SEDAR 70: US Gulf of Mexico Greater Amberjack

Operational Assessment

GMFMC SSC Presentation

January 2021

NOAA FISHERIES

SEFSC

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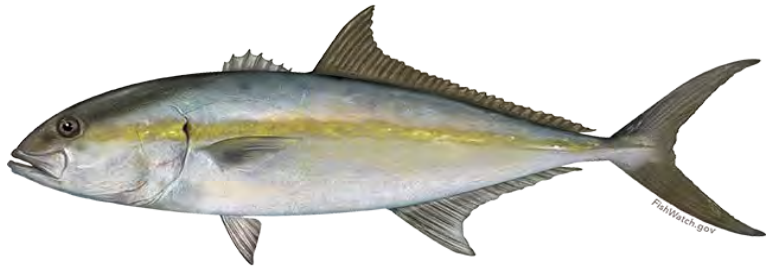
NOAA Fisheries, Southeast Fisheries Science Center,
Sustainable Fisheries Division (SFD)

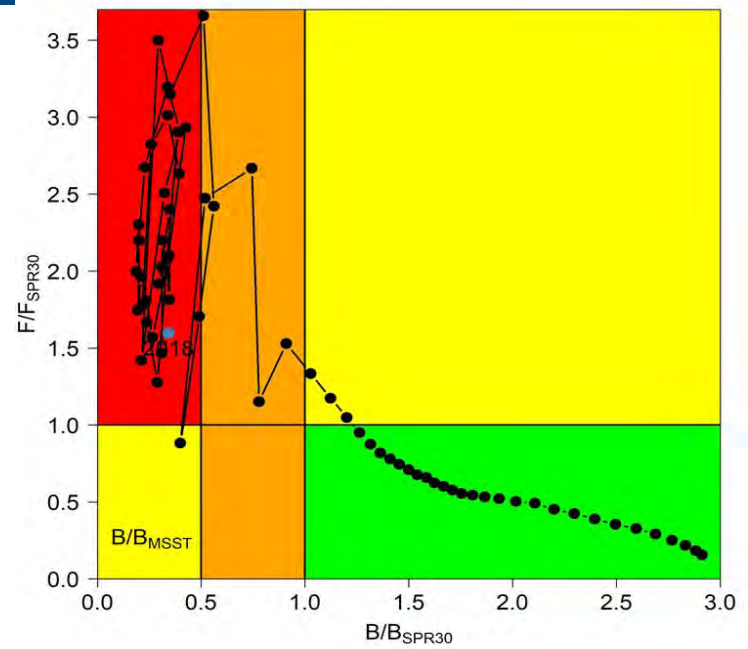
Outline

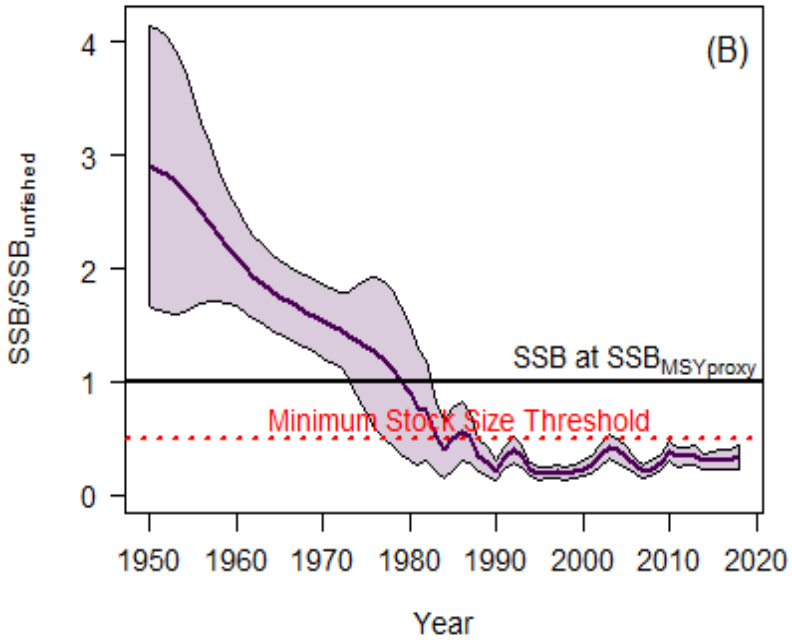
- Overview
- Data
- Base Model
  - Development
  - Fit
  - Results
  - Diagnostics
  - Sensitivities
- Projections
  - Settings
  - Results
- Summary



Results Summary

- The approved SEDAR 70 Gulf of Mexico Greater Amberjack base model was updated with data through 2018.
- Where practicable, the base model used the same data sets as the SEDAR 33 Update with an updated time series.
- The SEDAR 70 Greater Amberjack assessment included several important changes to data inputs and model parameterization that affected the assessment results:
  - Using the MRIP-FES for recreational landings and discards
  - Using a combined video survey index
  - Excluding the commercial vertical line index
  - Revising commercial discard estimates
  - Incorporating a spline function to model the vertical line size/age selectivity
  - Incorporating a self-weighting likelihood distribution for fitting length and age compositions
  - Weighting recreational (charter/private) and commercial length data by landings
- The base model found that Greater Amberjack in the Gulf of Mexico is undergoing overfishing and is overfished. (https://sedarweb.org/sedar-70)





SEDAR 70: Data
TOR 1 and 2

- Overview
- **Data**
- Base Model
  - Development
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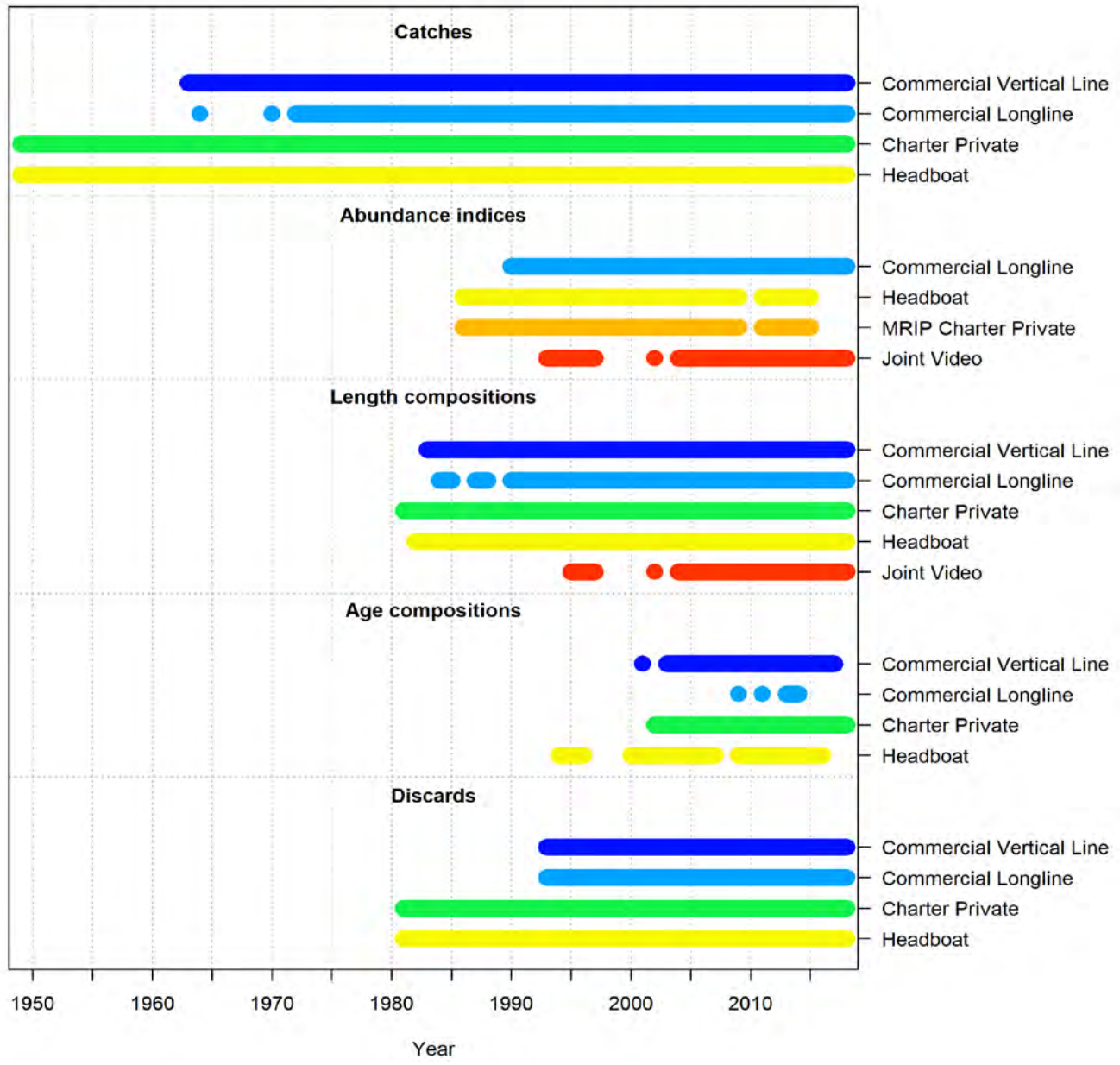
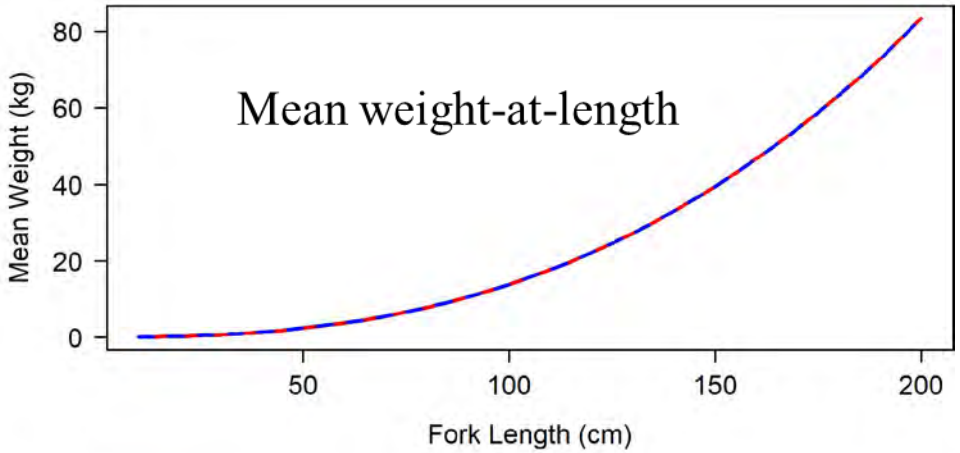
Data – Overview (TOR 1, 2)

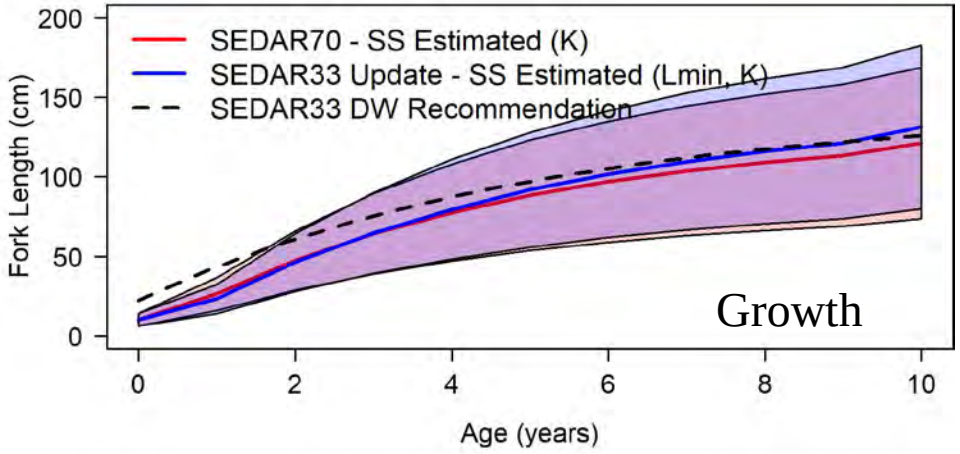
- Fishery-Dependent and Independent Data
- Recreational Landings and Discards
- Commercial Landings and Discards
- Recreational CPUE: MRIP and Headboat
- Commercial Length Compositions
- Recreational Length Compositions
- Age Compositions
- Joint Video Survey Indices and Length Compositions

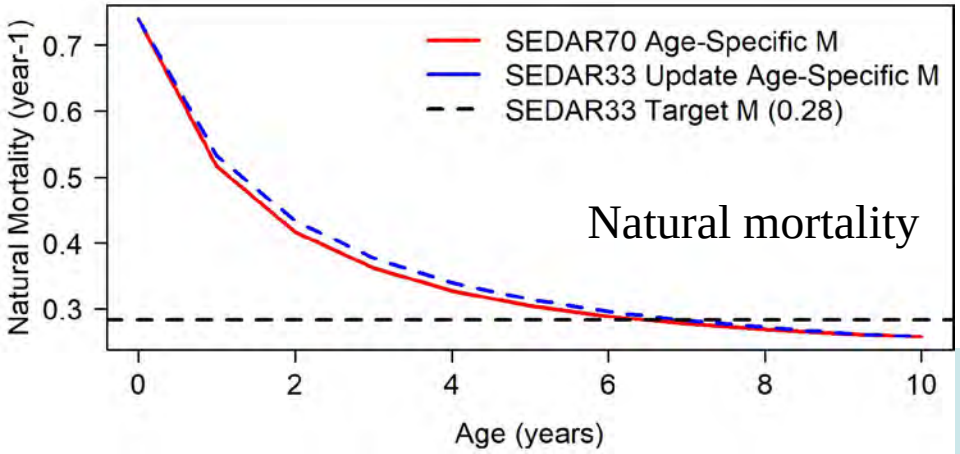


Data – Life History

Data Component	Decision
Length-Weight Conversion	Unchanged from SEDAR 33 Update
Maturity	Updated through 2018
SSB Metric	Unchanged
Natural Mortality	Lorenzen M at age updated
Age and Growth	K estimated within SS model, L_∞ fixed at updated value (Murie et al. 2020, SEDAR 70 WP-10)
Release Mortality	Commercial (0.1), Recreational and Headboat (0.2)



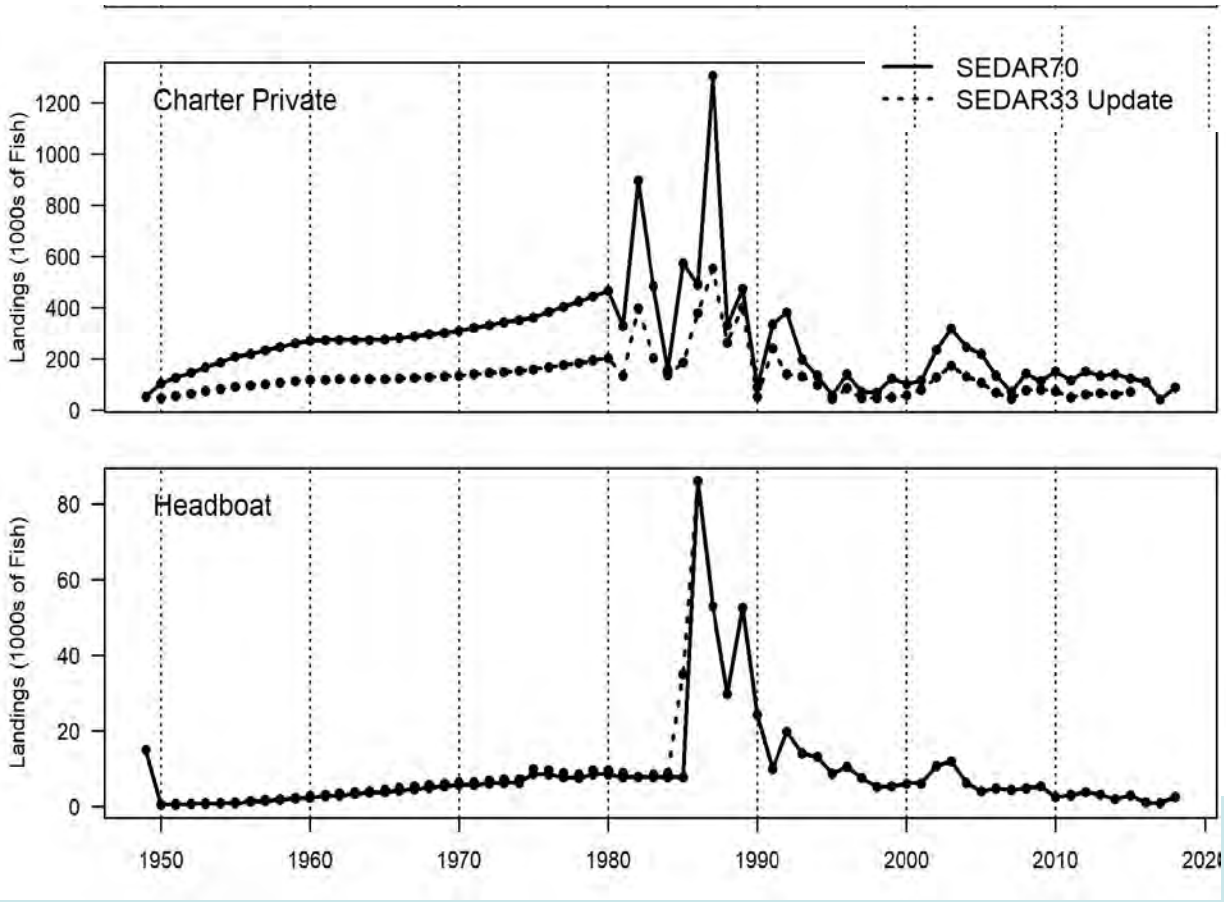




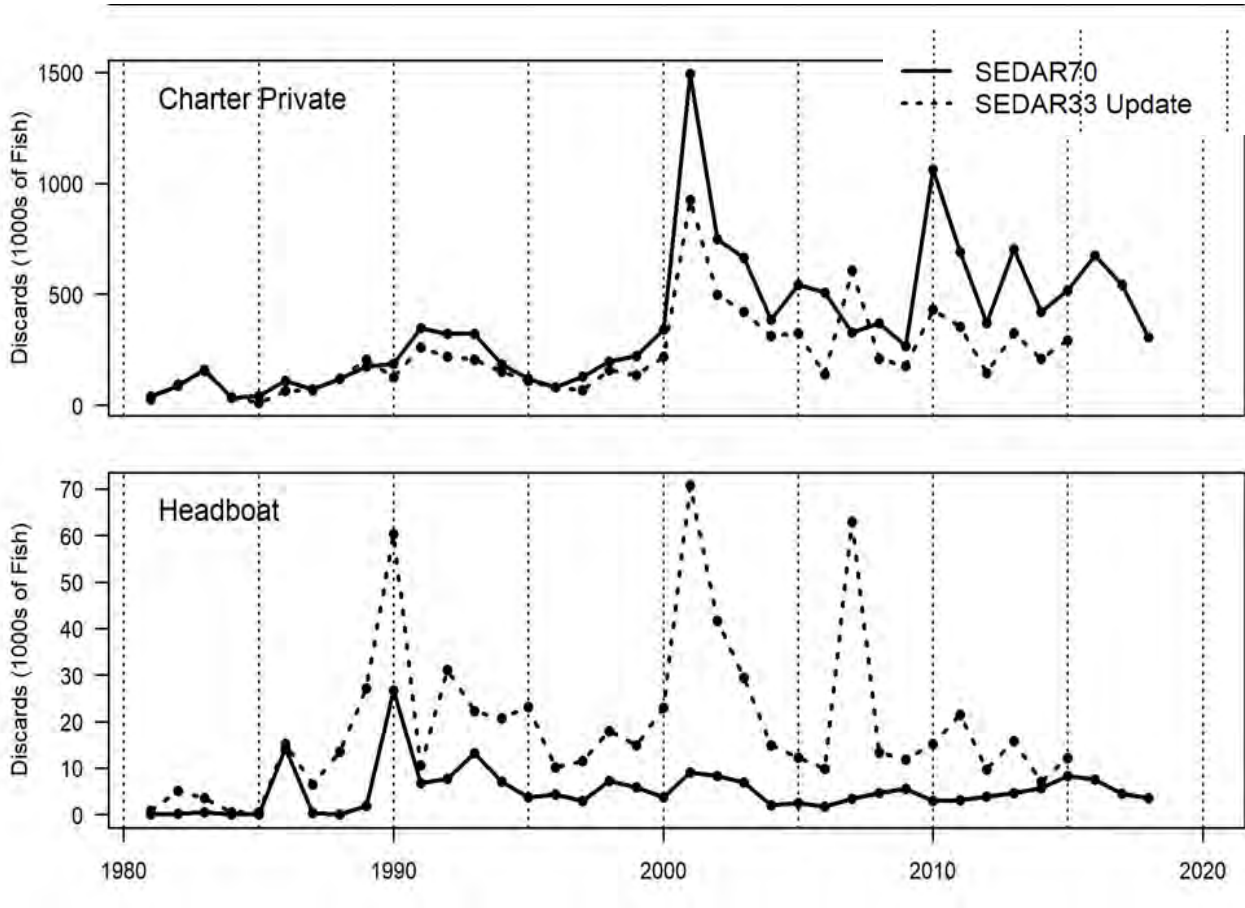
Data – Recreational Landings and Discards

Data Component	Decision
Recreational Landings	Use new MRIP-Fishing Effort Survey [FES]-adjusted WP-02
Recreational Discards	Use new MRIP-Fishing Effort Survey [FES]-adjusted WP-02

Landings



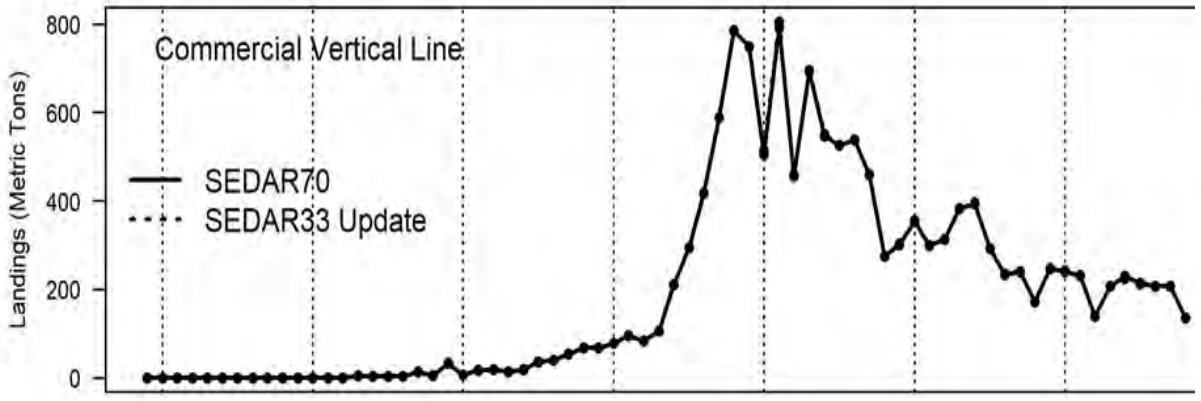
Discards

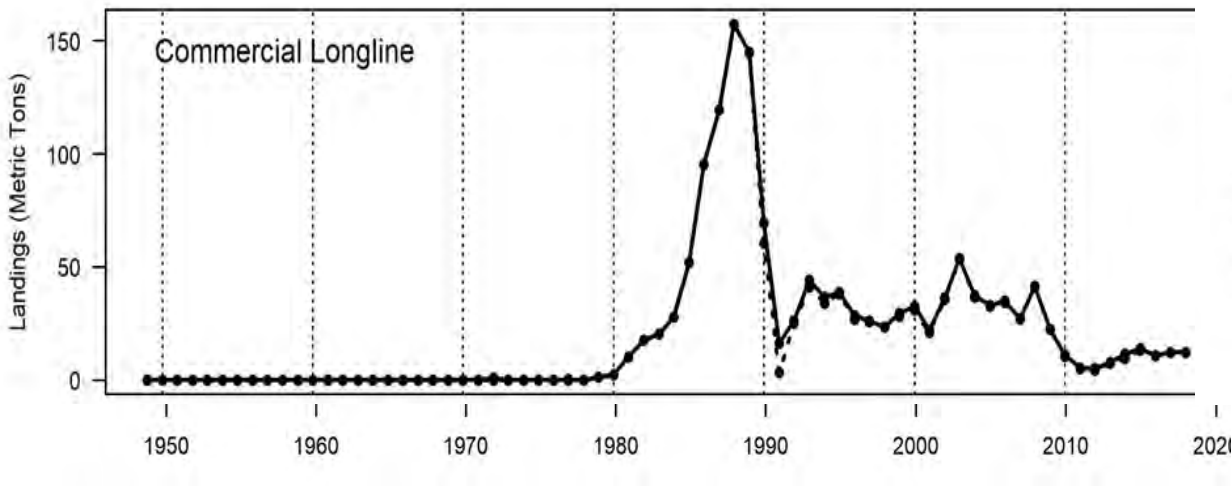


Data – Commercial Landings and Discards

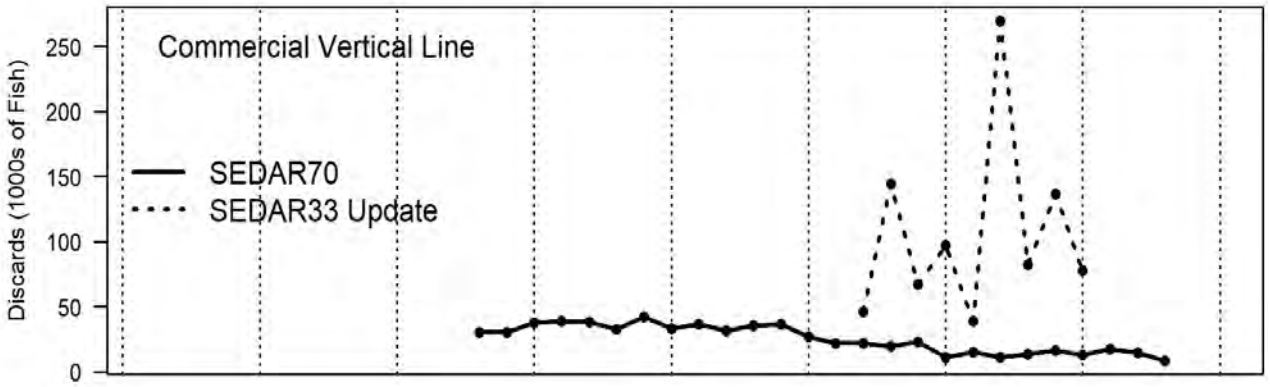
Data Component	Decision
Commercial Landings	Unchanged
Commercial Discards	CPUE expansion using coastal observer program in conjunction with total fishing effort from the commercial reef fish logbook program (used consistently in recent reef fish assessments)

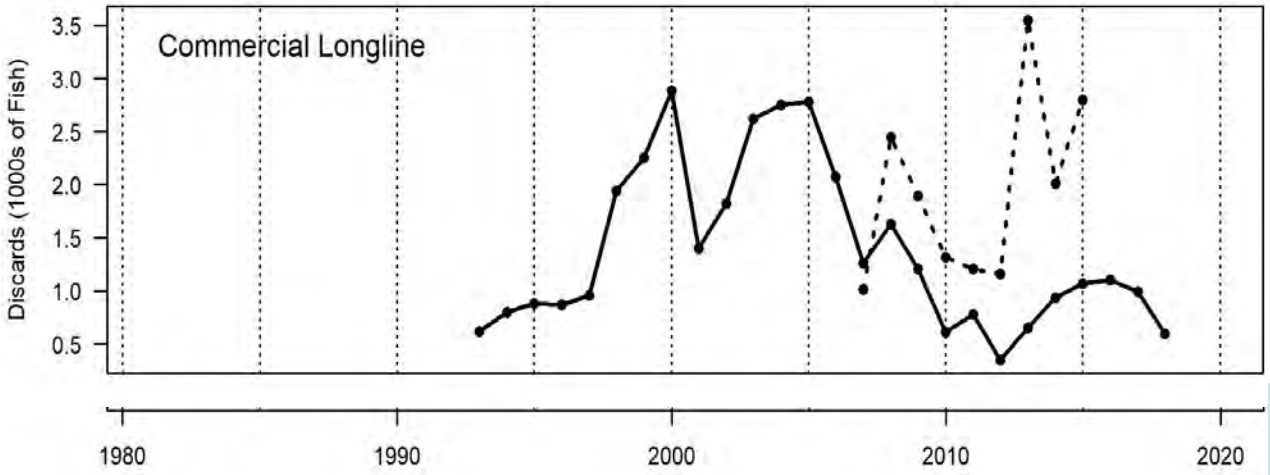
Landings





Discards



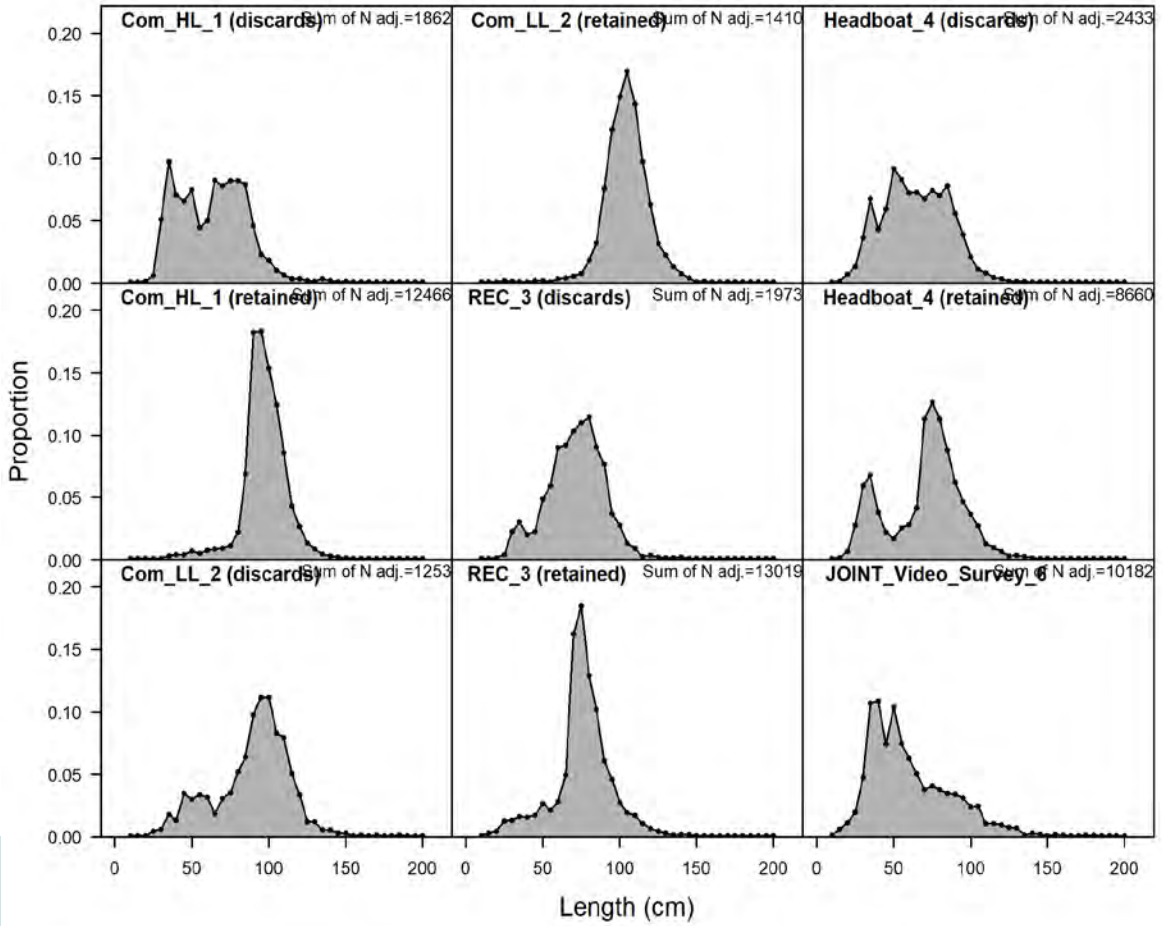


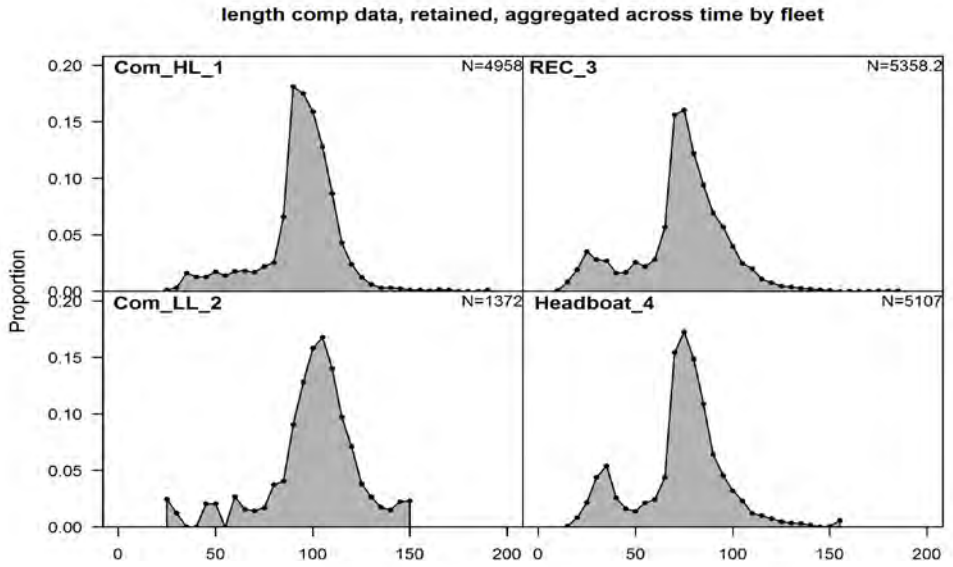
Data – Retained and Discarded Lengths

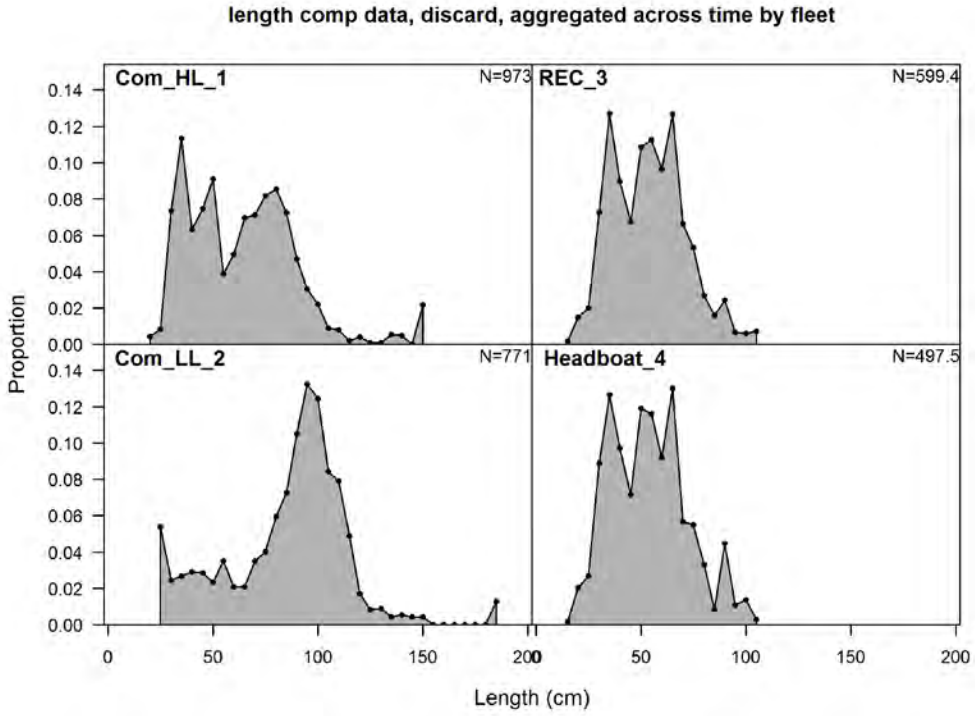
SEDAR 33 Update

Data Component	Decision
Recreational and Commercial	Annual compositions weighted by landings, Dirichlet Multinomial distribution

SEDAR70



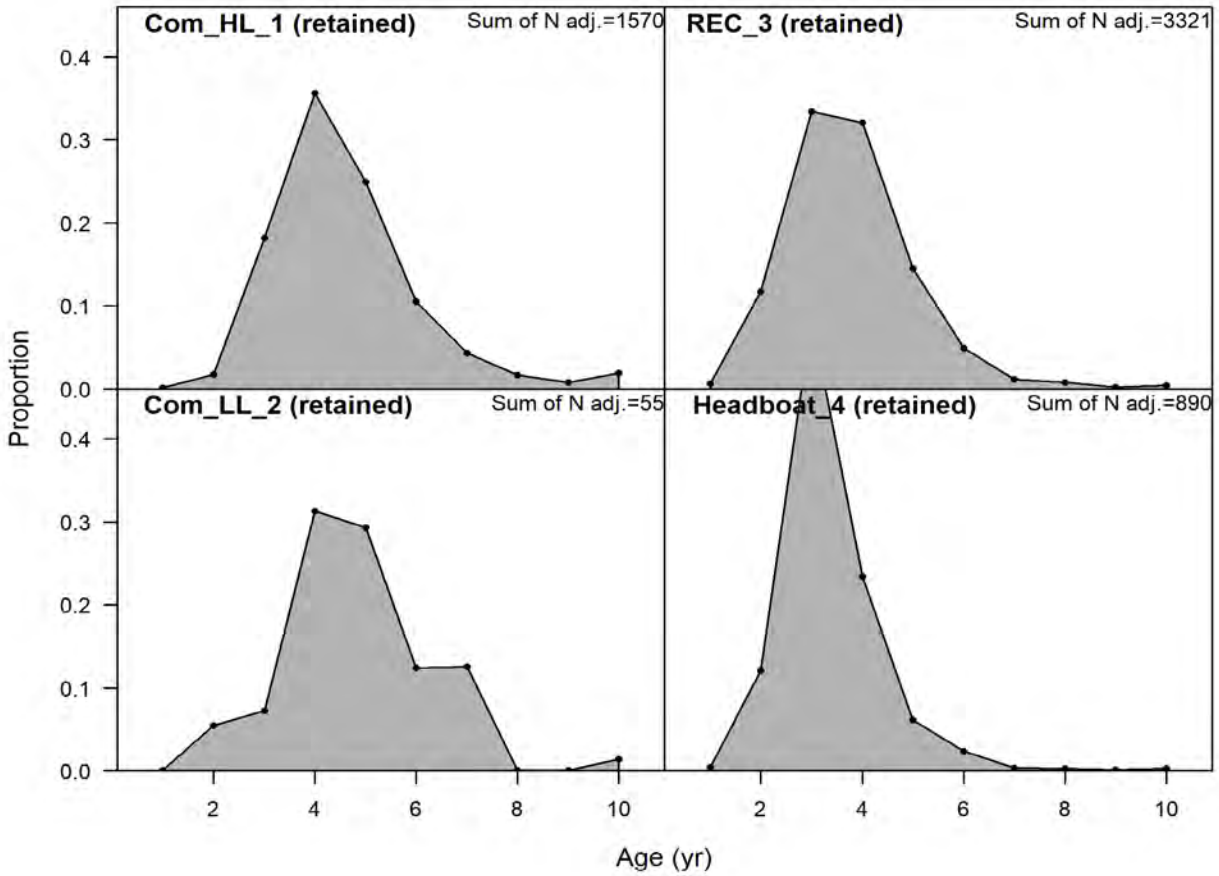




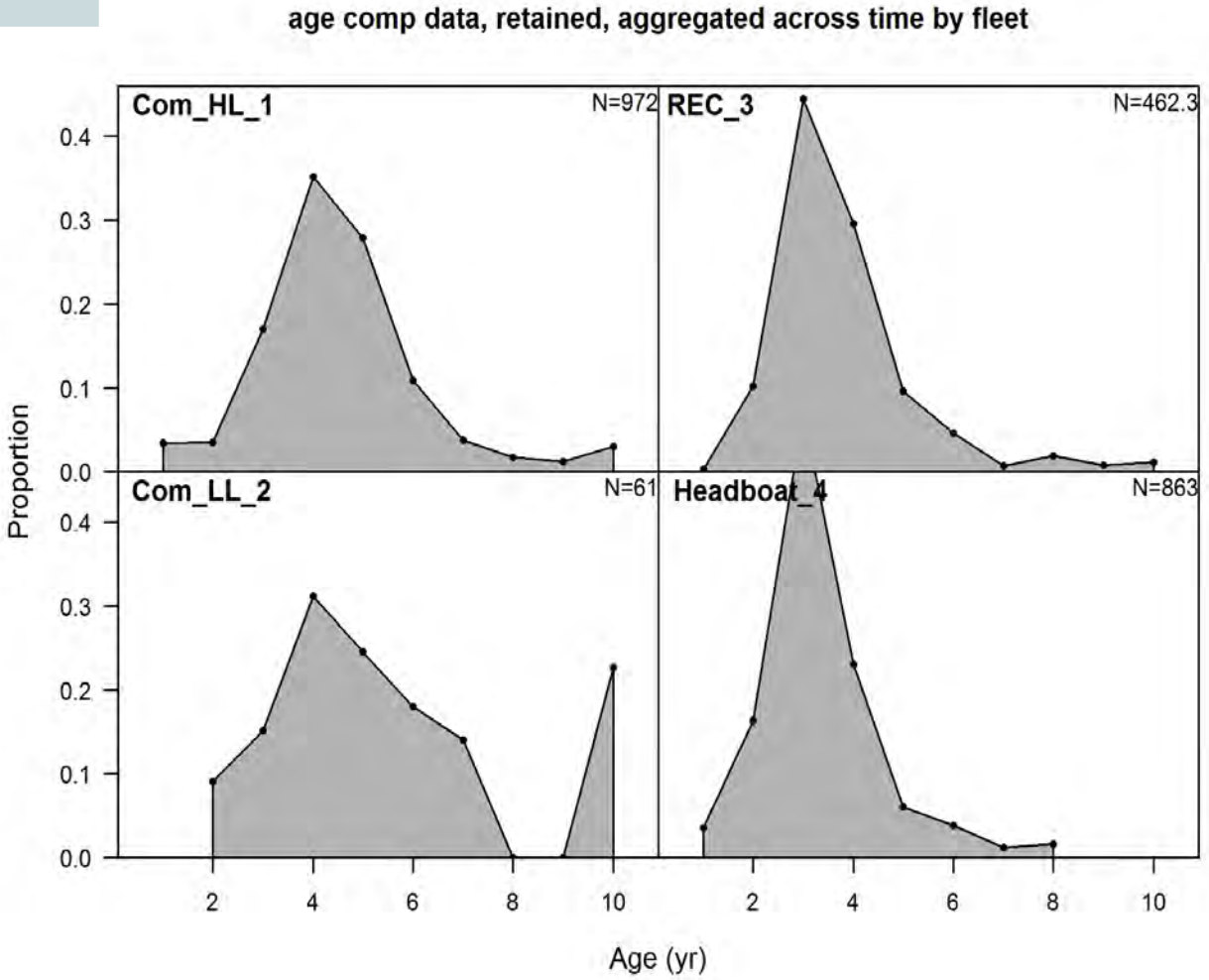
Data –Age Compositions

Data Component	Decision
Recreational and Commercial Age Compositions	Annual compositions re-weighted using weighted length composition and annual proportion age samples by length bin, Dirichlet Multinomial distribution

SEDAR 70

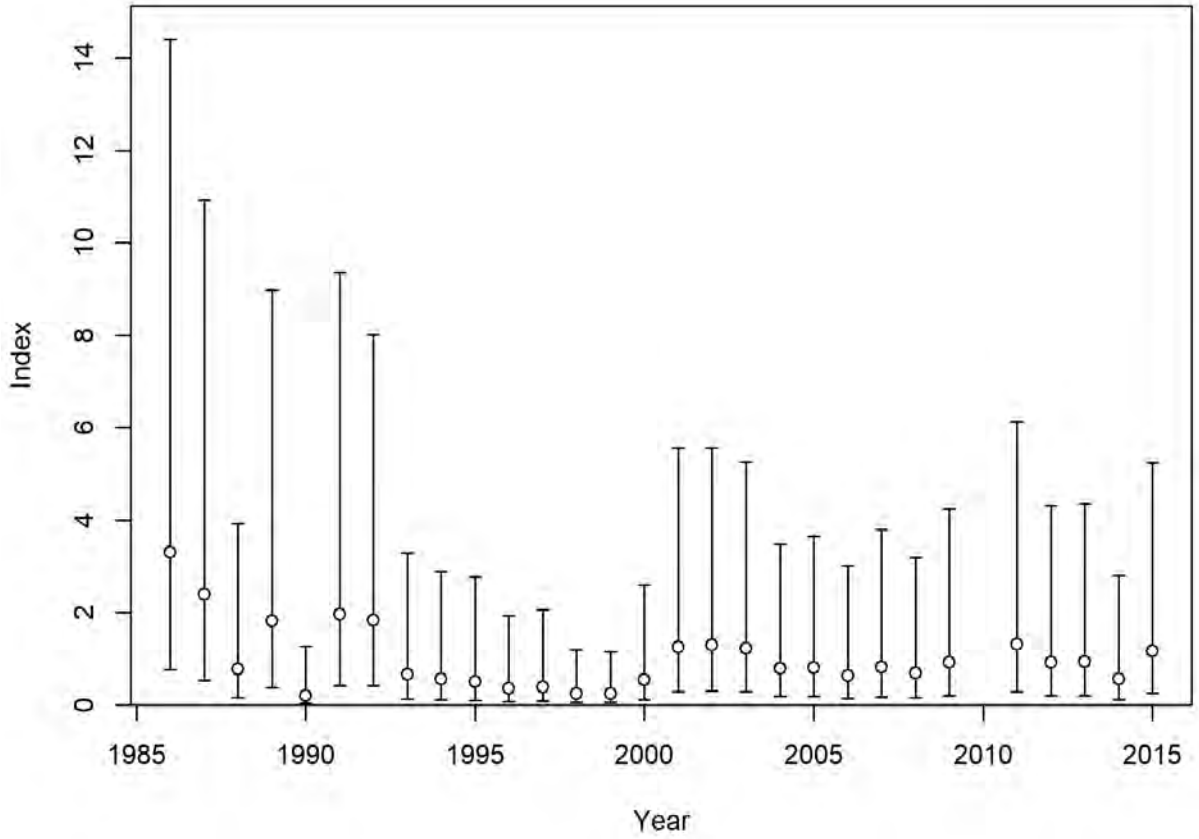


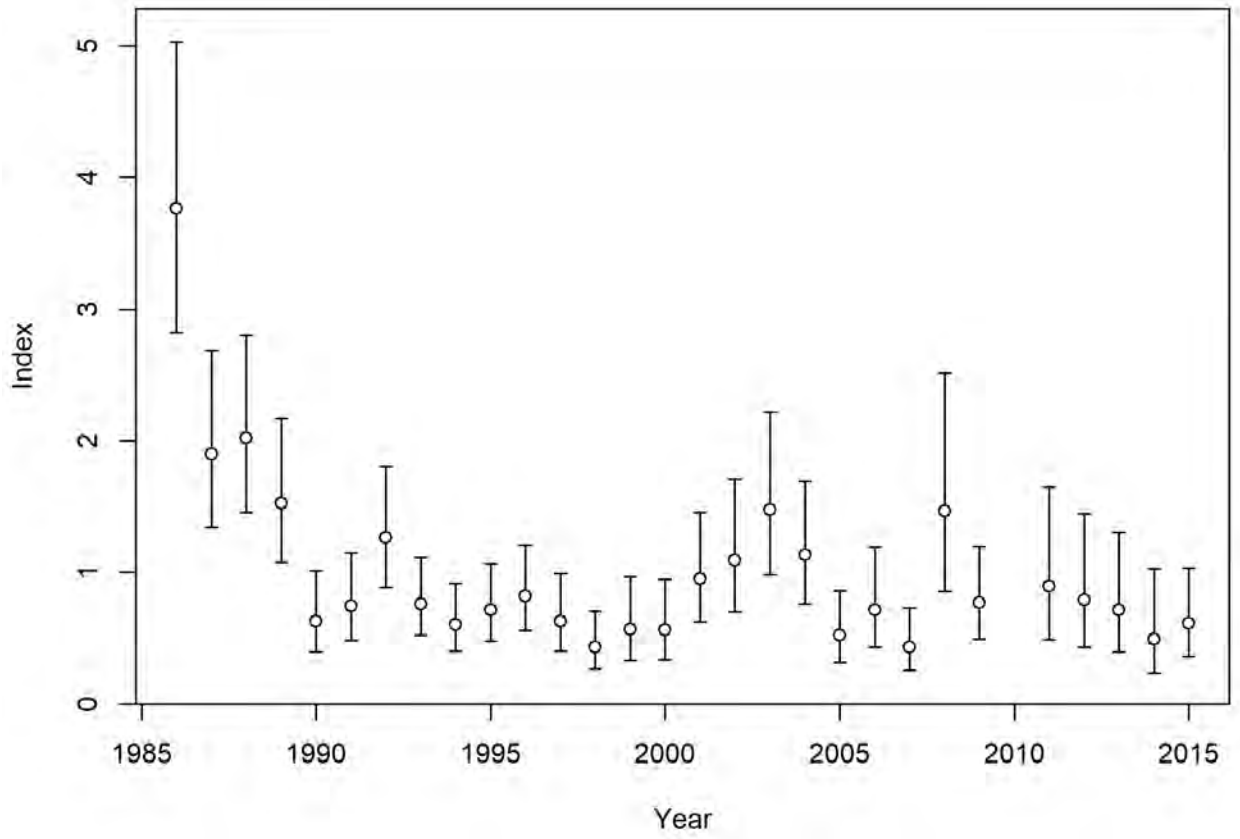
SEDAR 33 Update



Data – Recreational Indices

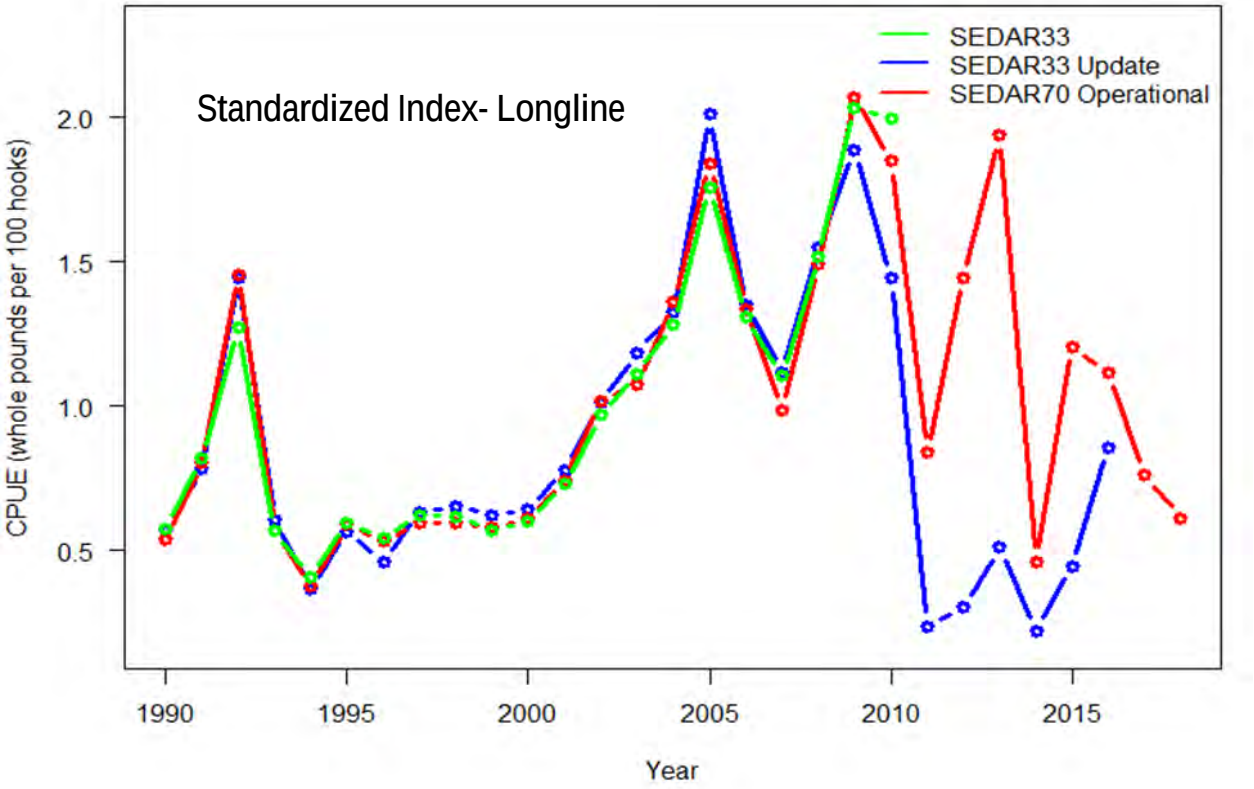
Data Component	Decision
MRIP CPUE Index	SEDAR 33 2016 Index used; not updated due to recreational closures from 2016 on
Headboat CPUE Index	SEDAR 33 2016 Index used; not updated due to recreational closures from 2016 on

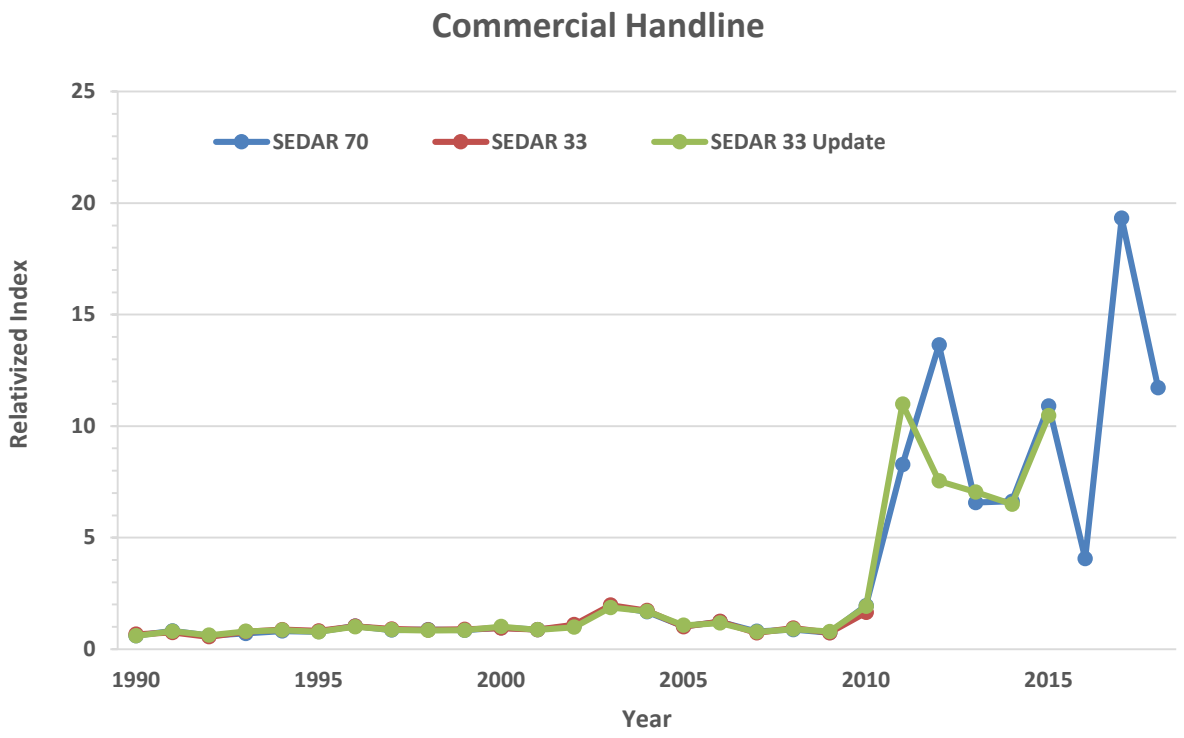




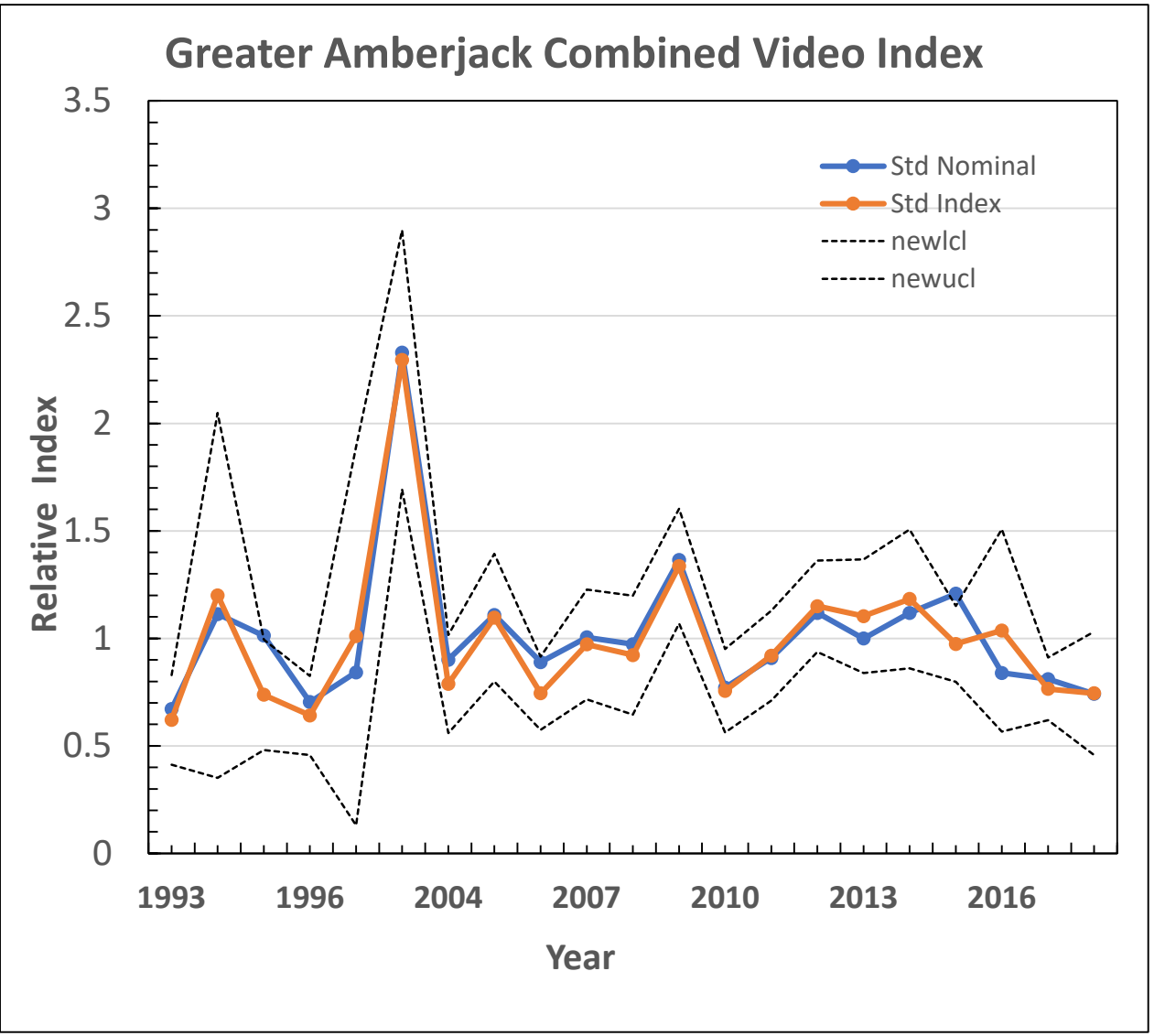
Data – Commercial Indices

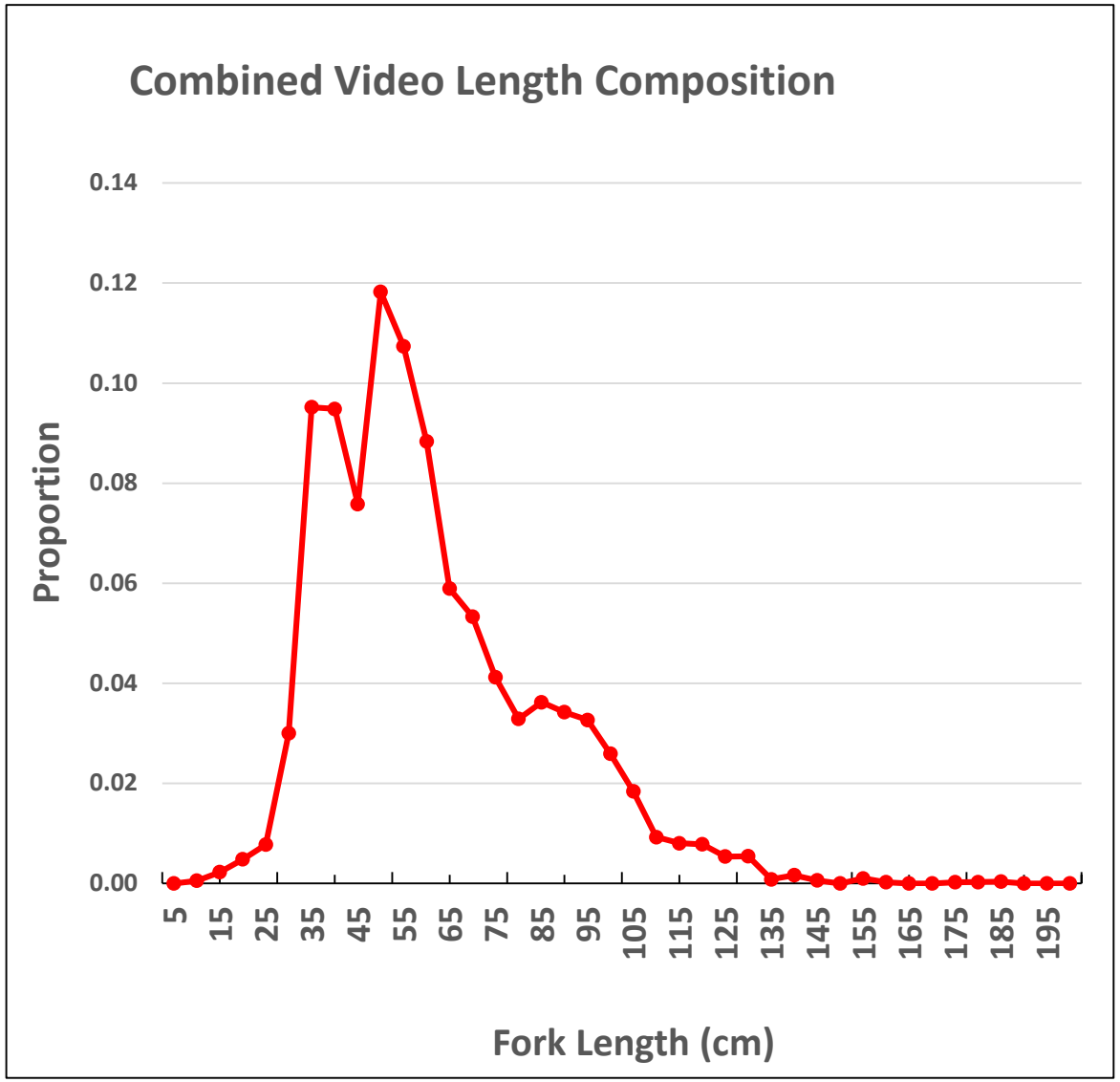
Data Component	Decision
Vertical Line CPUE Index	Index dropped by Assessment Panel due to a change in fishing behavior
Longline CPUE Index	





Fishery Independent Indices and Length compositions





Addressing ToR 2, part 2

- Preliminary results received from LGL suggest that a significant fraction (30-40%) of the total abundance of Greater Amberjack occur on oil and gas platforms in the Central and Western GOM.
- The results of this study could have important implications for the stock assessment and the resulting management advice
  - The changes needed to restructure the model and adequate time and resources to acquire the necessary data to inform a model with the required temporal and spatial stratification were outside the scope of this Operational Assessment.
  - The SEFSC strongly recommends further consideration of this study during the next Research Track assessment of GOM Greater Amberjack.

SEDAR 28 Update: Base Model
TOR 1 and 3

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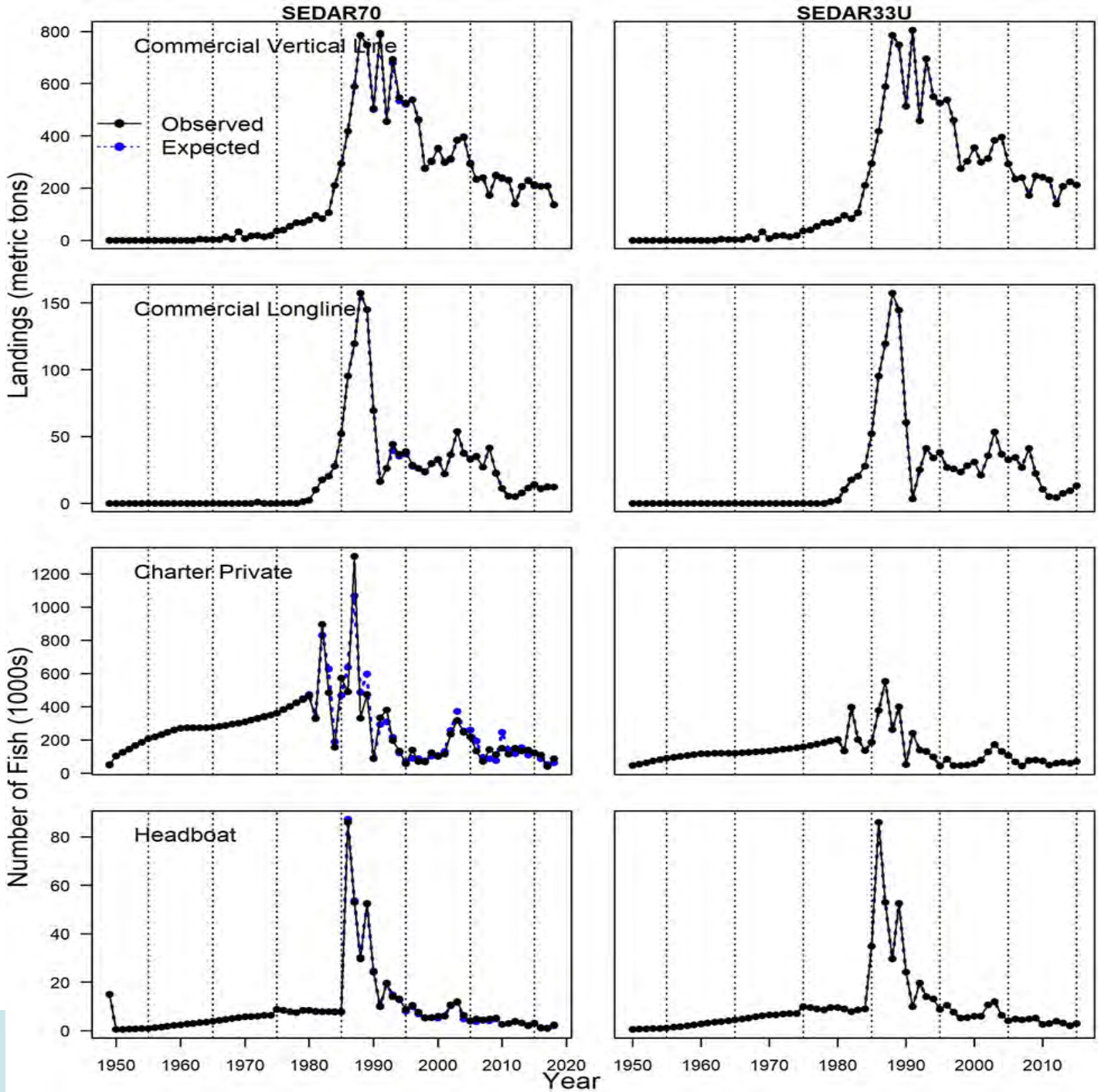
Base Model Development

Model Name	Description	SS Version	NLL	Gradient	ln(R0)
S33 2016 Update	S33 2016 Update	3.24s	1,191.02	0.003	7.930
Step 1	SS3.30 converted model of the S33 Update model	3.30_15	1,164.04	0.000	7.940
Step 2	Step 1 + FES catches for Charter/Private	3.30_15	1,192.82	0.005	8.380
Step 3	Step 2 + all new revised data	3.30_15	2,479.67	0.007	8.260
Step 4	Step 3 + updated growth, maturation parameters, added extra time block for Charter/Private and Headboat	3.30_15	2,411.43	0.024	8.090
Step 5	Step 4 + final length and age compositions (weighted), Dirichlet multinomial likelihoods, index reweighting's, steepness prior, removal of Commercial Vertical Line index, estimating all three S/R parameters	3.30_15	1,652.89	0.010	8.550
Step 6	Final Base Model SEDAR 70, no steepness prior, fixed sigmaR, fixed steepness, spline selex on Commercial Vertical Line	3.30_15	1,656.56	0.013	8.220

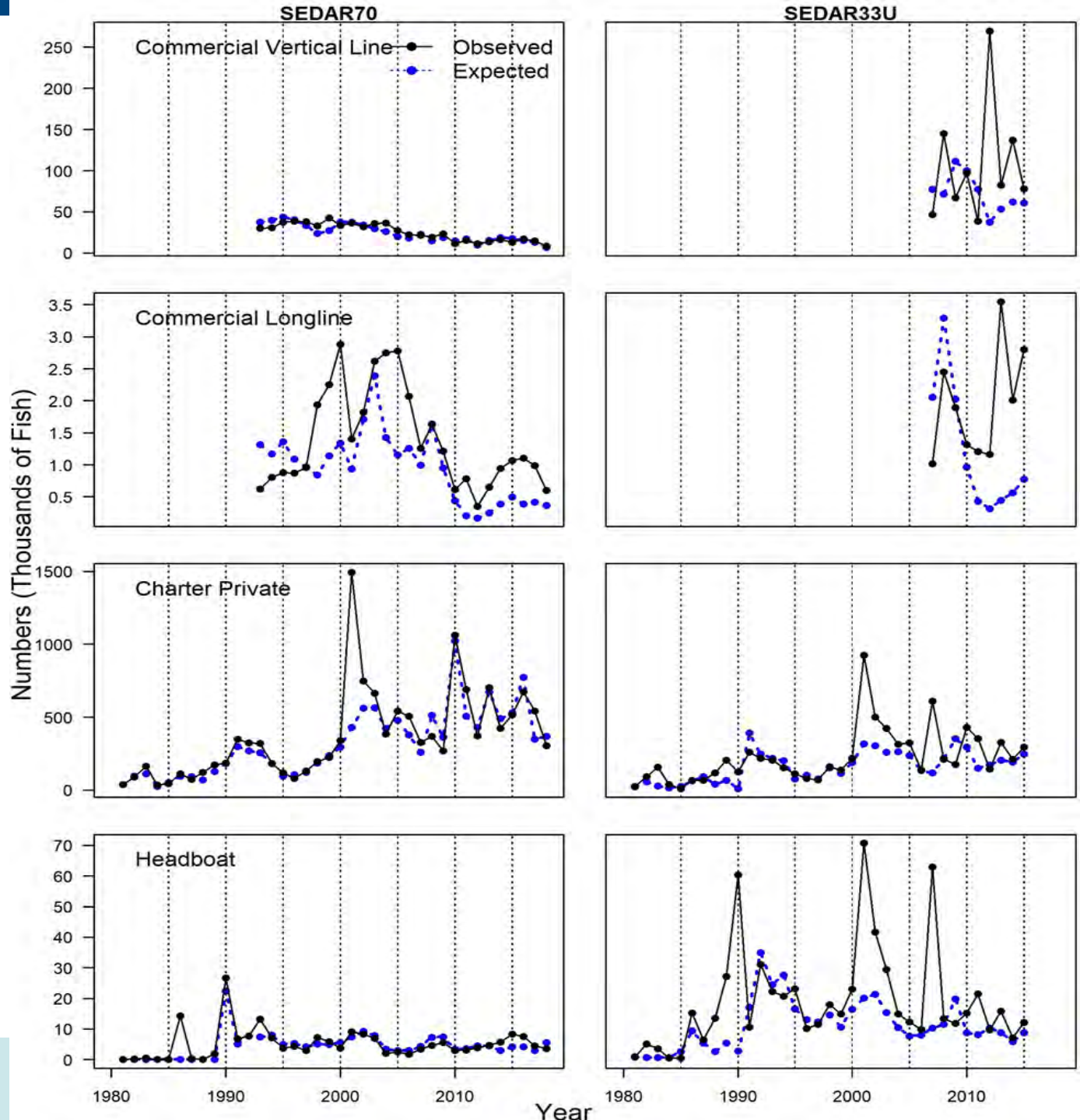
Base Model Fit

Landings



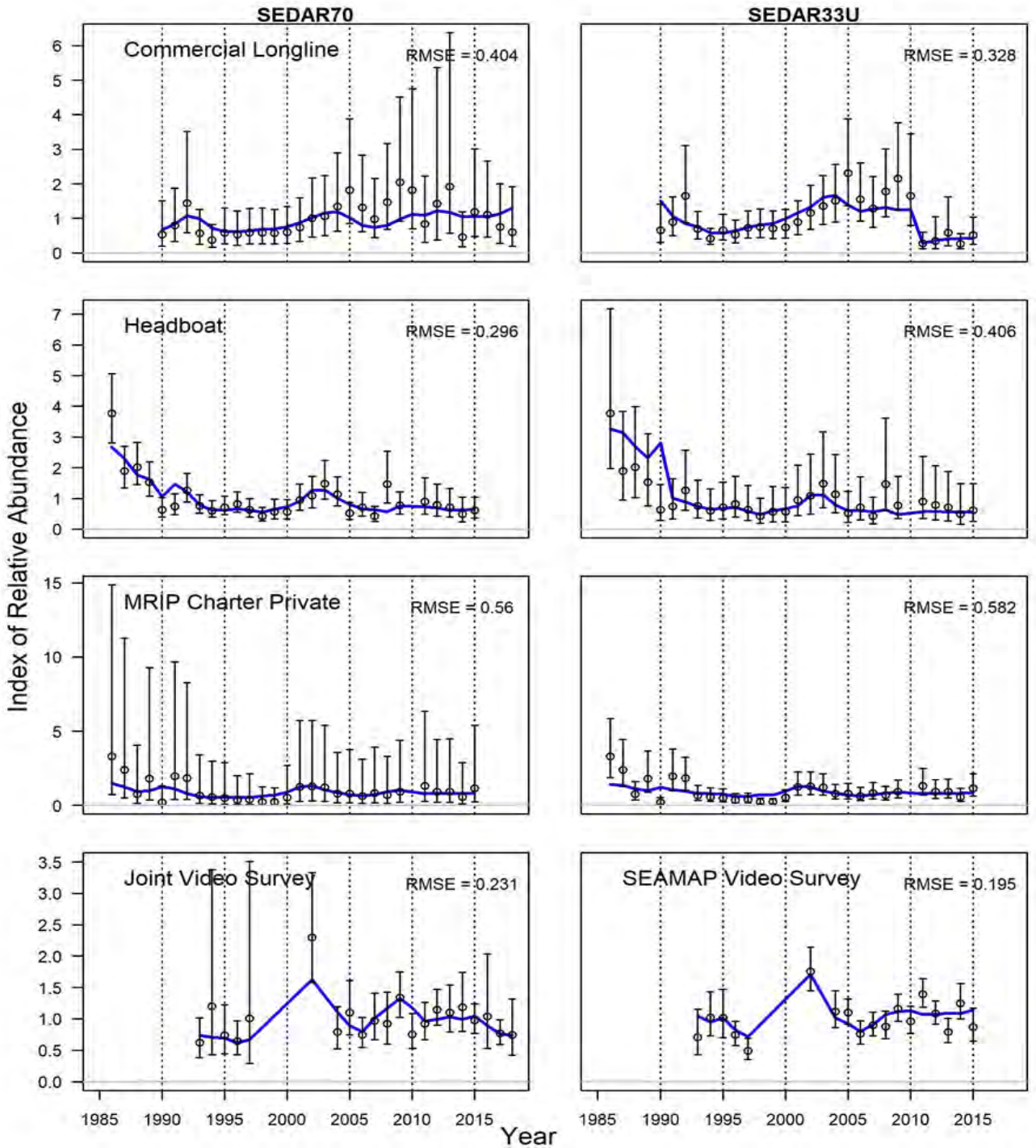
Base Model Fit

- Discards



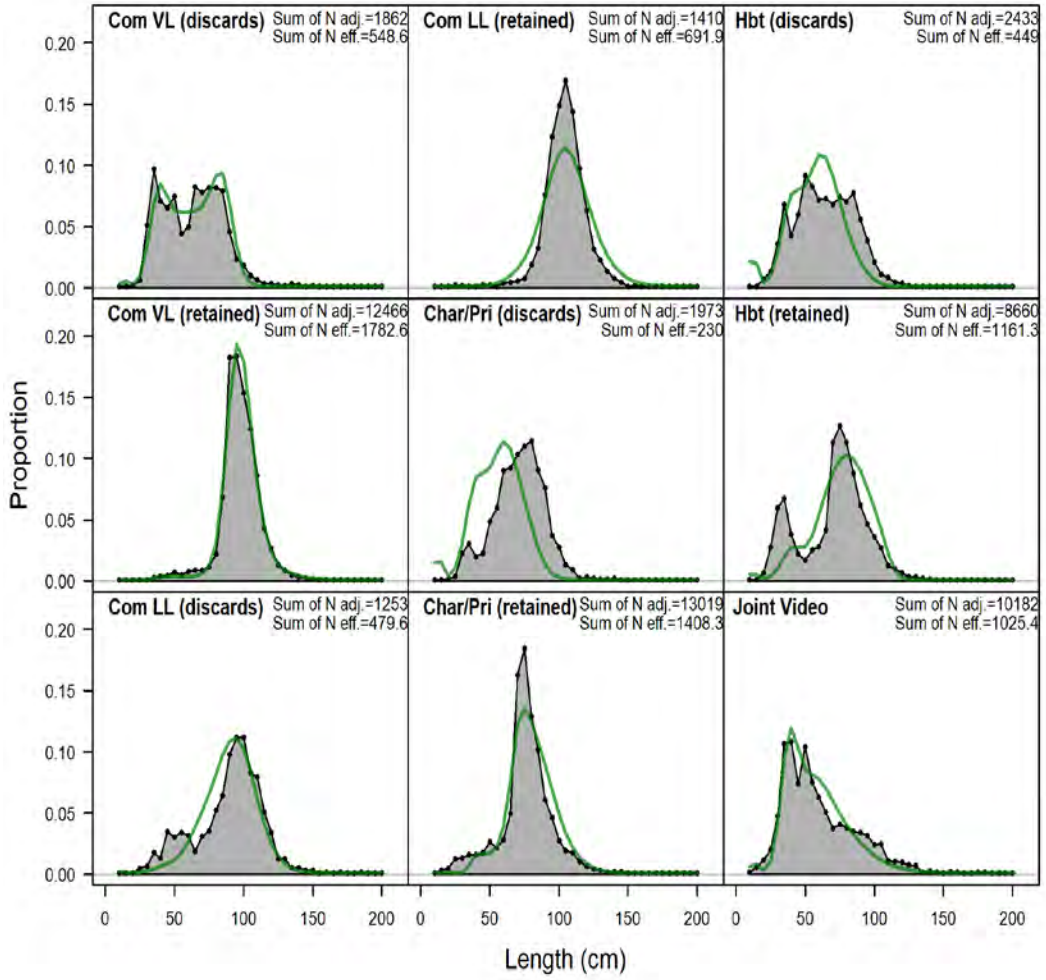
Base Model Fit

- Indices

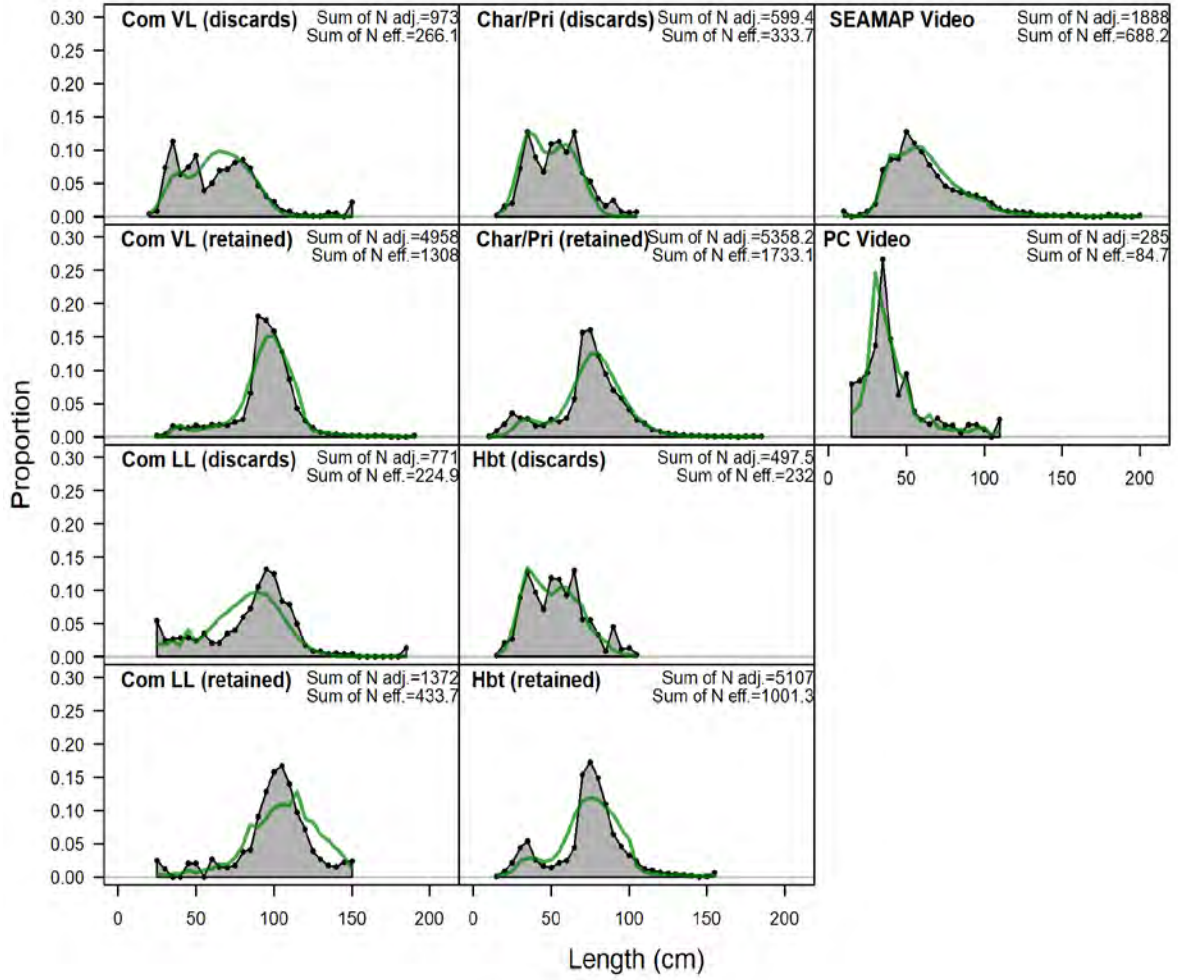


Base Model Fit - Length Compositions

SEDAR70

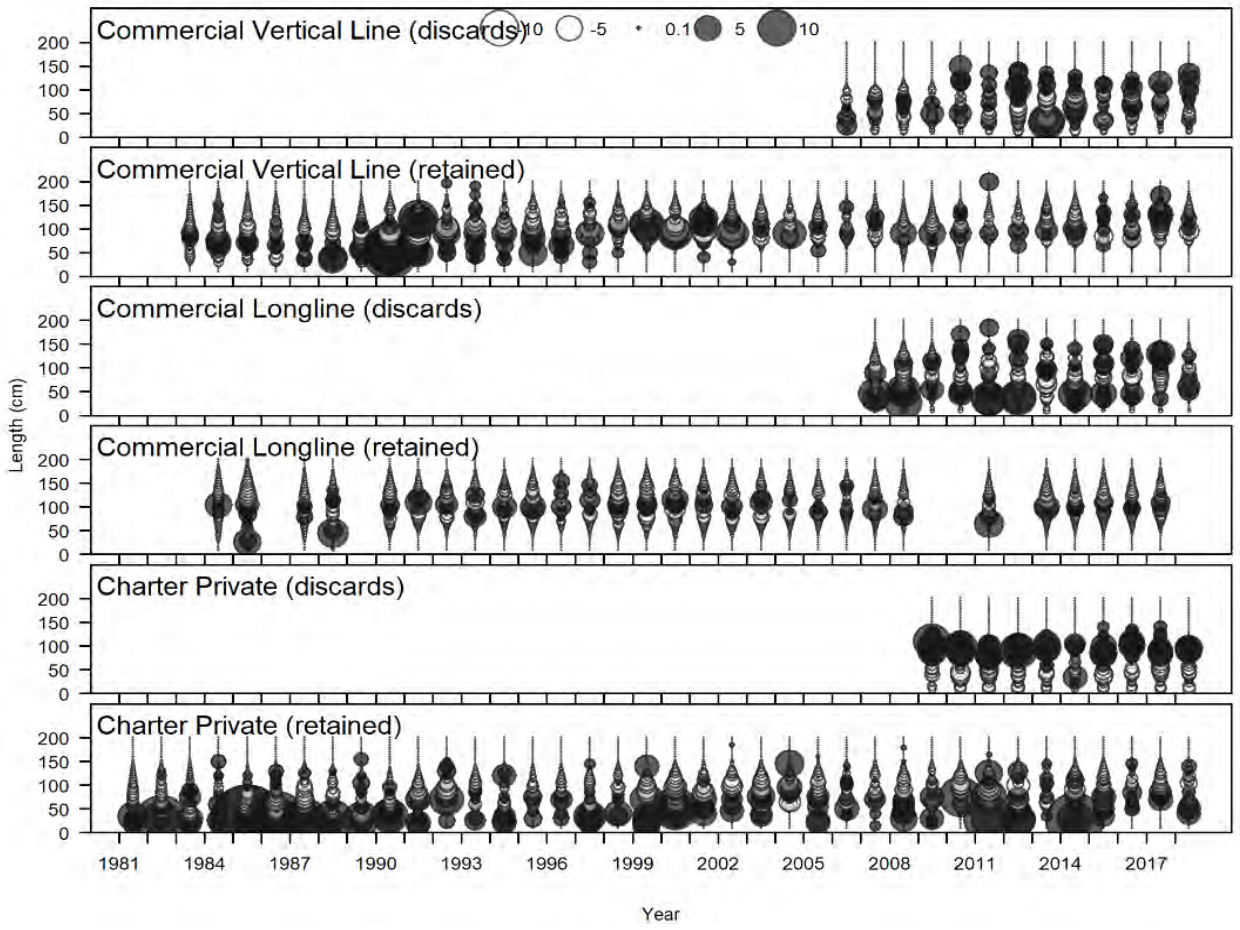


SEDAR 33 Update

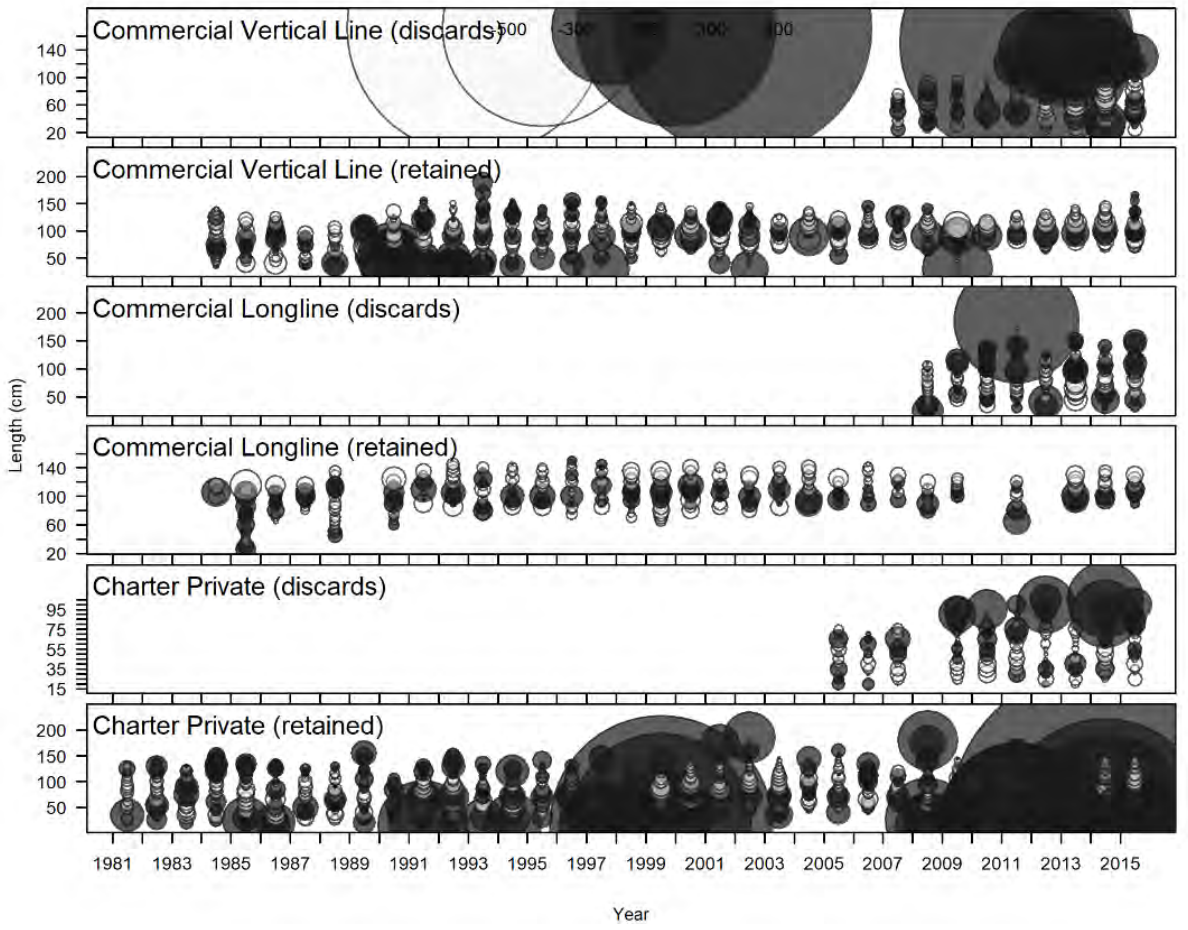


Base Model – Fit Length Compositions

SEDAR70



SEDAR33 Update



Base Model Fit – Length Compositions

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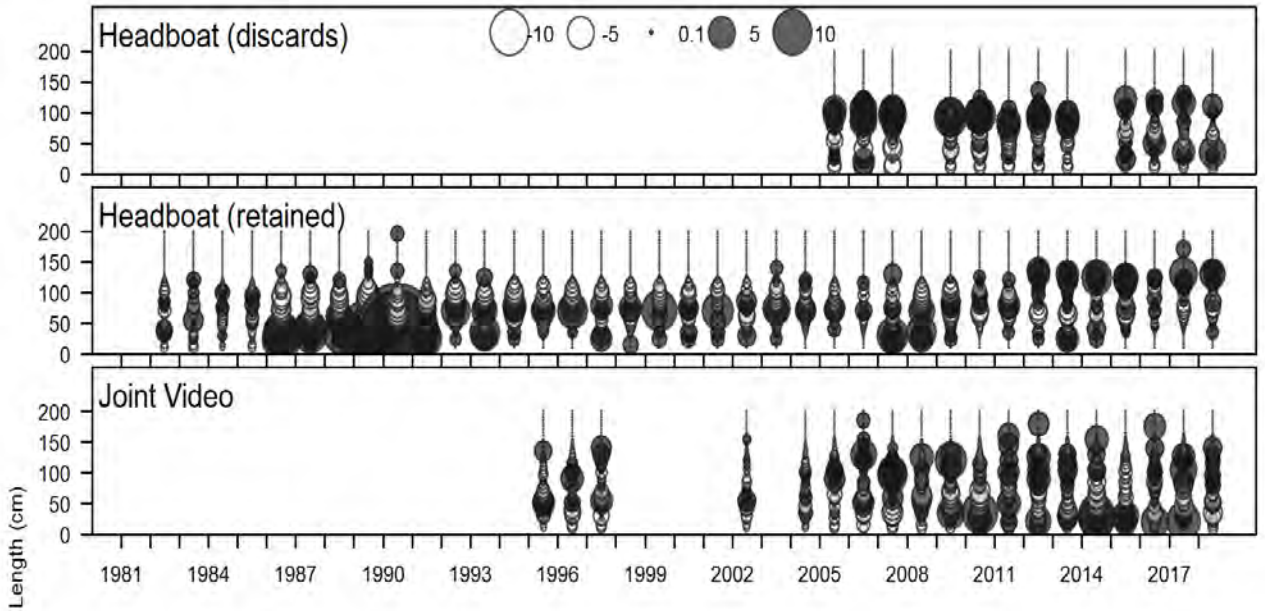

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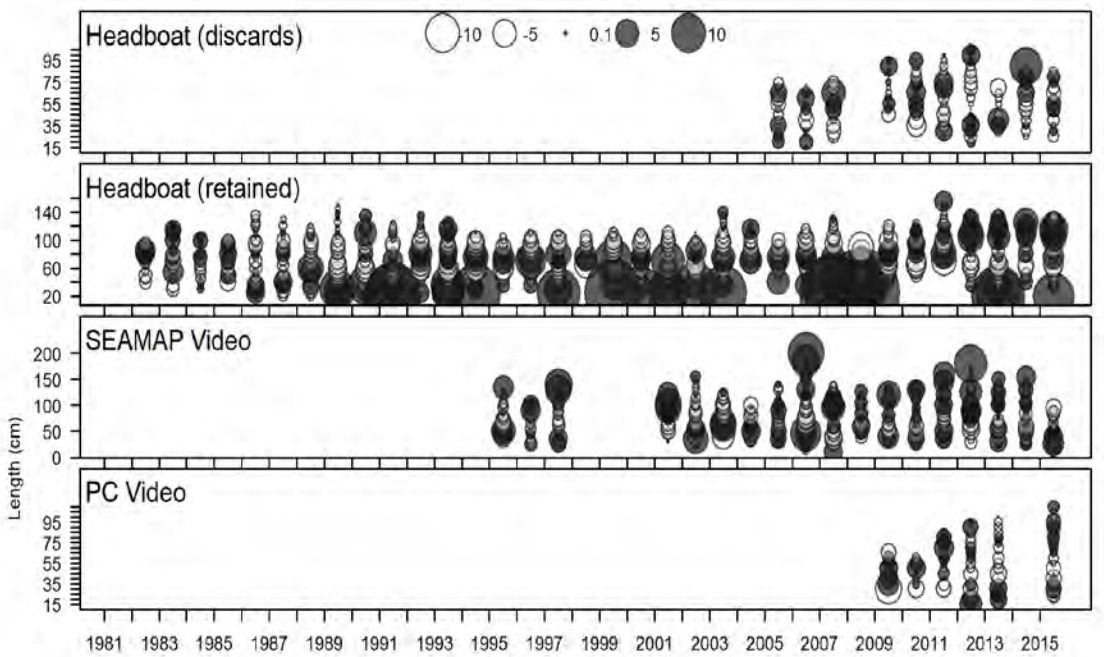
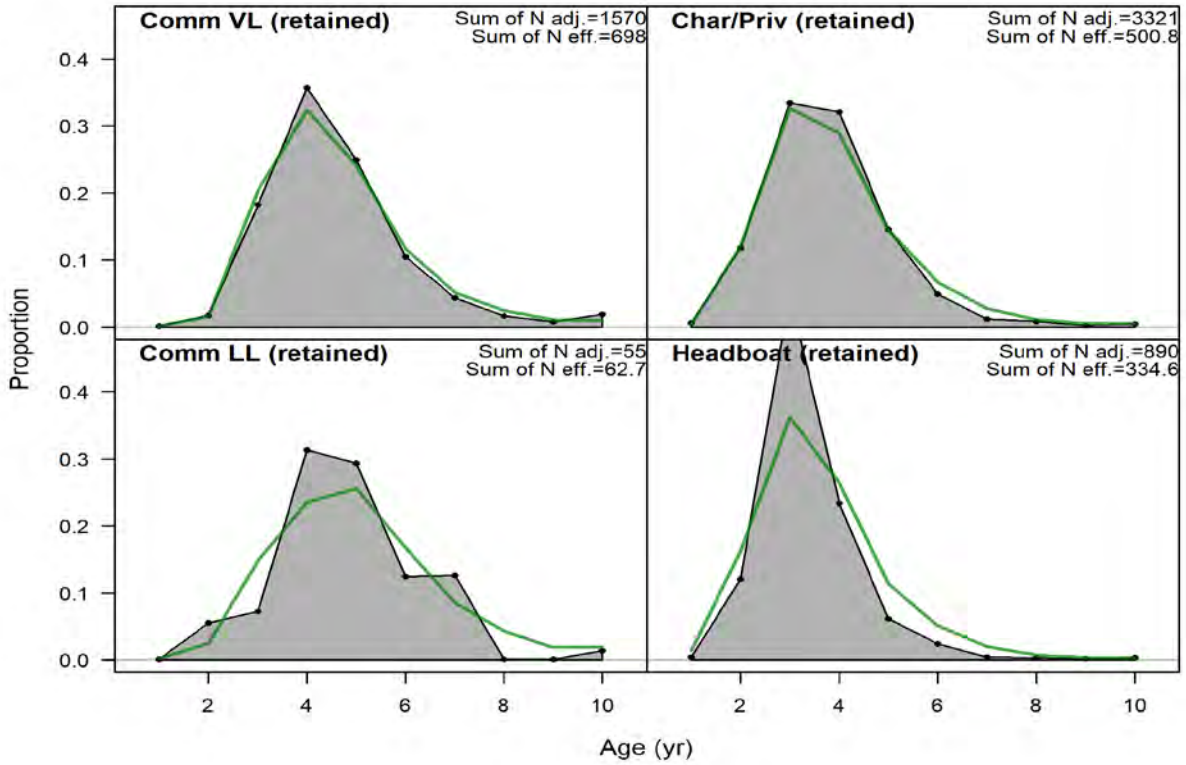
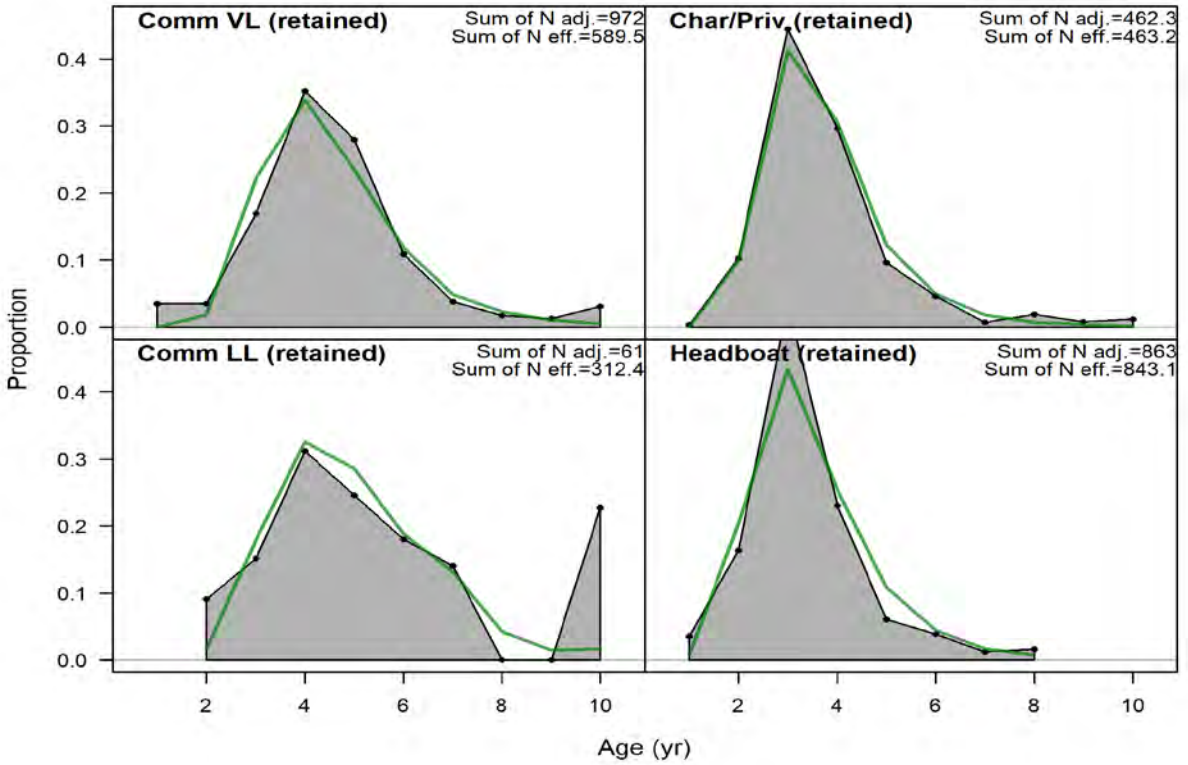


Base Model Fit - Age Compositions

SEDAR70

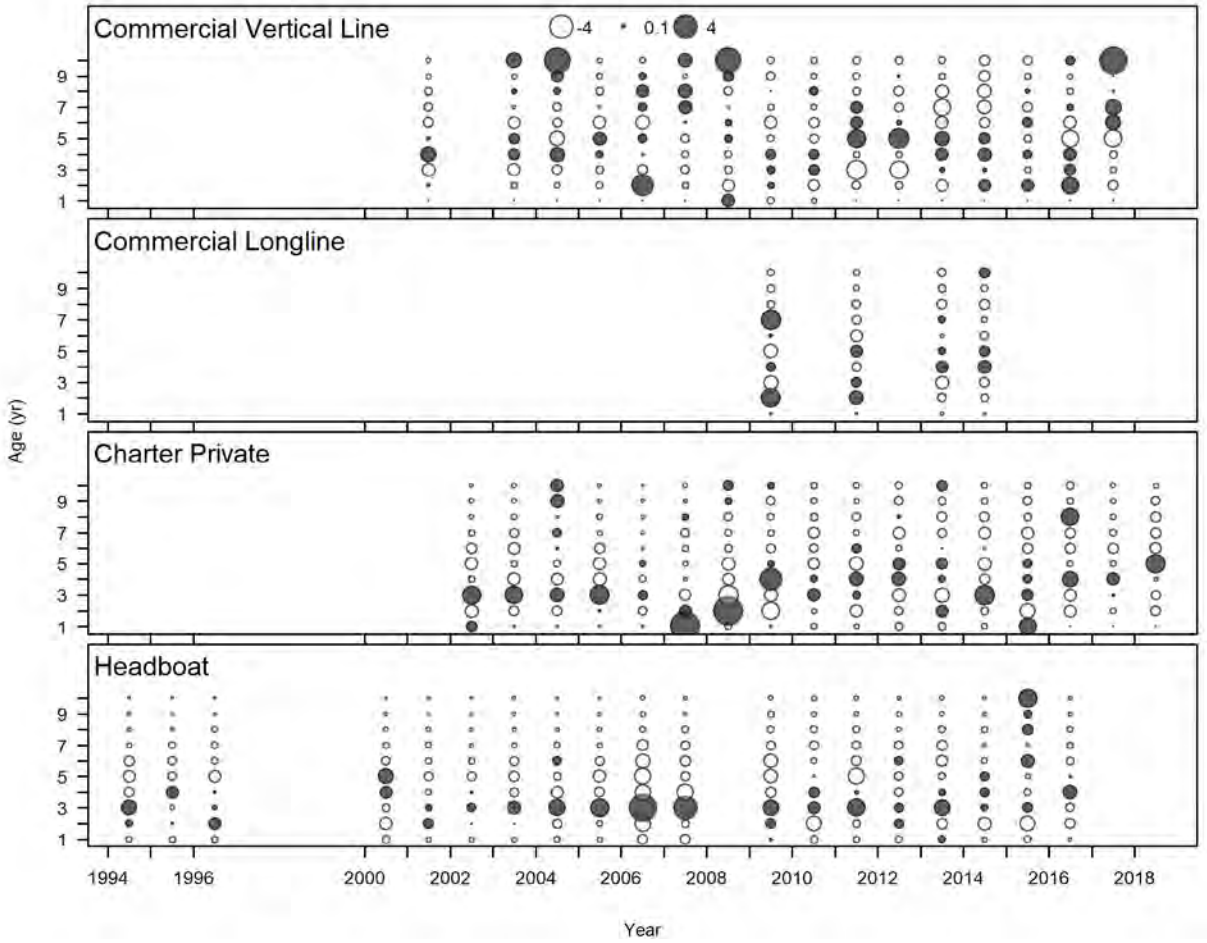


SEDAR33 Update

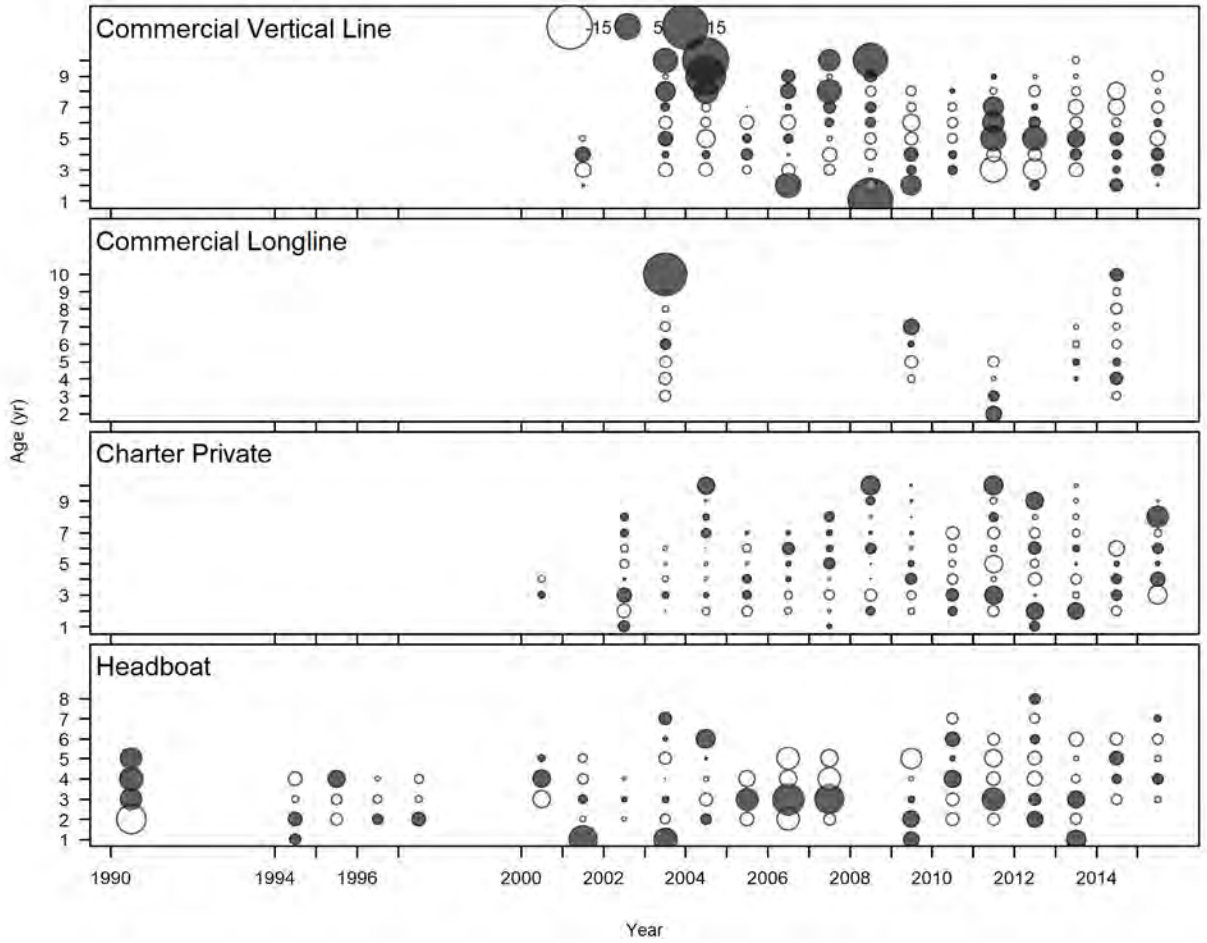


Base Model Fit – Age Compositions

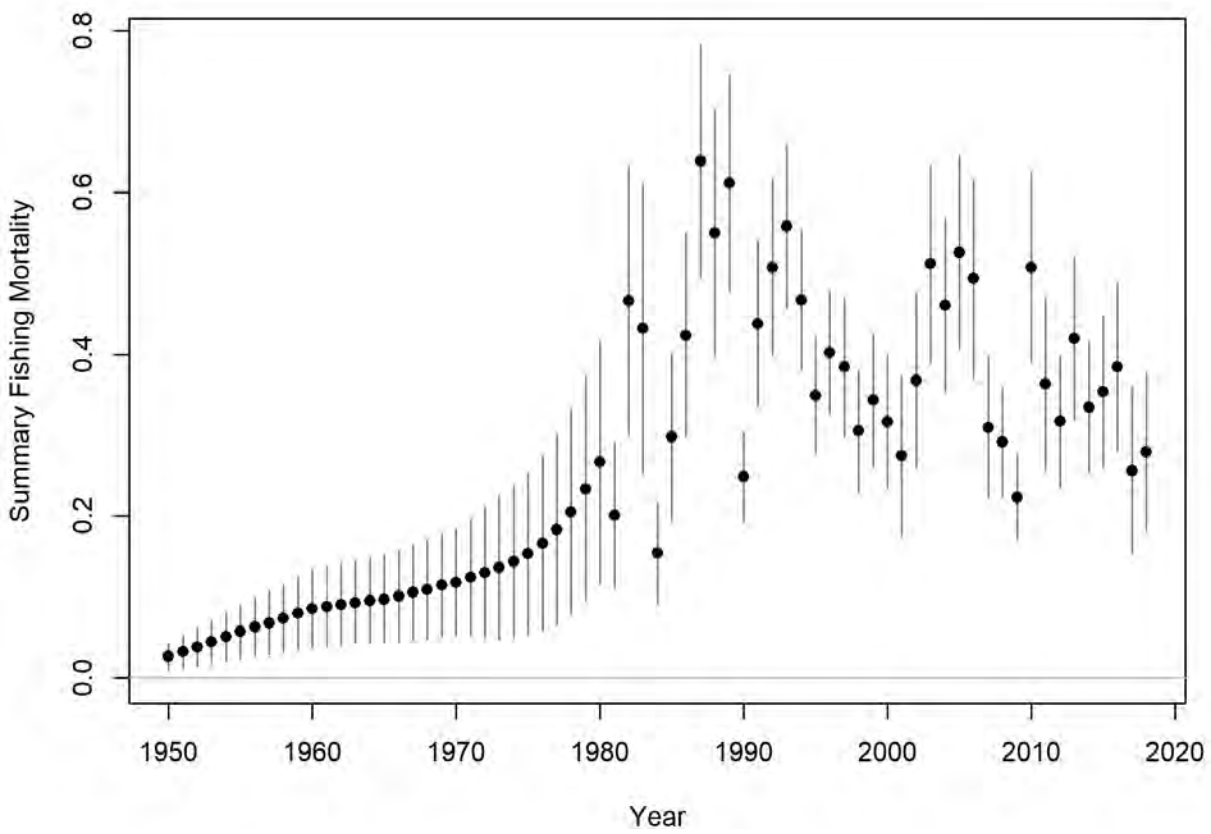
SEDAR70



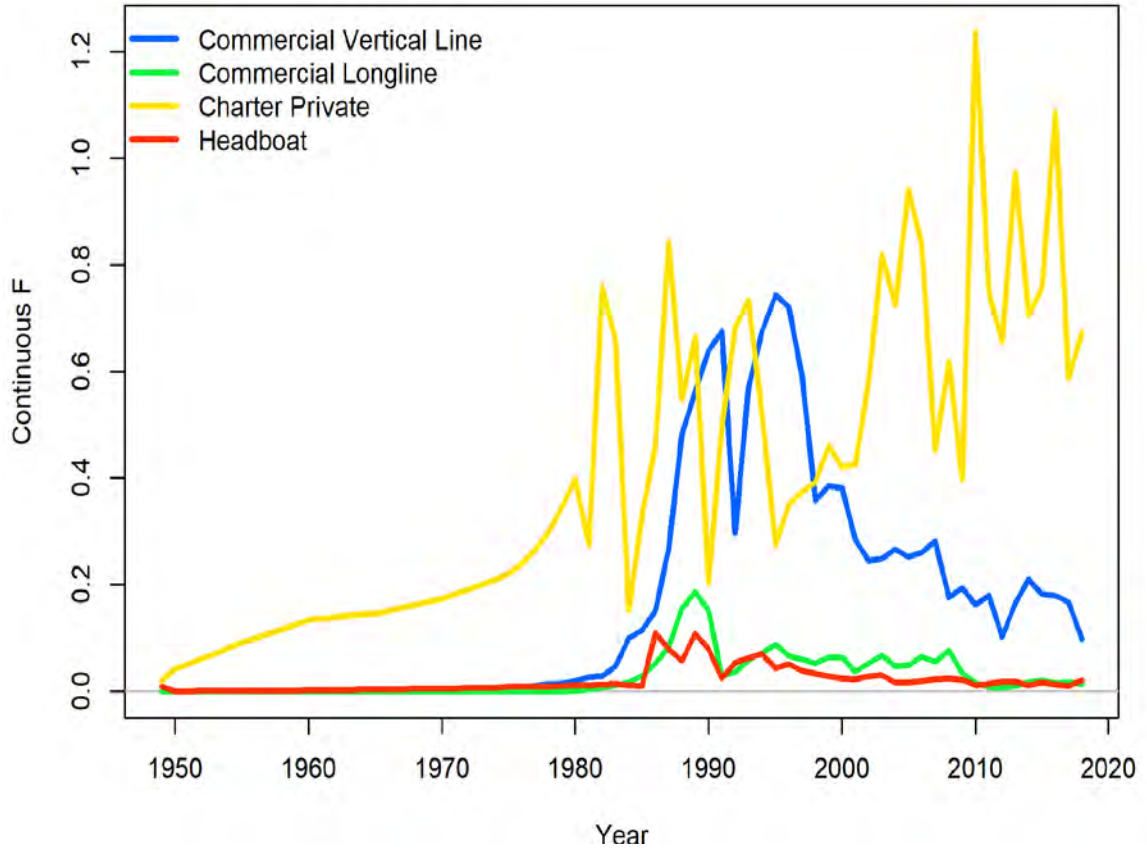
SEDAR33 Update



Base Model Results – Fishing Mortality

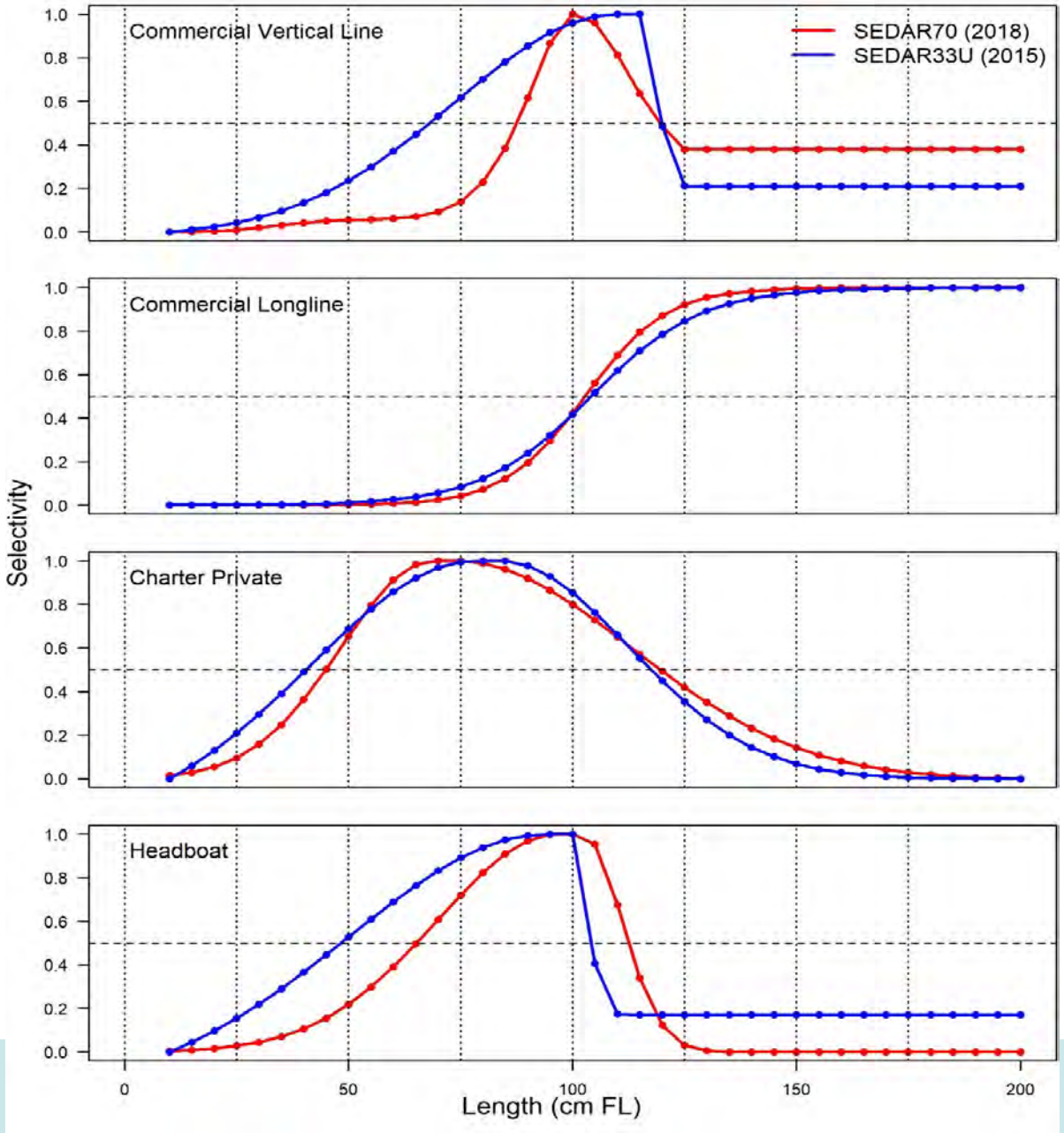


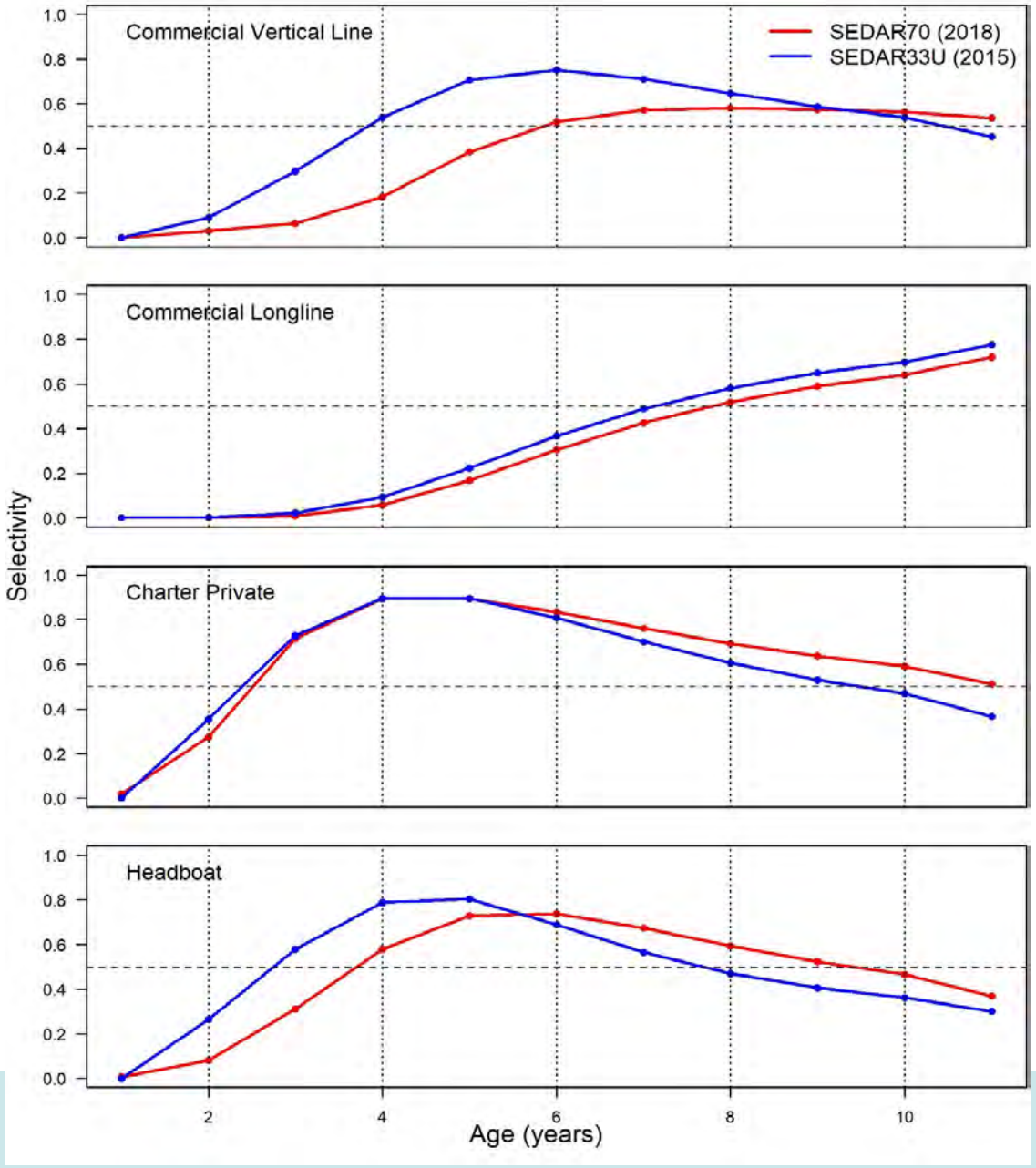
Annual exploitation rate (total kill/total biomass)



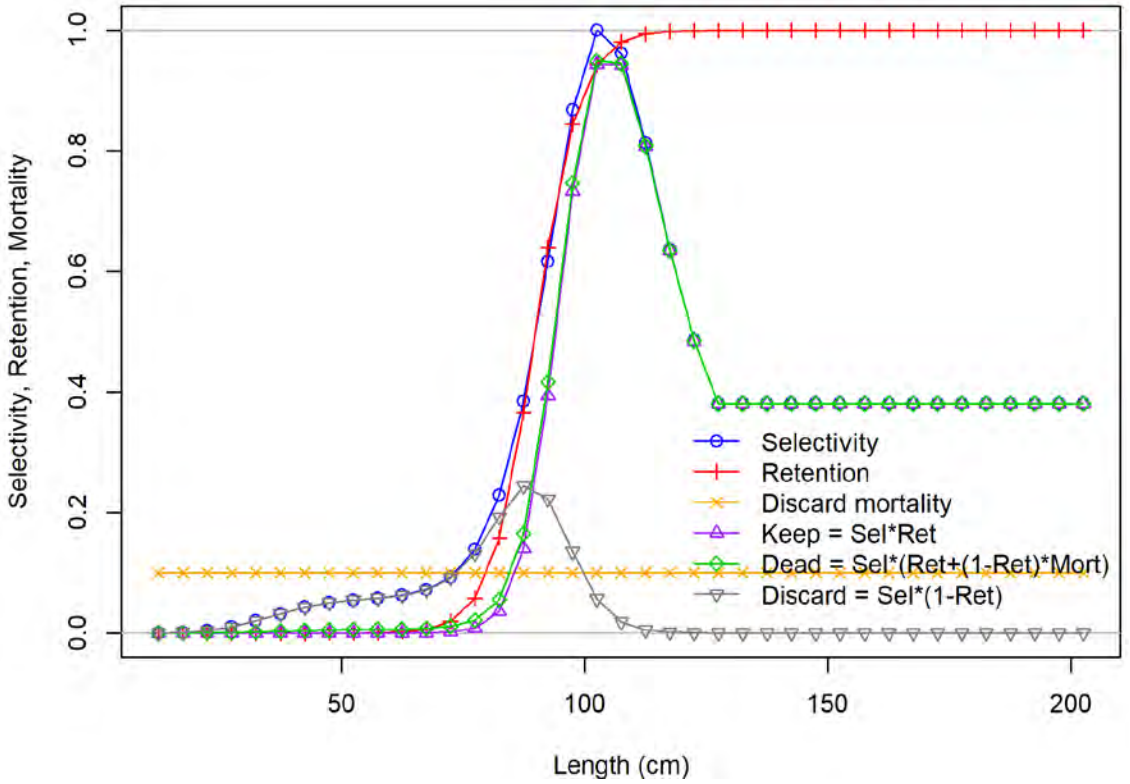
Fleet-specific estimates of instantaneous fishing mortality rate

Base Model Results – Length and Age-Based Selectivities

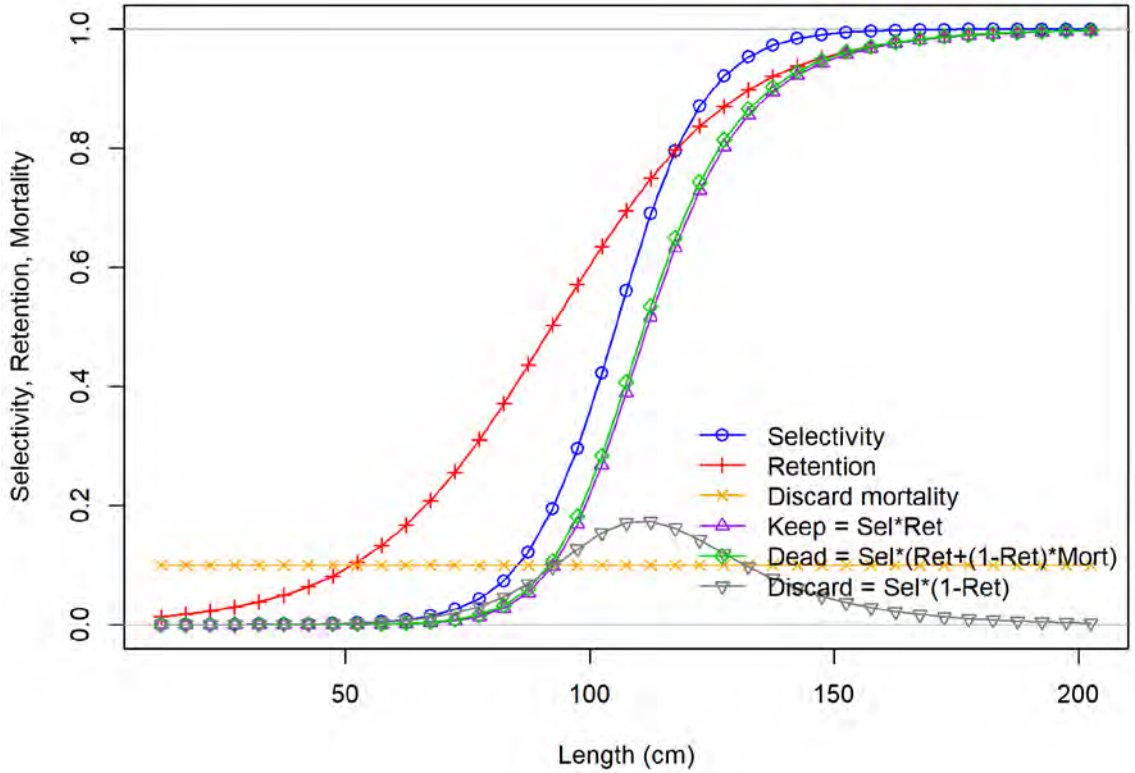




Base Model Results – Commercial Selectivities

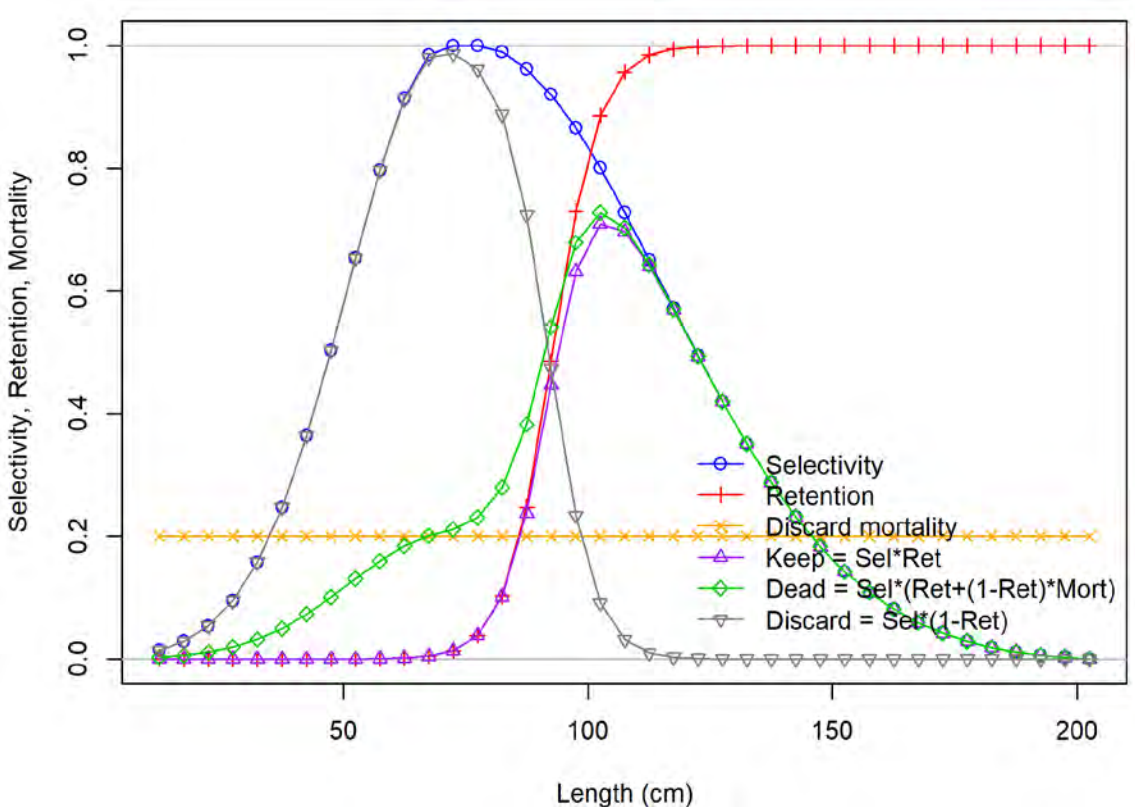


Commercial Vertical Line

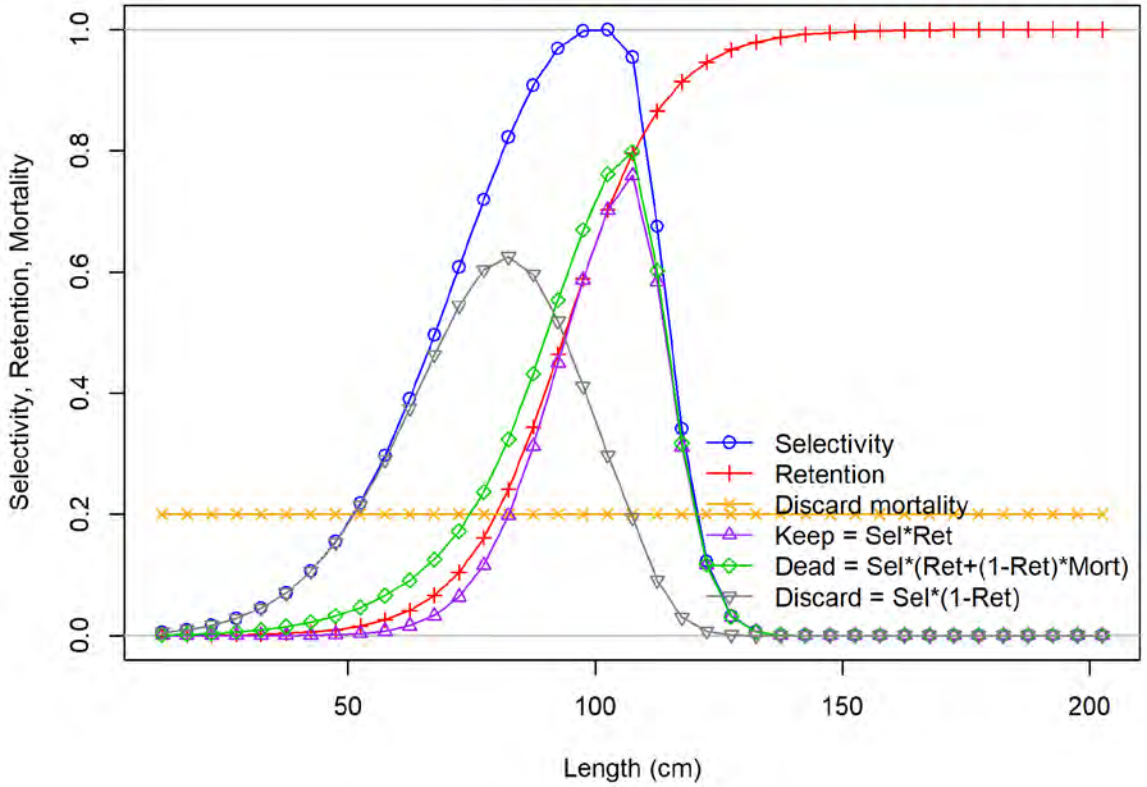


Commercial Longline

Base Model Results – Recreational Selectivities

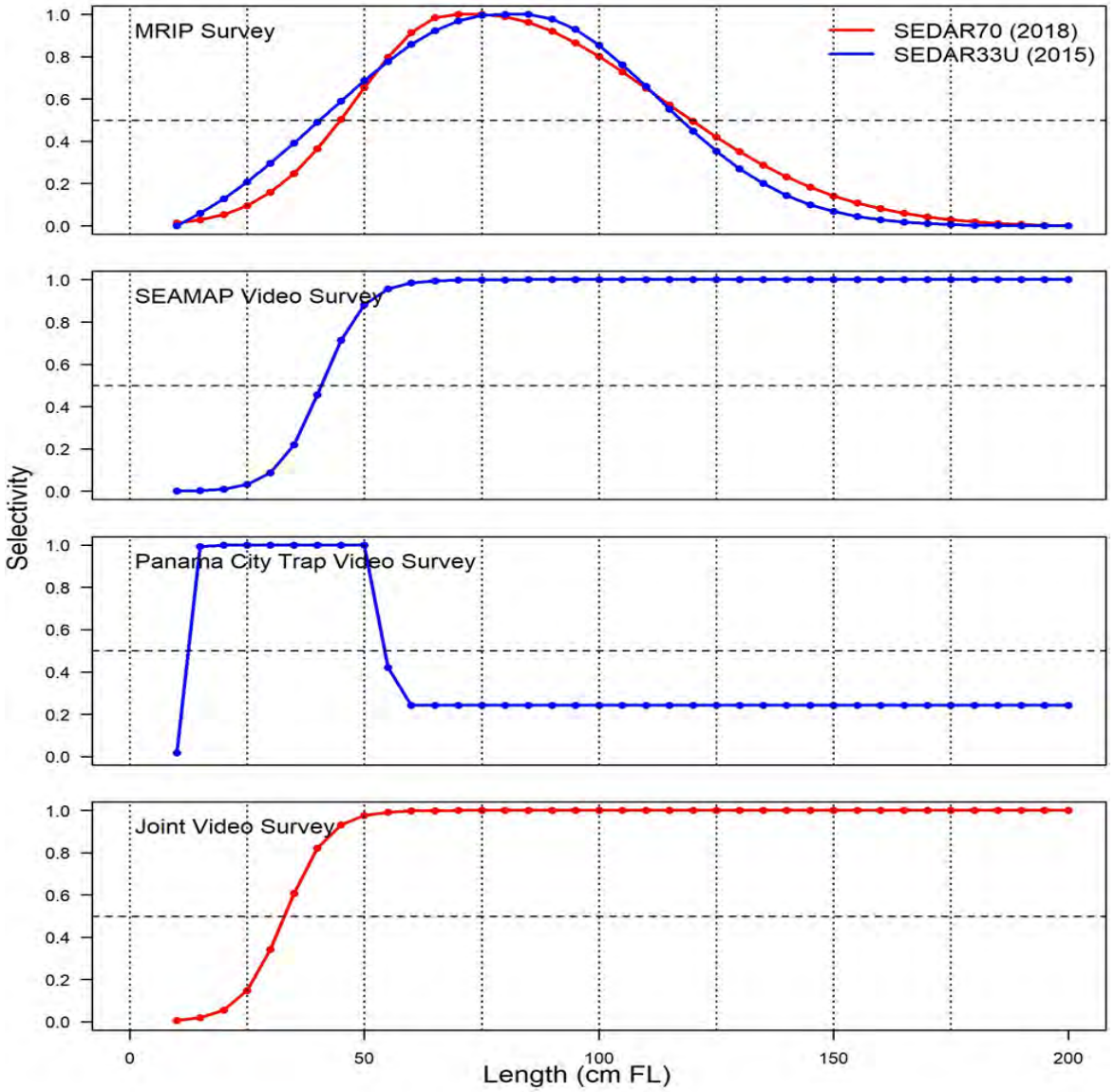


Recreational Private/Charter

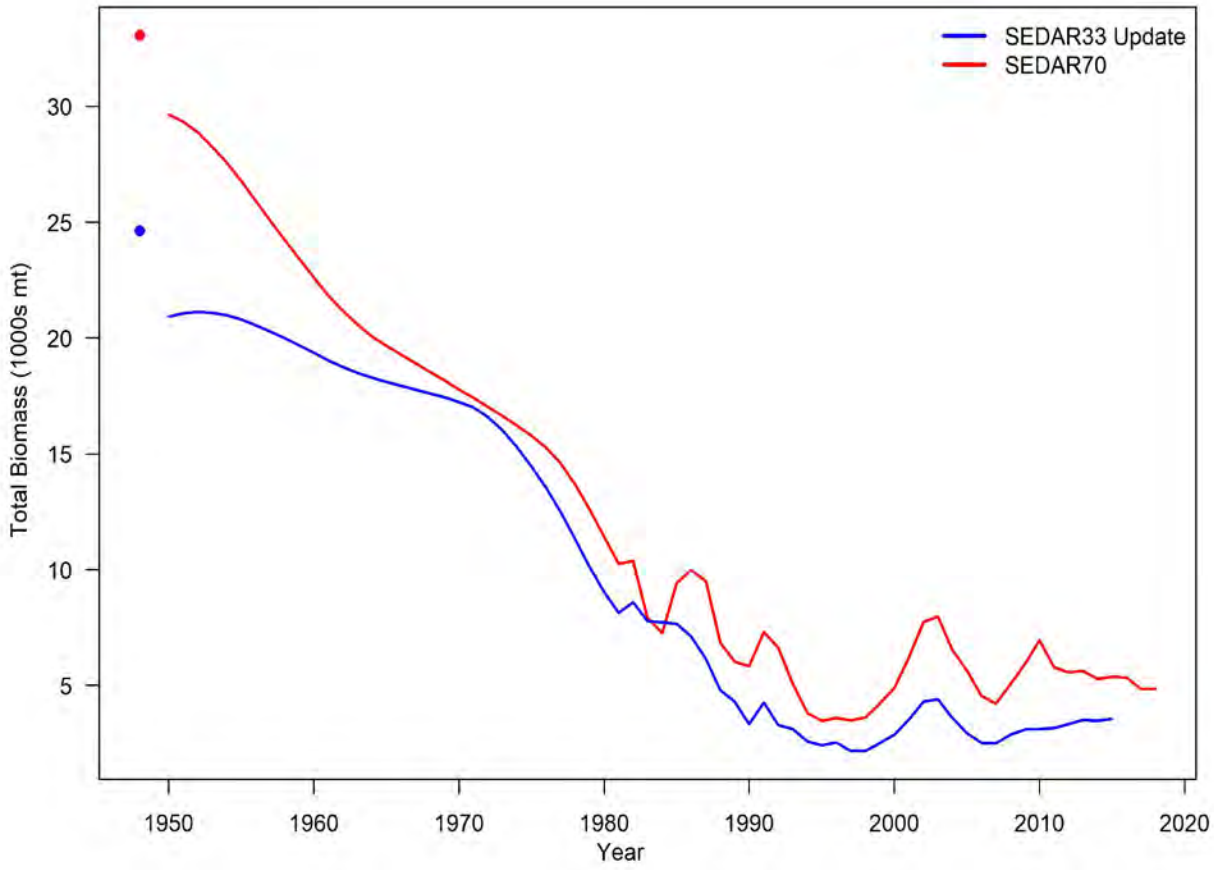


Headboat

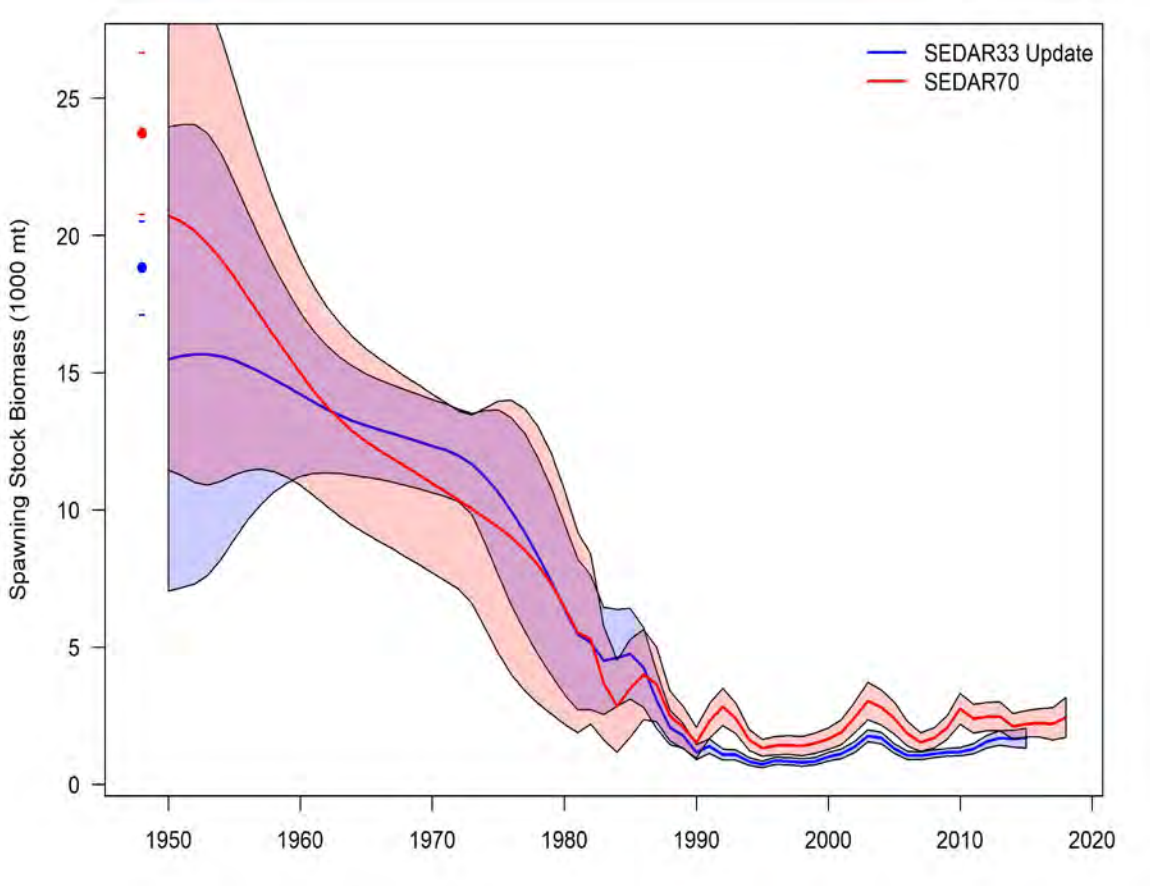
Base Model Results – Index Selectivities



Base Model Results – Estimated Biomass



Total biomass

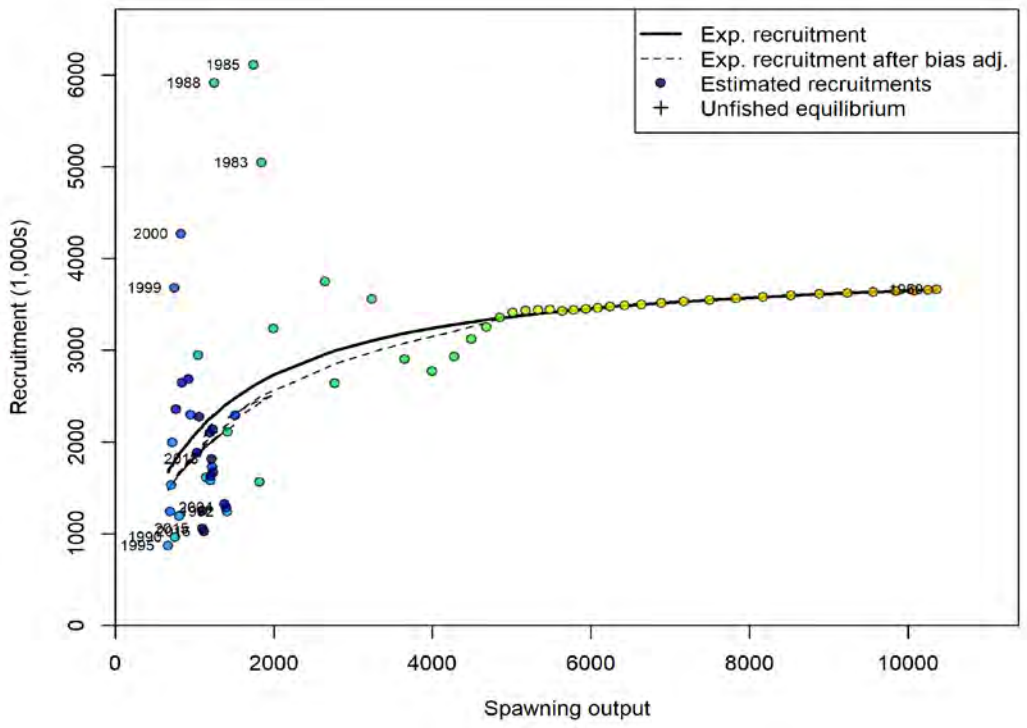


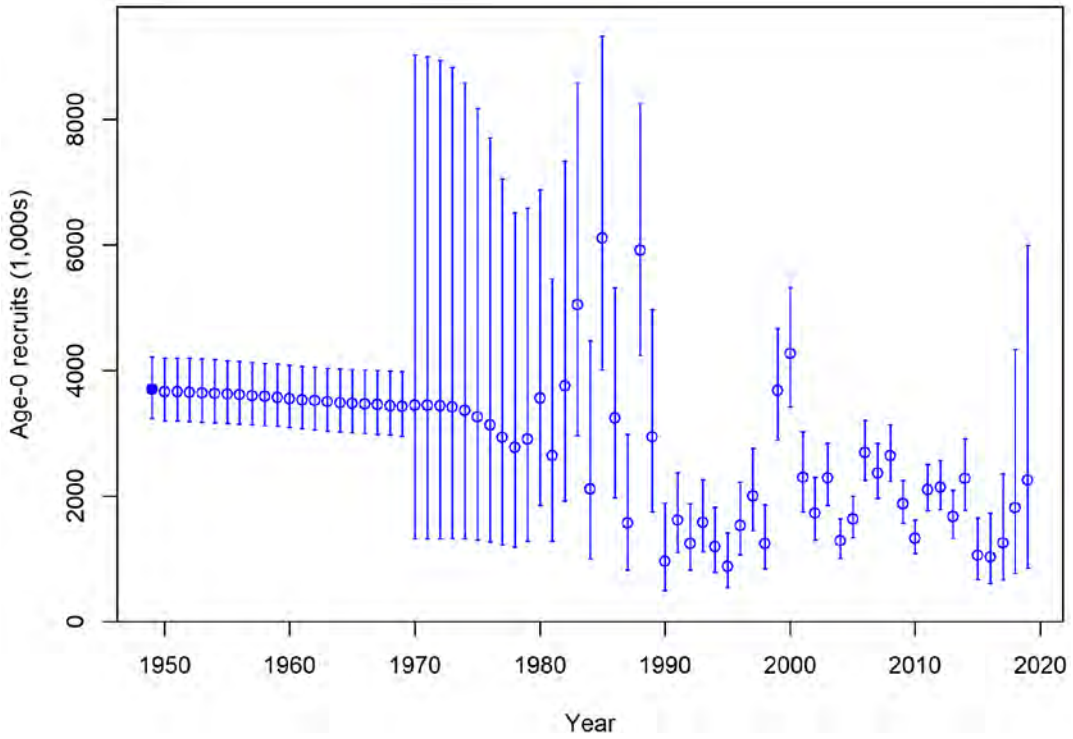
Spawning stock biomass

Base Model Results – Stock/Recruit Relationship

Spawner recruitment relationship not well-defined

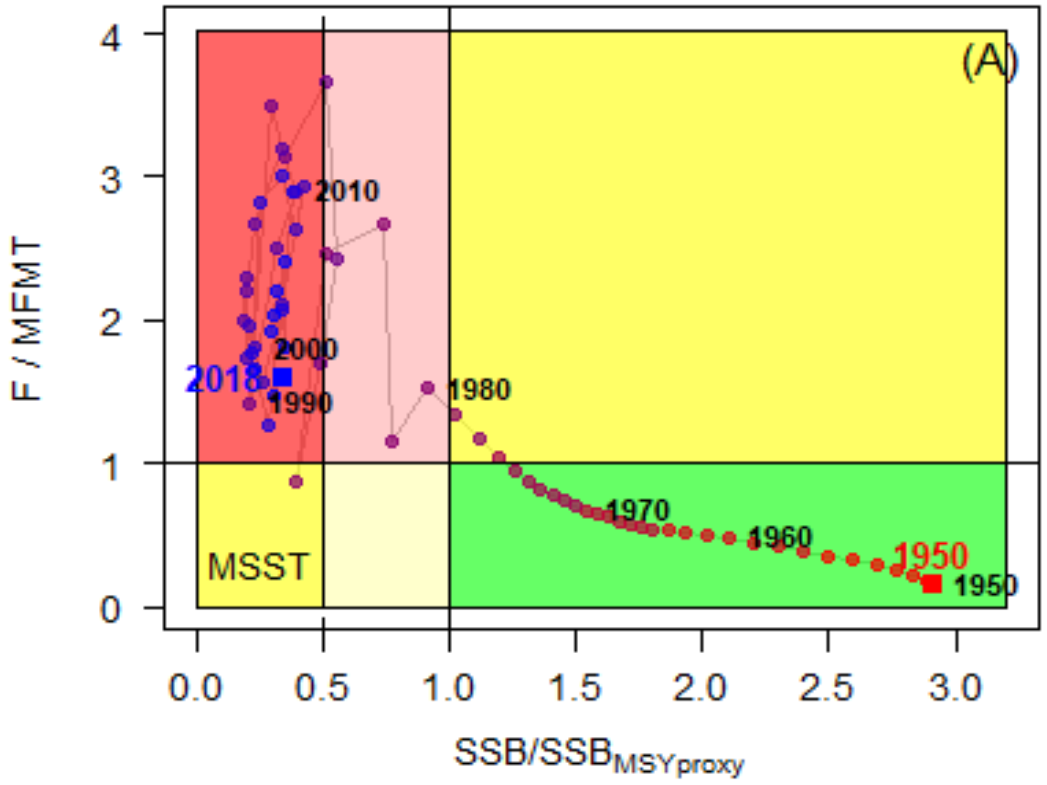
- Steepness initially estimated in base model, along with R0 and sigmaR.
- Profile on steepness and sigmaR was generally flat in the area of the MLE estimates.
- Model estimated values (MLE) for steepness and sigmaR used as fixed parameter in base model and led to more model stability.

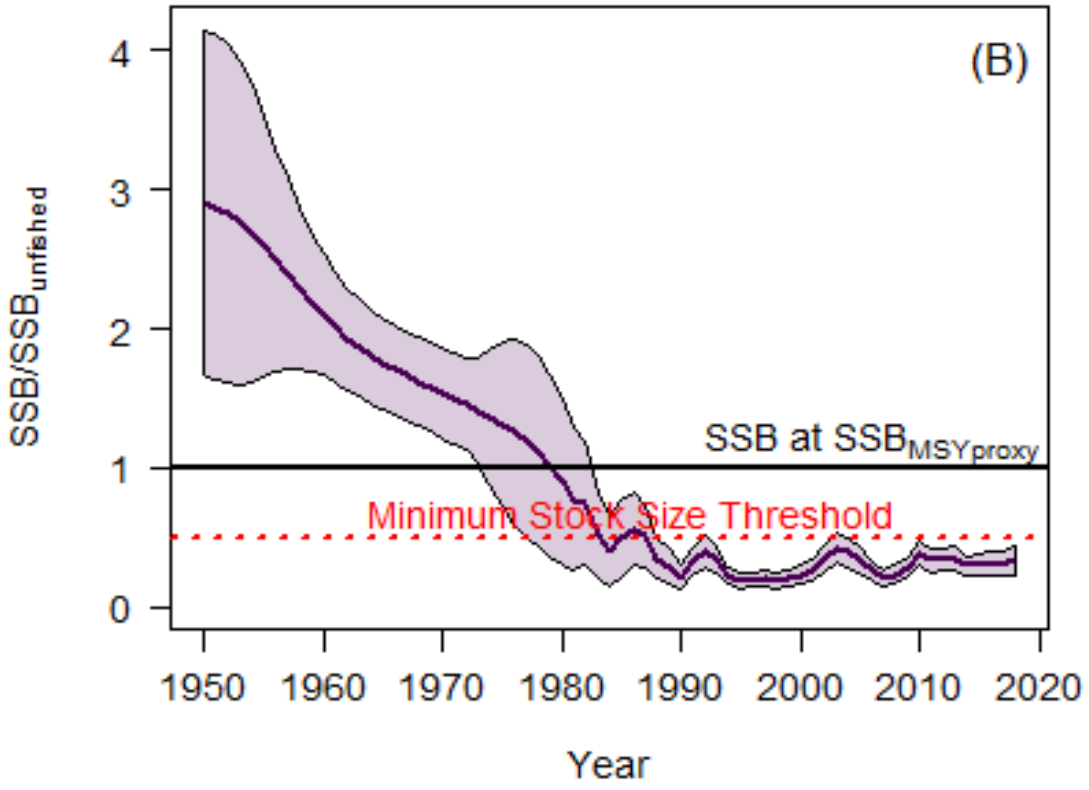




Base Model Results - Status

- Greater Amberjack in the Gulf of Mexico is undergoing overfishing and is overfished.
- Terminal year depletion estimate of 10% (SSB_{2018}/SSB_0) remains below the SSB at 30% SPR



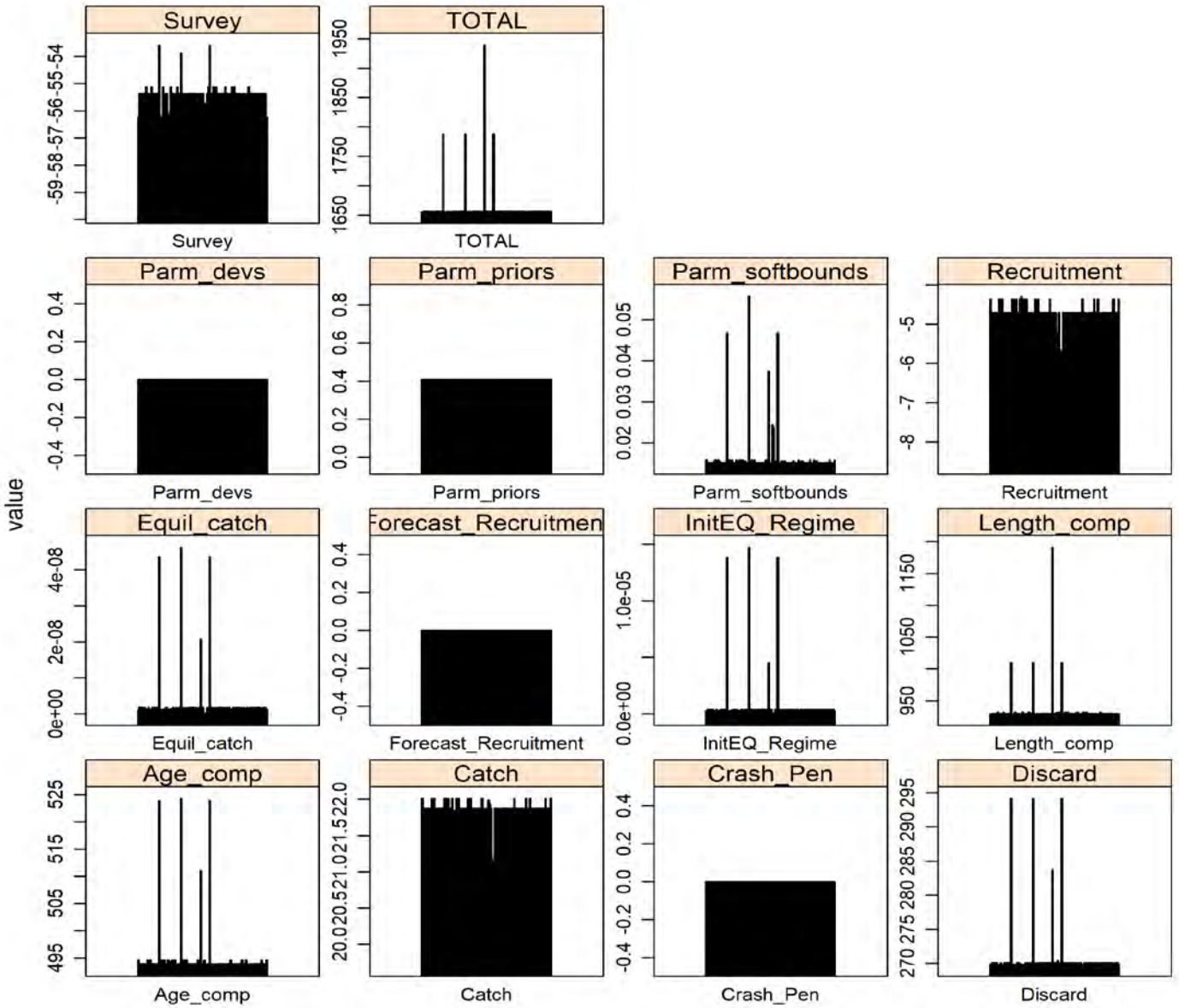


Base Model Diagnostics – Model Stability

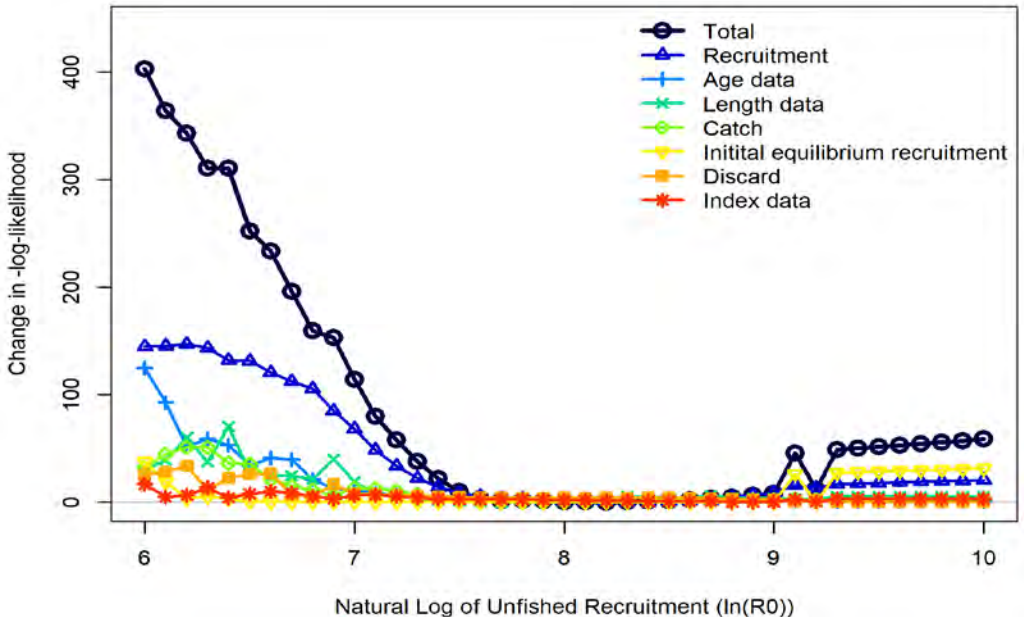
Jitter indicates reasonably stable model

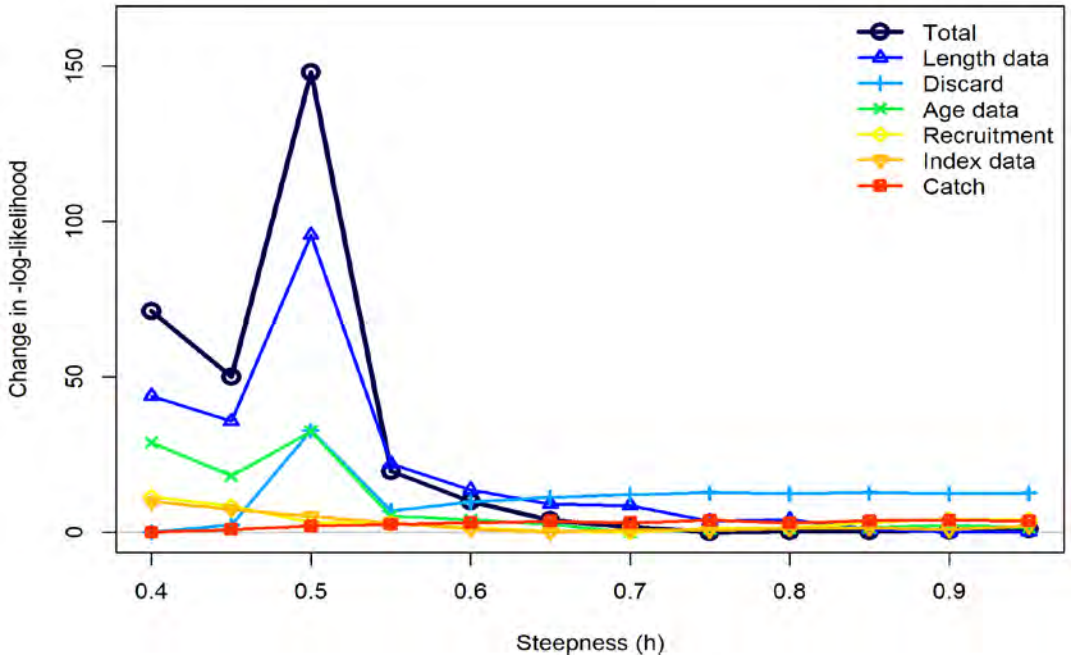
Each panel gives the results of 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the base model best fit values.

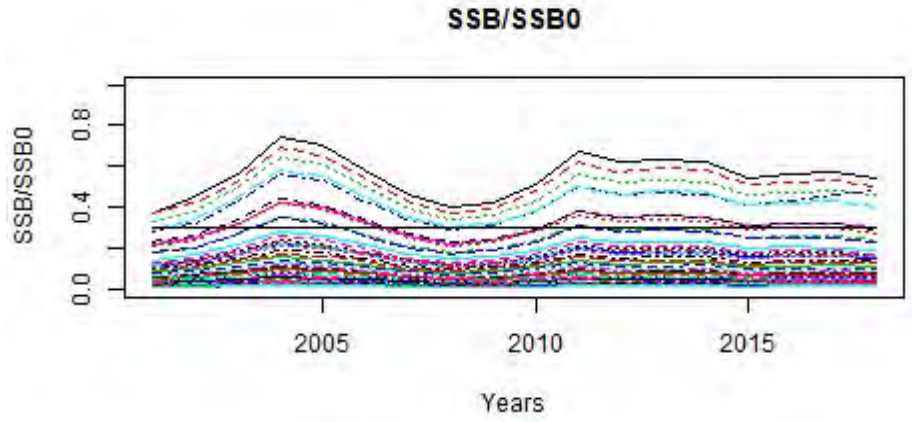
The model converged to within 1 likelihood point of the base model in 96% of the jitter runs and no runs demonstrated a lower negative log-likelihood solution.

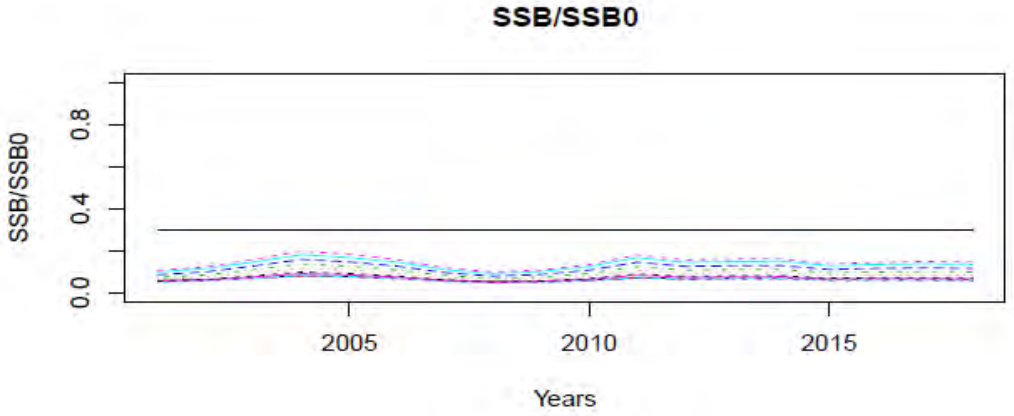


Base Model Diagnostics – Likelihood Profiles

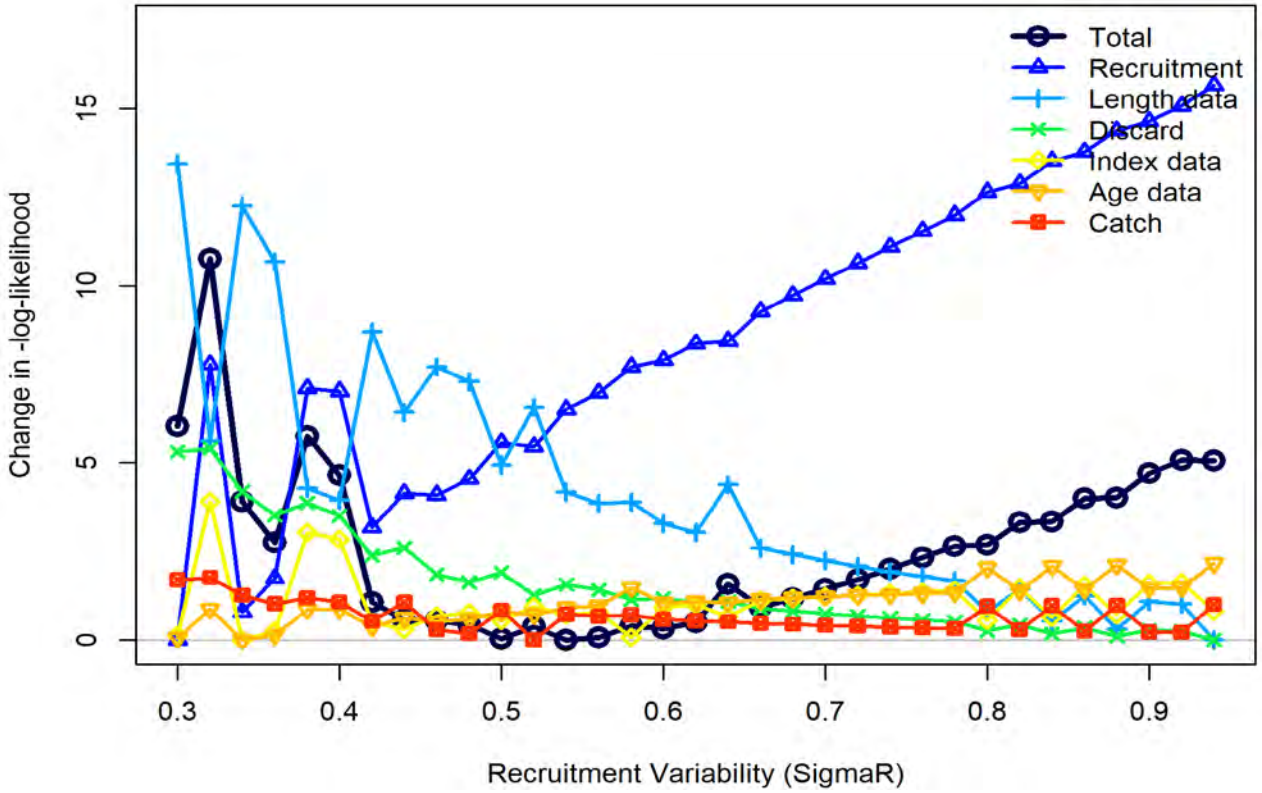


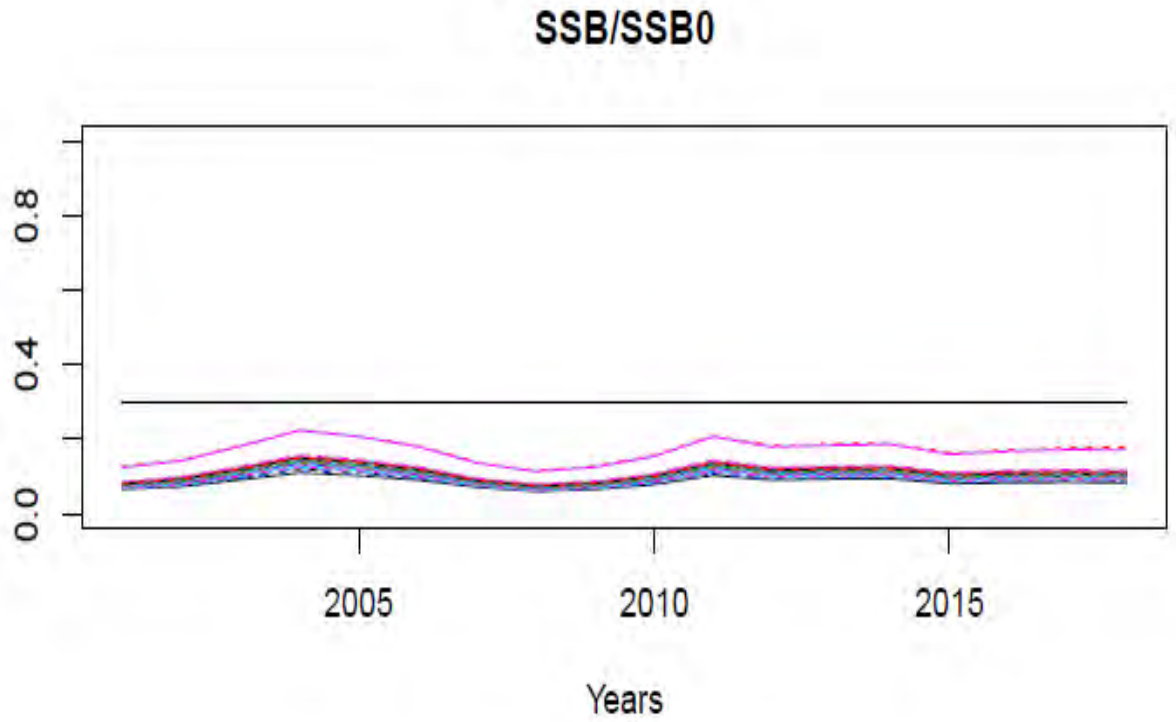






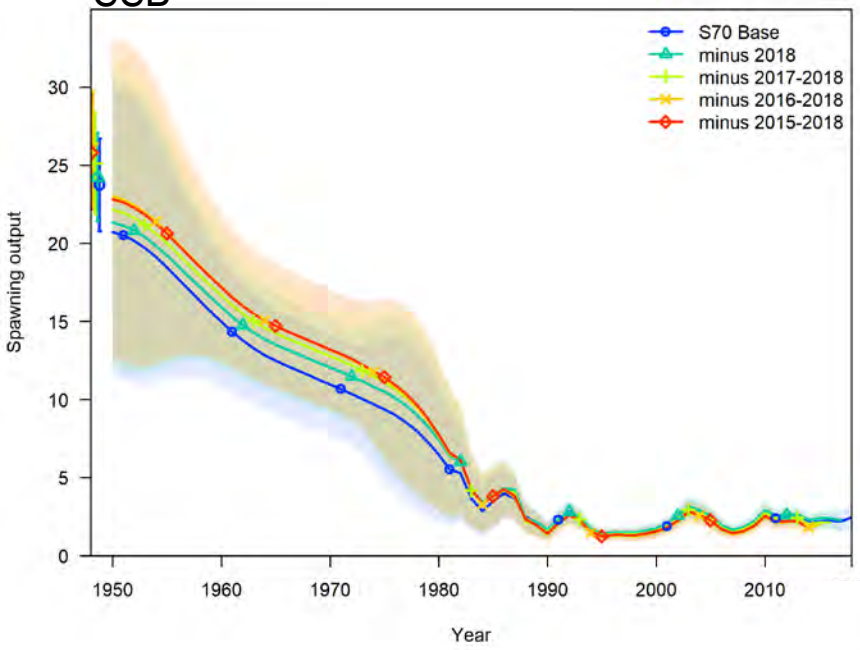
Base Model Diagnostics – Likelihood Profiles- sigmaR



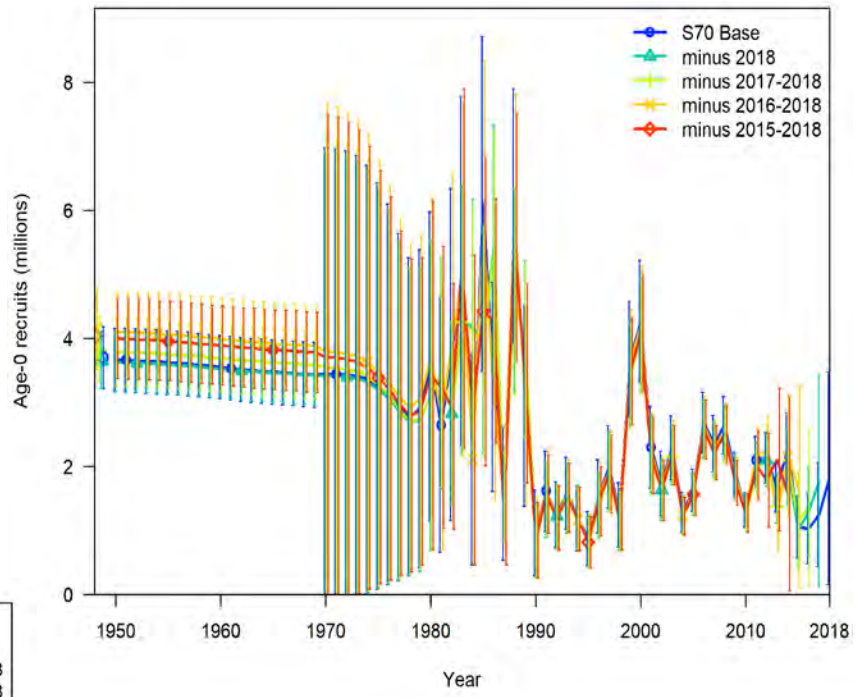


Base Model Diagnostics – Retrospectives

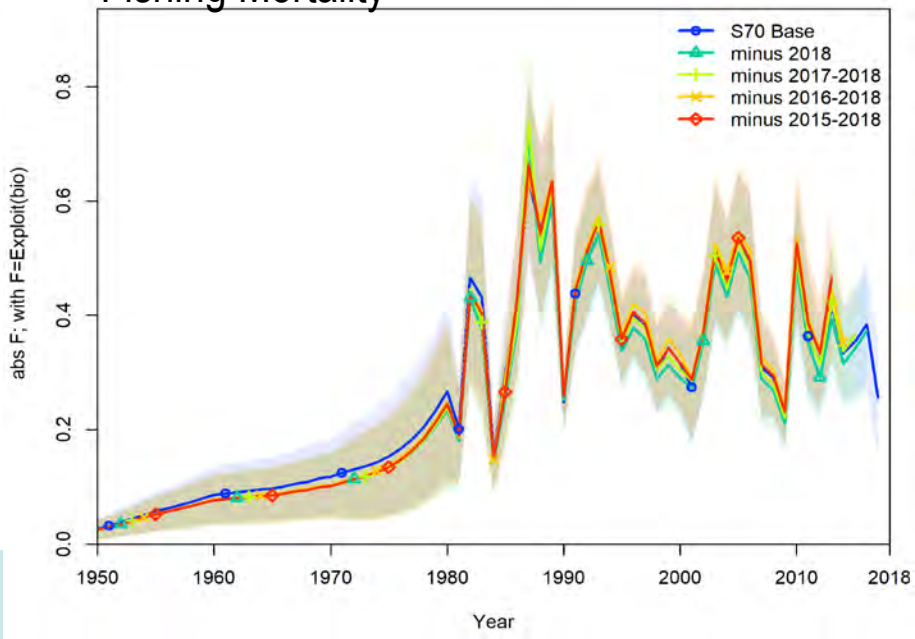
SSB



Recruits

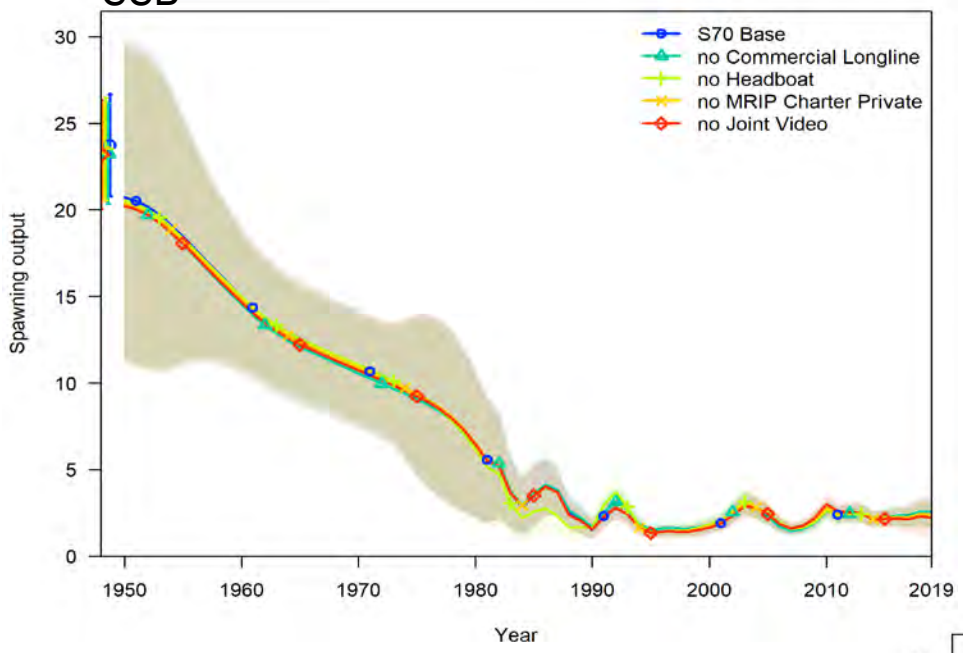


Fishing Mortality

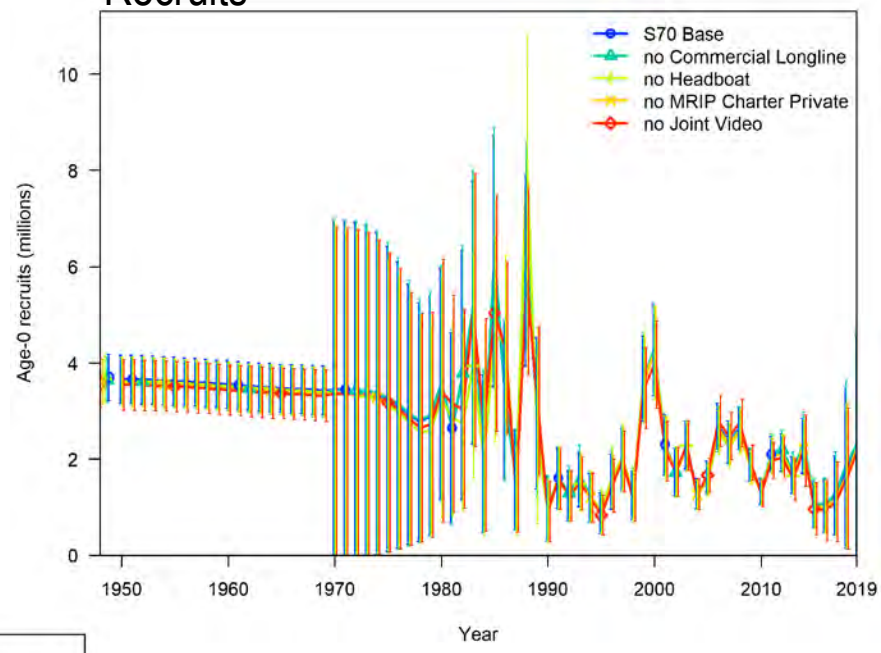


Base Model Diagnostics - Jackknife

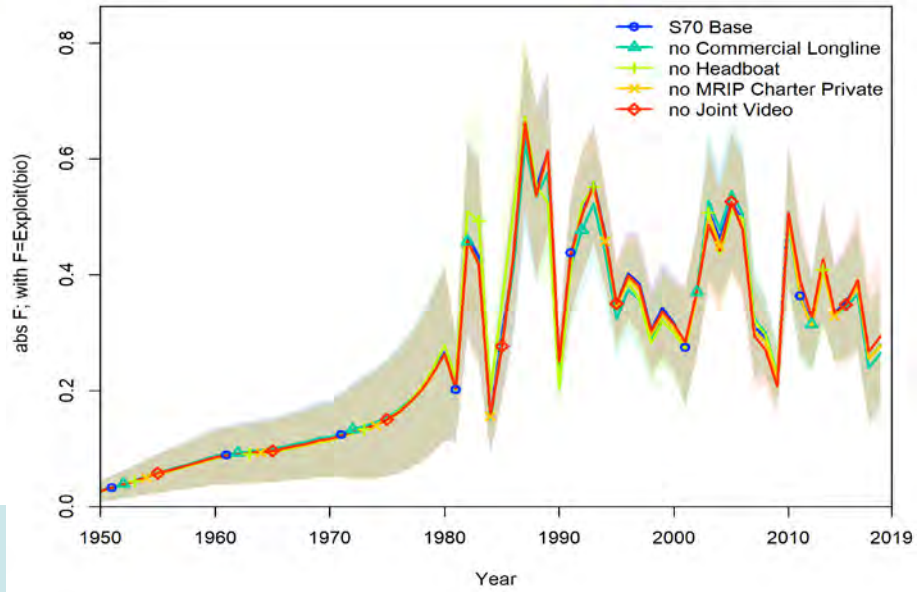
SSB



Recruits

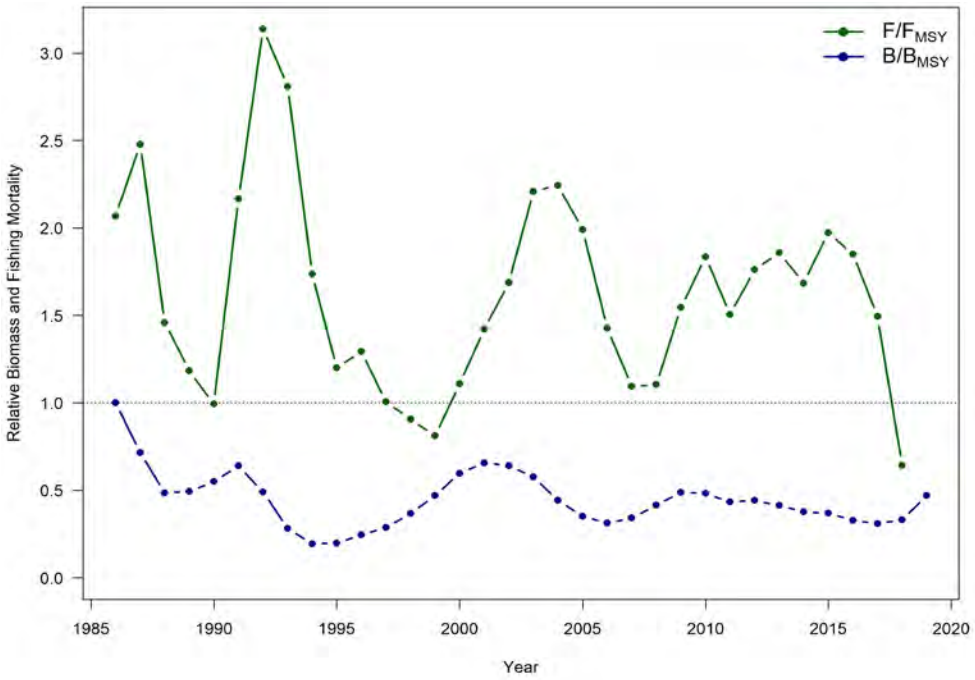


Fishing Mortality



ASPIC Sensitivity: TOR 4

- ASPIC results were available, but not used to produce OFL and ABC advice during SEDAR 9 because the ASPIC projections were considered unreliable.
- During SEDAR 33 two alternative base models were prepared, ASPIC and SS, but the assessment panel and the CIE reviewers considered the SS model to be superior.
  - ASPIC does not use selectivities to model the effects of time varying parameters or regulations, does not incorporate natural mortality, and does not fit to any composition data.
  - The SEDAR 33 RW Panel considered “that for greater amberjack, the Stock Synthesis modelling framework still remains appropriate for the type of data available, and allows flexibility to account for changes in size limits or IFQs that affect patterns of discarding in commercial and recreational fisheries”.
- We have provided a sensitivity using ASPIC, as per ToR 4. We did not deviate from the previous ASPIC configurations investigated for SEDAR 33.



Base Model Results
TOR 1, 3

MSRA Reference points

Variable	Definition	Value
Base M	Fully selected ages of Lorenzen Natural Mortality (M)	0.28
Steepness	Fixed Stock-Recruit (SR) parameter (not used in projections)	0.777
Virgin Recruitment	Estimated SR parameter (not used in projections)	3,698
Generation Time	Fecundity-weighted mean age	7.59
SSB Unfished	Estimated virgin spawning stock biomass	23,733
	Mortality Rate Criteria	
$F_{MSYproxy}$	Equilibrium F that achieves SPR30%	0.175
MFMT	Equilibrium F that achieves SPR30%	0.175
$F_{Rebuild}$	F that rebuilds the stock to $SSB_{SPR30\%}$ by 2027	0.1075
F_{OY}	0.75 * Directed F at $F_{SPR30\%}$	0.131
$F_{current}$	Geometric mean (F2016-2018)=$F_{Current}$	0.302
$F_{Current}/F_{MSYproxy}$	Current stock status based on $F_{MSYproxy}$	1.729
$F_{Current}/MFMT$	Current stock status based on MFMT	1.729
	Biomass Criteria	
$SSB_{MSYproxy}$	Equilibrium SSB at $F_{SPR30\%}$	7,118
MSST	$0.5*SSB_{SPR30\%}$	3,559
SSB at Optimum Yield	Equilibrium SSB when Directed F = 0.75 * Directed F at $F_{SPR30\%}$	8140
SSB_{2018}	SSB_{2018}	2,433
$SSB_{2018}/SSB_{FMSYproxy}$	Current stock status based on $SSB_{SPR30\%}$ (Equilibrium)	0.34
$SSB_{2018}/MSST$	Current stock status based on $MSST_{SPR30\%}$	0.68
$SSB_{2018}/SSB_{unfished}$	2018 SPR	0.10

SEDAR 70:Projections: TOR 3

- Overview
- Data
- Base Model
  - Development
  - Fit
  - Results
  - Diagnostics
  - Sensitivities
- Projections
  - Settings
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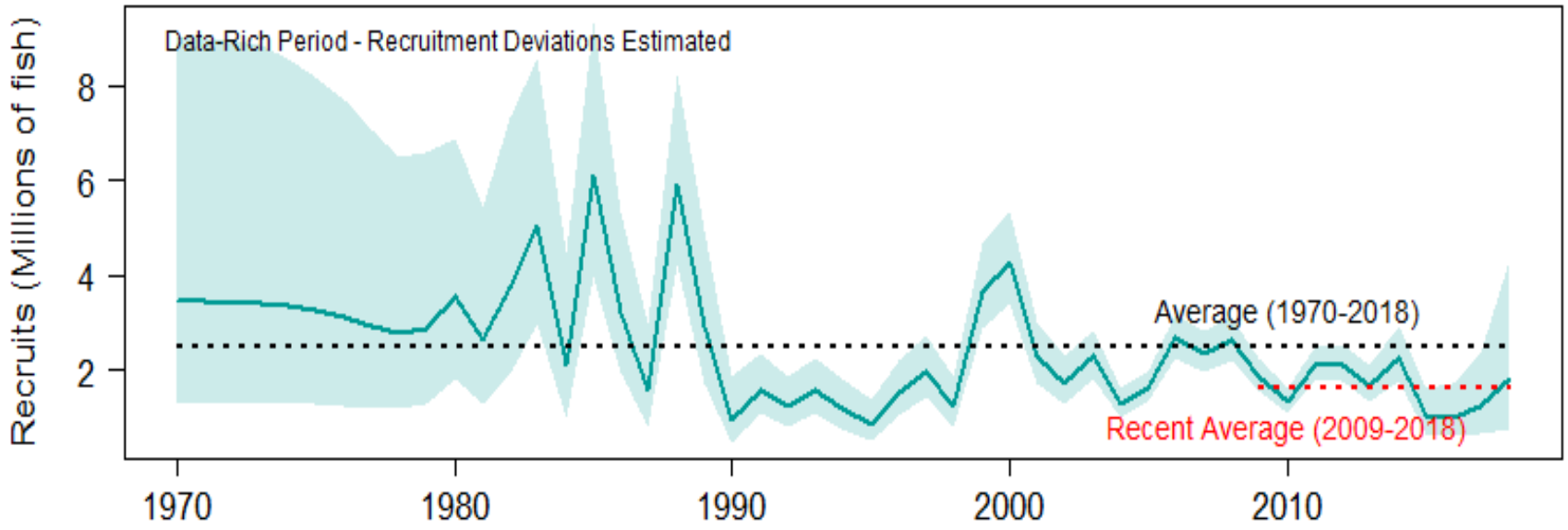
- Summary

Updated Projections – Settings

Assumptions

- Proxies were calculated based on long-term 100 year projections
  - Equilibrium assumed over last 10 years (2011-2021)
- MSST = $SSB_{SPR30\%}$ * 0.5
- Recruitment was fixed as recent estimated mean (2009-2018)
- Used 2017-2019, with the actual 2019 landings data pulled after the SAR was submitted



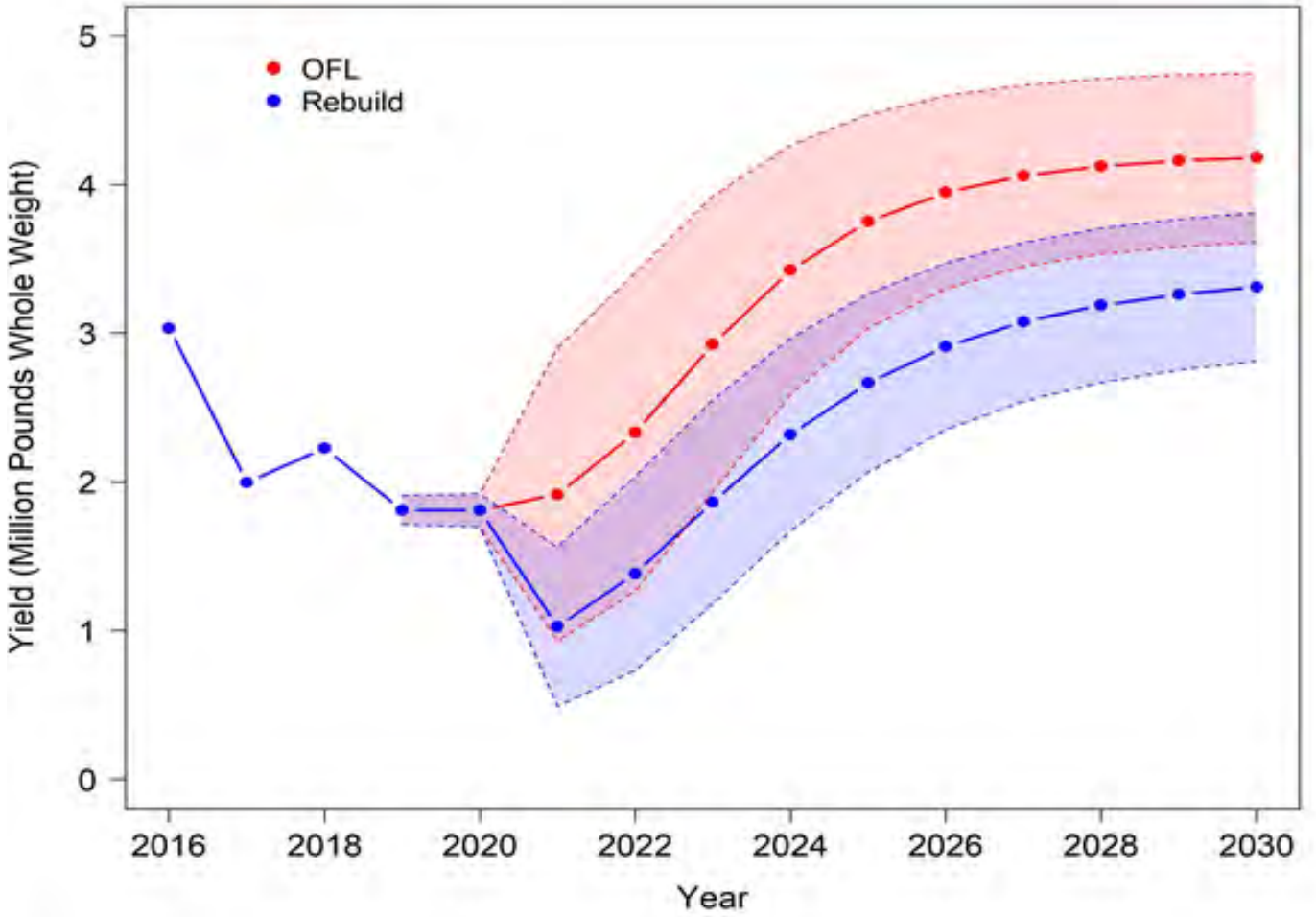
Projections – Settings

Parameter	Value	Comment
Relative F	Average from 2016 – 2018	Average relative fishing mortality over terminal three years (2016-2018) of model
Selectivity	Average from 2016 – 2018	Average fleet specific selectivity estimated over terminal three years (2016-2018) of model
Retention	Average from 2016 – 2018	Average fleet specific retention estimated over terminal three years (2016-2018) of model
Recruitment	Average from 2009 – 2018	Average recruitment over last 10 years
2019 and 2020 Landings	158.11 mt (Commercial Vertical Line), 12.4635 mt (Commercial Longline), 44.9437 thousands of fish (Charter/Private), 1.3209 thousands of fish (Headboat)	Average 2017-2019 landings
Allocation Ratio	27:73	commercial:recreational

Projections – Results

Criteria	Definitions	Yield	Year SSB>MSST	Year SSB>SSB_{SPR30}
OFL	Annual yield (mp ww) at MFMT=$F_{SPR30\%}$		2023	2036
	2021	1.915		
	2022	2.333		
	2023	2.925		
	2024	3.424		
	2025	3.752		
	2026	3.947		
ABC	Annual yield (mp, ww) at Frebuild		2023	2026
	2021	1.026		
	2022	1.383		
	2023	1.865		
	2024	2.317		
	2025	2.665		
	2026	2.910		

Projections - Results



Projections – Results (millions of pounds, whole weight)

Projections at SPR30% = OFL

Year	R	F	F/F_{SPR30}	SSB	SSB/SSB_{SPR30}	SSB/MSST	SSB/SSB_0	OFL
2021	2,805	0.206	1.180	2,535	0.356	0.712	0.107	1.915
2022	2,805	0.211	1.208	2,991	0.420	0.840	0.126	2.333
2023	2,805	0.221	1.265	3,649	0.513	1.025	0.154	2.925
2024	2,805	0.228	1.306	4,273	0.600	1.201	0.180	3.424
2025	2,805	0.232	1.328	4,733	0.665	1.330	0.199	3.752
2026	2,805	0.233	1.334	5,042	0.708	1.417	0.212	3.947
2027	2,805	0.233	1.334	5,240	0.736	1.472	0.221	4.059
2028	2,805	0.233	1.334	5,365	0.754	1.507	0.226	4.123
2029	2,805	0.233	1.334	5,446	0.765	1.530	0.229	4.160
2030	2,805	0.233	1.334	5,492	0.772	1.543	0.231	4.181

Projections at $F_{rebuild}$

Year	R	F	SSB	SSB/SSB_{SPR30}	SSB/MSST	SSB/SSB_0	Yield
2021	2,805	0.107	2,535	0.356	0.712	0.107	1.026
2022	2,805	0.111	3,336	0.469	0.937	0.141	1.383
2023	2,805	0.118	4,403	0.619	1.237	0.186	1.865
2024	2,805	0.123	5,498	0.772	1.545	0.232	2.317
2025	2,805	0.126	6,428	0.903	1.806	0.271	2.665
2026	2,805	0.127	7,161	1.006	2.012	0.302	2.910
2027	2,805	0.127	7,713	1.084	2.167	0.325	3.076
2028	2,805	0.127	8,121	1.141	2.282	0.342	3.187
2029	2,805	0.126	8,425	1.184	2.367	0.355	3.261
2030	2,805	0.126	8,628	1.212	2.424	0.364	3.310

Projections – Results for SEDAR 28 with FES Landings

- Updating the SEDAR 33 Update model with the FES recreational landings resulted in notably increased estimates of virgin spawning stock biomass, recruitment, and projected yields
- Had the FES recreational landings been available during SEDAR 33 Update the equilibrium yield estimate would have been about 5.97 million pounds rather than the 3.71 million pounds estimated at the time
- Assuming the ABC from the hypothetical SEDAR 33 update FES run had been about 6 million pounds, the current recommendation of around 4 million pounds would represent a roughly 33% decrease in yield rather than the larger increase in yield that it appears to be.

Model	Terminal year (TY)	SSB (TY)	Recruits (TY)	F_{SPR30}	SSB_0	SSB_{SPR30}	Equilibrium Yield (mp ww)
S33 Update	2015	1,640.28	1,341	0.198	18,779	5,685	3.706
S33 Update with FES	2015	2,169.95	2,507	0.199	28,986	8,798	5.968
S70 Operational	2018	2,432.83	1,813	0.175	23,733	7,119	3.969

SEDAR 70 Update: Summary

- Overview
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  - Development
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  - Results
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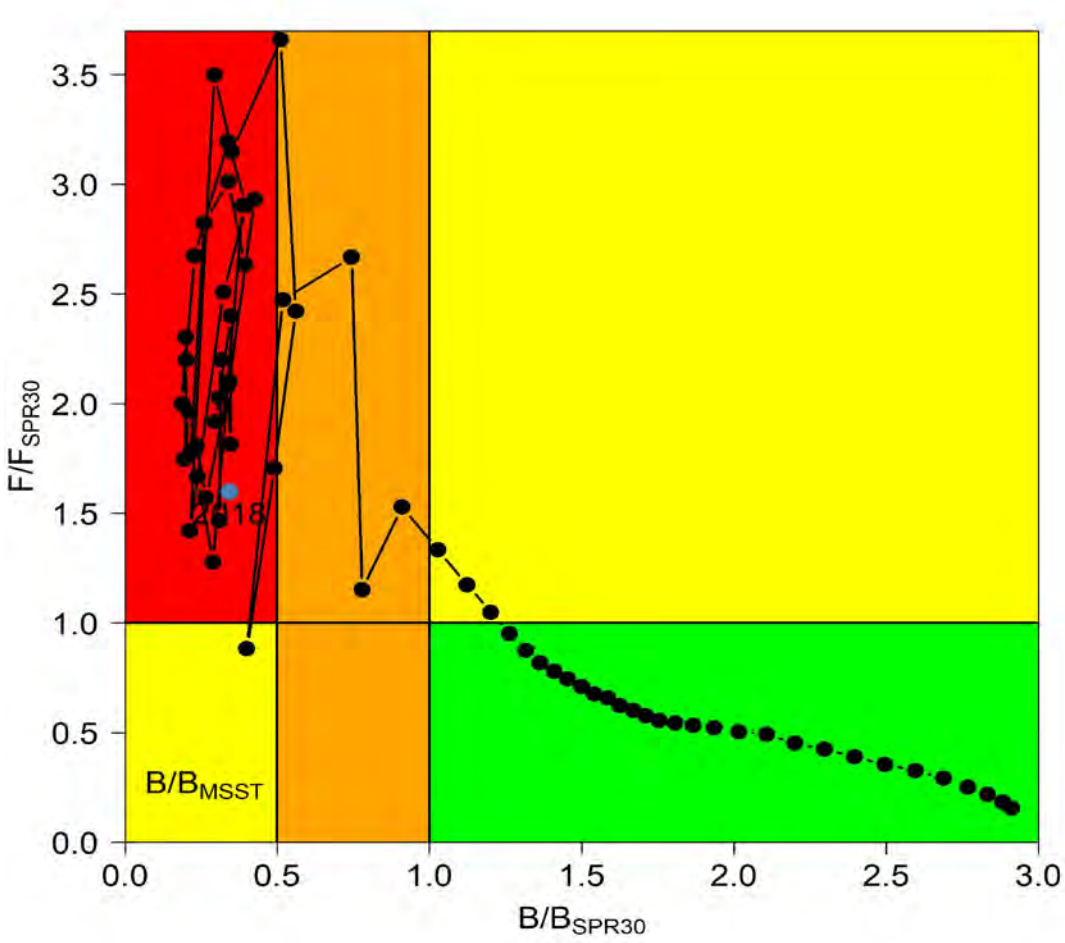
  - Sensitivities
- Projections
  - Settings
  - Results
- Summary

Final Summary of SEDAR 70

- The SEDAR 70 Greater Amberjack assessment predicts a steady and significant decline in total biomass and spawning stock biomass and associated increasing and intense exploitation (as Gulf of Mexico greater amberjack remain in an unhealthy state with overfishing occurring and biomass at reduced levels (depletion estimate SSB_{2018}/SSB_0 =10%).

- The GOM Greater Amberjack stock is undergoing overfishing and remains in an overfished state based on the definition of MSST (0.5 * $SSB_{SPR30\%}$) and MFMT for the final SEDAR 70 base model.

- Overall, the SEDAR 70 base model is improved since the SEDAR 33 Benchmark and Update assessments, and it incorporates the best available data and addressed modeling issues evident in the prior assessments.



Summary: Uncertainties

- The landings data are dominated by the recreational fishery, and recreational landings are more uncertain than commercial data.
- Before 1981, recreational data are estimated using a hindcasting procedure, and discards prior to 1981 are not quantified.
- Some data on the size of discarded fish are available for the Charter+Private and headboat fleets, however the sample sizes are low in many years.
- The SEFSC Coastal Logbook Reef fish Program (CLP) observer project provided some information on the size composition of released fish for the commercial fishery in recent years (2006-2018), however as with the recreational discard size composition the sample sizes are very low.

Research Recommendations

Life History

- Improved estimates of maturity and fecundity.

Landings and Discards

- Expand commercial fishery observer coverage and in particular focus on better quantifying retained fish out of season.
- Increased length and age sampling from both the commercial and recreational fleets, with special attention to discarded fish
- Quantify and evaluate appropriate weighting procedures of length and age compositions at finer spatial and temporal scales (e.g., quarterly/state/sub-region strata)

Fishery Independent Indices

- A larval abundance index for Greater Amberjack does not currently exist. Seriola spp. larvae are taken in both bongo and neuston nets during SEAMAP surveys. At the time of the SEDAR 33 Benchmark assessment at least 3,500 specimens initia identified as Seriola spp., however these specimens will have to be re-examined to verify identification.

Fishery Dependent Indices

- Investigate options for developing fishery-dependent indices that better reflecting abundance of Greater Amberjack from fisheries with particular focus on the impact of regulations.

Acknowledgements

- Stock Synthesis Model developers and reviewers
  - Richard Methot
  - Ian Taylor

  - SEFSC SFD reviewers
  - Skyler Sagarese (SEFSC, SFD - Markdown document preparation)

Thank you

SEDAR 70 Questions?

Extra slides

SEDAR 70 Summary (TOR 5 abridged)

- The SEDAR 70 model is generally consistent with the SEDAR 33 Update model
- There are some notable differences in the early part of the time series (1950-1960s) during the years of high uncertainty in catches. These differences are likely mostly due to lack of FES-calibrated catch data in the SEDAR 33 Update assessment.
- After the mid-1980s the models line up very closely, around the time when size/age information becomes available. However, the SEDAR 70 model is overall slightly more optimistic than the SEDAR 33 Update model.

- The remaining changes did not have as large an impact on the overall assessment results and estimates of parameters (growth rate, R0, etc.) or key derived quantities. However, the remaining changes did lead to significant improvements in model fits and a more stable model. This was demonstrated through better gradients (and lower standard errors) in the parameter fitting process for many parameters, the elimination of bounded parameters from the previous SEDAR 33 model, and only a few parameters with correlations > 0.7.

- Additionally, converting the previous SEDAR 33 SS 3.24s model to the upgraded SS 3.30 version had virtually no impact on model results but was seen as an overall improvement in the assessment as the updated SS version (3.30_15) allows even greater flexibility in handling a number of processes including projections.

Recalling: Greater Amberjack Minimum size regulations

Species Affected	First Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Size-FL CM	Length Type
Greater Amberjack	1990	2/21/1990	8/3/2008	Rec	28"	71.1	FL
	1990	2/21/1990	Ongoing	Com	36"	91.4	FL
	2008	8/4/2008	1/3/2016	Rec	30"	76.2	FL
	2016	1/4/2016	Ongoing	Rec	34"	86.4	FL

SS Block Setup for Time varying Parameters

Fleet	Block 1 Start	Bock 1 Ed	Block 2 Start	Bock 2 End	Block 3 Start	Block 3 End	Block 4 Start	Block 4 End
Com_HL	1990	2007	2008	2010	2011	2018		
Com_LL	1990	2018						
REC & Headboat	1990	1997	1998	2007	2008	2015	2016	2018
Stock-Recruitment r	1949	1949						
Com_HL Q	2011	2018						

Blocks defined as per SEDAR 33 benchmark and SEDAR 33 2016 Update and incorporate minimum size regulations, seasonal closures, and changes in catchability observed over the time series.

Change in Likelihood Distribution for Length & Age Composition

S33 Benchmark/S33 Update- utilized the multinomial distribution to calculate the composition likelihoods and applied the Francis reweighting method to adjust sample sizes.

S70 Operational is using the Dirichlet-multinomial based on recommendations from the SS developer

Challenges of using Francis approach

- *Subjective choice of # iteration*s required to achieve adequate convergence. Often just one iteration is applied.
- Takes time to implement so tuning is rarely repeated during retrospective or sensitivity analyses.
- Recommended adjustment can be sensitive to outliers (remove a few years of anomalous composition data can lead to large change in recommended adjustment).

Pros/Cons of using the Dirichlet

- Self weighting so no subjectivity introduced
- Not yet widely used so little guidance is available.
- Does not allow weights above 100% (by design) so it is not yet clear how best to deal with the situation when the estimated weight is close to 100%.
- Parameterization has potential to cause convergence issues or inefficient MCMC sampling when weights are close to 100% (Jim Thorson (NOAA, NWAFC) has proposed a prior distribution that may help with this, but has not yet been tested).
- Interpretable estimates of effective sample sizes

Reference: SS 3.30.12 (dated August 18 2018) Manual Appendix B. data Weighting @pages 185-192.