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SEDAR 96: Southeastern U.S. Yellowtail Snapper

Joint SSC Meeting

February 25, 2025

Christopher E. Swanson

FWRI Stock Assessment Group, St. Petersburg, FL





Outline

Part 1

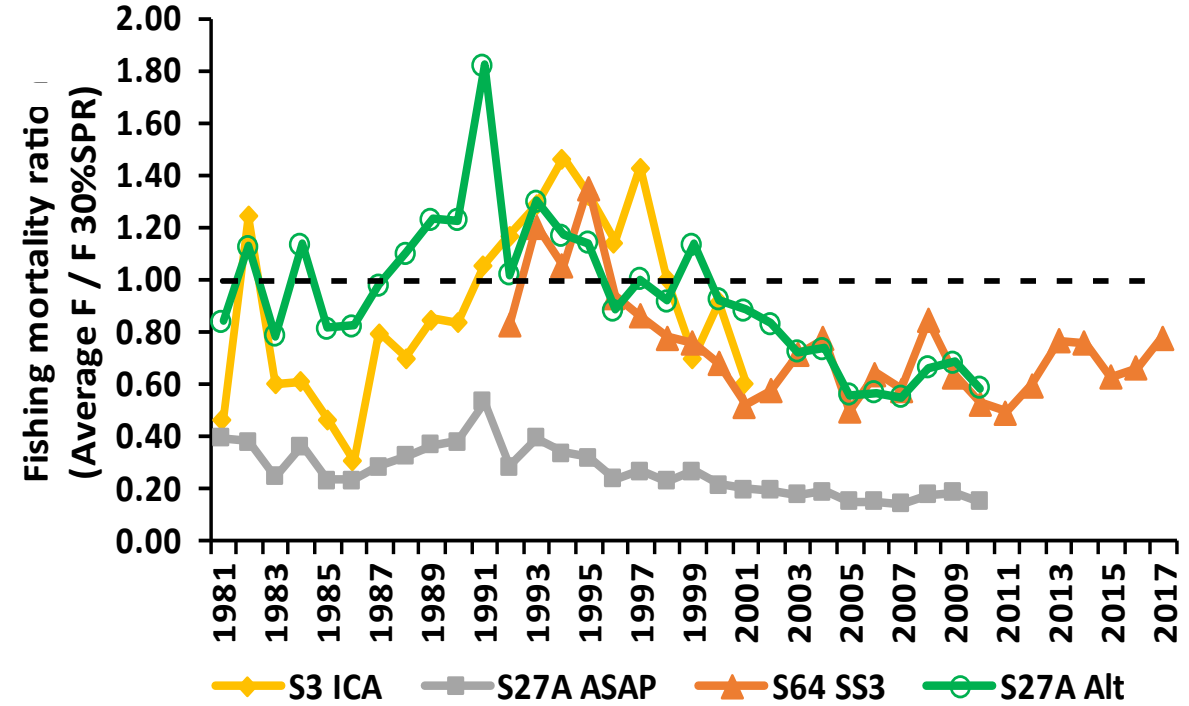
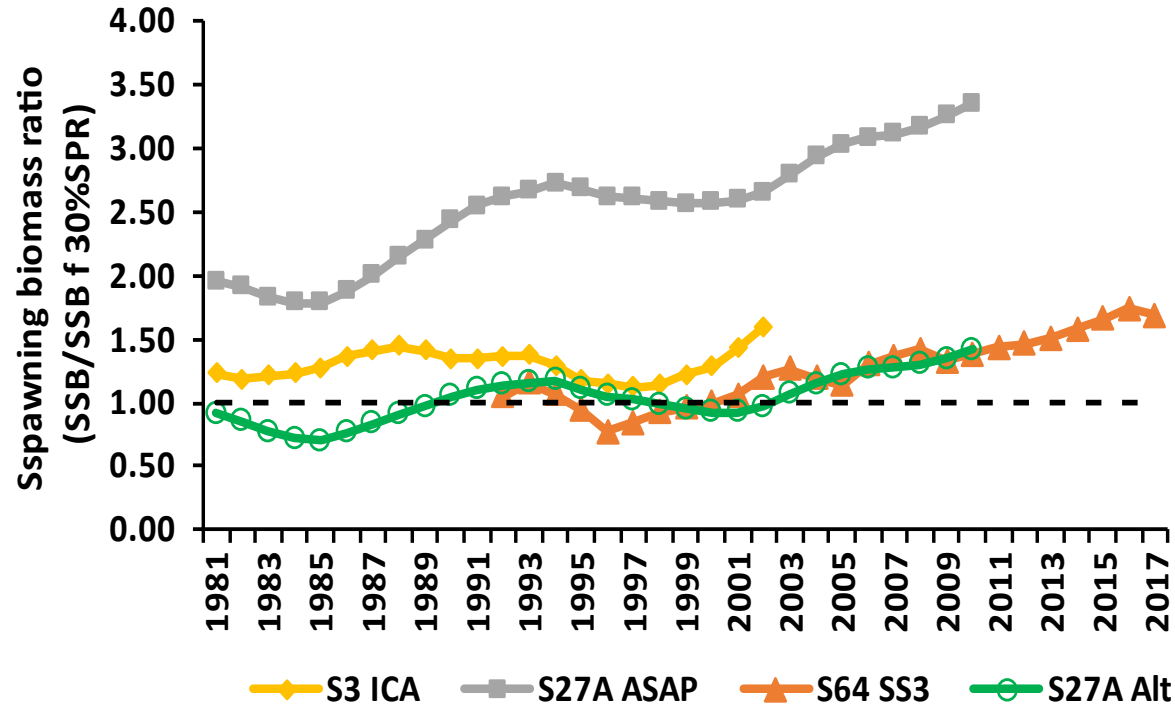
- Orientation: assessment and quota history
 - Updates to the data
 - Updates to model configuration
 - Model results
-

Part 2

- Model diagnostics
- Model uncertainty
- Stock status overview
- Bridge building



S64 Model Bridging



Model	Description
S3 ICA	SEDAR 3 Final Model
S27A ASAP	SEDAR 27A Final Model
S27A Alt	Alternative SEDAR 27A Model with additional weight at age matrices
S64 SS3	SEDAR 64 Final Model



Quota History

Date	Total ACL
1/30/2012 – 11/2012	2,898,875 lbs. (1,315 mt)
9/3/2013 – present	3,938,625 lbs. (1,787 mt) ←

South Atlantic (77%)

	Date	ACL
Commercial	Apr 2012 – Nov 2012	1,142,589 lbs.
	Nov 2012 – Current	1,596,510 lbs. ←
Commercial Closures	10/31/2015 – 12/31/2015	
	6/3/2017 – 7/31/2017	←
	6/5/2018 – 7/31/2018	
	6/7/2019 – 7/31/2019	
	Apr 2012 – Sept 2013	1,031,286 lbs.
Recreational (CHTS)	Sept 2013 – Current	1,440,990 lbs. ←

Gulf of Mexico (23%)

	Date	ACL
Commercial and Recreational (CHTS)	Jan 2012 – Sept 2013	725,000 lbs.
	Sept 2013 – Current	901,125 lbs. ←



SEDAR 96: Yellowtail Snapper
Data

Term of Reference #1

“Update the SEDAR 64 Southeastern U.S. Yellowtail Snapper base model (including modifications approved in the 2022 Interim analysis) with data through 2023.

- Explore the State of Florida’s State Reef Fish Survey (SRFS) to inform private recreational landings data and consider its use in the current assessment.*
 - Document any changes or corrections made to model and input datasets and provide updated input data tables.*
 - Update life history data (e.g., growth, reproduction, natural mortality) if warranted.”*
- As was determined for the S64 benchmark assessment, only data from Florida waters were considered as input.



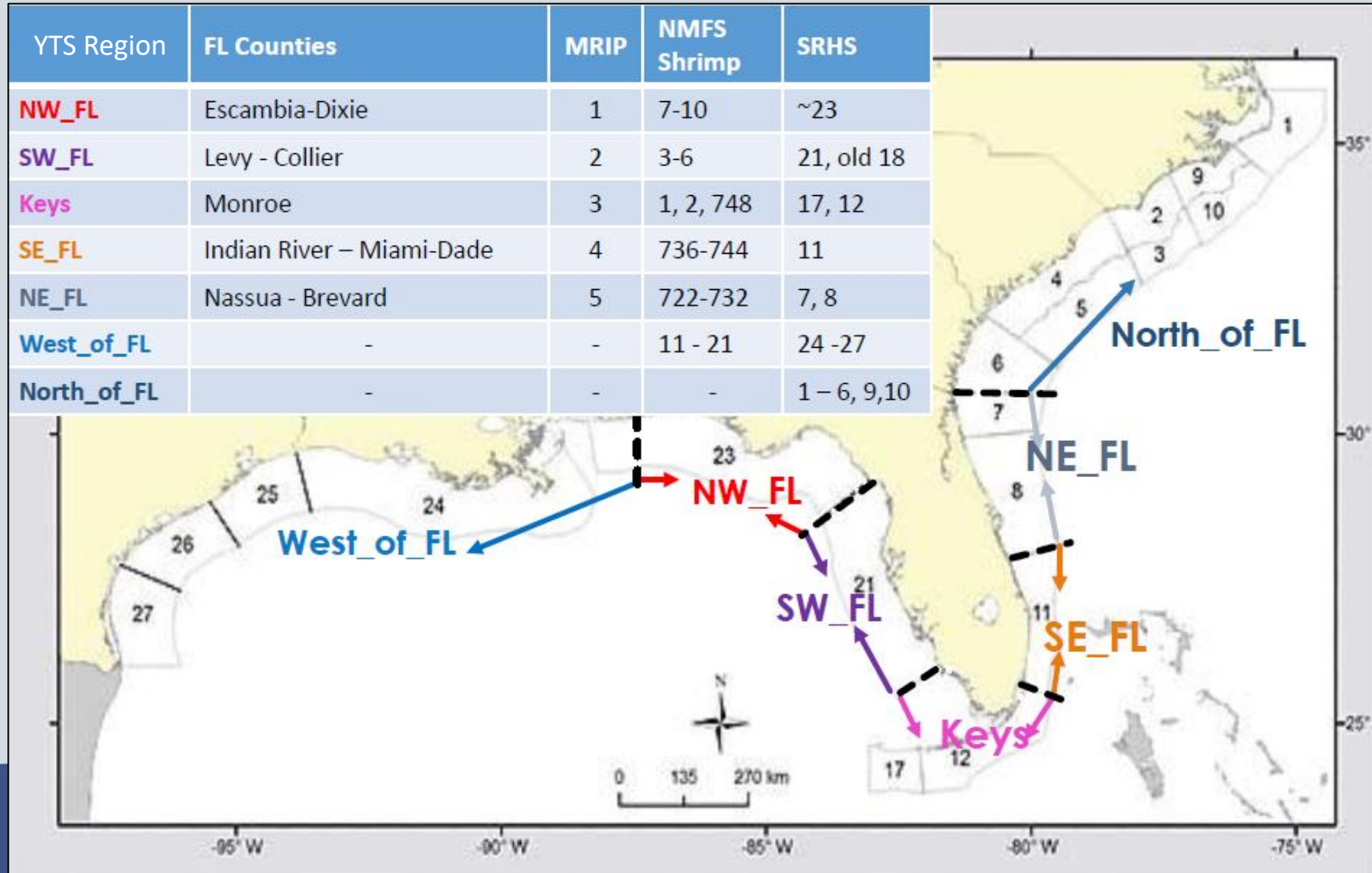
Changes to data

“Document any changes or corrections made to model and input datasets and provide updated input data tables.” (TOR #1 sub-bullet 2)

- Landings
 - Commercial (numbers): how mean weights from TIP were spatio-temporally aggregated to meet sample size
 - Recreational private mode: MRIP → SRFS (NOAA 2022)
- Discards
 - Commercial: logbook → observer (Alhale et al. 2024)
 - Headboat: ‘super-ratio’ → ‘SRHS-Mean’
- Indices
 - Commercial: changes to positive submodel error distribution, updated data impacting Stephens and MacCall subsetting
 - MRIP: total catch per angler → total catch per trip (sensitivity run in Interim Analysis)
 - RVC: separate juvenile and adult combined FL Keys and DRTO → separate FL Keys and DRTO combined juvenile and adult



Regions of Florida





SEDAR 96: Yellowtail Snapper
Data: Life History

Otolith subsampling routine (2,439 aged)

Table 6

Region	Fishery	YTS Region	Avg. Landings** (2016 - 2020)	Proportion	Subsample Target	Available	2021	Aged	2022			2023		
							Subsampled		Available	Subsampled	Aged	Available	Subsampled	Aged
Florida	Commercial	NE	201	0.0001	0.0	35	0	0	18	0	0	3	0	0
		SE	41,524	0.0193	5.8	38	6	6	70	6	6	120	6	6
		KY	2,090,976	0.9715	291.5	269	269	257	1,630	291	291	957	291	291
		SW	19,451	0.0090	2.7	101	3	3	161	3	3	239	3	3
		NW	63	0.0000	0.0	17	0	0	5	0	0	25	0	0
	Headboat	NE	225	0.0014	0.4	5	0	0	9	0	0	15	0	0
		SE	46,149	0.2815	84.5	232	85	86	484	85	85	977	85	85
		KY	107,518	0.6559	196.8	57	57	43	1,132	197	194	999	197	196
		SW	10,016	0.0611	18.3	12	12	10	36	18	19	51	18	18
		NW	28	0.0002	0.1	0	0	0	0	0	0	0	0	0
	MRIP	NE	2,422	0.0017	0.5	2	0	0	3	0	0	0	0	0
		SE	607,424	0.4284	128.5	145	129	98	263	129	129	328	129	127
		KY	705,717	0.4977	149.3	393	149	145	437	149	140	321	149	142
		SW	102,310	0.0722	21.6	15	15	11	26	22	23	47	22	22
		NW	0	0.0000	0.0	0	0	0	1	0	0	1	0	0



** Landings units: Commercial (pounds), Headboat (numbers), MRIP (numbers)

Otolith subsampling routine (2,439 aged)

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Florida	Commercial	NE	201	0.0001	0.0	35	0	0	18	0	0	3	0	0
		SE	41,524	0.0193	5.8	38	6	6	70	6	6	120	6	6
		KY	2,090,976	0.9715	291.5	269	269	257	1,630	291	291	957	291	291
		SW	19,451	0.0090	2.7	101	3	3	161	3	3	239	3	3
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		SW	10,016	0.0611	18.3	12	12	10	36	18	19	51	18	18
		NW	28	0.0002	0.1	0	0	0	0	0	0	0	0	0
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		NW	0	0.0000	0.0	0	0	0	1	0	0	1	0	0



** Landings units: Commercial (pounds), Headboat (numbers), MRIP (numbers)

Age data

- 74,402 total otoliths sampled
- 71% Florida Keys
- 25% SE Florida
- Ages 2 – 3
 - 50%
- Ages 2 – 6
 - 89%

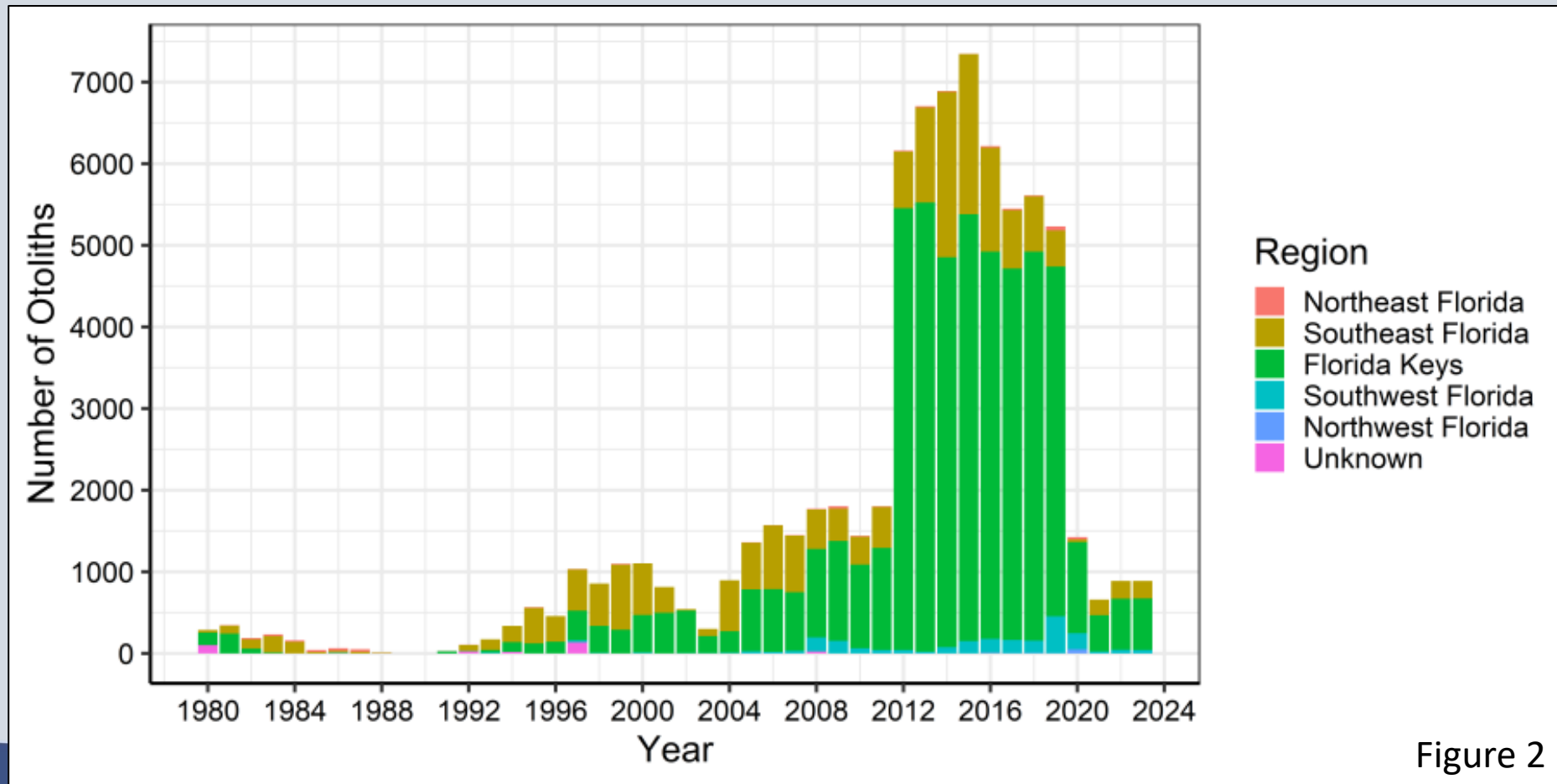


Figure 2



Age data

- Predominantly FD sampling
- 55% Commercial
- 35% Headboat
- 8% MRIP
- 2% FI

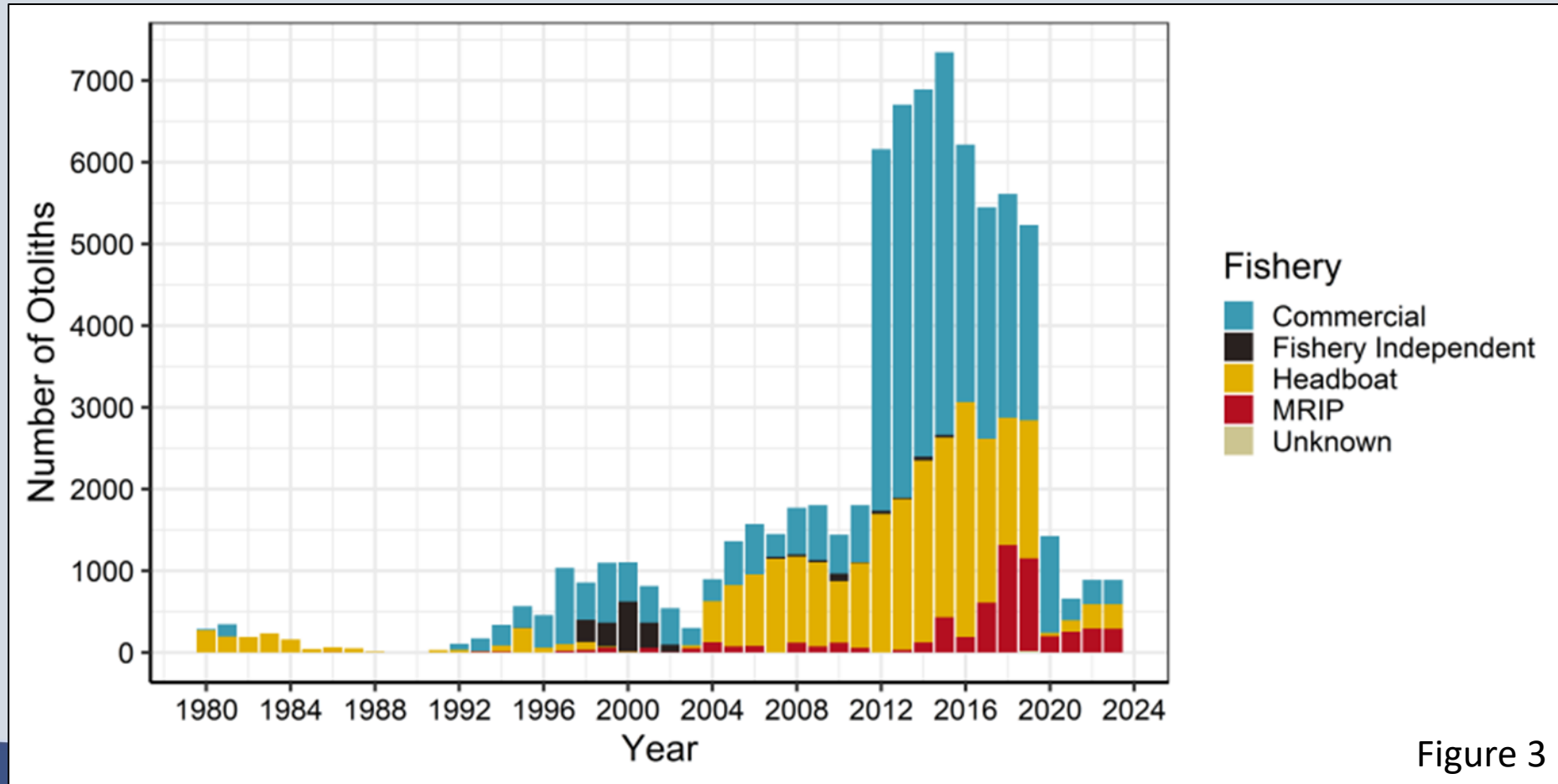
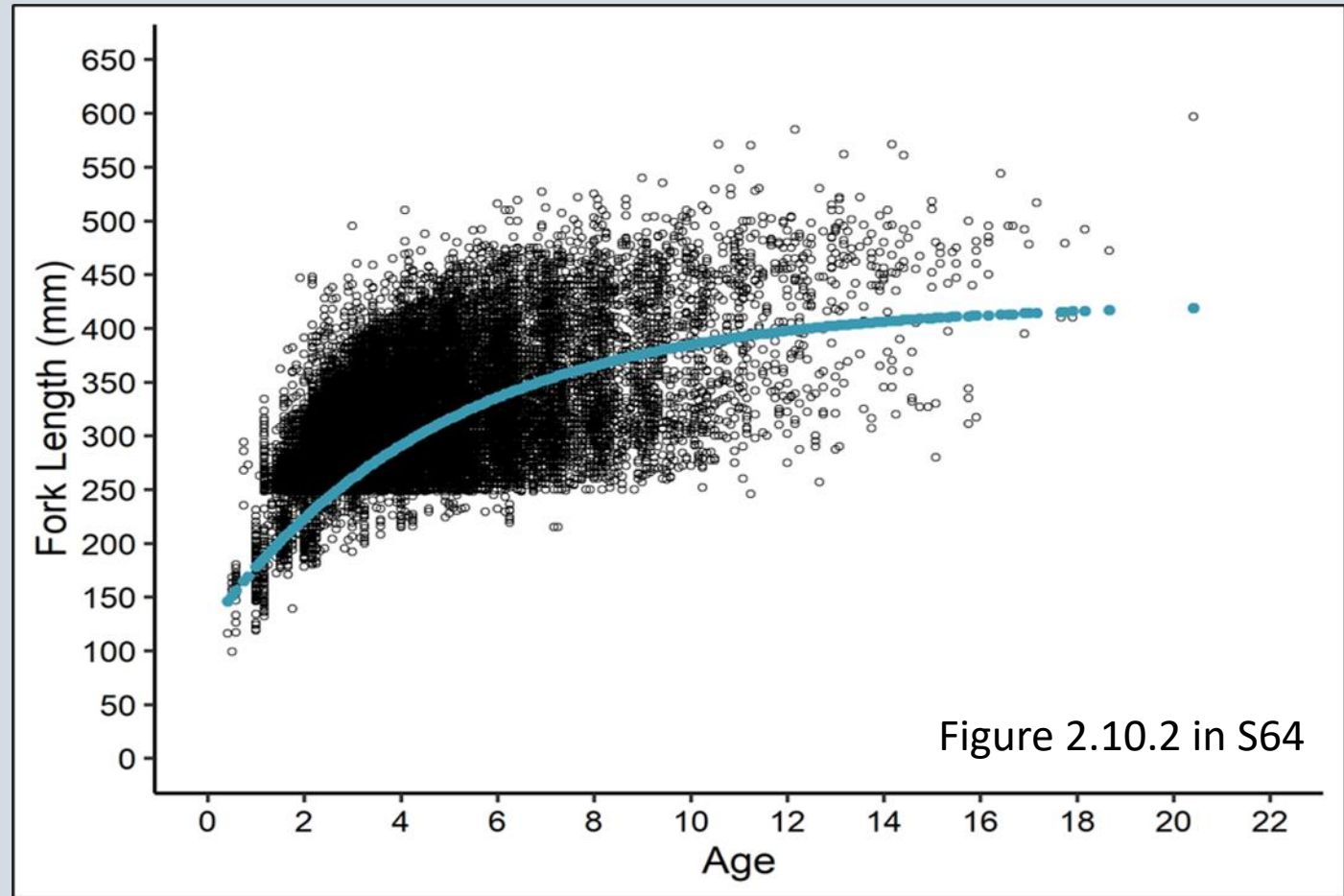


Figure 3



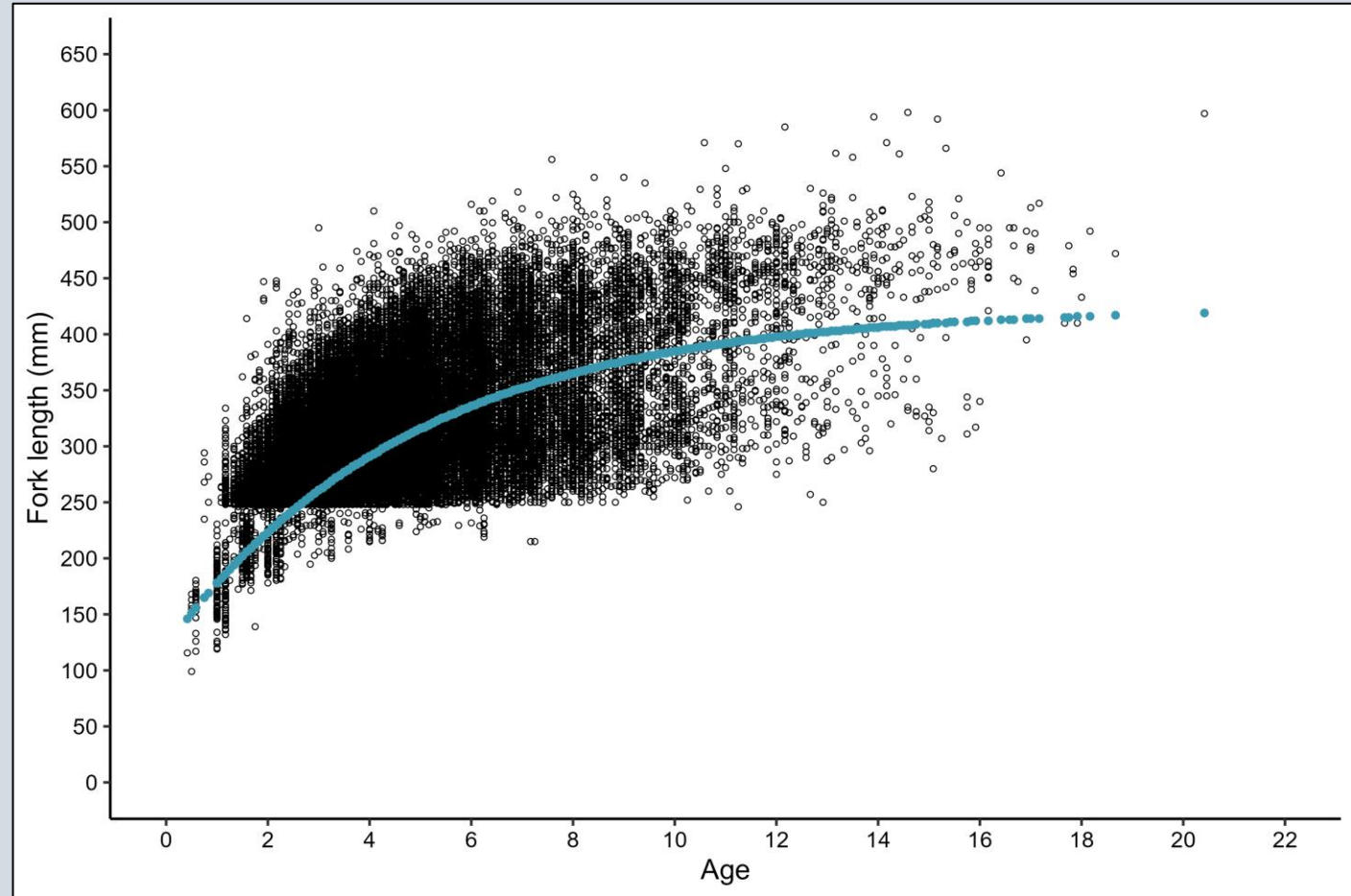
External Growth Model

- Size-truncated von Bertalanffy growth model (Diaz et al. 2004)
 - $L_{inf} = 42.3$ cm FL
 - $k = 0.207$ yr⁻¹
 - $t_0 = -1.636$
 - 45,833 otoliths
- Calendar ages to fractional age based on 4/1 hatch date



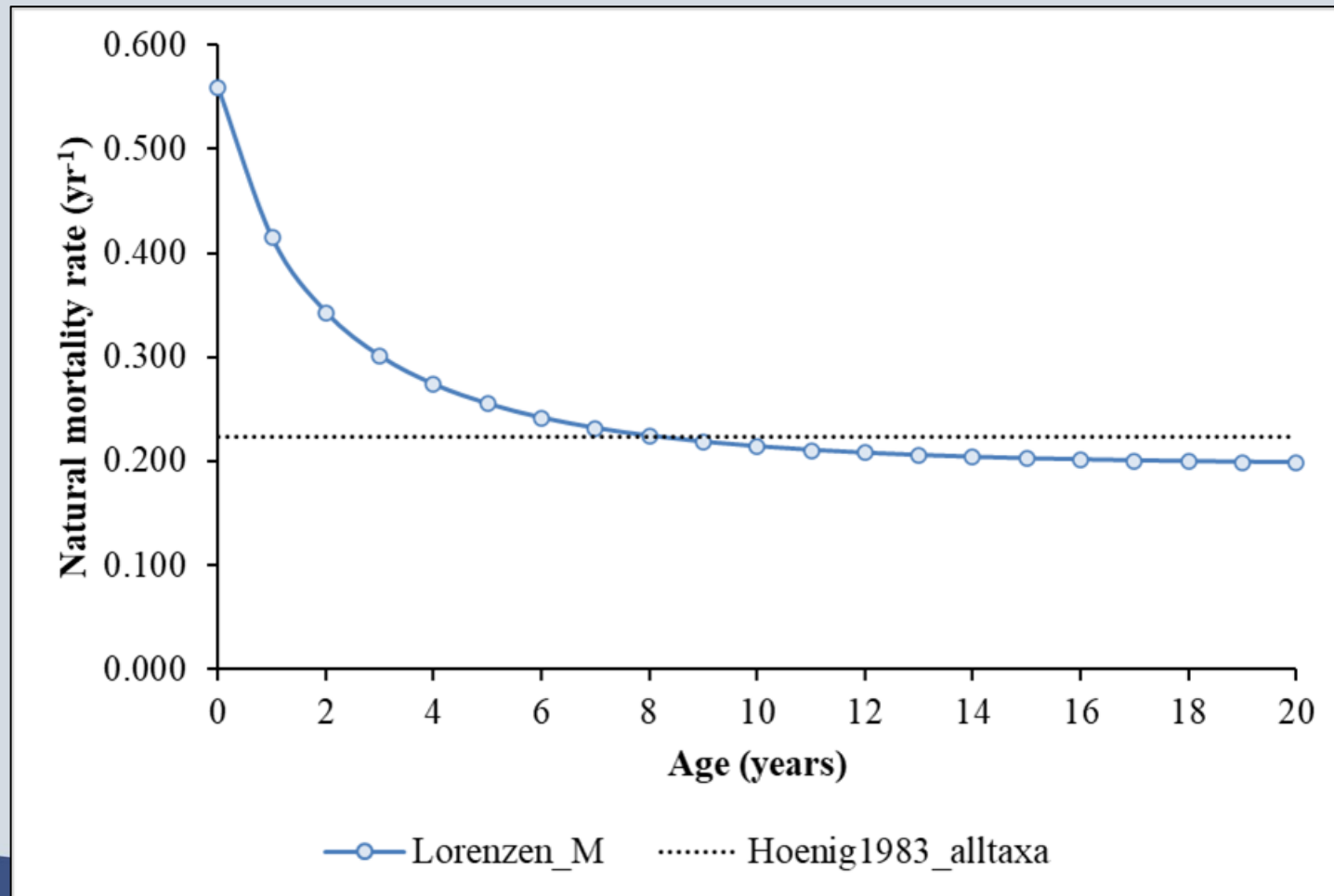
External Growth Model

- Size-truncated von Bertalanffy growth model (S96; Diaz et al. 2004)
 - $L_{inf} = 42.3$ cm FL
 - $k = 0.207$ yr⁻¹
 - $t_0 = -1.636$
 - 74,402 → 71,472 otoliths
- Calendar ages to fractional age based on 4/1 hatch date



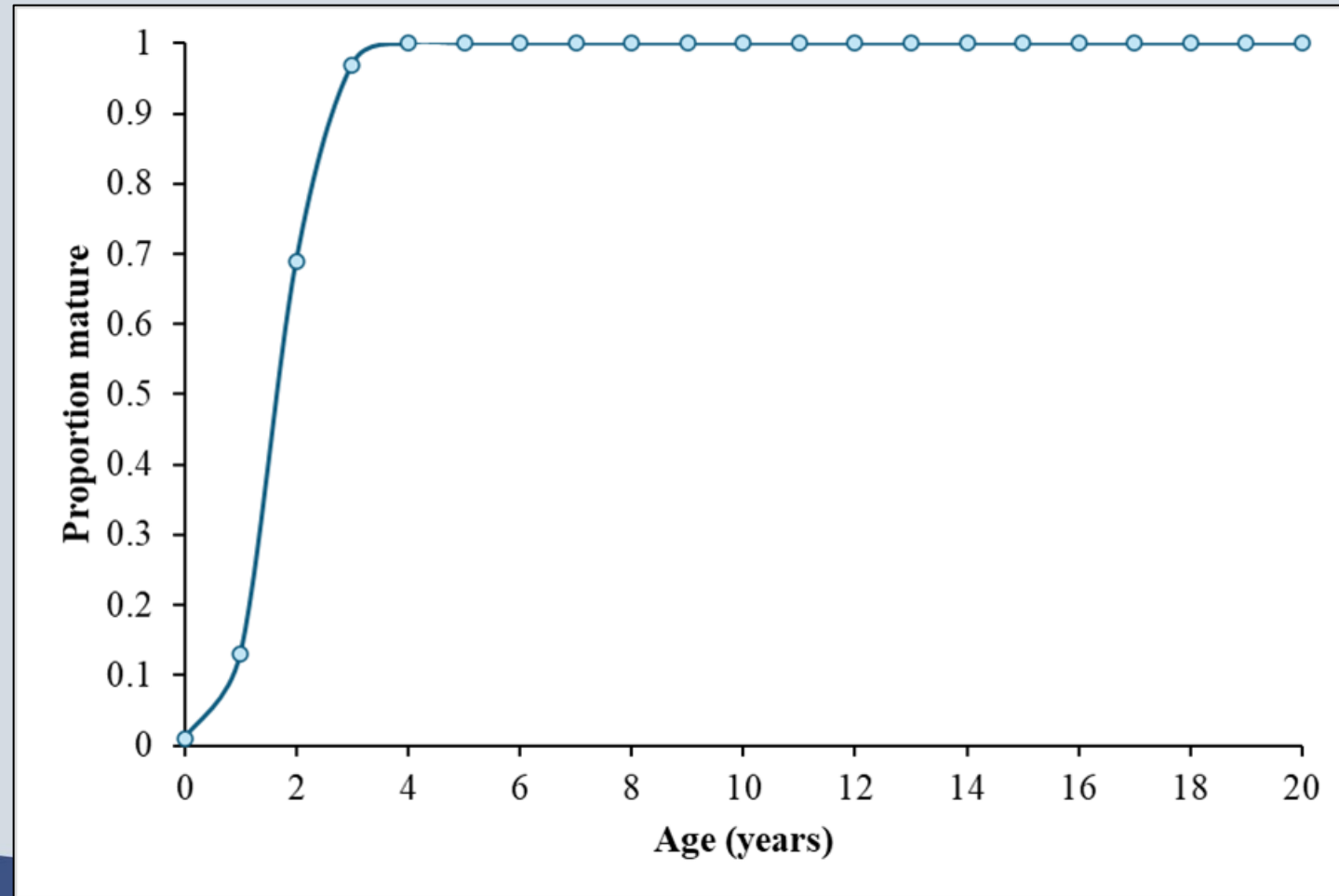
Natural mortality

- $M_{\text{at-age}}$ developed during SEDAR 64
- Hoenig_{all taxa} (1983) constant mortality-at-age as the target M
 - Max age = 20 (oldest observed in Florida)
 - Scaled between vulnerable ages 3 – 20 years
 - $M = 0.223 \text{ yr}^{-1}$
 - Hamel and Cope (2022) $M = 0.270 \text{ yr}^{-1}$
- Follows Lorenzen (2005, 2022)
 - M should be inversely related to length
 - Uses external von Bertalanffy growth model parameters
- $M(a)$ is 0.558 yr^{-1} to 0.198 yr^{-1} for ages 0 – 20



Maturity

- No new data since SEDAR 27a
- Data source
 - Barbieri and Colvocoresses (2003)
 - Florida Keys and southeast Florida
- Age-at-maturity
 - 205 samples
 - **$A_{50} = 1.7$ years old; 1.5 – 1.9 yr old 95% CI**
- Size-at-maturity
 - 218 samples
 - **$L_{50} = 192$ mm FL; 162 – 222 mm FL 95% CI**

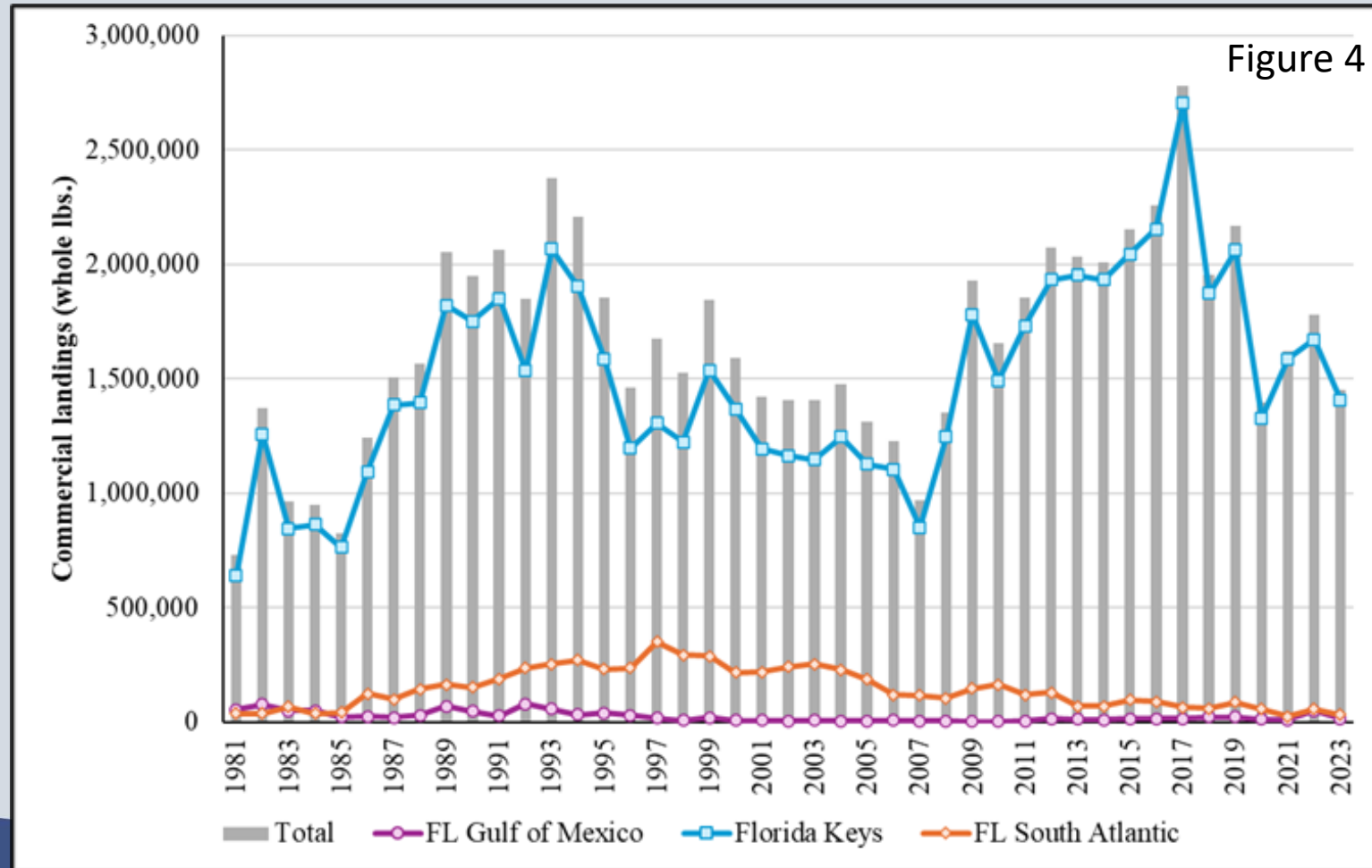




SEDAR 96: Yellowtail Snapper
Data: Landings

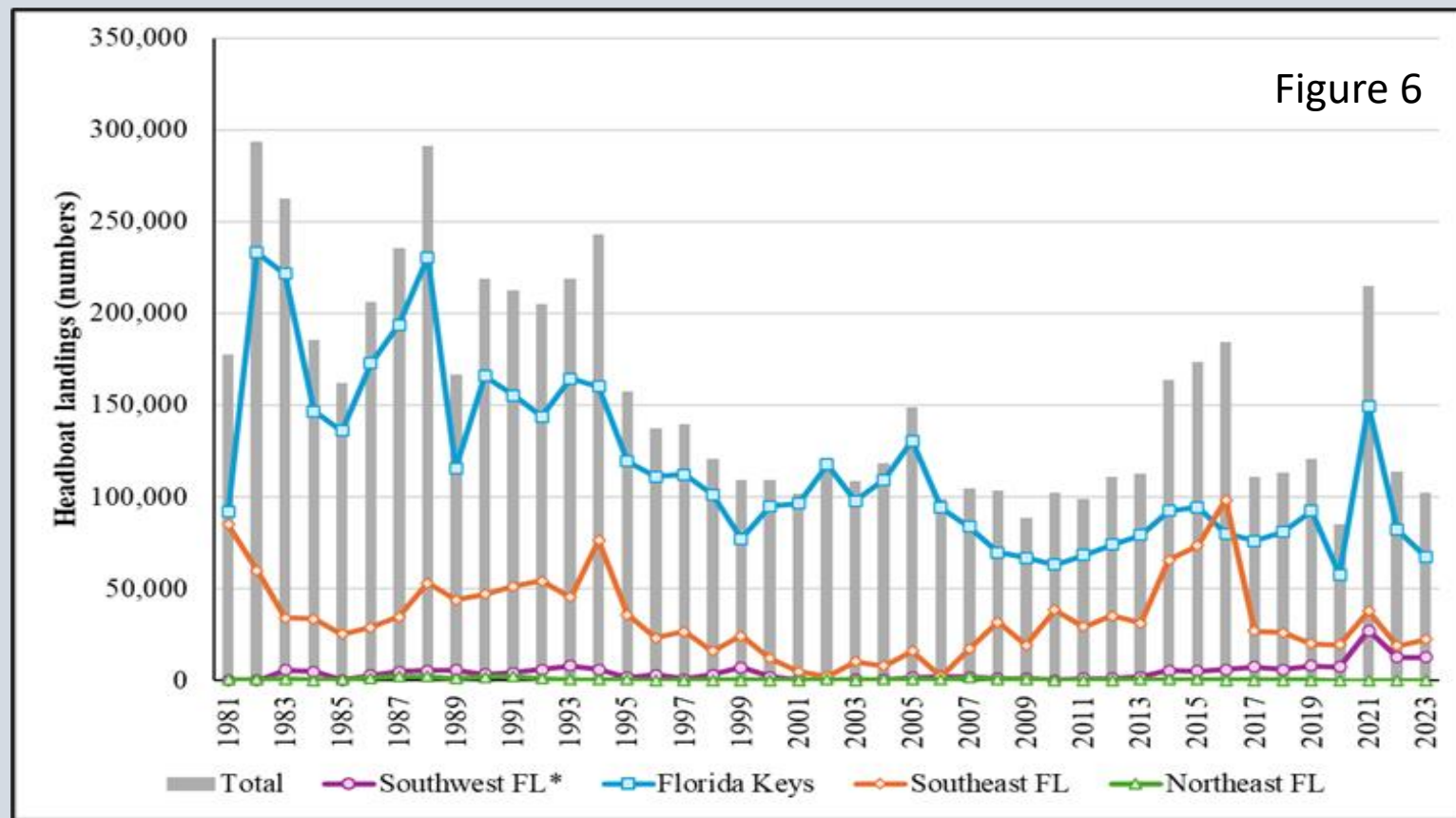
Updated Commercial Landings

- NMFS ALS (1981 – 1985); FL TTK (1986 – 2023)
- Predominantly hook and line gear
- CV = 0.05 (1986 – 2023)
- Decreasing trend since timeseries high in 2017
- Chiefly from Florida Keys
 - 2021 – 2023: 97.9%, 94.0%, 96.8%
- South Atlantic region < 5%



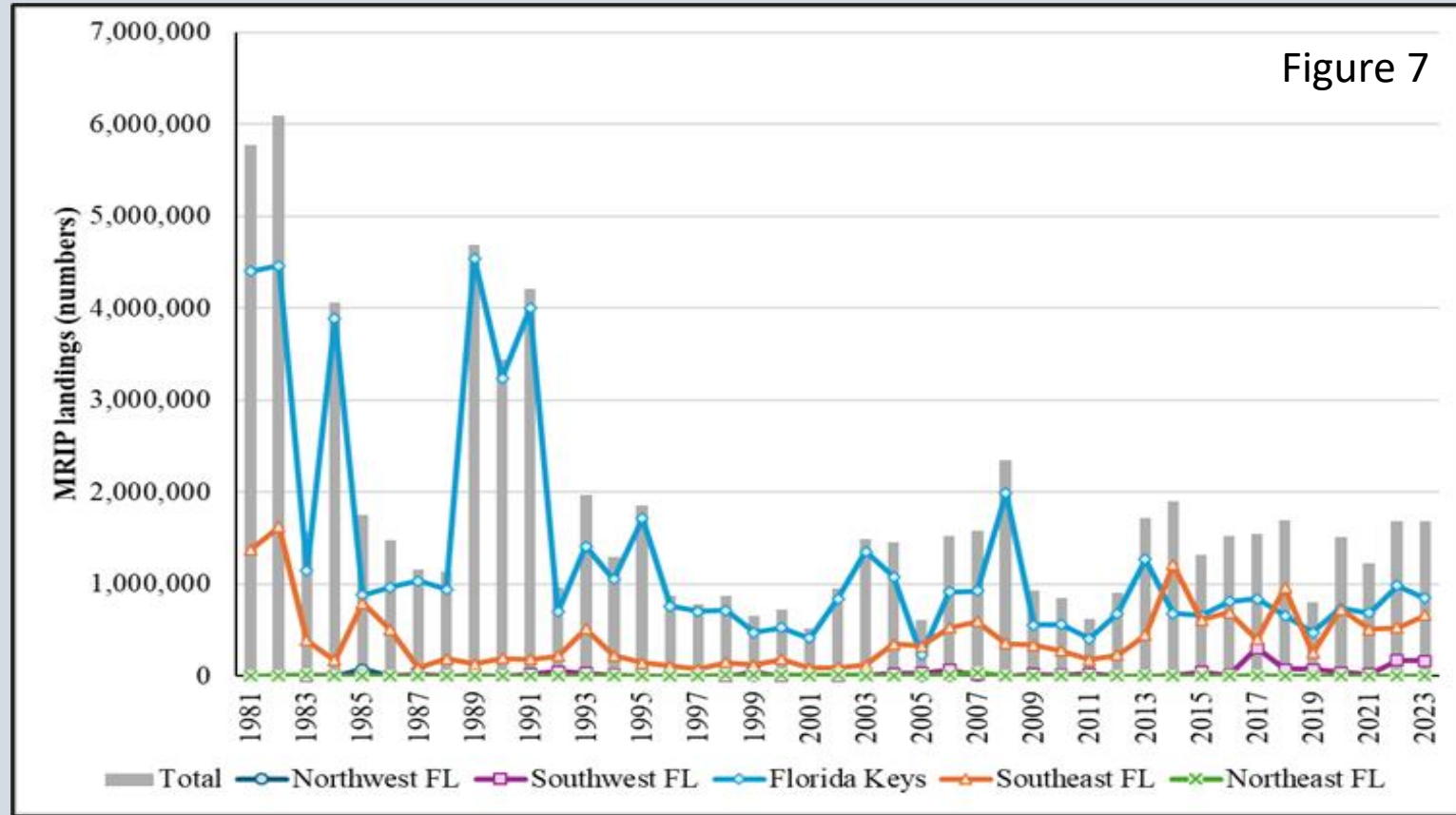
Updated Headboat Landings

- SRHS (1981 – 2023); MRIP HB mode (1981 – 1985)
- Hook and line gear
- CV = 0.05
- Variable but stable trend
- Chiefly from Florida Keys (Avg. 64%)
 - Southeast FL: Avg. 19%
- Recent increases in southwest FL region



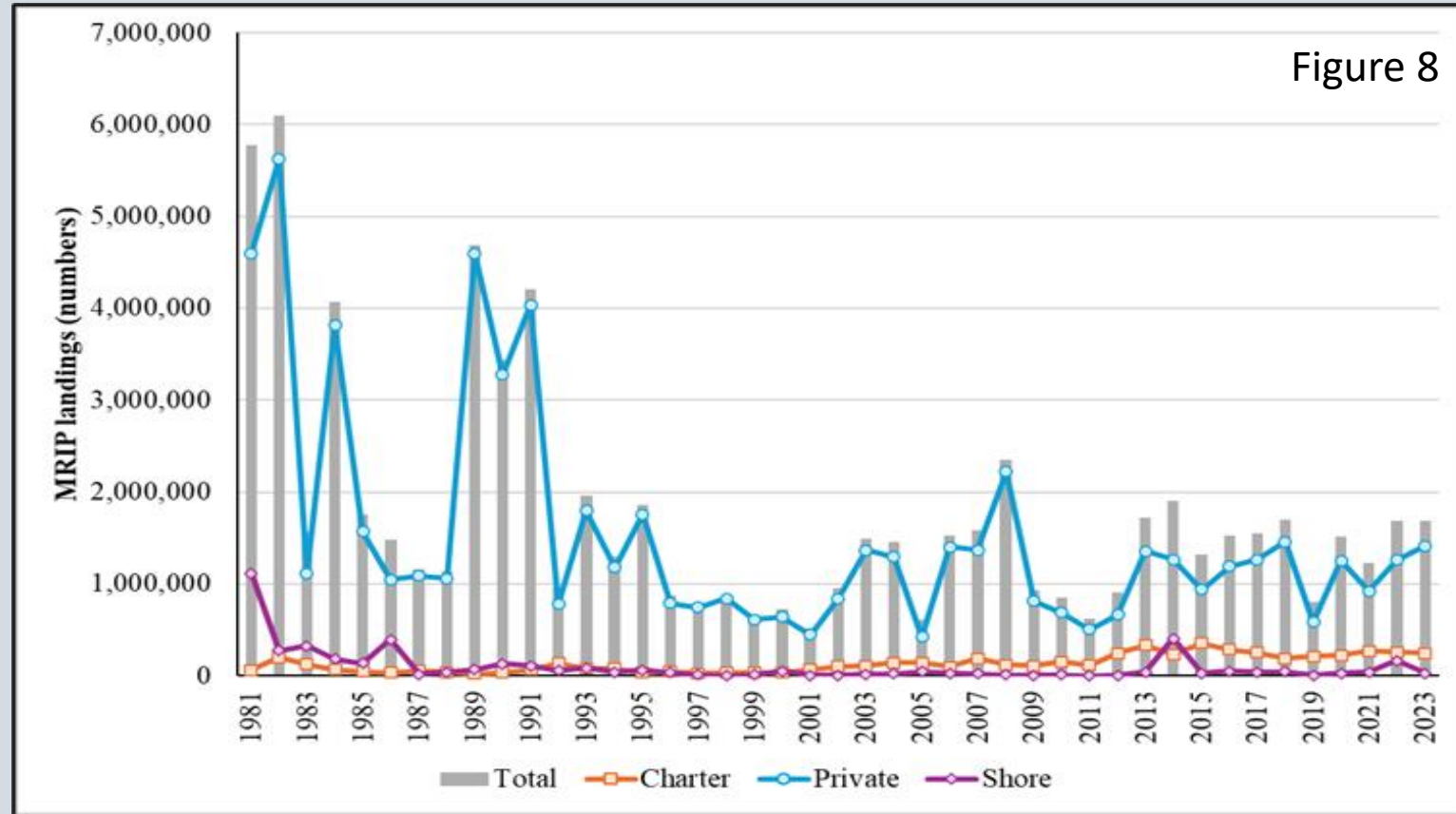
Updated MRIP Landings

- MRIP-FES (1981 – 2023)
 - A + B1 fish
- Primarily hook and line gear
- Avg. CV = 0.24 (1992 – 2023)
- Variable but stable trend
- Florida Keys and southeast FL regions
 - Similar since 2014
 - 98%, 90%, 90% (2021 – 2023)
- Recent increases in southwest FL region



Updated MRIP Landings

- MRIP-FES (1981 – 2023)
 - A + B1 fish
- Primarily hook and line gear
- Private mode
 - Avg. 80%
- Charter mode
 - Avg. 18%
- Shore mode
 - Increase in 2014, 2022



Rec Landings Topical Working Group

“Explore the State of Florida’s State Reef Fish Survey (SRFS) to inform private recreational landings data and consider its use in the current assessment.” (TOR #1 sub-bullet 1).

- TWG convened May 2024



Rec Landings Topical Working Group

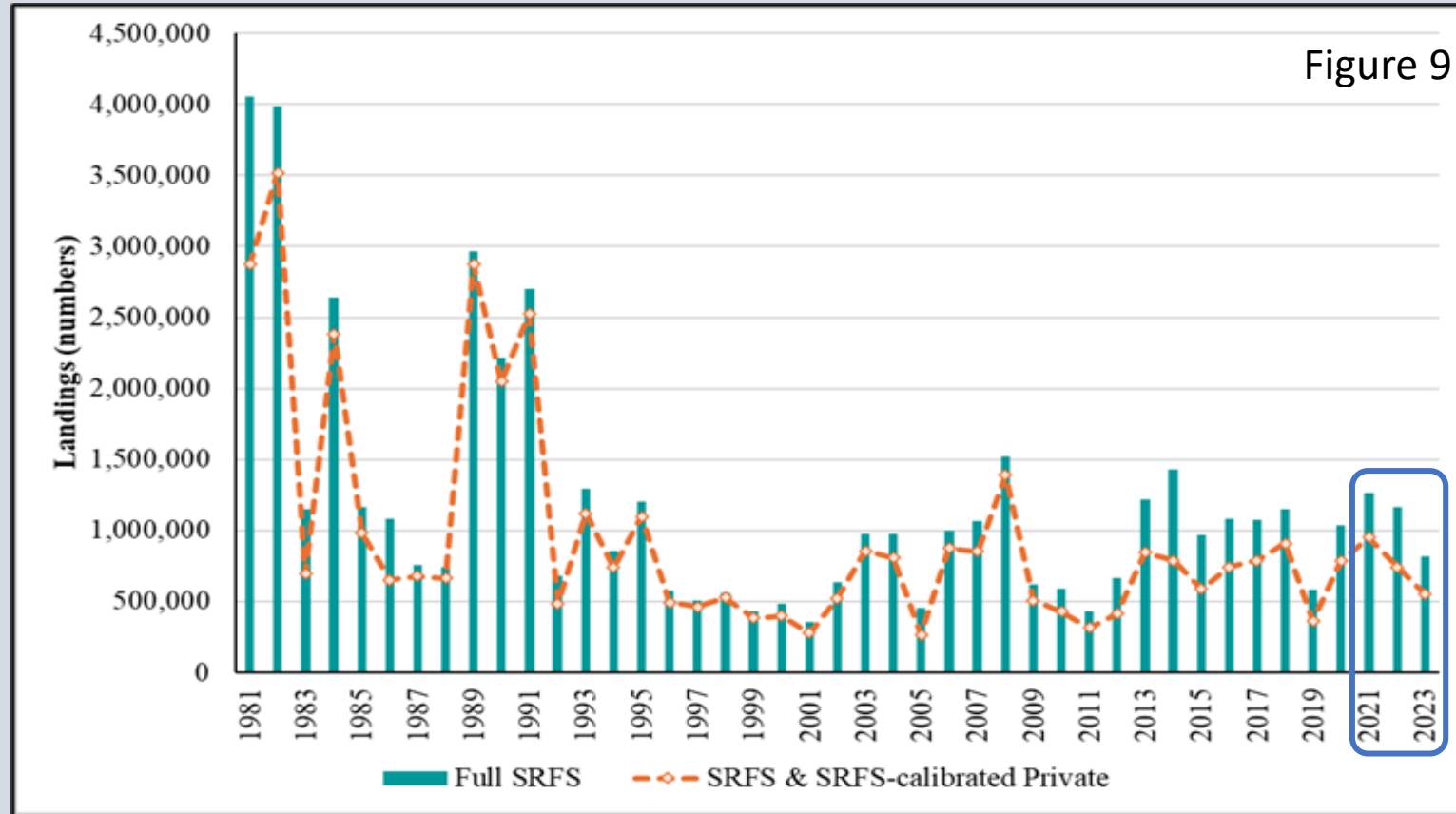
“Explore the State of Florida’s State Reef Fish Survey (SRFS) to inform private recreational landings data and consider its use in the current assessment.” (TOR #1 sub-bullet 1).

- TWG convened May 2024
 - Reviewed both the SRFS and MRIP private mode landings and discard data for Florida
 - Reviewed Ramsay et al. (2024)
 - Looked at exploratory model runs using SRFS data in SEDAR 64 base model to understand potential model impact
 - Made recommendations on which data series should be used in the SEDAR 96 base model



SRFS and SRFS-calibrated Landings

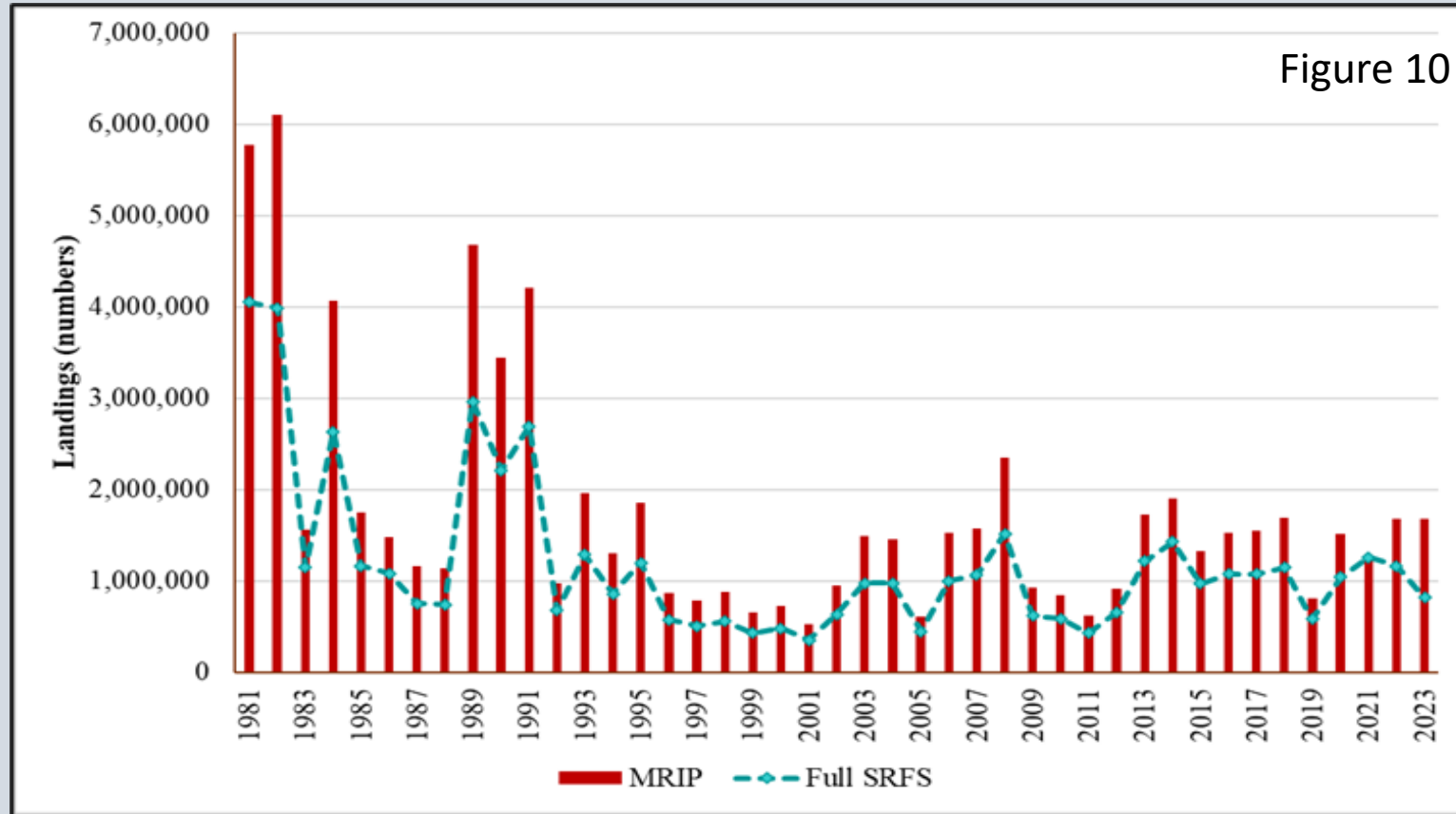
- State Reef Fish Survey (SRFS)
 - Ramsay et al. (2024)
 - 2021 – 2023
 - Avg. CV = 0.12
- Ratio-based calibration on historic MRIP private mode
 - 1981 – 2020
 - 0.625323 (numbers)
 - Avg. CV = 0.26 (1992 – 2020)
- ‘Full SRFS’ = SRFS and SRFS-calibrated + MRIP charter + MRIP shore



Comparison: Full SRFS and MRIP Landings

Trends

- Differ for years 2021 – 2023
 - Decreasing vs. increasing
 - May continue to show differences in years to come
- Scalar reduction for years 1981 – 2020



Comparison: Full SRFS and MRIP Landings

Trends

- Differ for years 2021 – 2023
 - Decreasing vs. increasing
 - May continue to show differences in years to come
- Scalar reduction for years 1981 – 2020
- TWG approved use of SRFS data

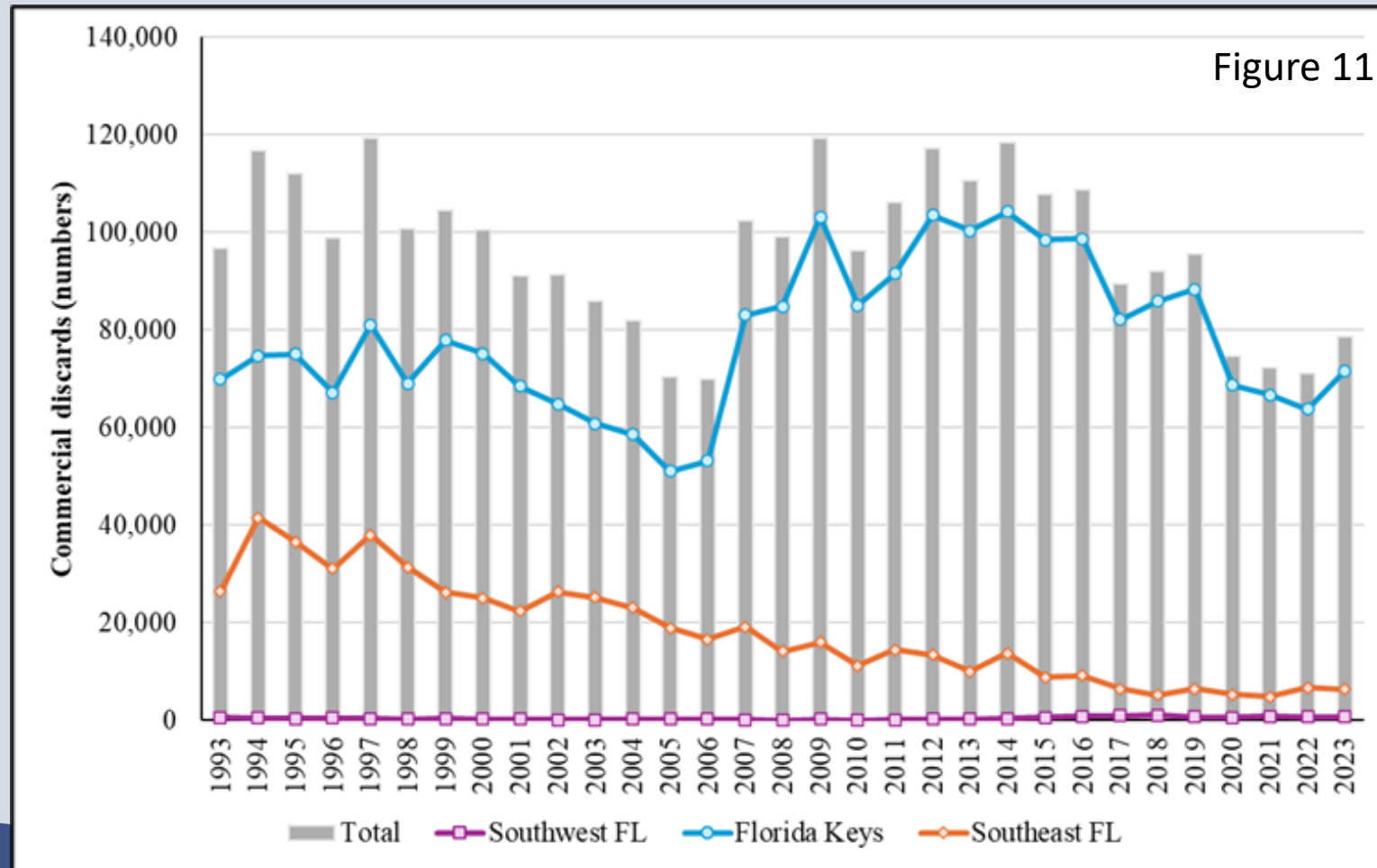




SEDAR 96: Yellowtail Snapper
Data: Discards

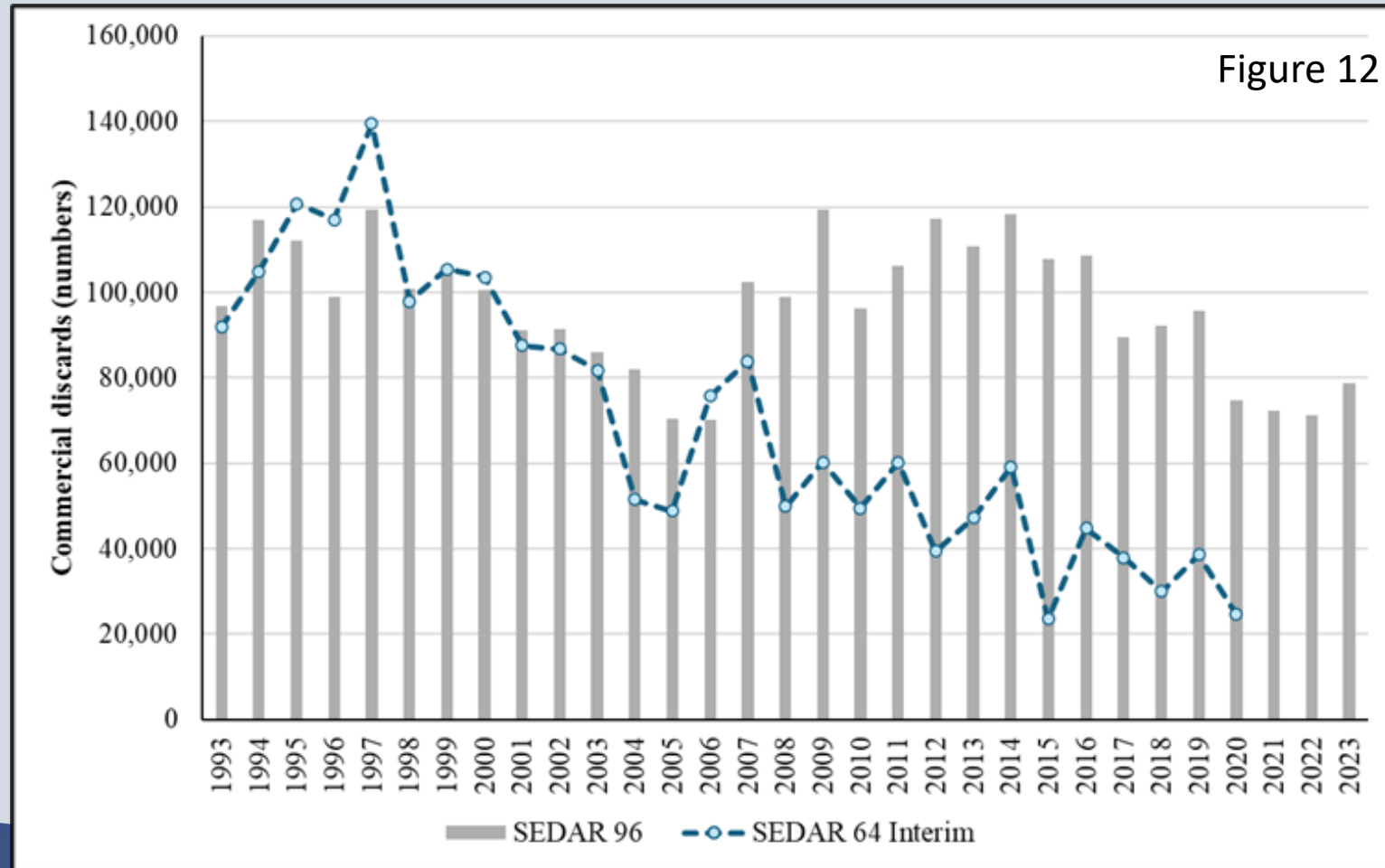
Updated Commercial Discards

- Alhale et al. (2024)
 - No longer recommend discard logbook data for estimating discards for SEDAR
- Discards
 - Discard rate (RFOP)
 - Total fishing effort (CFLP)
- Two methods
 - Florida Keys
 - SE and SW FL (data-limited)
- Avg. CV = 0.51



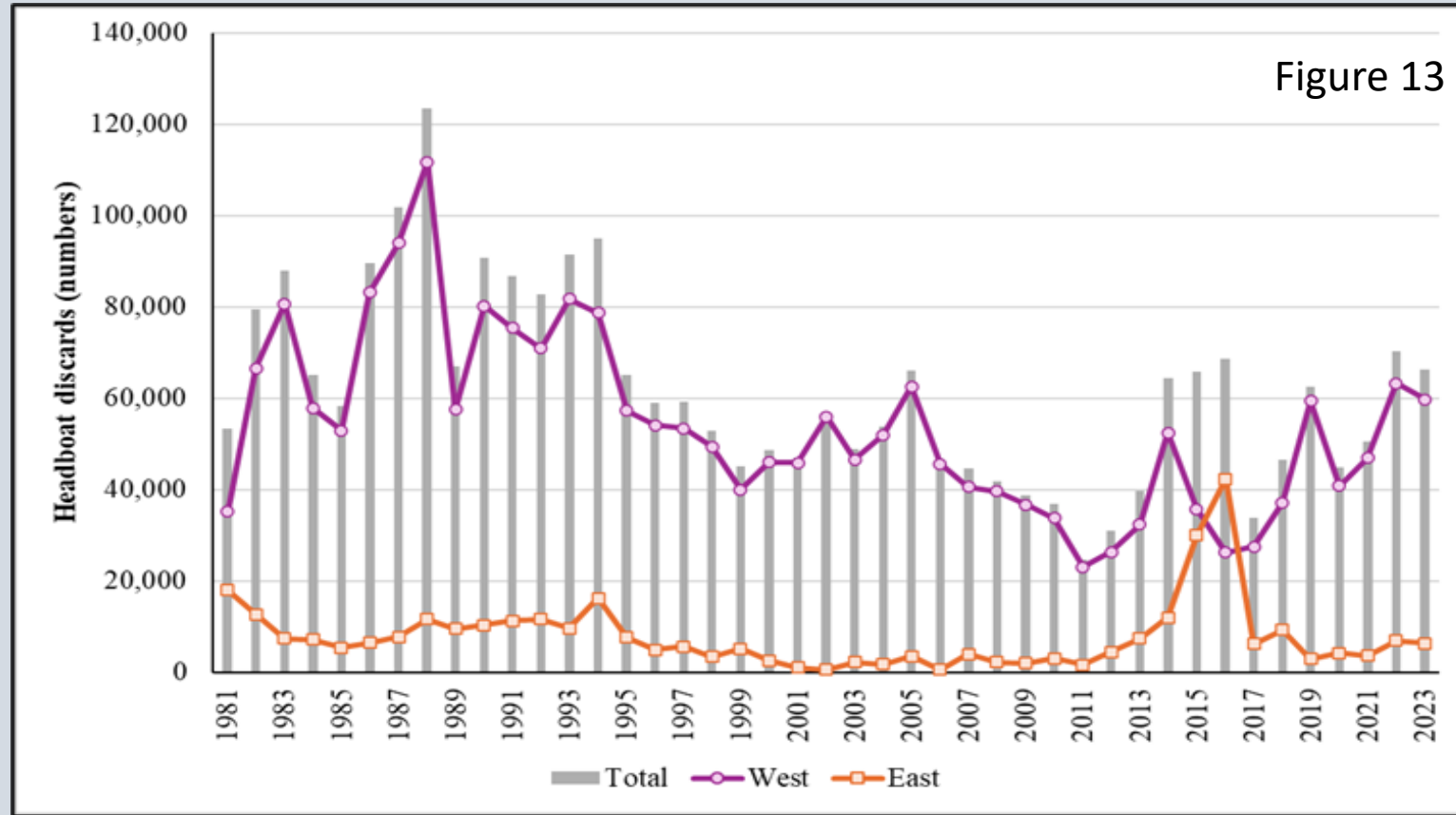
Updated Commercial Discards

- Logbook- vs. observer-based methods
- Trend differences
 - 2008 onward
- CV
 - Avg. 2.74 → avg. 0.51



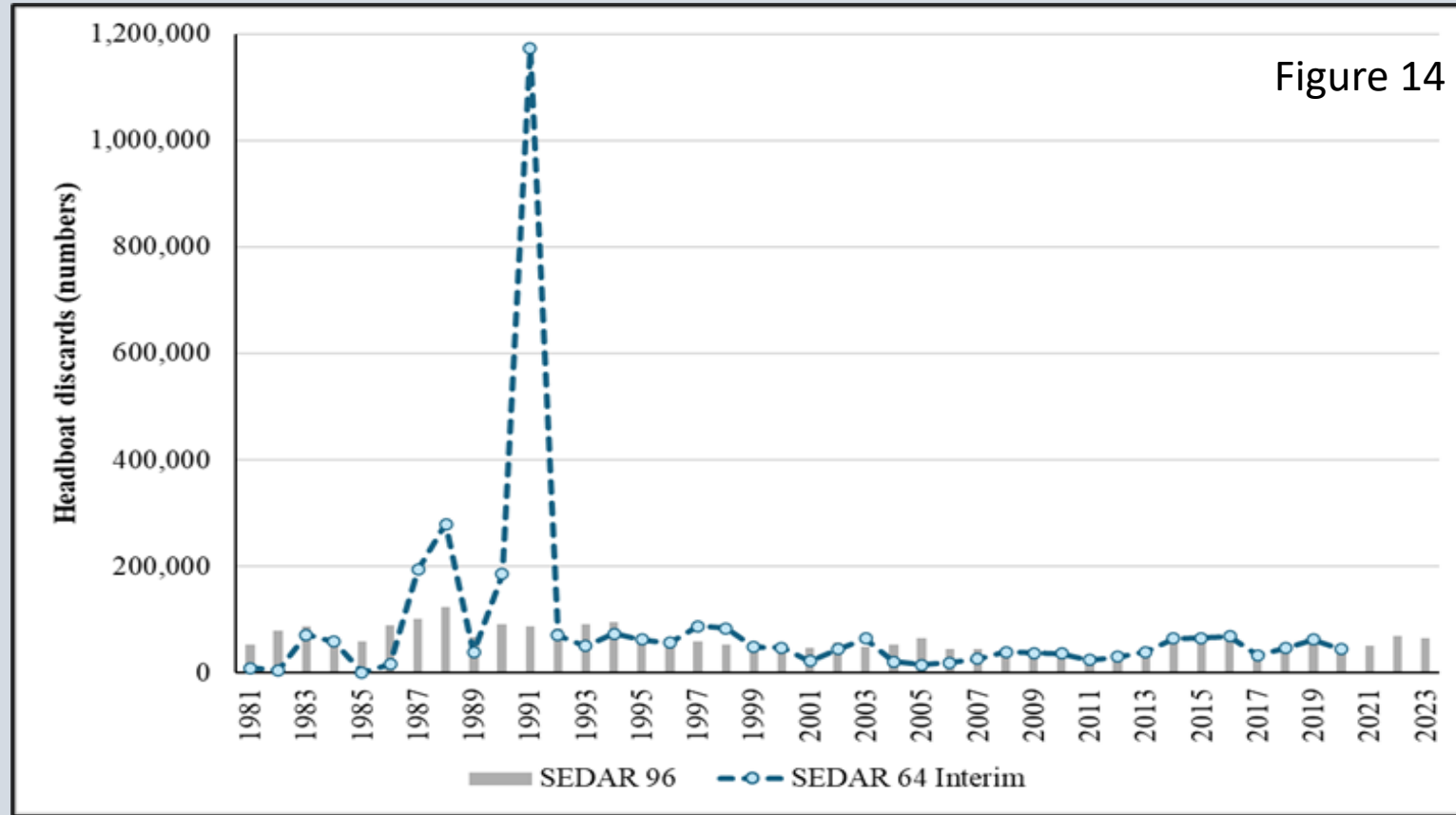
Updated Headboat Discards

- SRHS logbook
 - 2008 – 2023 (reliable)
 - 1981 – 2007 (proxy)
- ‘Super-ratio’ vs. ‘SRHS-Mean’ approach
 - Super-ratio influenced by unrepresentative trend from MRIP
 - SRHS-Mean recommended
- West region: 92.8%, 90.1%, 90.4% (2021 – 2023)
- CV = 0.5



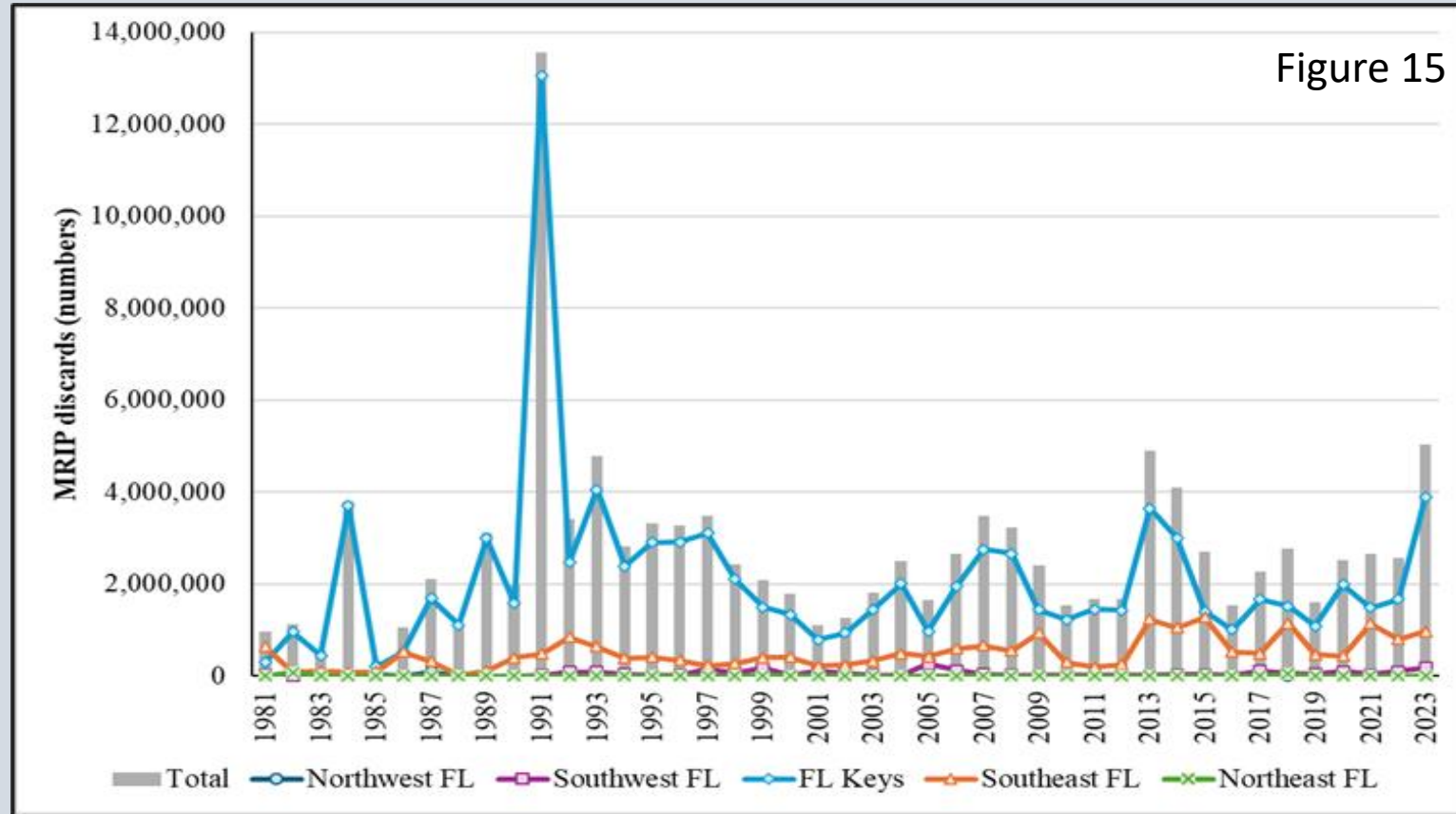
Updated Headboat Discards

- SEDAR 64 and Interim
 - Super-ratio
 - MRIP influence (1987 – 1991)
- SEDAR 96
 - SRHS-Mean



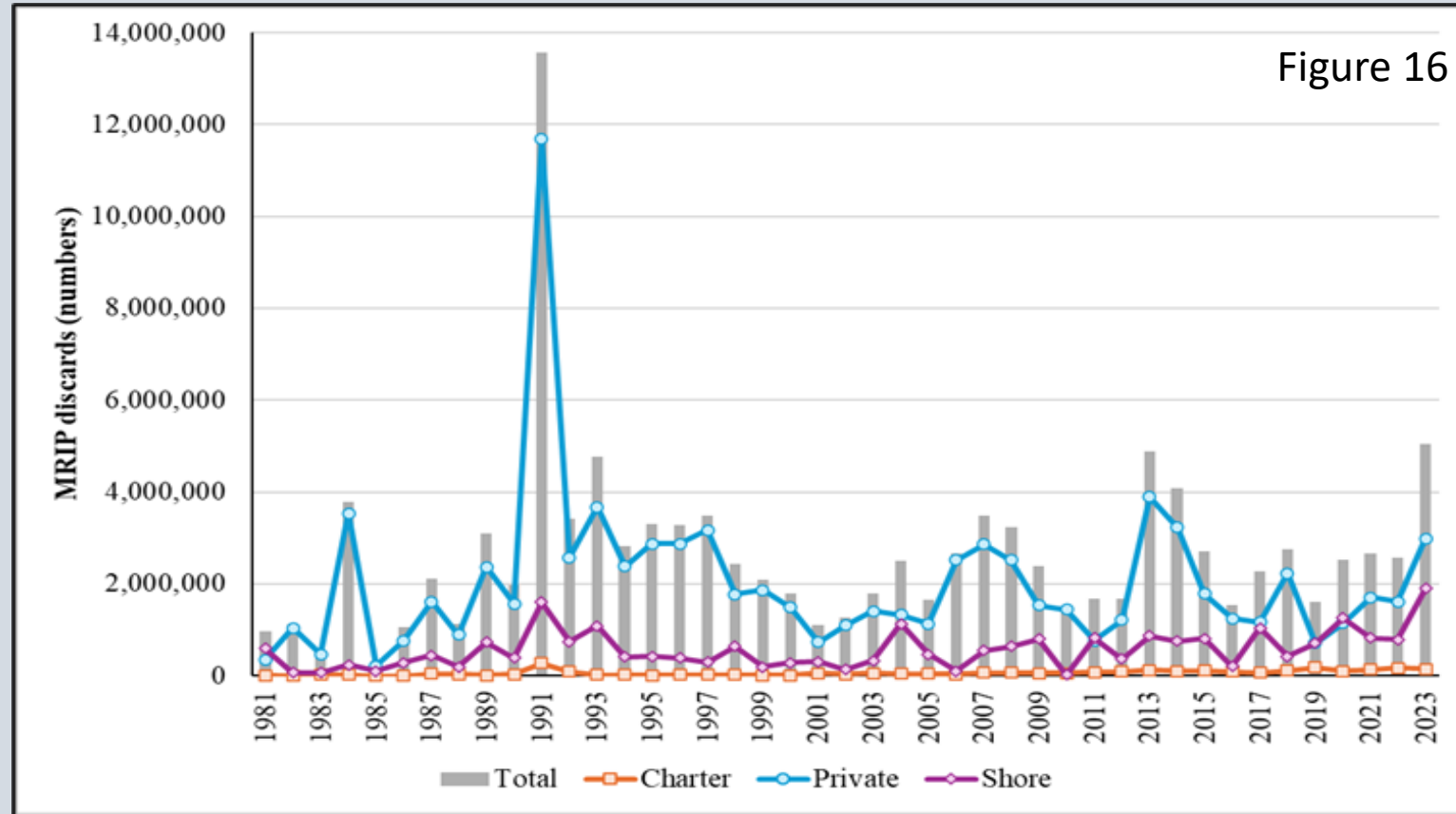
Updated MRIP Discards

- MRIP-FES (1981 – 2023)
 - B2 fish (live releases)
- Avg. CV = 0.21 (1992 – 2023)
- Avg. ~65% of total catch since 2017
- 5.035 million fish in 2023
- Largely from Florida Keys and southeast FL regions
 - Avg. 97% (2021 – 2023)



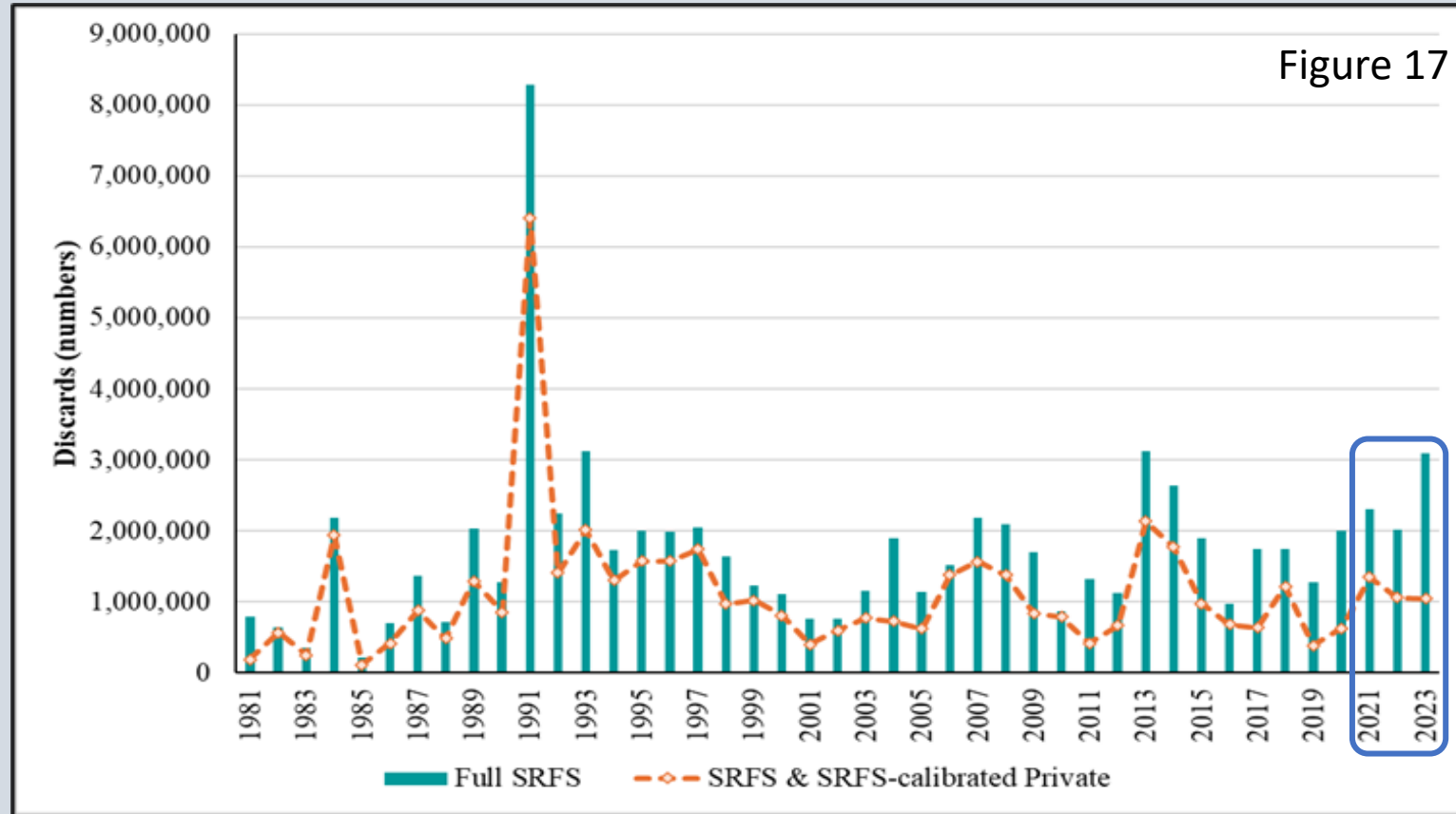
Updated MRIP Discards

- MRIP-FES (1981 – 2023)
 - B2 fish (live releases)
- Private mode
 - Avg. 58%
- Charter mode
 - Avg. 5%
- Shore mode
 - Avg. 36%
 - Recent increasing trend



SRFS and SRFS-calibrated Landings

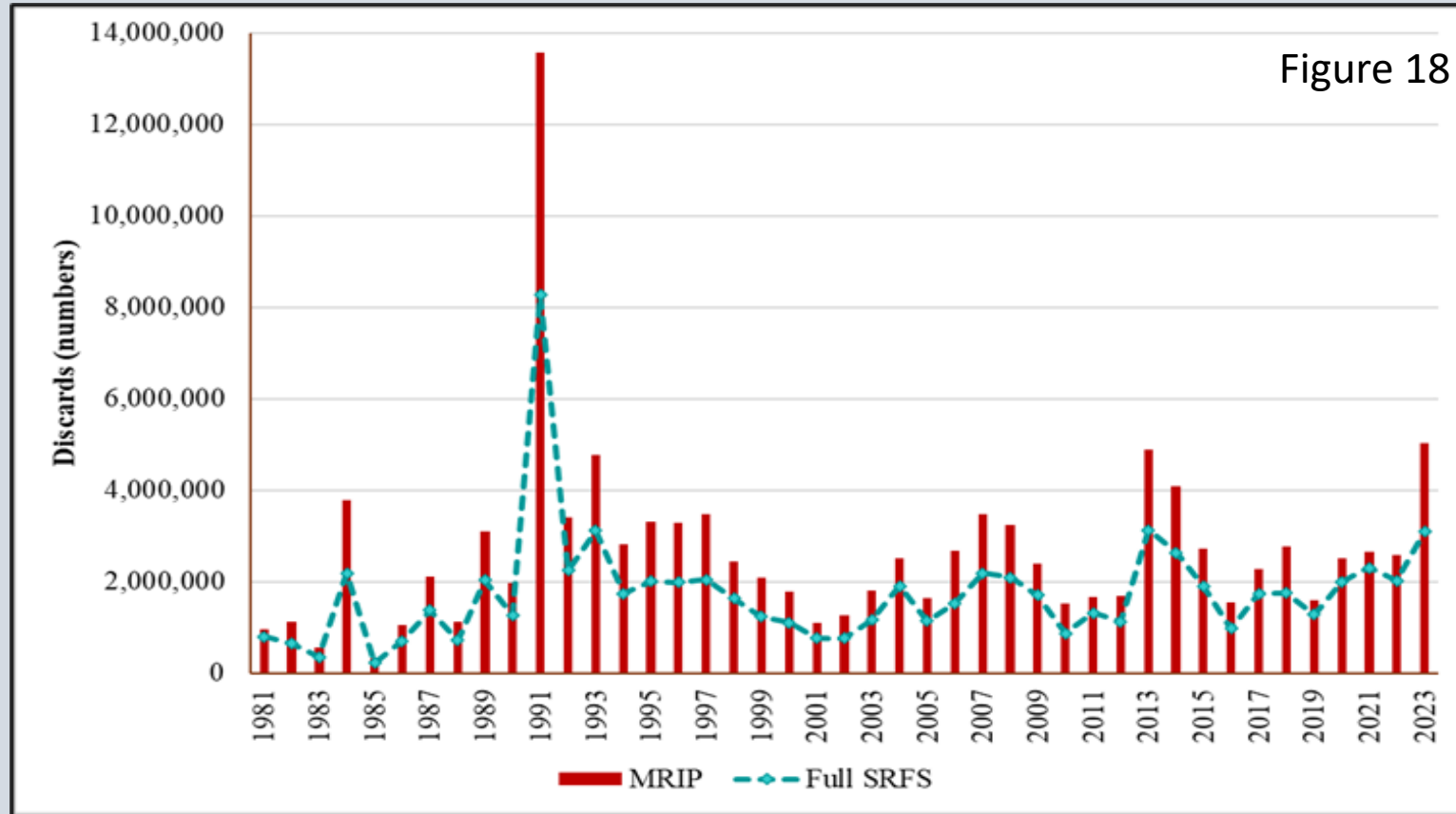
- State Reef Fish Survey (SRFS)
 - Ramsay et al. (2024)
 - 2021 – 2023
 - Avg. CV = 0.12
- Ratio-based calibration on historic MRIP private mode
 - 1981 – 2020
 - 0.547875 (numbers)
 - Avg. CV = 0.24 (1992 – 2020)
- ‘Full SRFS’ = SRFS and SRFS-calibrated + MRIP charter + MRIP shore



Comparison: Full SRFS and MRIP Landings

Trends

- Years 2021 – 2023
 - Both increasing due to shore mode influence
 - May continue to show differences in years to come
- Scalar reduction for years 1981 – 2020
 - 1991: nearly 14 million fish to roughly 8 million fish



Discard mortality rate

- Fixed model inputs based on SEDAR 64 recommendations
 - Commercial: 10%
 - Headboat: 10%
 - MRIP SRFS: 10%

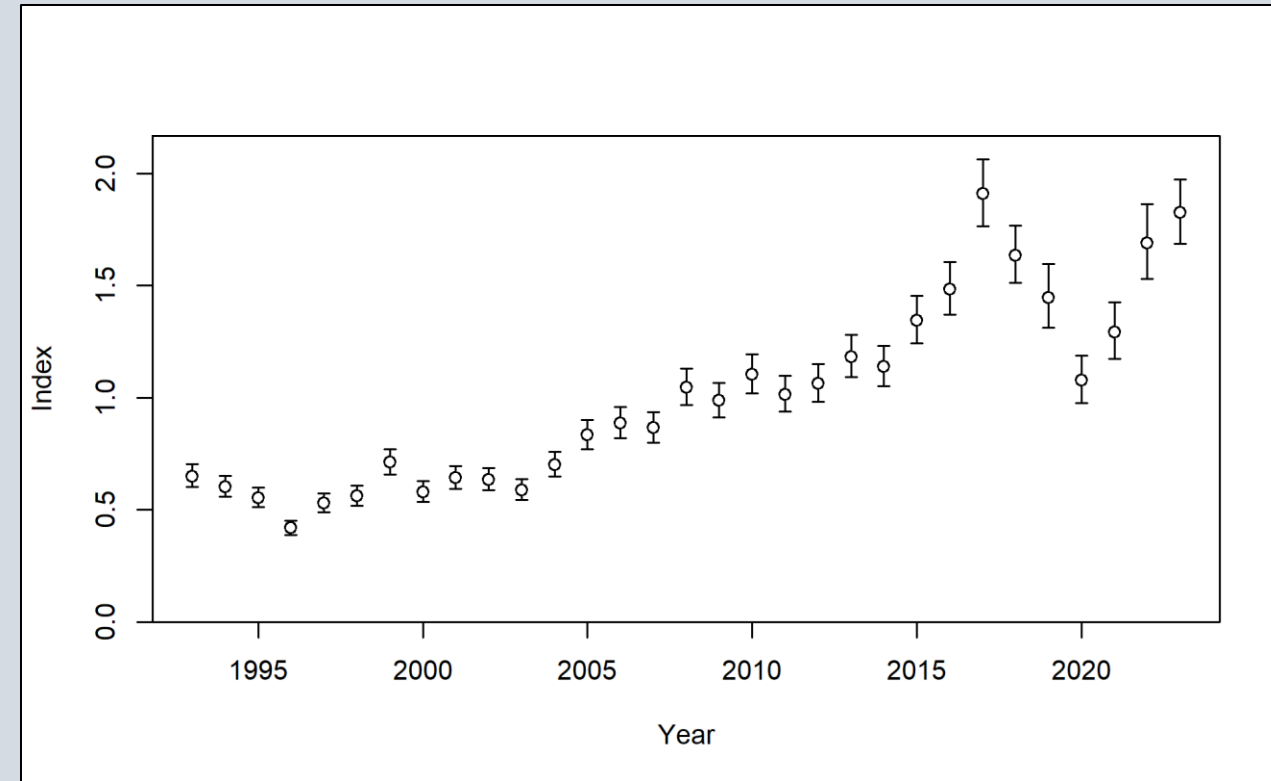




SEDAR 96: Yellowtail Snapper
Data: Indices

Updated Commercial CPUE

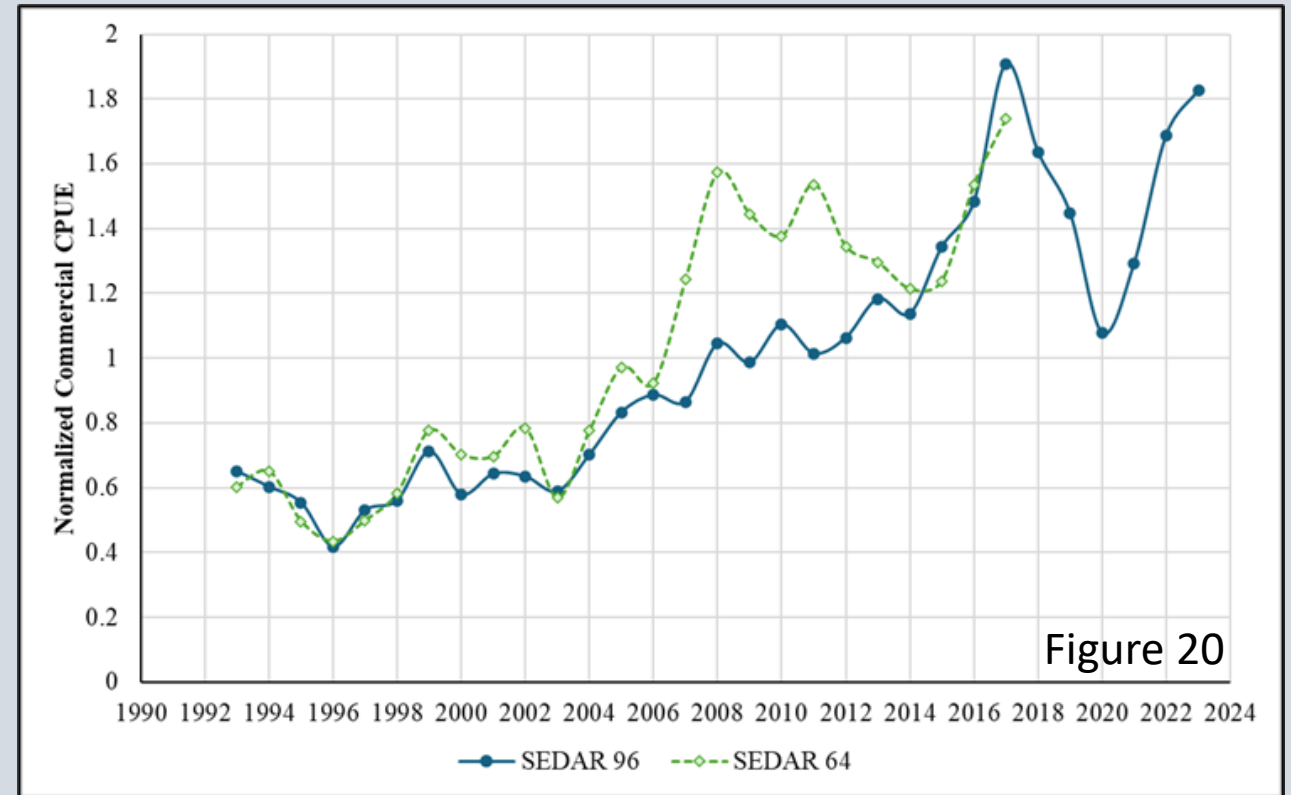
- Coastal Fisheries Logbook Program (CFLP)
 - 1993 – 2023
- Vertical line trips in southern Florida
 - Excludes trips in months during fishery closures (e.g., 2015, 2017, 2018)
- Stephens and MacCall subsetting
- Delta-glm (binomial, gamma)
 - Retained catch per hook-hr
 - Avg. CV = 0.04
- Linked to the commercial fleet



Updated Commercial CPUE

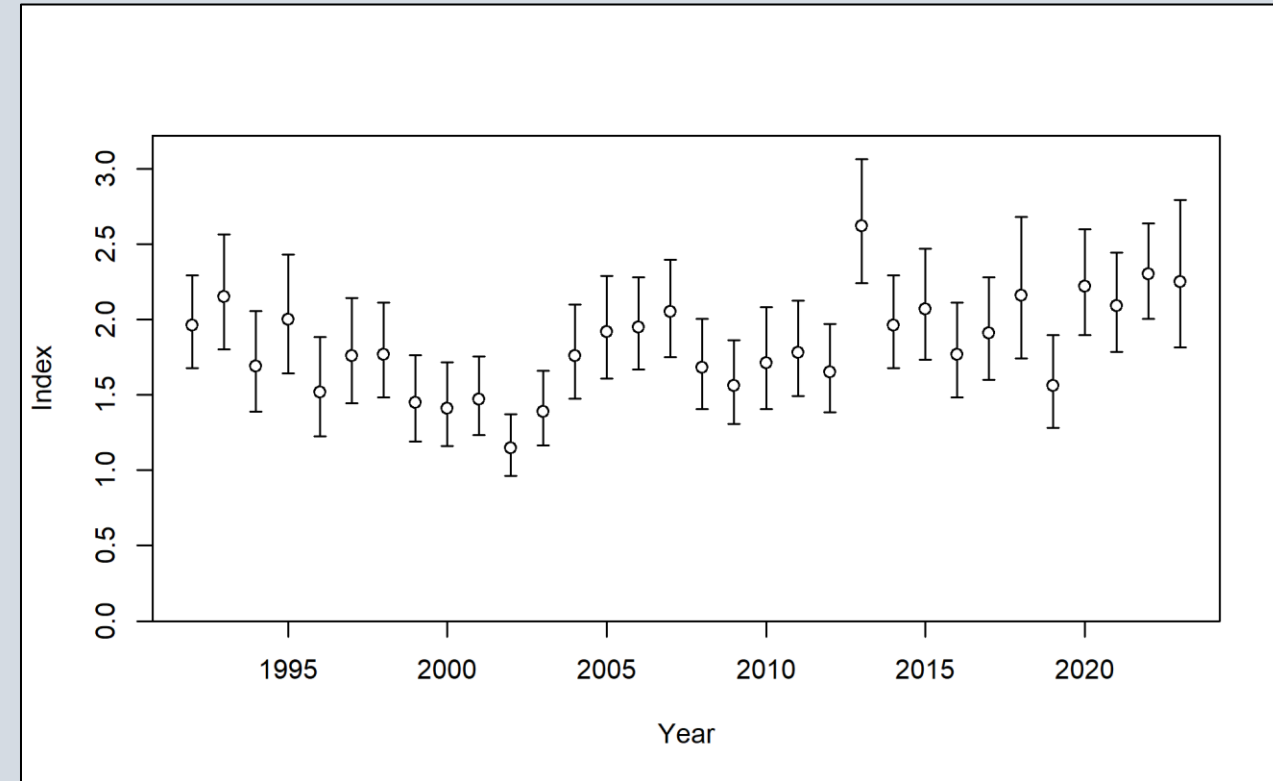
Differences: SEDAR 64 to 96

- CVs
 - Avg. 0.18 → Avg. 0.04
- 2006 – 2014
 - Abrupt to gradual change
- Updated data affecting Stephens and MacCall subsetting
- Change in positive submodel error distribution
 - Lognormal → gamma



Updated MRIP CPUE

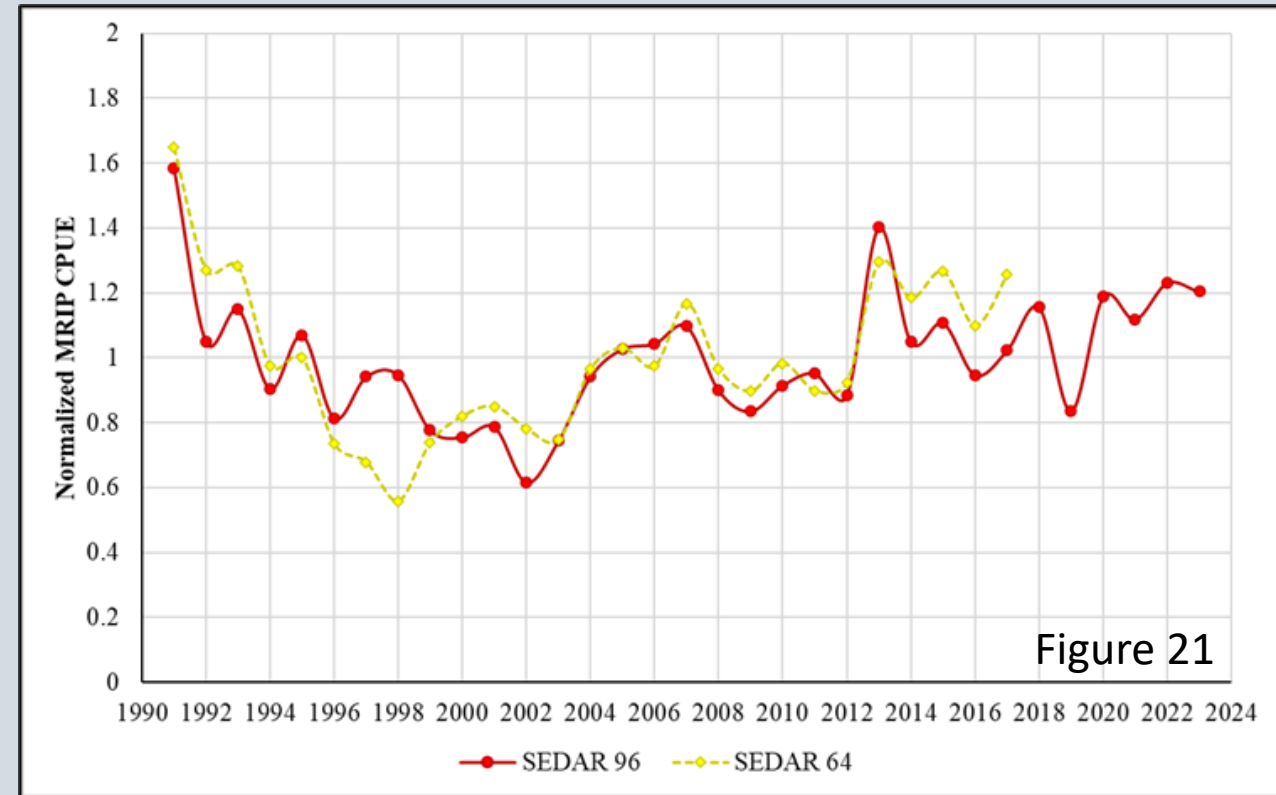
- MRIP total catch (A+B1+B2)
 - 1991(2) – 2023
 - Avg. CV = 0.09
- Hook and line trips in southern Florida
 - Florida Keys (Monroe)
 - Southeast FL (Palm Beach, Broward, Miami-Dade)
- Hierarchical clustering analysis (Shertzer and Williams 2008)
- Delta-lognormal glm
 - Total catch per trip



Updated MRIP CPUE

Differences: SEDAR 64 to 96

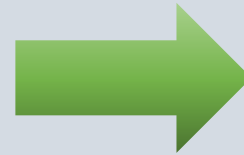
- Change in effort definition
 - angler vs. trip
- Sensitivity run performed during Interim Analysis
- Mostly stable but variable trend rather than sharp decline then increasing trend
- CVs
 - Avg. 0.09 → Avg. 0.09



Updated Reef Fish Visual Census (RVC)

RVC in SEDAR 64

- Two-stage SRS design using divers in water <30 m
 - SSU (diver cylinder)
- Combined data in overlapping years for the FL Keys and the Dry Tortugas
- 1999, 2000, biennially 2004 – 2016
- Design-based
- Juvenile and subadult (1 – 18 cm); Adult (19+ cm) indices of abundance



RVC in SEDAR 96

- Two-stage SRS design using divers in water <30 m
 - One-stage design change in 2021
 - SSU (diver cylinder)
- Separated Florida Keys and Dry Tortugas
 - Keys: 1999 – 2012, biennially 2014 – 2018, 2022
 - Avg. CV = 0.17
 - DRTO: 1999, 2000, biennially 2004 – 2018, 2021, 2023
 - Avg. CV = 0.12
- Design-based
- Combined all length classes



Updated Reef Fish Visual Census (RVC)

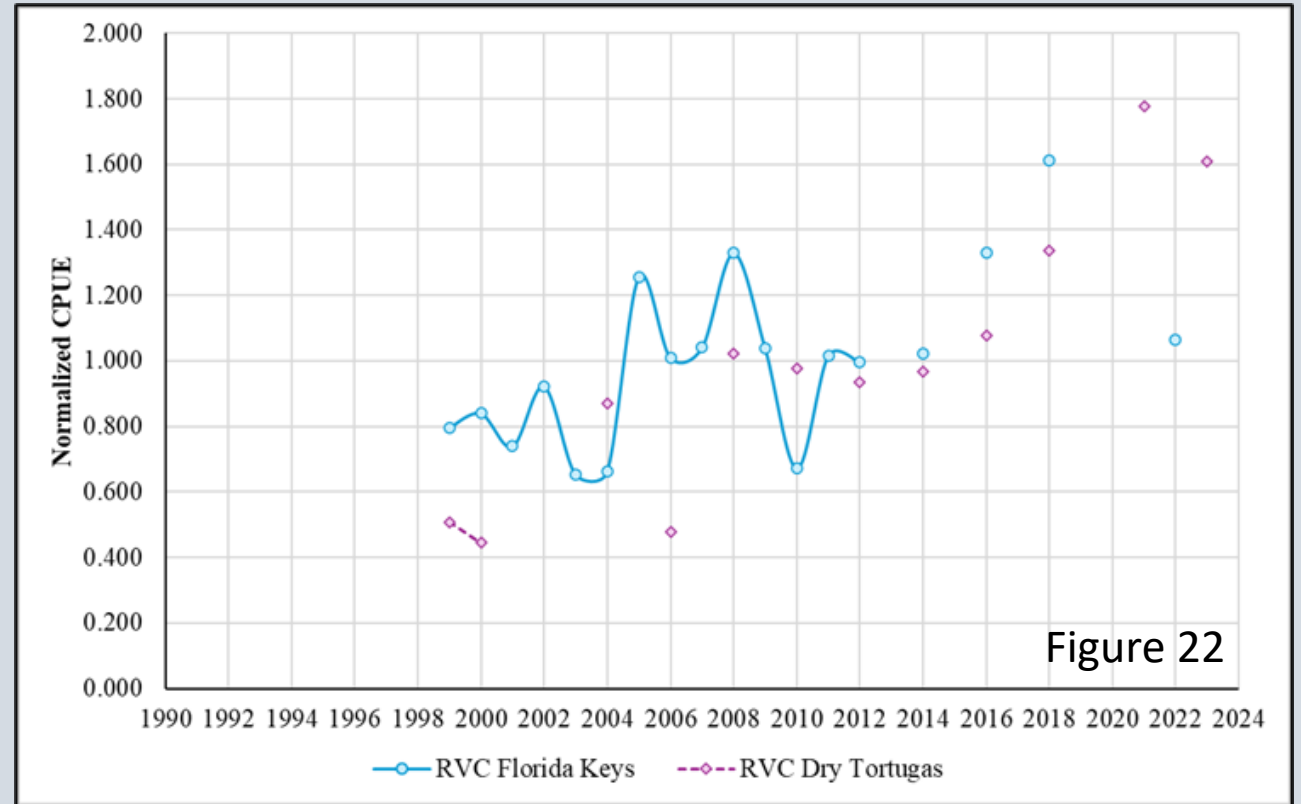
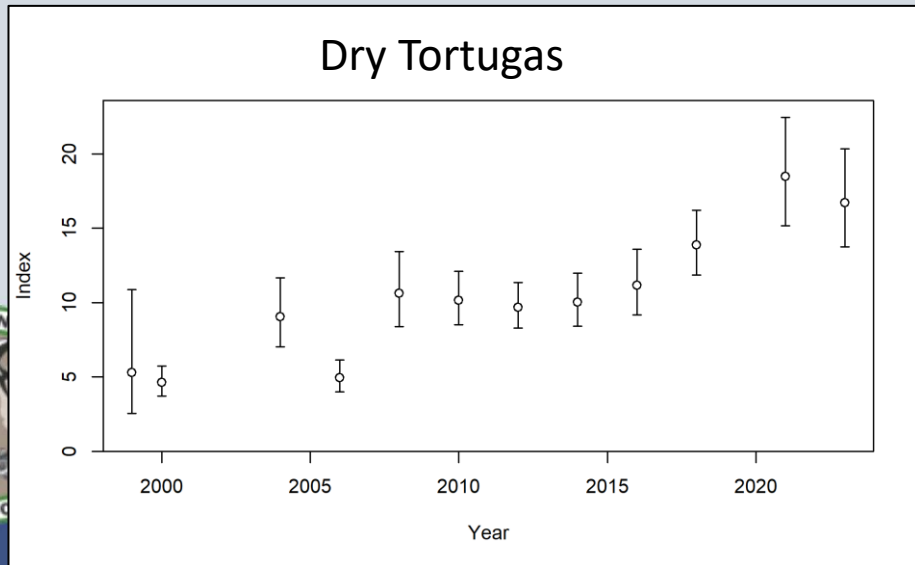
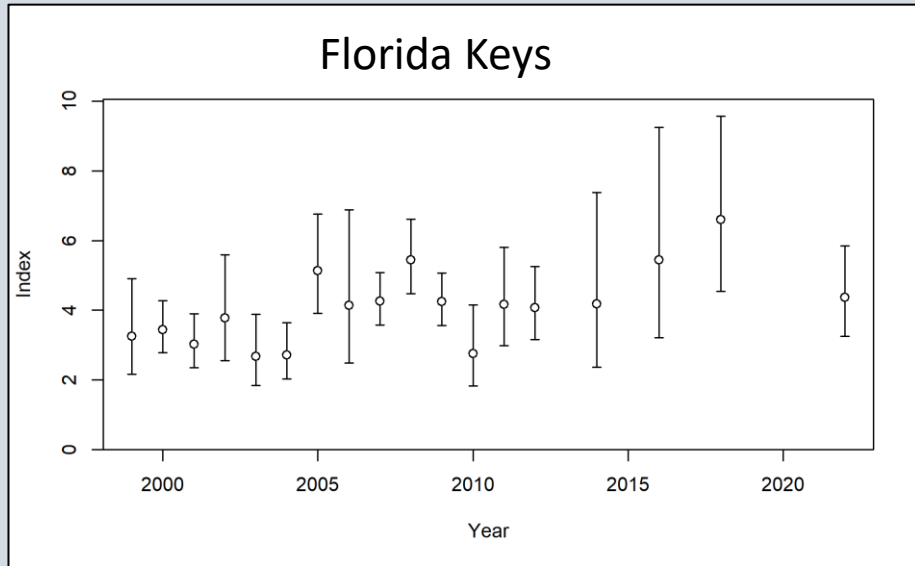


Figure 22

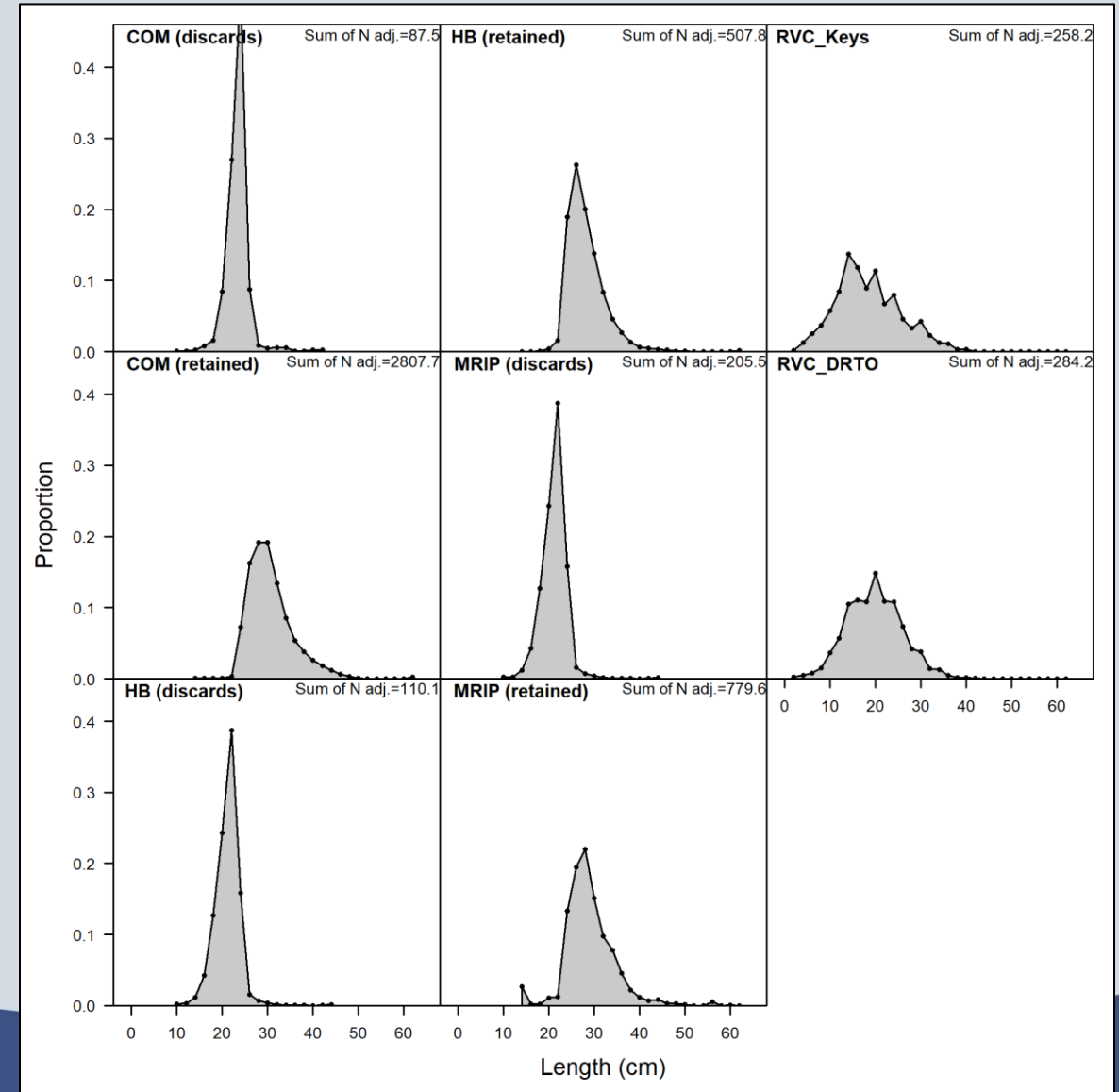




SEDAR 96: Yellowtail Snapper
Data: Length and Age Composition

Updated Length Composition

- 2cm fork length bins
 - Unimodal
- Retained
 - Primarily between 24 – 60 cm fork length
- Discards
 - Largely below minimum size limits
- RVC
 - Now unimodal
 - Underlying digit bias



Updated Length Composition

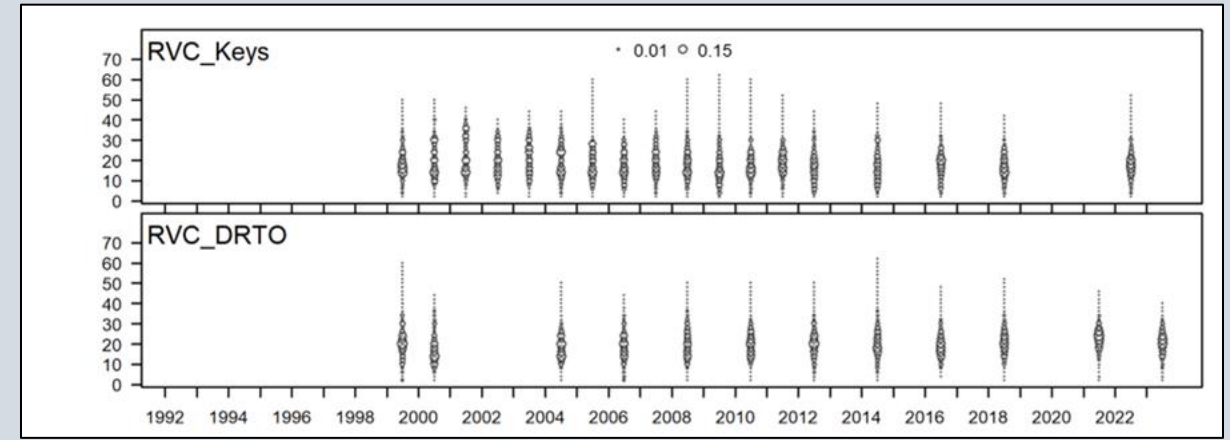
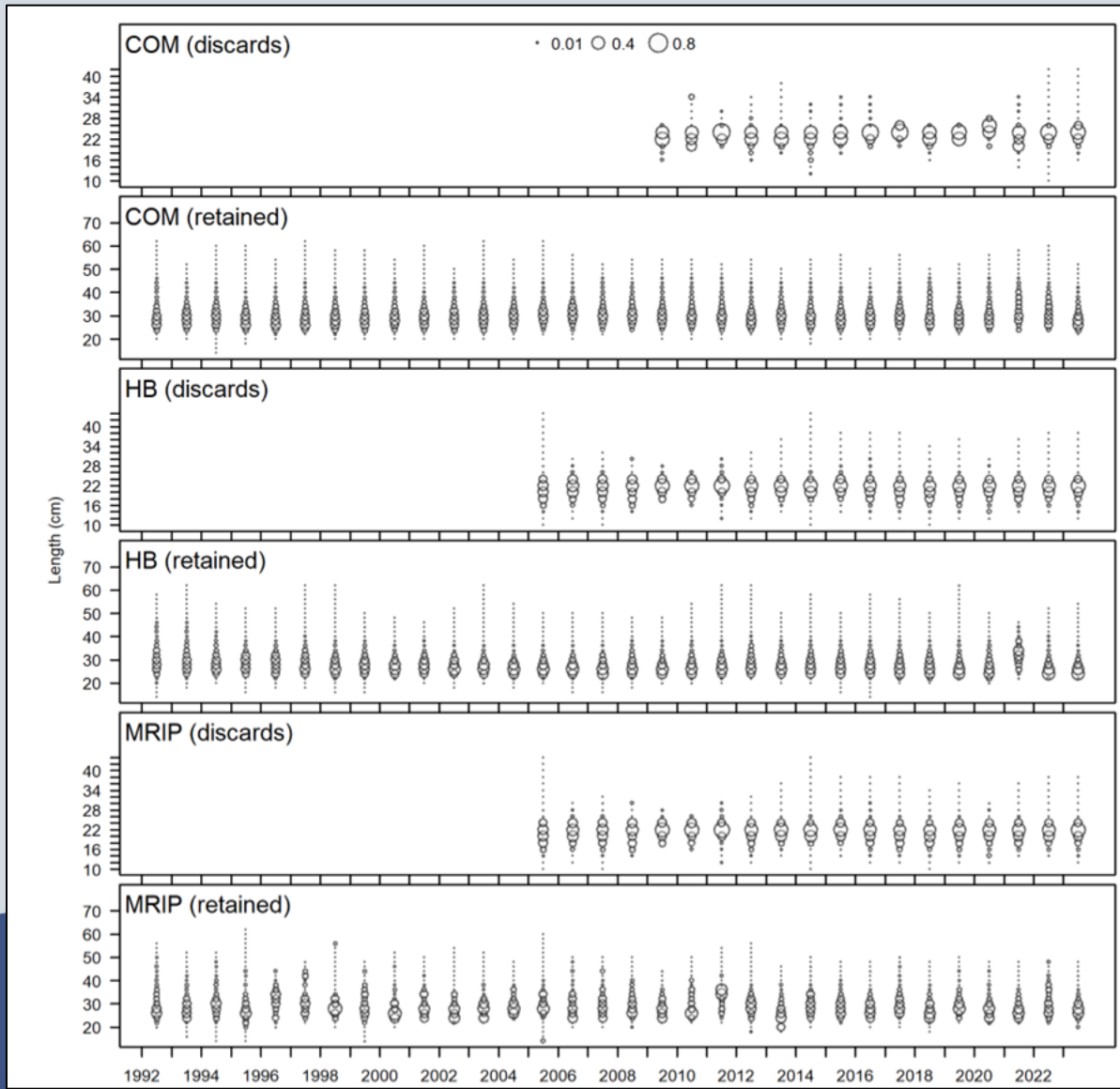
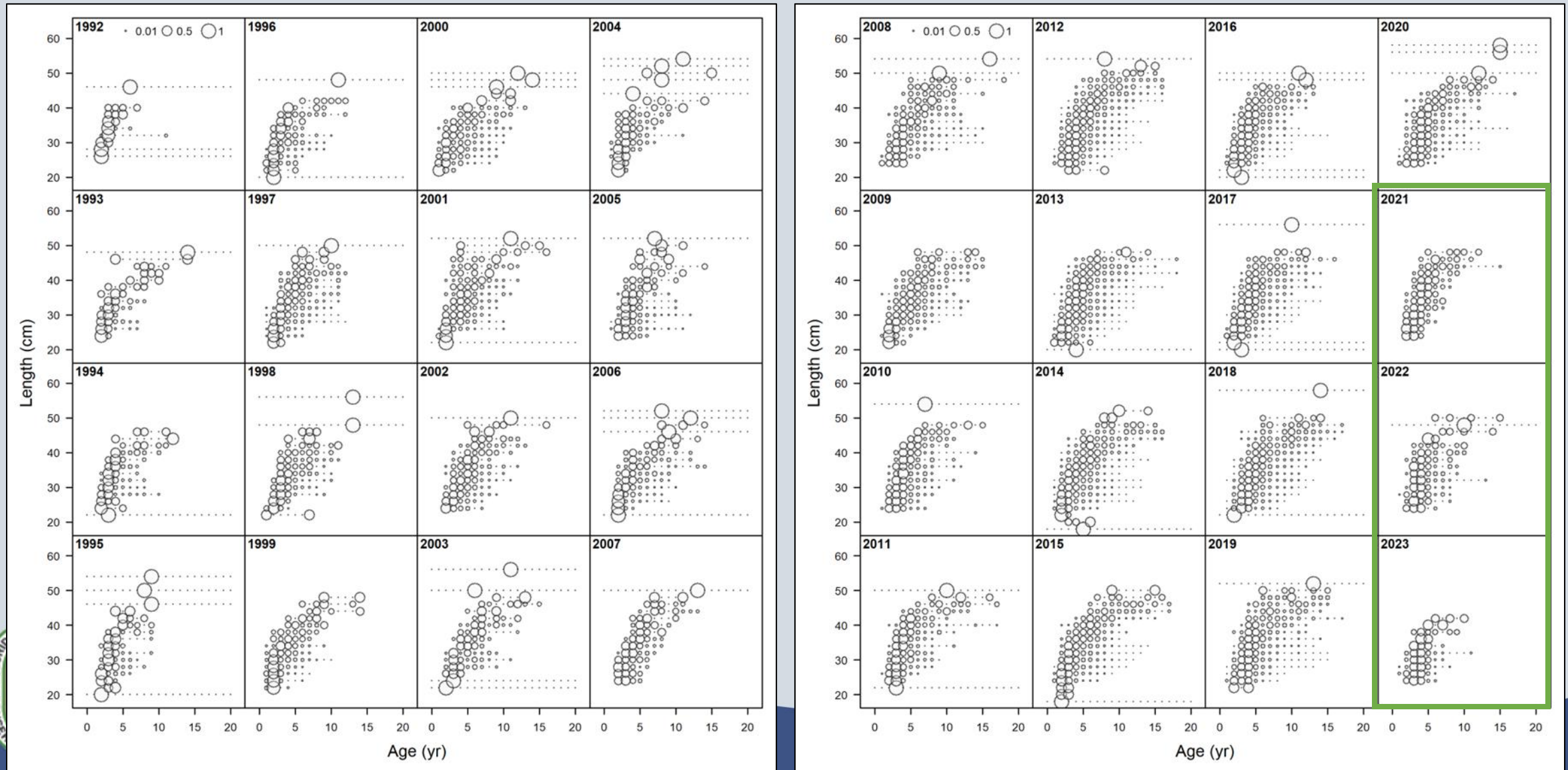


Figure 23

Updated Conditional Age-at-Length

Figure 24



Updated Conditional Age-at-Length

- Fishery-independent data
 - Smaller, younger fish
 - Lack of samples at asymptotic lengths
 - Poor estimator of L_{inf}

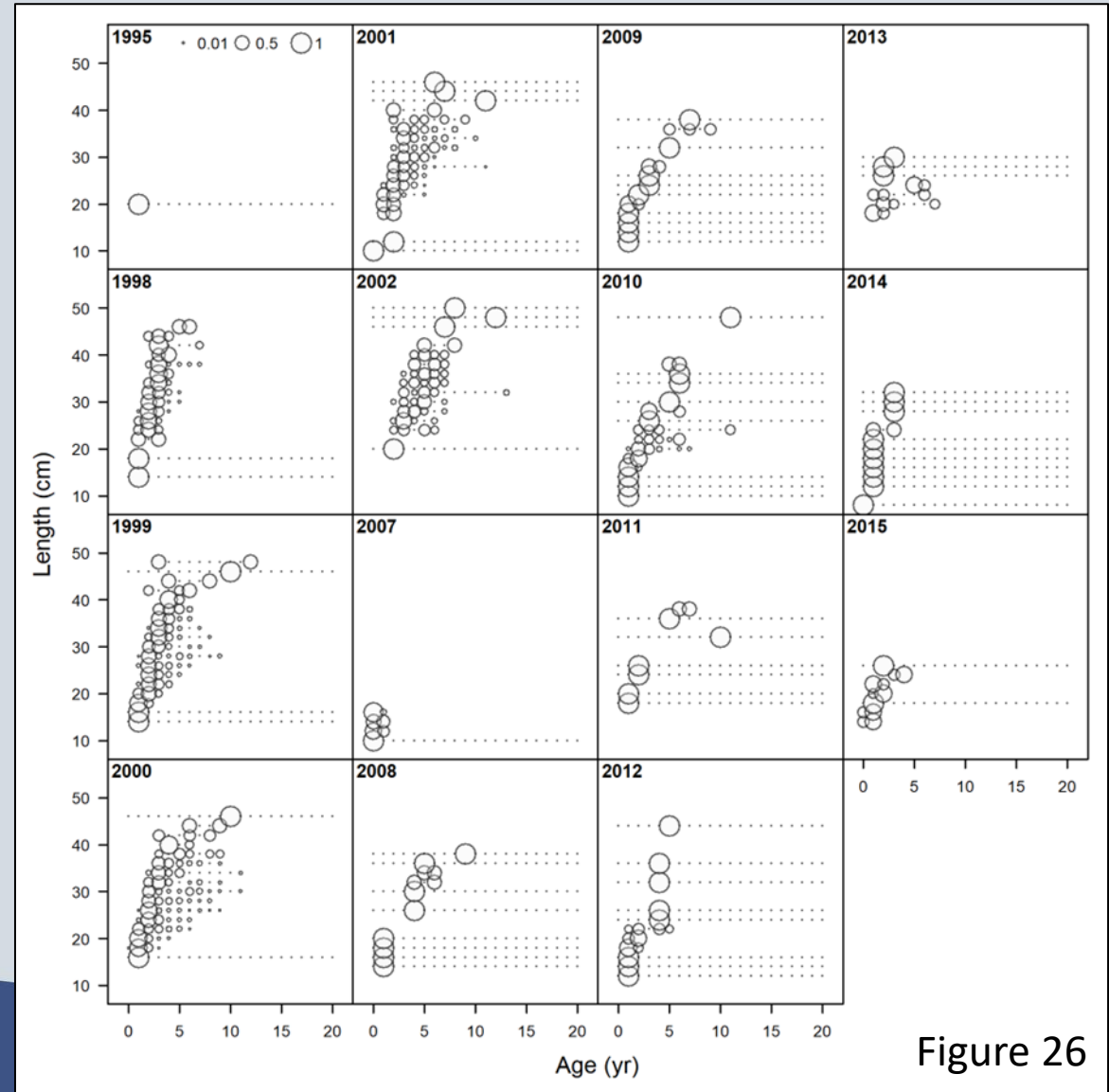
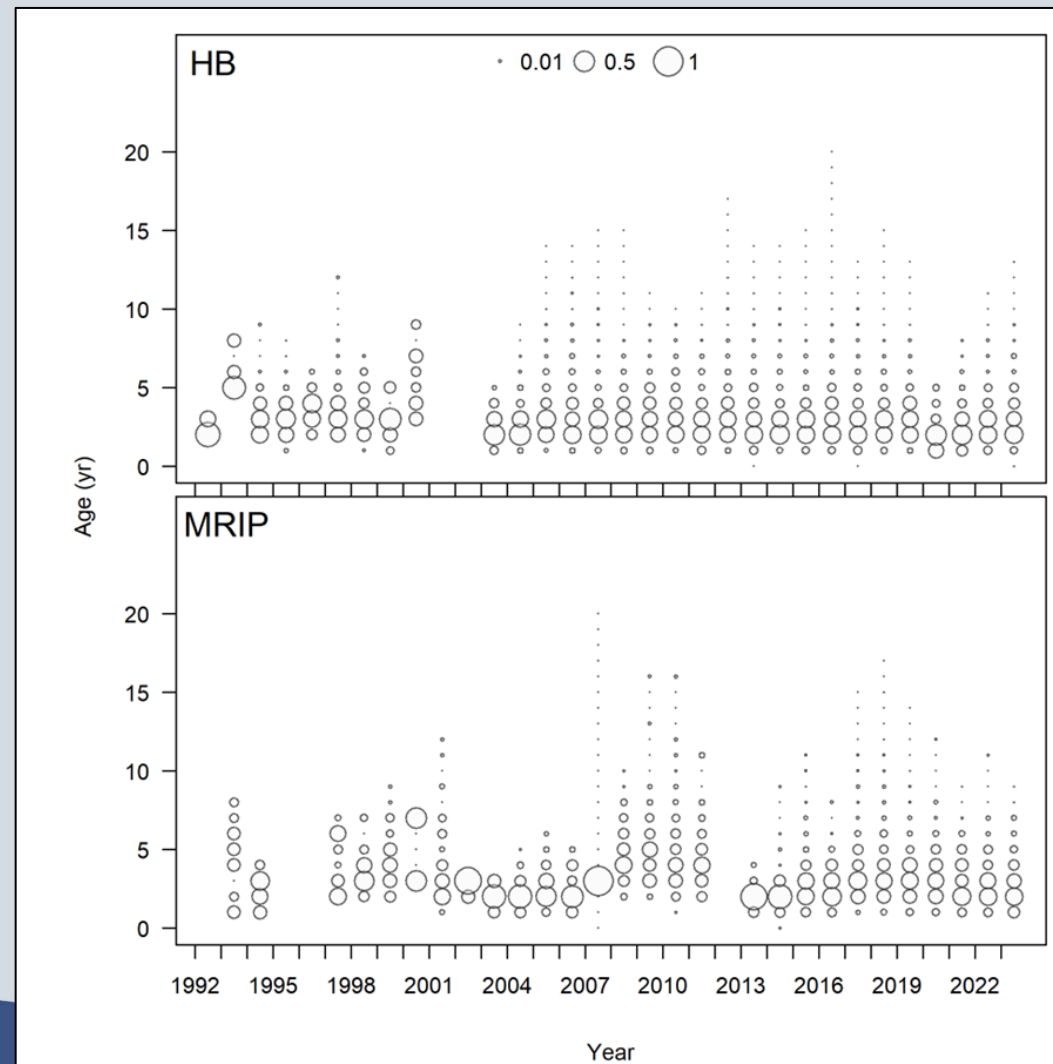
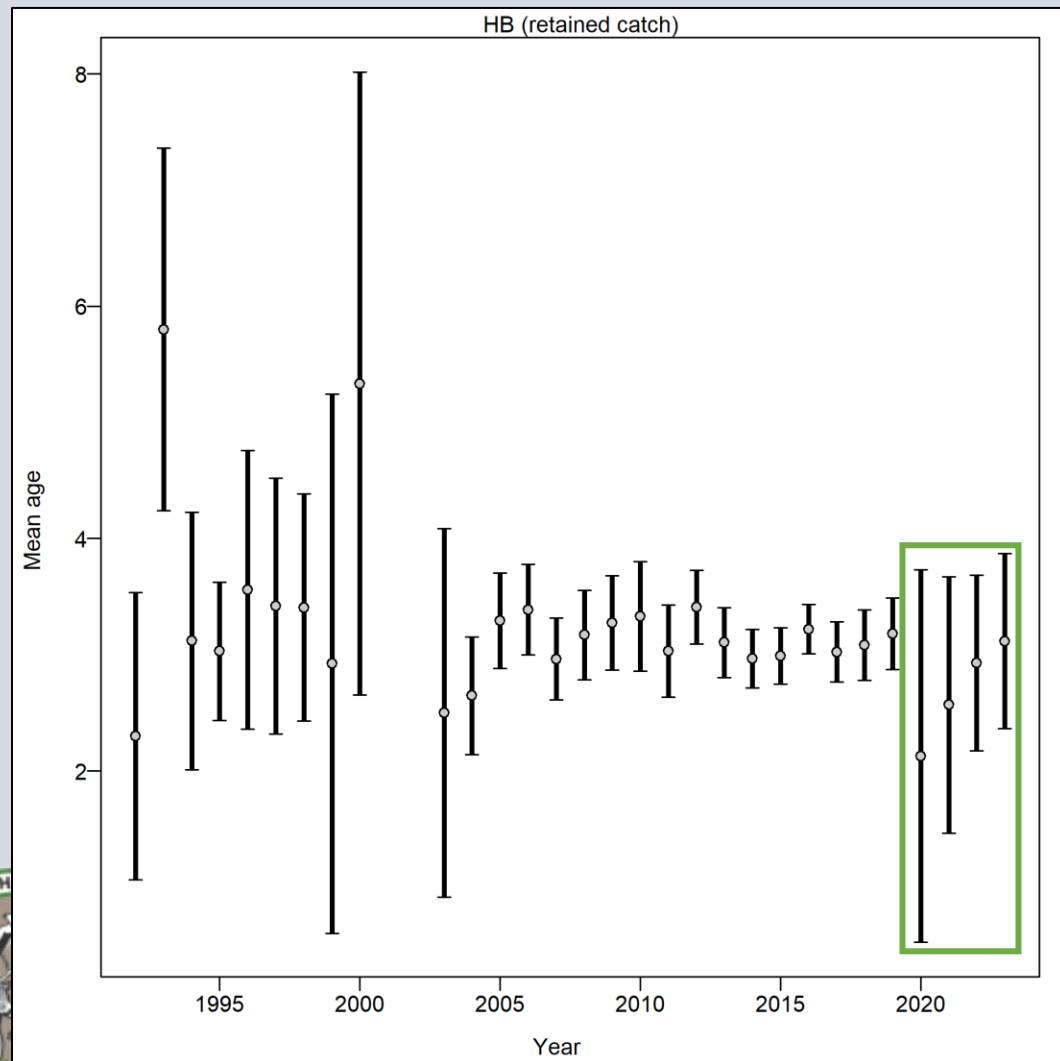


Figure 26



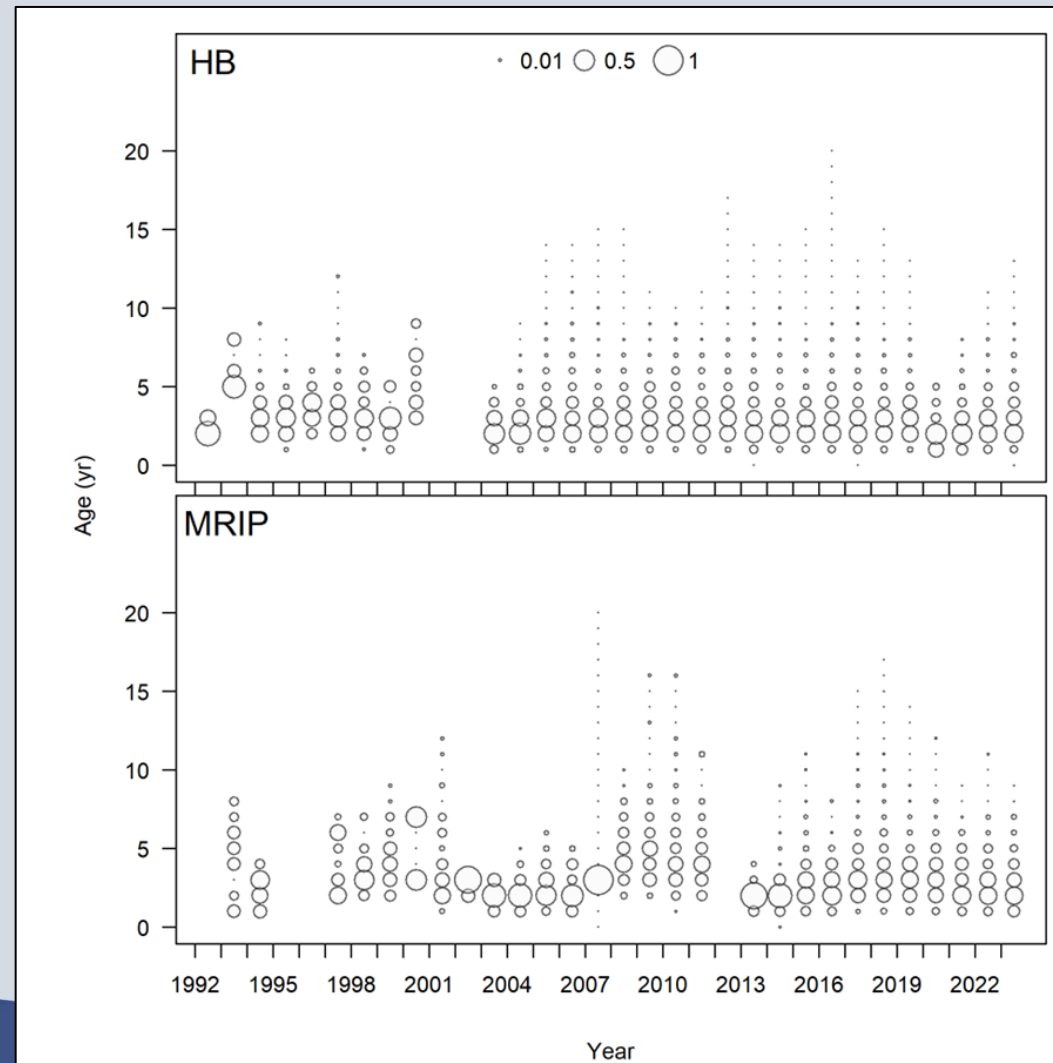
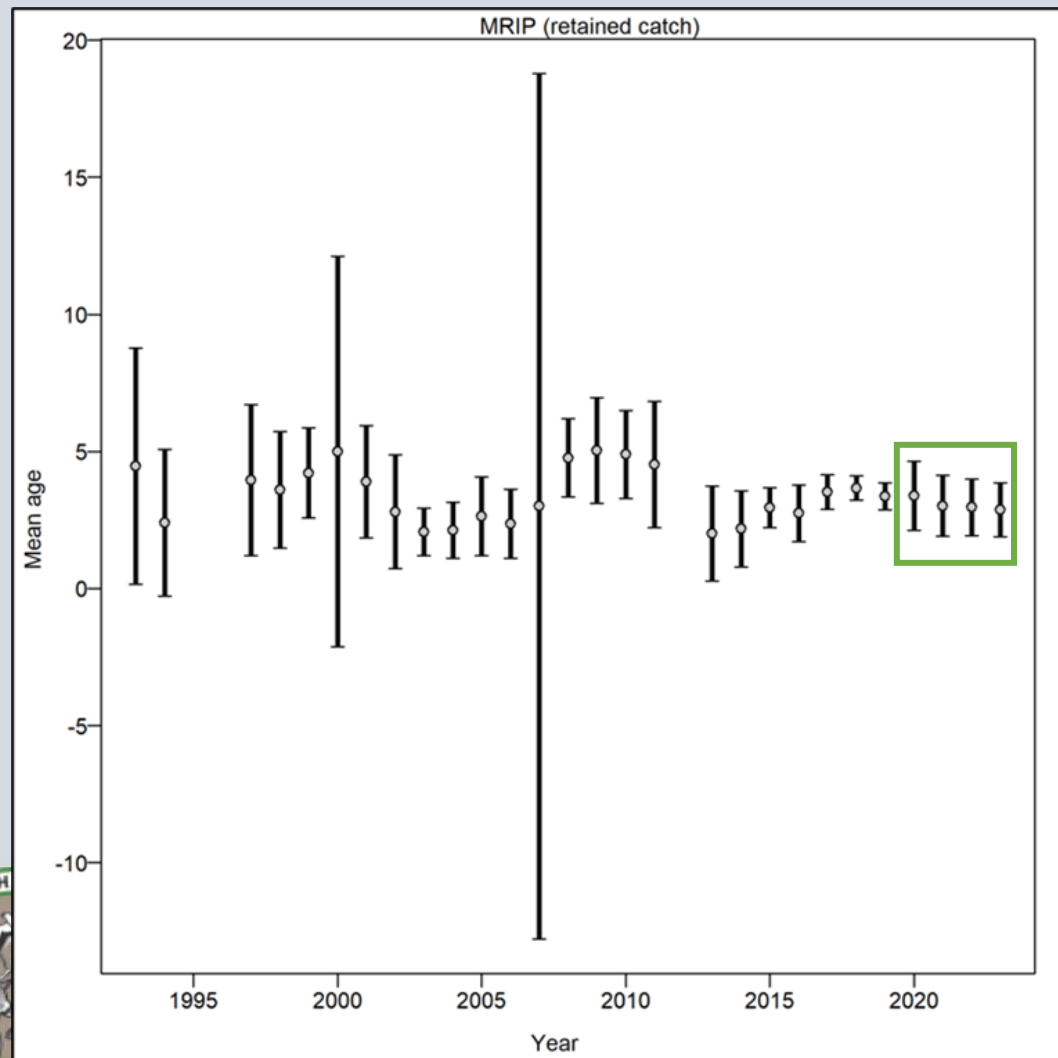
Updated Age Composition

Figure 25



Updated Age Composition

Figure 25





SEDAR 96: Yellowtail Snapper
Base Model Configuration

Base Model Configuration

Assessment Model

- Stock Synthesis v.3.30.15
 - SCA in the integrated analysis class
- Moderate complexity

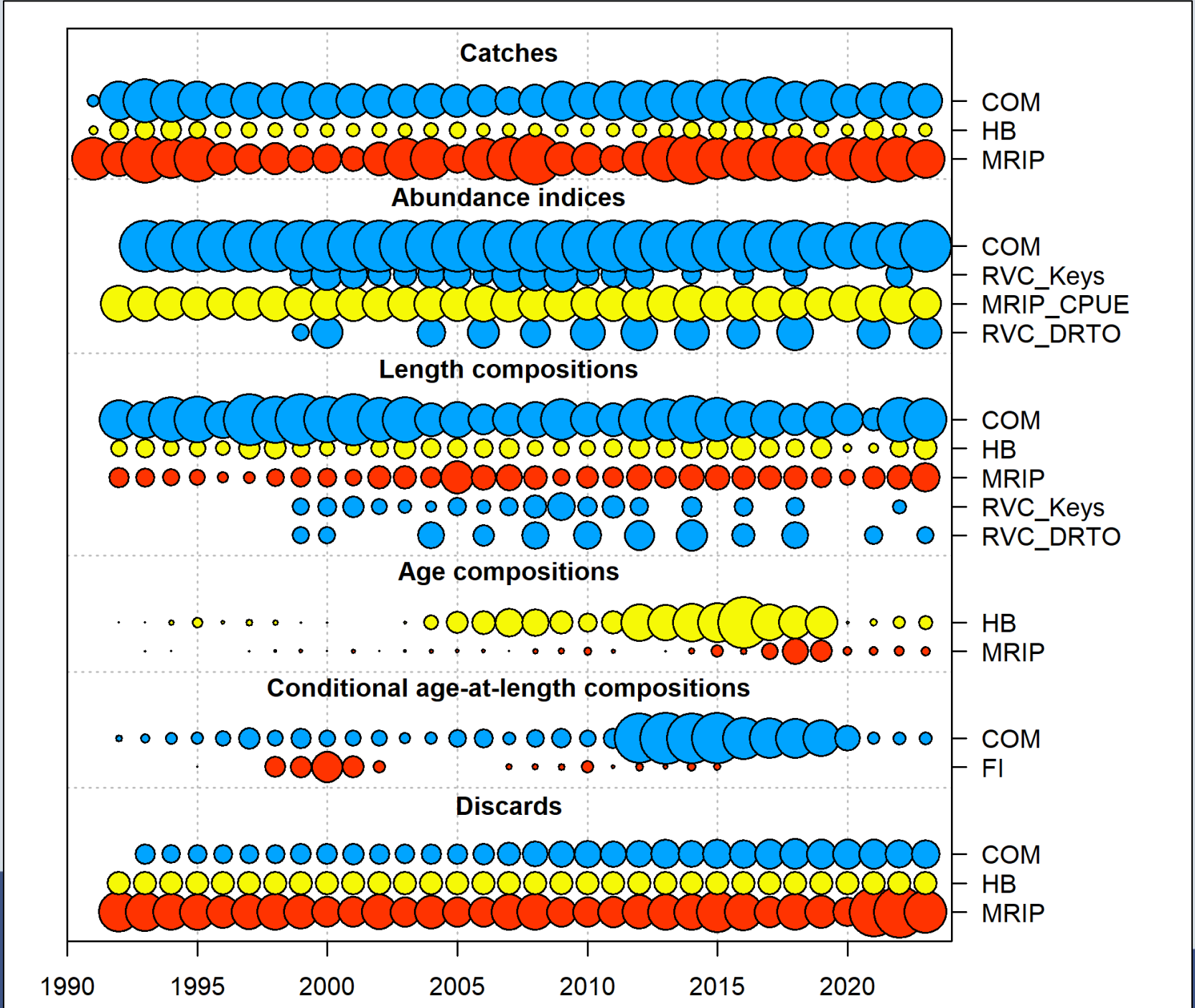
Spatio-temporal

- Years: 1992 – **2023**
 - 1980 – 1991 (early data period)
- 1 season (annual), 1 area (Florida)
- Spawning: January
- Settlement: January at age 0, 2 cm FL

Life History

- Estimated growth using VB growth model
 - External parameters as initial values
- Ages 0 – 20 years in the model
- Natural mortality: Fixed vector by age (Lorenzen 2005)
- Length-Weight: fixed
- Maturity: Fixed vector by age
- Fecundity = Spawning biomass at length
- Combined sex model with female-only SSB ($\text{frac_female} = 0.5$)





Base Model Configuration

Fleet Selectivity

- Commercial
 - Selectivity: Simple logistic (flat-topped)
 - Estimated Retention (flat-topped)
 - Discard Mortality = 10%
- Headboat
 - Selectivity: Double normal (dome)
 - Estimated Retention (flat-topped)
 - Discard Mortality = 10%
- MRIP SRFS
 - Selectivity: Double normal (dome)
 - Estimated Retention (flat-topped)
 - Discard Mortality = 10%

Index Selectivity (Updated)

- Commercial CPUE
 - Linked to Commercial fleet
 - Catchability Time Block: 2009 - 2023
- RVC Florida Keys
 - Selectivity: Double normal (dome)
 - Constant catchability
- RVC Dry Tortugas
 - Selectivity: Double normal (dome)
 - Constant catchability
- MRIP CPUE
 - Selectivity: Mirrored to MRIP SRFS fleet
 - Constant catchability



Base Model Configuration

Recruitment Dynamics (Updated)

- Beverton-Holt stock-recruitment relationship
 - Virgin recruitment in log-space ($\ln(R0)$), the standard deviation of log of recruitment (σR), and *steepness* estimated in model
- Simple recruitment deviations
 - no sum-to-zero constraint
- Early recruitment deviations
 - 1981 – 1990 (period of lower data-richness)
- Main recruitment deviations
 - 1991 – **2023** (period of higher data-richness)
- Bias adjustments (following Methot and Taylor 2011)
 - Updated in the base model



Base Model Configuration

Parameters (Updated)

- 88 out of 123 parameters estimated
 - Selectivity at first length bin (2cm) parameter for double normal (fixed)
 - Estimated values mostly consistent with S64 Base Model

Priors

- Symmetric betas on initial fishing mortality rates for Commercial, Headboat, and MRIP SRFS fleets

Lambda

- No emphasis on model fit (=0)
 - Initial equilibrium catch for all three fleets

Fishing Mortality Rates

- F_{hybrid}
- Reporting on age 4



Base Model Configuration

Model Convergence Criteria

- Total likelihood (sum of individual data source component's likelihoods)
- Invertible Hessian matrix
- Maximum gradient <0.0001

Error Structure

- Assumed log-normal for all landings, indices, and discard data (except commercial discards)


Multinomial Distribution (Updated)

- Length composition (all fleets)
- Age composition (HB, MRIP SRFS)
- Conditional age-at-length data (Comm, FI)

Data Weighting (Updated)

- Length composition and conditional age-at-length data
- Initial sample sizes equal to number of trips or number of fish
- Iterative re-weighting following Francis (2011; Updated)



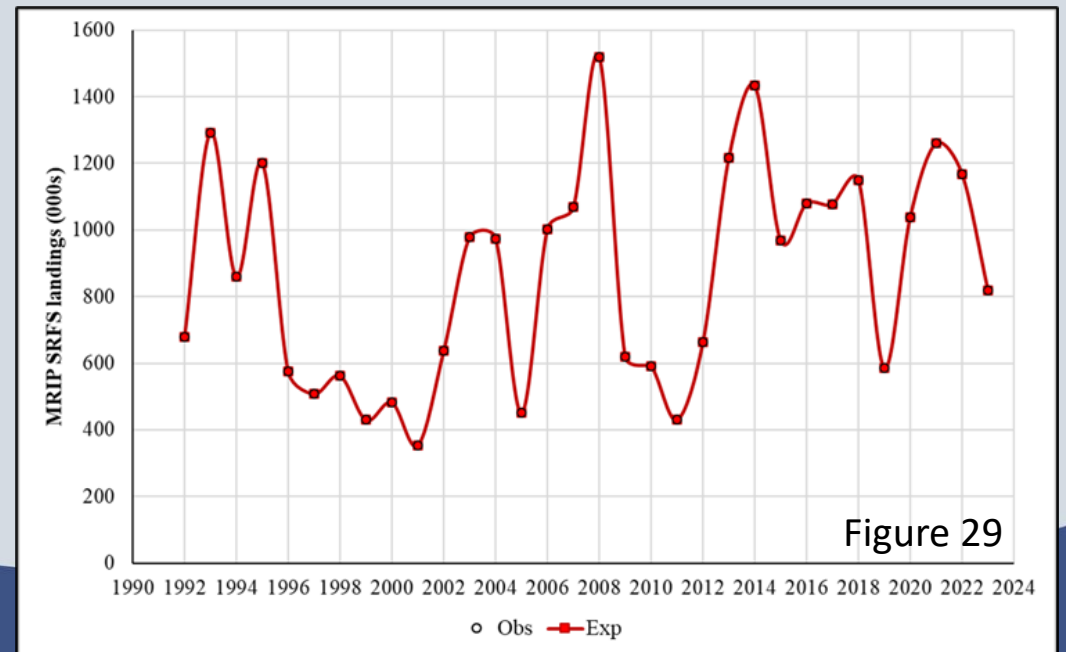
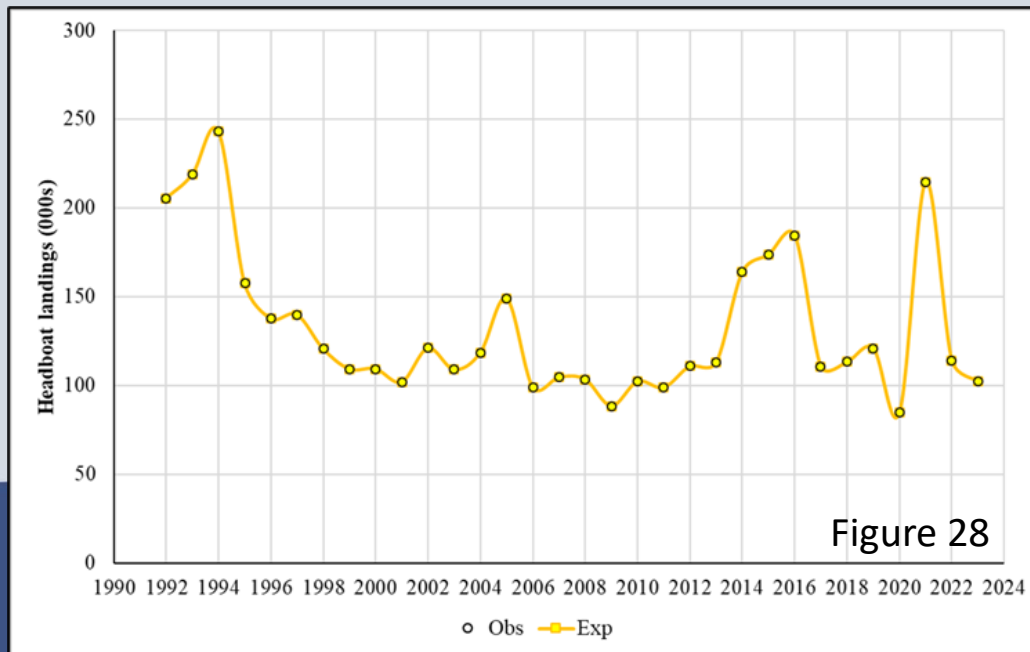
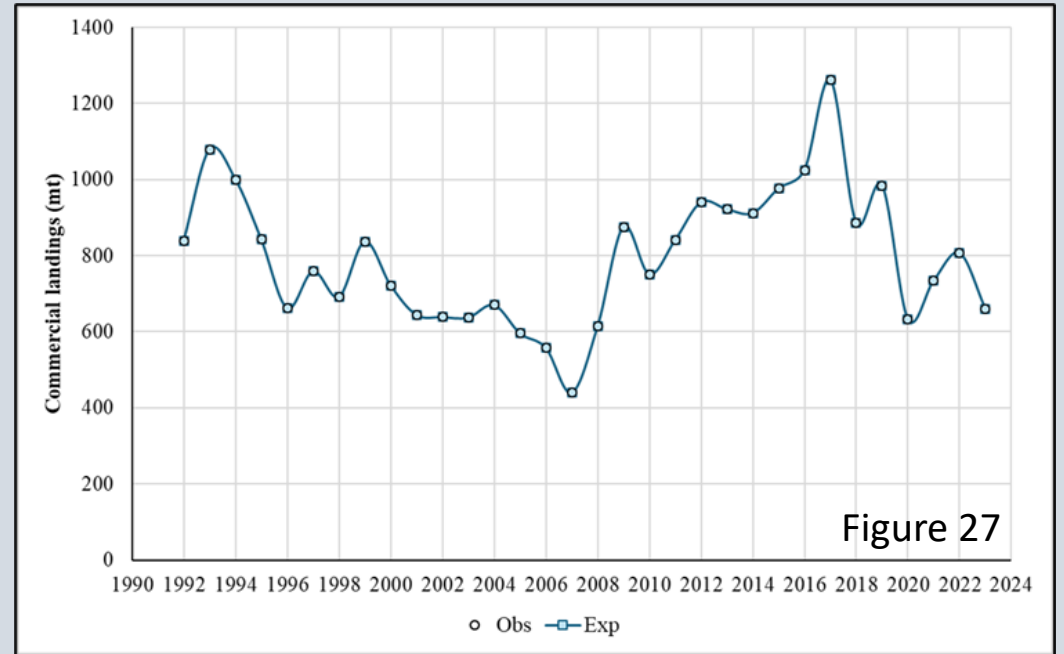
A school of yellowtail snappers swimming in clear blue water. The fish are characterized by their yellow and silver stripes and prominent yellow tails. They are swimming in various directions, creating a sense of movement and depth.

SEDAR 96: Yellowtail Snapper Base Model Results

Landings

Observed vs. expected

- Landings fit near exact
- F_{hybrid} approach



Discards

Observed vs. expected

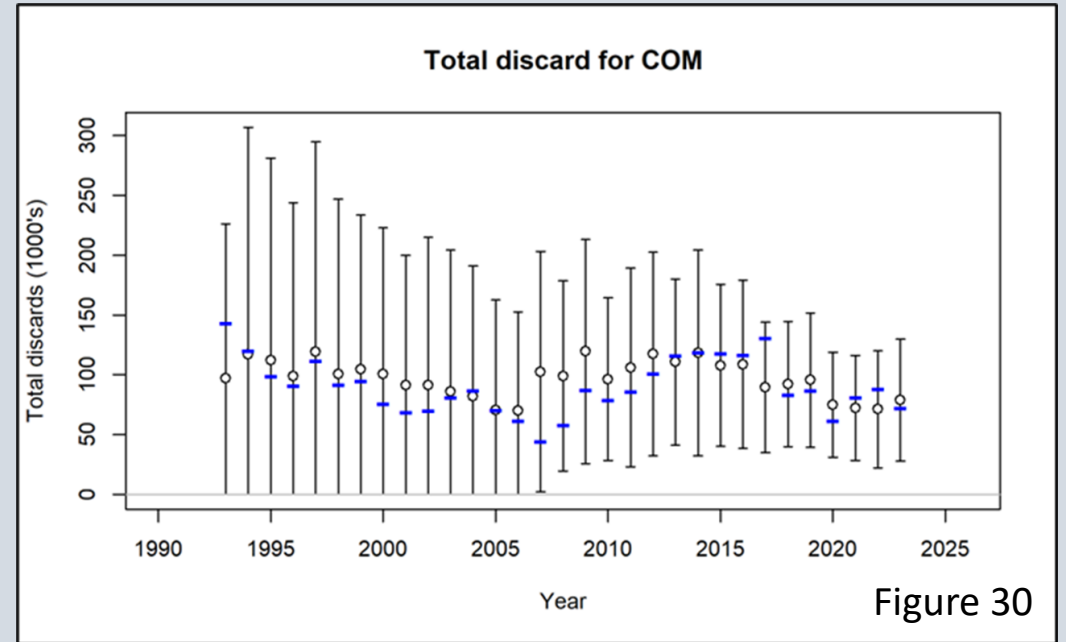


Figure 30

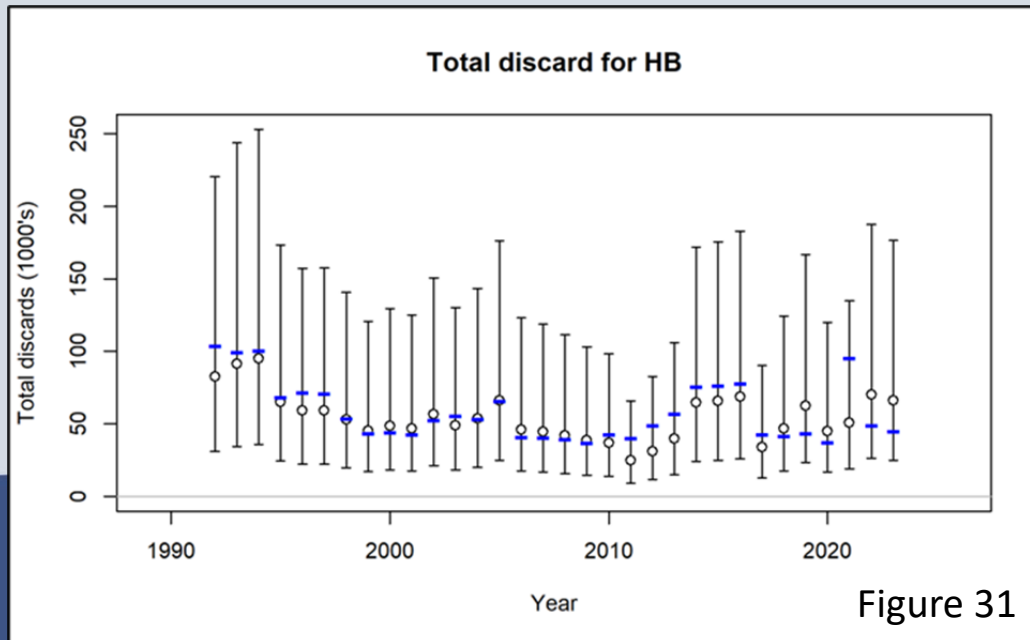


Figure 31

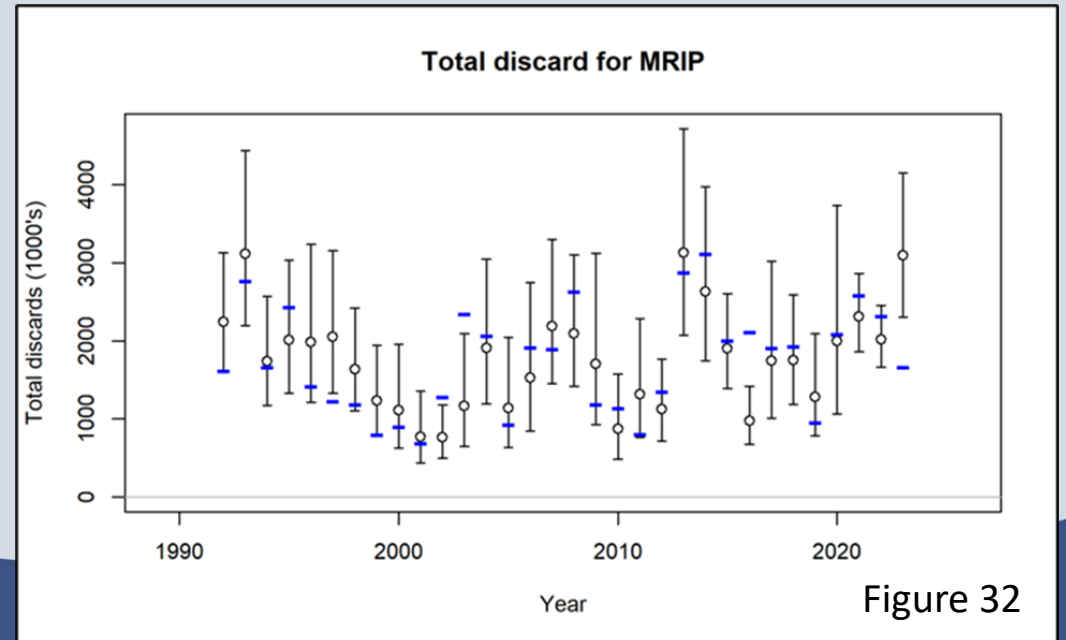
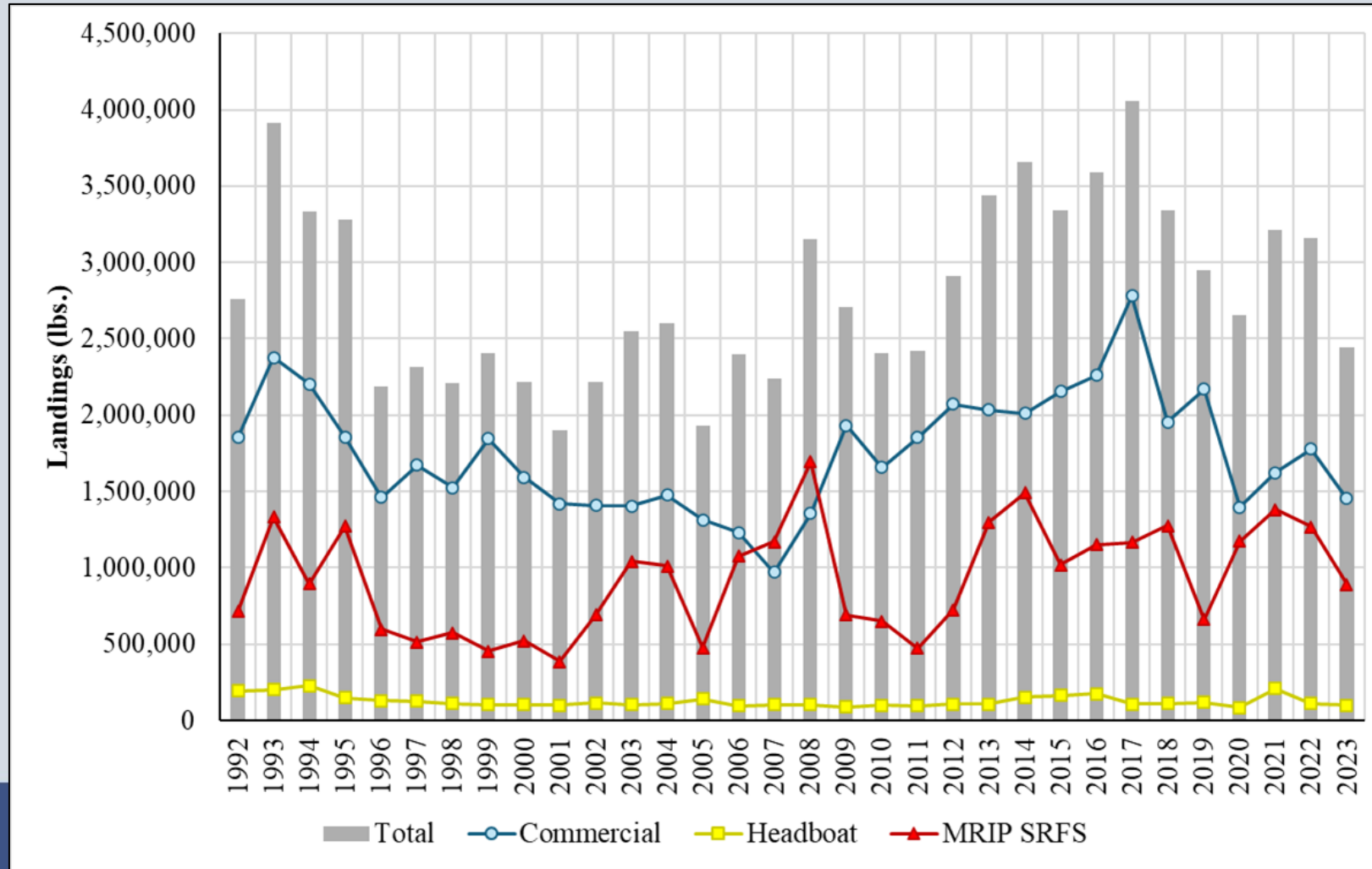


Figure 32



Model Estimated Landings (lbs.)

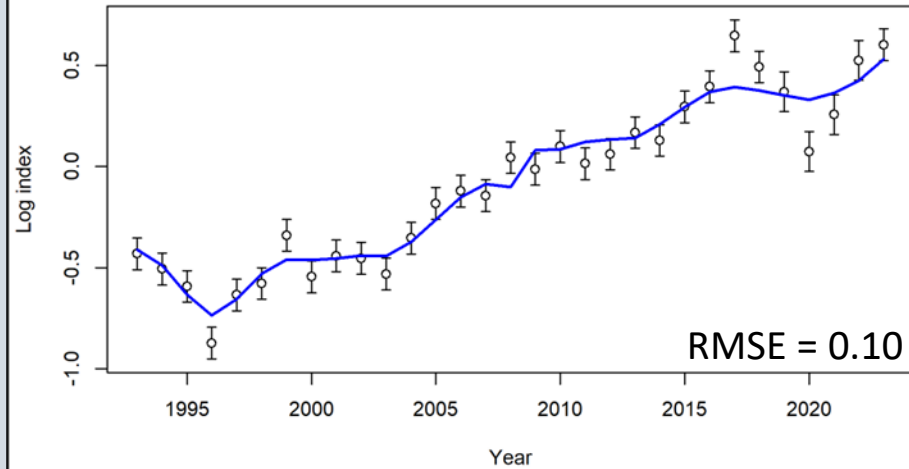


adapted from Figure 33

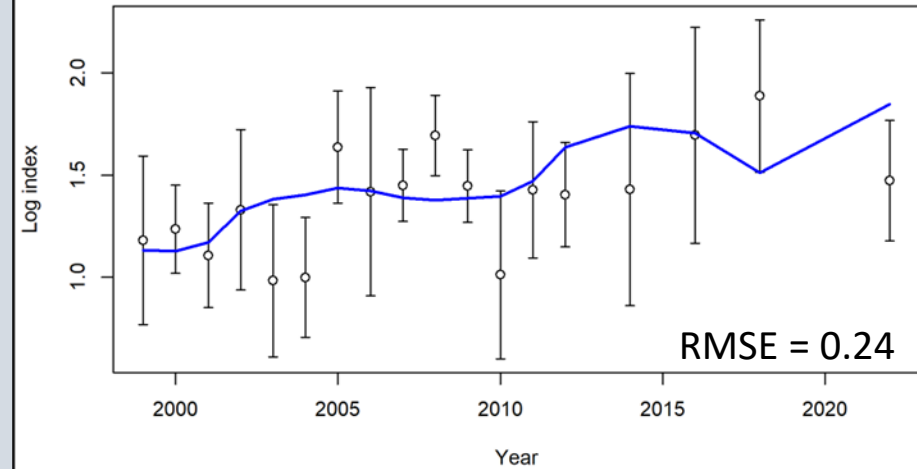


Indices of Abundance

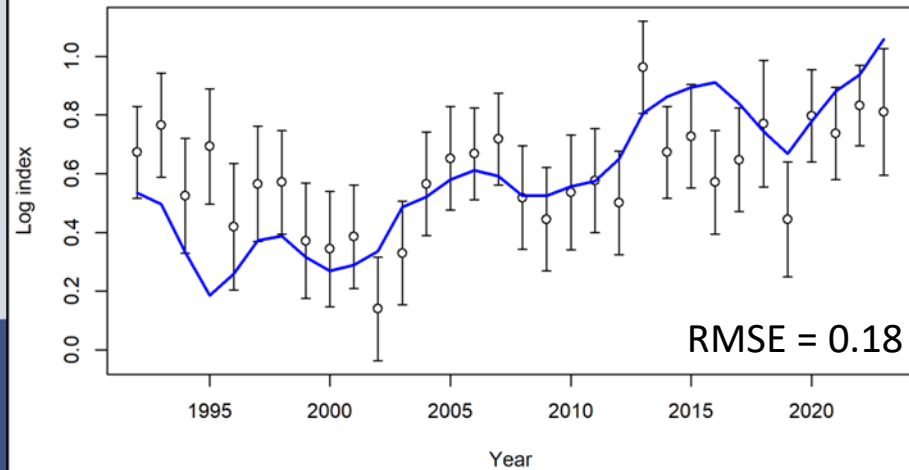
Commercial CPUE (Figure 35)



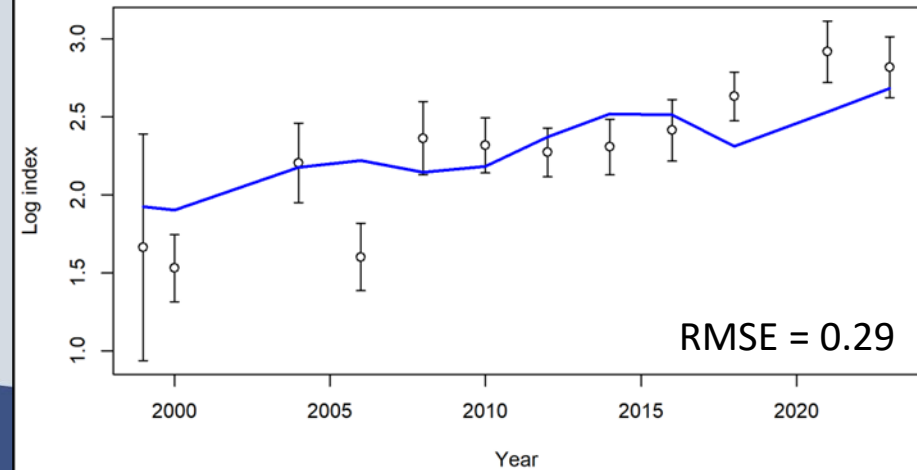
RVC Florida Keys (Figure 37)



MRIP CPUE (Figure 36)



RVC Dry Tortugas (Figure 38)



Length Composition

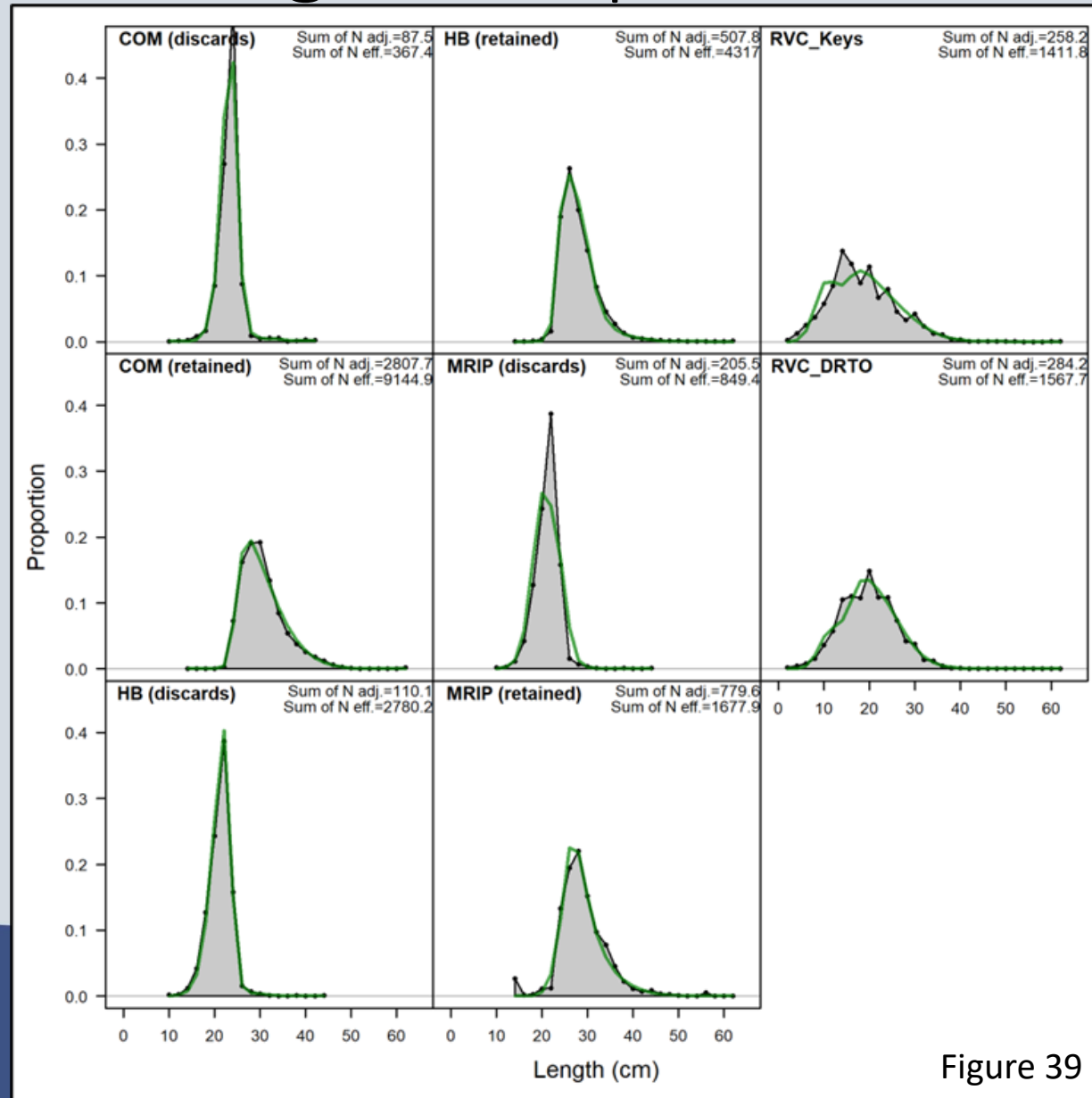
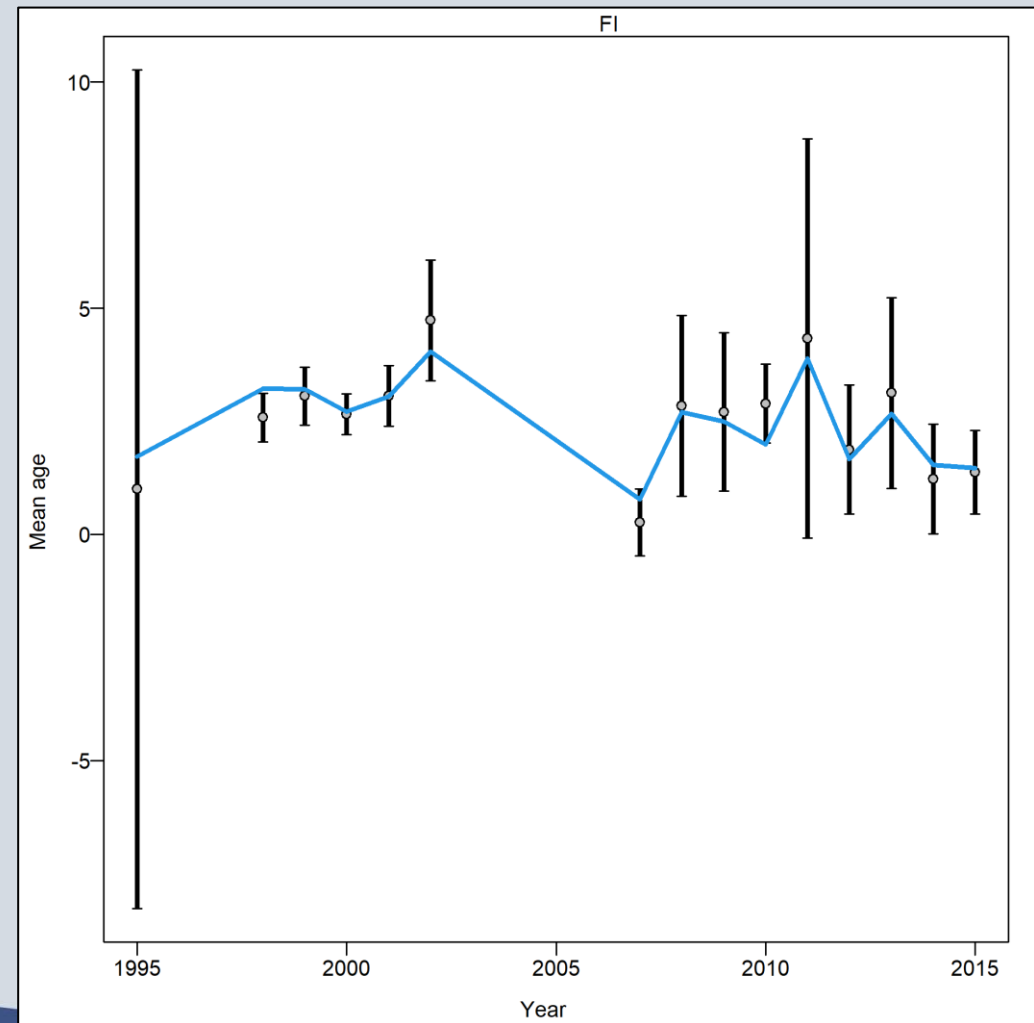
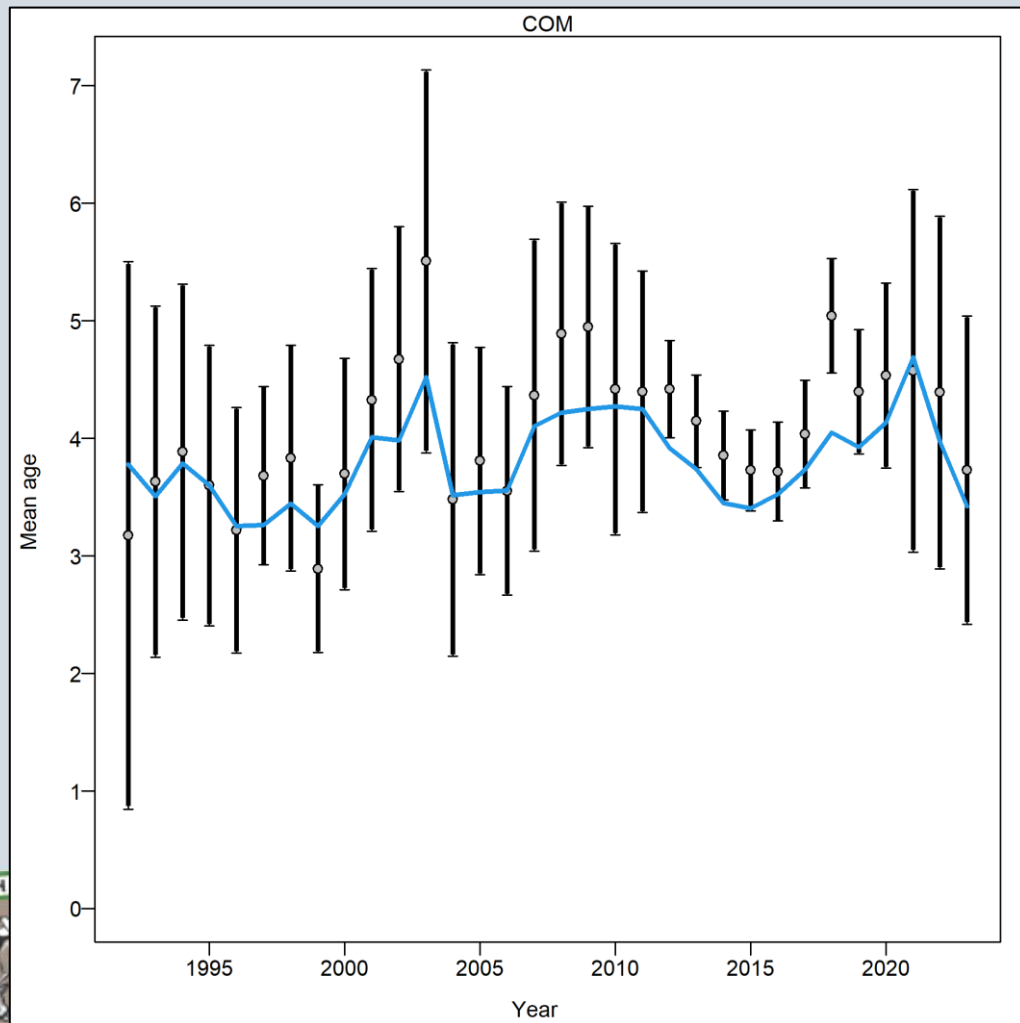


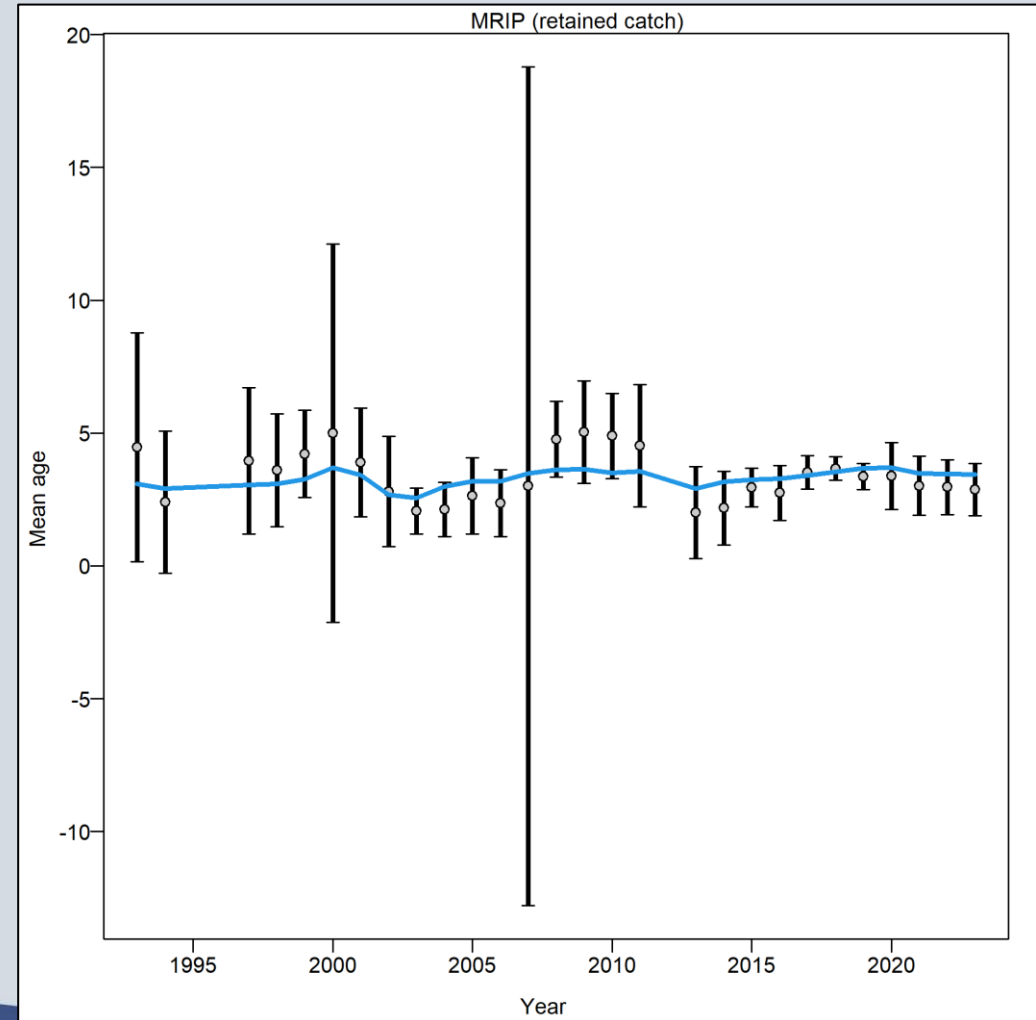
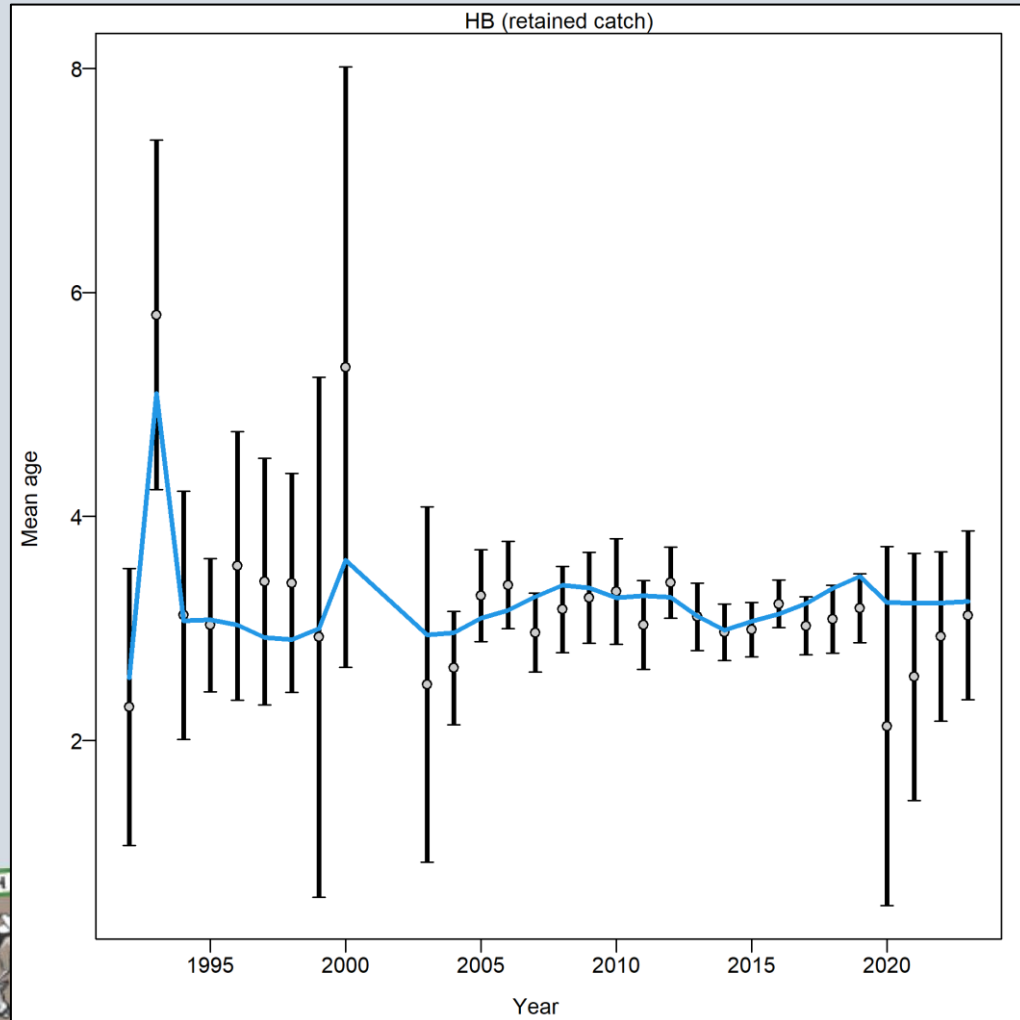
Figure 39



Conditional Age-at-Length



Age Composition



Total and Spawning Stock Biomass

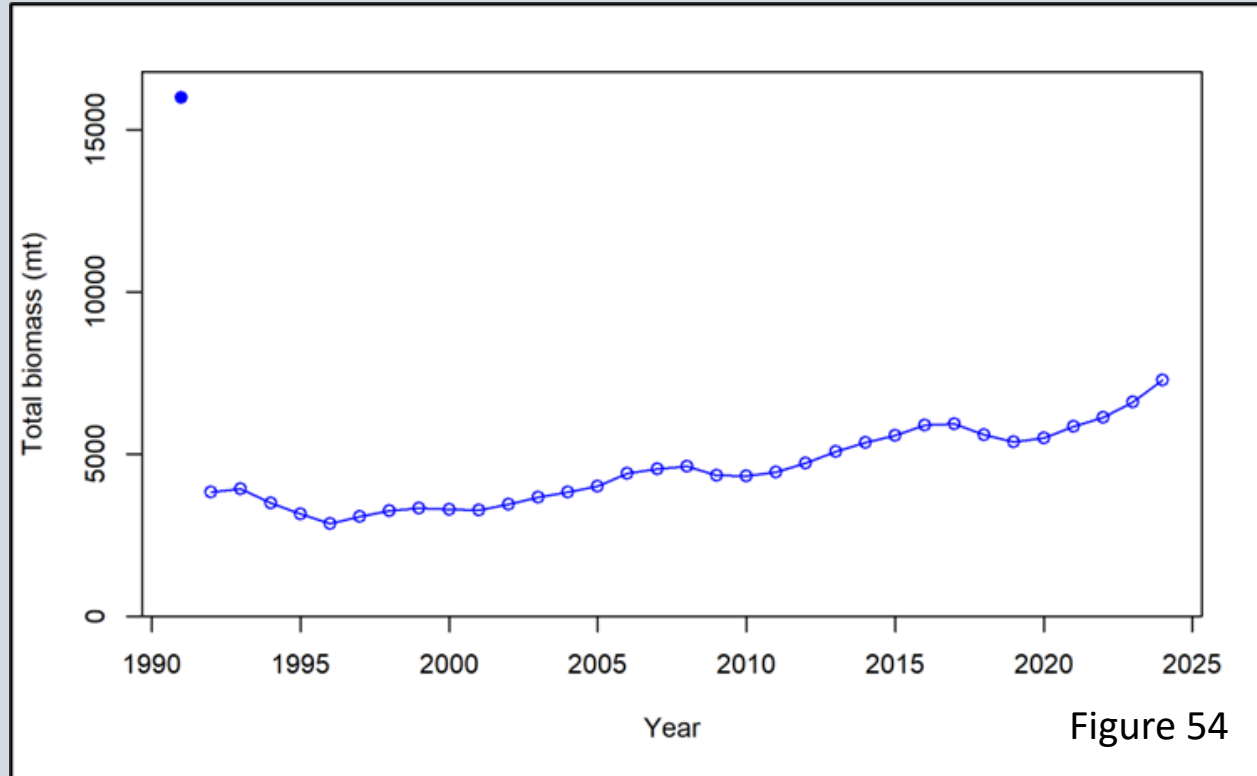


Figure 54

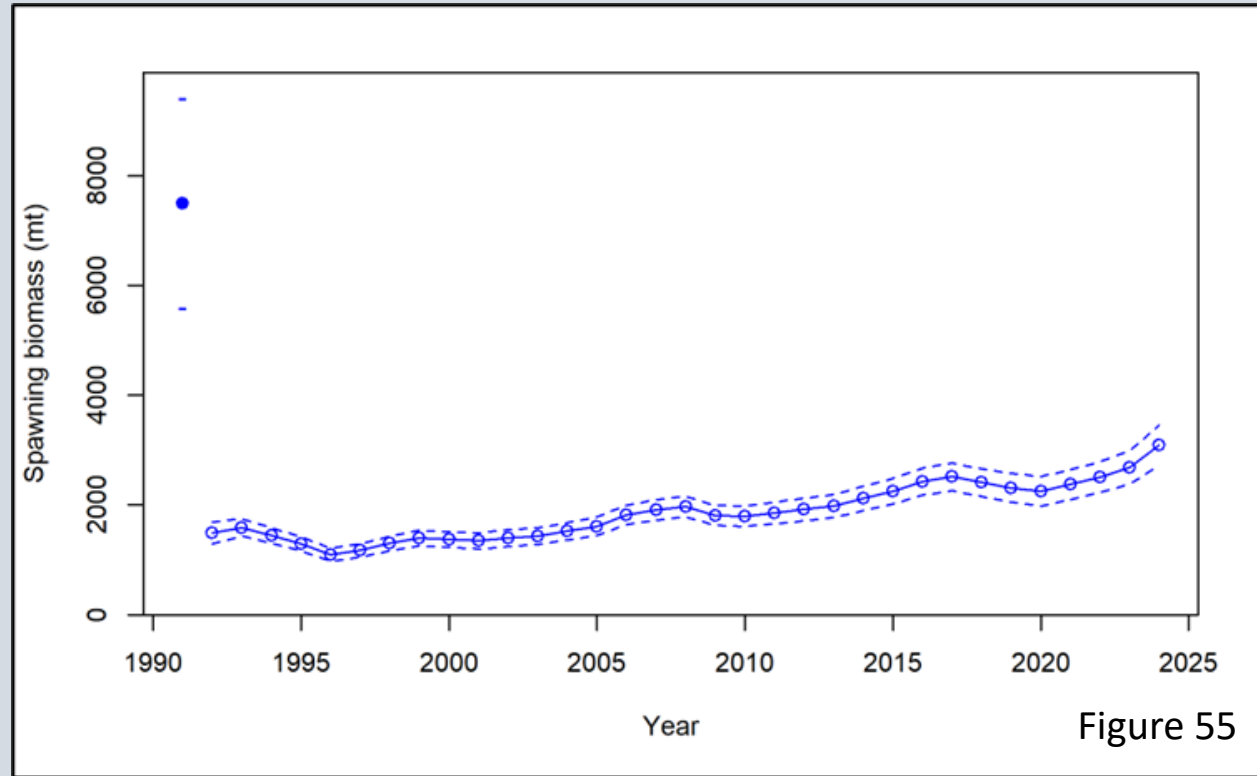
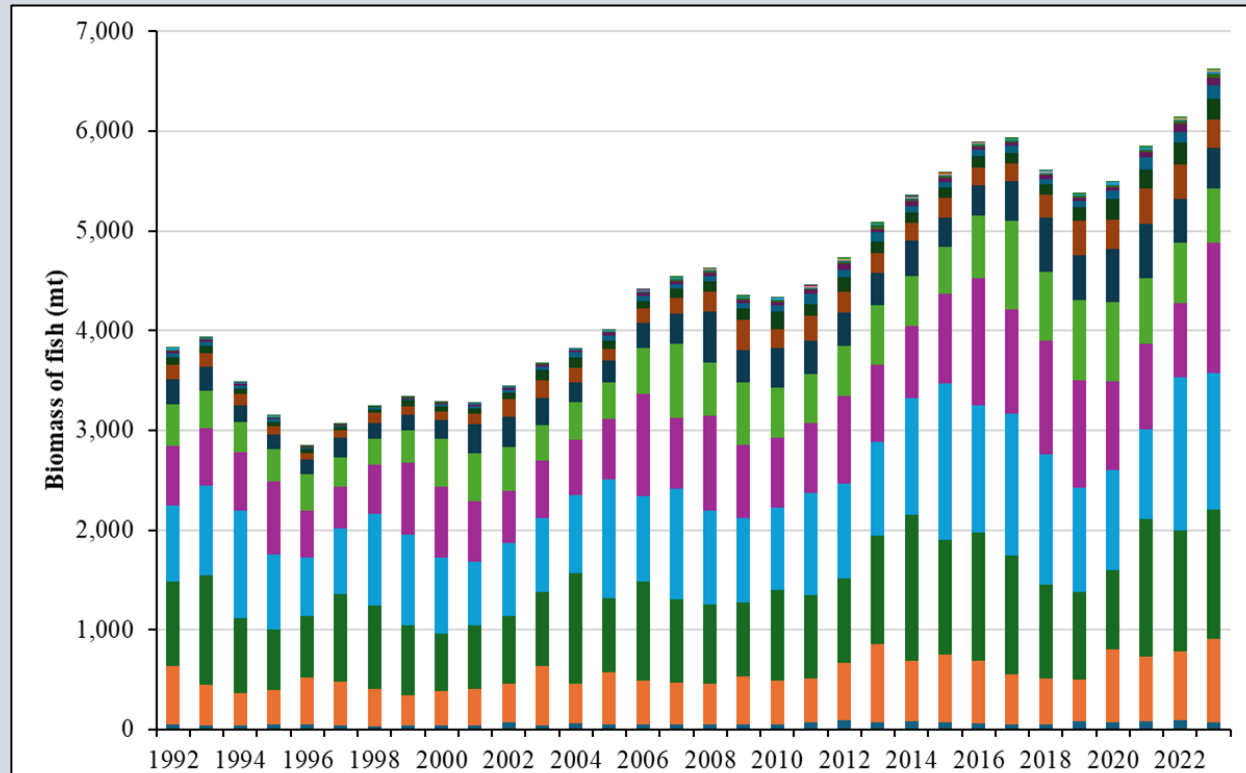
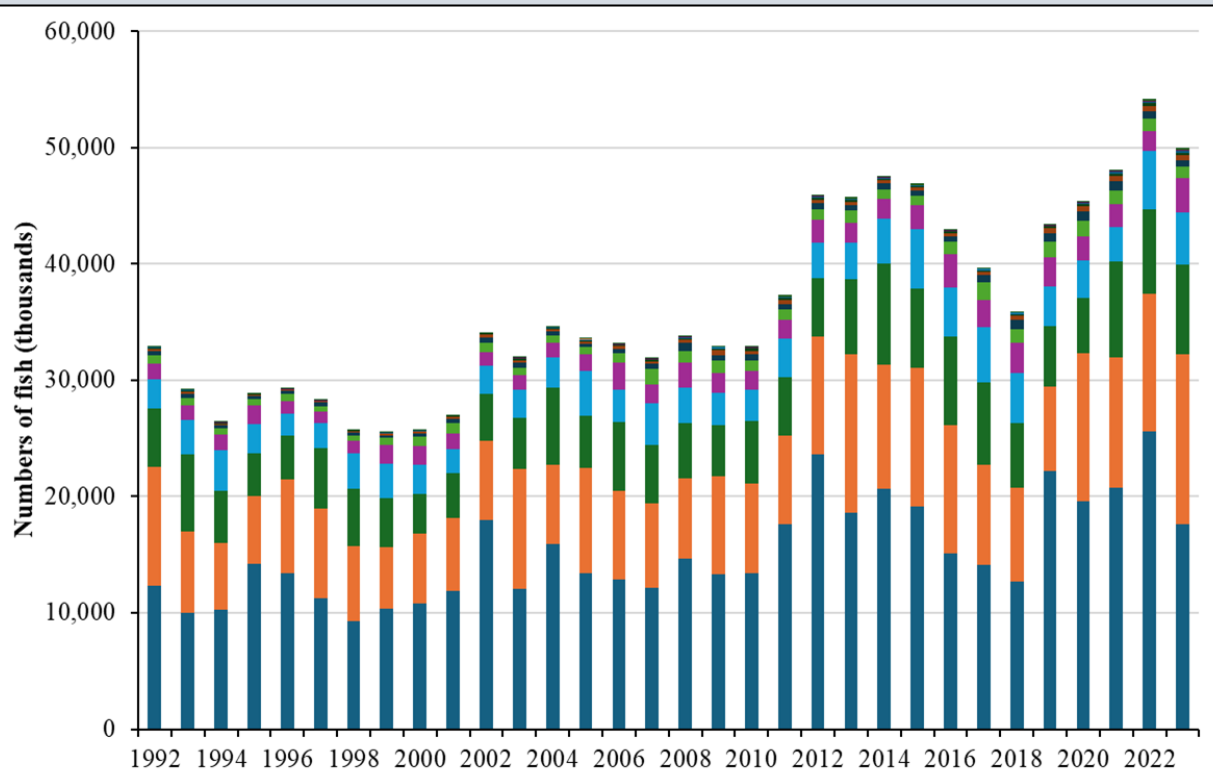


Figure 55



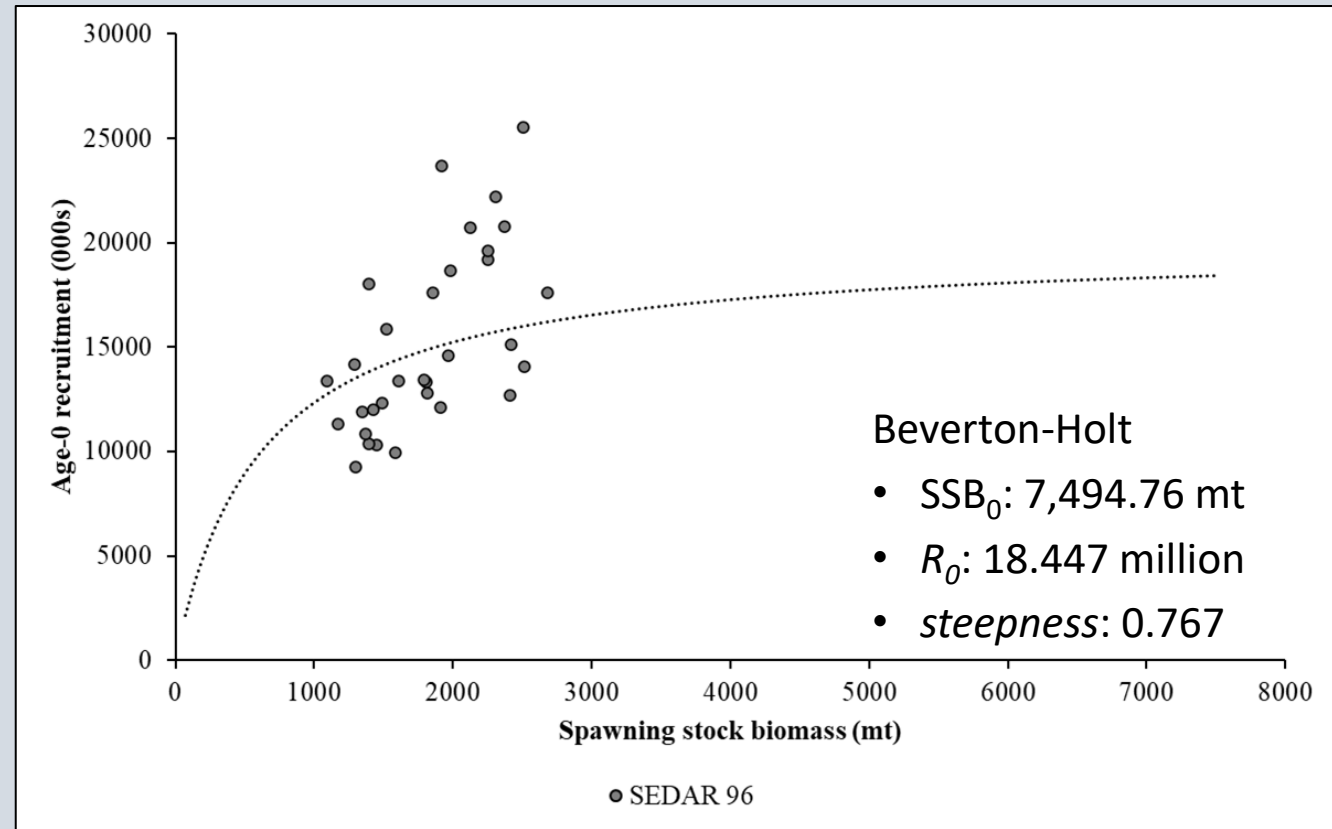
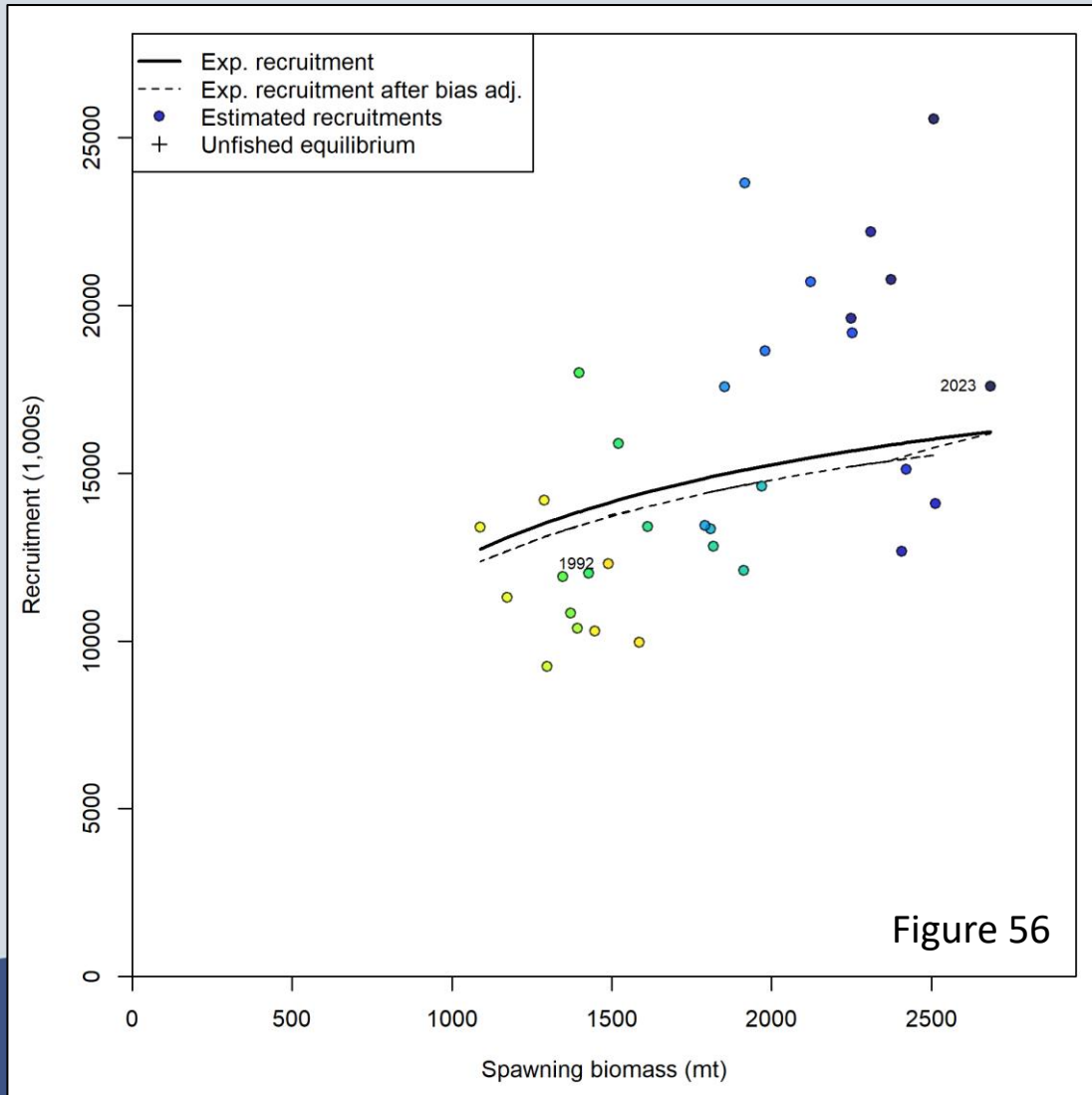
Numbers- and Biomass-at-Age



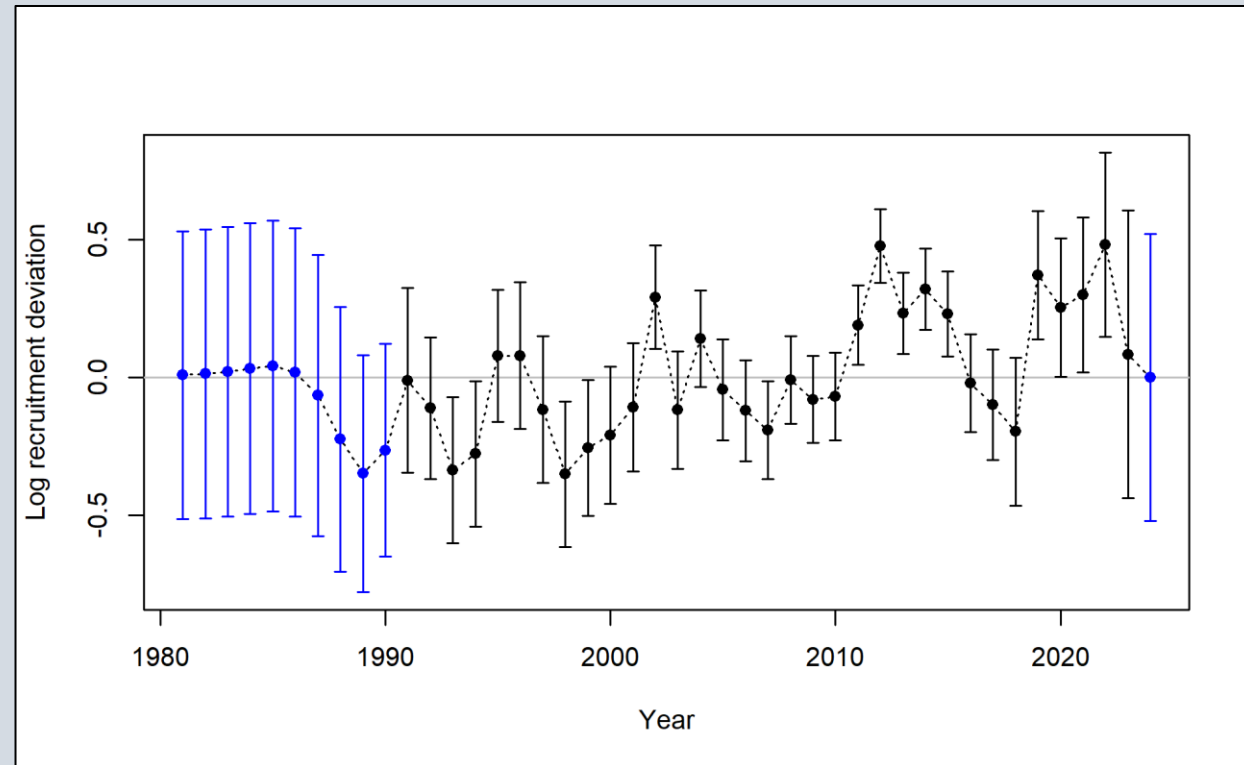
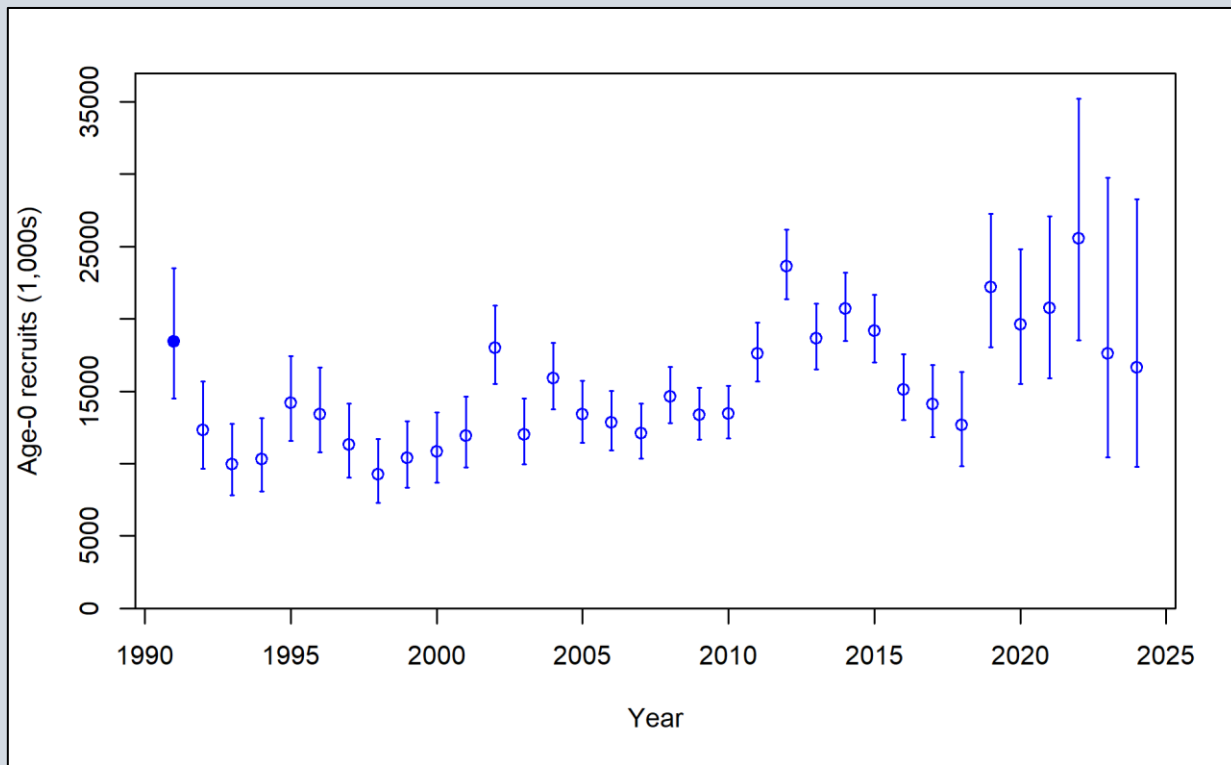
■ Age-0
 ■ Age-1
 ■ Age-2
 ■ Age-3
 ■ Age-4
 ■ Age-5
 ■ Age-6
 ■ Age-7



Stock-recruitment



Estimated Recruitment



adapted from Figure 57



Fishing Mortality Rates

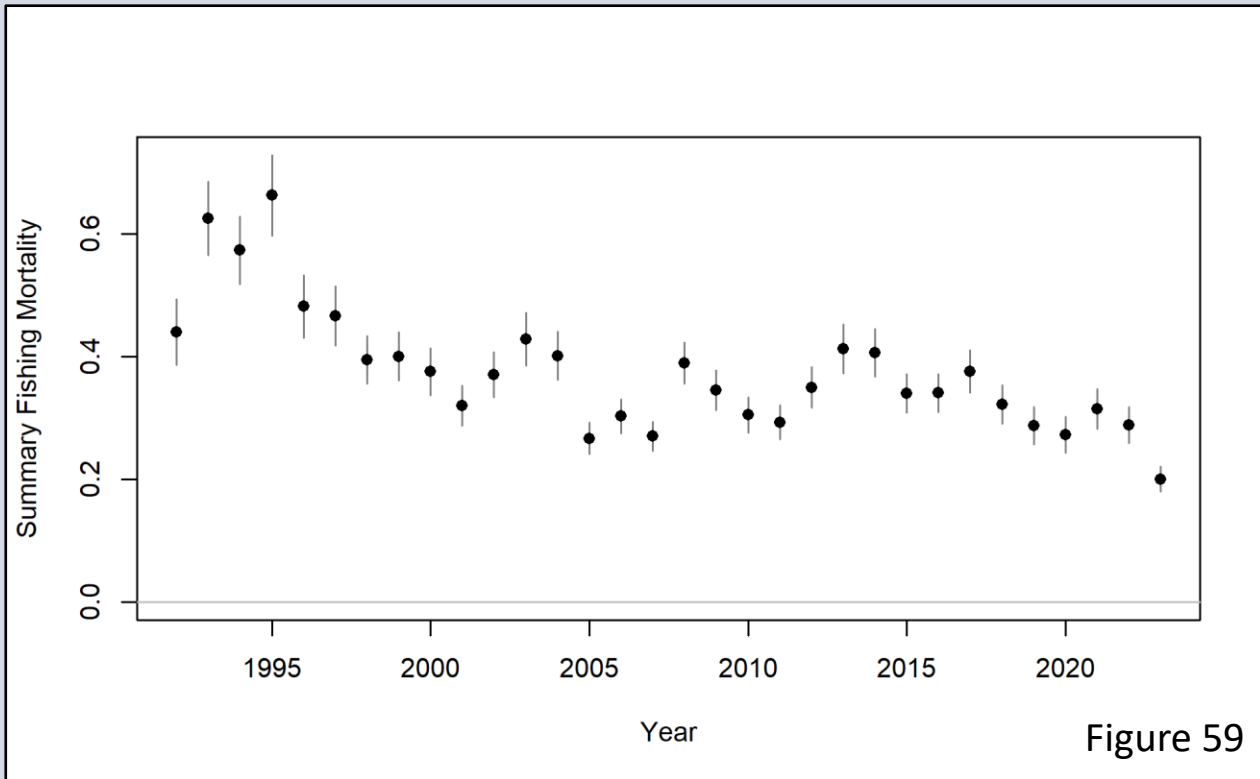


Figure 59

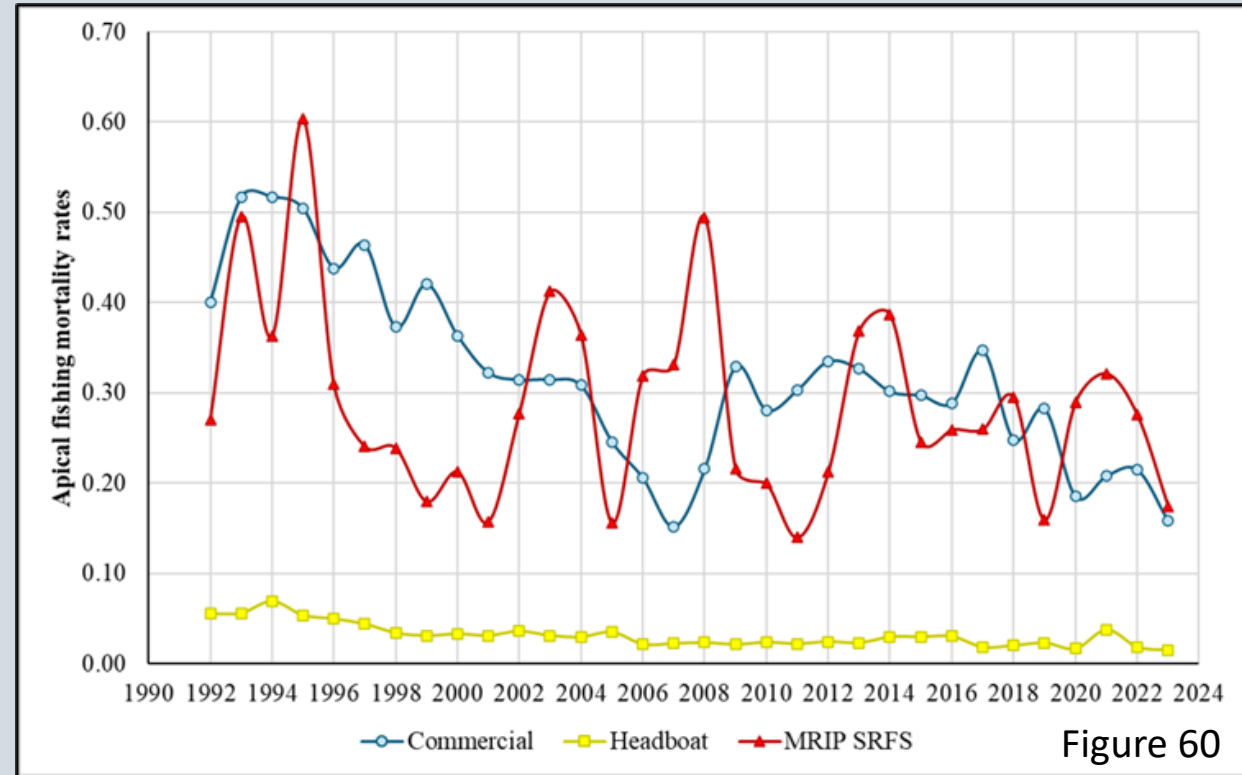
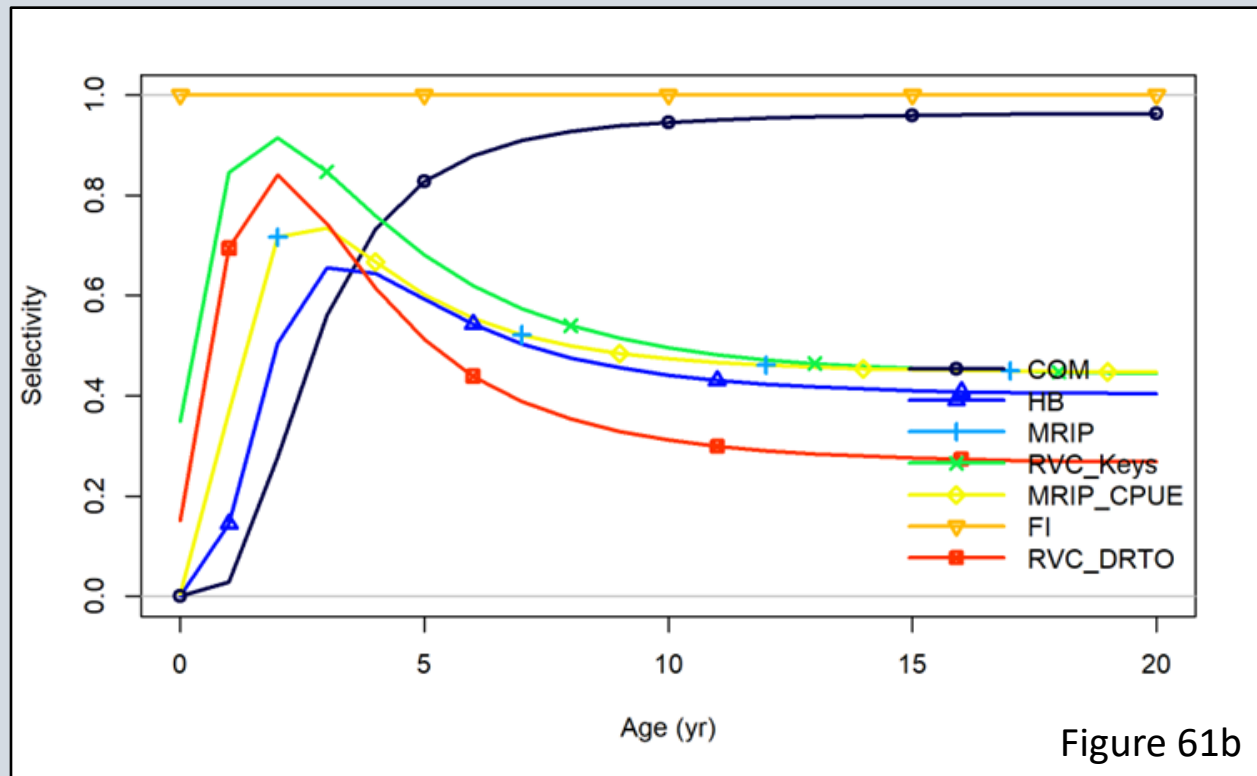
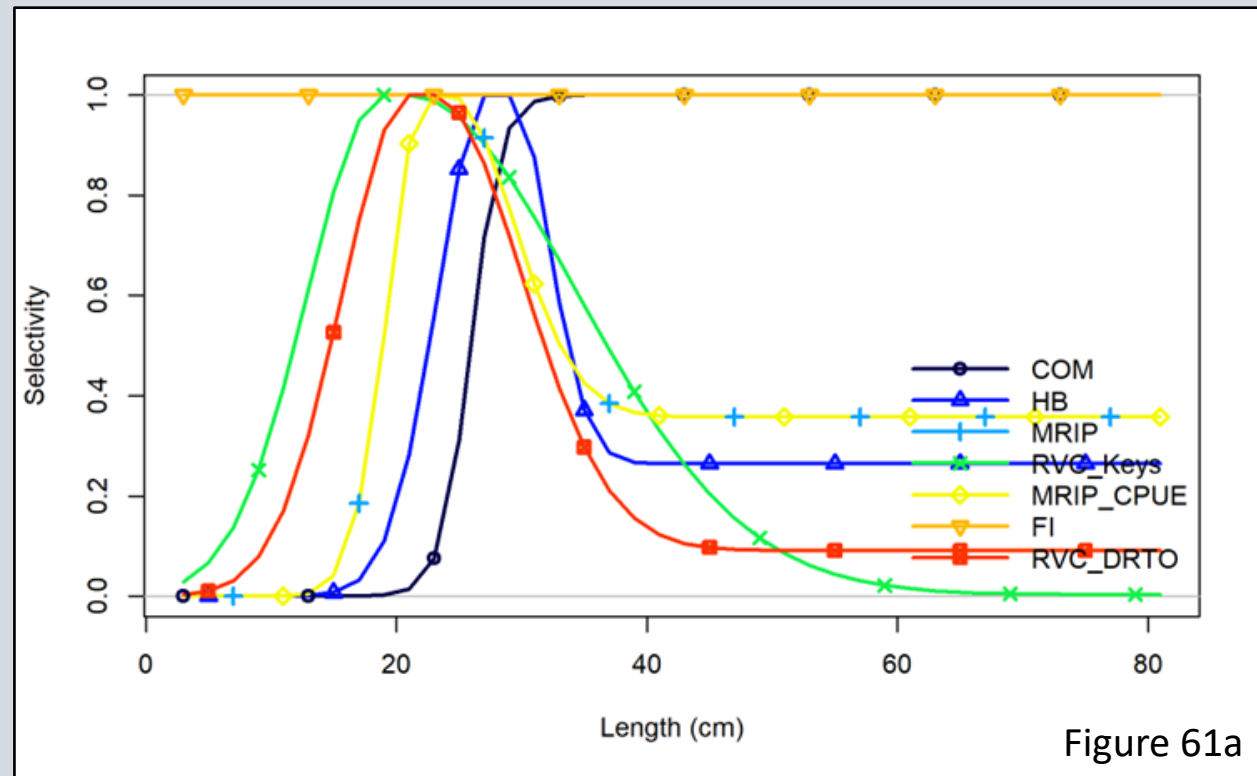


Figure 60



Selectivity



SEDAR 96: Yellowtail Snapper
Base Model Diagnostics

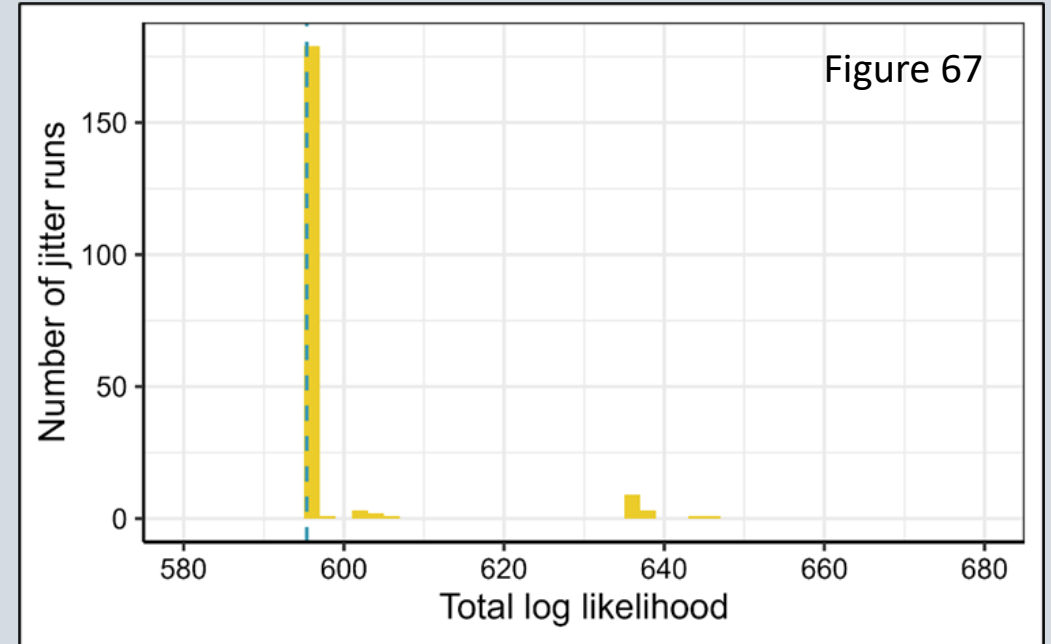


Model Convergence

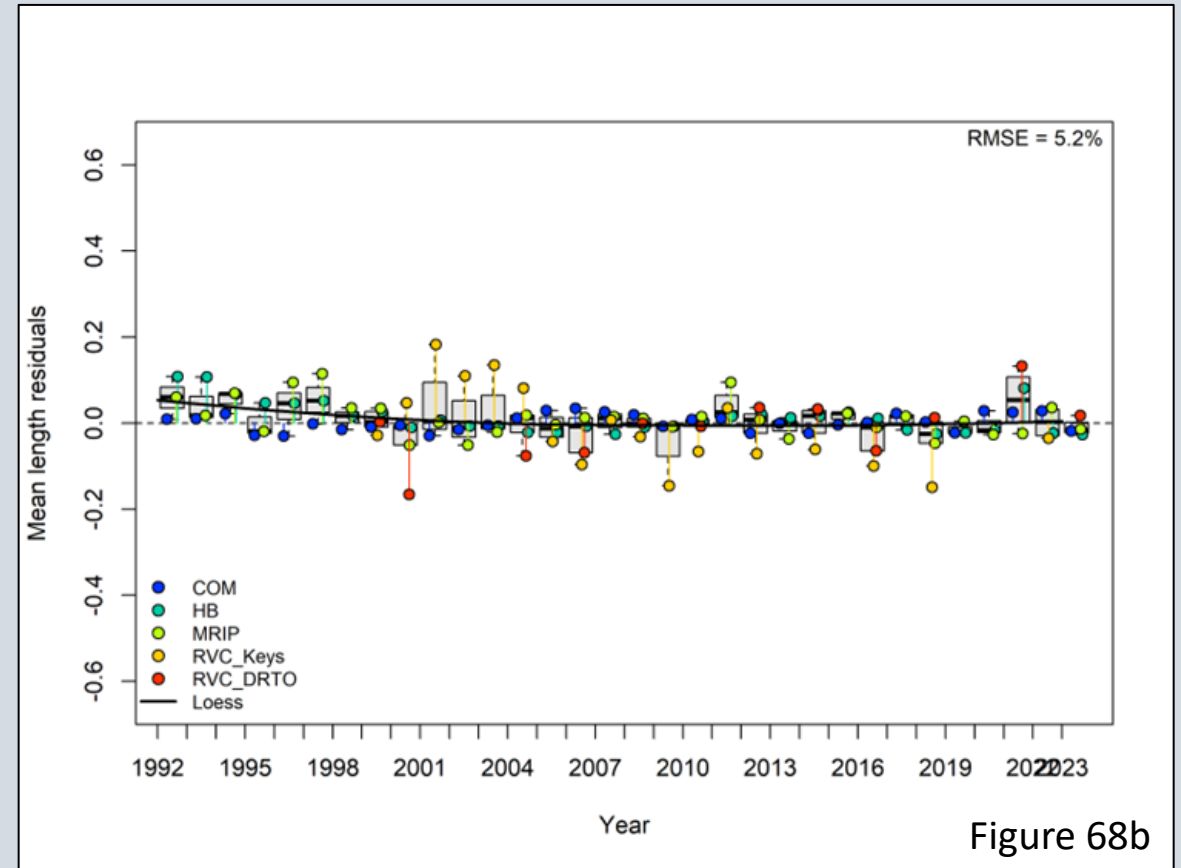
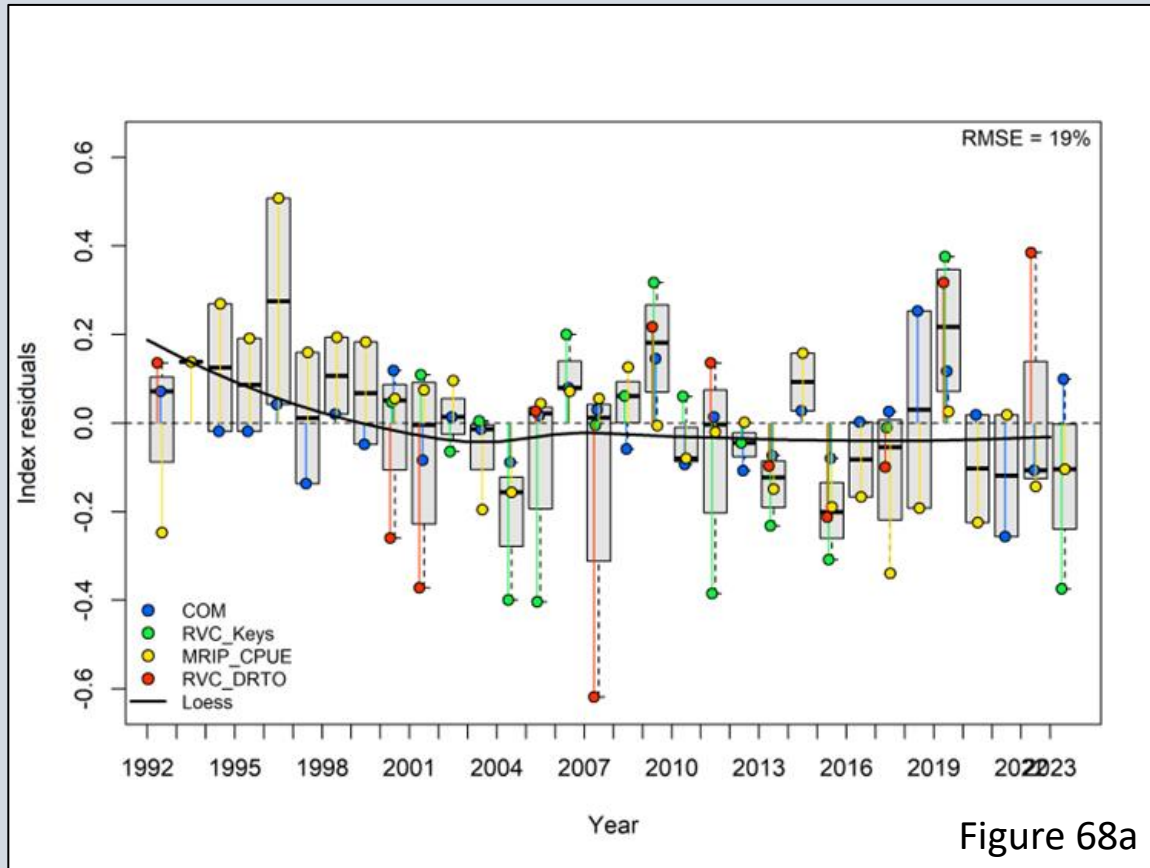
- No estimated parameters on the bounds
- Final gradient < 0.0001
- Positive definite Hessian

Jitter Analysis

- 200 jittered runs
 - Initial values jittered by 20%
 - 110 runs (55%) had a low gradient (< 0.0001) but no other run had a gradient > 0.01 .
- No jittered runs contained a total likelihood lower than the base model.
- Results suggested that the base model had converged on a global solution.



Goodness of Fit



Goodness of Fit

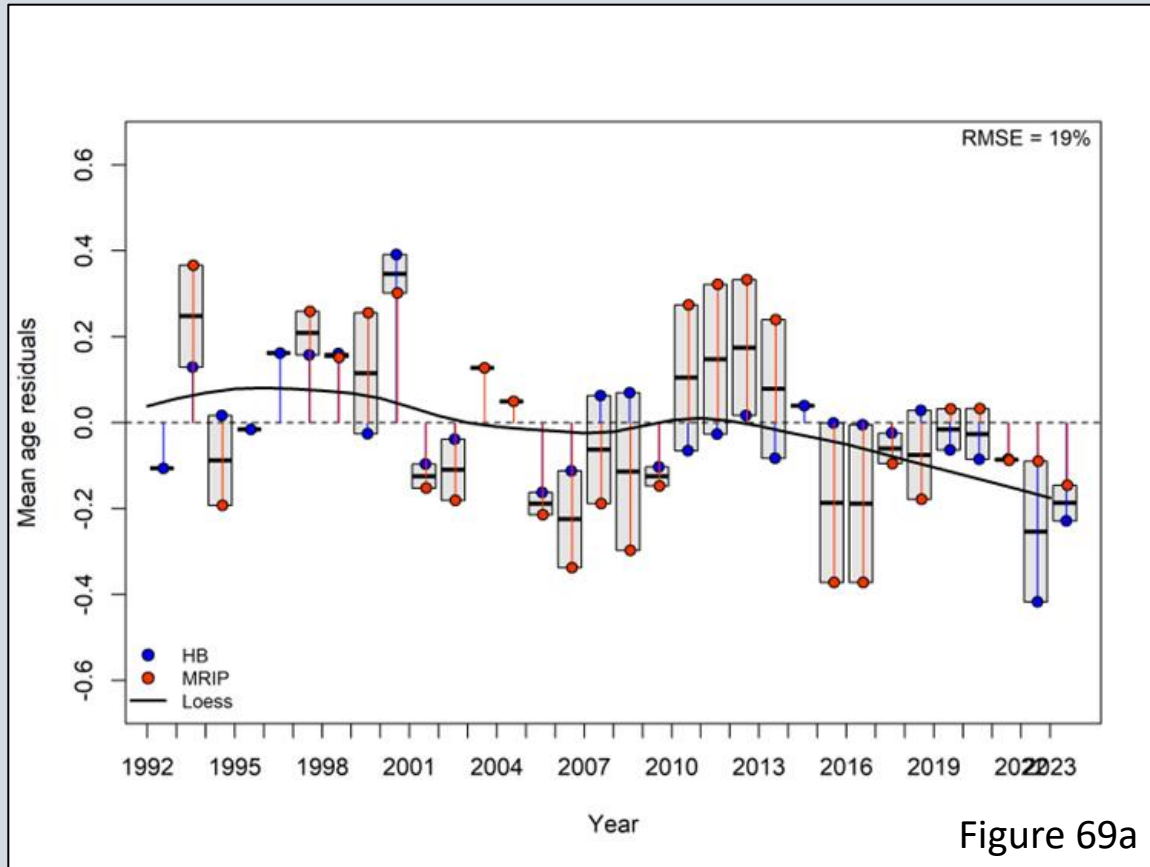


Figure 69a

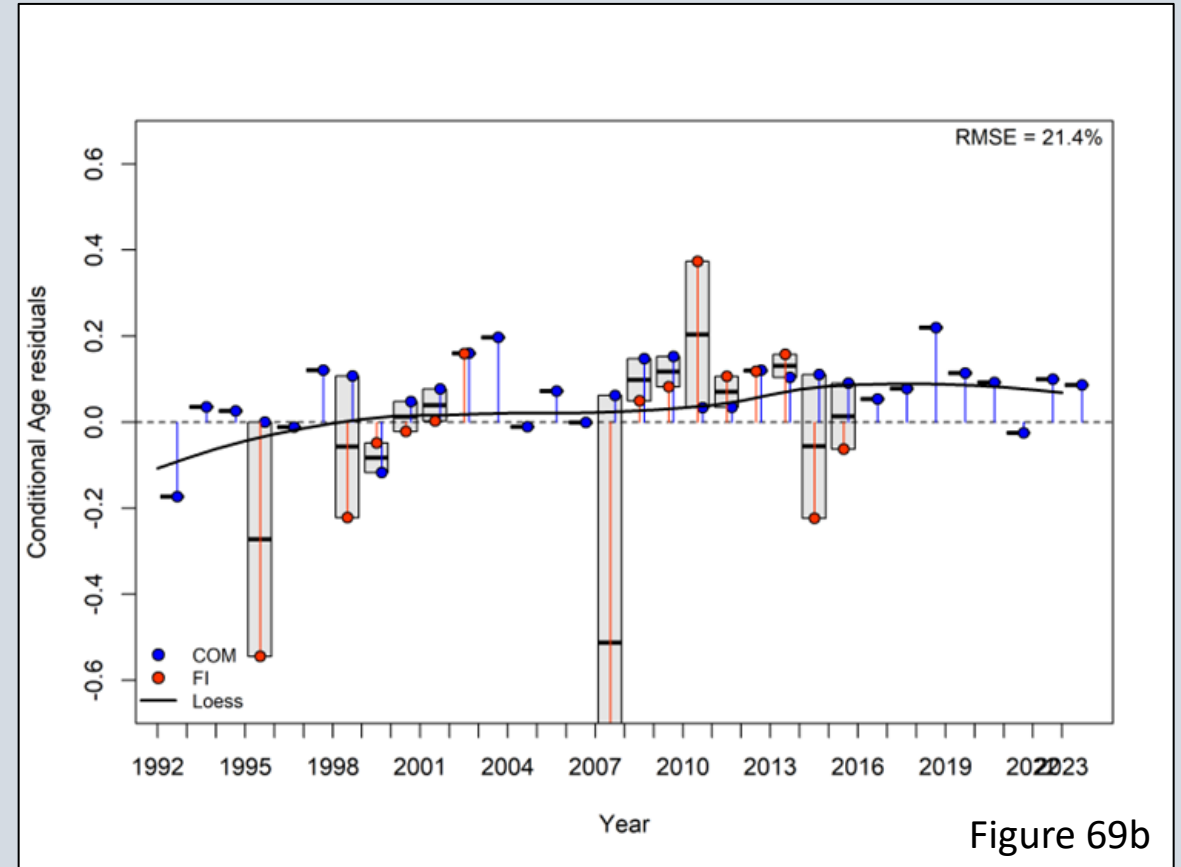


Figure 69b



Model Consistency

Profiling of R_0

- Identify how sources of information influence various model estimates
- $R_0 \approx$ global scaling parameter
- R_0 largely influenced by the recruitment deviations component (blue line)
- Minimum agrees with base model ($R_0 = 9.82$)

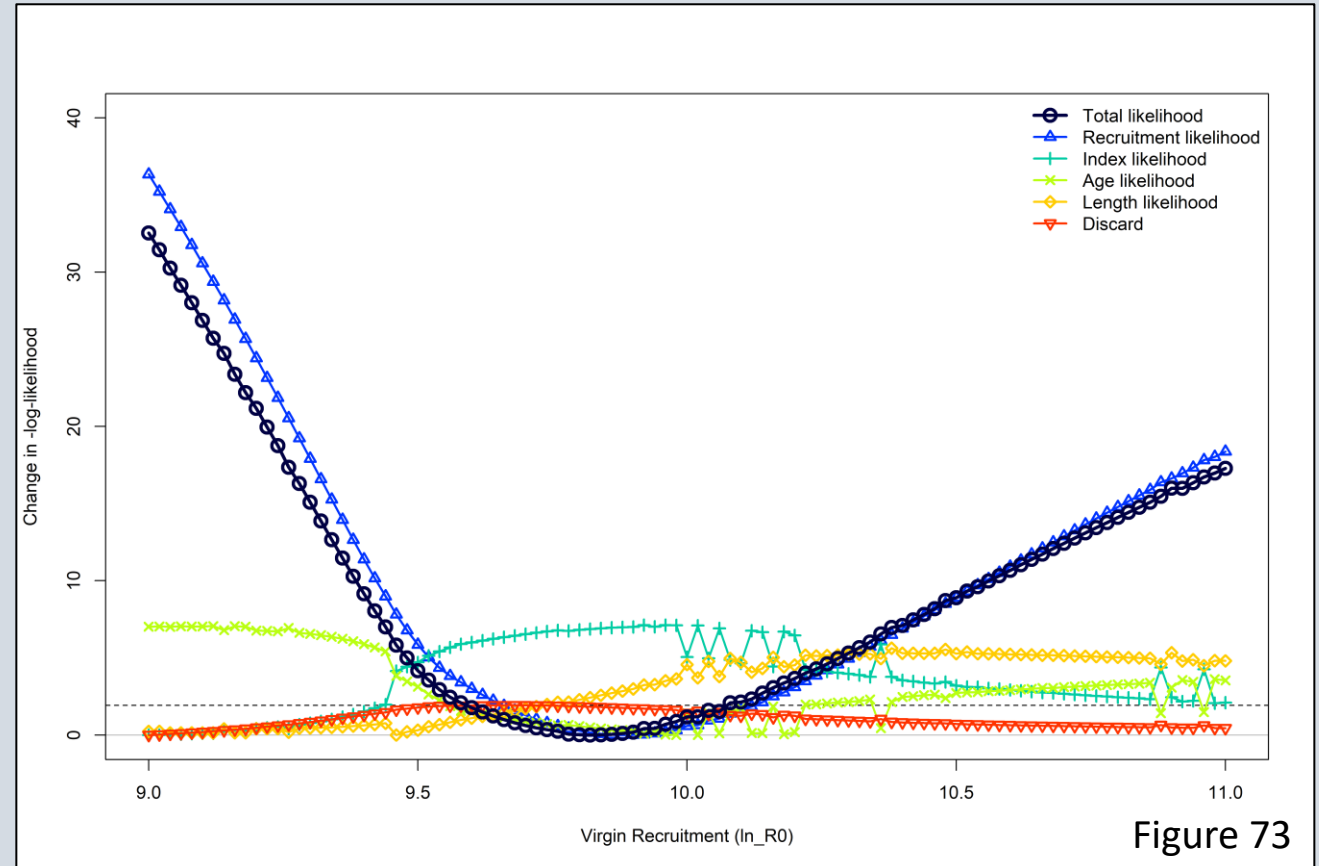


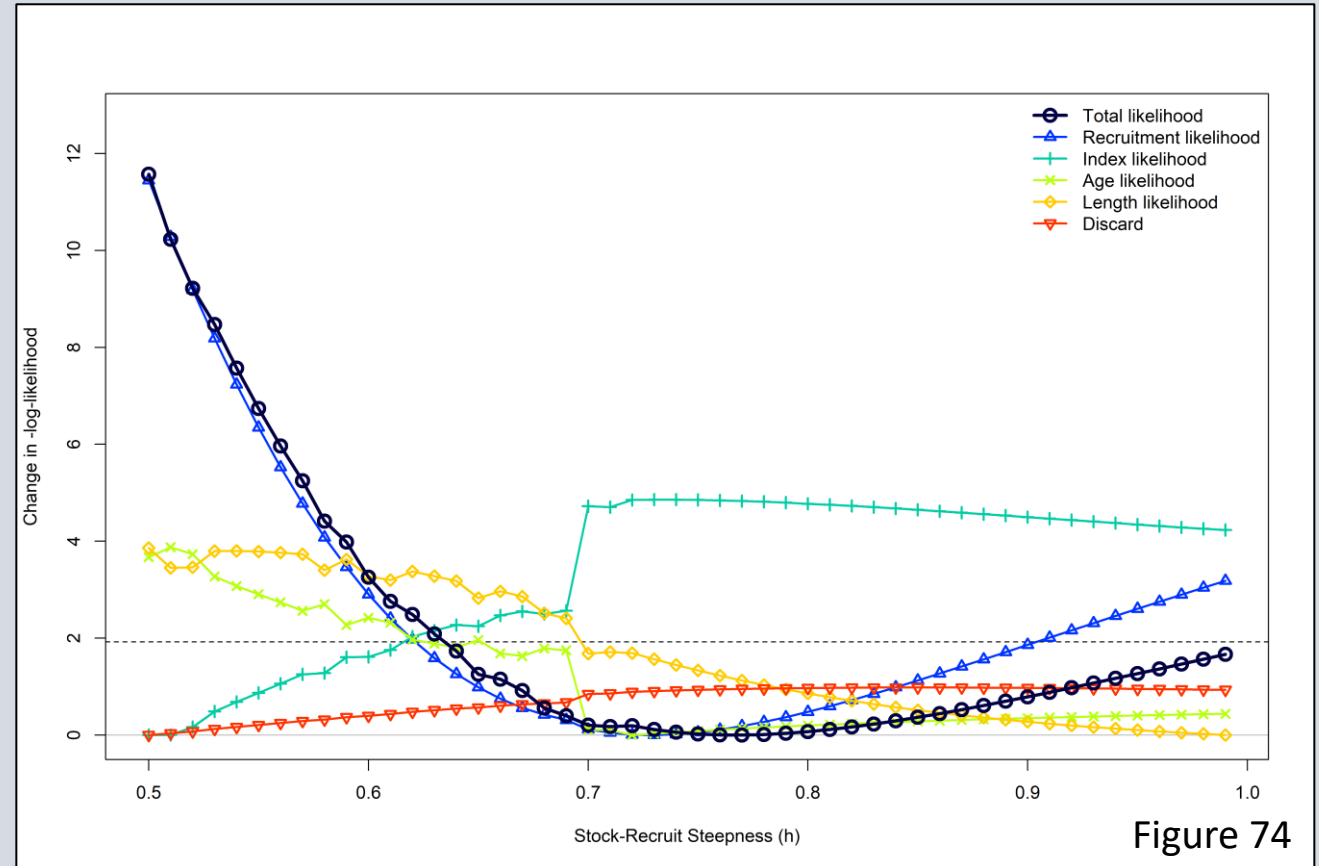
Figure 73



Model Consistency

Profiling of *steepness*

- steepness largely influenced by the recruitment deviations component
- Minimum agrees with base model (steepness = 0.76)
- Likelihood surface less defined
 - Multiple values likely *given the data*
 - Not strong evidence for stock-recruitment relationship



Model Consistency and Predictive Skill

Retrospective Analysis

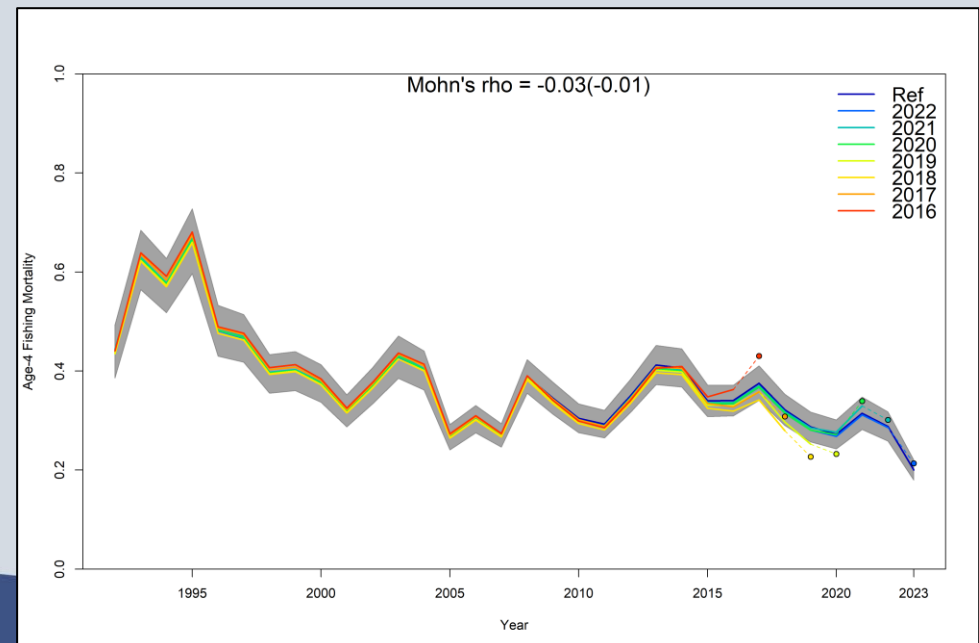
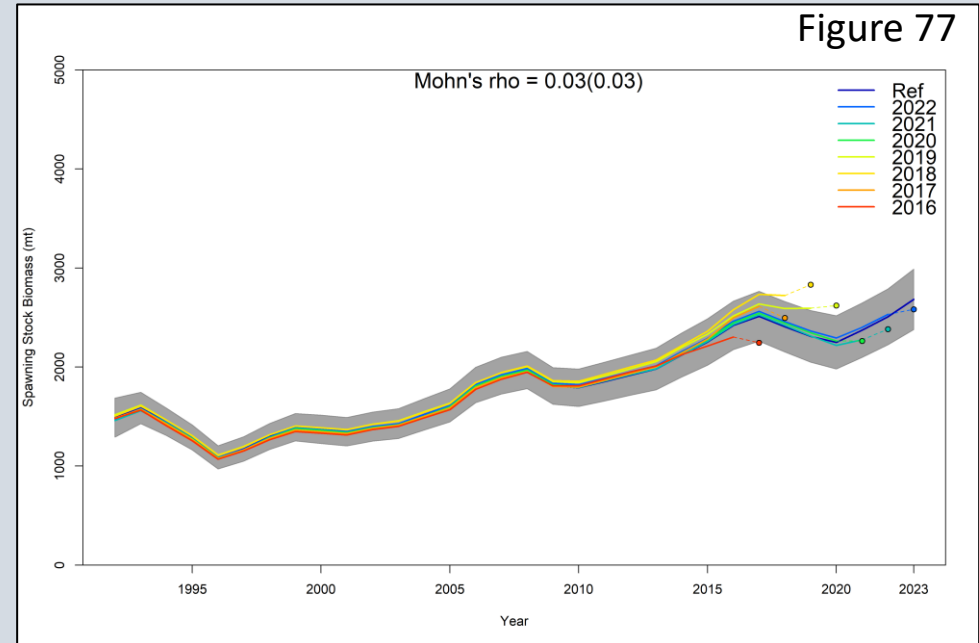
- Seven-year peel
- Helps evaluate the effect of the final year on model results
- Patterns can indicate model misspecification or temporal dynamics
- Evaluated visually and quantitatively
 - Mohn's Rho
 - Hurtado –Ferro et al (2015) "Rule of thumb"
 - - 0.15 to 0.20 for longer-lived species

Retrospective Forecasting

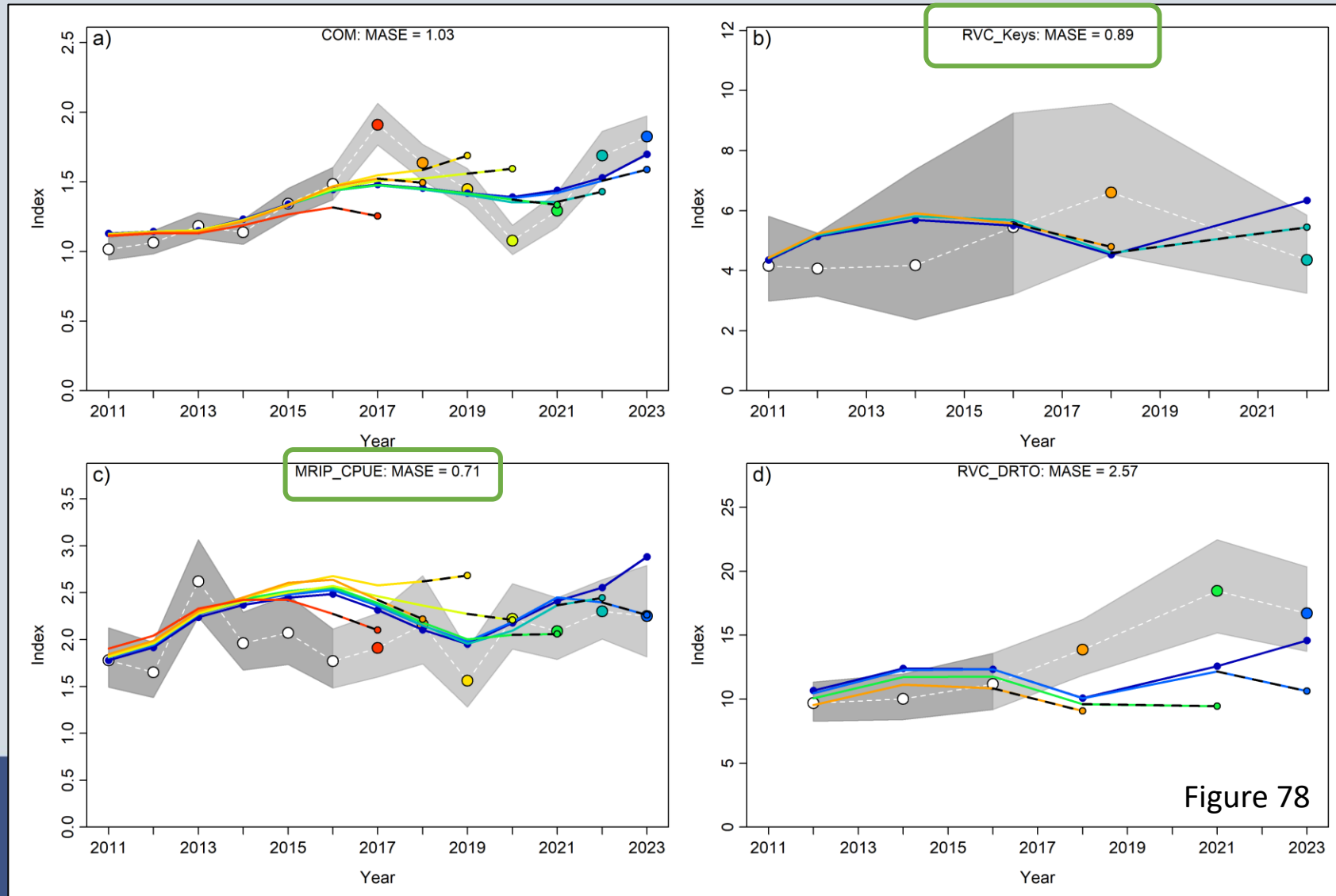
- Model-based hindcasts to seven-year peels
- Evaluated visually and quantitatively
 - Forecast bias corresponding to Mohn's Rho



Figure 77



Prediction Skill



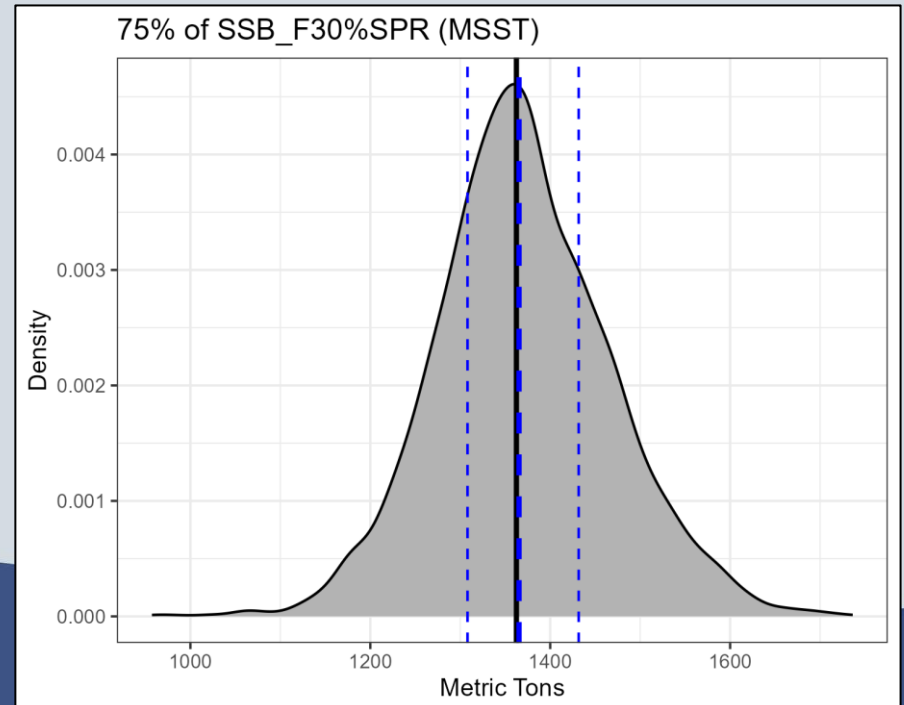
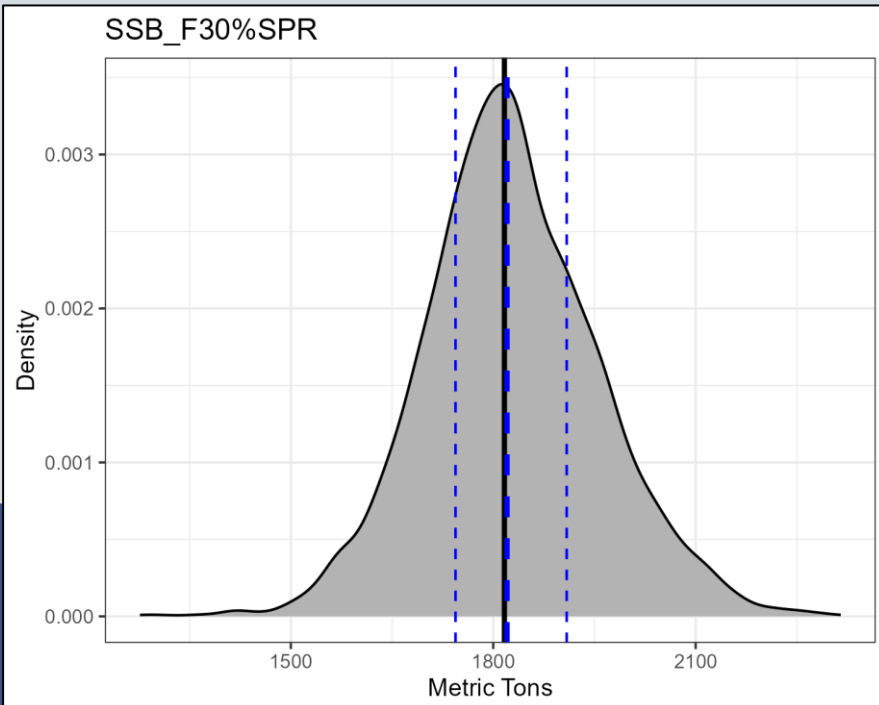
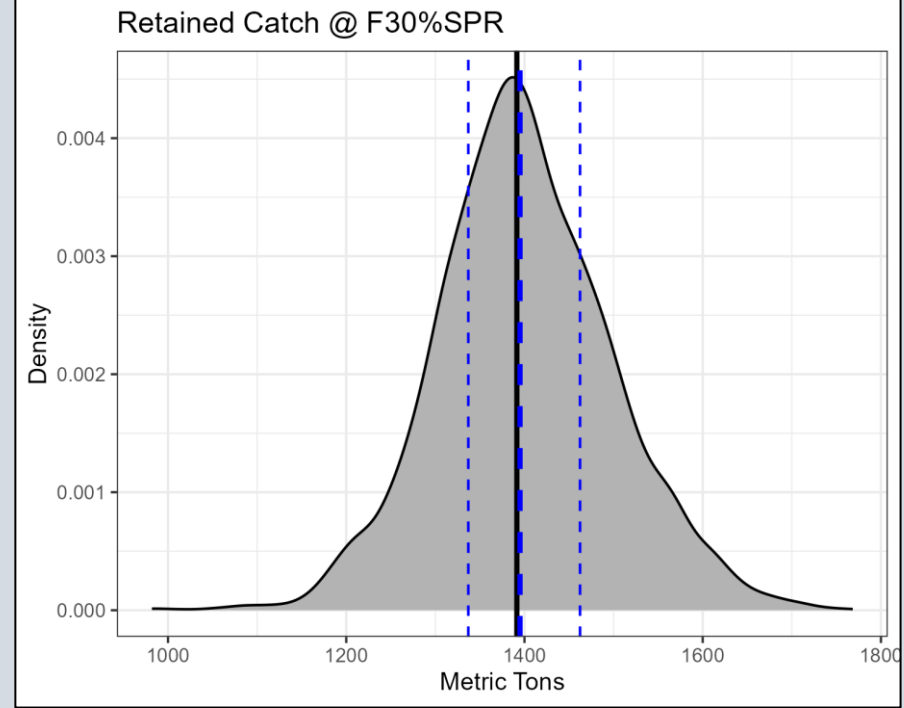
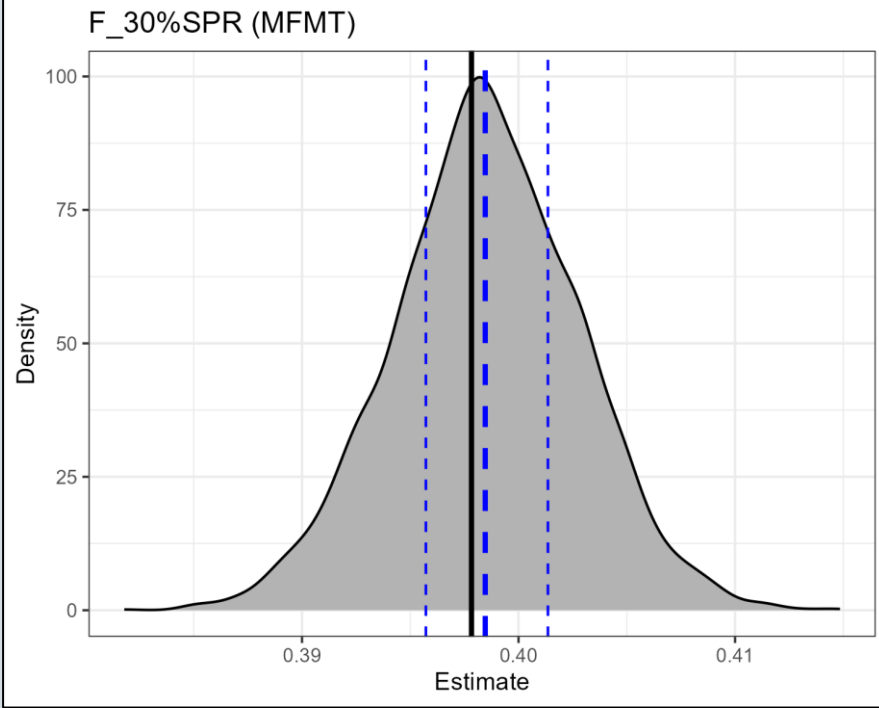


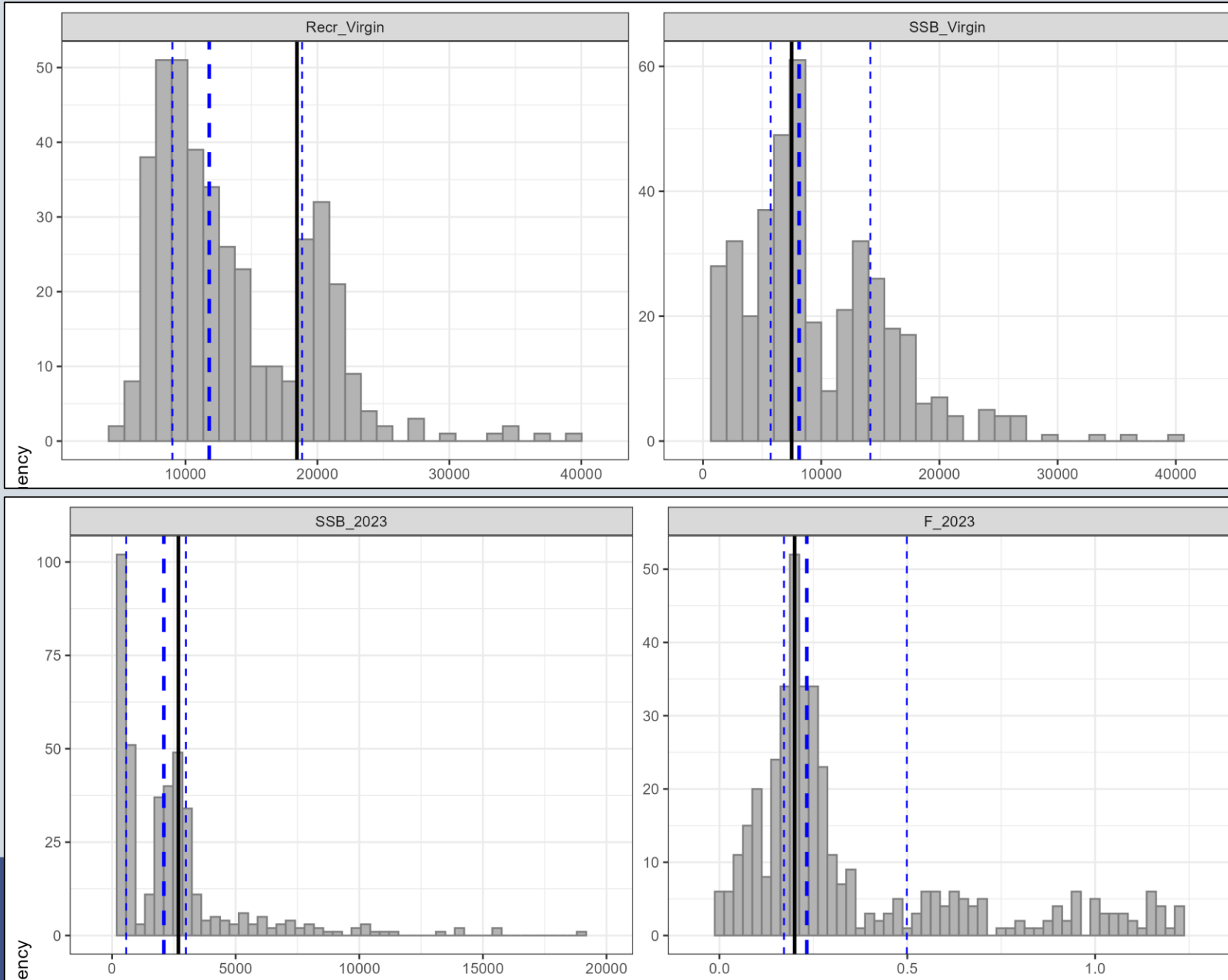
SEDAR 96: Yellowtail Snapper
Base Model Uncertainty

Model Uncertainty

- Markov chain Monte-Carlo (MCMC)
 - Generate posterior distributions of model parameters and derived quantities
 - R_0 , SSB_0 , *steepness*, SSB_{2023} , F_{2023} , $F_{30\%SPR}$, $SSB_{F30\%SPR}$, Retained yield at $F_{30\%SPR}$
 - Two chains
 - 5,000 iterations saved from the 10,000,000 performed
 - Burn-in set at 1,000 with thin rate of 2
 - 2,000 iterations remained for each chain before combining
 - Convergence
 - Gelman and Rubin's (1992) potential scale reduction factor (PSRF)
 - Visual inspection of trace plots
- Parametric Bootstrap
 - 500 bootstrapped datasets
 - 410 models converged (82%)
 - 428 had a gradient >0.0001 (85%)



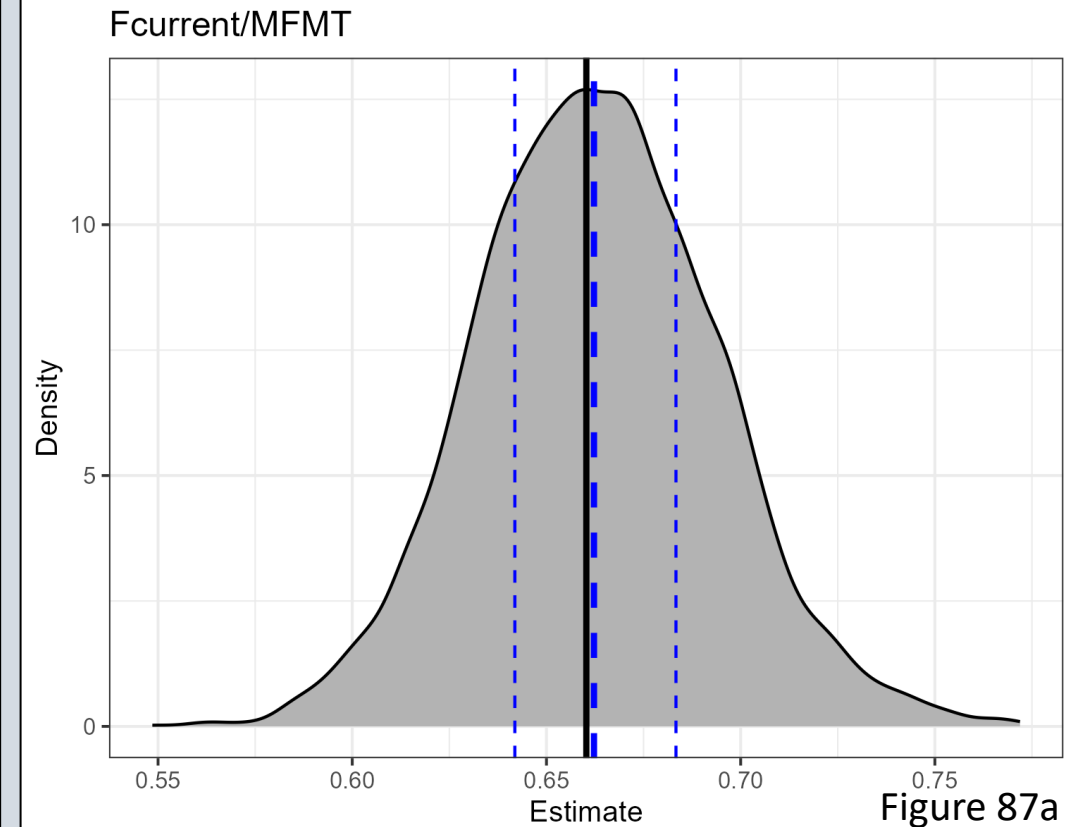
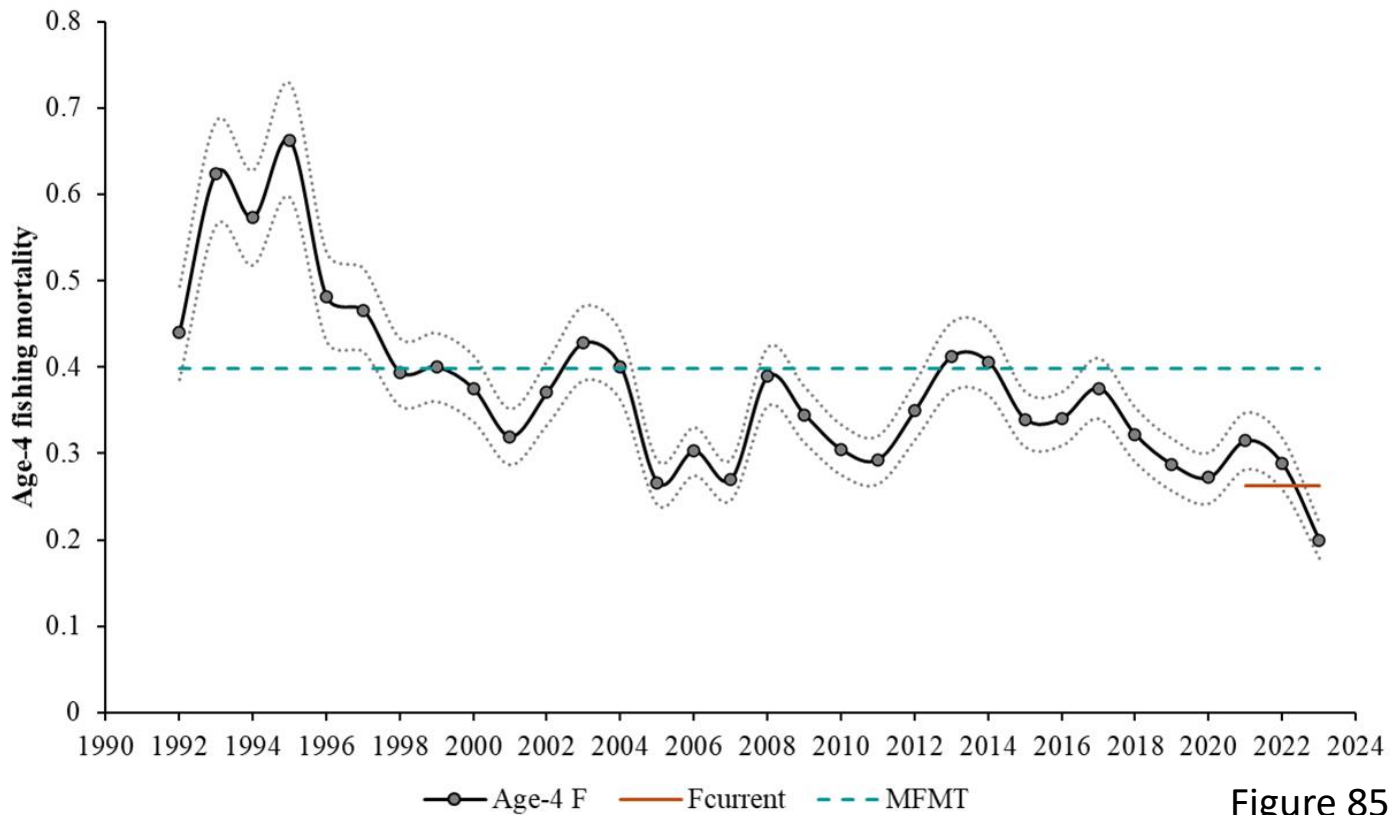




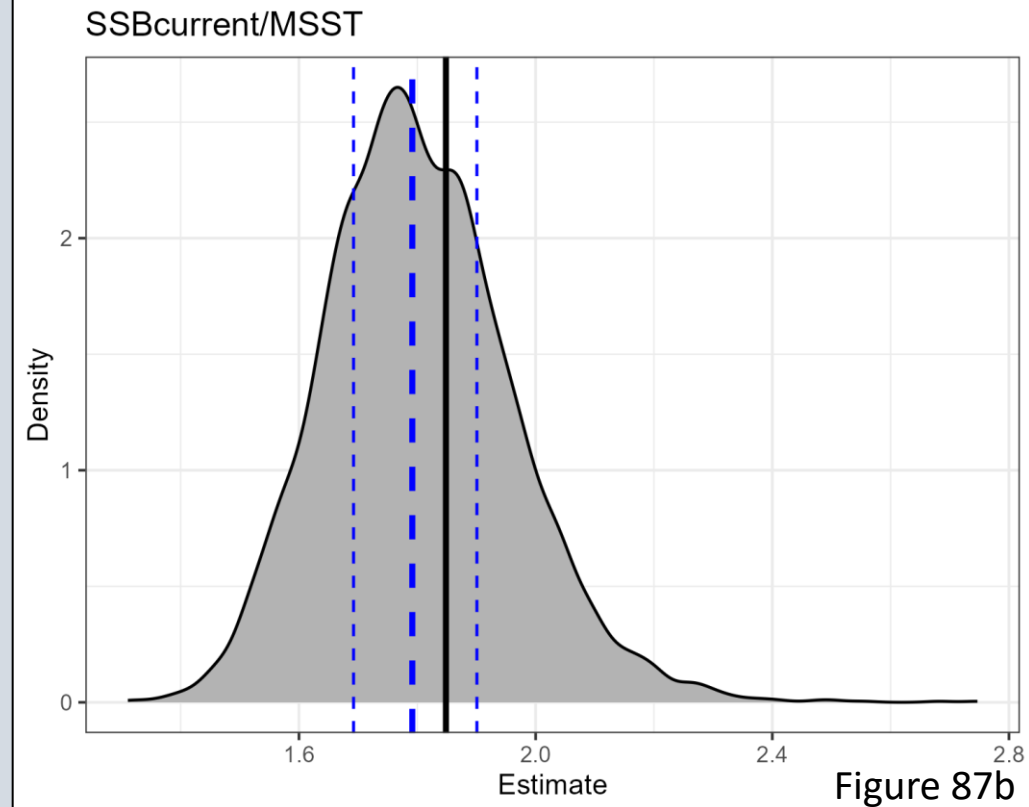
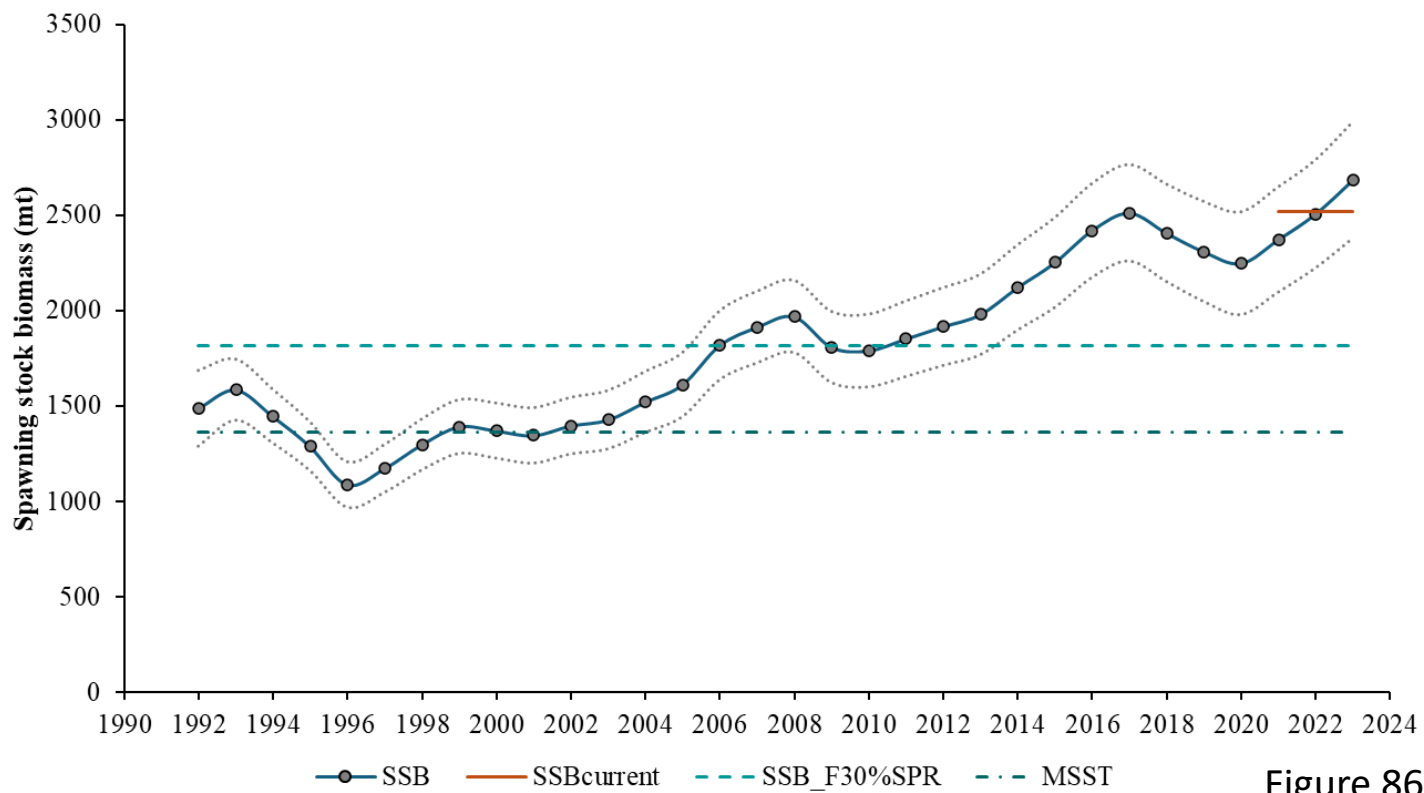
Adapted from figure 84



Stock Status: Not undergoing overfishing



Stock Status: Not overfished

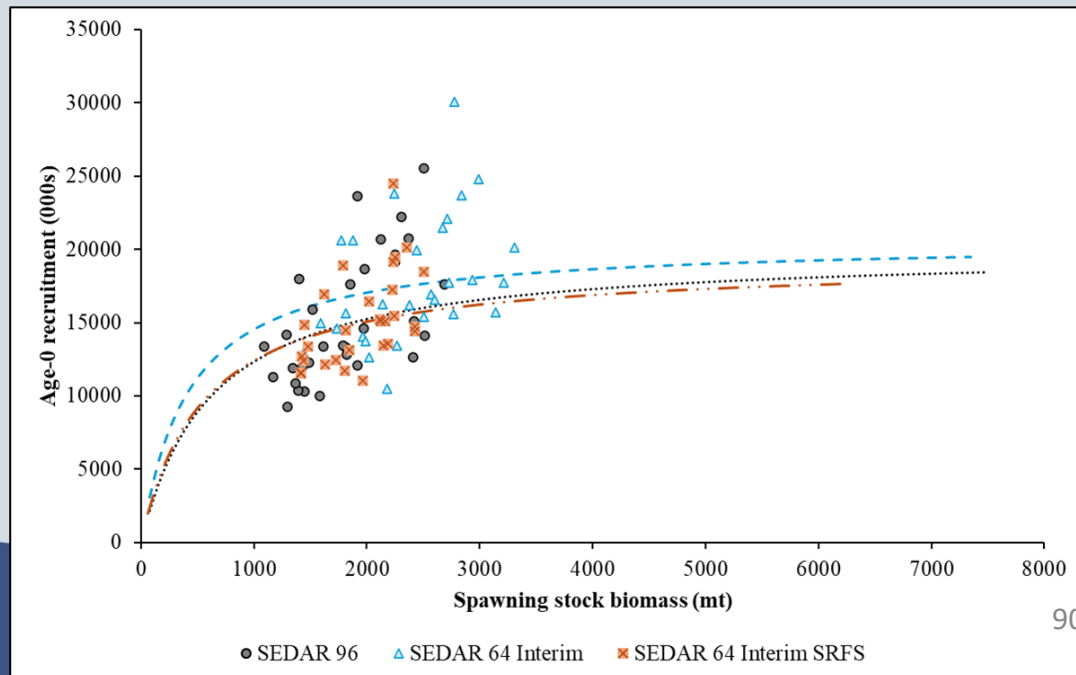
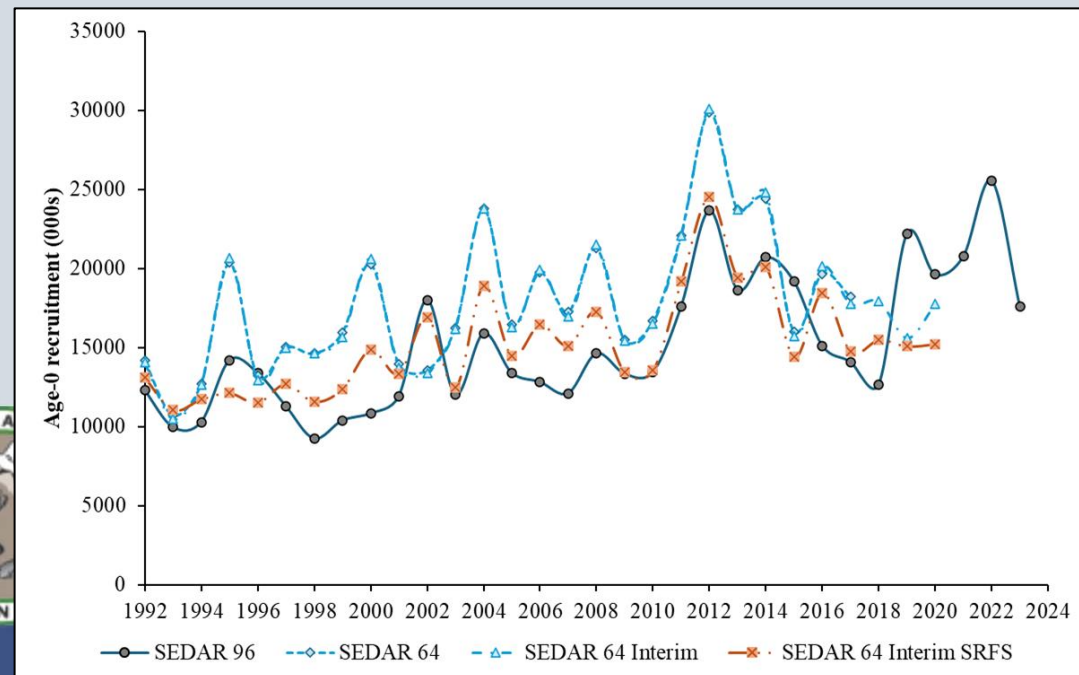
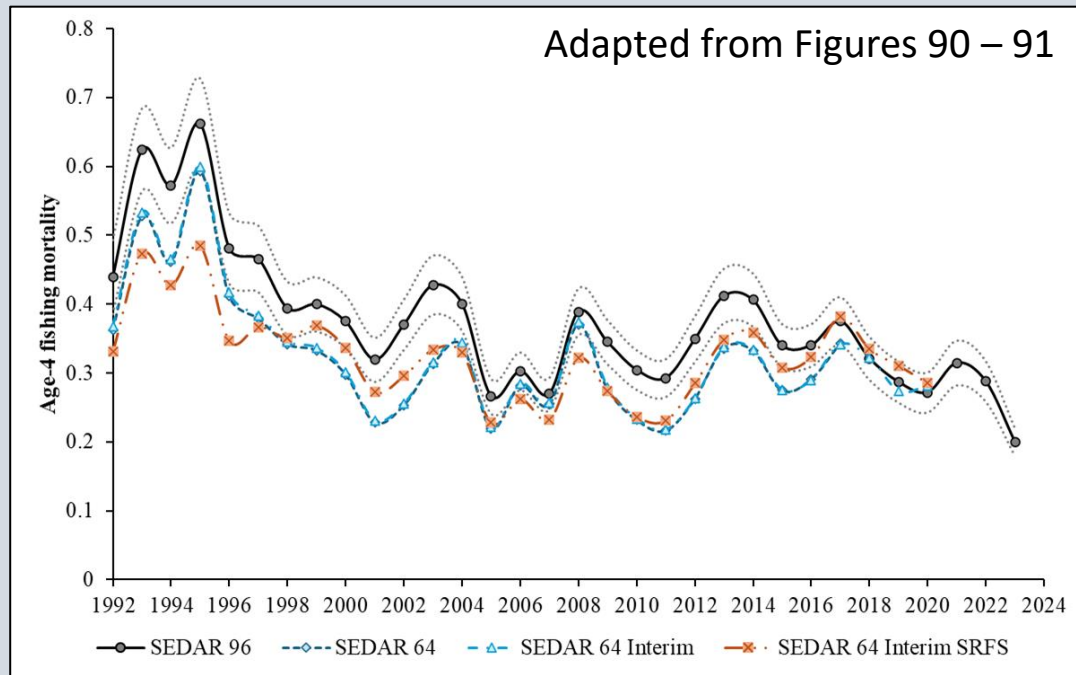
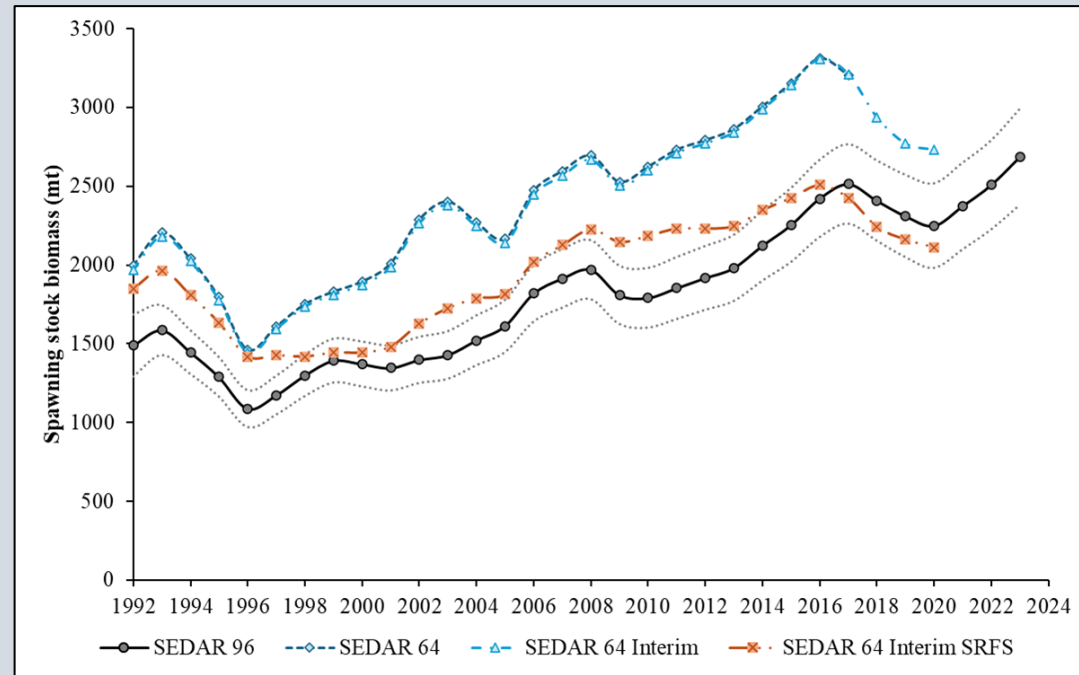


Stock Status Determination Criteria (Table 33)

South Atlantic and Gulf of Mexico Fishery Management Councils

Criteria	Definition	Base	MCMC
MSY	The retained yield at F_{MSY} (or proxy, $F_{30\%SPR}$)	1,391.44 mt (3,067,600 lbs.)	1394.99 mt (3,075,437 lbs.)
F_{MSY} or proxy	The fishing mortality rate associated with MSY (or proxy, 30% SPR)	0.398 yr ⁻¹	0.398 yr ⁻¹
MFMT (Maximum Fishing Mortality Threshold)	F_{MSY} or 30% SPR	0.398 yr ⁻¹	0.398 yr ⁻¹
$F_{current}$ (recent average fishing mortality rate on age-4 fish)	The geometric mean of F on age-4 fish for 2021 – 2023	0.263 yr ⁻¹	0.264 yr ⁻¹
SSB_{MSY} or proxy	The estimated spawning stock biomass associated with F_{MSY} or $F_{30\%SPR}$	1,816.54 mt (4,004,785 lbs.)	1,820.46 mt (4,013,438 lbs.)
MSST (Minimum Stock Size Threshold)	$0.75 * SSB_{MSY}$ or $F_{30\%SPR}$	1,362.41 mt (3,003,589 lbs.)	1,365.35 mt (3,010,079 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2021 – 2023	2,518.21 mt (5,551,692 lbs.)	2,456.02 mt (5,414,597 lbs.)
OY (Optimum Yield)	ABC, based on SAFMC control rule	TBD	TBD





Questions?

