Proxy (based on $MSY_{SPR\ 40\%}$) for the SEDAR 84 Puerto Rico Yellowtail Snapper sensitivity runs.

Label	Equilibrium Catch	MSY Proxy	SD	CV	MSY Proxy in Pounds
Alt. length (16)	124.84	108.96	2.74	0.03	240,209
Est. sel. (17)	173.934	135.14	4.82	0.04	297,928
Alt. sel. (18)	148.461	116	4.38	0.04	255,736
Est. h (19)	200.751	145.54	6.24	0.04	320,852
Alt. h (20)	214.52	151.43	6.25	0.04	333,842
Alt. L, Est. sel. (21)	130.257	114.25	3.03	0.03	251,867
Alt. L, Alt. sel. (22)	117.67	102.31	2.38	0.02	225,557
Alt. L, Est. h (23)	245.155	212.8	11.85	0.06	469,146
Alt. L, Alt. h (24)	265.701	227.69	10.53	0.05	501,968
Est. h, Est. sel (25)	216.155	154.99	6.96	0.04	341,688
Est. h, Alt. sel (26)	244.666	161.56	7.49	0.05	356,190
Alt. h, Est. sel (27)	234.138	162.99	7.1	0.04	359,323
Alt. h, Alt. sel (28)	186.412	135.18	4.32	0.03	298,025
Alt. L, Est. h, Est. sel (29)	244.815	212.67	11.79	0.06	468,859
Alt. L, Est. h, Alt. sel (30)	242.841	211.52	11.71	0.06	466,324
Alt. L, Alt. h, Est. sel (31)	269.88	231.5	11.35	0.05	510,374
Alt. L, Alt. h, Alt. sel (32)	269.386	231.05	11.24	0.05	509,369
2014-2022 Rec. Dev. (33)	165.483	128.9	4.45	0.03	284,180
Estimate NCRMP end Sel. (34)	171.372	133.25	4.71	0.04	293,768
Estimate h and NCRMP end Sel. (35)	213.404	153.47	6.9	0.04	338,352

6 Figures

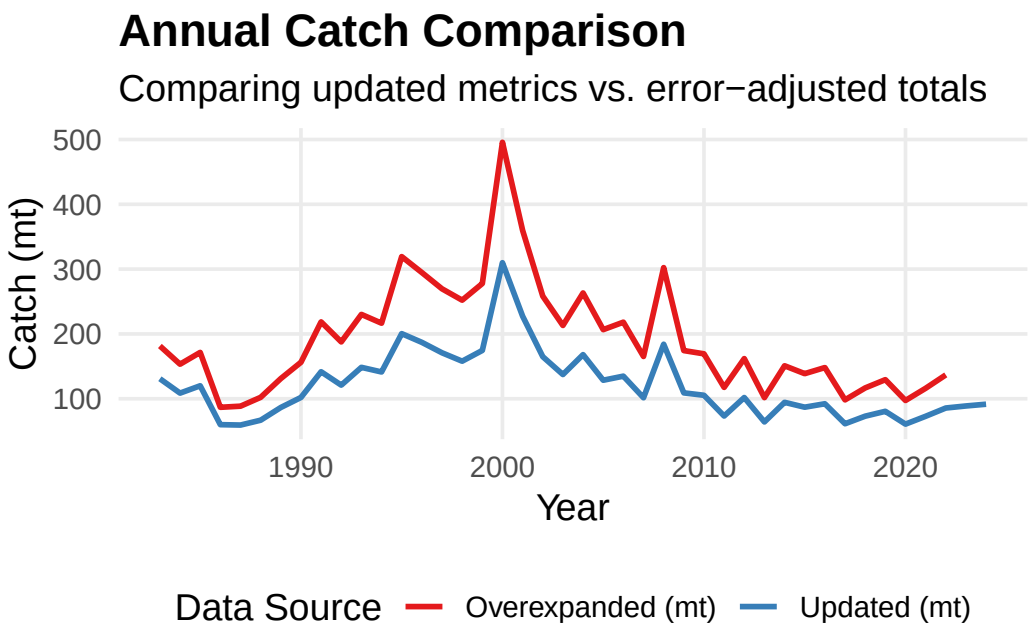


Figure 1: Comparison of total annual catch. The Updated line represents the refined catch estimates, while the Overexpanded line illustrates the values used in SEDAR 84 prior to correcting the recreational landings estimate to be 7.78% of the commercial landings associated with the line gear group (Figure 2). The Overexpanded total included the recreational landings estimated to be 80% of the commercial landings associated with the line gear group. Landings are shown in metric tons (mt).

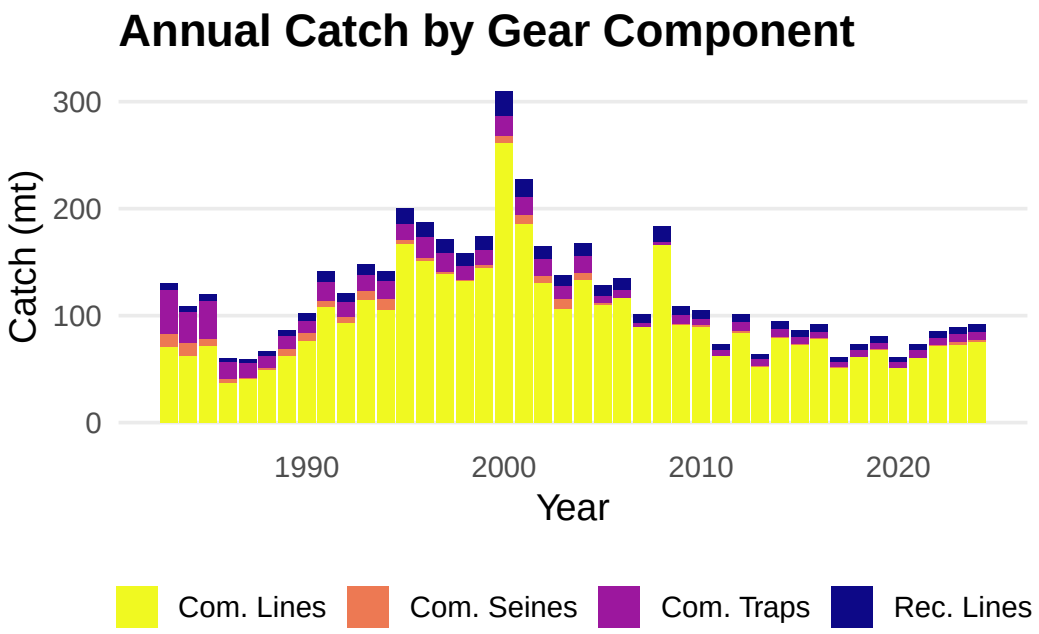


Figure 2: Composition of total catch by gear type. Components are stacked by sector, with commercial line gear at the base and recreational line gear at the top. This shows the relative contribution of each gear type to the annual totals used as a combined single Puerto Rico Commercial Fleet.

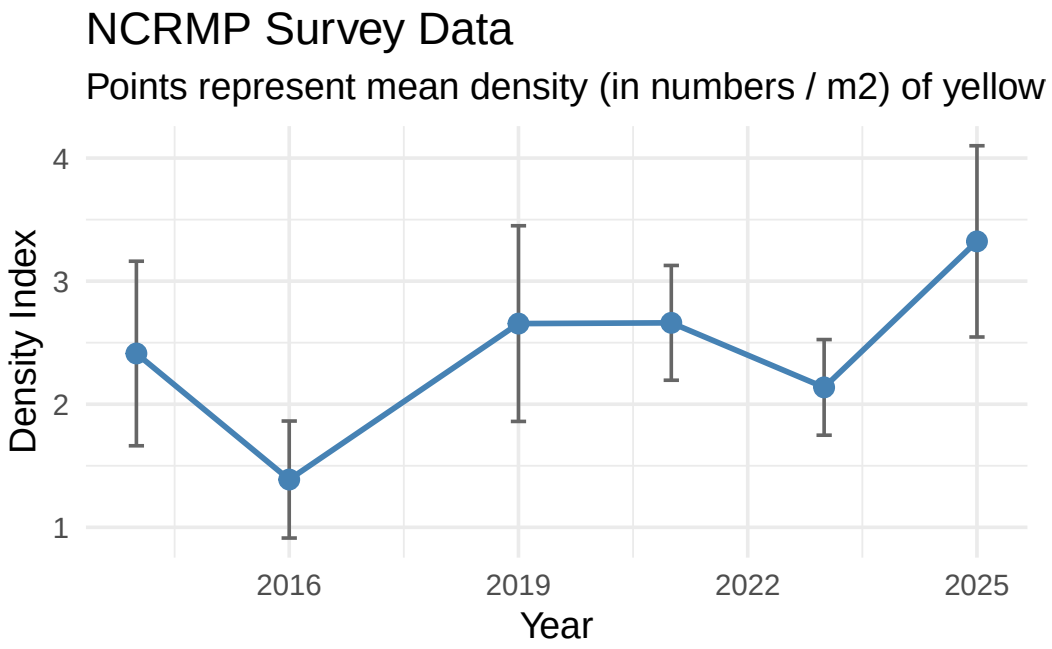
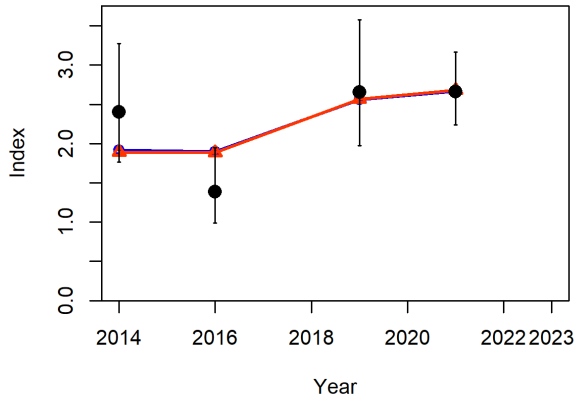
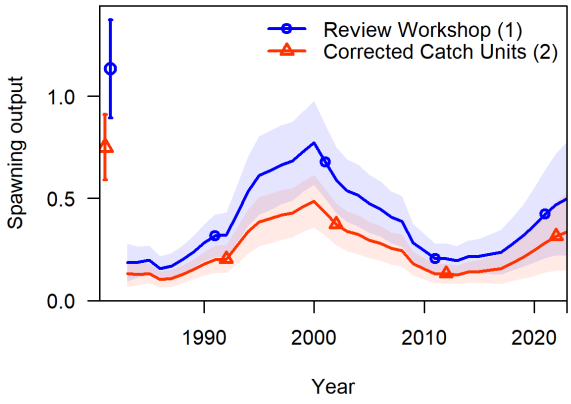


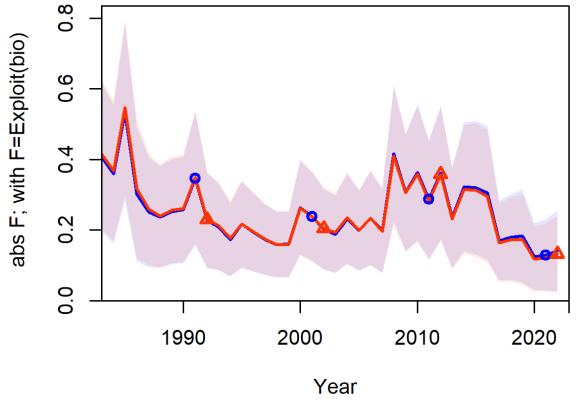
Figure 3: NCRMP density index trends. Points represent the mean annual density, with error bars indicating the 95% confidence interval. The intervals provide a visual measure of the precision of each year's survey estimate. Models presented in this report were updated to a terminal year of 2024 and therefore do not include the NCRMP data for 2025.



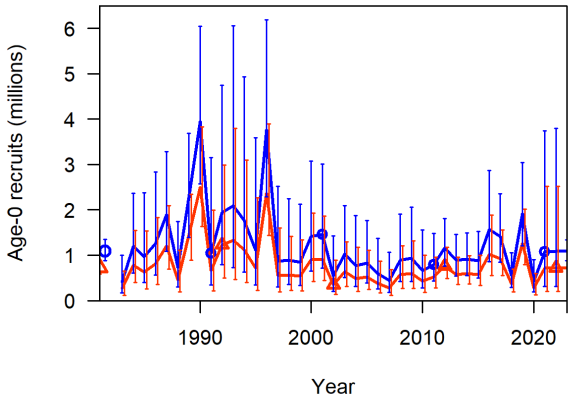
(a) NCRMP Density



(b) Spawning Biomass

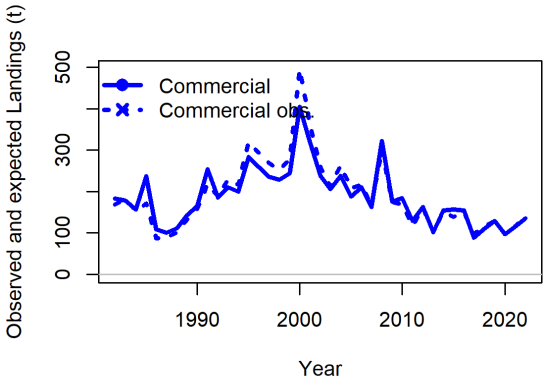


(c) Fishing Mortality

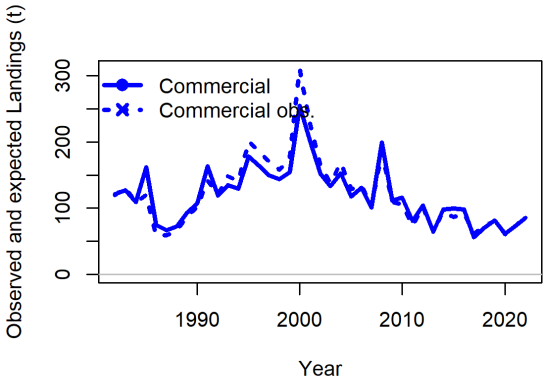


(d) Recruitment

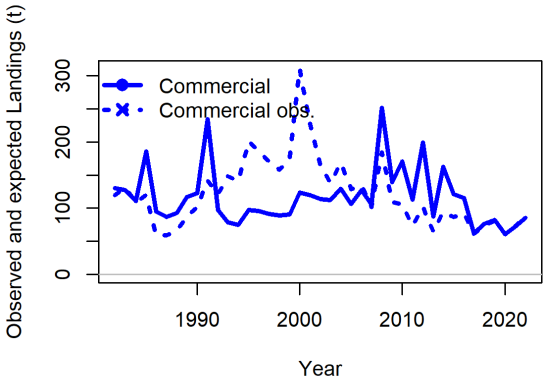
Figure 4: **Landings Correction** Puerto Rico Yellowtail Snapper derived quantity time series compared between the Review Workshop Model 1 (blue), as presented in the SEDAR 84 Stock Assessment Report Addendum, and of that model with corrected units for recreational catch (red). Derived quantities plotted over time for (a) the fit to index data for the NCRMP survey, (b) spawning stock biomass in thousands of metric tons, (c) fishing mortality (total biomass killed / total biomass), (d) and recruitment in millions of fish. The shaded areas and vertical bars in the derived quantities time series represent 95% confidence intervals. The values plotted prior to the model start year of 1983 reflect the unfished conditions and associated 95% confidence intervals.



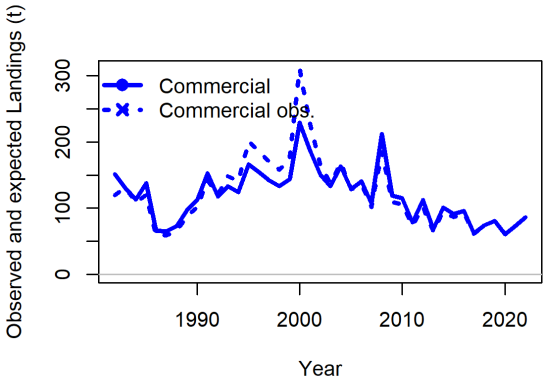
(a) Review Workshop (1)



(b) Corrected Catch Units (2)

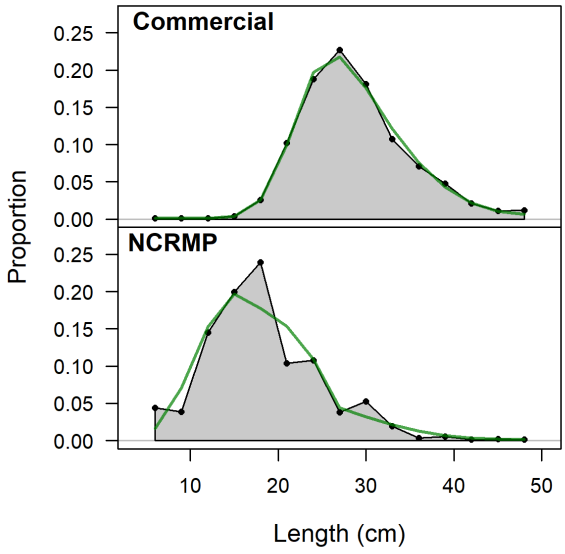


(c) No Rec. Dev. (3)

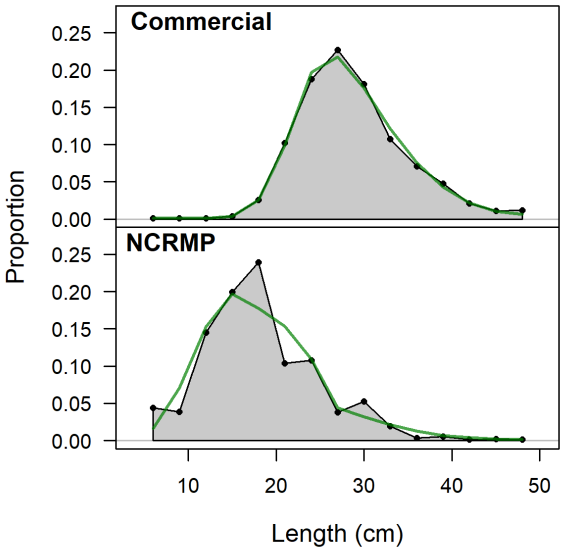


(d) Catch CV 0.1 (6)

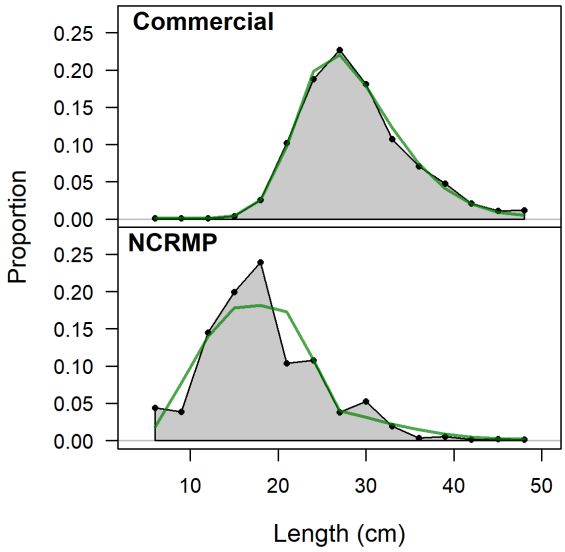
Figure 5: **Removal of Recruitment Deviations** Puerto Rico Yellowtail Snapper observed and expected landings (metric tons) compared between (a) Review Workshop Model 1, as presented in the SEDAR 84 Stock Assessment Report Addendum, (b) corrected units for recreational catch, (c) removal of recruitment deviations, and (d) reducing catch CV to 0.1.



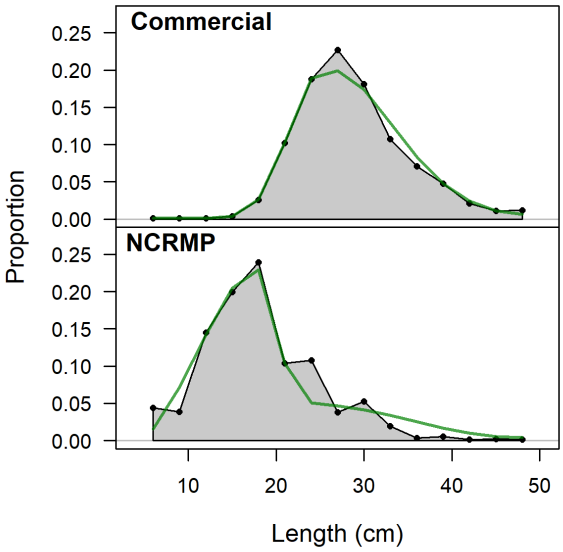
(a) Review Workshop (1)



(b) Corrected Catch Units (2)

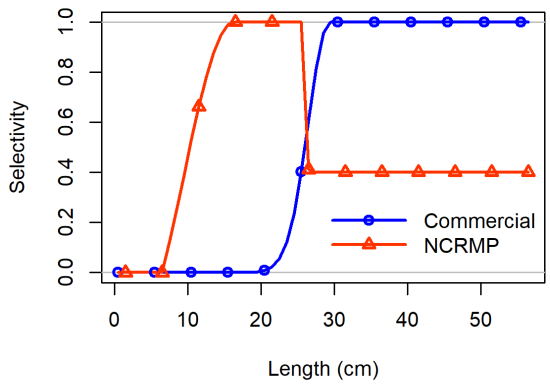


(c) No Rec. Dev. (3)

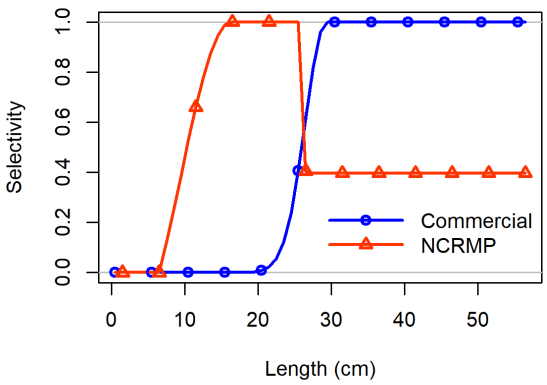


(d) Catch CV 0.1 (6)

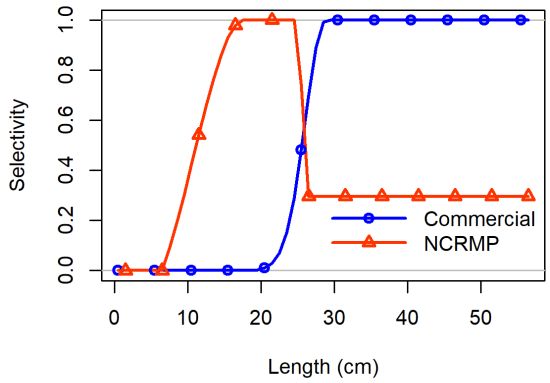
Figure 6: **Removal of Recruitment Deviations** Puerto Rico Yellowtail Snapper observed and observed and predicted length distributions in centimeters, aggregated across time by fleet, compared between (a) Review Workshop Model 1, as presented in the SEDAR 84 Stock Assessment Report Addendum, (b) corrected units for recreational catch, (c) removal of recruitment deviations, and (d) reducing catch CV to 0.1.



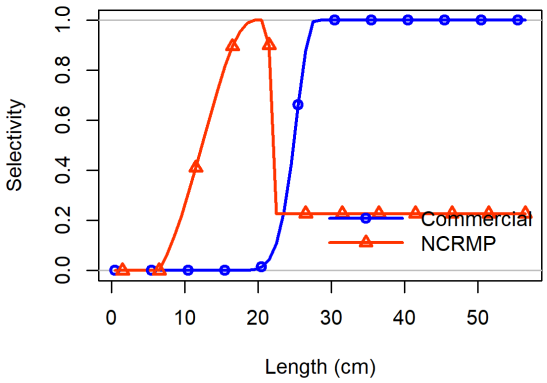
(a) Review Workshop (1)



(b) Corrected Catch Units (2)

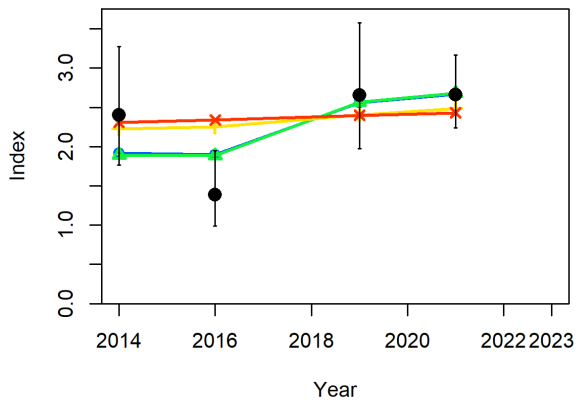


(c) No Rec. Dev. (3)

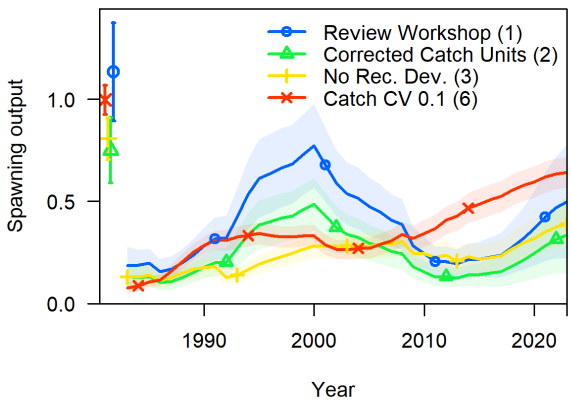


(d) Catch CV 0.1 (6)

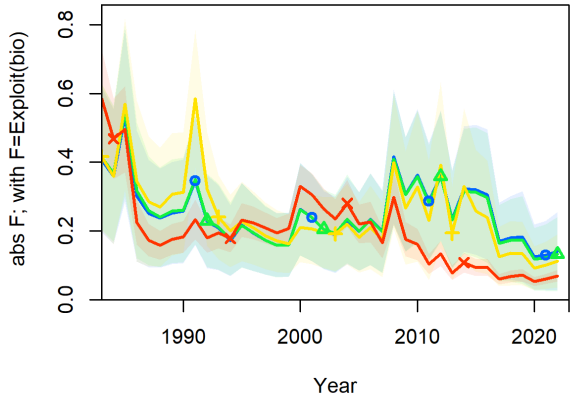
Figure 7: **Removal of Recruitment Deviations** Puerto Rico Yellowtail Snapper selectivity at length by fleet compared between (a) Review Workshop Model 1, as presented in the SEDAR 84 Stock Assessment Report Addendum, (b) corrected units for recreational catch, (c) removal of recruitment deviations, and (d) reducing catch CV to 0.1.



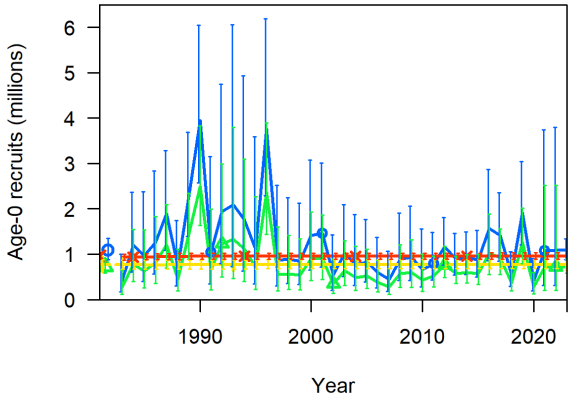
(a) NCRMP Density



(b) Spawning Biomass

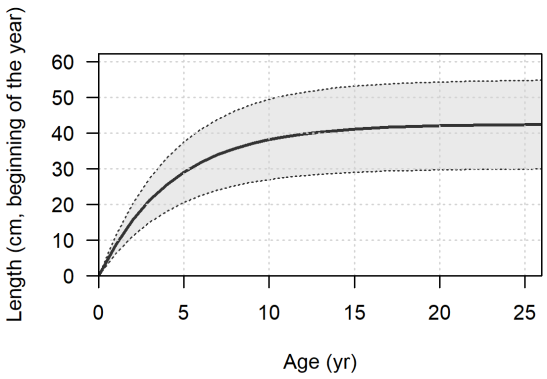


(c) Fishing Mortality

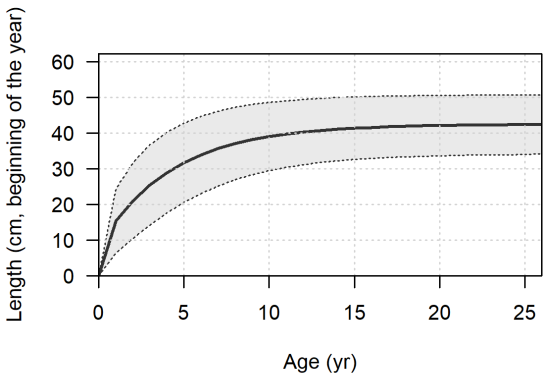


(d) Recruitment

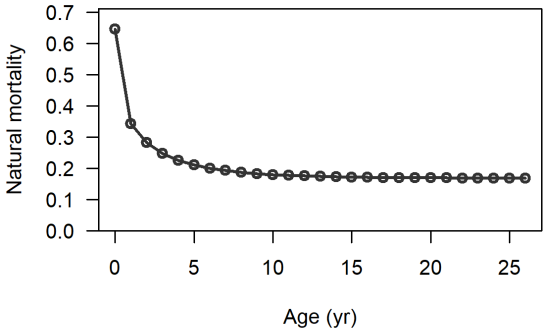
Figure 8: **Removal of Recruitment Deviations** Puerto Rico Yellowtail Snapper derived quantity time series compared between the Review Workshop Model 1 (blue), as presented in the SEDAR 84 Stock Assessment Report Addendum, and scenarios with corrected units for recreational catch (green), removal of recruitment deviations (yellow), and reducing catch CV to 0.1 (red). Derived quantities plotted over time for (a) the fit to index data for the NCRMP survey, (b) spawning stock biomass in thousands of metric tons, (c) fishing mortality (total biomass killed / total biomass), (d) and recruitment in millions of fish. The shaded areas and vertical bars in the derived quantities time series represent 95% confidence intervals. The values plotted prior to the model start year of 1983 reflect the unfished conditions and associated 95% confidence intervals.



(a) End Year 2024 (7)

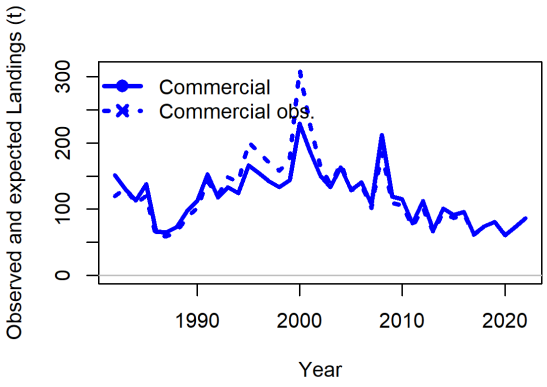


(b) Simplified (15)

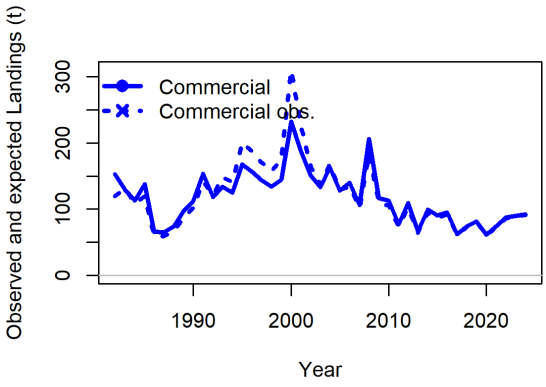


(c) Simplified (15)

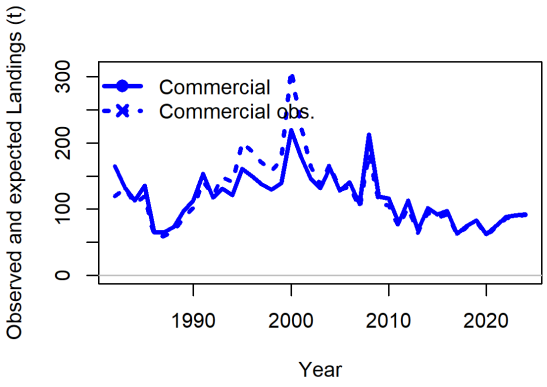
Figure 9: **Adjusted Biological Inputs** Puerto Rico Yellowtail Snapper Length at age compared between (a) all SEDAR 84 models before (a) and after the structural simplification and adjusted biological inputs. (c) Natural mortality at age for all models after adopted changing from a single natural mortality applied equally to all ages, to a Lorenzen mortality curve that scales the overall natural mortality to be higher for younger ages.



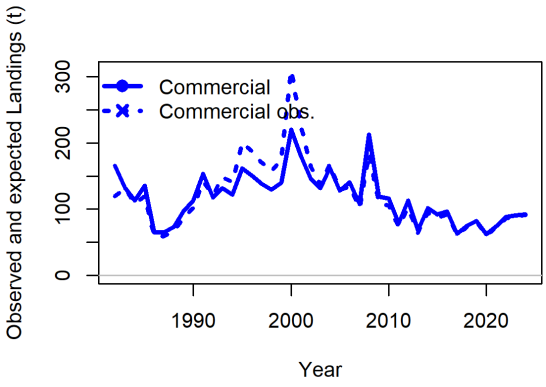
(a) Catch CV 0.1 (6)



(b) End Year 2024 (7)

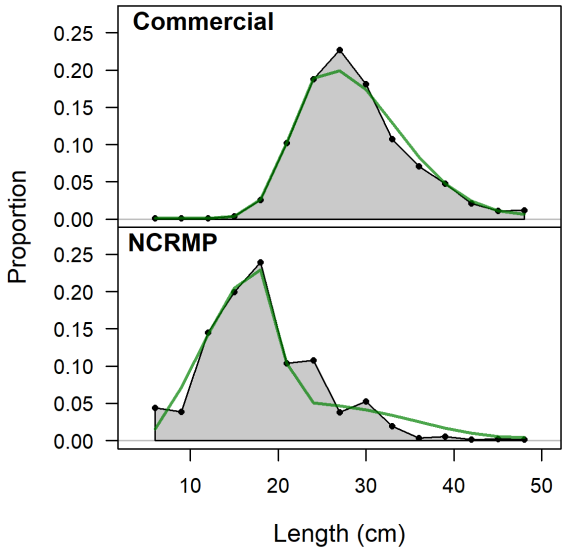


(c) Simplified (15)

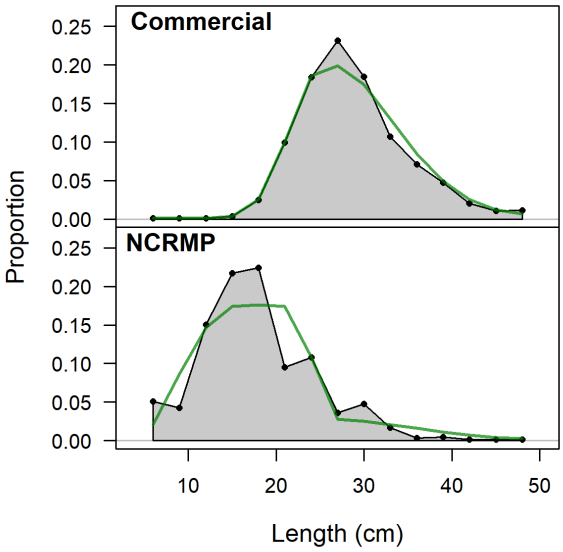


(d) 2014-2022 Rec. Dev. (25)

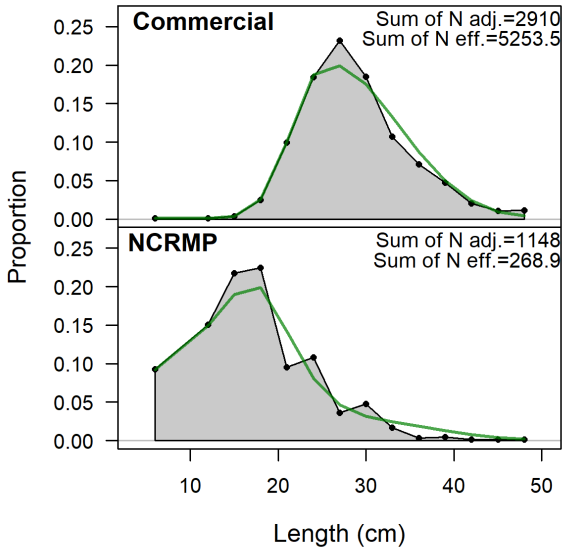
Figure 10: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper observed and expected landings (metric tons) compared between (a) reducing catch CV to 0.1, (b) including two additional years of data (2023-2024), (c) simplifying model structure and (d) inclusion of recruitment deviations for 2014-2022.



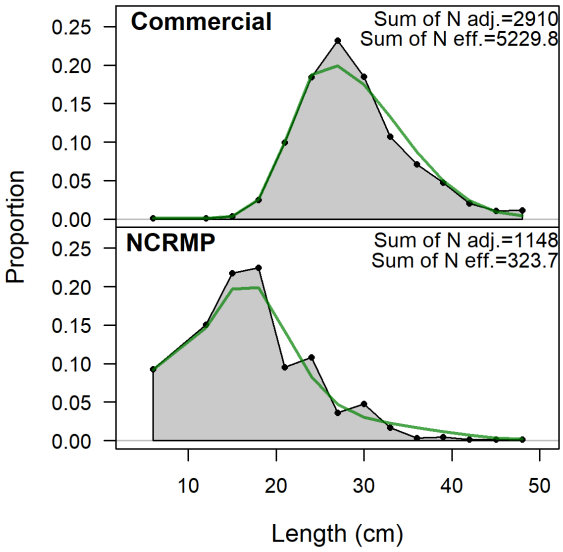
(a) Catch CV 0.1 (6)



(b) End Year 2024 (7)

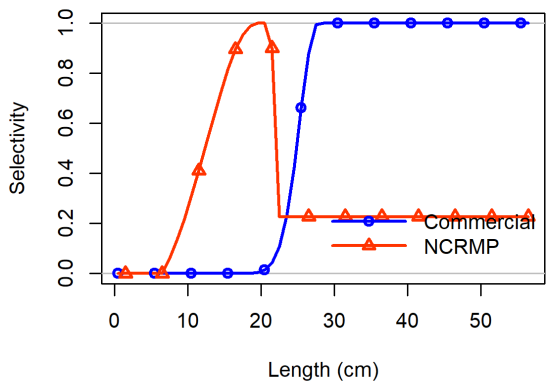


(c) Simplified (15)

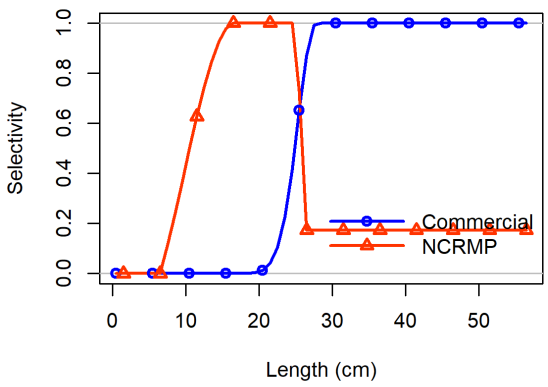


(d) 2014-2022 Rec. Dev. (25)

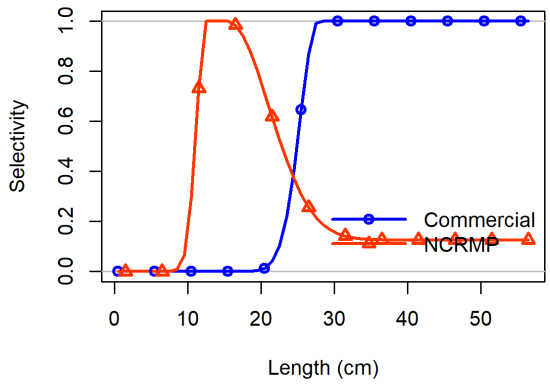
Figure 11: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper observed and observed and predicted length distributions in centimeters, aggregated across time by fleet, compared between (a) reducing catch CV to 0.1, (b) including two additional years of data (2023-2024), and (c) simplifying model structure and (d) inclusion of recruitment deviations for 2014-2022.



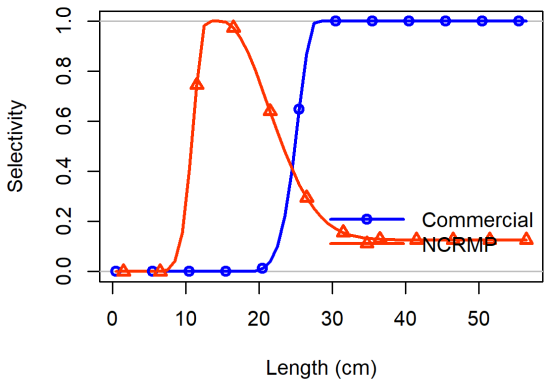
(a) Catch CV 0.1 (6)



(b) End Year 2024 (7)

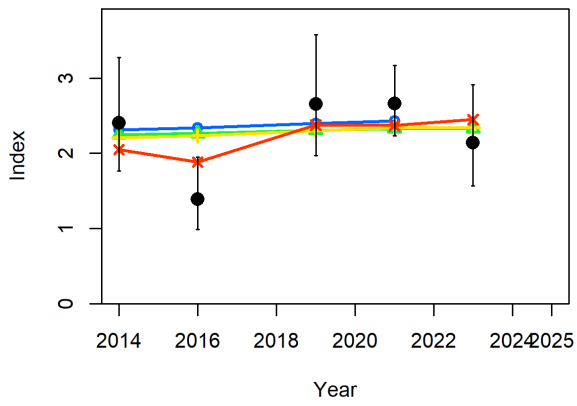


(c) Simplified (15)

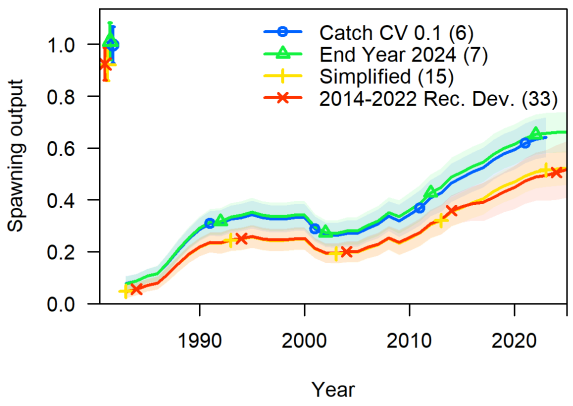


(d) 2014-2022 Rec. Dev. (25)

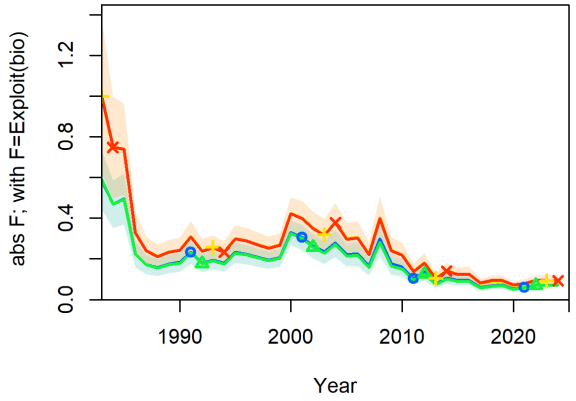
Figure 12: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper selectivity at length by fleet compared between (a) reducing catch CV to 0.1, (b) including two additional years of data (2023-2024), and (c) simplifying model structure and (d) inclusion of recruitment deviations for 2014-2022.



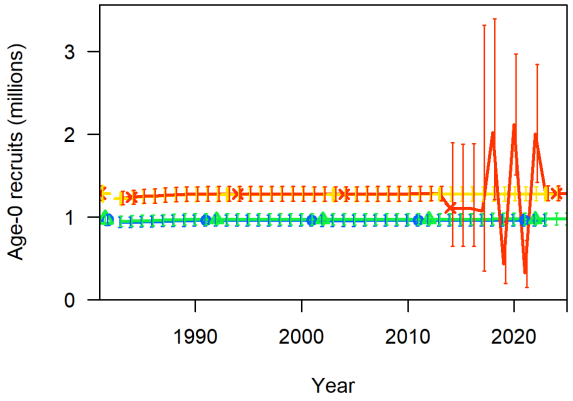
(a) NCRMP Density



(b) Spawning Biomass

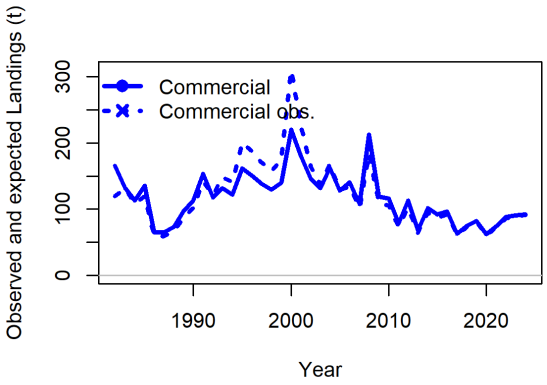


(c) Fishing Mortality

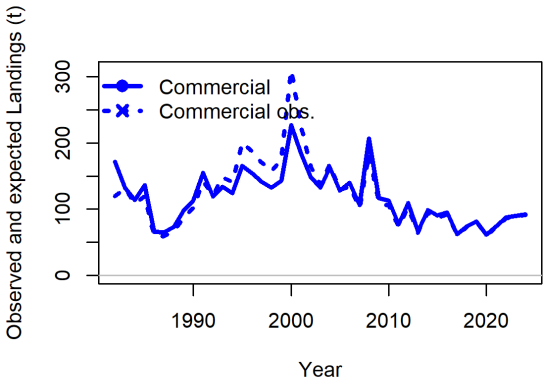


(d) Recruitment

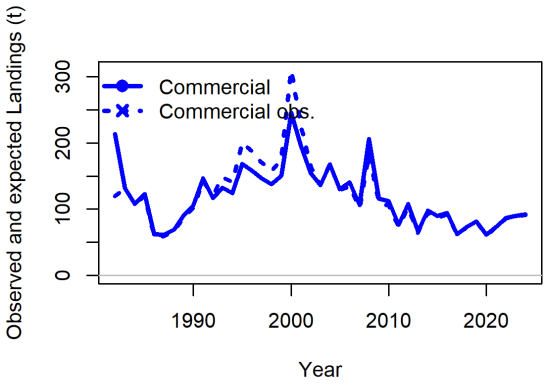
Figure 13: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper derived quantity time series compared between the model with the catch CV reduced to 0.1 (blue), including two additional years of data (green), simplified model structure (yellow) and inclusion of recruitment deviations for 2014-2022 (red). Derived quantities plotted over time for (a) the fit to index data for the NCRMP survey, (b) spawning stock biomass in thousands of metric tons, (c) fishing mortality (total biomass killed / total biomass), (d) and recruitment in millions of fish. The shaded areas and vertical bars in the derived quantities time series represent 95% confidence intervals. The values plotted prior to the model start year of 1983 reflect the unfished conditions and associated 95% confidence intervals.



(a) 2014-2022 Rec. Dev. (33)

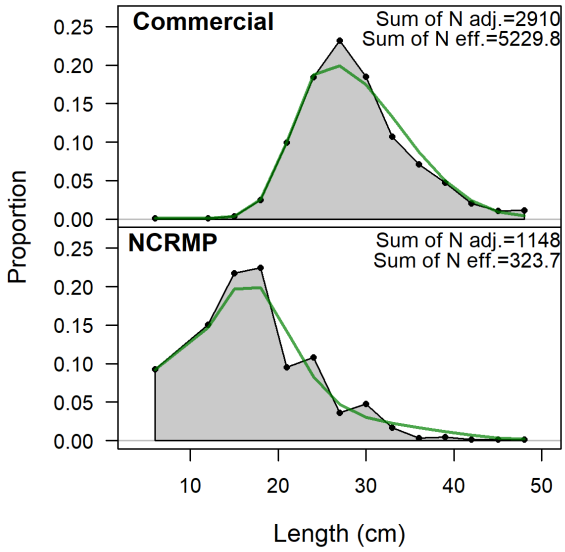


(b) Estimate NCRMP end Sel. (34)

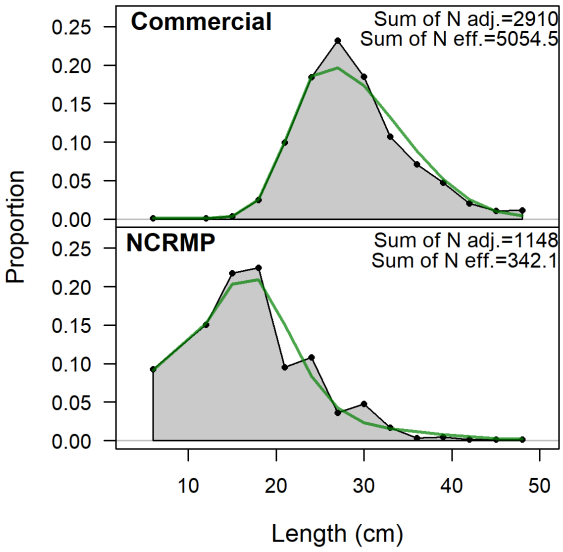


(c) Estimate h and NCRMP end Sel. (35)

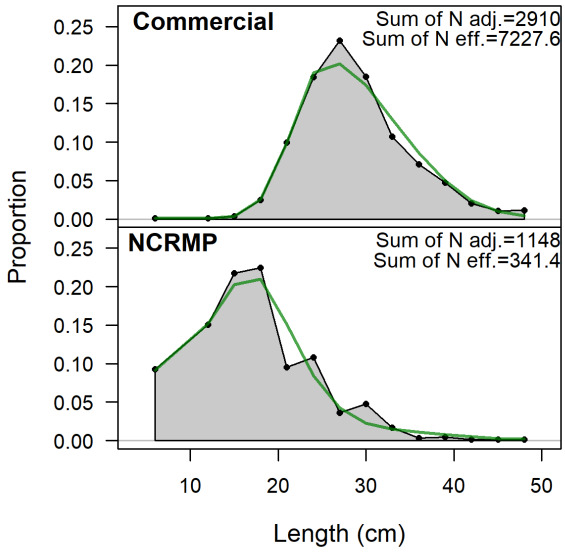
Figure 14: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper observed and expected landings (metric tons) compared between (a) inclusion of recruitment deviations for 2014-2022, (b) estimating end NCRMP survey selectivity, and (c) estimating steepness (h) and end NCRMP survey selectivity.



(a) 2014-2022 Rec. Dev. (33)

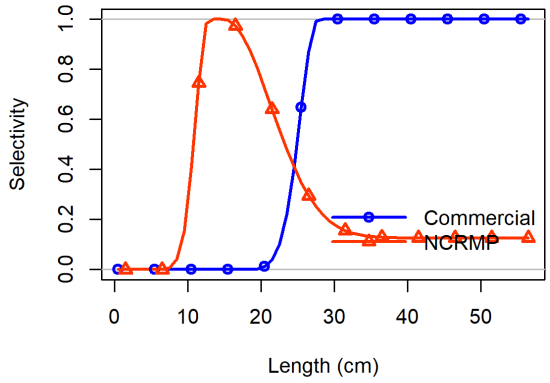


(b) Estimate NCRMP end Sel. (34)

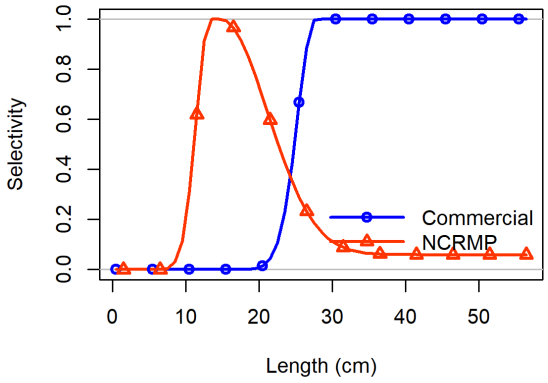


(c) Estimate h and NCRMP end Sel. (35)

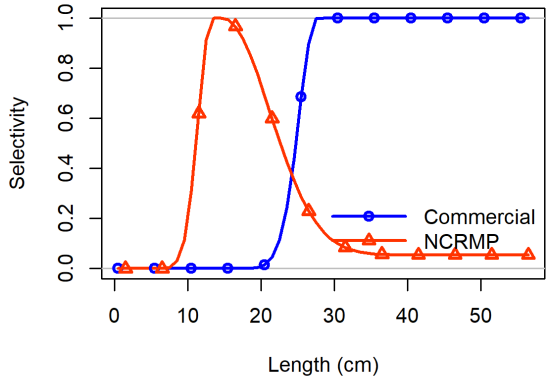
Figure 15: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper observed and observed and predicted length distributions in centimeters, aggregated across time by fleet, compared between (a) inclusion of recruitment deviations for 2014-2022, (b) estimating end NCRMP survey selectivity, and (c) estimating steepness (h) and end NCRMP survey selectivity.



(a) 2014-2022 Rec. Dev. (33)

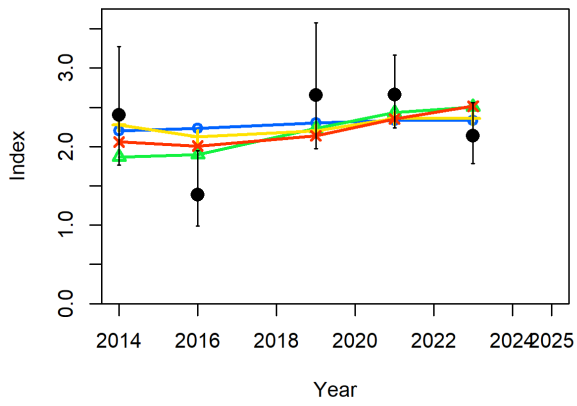


(b) Estimate NCRMP end Sel. (34)

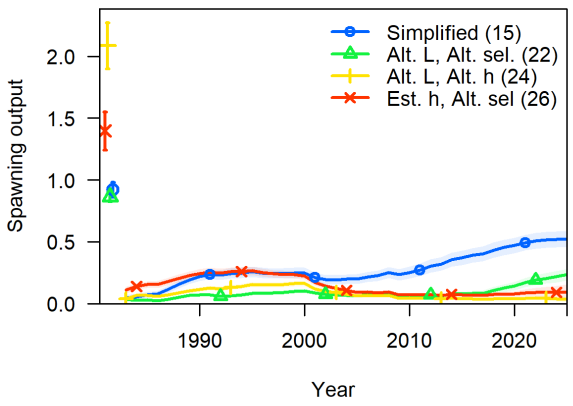


(c) Estimate h and NCRMP end Sel. (35)

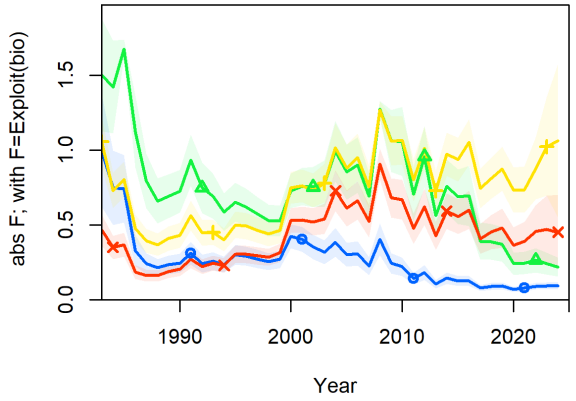
Figure 16: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper selectivity at length by fleet compared between (a) inclusion of recruitment deviations for 2014-2022, (b) estimating end NCRMP survey selectivity, and (c) estimating steepness (h) and end NCRMP survey selectivity.



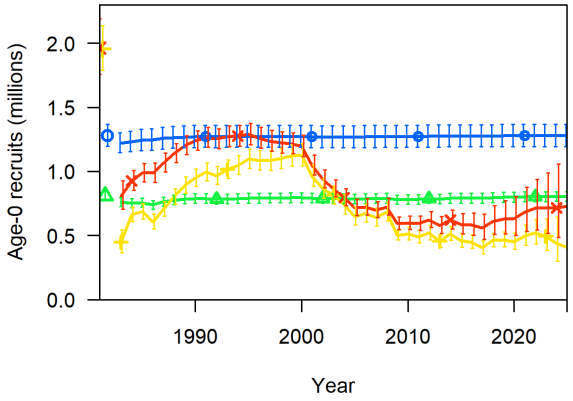
(a) NCRMP Density



(b) Spawning Biomass



(c) Fishing Mortality



(d) Recruitment

Figure 17: **Terminal Year Update, Structural Simplification & Restricted Recruitment Estimation** Puerto Rico Yellowtail Snapper derived quantity time series compared between the model with the inclusion of recruitment deviations for 2014-2022 (blue), estimated end NCRMP survey selectivity (red), and estimated steepness (h) and estimated end NCRMP survey selectivity (green). Derived quantities plotted over time for (a) the fit to index data for the NCRMP survey, (b) spawning stock biomass in thousands of metric tons, (c) fishing mortality (total biomass killed / total biomass), (d) and recruitment in millions of fish. The shaded areas and vertical bars in the derived quantities time series represent 95% confidence intervals. The values plotted prior to the model start year of 1983 reflect the unfished conditions and associated 95% confidence intervals.

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