

SEDAR 94: Florida Hogfish Review Workshop *West Florida Shelf*

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USF | FWC-FWRI Marine Fisheries Research

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Goals

- Base Model Diagnostics
 - Model convergence
 - Model consistency
 - Model validation/prediction skill
 - Sensitivity runs
- Base Model Uncertainty
 - MCMC analysis
 - Bootstrap analysis
- Stock Status Overview
 - Per-recruit analysis
 - Gulf SSDC
- Bridge Building
 - “S37data_S94config” model
 - “S37_SRFS” model





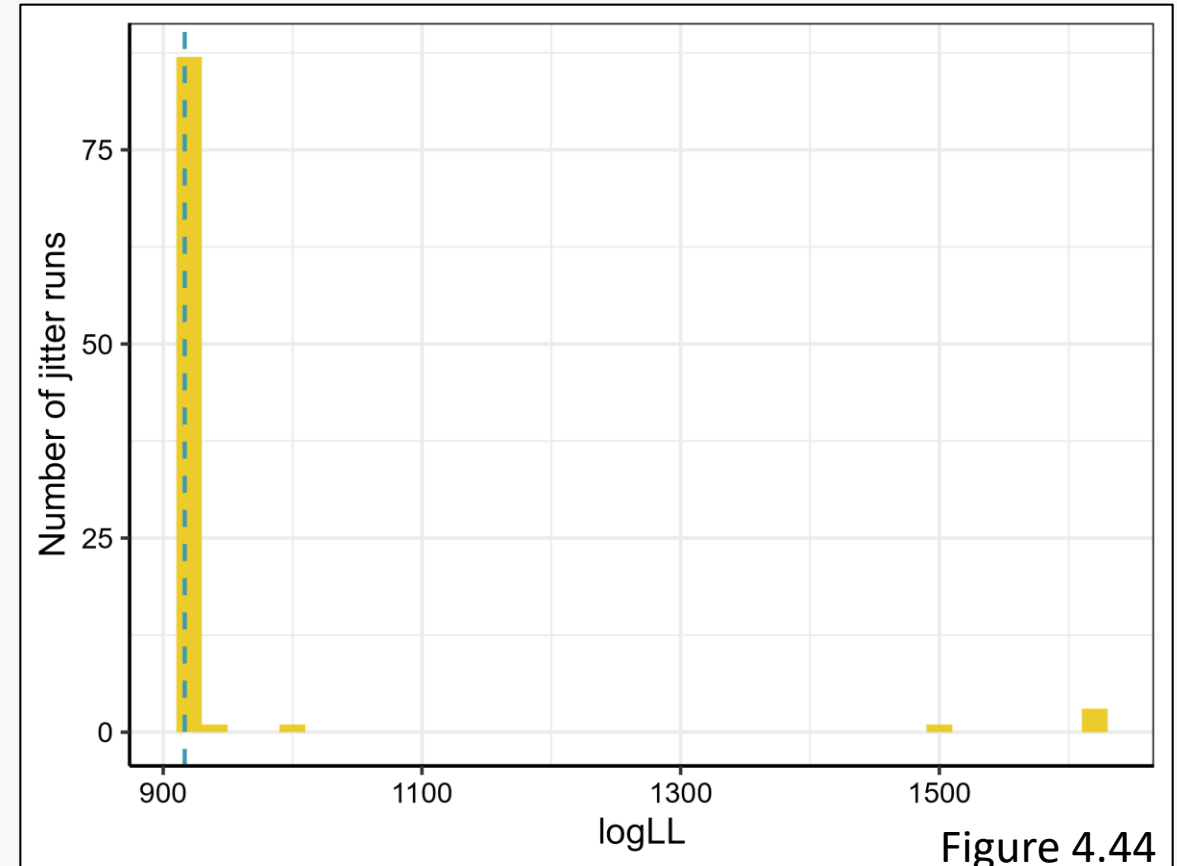
SEDAR 94: Florida Hogfish WFS Base Model Diagnostics

Model Convergence

- No estimated params on bounds
- Final gradient < 0.0001
- Positive definite hessian

Jitter Analysis

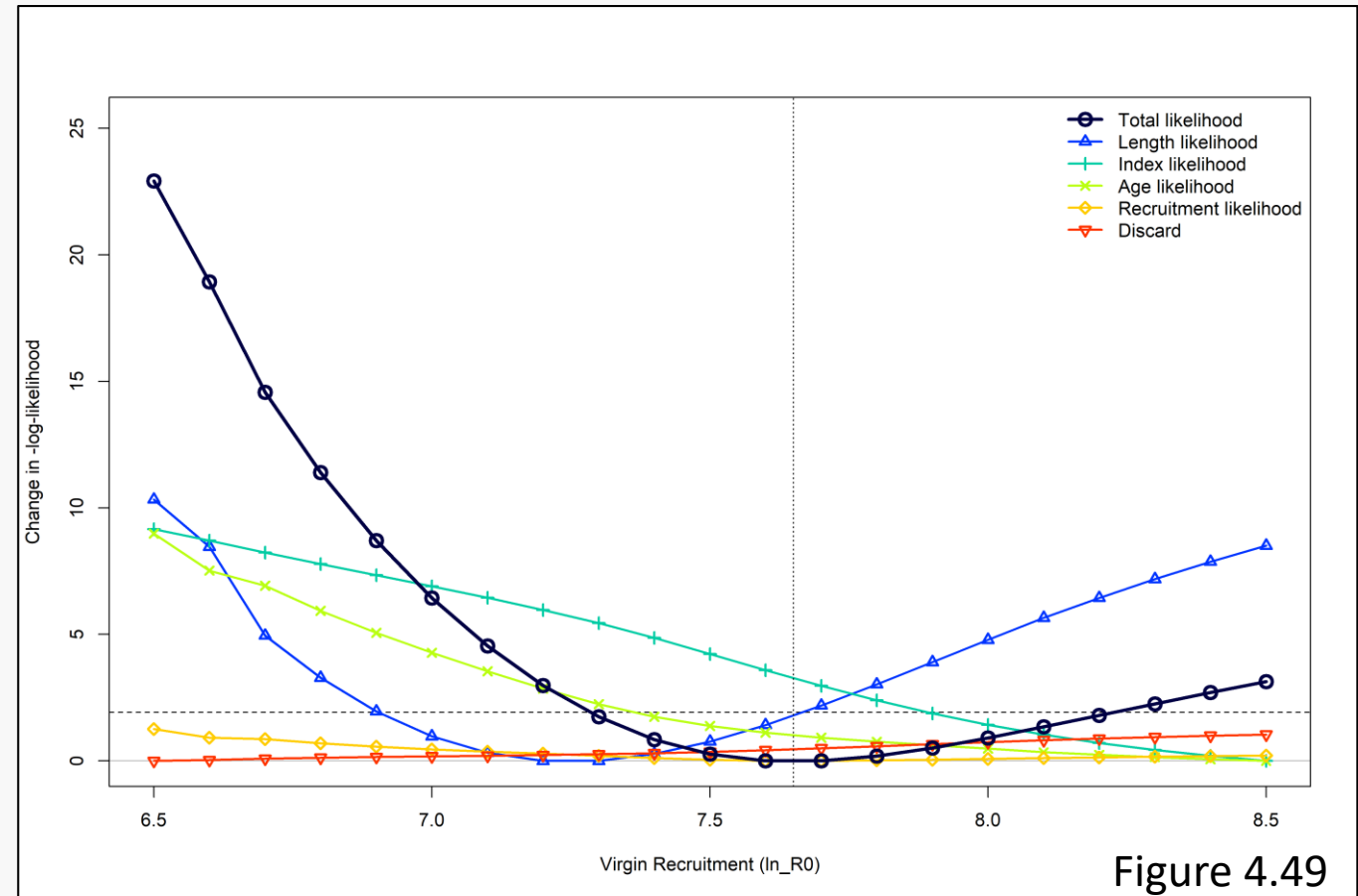
- 100 iterations
- Initial params jittered by 20%
- Jitter LL: 916 – $> 3000^*$
 - 77% within 2 LL units from min
 - No jittered runs with a lower Total LL
- Gradient
 - 41% had gradient > 0.0001
 - 37 runs had at least 1 param on bounds
 - REC retain width param



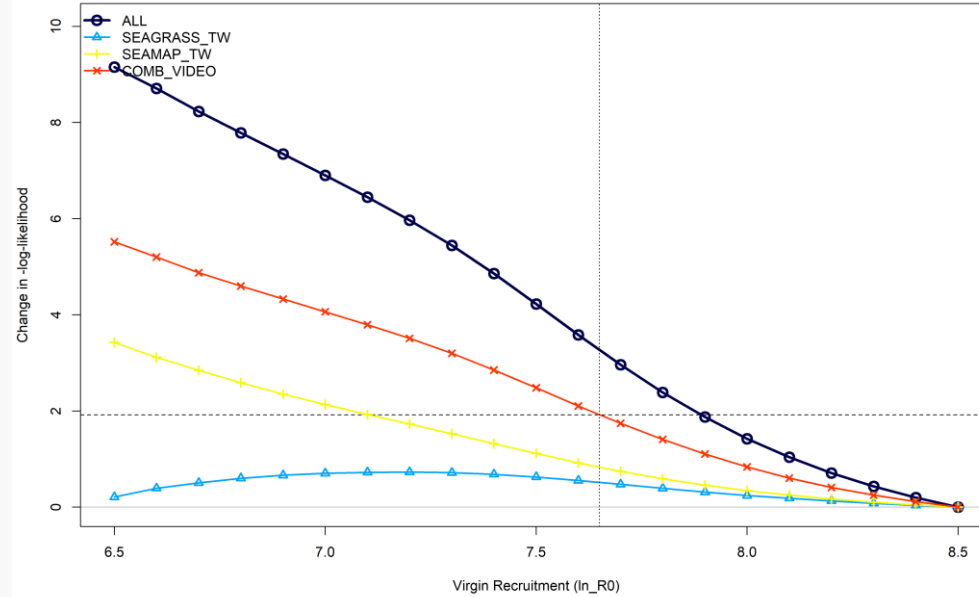
Model Consistency

Profiling of $\ln(R_0)$ parameter

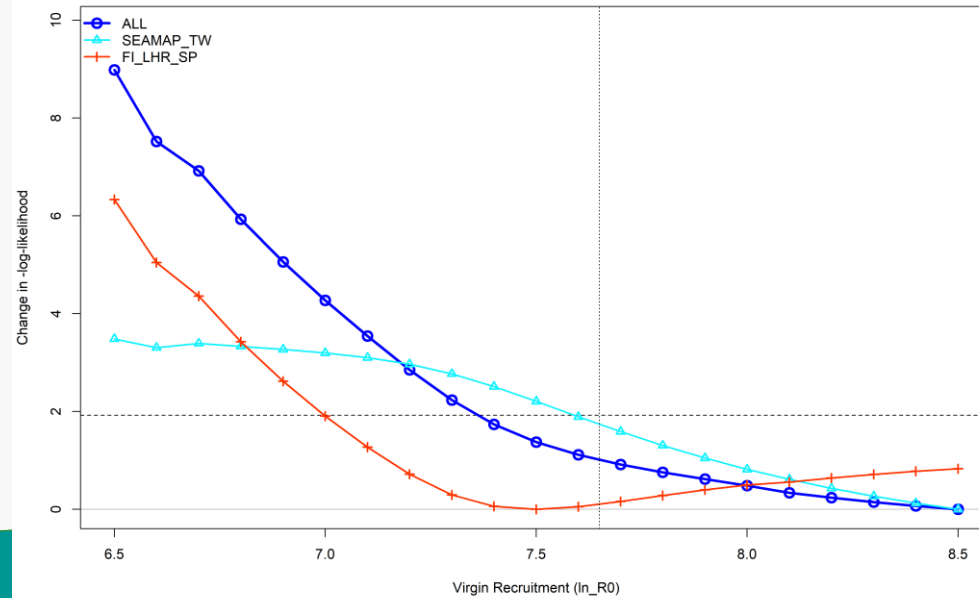
- Identify how sources of information influence various model estimates
- $R_0 \approx$ global scaling parameter
- Mostly informed by length (blue), index (teal) and age (lime) data
 - Minimum $\sim \ln(7.6)$
- Not informed by recruitment variability (golden)
 - Supports recruitment being primarily informed by composition data and indices



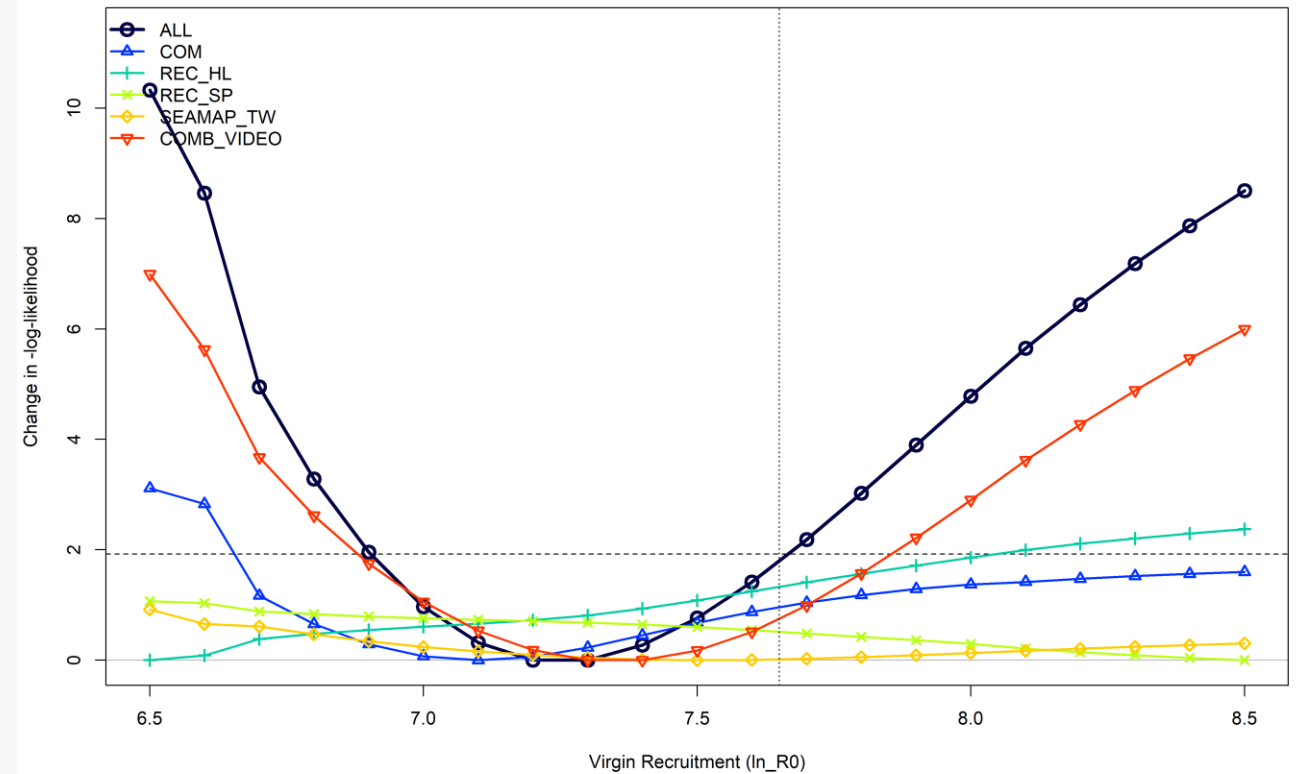
Changes in survey likelihoods by fleet



Changes in age-composition likelihoods by fleet



Changes in length-composition likelihoods by fleet



Model Consistency

Age Structured Production Models (ASPM)

Results indicate the production function is unable to drive stock dynamics

- Catch and index data not informative to production function
- Model relies on length and age composition to estimate population scale and recruitment variability

ASPM

- Population and recruitment magnitudes significantly lower
- Higher exploitation values

ASPM_dev uses recruitment deviations (process error) to further improve fit to indices

- Model scaled larger population magnitude
- Exploitation significantly lower
- Uncertainty also highly elevated

Age Structured Production Models (ASPM)

- Since recruitment variability is not an informer of R_0 , the ASPM_dev has insufficient information without any composition data

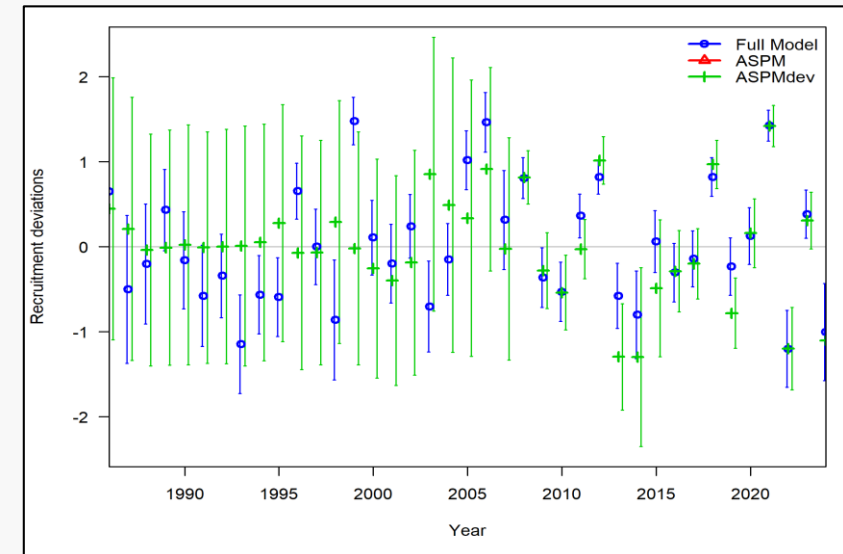
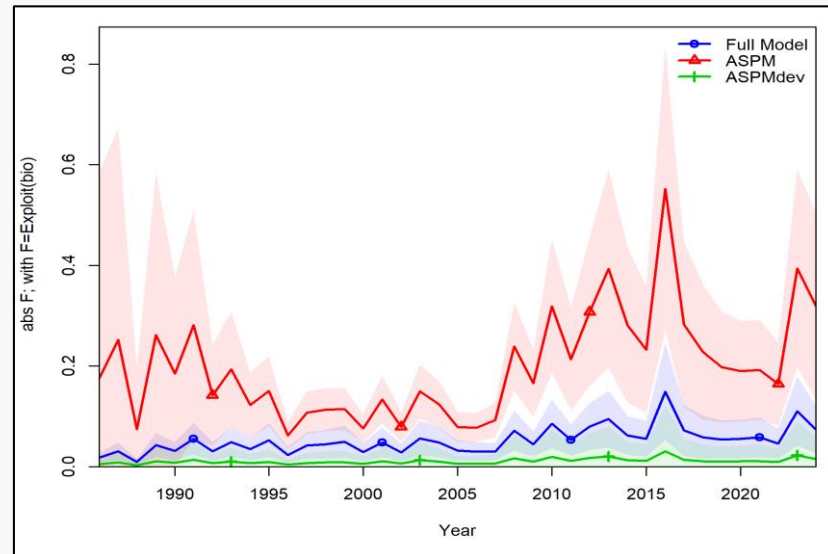
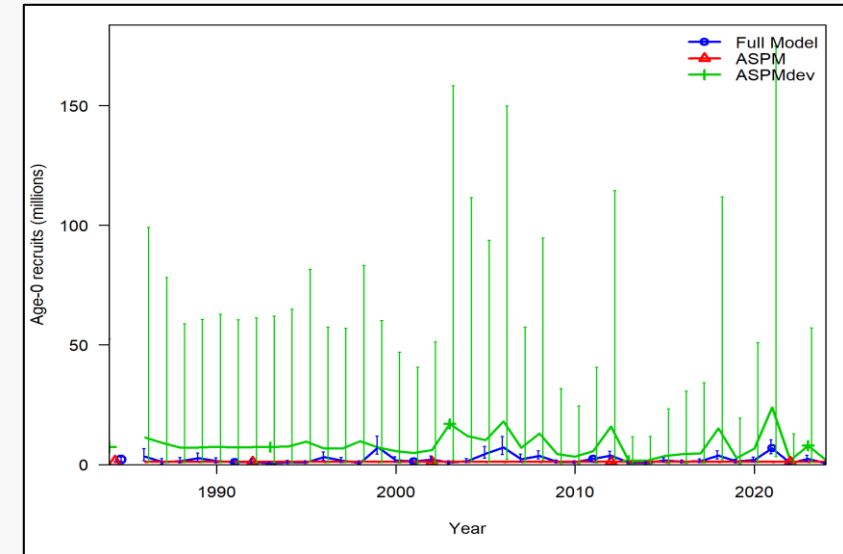
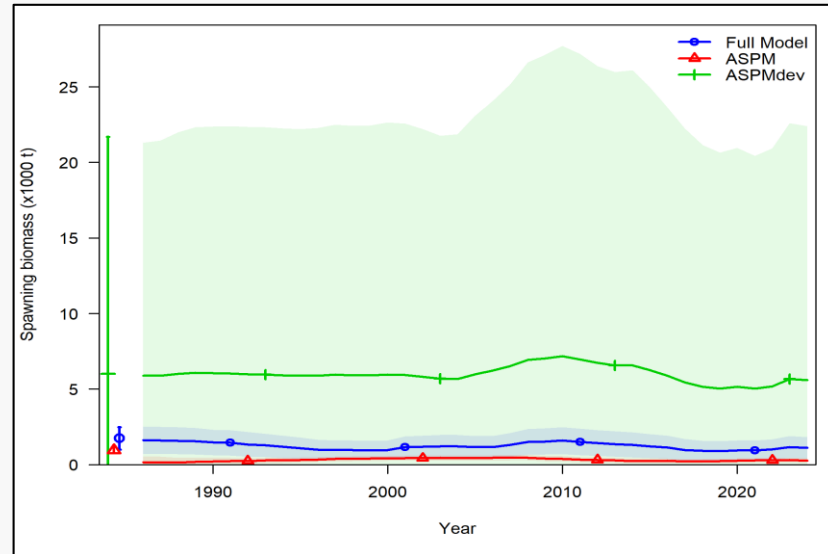


Figure 4.50

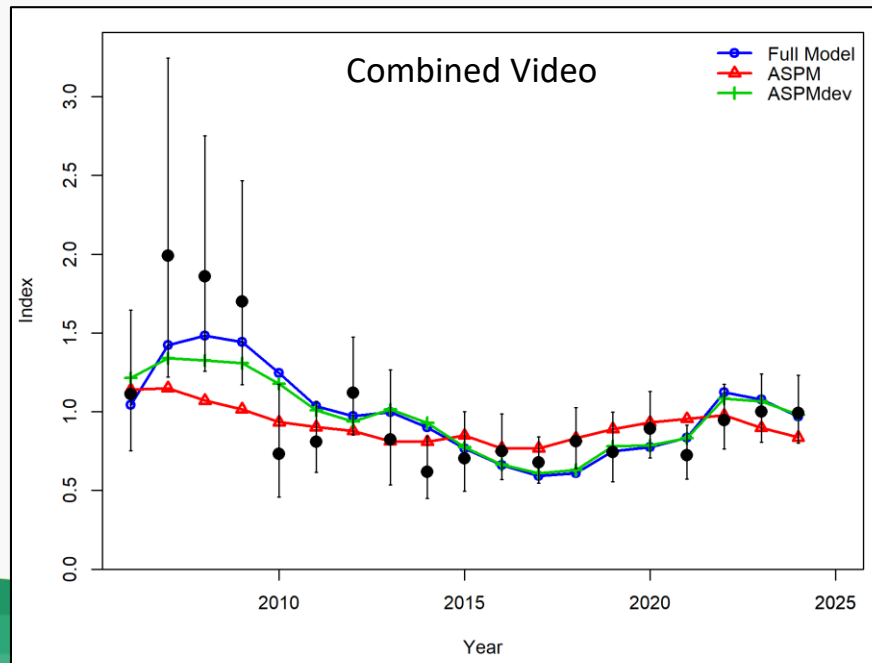
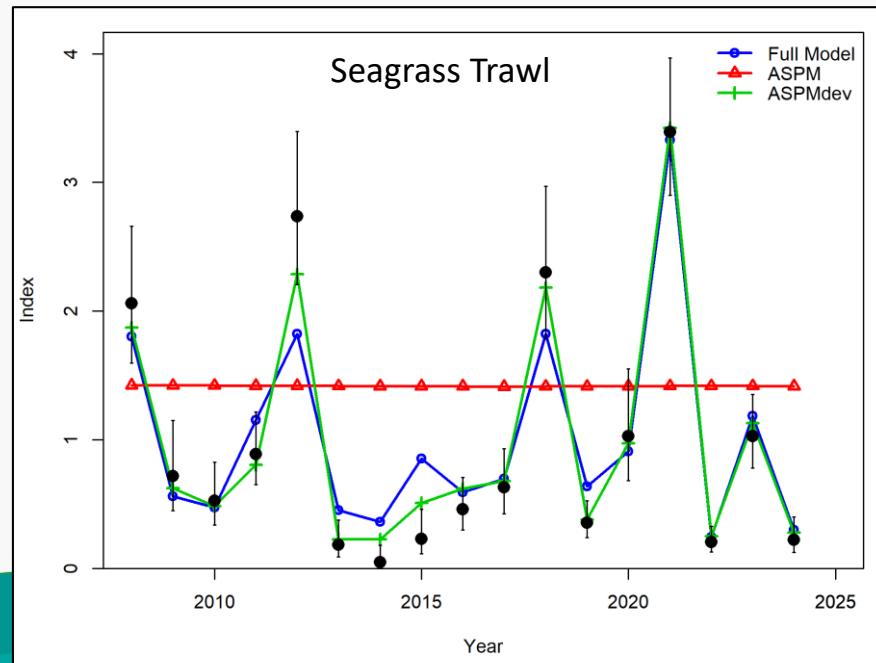
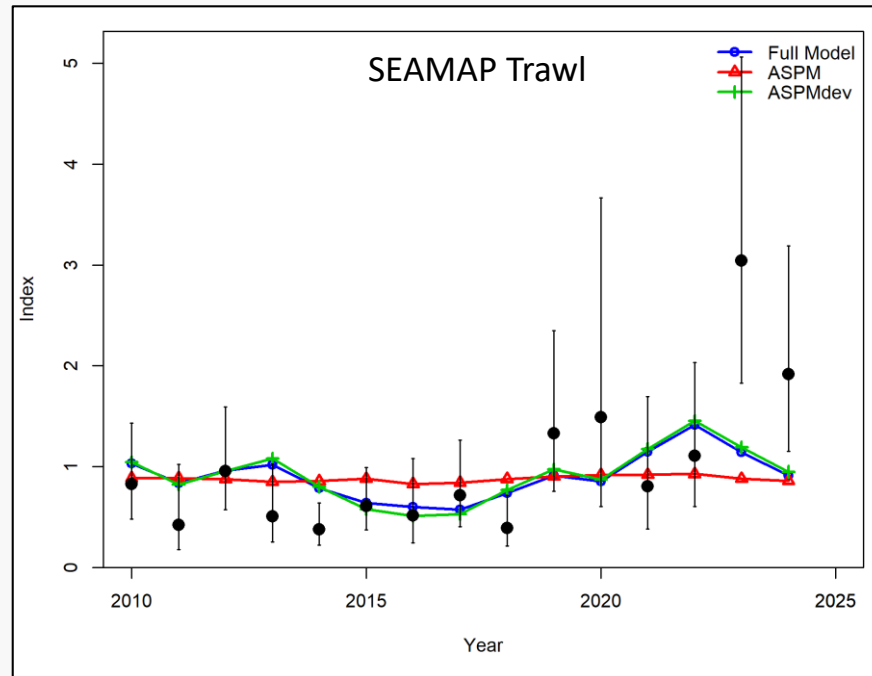
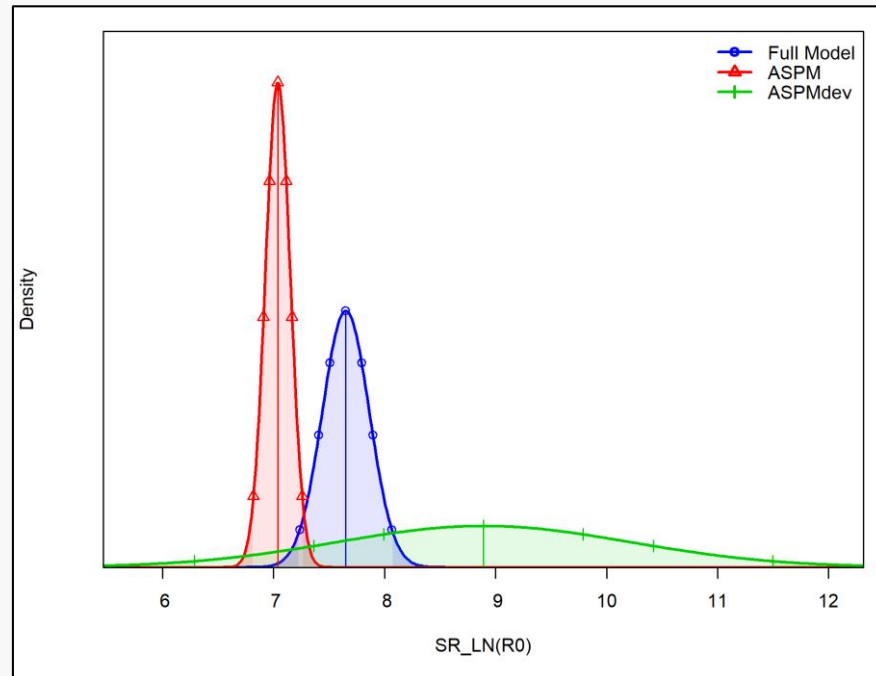


Figure 4.51

Model Consistency and Predictive Skill

Retrospective Analysis

- Six-year peel
- Helps evaluate the effect of the final years on model results
- Patterns can indicate model misspecification or temporal dynamics
 - Minor pattern in SSB and F
- Evaluated visually and quantitatively
 - Mohn's Rho
 - Hurtado –Ferro et al (2015) “Rule of thumb”
 - - 0.15 to 0.20 for longer-lived species
 - negative value for SSB indicates slight underestimation of biomass in terminal years
 - positive value for F indicates a tendency to overestimate fishing mortality

Retrospective Forecasting

- One year forward projections for every peel
- Evaluated visually and quantitatively
 - Forecast bias corresponding to Mohn's Rho
 - All retrospective forecasts fell within 95% CI of base model

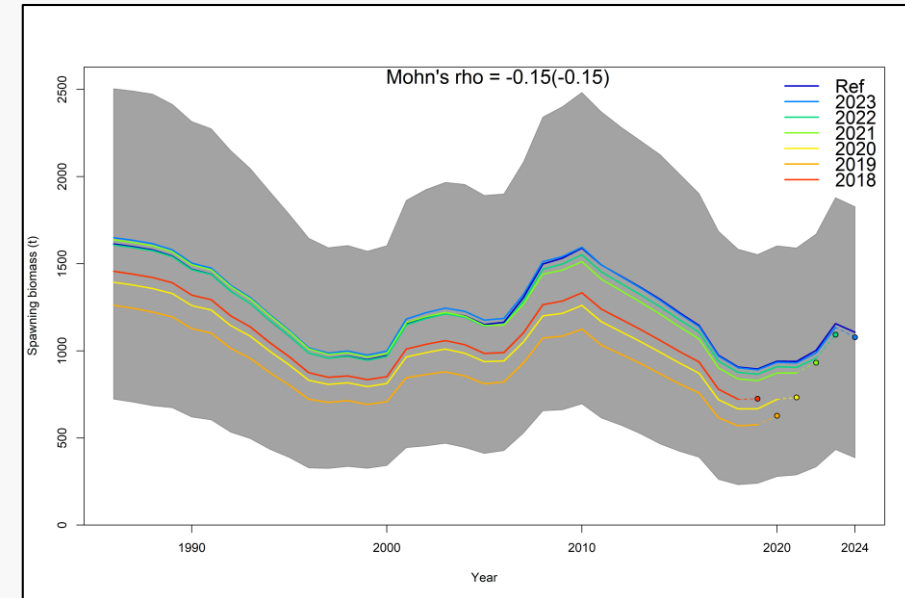


Figure 4.52a

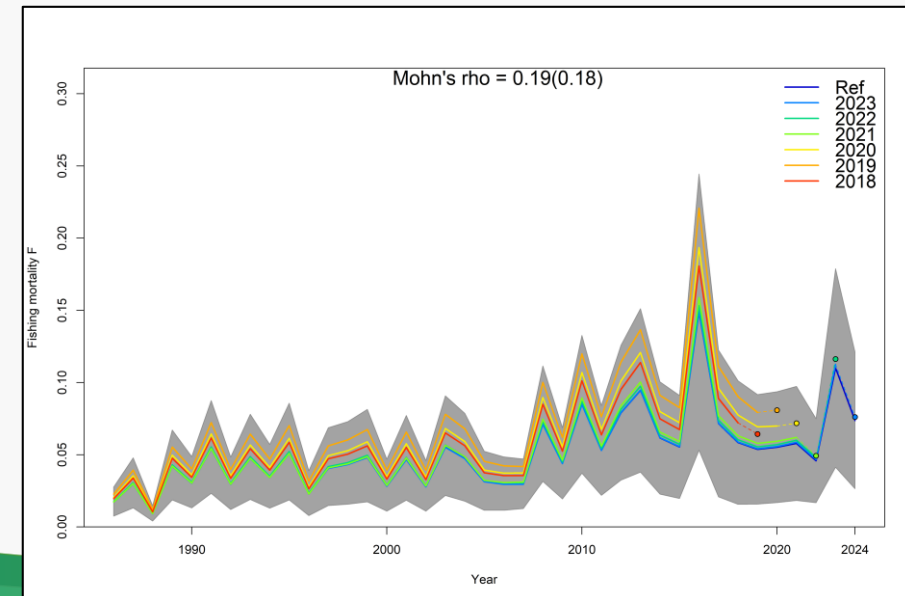


Figure 4.52b

Hindcast Cross Validation

Table 4.15

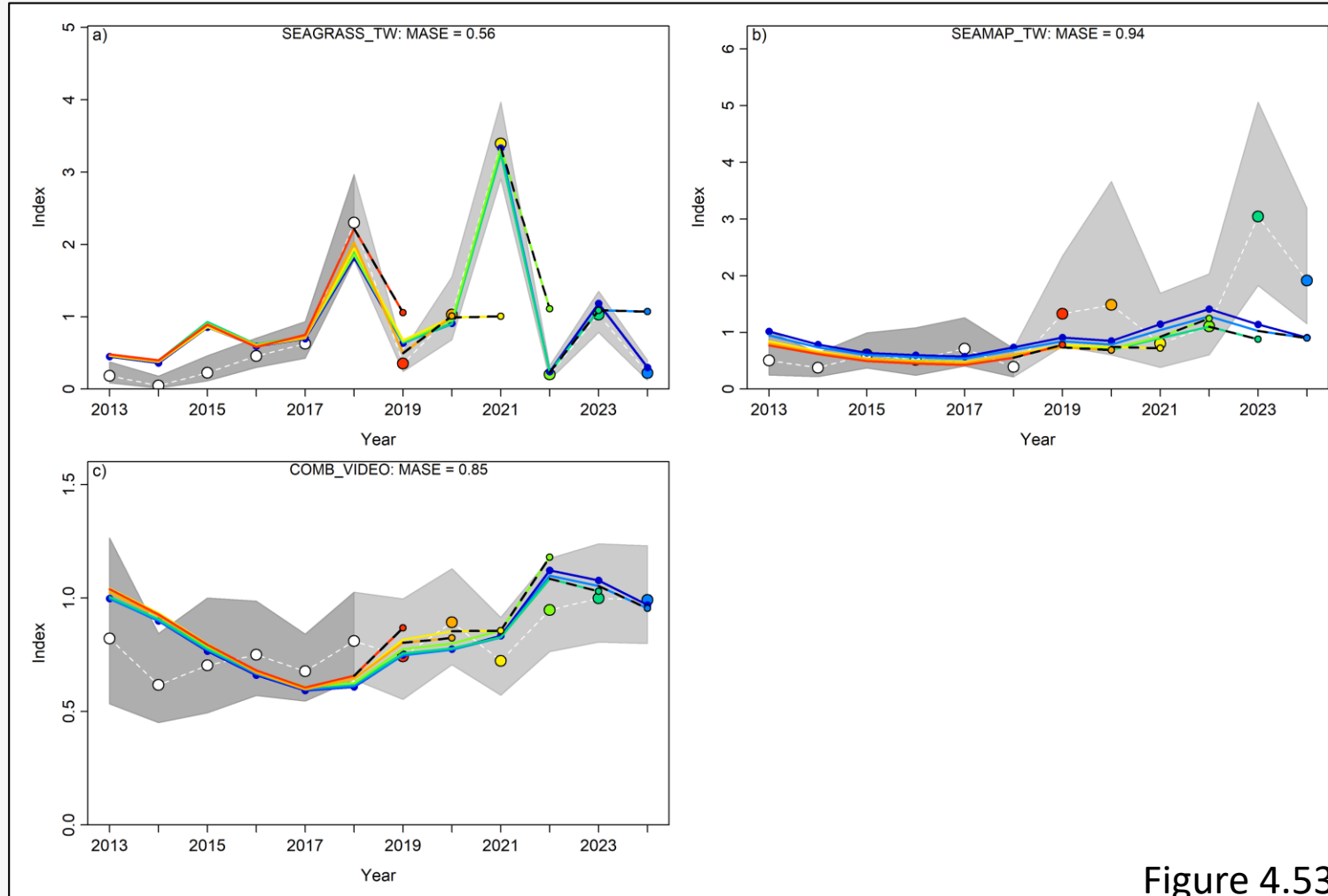


Figure 4.53

stk	Component	Fleet	MASE
hog_wfs	Index	SEAGRASS_TW	0.560502
hog_wfs	Index	SEAMAP_TW	0.941681
hog_wfs	Index	COMB_VIDEO	0.853264
hog_wfs	Index	joint	0.674203
hog_wfs	Length	COM	NA
hog_wfs	Length	REC_HL	NA
hog_wfs	Length	REC_SP	NA
hog_wfs	Length	SEAMAP_TW	0.791491
hog_wfs	Length	COMB_VIDEO	0.712678
hog_wfs	Length	joint	0.75345
hog_wfs	CAAL	SEAMAP_TW	0.343626
hog_wfs	CAAL	FI_LHR_SP	NA
hog_wfs	CAAL	joint	0.343626

***improved predictive skill in all components

*** MASE (Mean Absolute Scaled Error) = Average of mean absolute error of prediction residuals (Model MAE)/Naïve Predictions (Naïve MAE)



S94: Florida Hogfish
Sensitivity Runs

WFS: Sensitivity Runs

Natural Mortality

Base: Lorenzen (2022) with HamelCope longevity estimate

- $M = 0.235$ averaged across ages 3 - 23
- $M(a) = 0.988 - 0.168$

Lorenzen (1996) mortality-at-weight (method in KEYS model)

- $M(a) = 0.514 - 0.110$
- Higher *Linf* (114.7 cm) to help compensate but worsened total LL

HamelCope_age3 (in earlier iterations of WFS model development)

- $M = 0.235$
- Lower *Linf* (54.2 cm) and worsened total LL

est_HamelCope_ages3_23_noprior

- $M = 0.286$; $M(a) = 1.239 - 0.205$
- Similar *Linf* (86.5 cm) but much higher recruitment
- Not a significantly different total LL but inflates uncertainty of derived quantities

WFS: Natural Mortality

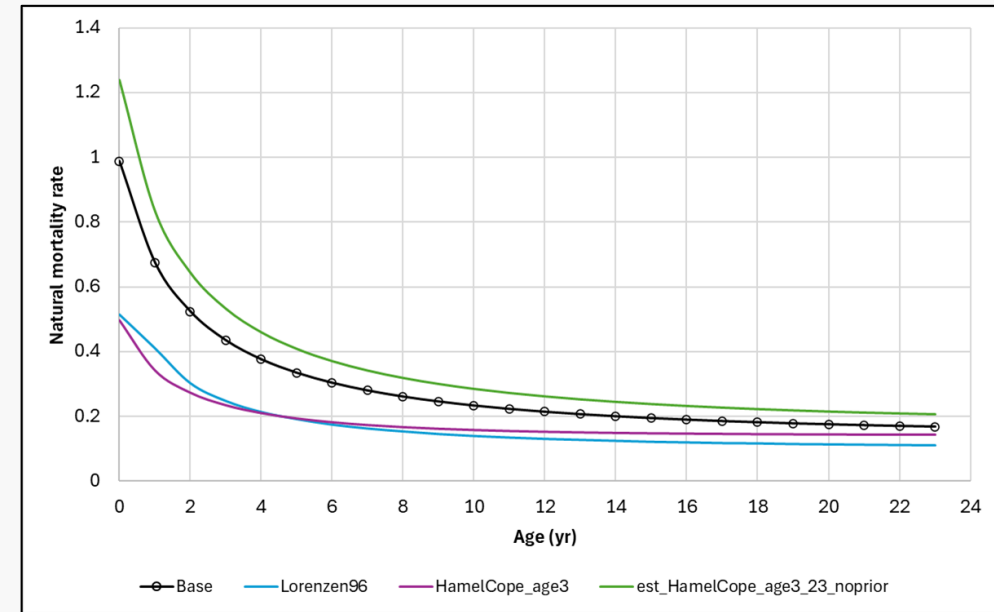
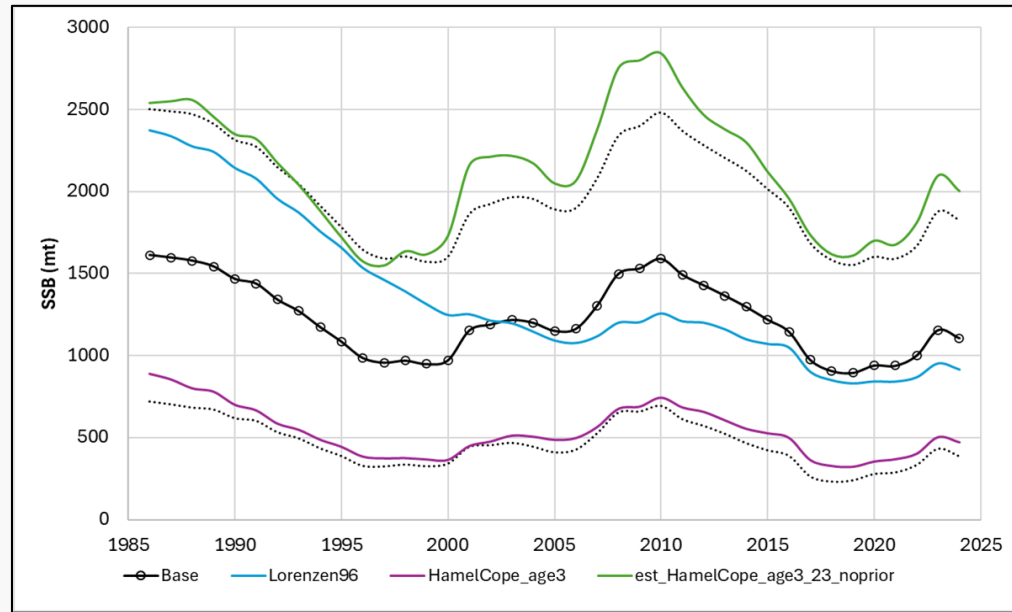
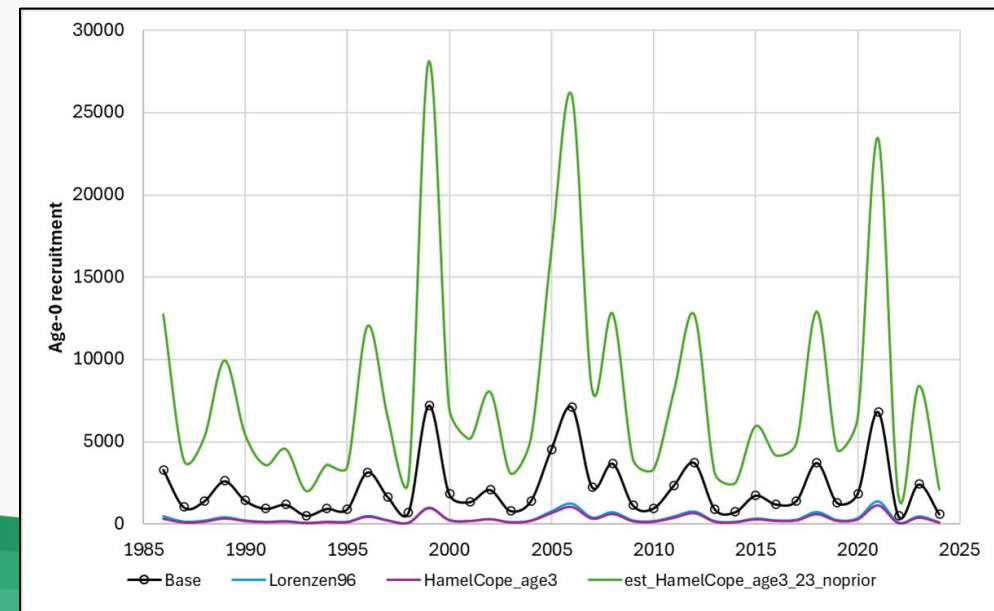
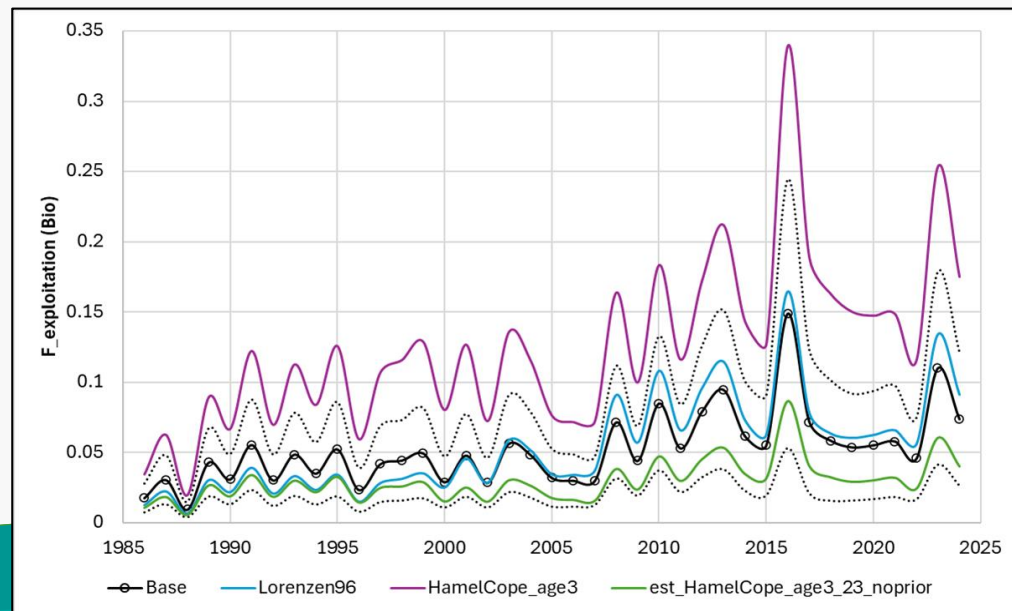


Figure 4.55



WFS: Discard Mortality

- REChI fleet
 - Low: 23.8% *[S94-DW-12]*
 - **Base: 41.4 %** *[Avg. High and Low]*
 - High: 59.0% *[S94-DW-16]*
- No discard estimates for COM or RECsp

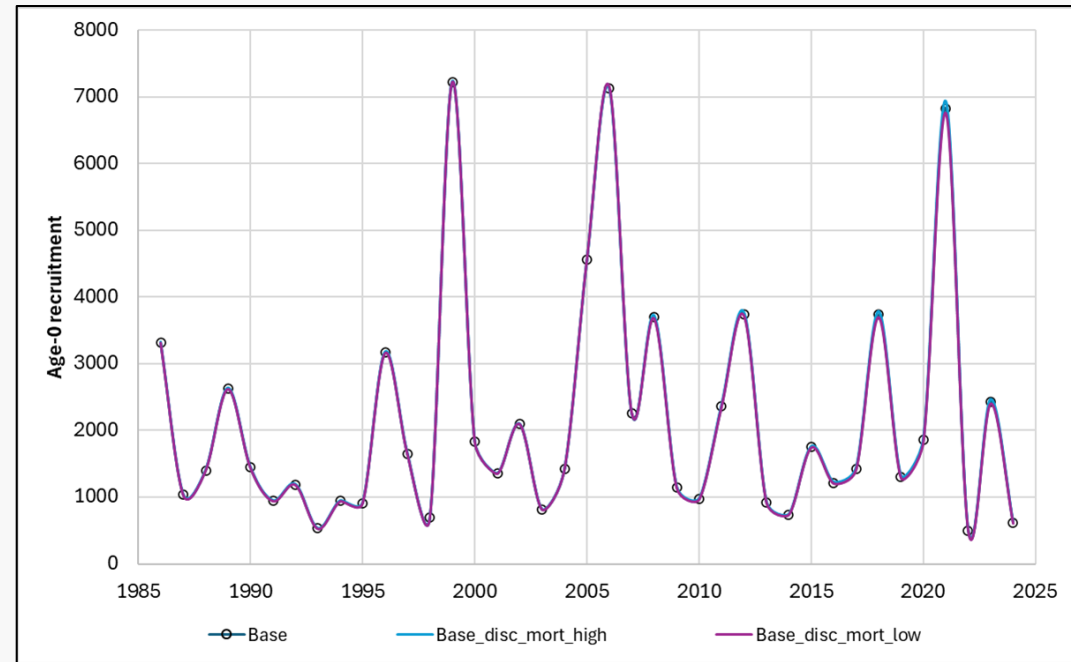
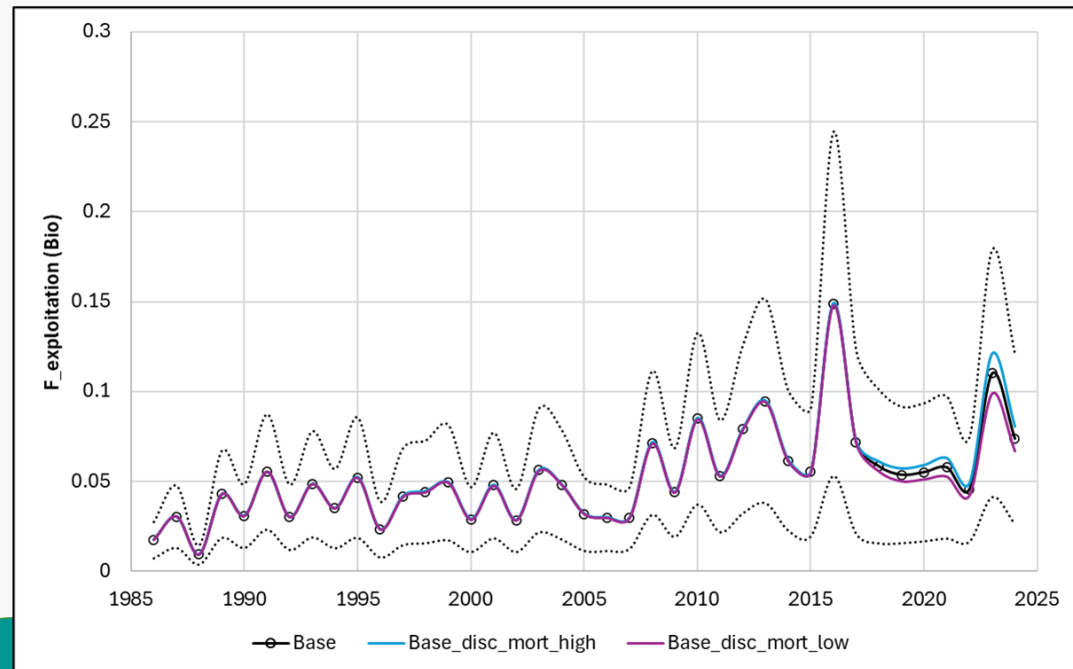
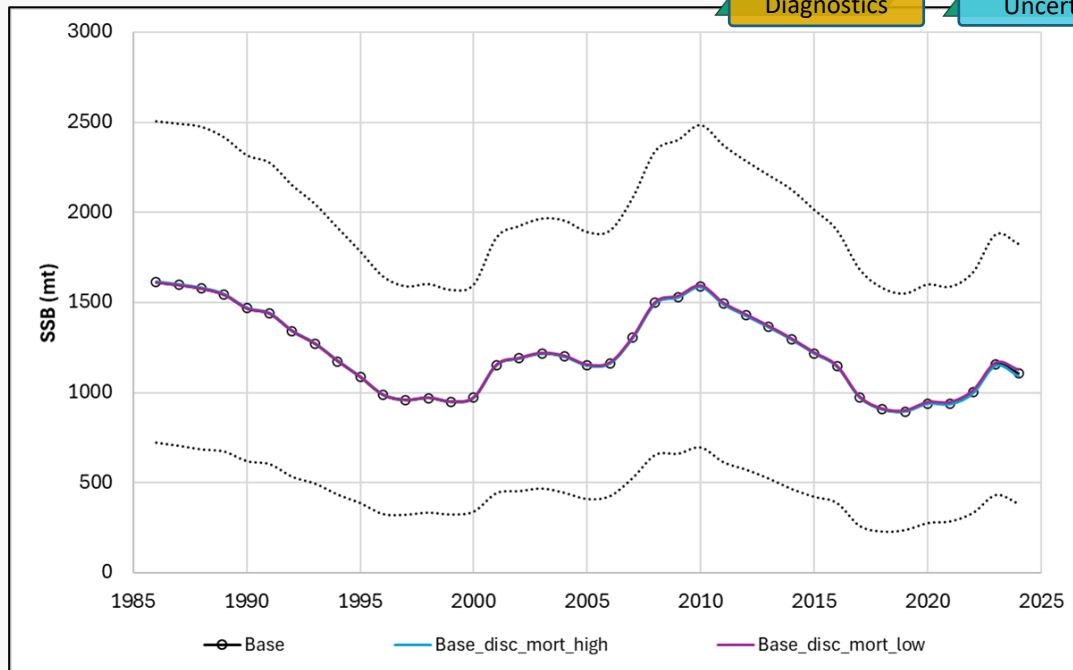


Figure 4.56

S94: Florida Hogfish Uncertainty Analyses



Markov chain Monte-Carlo (MCMC)

- Evaluate model uncertainty and generate posterior distributions of key model parameters and derived quantities
 - e.g., R_0 , SSB_0 , *steepness*, SSB_{2024} , F_{2024} , $F_{MSY \text{ or } 30\%SPR}$, $SSB_{MSY \text{ or } 30\%SPR}$, Retained yield at $F_{MSY \text{ or } 30\%SPR}$
- Obstacles
 - Both base models forced to re-configure recruitment deviations: remove zero-sum constraint
 - Not an issue with WFS model (i.e., very similar results)

Markov chain Monte-Carlo (MCMC)

WFS: eight chains attempted

- 2,000 iterations saved from the 1,000,000 performed with every 500 thinned
 - Burn-in set at 500
- 1,500 iterations remained from six chains before combining (**9,000 total**)
- Convergence
 - Geweke's diagnostic test on each chain (p value >0.05)
 - Gelman and Rubin's (1992) potential scale reduction factor (PSRF) ≤ 1.1
 - Visual inspection of trace plots

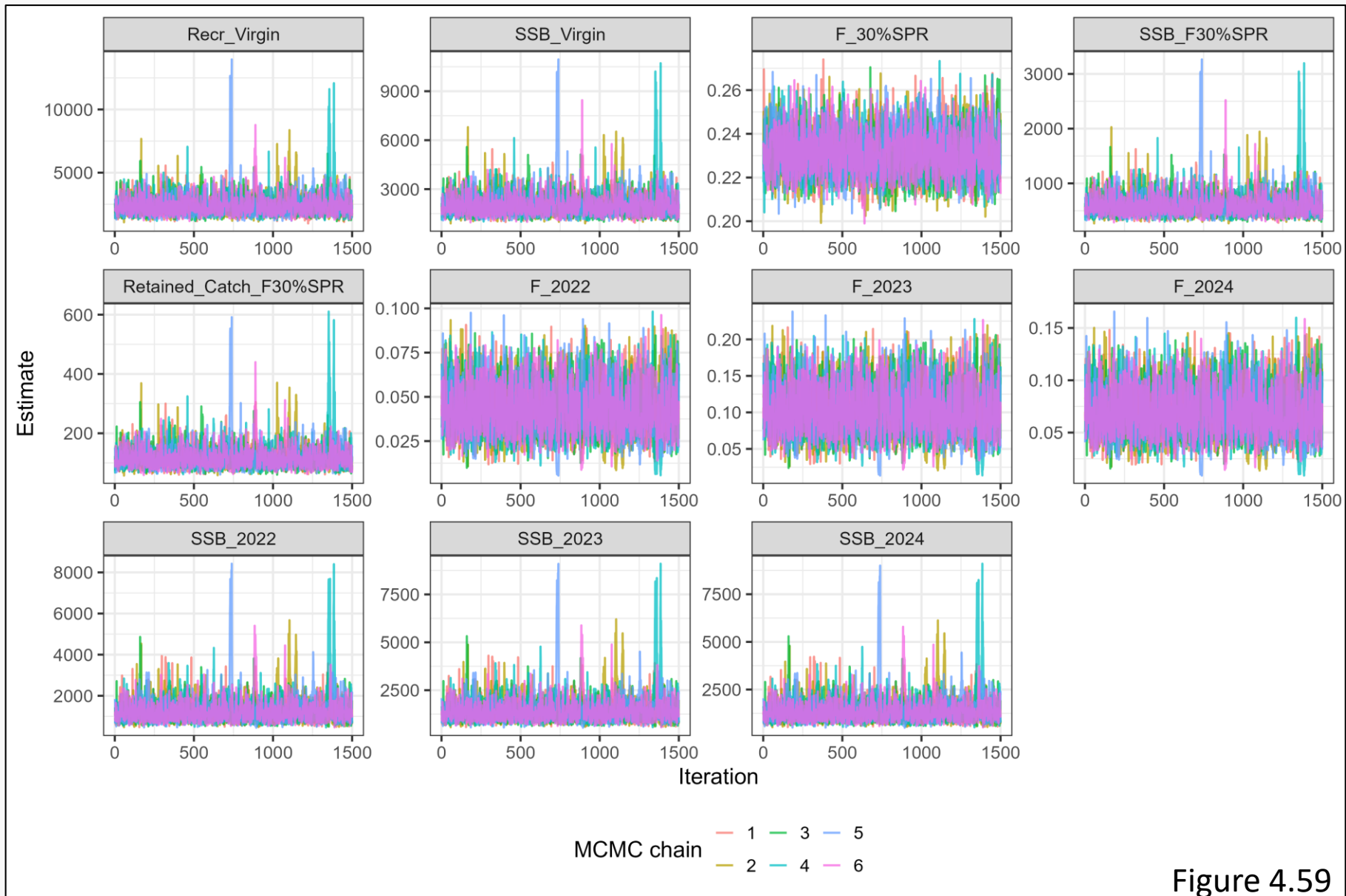


Figure 4.59

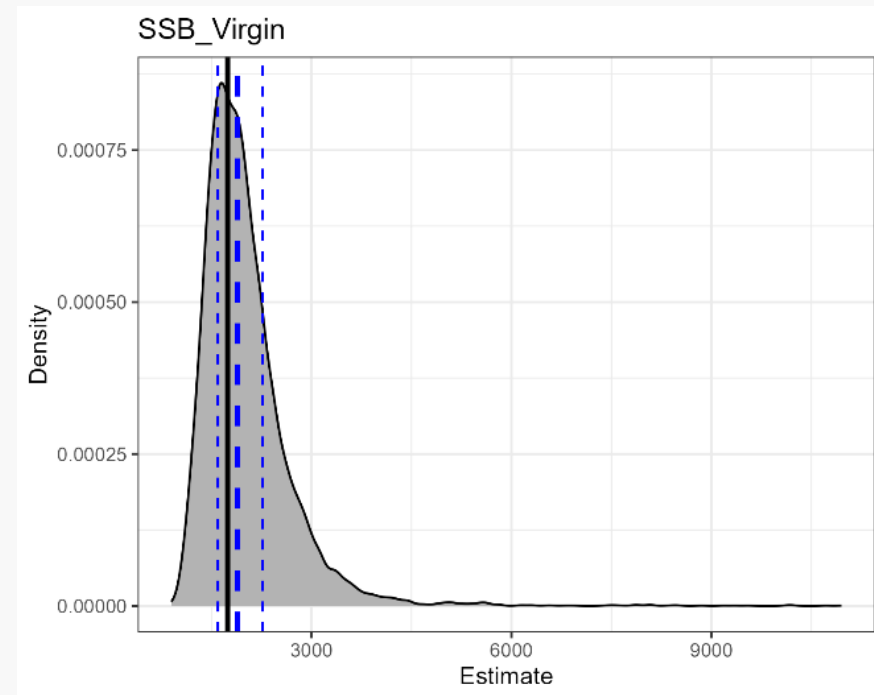
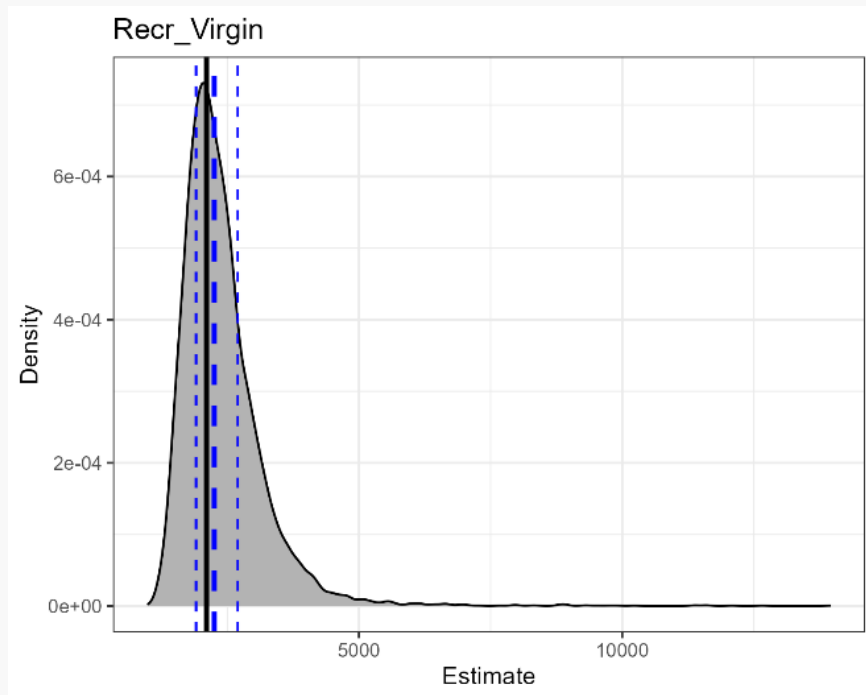


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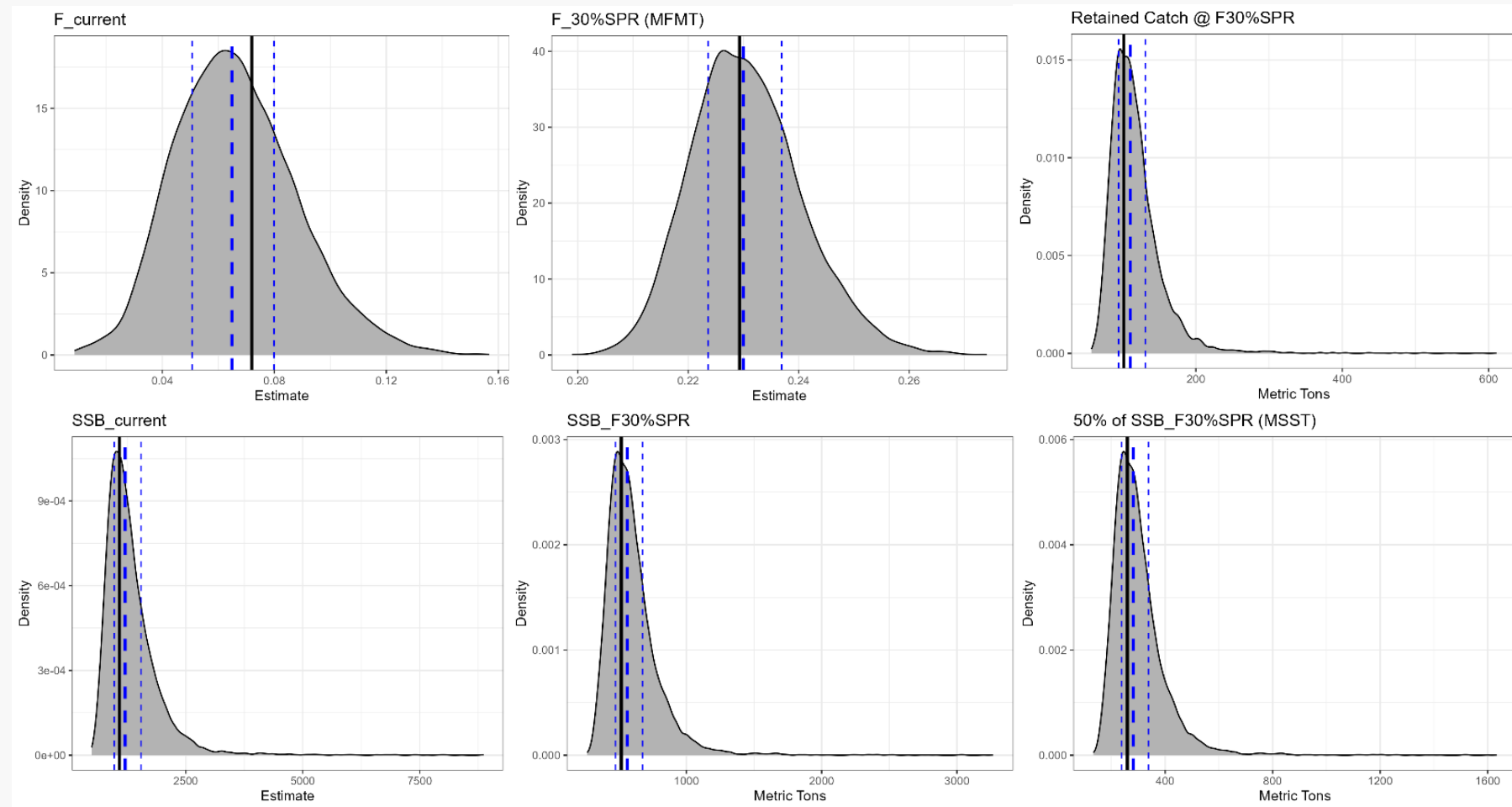


Figure 4.61

Parametric Bootstrap

- Bootstrapping in SS
 - “An internal parametric bootstrap function generates a simulated data set by parametric bootstrap sampling the **expected values given the input observation error.**” (Section 12.8 SS Manual)
 - Causes some mismatch between *observed* values and distribution medians when model doesn't fit observed data well.
- WFS
 - 500 bootstrapped datasets
 - 490 runs with gradient >0.0001
 - 34% of runs had at least one parameter on bounds
 - WFS base model estimates fell within the interquartile ranges of selected parameter estimates and derived quantities distributions

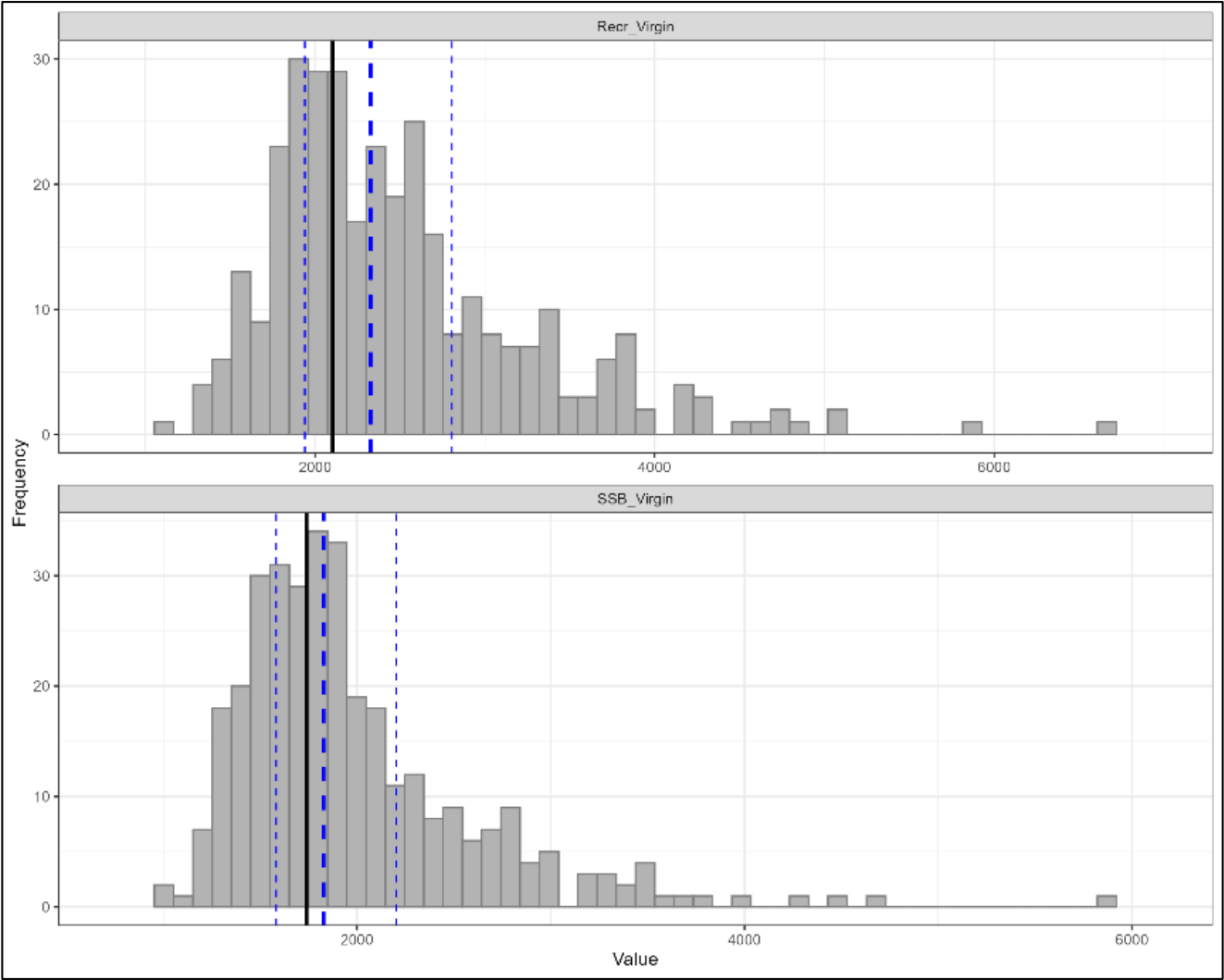


Figure 4.62



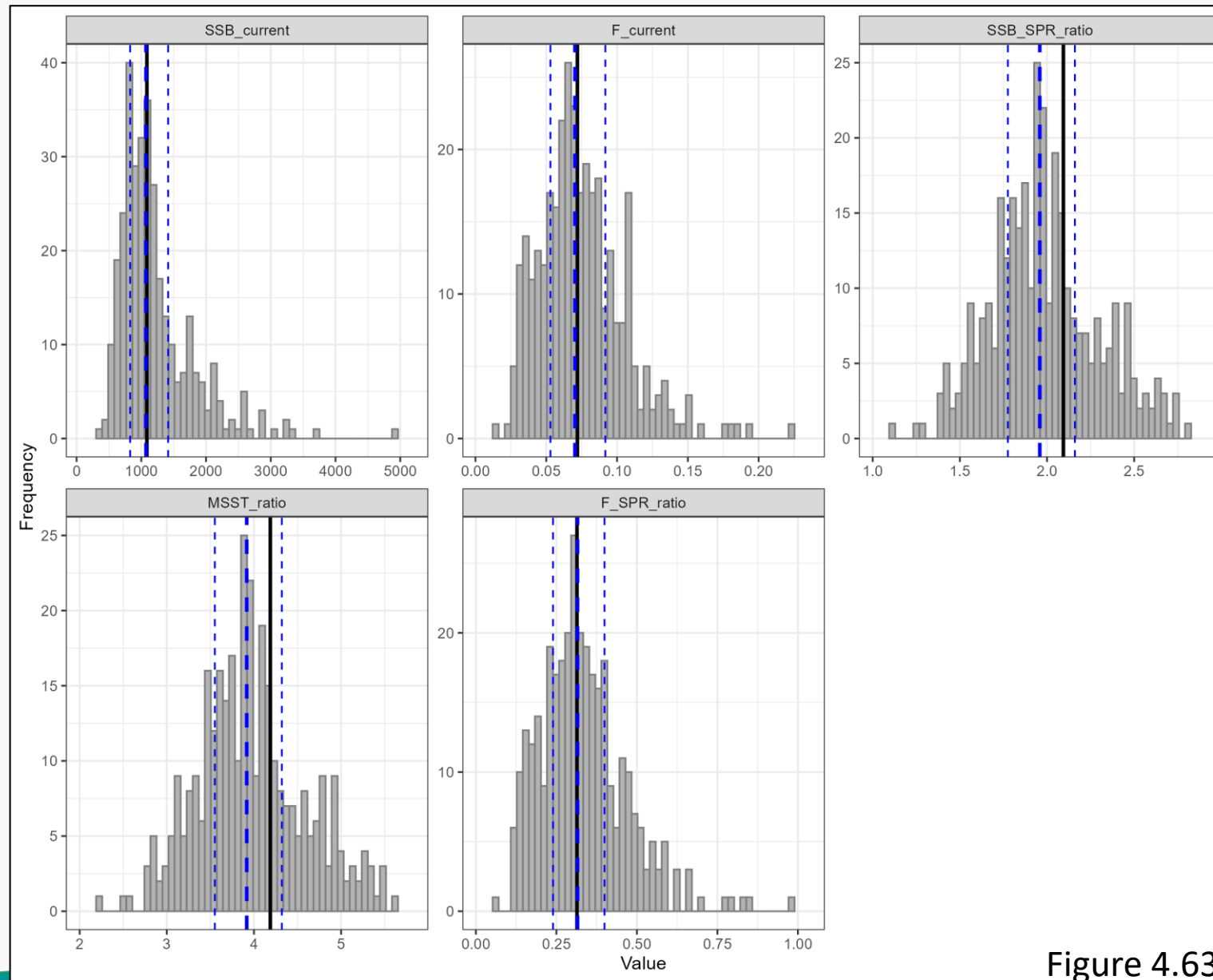


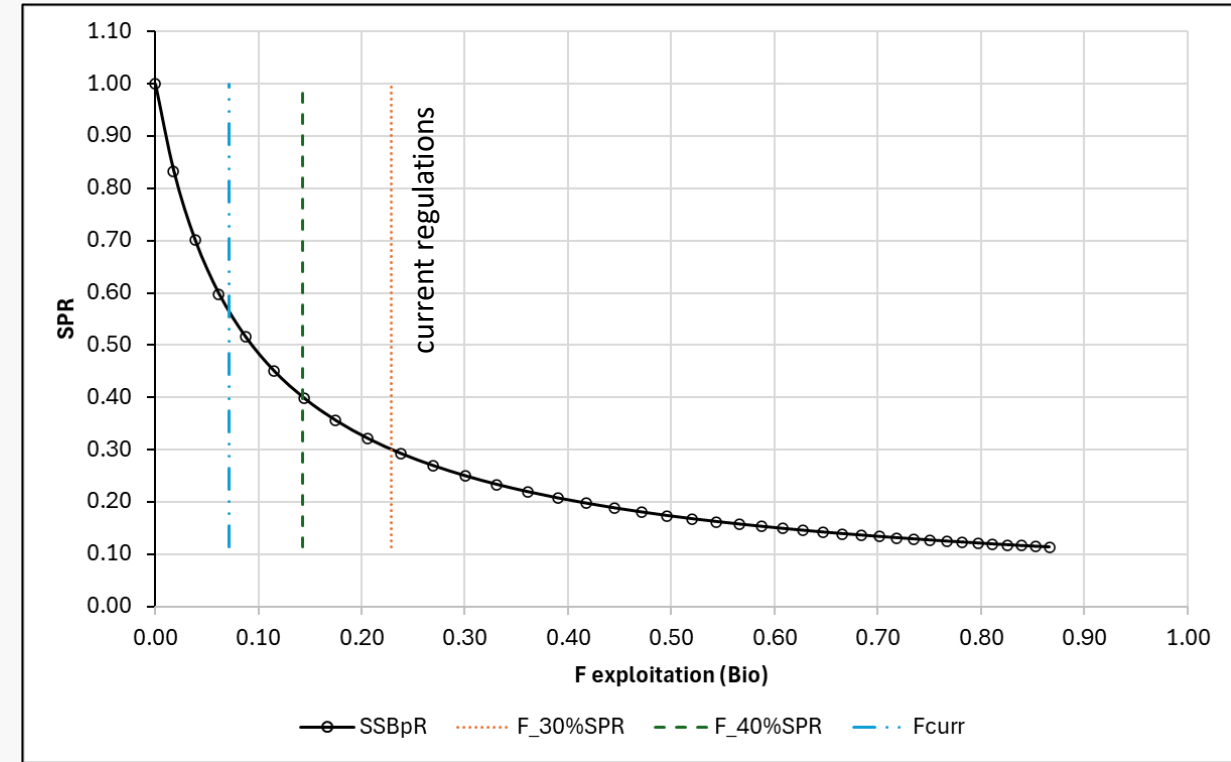
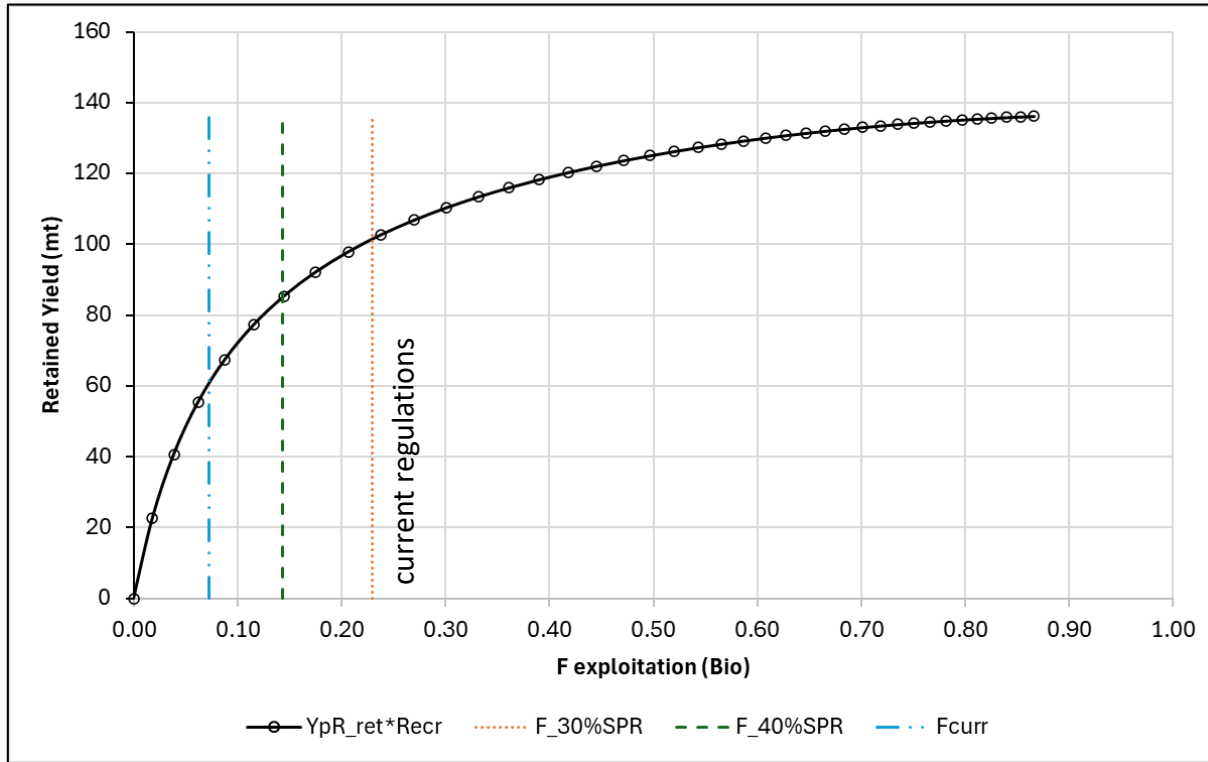
Figure 4.63

SEDAR 94: Florida Hogfish

Stock Status Overview



Yield- and Spawner-per-recruit



** steepness (h) = 0.99 **

Figure 4.57

Stock Status Determination Criteria

TOR 5

- *“Provide estimates of yield and productivity. Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models.”*

TOR 6.1 – 6.2

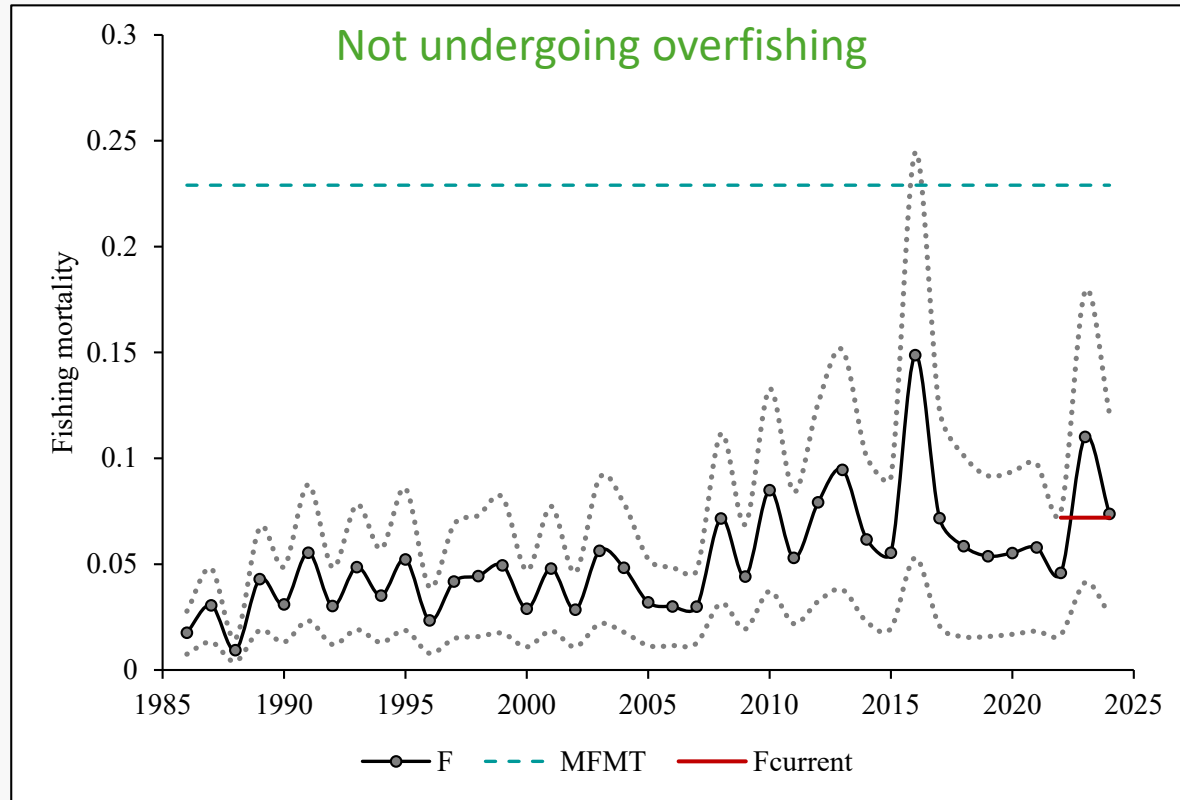
- *“Evaluate existing or proposed management criteria as specified in the management summary.”*
- *“Review and provide recommendations for proxy values (e.g. MSY) when necessary, and provide appropriate justifications.”*
 - Currently F30%SPR proxy values are used for both stocks

Gulf Council			
Criteria	Definition	40% SPR	30% SPR
MSY	The retained yield at F_{MSY} or $F_{SPR \text{ proxy}}$	85.098 mt (187,608 lbs.)	101.489 mt (223,745 lbs.)
$F_{MSY \text{ or proxy}}$	The fishing mortality rate associated with MSY or SPR proxy	0.143 yr ⁻¹	0.229 yr ⁻¹
MFMT (Maximum Fishing Mortality Threshold)	$F_{MSY \text{ or SPR proxy}}$	0.143 yr ⁻¹	0.229 yr ⁻¹
$SSB_{MSY \text{ or proxy}}$	The estimated spawning stock biomass associated with F_{MSY} or $F_{SPR \text{ proxy}}$	693.335 mt (1,528,542 lbs.)	518.900 mt (1,143,979 lbs.)
MSST (Minimum Stock Size Threshold)	0.50 * $SSB_{MSY \text{ or FSPR proxy}}$	346.668 mt (764,271 lbs.)	259.450 mt (571,989 lbs.)
$OY_{\text{Gulf Council}}$ (Optimum Yield)	<i>0.90*MSY or 30% SPR?</i>		

Gulf Council		
Criteria	Definition	Value
F_{current} (recent average fishing mortality rate)	The geometric mean of F exploitation for 2022 - 2024	0.072 yr ⁻¹
SSB_{current} (recent average SSB)	The geometric mean of SSB for 2022 - 2024	1,086.509 mt

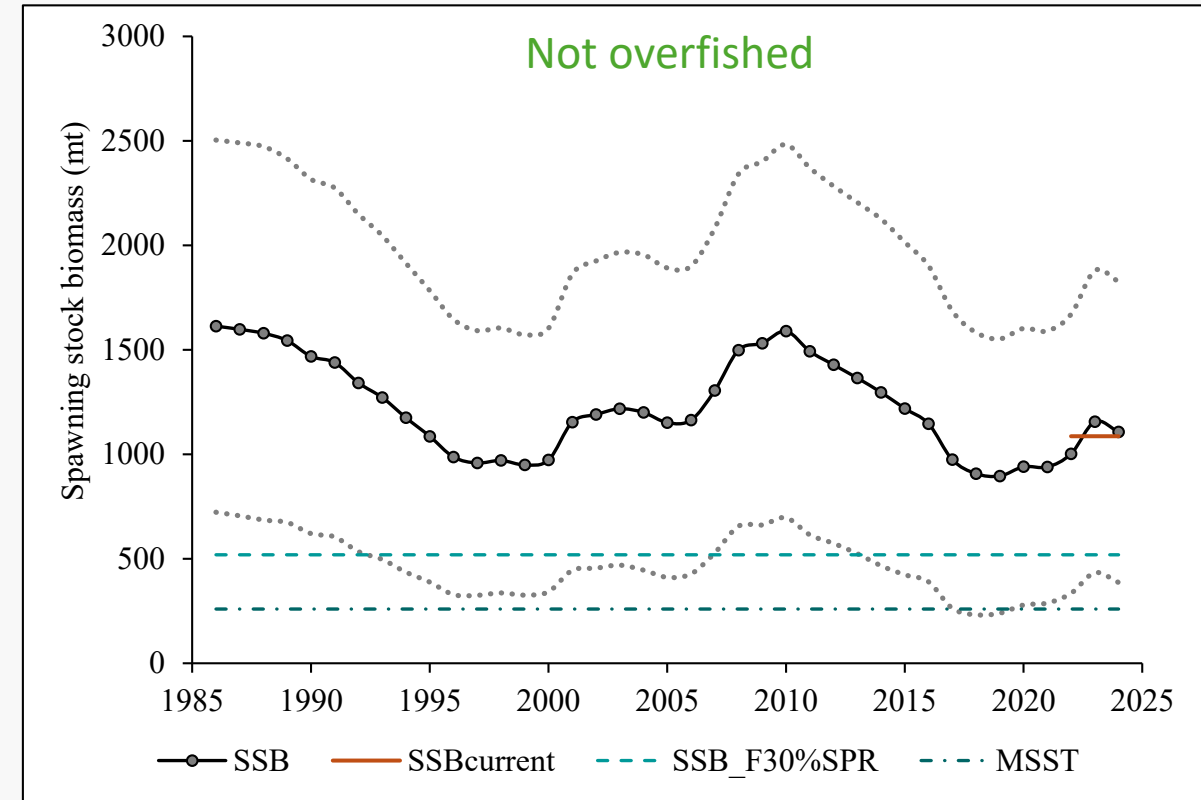
Stock Status

SPR-based reference points



$$F_{\text{current}}/F_{30\% \text{ SPR}} = 0.229$$

Figure 4.64

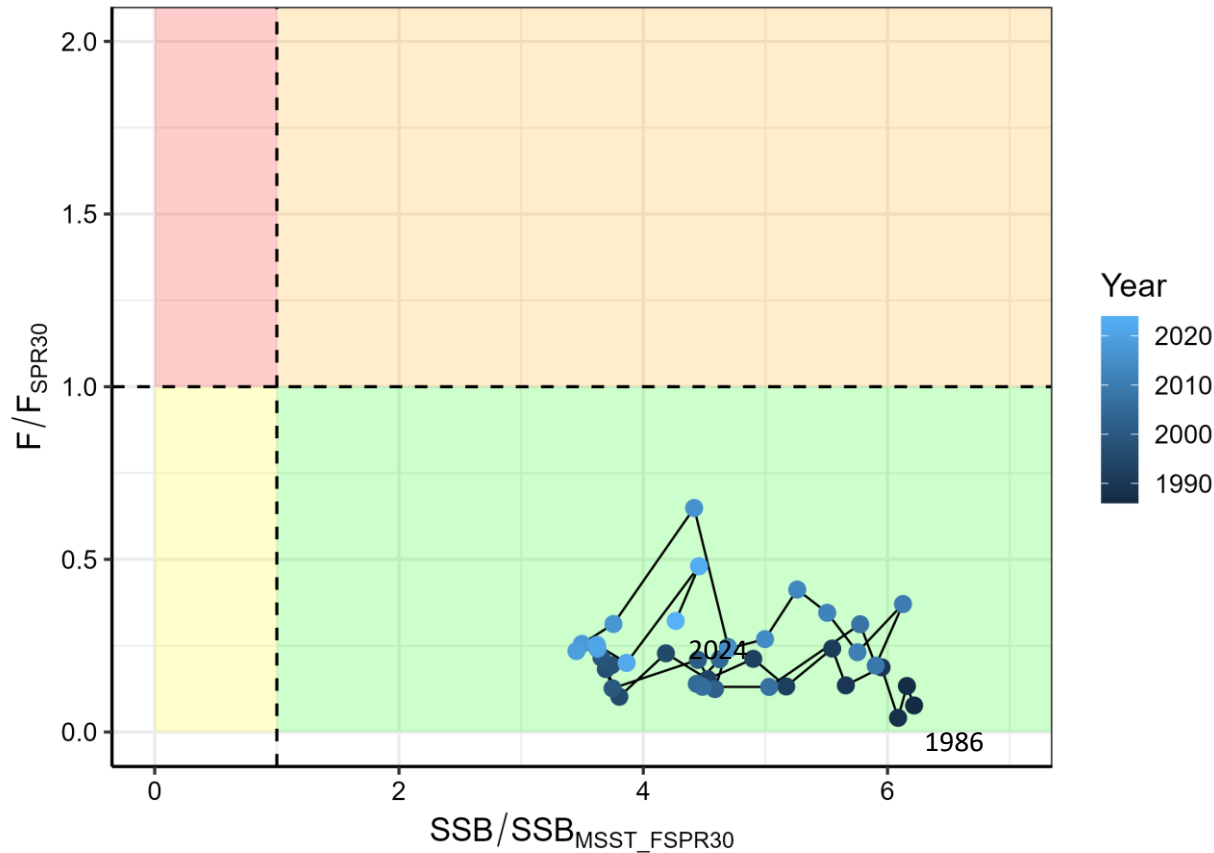


$$SSB_{\text{current}}/MSST = 4.188$$

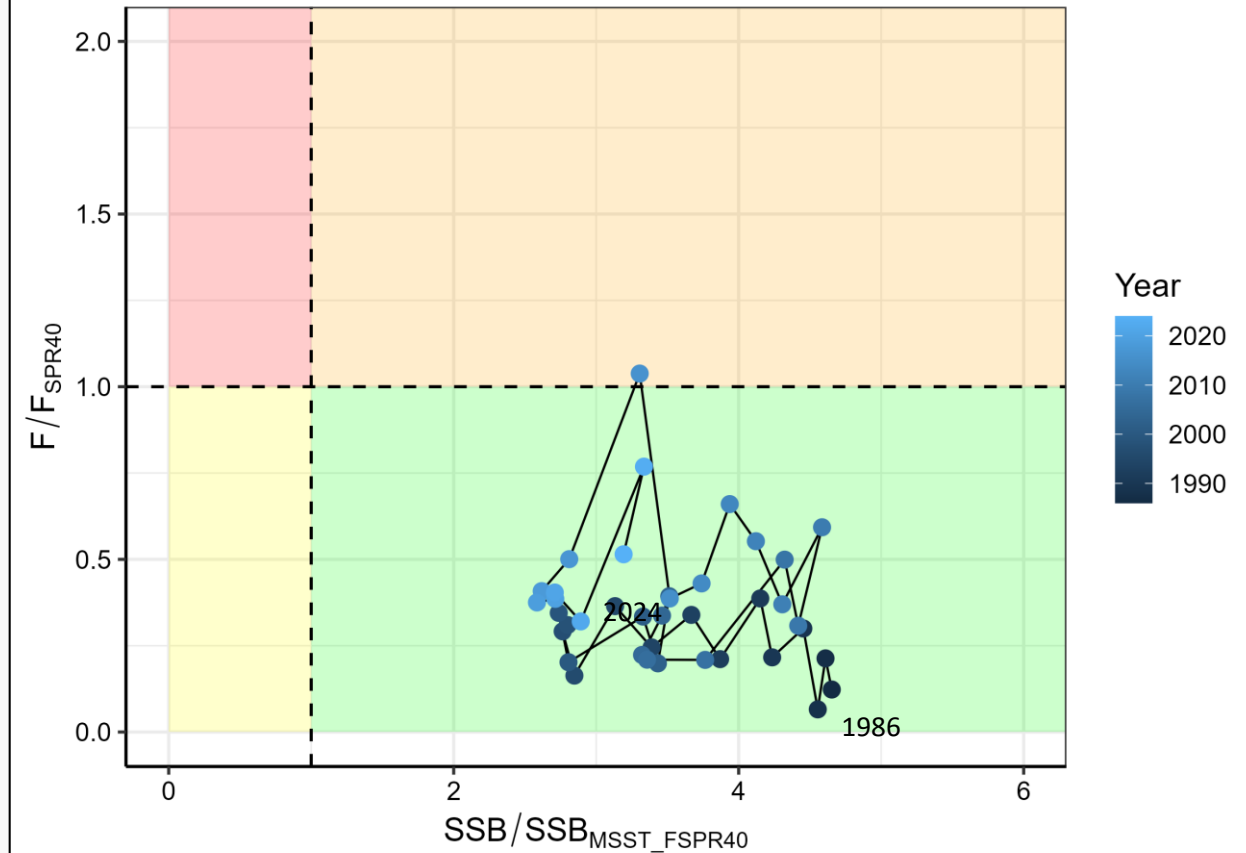
Figure 4.65

Stock Status

SEDAR 94 WFS Hogfish Kobe Phase Plot

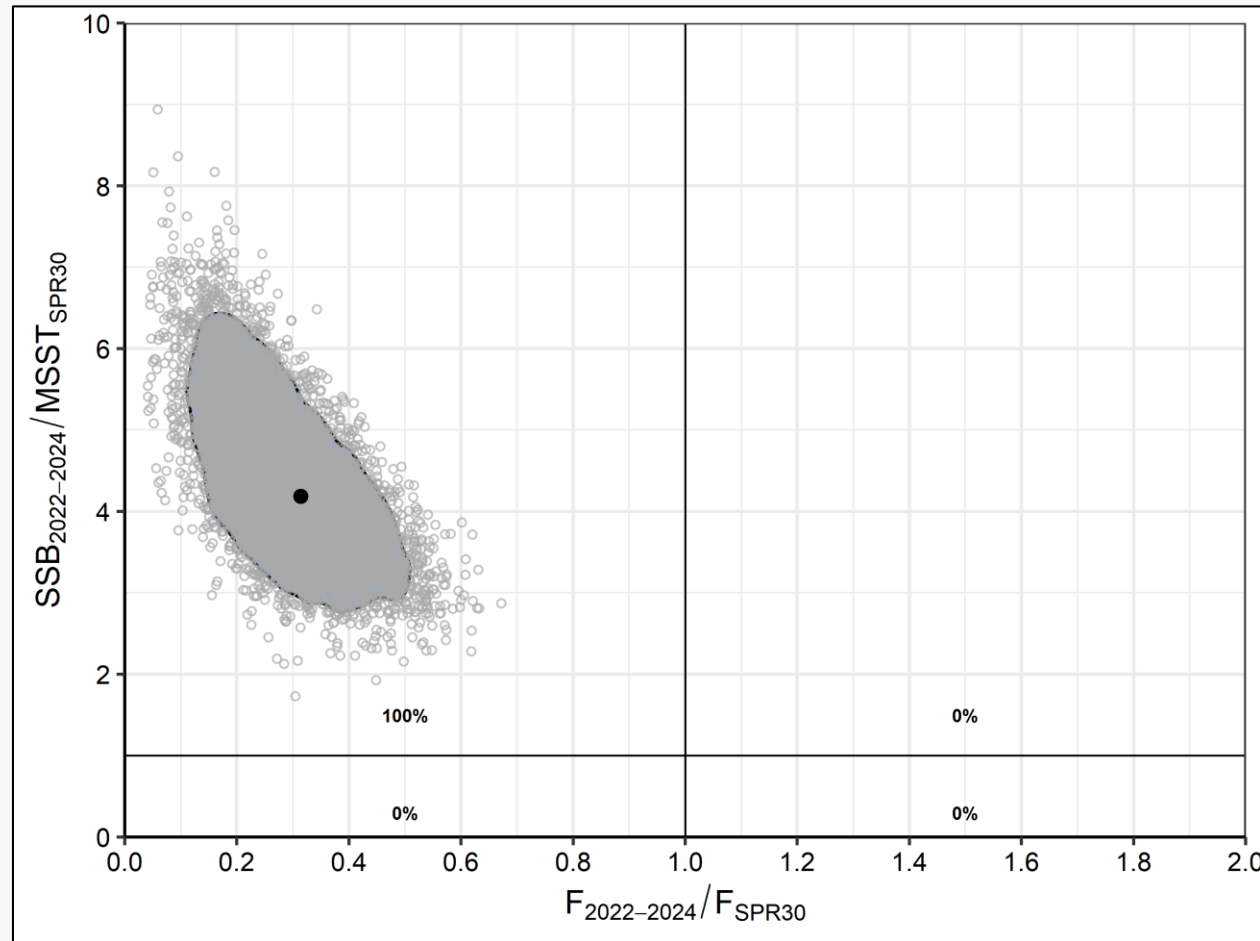


SEDAR 94 WFS Hogfish Kobe Phase Plot



Stock Status

Phase plot of the terminal estimates based on the MCMC from the WFS base model



S94: Florida Hogfish Bridge Building



Continuity Models

TOR 2.2

- *“Provide a continuity model consistent with the prior benchmark (SEDAR 37) and update (SEDAR 37U) assessment configurations, **if one exists**, updated to include the most recent observations. **Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered.**”*
- *Provide additional continuity models which update these prior assessment’s configurations and terminal years with ~~MRIP-FES~~ (SRFS) landings and discards.”*
- Strict continuity models largely unreproducible
 - Large changes to data streams (e.g., MRFSS to MRIP to SRFS, no COM discards, COMB_VIDEO design changes, no BAITFISH survey, no FD surveys [except WFS MRIP HL])
- We took the S37AU assessment model and updated to S94 configuration



WFS Continuity Model

Objective: SEDAR 37AU base model data incorporating SEDAR 94 configuration

Key Configuration Changes to S37U:

- SS model version 3.24 to 3.30
- Combine 3 Comm fleets into 1 Comm Fleet
- Add regulatory time block in 2000
- Indices: Remove all FD and Baitfish
- Selectivity – Time Varying with regulatory block – all fleets/surveys double normal except Video (single logistic)
- Apply Francis weighting on length comps
- Added 3 growth platoons
 - Fixed Platoon Standard deviation ratio S94
- Used natural mortality, growth, maturity, hermaphroditism configs from S94
- Fixed Steepness at 0.99
- Fixed growth
- Estimate SigmaR
- Number of ages from 23 to 18
- Don't estimate early recruitment deviation
- Estimate initial F for REC_SP
- Add super periods



WFS Continuity Model Comparison

	SEDAR 37AU Base	S37 Data S94 Config	SEDAR 94 Base
Model years	1986-2016	1986-2016	1986-2024
Fleets	Comm HL Comm Spear Comm Trap Rec HL Rec Spear	Gen Comm Rec HL Rec SP	Gen Comm Rec HL Rec SP FI_life_history_sp
Indices	Comm HL Comm Spear Rec HL Rec Spear Baitfish SEAMAP Trawl Comb Video Seagrass Trawl	Seagrass Trawl SEAMAP Trawl Comb Video	Seagrass Trawl SEAMAP Trawl Comb Video
Total Log Likelihood	2785.02	321.459	916.605
Gradient	7.58411e-005	1.72e-05	0.000544254
Steepness	0.86	0.99 (fixed)	0.99 (fixed)
R0	6.10	6.66	7.65

WFS Continuity Model Comparison

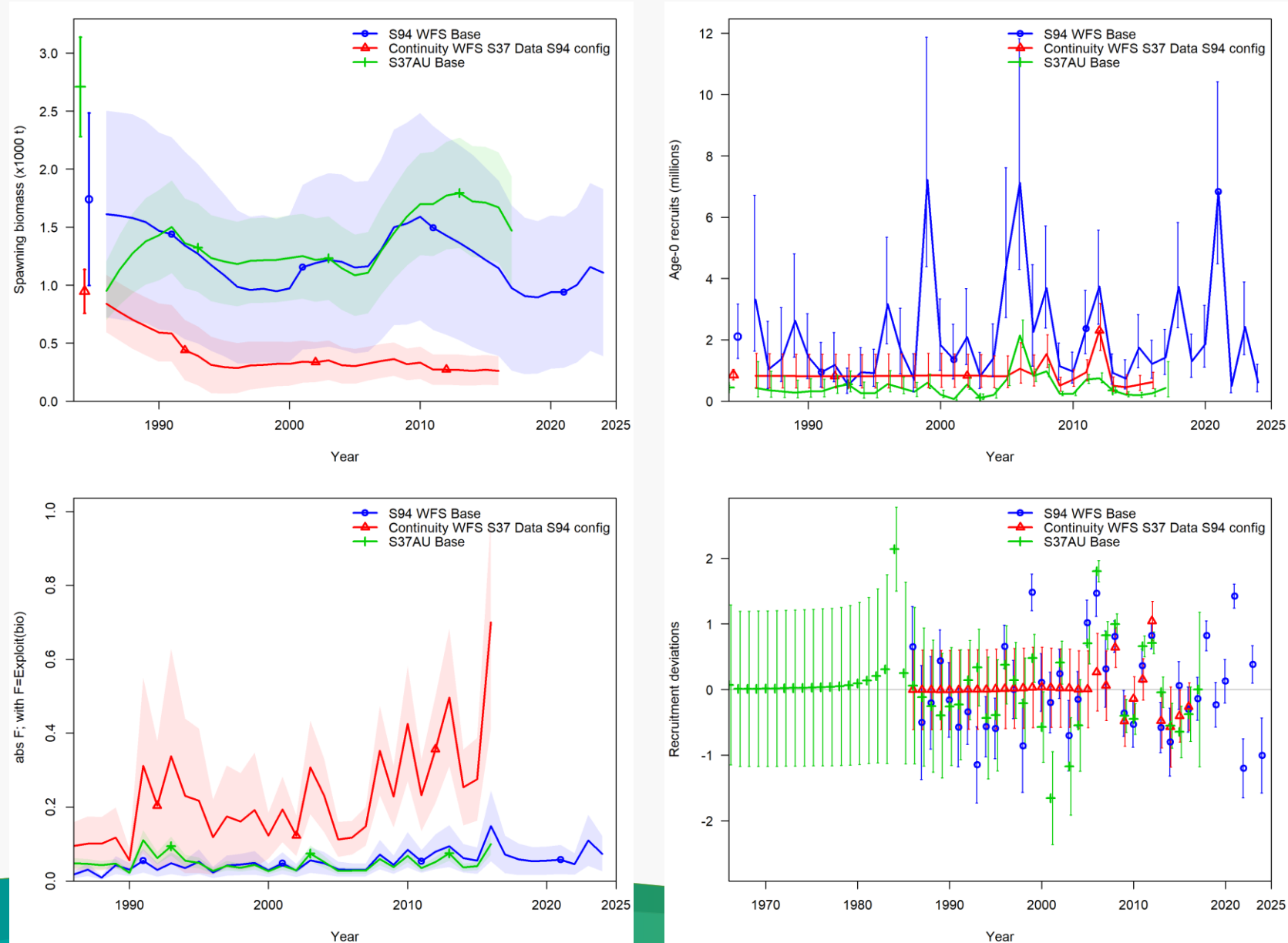
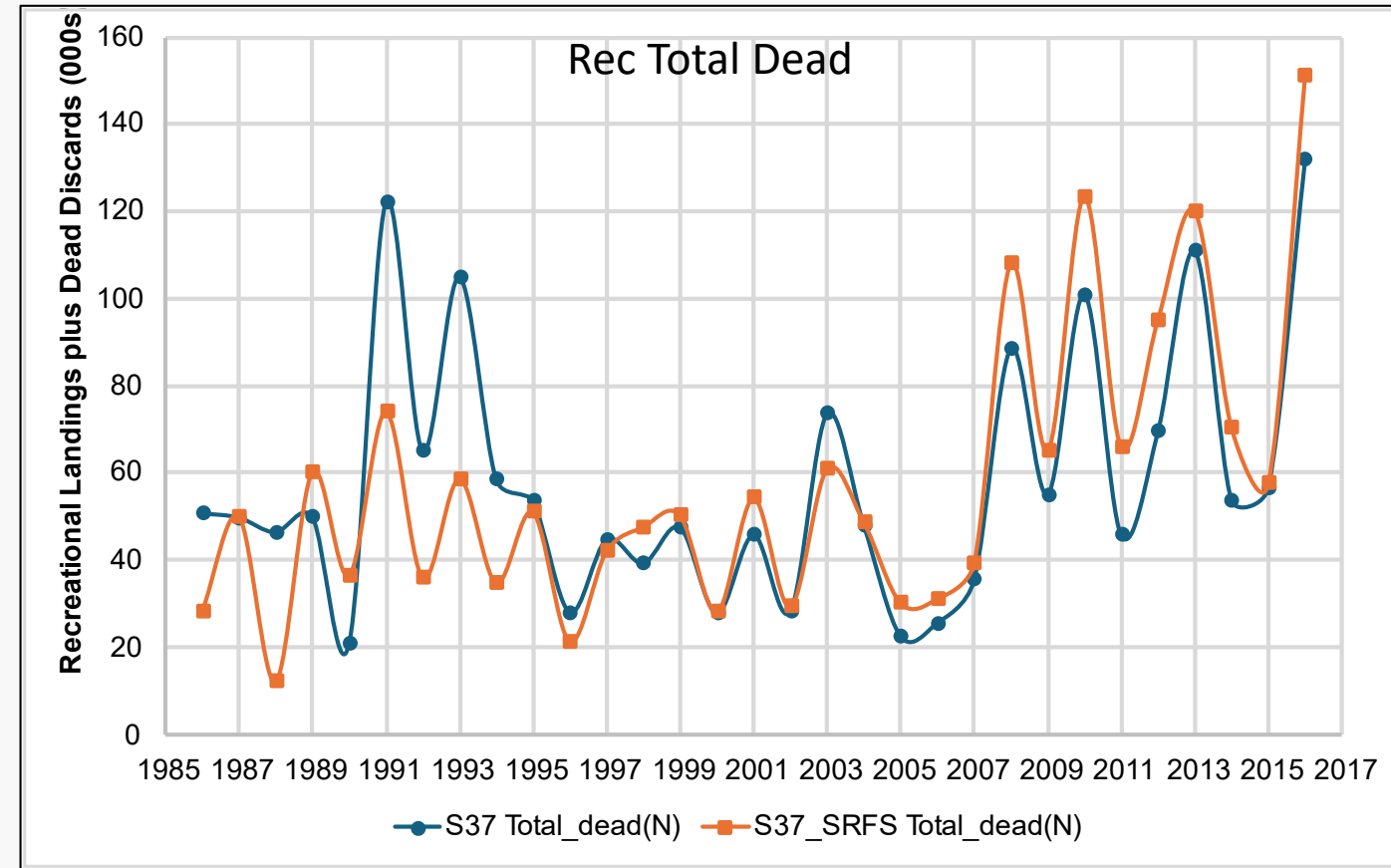
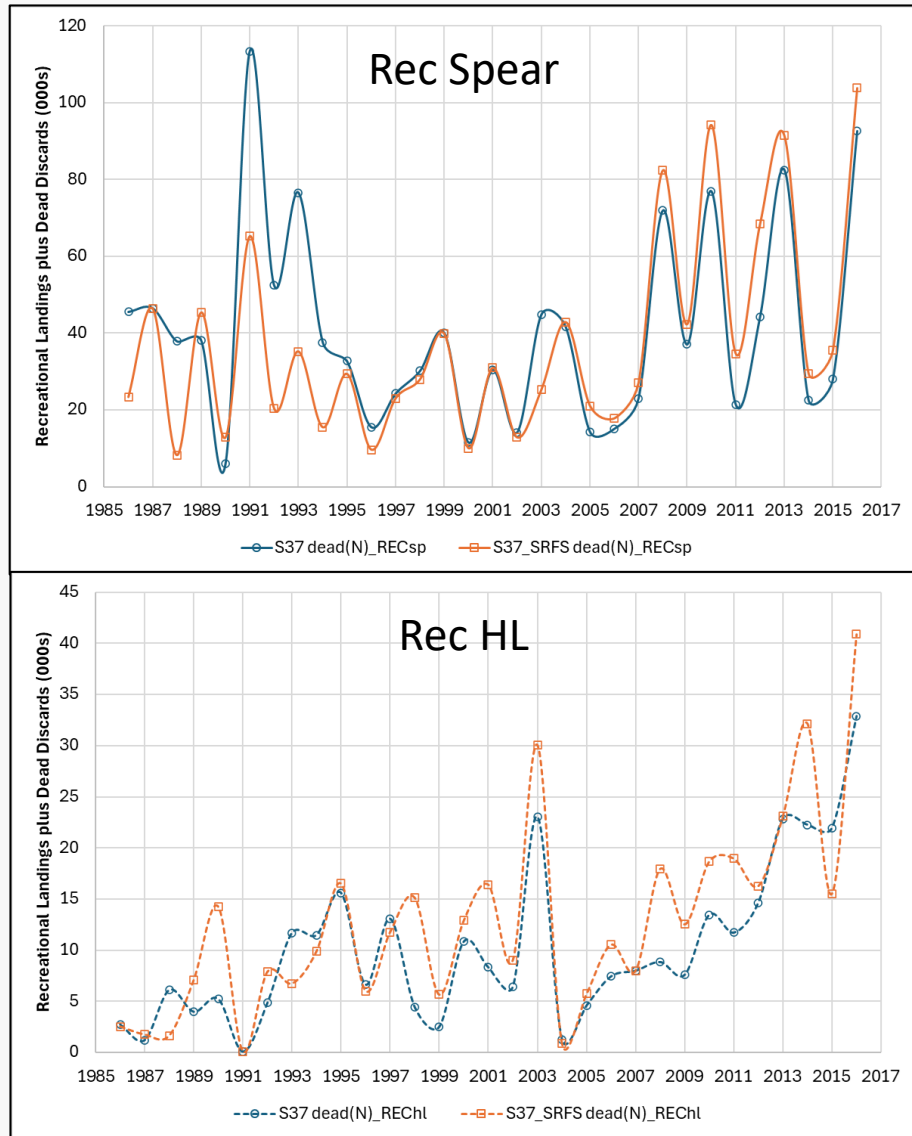


Figure 4.67

WFS S37AU with SRFS-Calibrated Landings



** S37 in CHTS units **

Figure 4.68



WFS S37AU with SRFS-Calibrated Landings

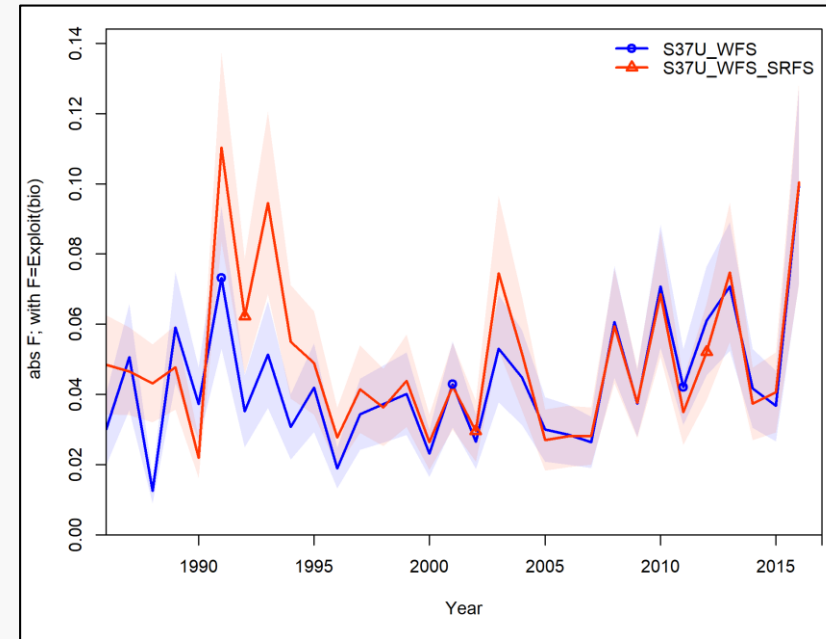
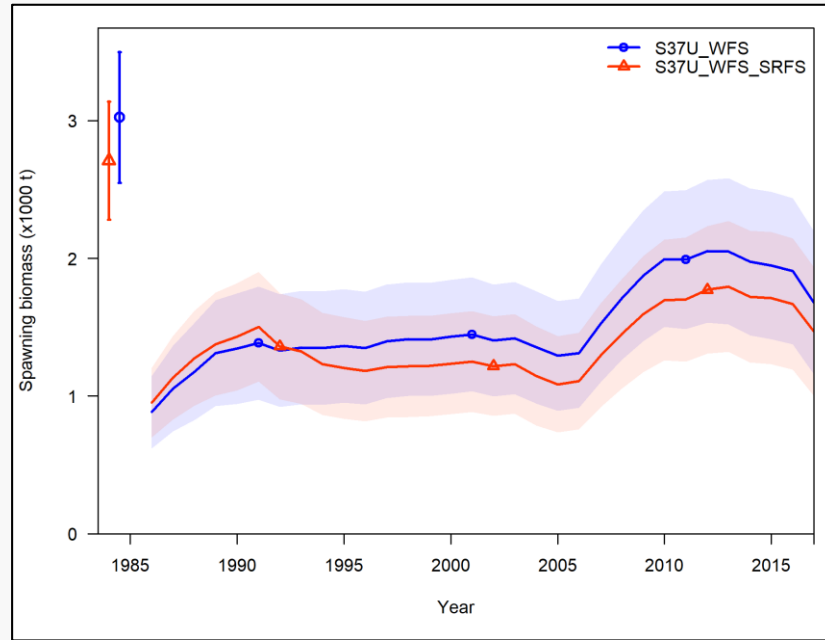
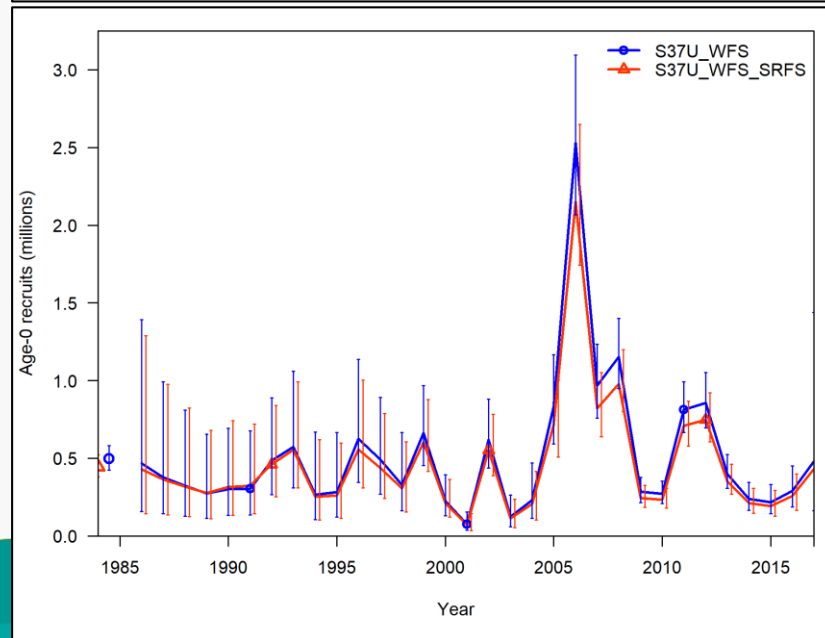


Figure 4.69



Thank You!

