Gulf of Mexico King Mackerel Stock Assessment Update

SEDAR 38 UPDATE

Presentation to

Gulf of Mexico SSC

September 14-17, 2020
SEFSC staff
Tampa, FL

SEDAR 38 Update
Outline

- Terminology
- Terms of Reference
- Overview
- Data
- Base Model
  - Development
  - Fit
  - Results
  - Diagnostics
- Projections
  - Settings
  - Results
- Summary

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SEDAR 38 Update
Terminology

- **Catch** = Fish caught (retained + discarded dead + released alive)
- **Landings** = Retained Catch
- **Removals** = Retained Catch + Dead Discards
- **Discards** = All discarded fish (dead and released alive)
- **Dead discards** = Discarded fish that are assumed dead

SEDAR 38 Update
Status Determination Criteria

Overfished:

- $SSB_{Current}$ < MSST; where $SSB_{Current}$ = SSB in the terminal year of data used in the model; and, MSST = (1-M)*SSB_{MSY} (or proxy), where and M = 0.174. The proxy for SSB_{MSY} is $SSB_{SPR30\%}$

Overfishing:

- $F_{Current}$ > MFMT; where $F_{Current}$ = the geometric mean of the most recent three years; and, MFMT = F_{MSY} or proxy. F_{MSY} proxy is $F_{SPR30\%}$

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Terms of Reference

- Update the approved SEDAR 38 Gulf of Mexico king mackerel base model with data through 2017-2018 fishing year.
- Document any changes or corrections made to model and input datasets and provide updated input data tables. Provide commercial and recreational landings and discards in pounds and numbers, when possible.
- Update model parameter estimates and their variances, model uncertainties, estimates of stock status and management benchmarks, and provide the probability of overfishing occurring at specified future harvest and exploitation levels.
- To the extent practical, provide recommendations of future research to be conducted on Gulf of Mexico migratory group king mackerel, and any additional analyses which should be considered during the subsequent stock assessment.
- Develop a stock assessment update report to address these TORS and fully document the input data and results of the stock assessment update.

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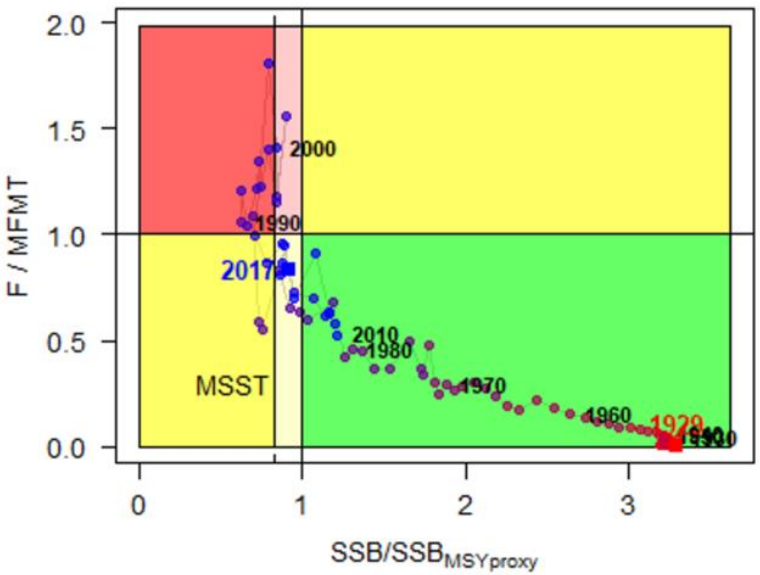
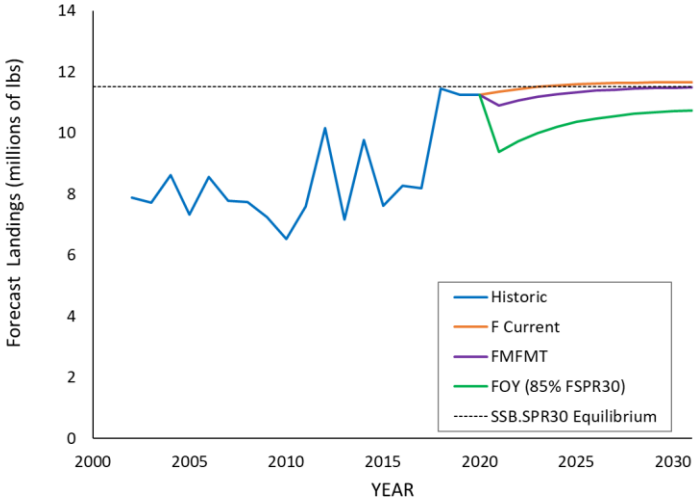
Overview

- The approved SEDAR 38 Gulf of Mexico king mackerel base model was updated with data through 2017
- Where practicable, the SEDAR 38 update base model used the same data sets as the SEDAR 38 base model with an updated time series
- Key changes from SEDAR 28 include incorporating the Fishing Effort Survey (FES) adjustments to the recreational catch and method of estimating shrimp fishery bycatch of king mackerel
- The stock assessment update report fully documents the input data and results of the SEDAR 38 update base model
- **The update base model found that king mackerel in the Gulf of Mexico is <u>not overfished and not undergoing overfishing.</u> In 2017, the stock was being harvested at 84% of MFMT and SSB was 112% of MSST.**
- **The update base model projections indicate that landings can remain at current values with a low probably of future overfishing or becoming overfished.**





SEDAR 38 Update
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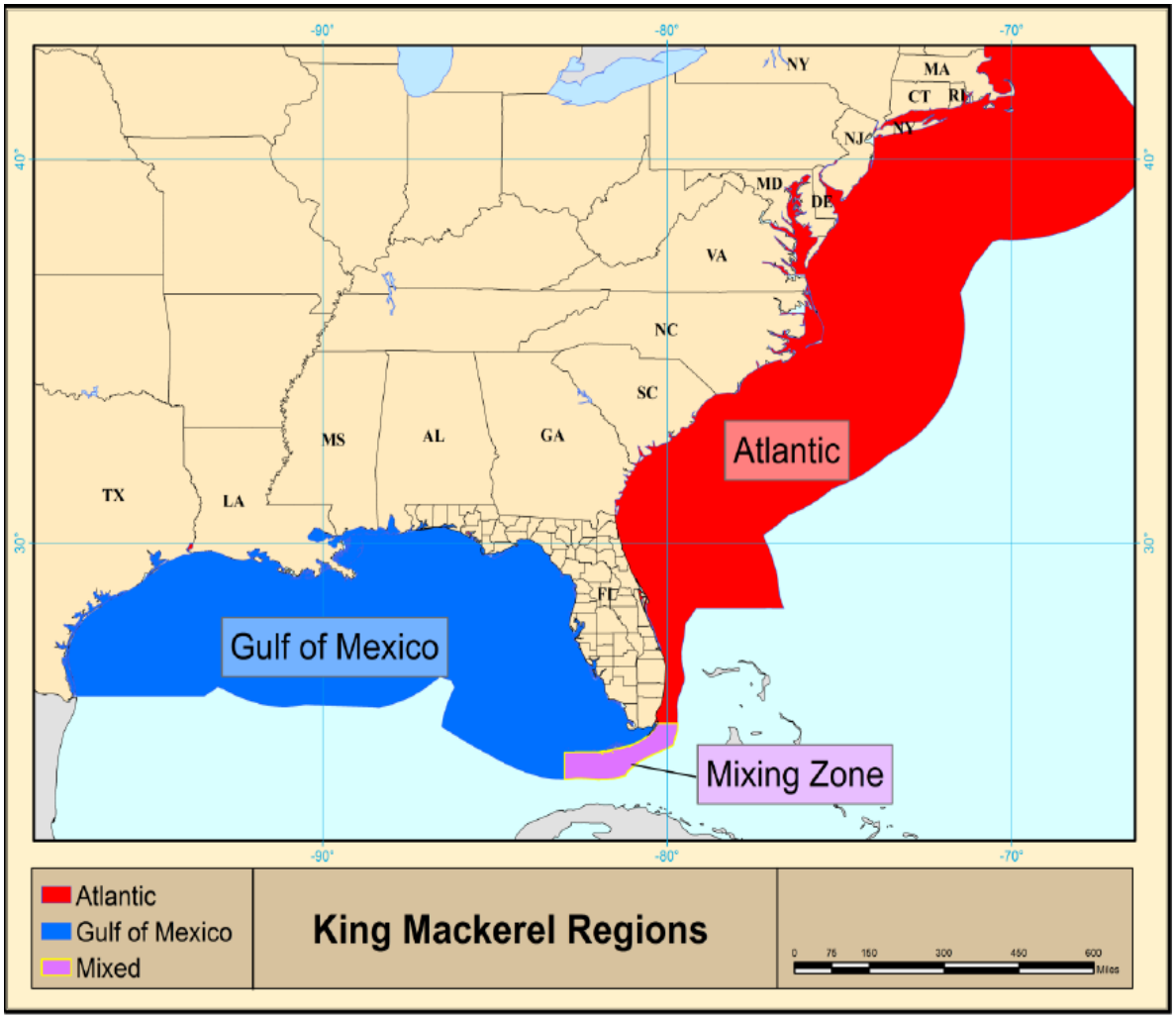
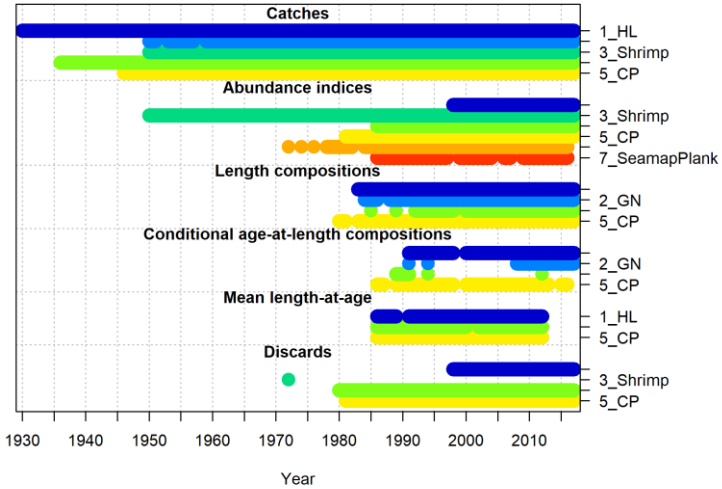
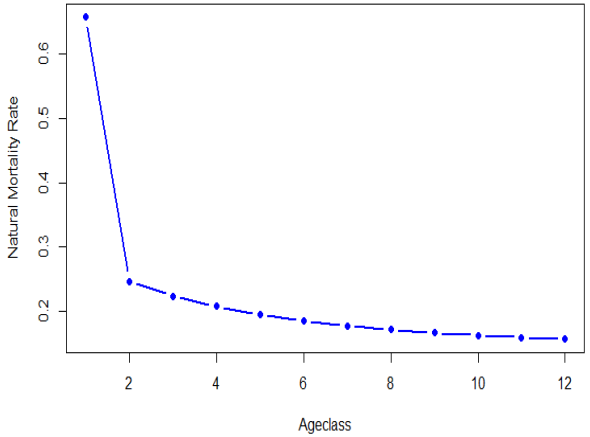
SEDAR 38/Update Stock Boundaries



Data - SEDAR 38/Update Model Configuration

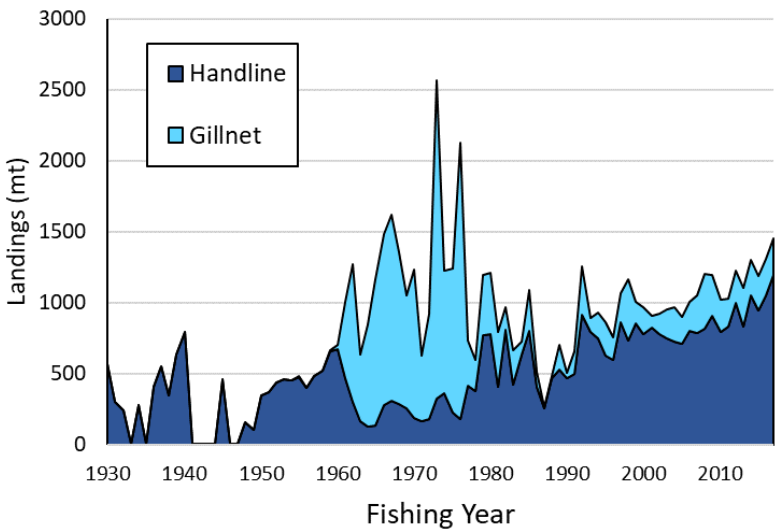
- Data by Fishing Year (July 1 - 30-June 30)
- Gender-specific growth (von Bertalanffy)
- Fixed natural mortality (length-based Lorenzen)
- Beverton-Holt recruitment, steepness fixed at 0.99
- Start year = 1929 (unfished state), End year = 2017
- Fleets: Com HL, Com GN, Shrimp bycatch, Rec HB, Rec CP
- Dome-shaped selectivity f or all fleets except Com HL (asymptotic)
- Indices of relative abundance: Com HL-trolling logbooks, Rec HB survey, SEAMAP trawl juvenile survey
- Shrimp bycatch effort driven
- Regulation (size limits) time blocks of retention-at-length
- MSST = (1 - M) * SSB_{SPR30} (where M = 0.174)
- MFMT = F_{SPR30}



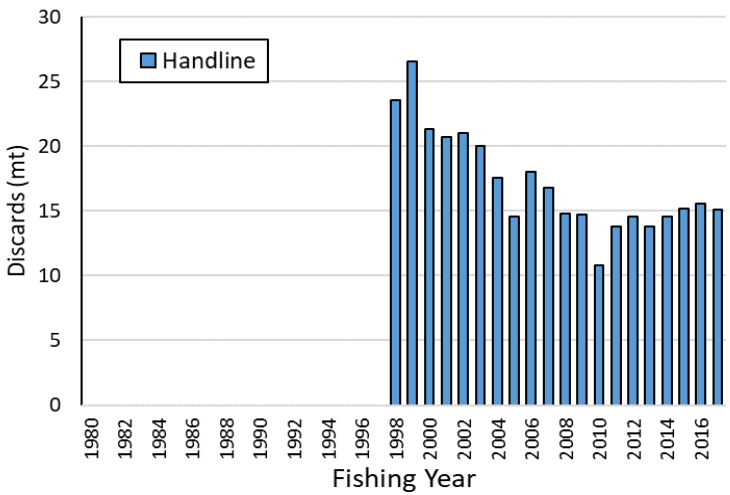


Data - Commercial Landings and Discards

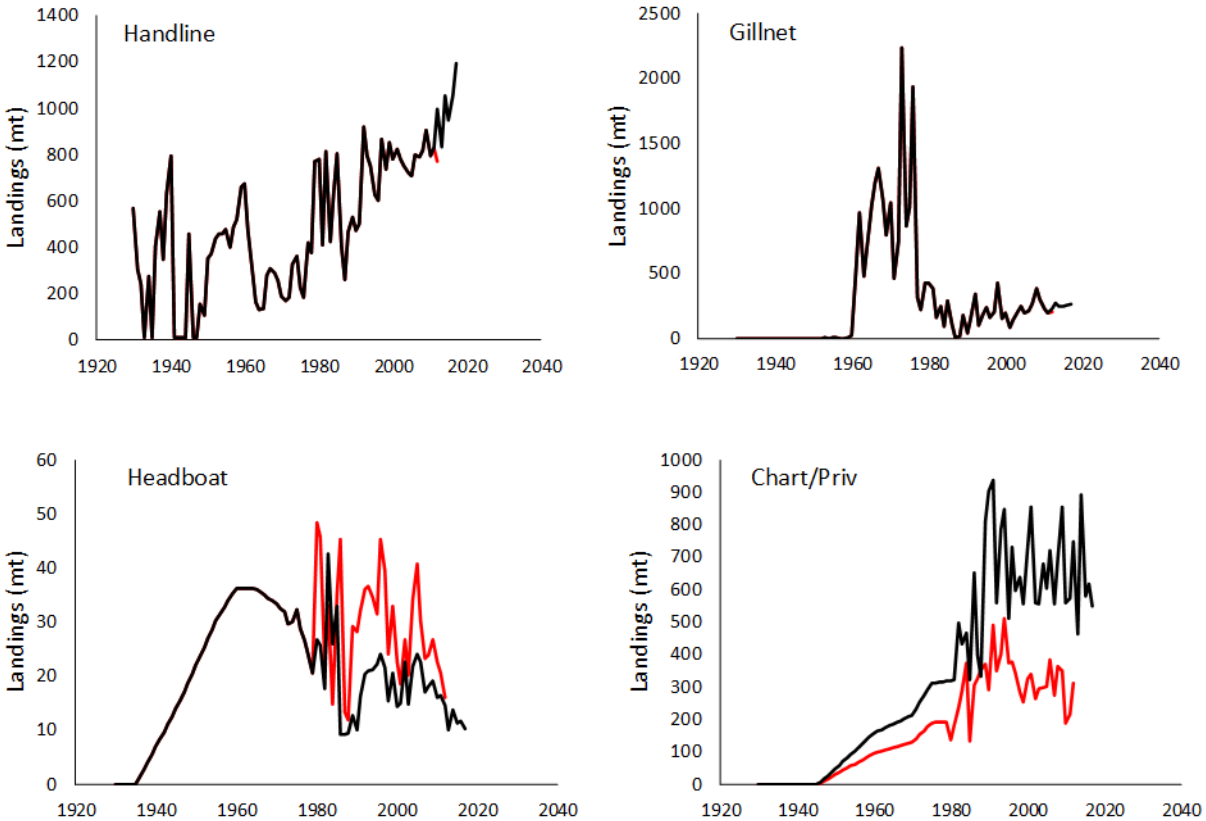
- Overall commercial landings have shown a steady increase since 1990



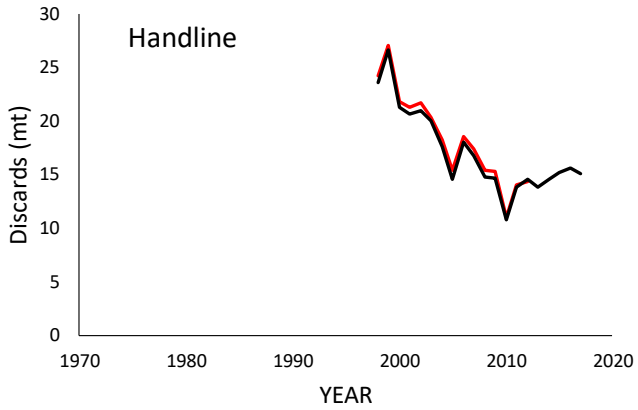
- HL discards have shown an initial decreasing trend (1998-2010) with a slight increasing trend after 2011

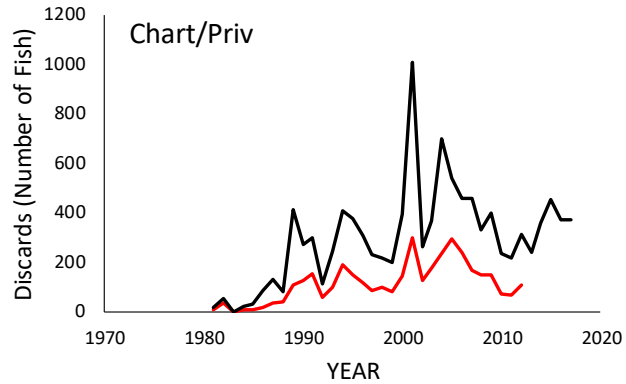


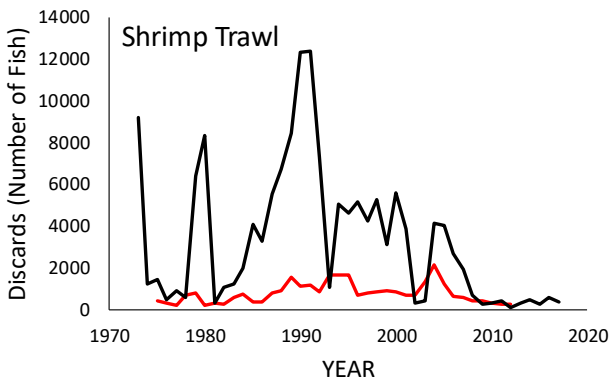
Data - Updated Landings

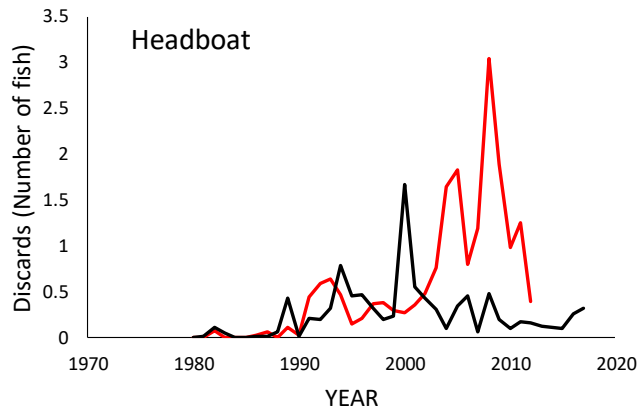


Data - Updated Discards



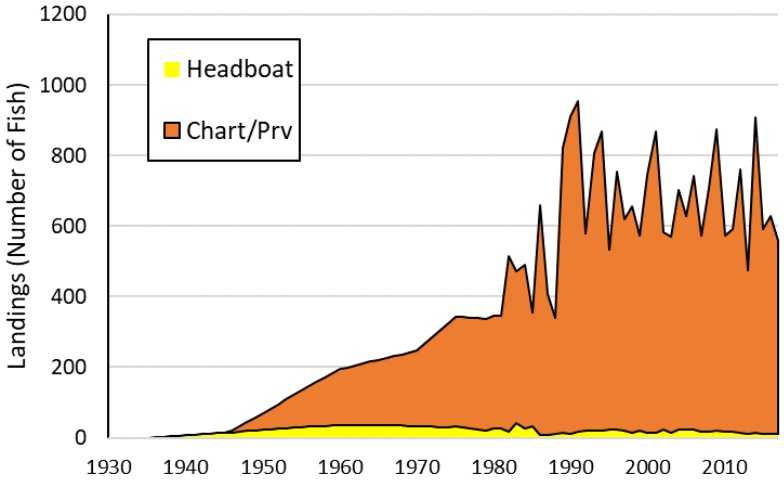




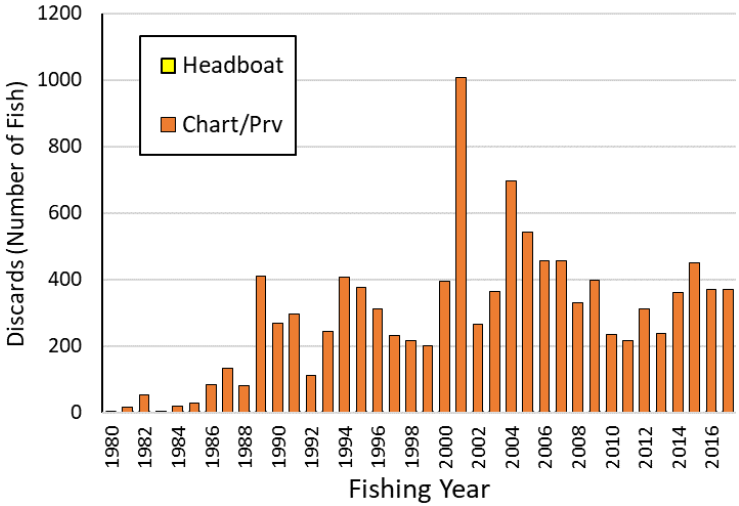


Data - FES Recreational Catch / Discards SEDAR 38U

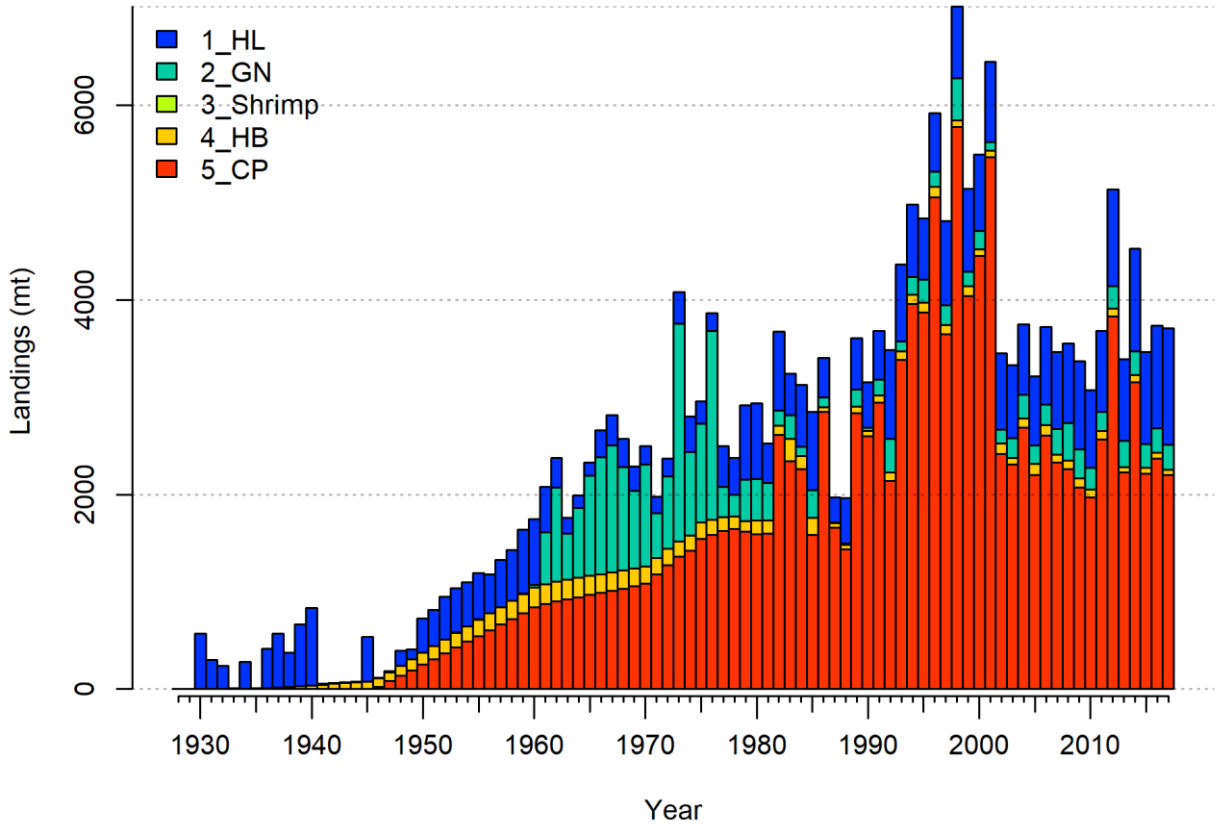
- Overall recreational landings have been steady since ~1990



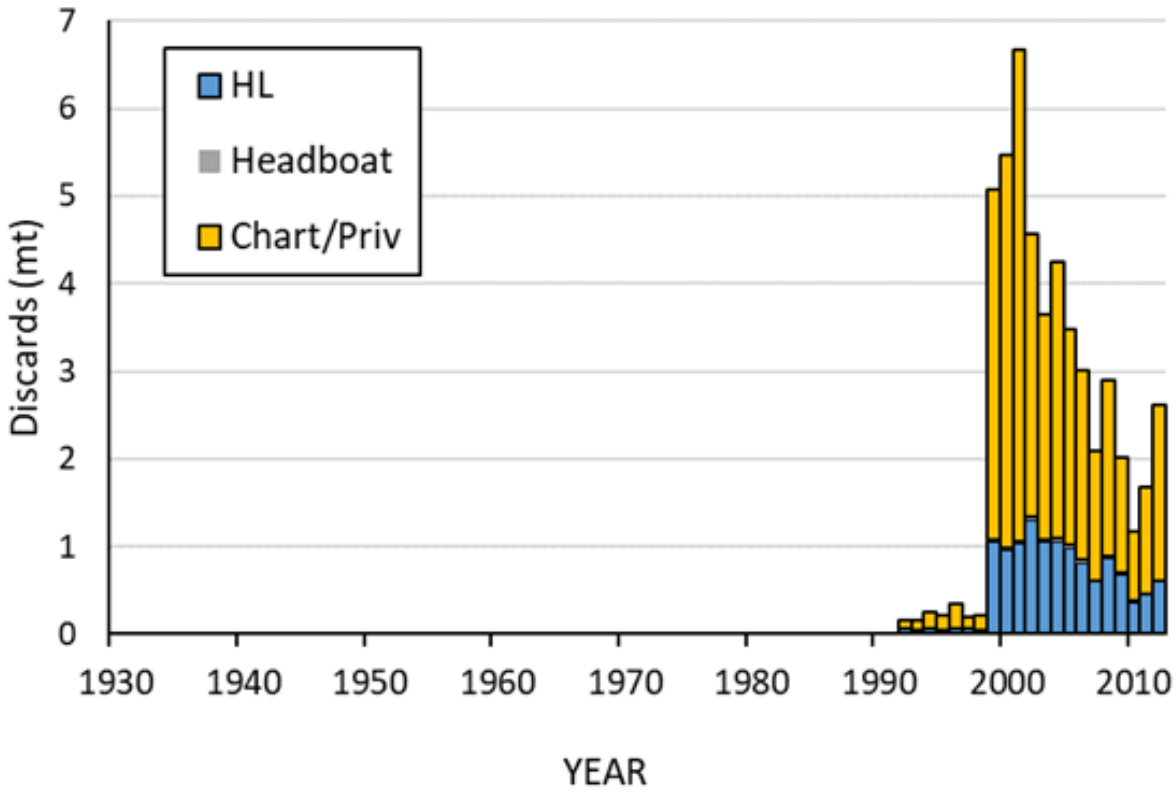
- Discards, mostly from Chart/Priv, have been stable with fluctuations around a mean after 1994



Data – Total Gulf of Mexico King Mackerel Landings



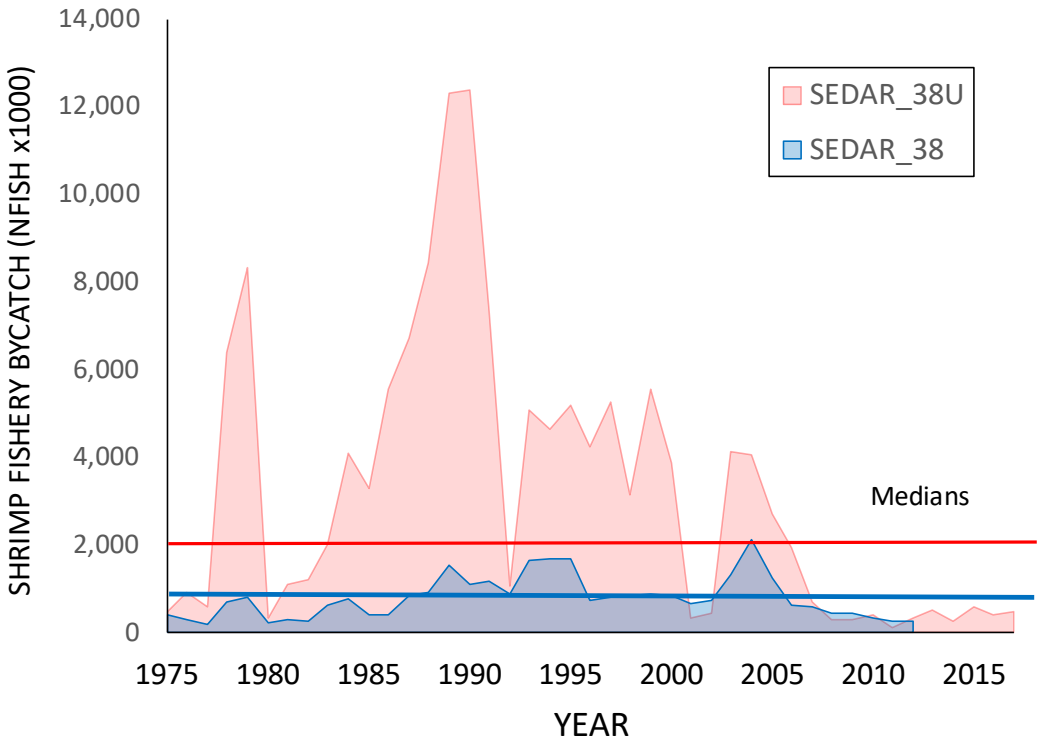
Data - Total Discards



Data - Compare Shrimp Fishery Bycatch

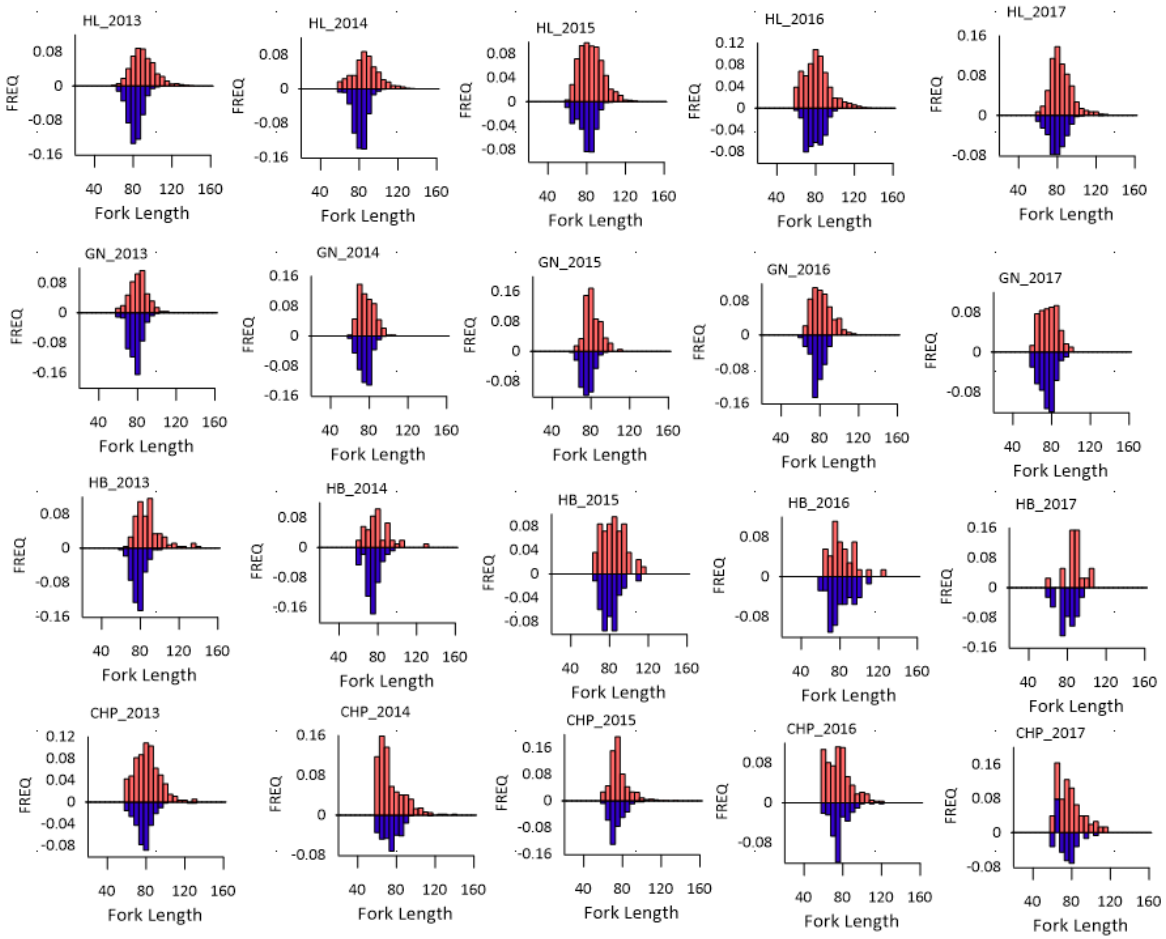
Zhnag, X., J. Isely. 2019. Shrimp Fishery Bycatch Estimates for Gulf of Mexico King Mackerel, 1972-2017

- Shrimp effort trend was essentially identical to SEDAR 38
- Method used to estimate king mackerel bycatch was changed. The SEDAR 38 median was 708k fish and SEDAR 38U is 1,998k fish



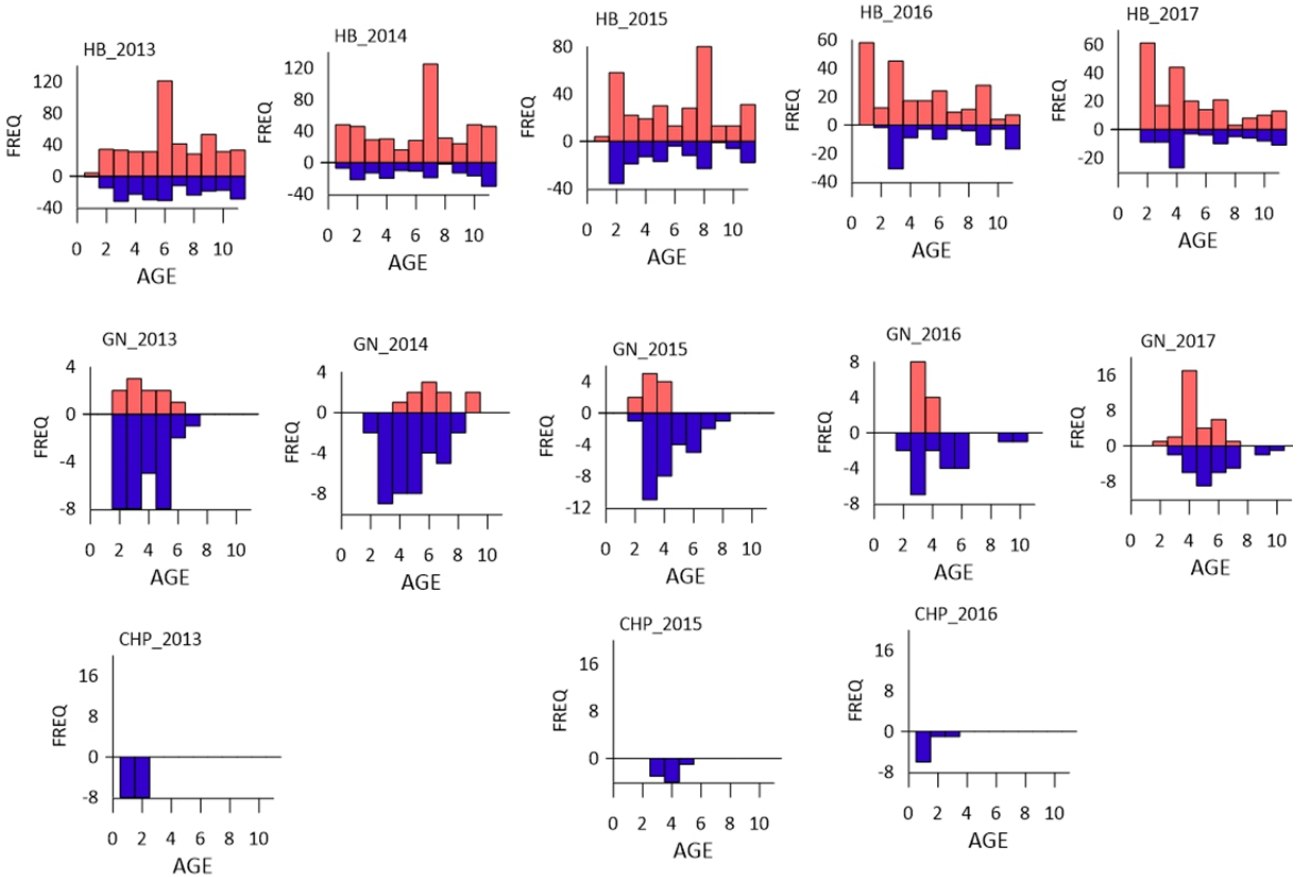
Data - Fisheries Length Compositions

- Thousands of fish measured annually
- Effective sample size was capped at 100
- The need for lengths of discarded fish was evident in the lack of signal for ascending limb of selex
- Future work should seek balance of variance between major data sources

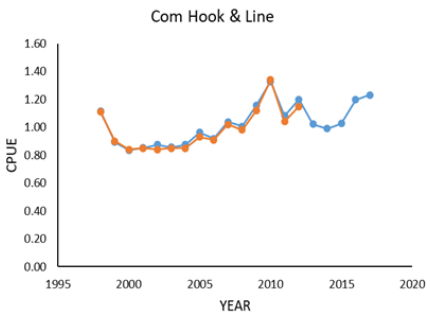


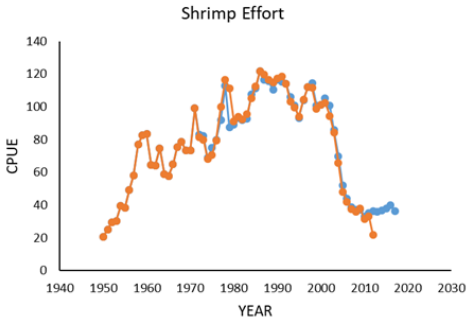
Conditional Age at Length

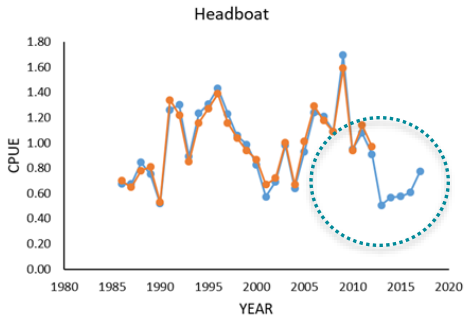
- These ages are NOT assumed to be random sample of the catch
- Due to the sheer number of samples, ages made up the majority of the –LL
- Future work should seek balance of variance between major data sources

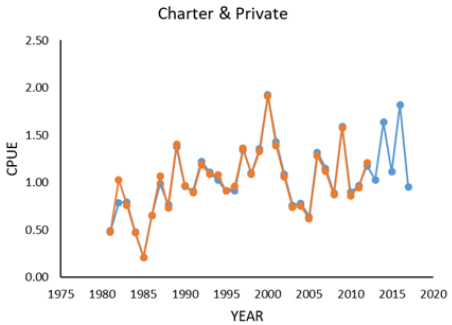


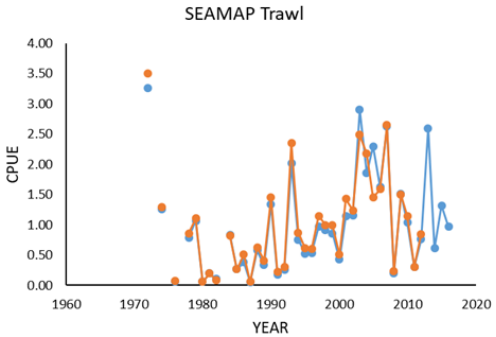
Data - Updated Indices of Abundance and Shrimp Effort

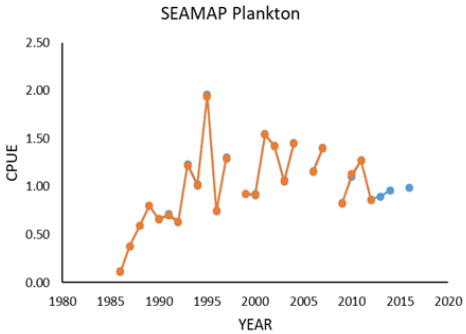












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Base Model

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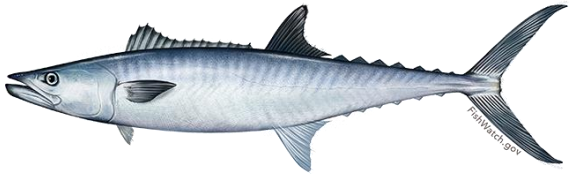
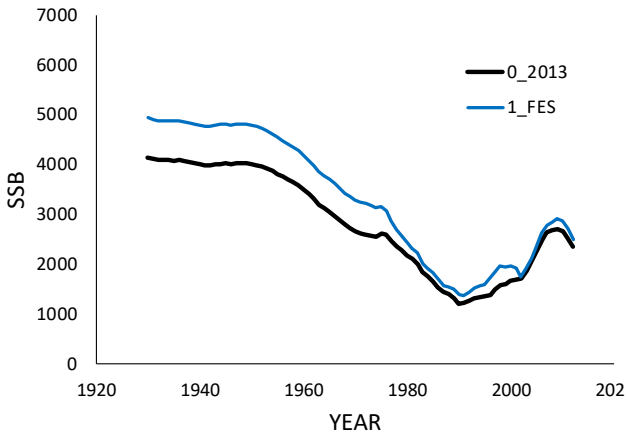
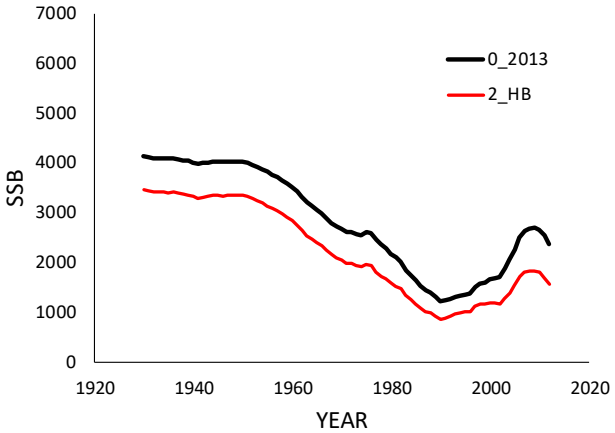
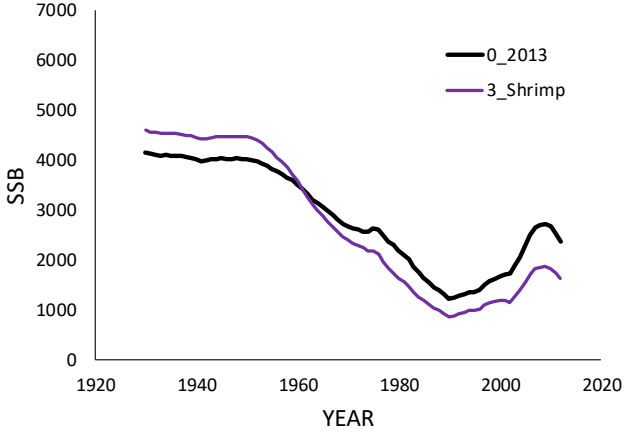


Effects of Updated Observational Data: Individually
(Fit up to 2012 for comparison)

- Increased CH&PB removals led to increased virgin SSB
- Increased headboat discards led to a decrease in virgin SSB and overall population size
- Increased shrimp dead discards lead to a virgin SSB, sharper decline and lower current SSB

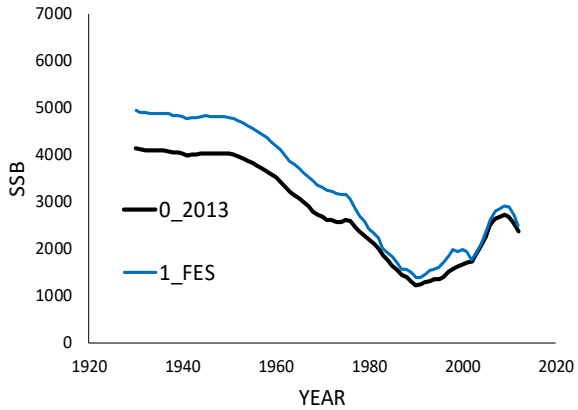


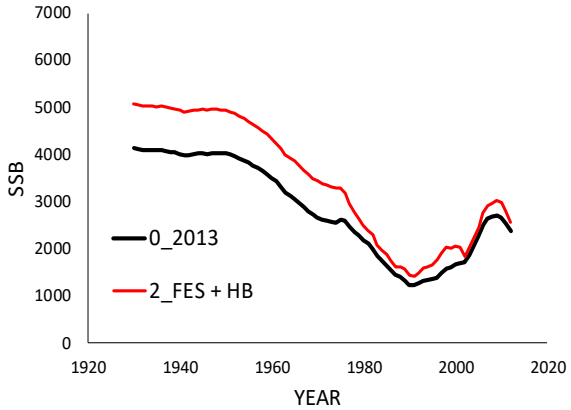


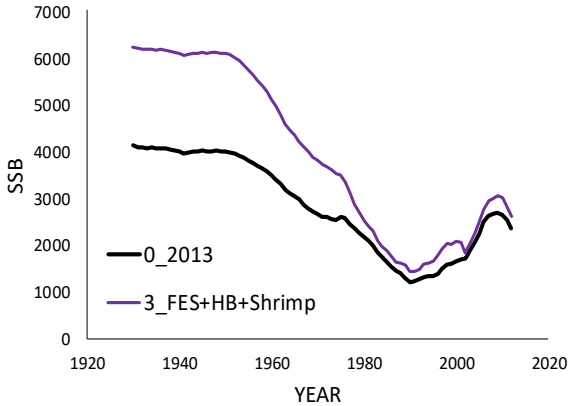


Effects of Updated Observational Data: Cumulative
(Fit up to 2012 for comparison)

- Increased CH&PB landings led to increased population size
- Adding new HB discards make little difference
- Adding increased shrimp dead discards lead to a higher virgin SSB slightly sharper decline, similar ending SSB

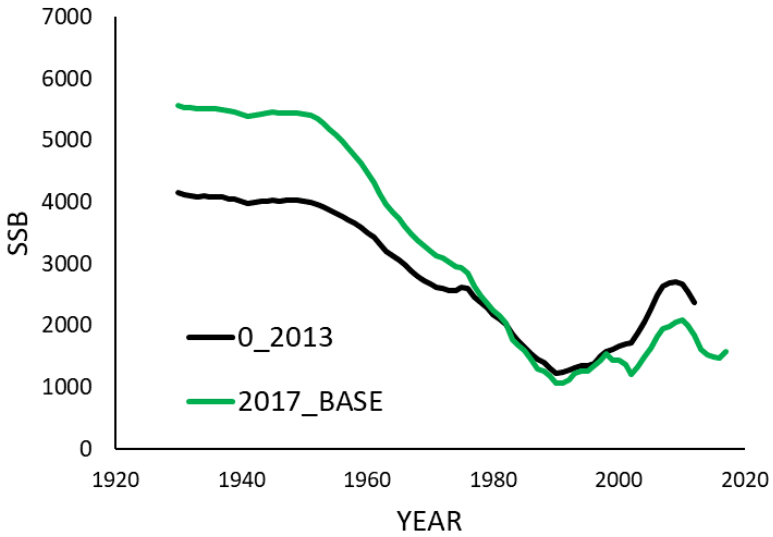


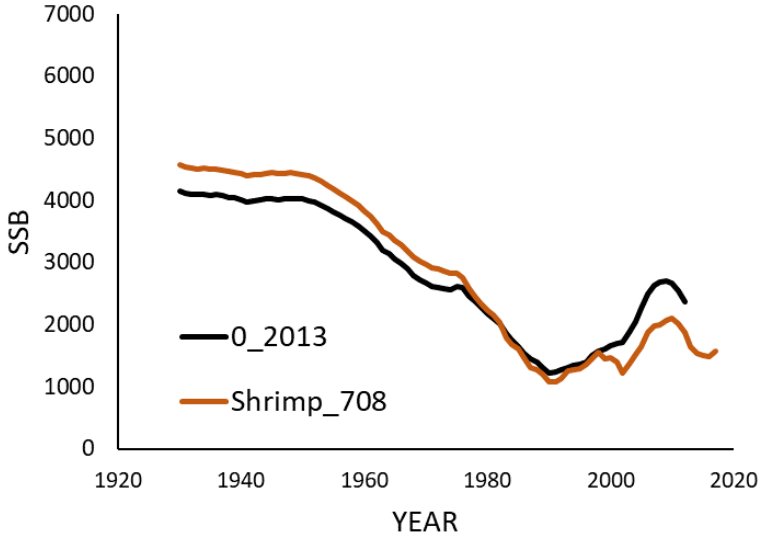




Effects of updating All Data and fitting to up to 2017

- Adding and fitting to the 2017 data increased the estimate of virgin biomass (R0)
- Furthermore, estimates of biomass over the last 17 years has not increased as rapidly
- When S38 shrimp bycatch is used this trend remains similar to S38
- So, the drop in estimated SSB over the past 10 years is due to more than just changes in the shrimp bycatch

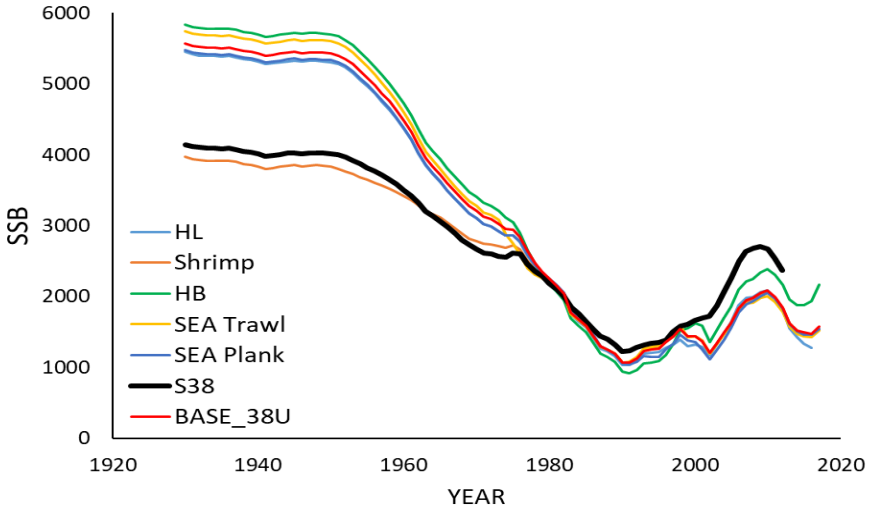


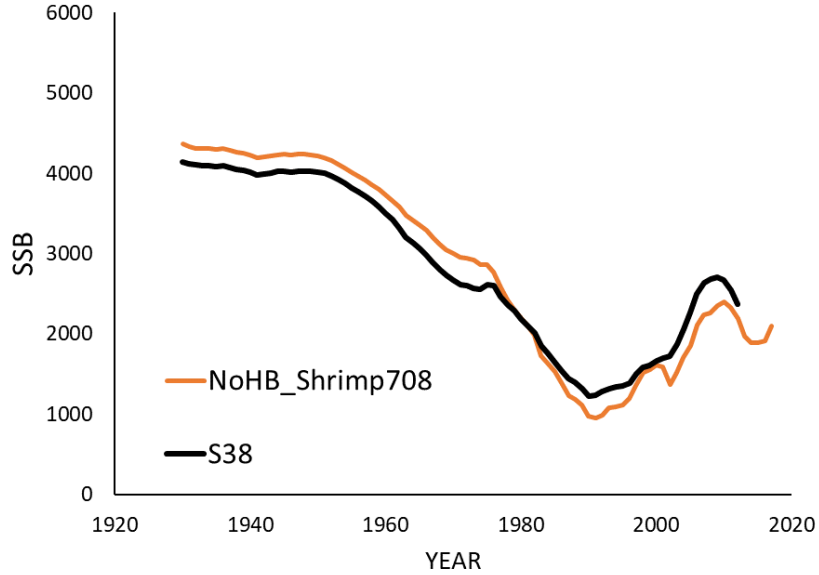


Jack-Knife Analysis

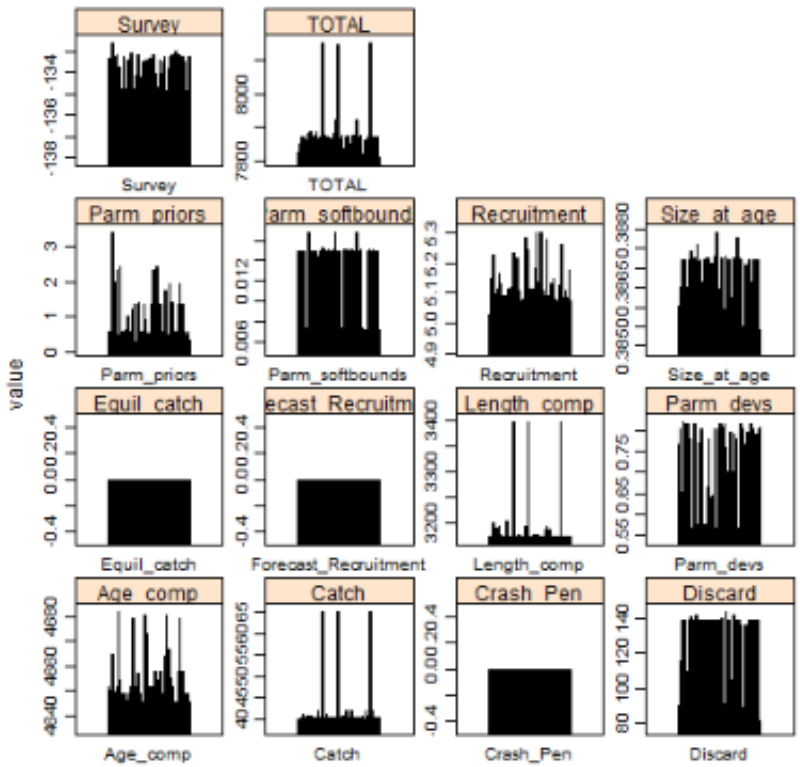
Remove only one index at a time

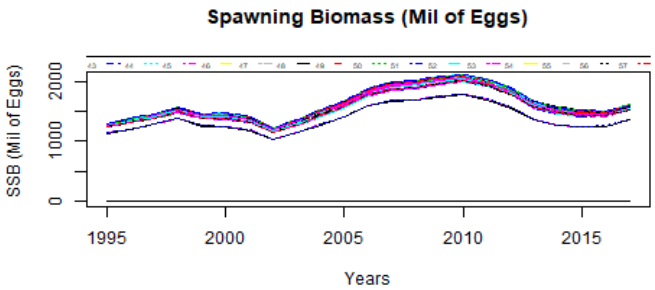
- New FES landings and increased shrimp bycatch are responsible for the increased estimate of virgin SSB
- The recent down turn in the updated headboat index is mostly responsible for the slowing rate of increase in SSB
- For verification if the updated headboat CPUE is removed and the SEDAR 38 shrimp median is used, the trend is very to the SEDAR 38 trend (new FES data still used)

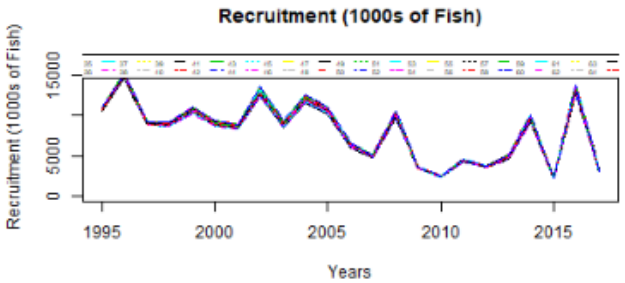


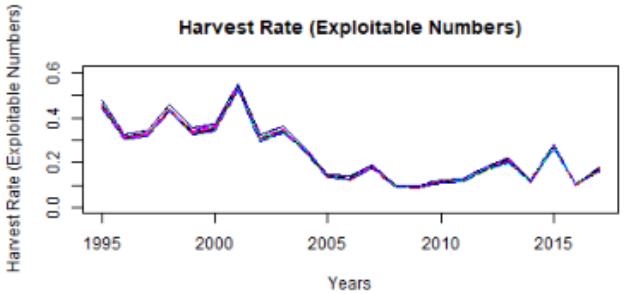


Jitter Analysis
Likelihoods not as stable but resulting trends are



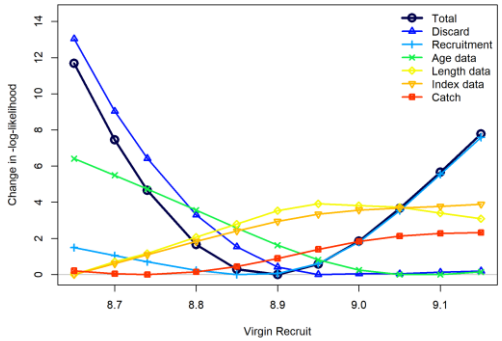






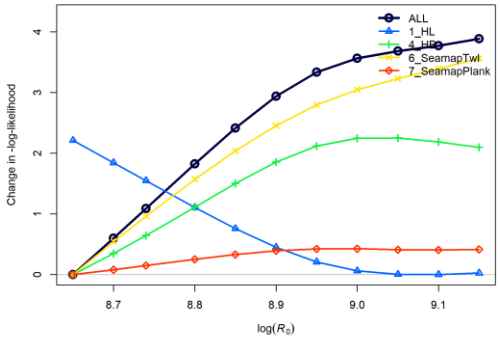
Model Diagnostics: Profile on Virgin Recruitment (R0)

Changes in likelihood by data type

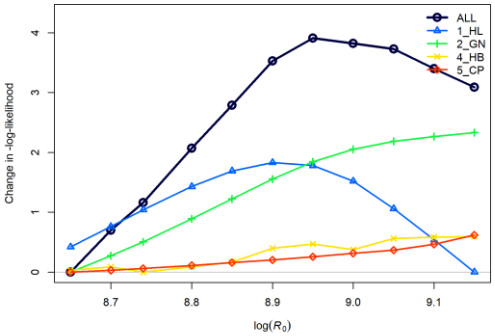


- Conflicts in signals from observational data
- Length and index data push the estimate of R0 to lower
- Age data and discards push the estimate of R0 to higher levels
- Difference between lower estimate and higher estimate is a change of approximately 12 likelihood units

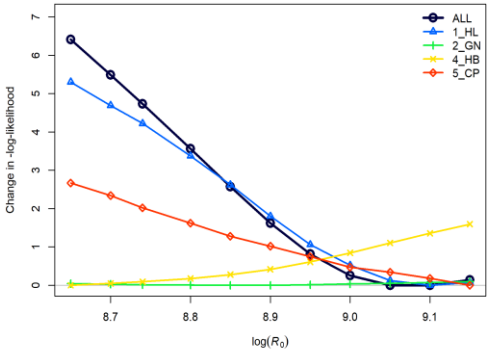
Changes in Survey likelihoods by fleet



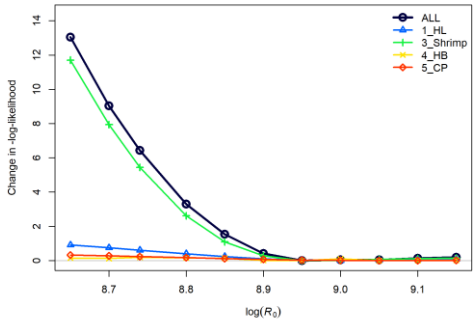
Changes in Length likelihoods by fleet



Changes in Age likelihoods by fleet

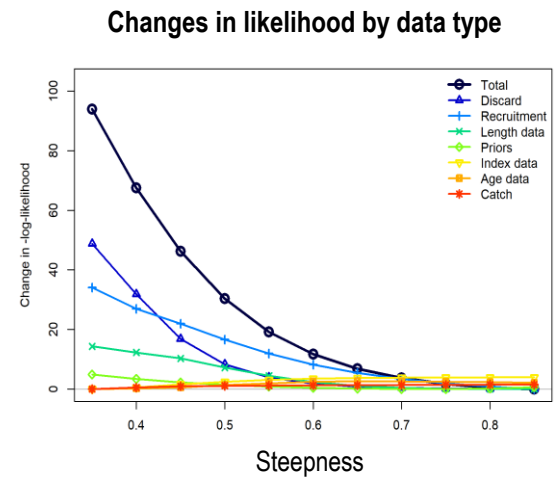


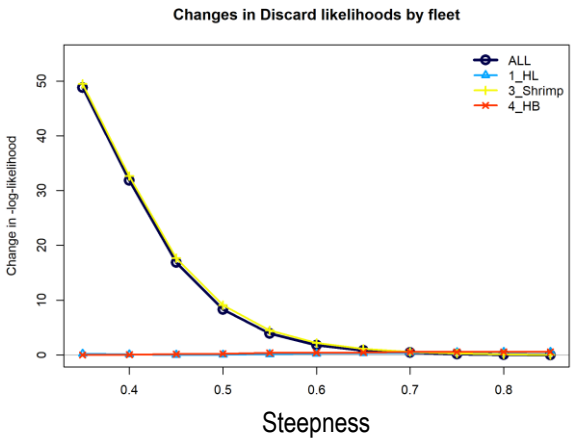
Changes in Discard likelihoods by fleet

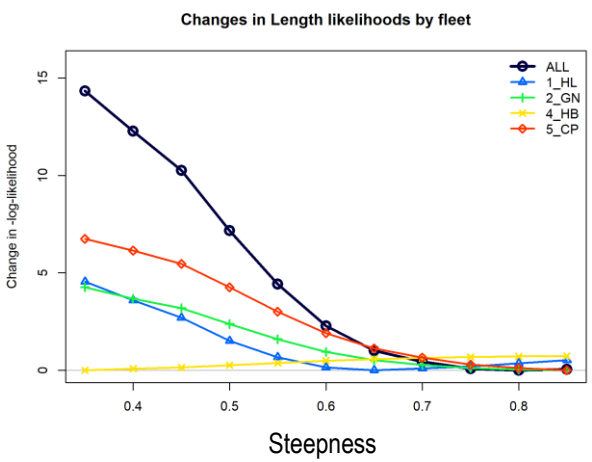


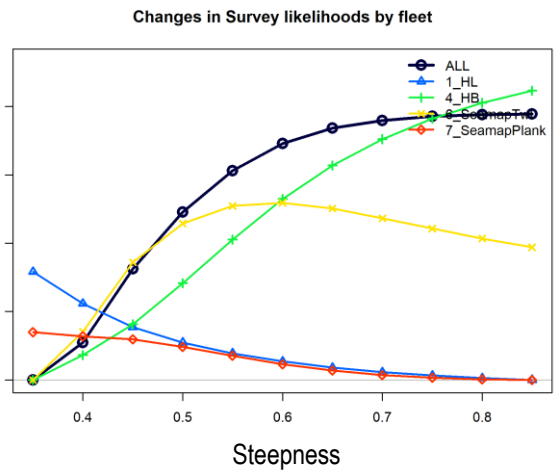
Model Diagnostics: Profile on Steepness (*h*)

- Conflicts in signals from observational data
- Total likelihood fits best at very high values
- This is being driven mostly by the shrimp fishery bycatch, accounting for half of total differences
- If steepness where estimated it would likely take a rebalancing of the data weighting and/or an informative prior



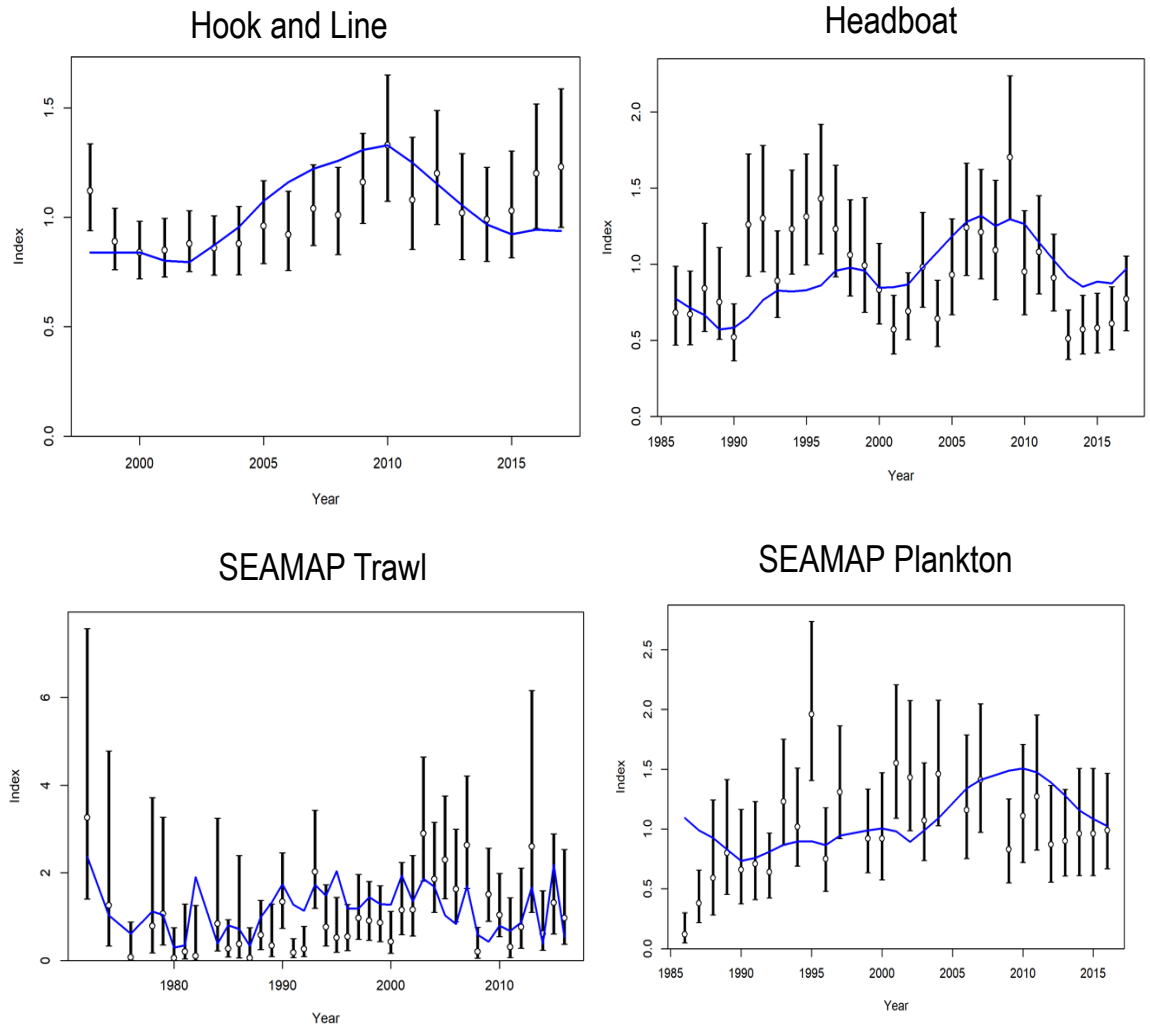






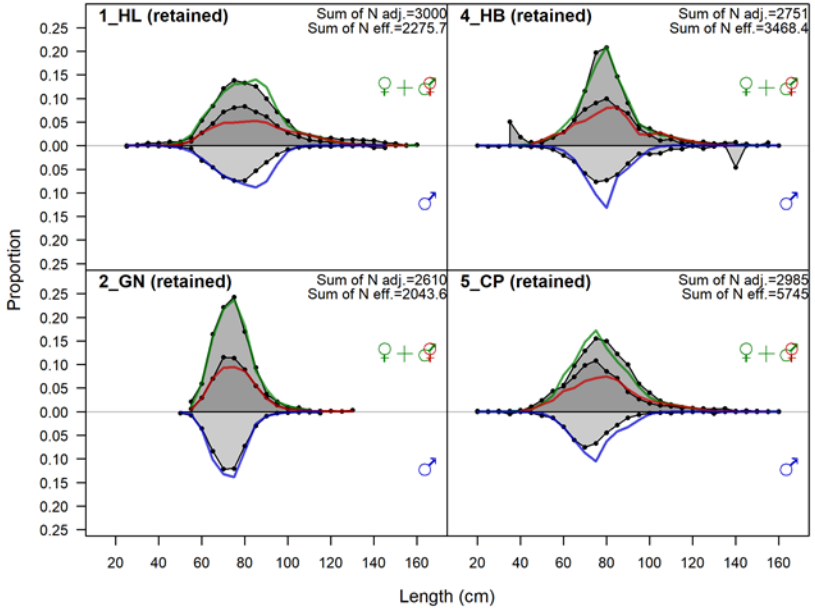
Fits to Indices of Abundance

- Fishery dependent trends generally increasing since S38
- Missed the magnitude of change in some periods
- SEAMAP trawl does a great deal to drive the estimates of recruitment as it was modeled with an age_0 selectivity



Length comps/fits, aggregated across time by fleet

SEDAR 38



SEDAR 38U

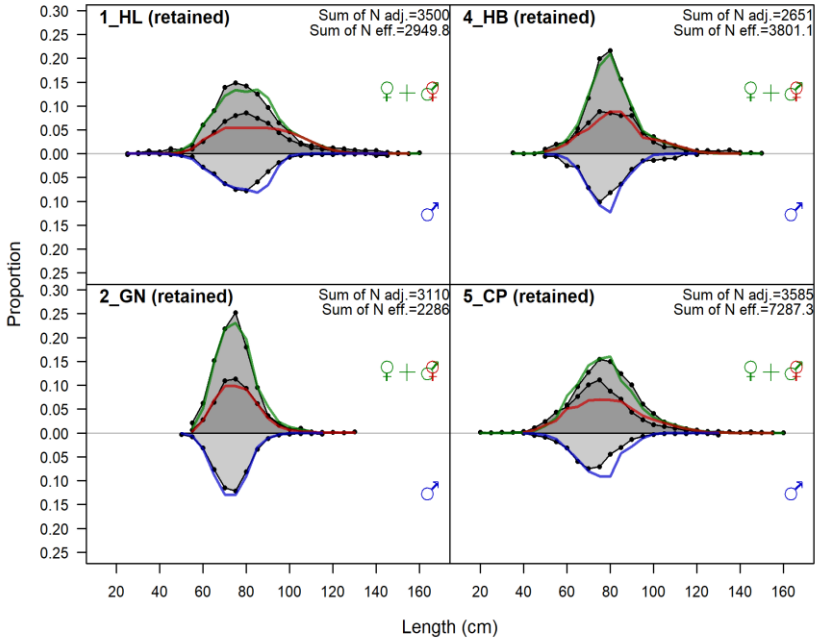
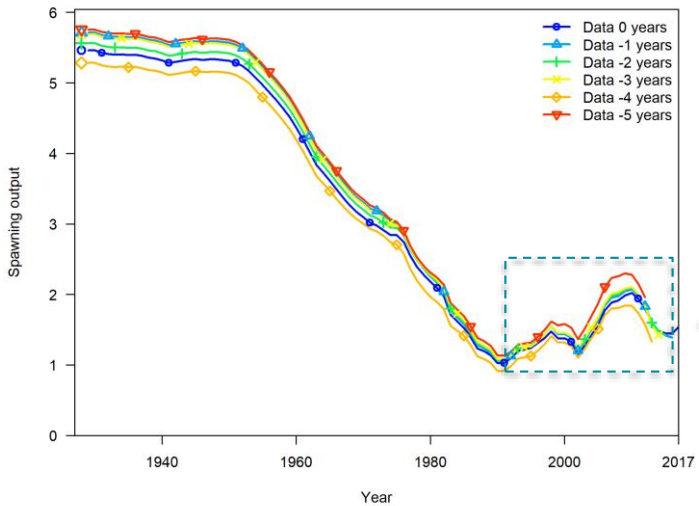
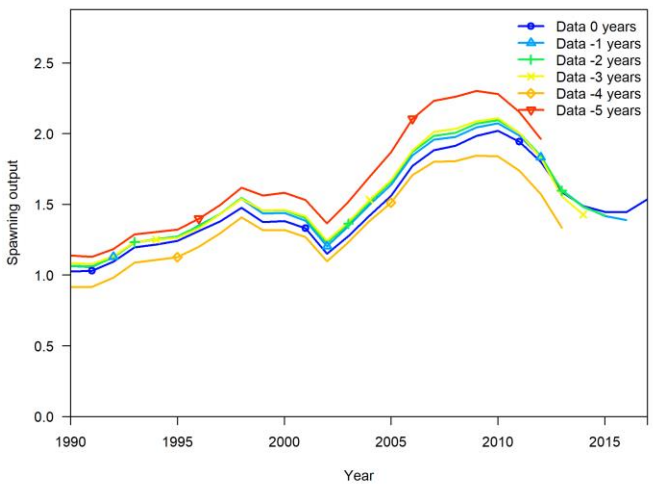


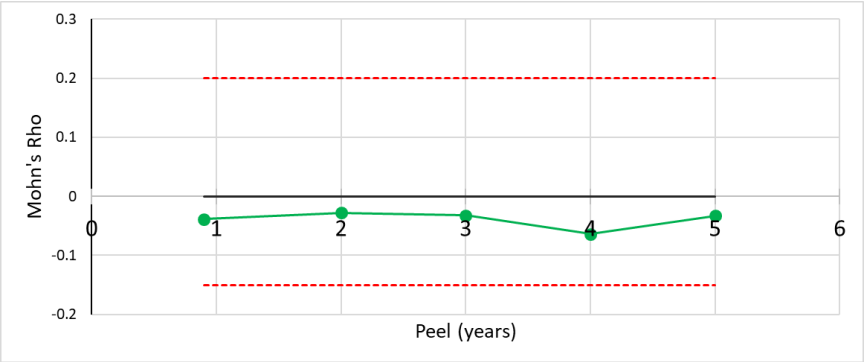
Fig 4.10

Assessment Model Diagnostics: Retrospective Analysis



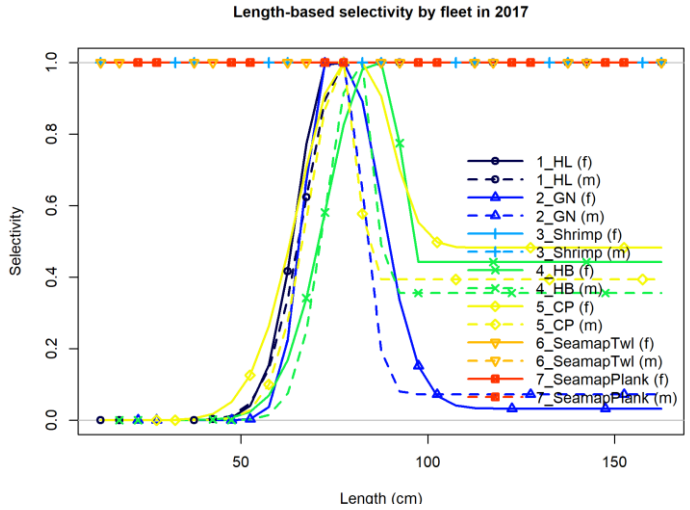


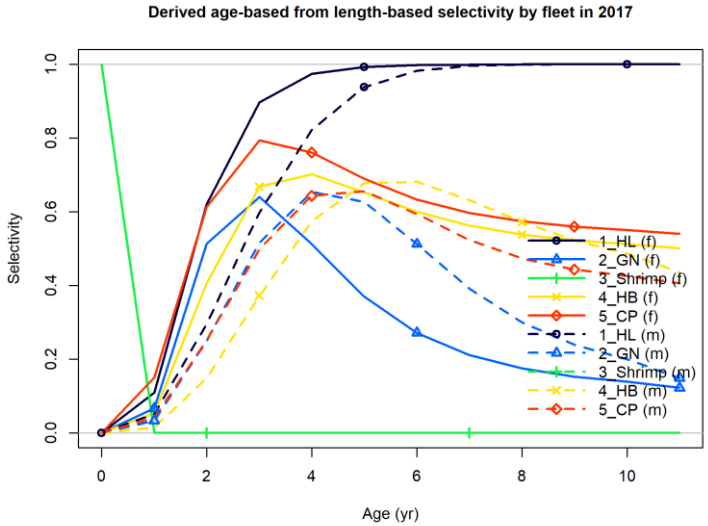
Mohn's rho was well within the Acceptable limits (-0.15 to 0.20)



Fleet Selectivities by Length (top) and derived age (bottom)

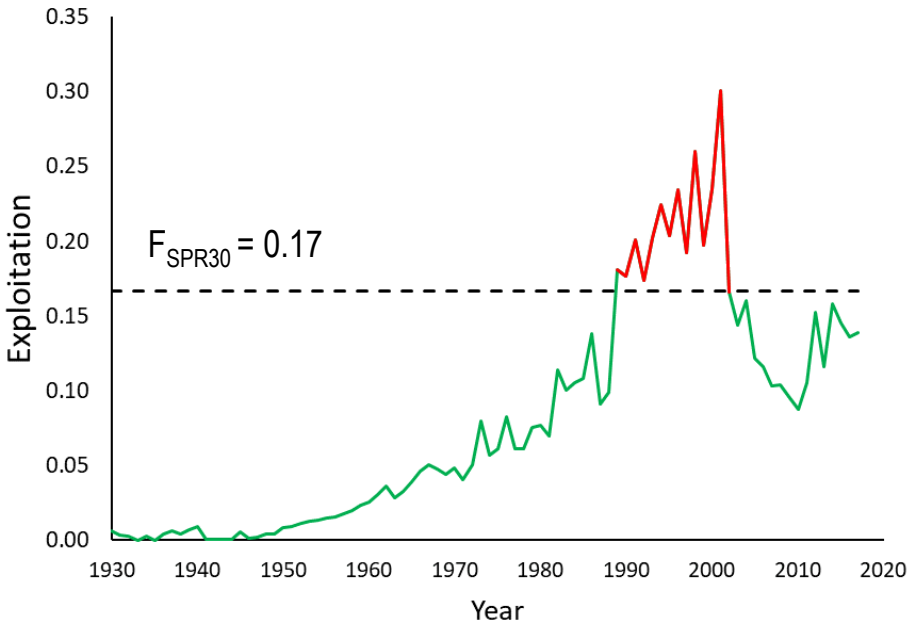
- Asymptotic selectivities for commercial H&L (male) and dome-shaped for recreational CP/PR+HB
- Fish enter the fisheries around 24-inches, age 2
- The shrimp fishery and the SEAMAP trawl survey assumed full selectivity of age_0 fish with older ages being non-selected.





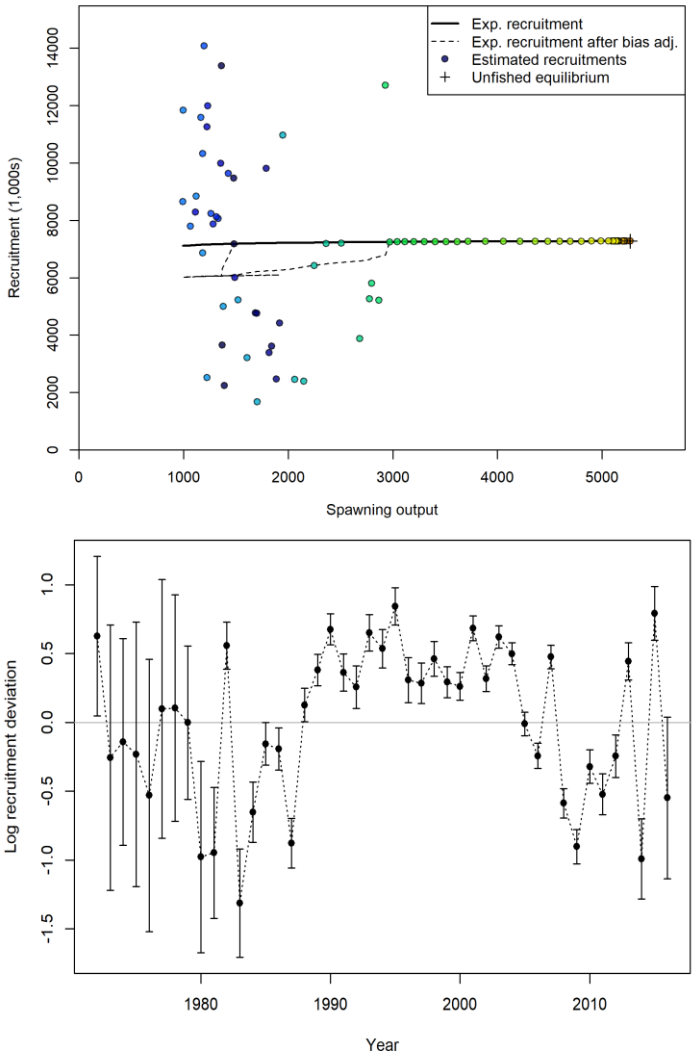
Exploitation

- SS3 can use exploitation (percentage of the fish available to the gear that are removed from that population) as a proxy for fishing mortality.
- Exploitation increased with the increase in Charter/Private landings
- Exploitation a strong decline with the advent of regulations Lowest exploitation of the stock since the 1970s.
- Currently very close to target $F_{SPR30} = 0.17$



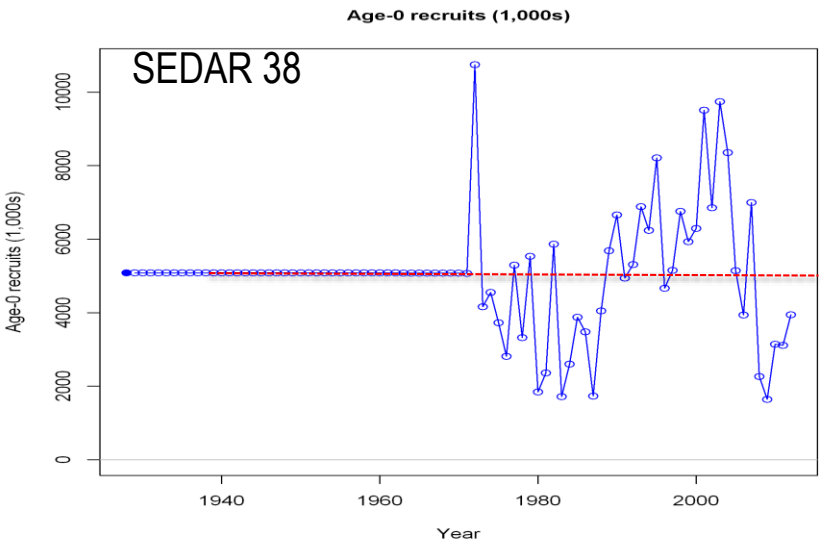
Stock-Recruitment

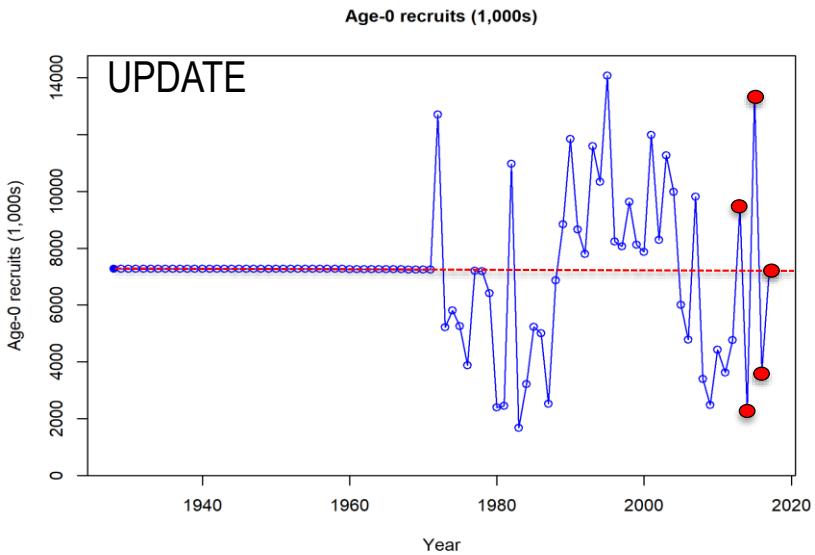
- Lack of recruitment pattern led SEDAR 38 panel to recommend steepness be fixed at 0.99
- That assumption was retained for the update
- Unfished mean recruitment (*R0*)= 7.68 million age-0 recruits/year
- Cyclical pattern in recruitment deviations detected (1972-2016)
- Trends in recruitment deviations are influenced by SEAMAP TWL CPUE series. Thus, this index drives short term projections



Estimated Recruitments

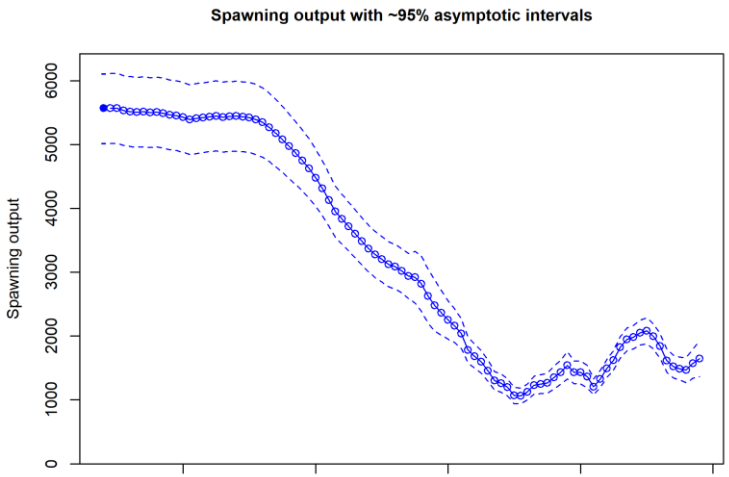
- Increase in R0 between S38 and the update due to FES and shrimp data updates
- Downward trend/low has changed direction. This is due to the trend in the SEAMAP TWL Survey
- The most recent five year recruitment deviations are centered around the mean but estimates show large annual deviations with a large 2016 year class and smaller 2015 year class

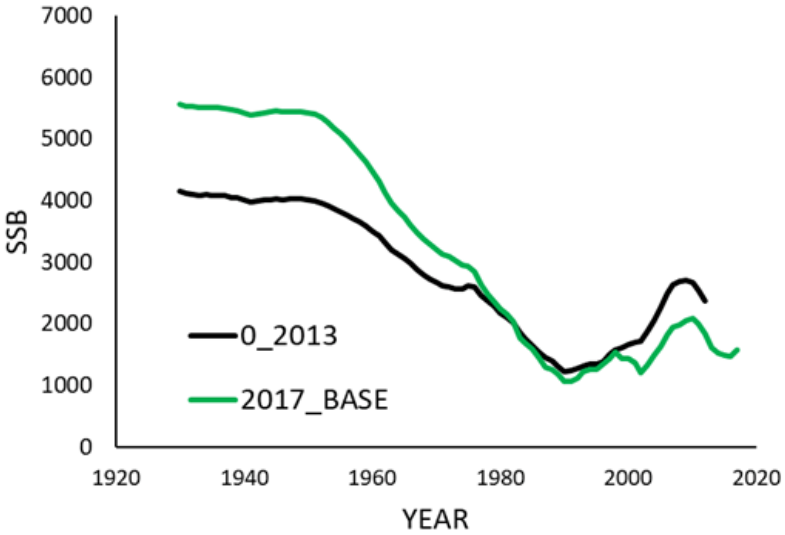




Stock Biomass

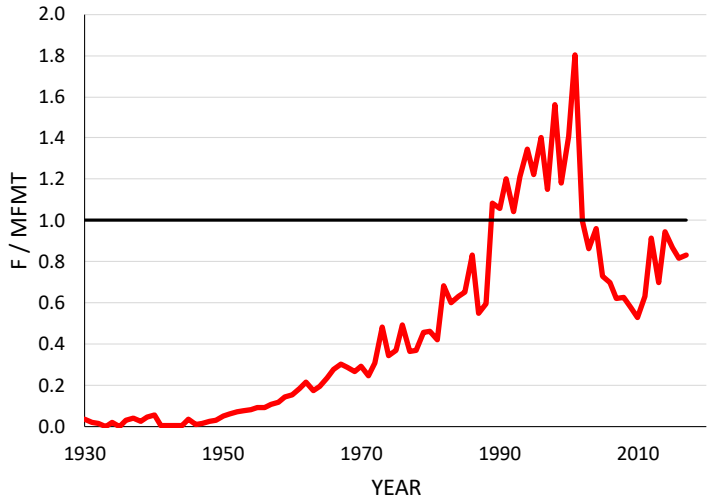
- Total and spawning biomass on a generally increasing trend since 1990
- The population has seemed to have grown out of the low recruitments of 2005-2012
- The 95% CIs are unrealistically small due to fixed parameters
- Differences in biomass trends are due to update in shrimp bycatch and FES landings.

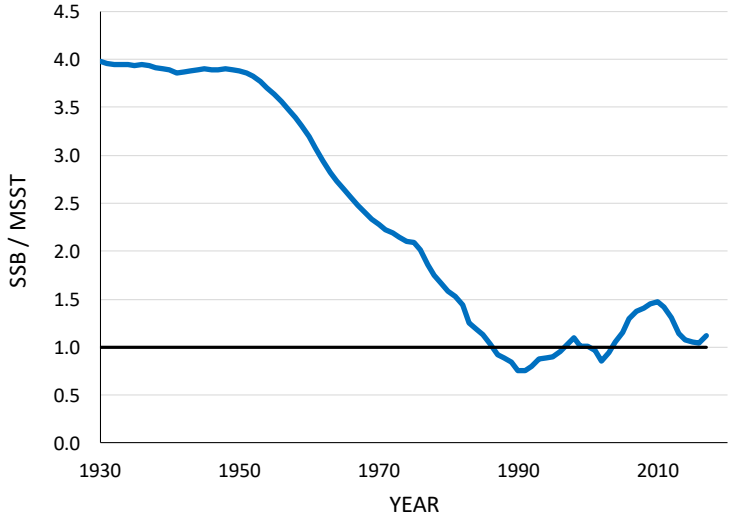




Stock Status: Not Overfished; Not Overfishing

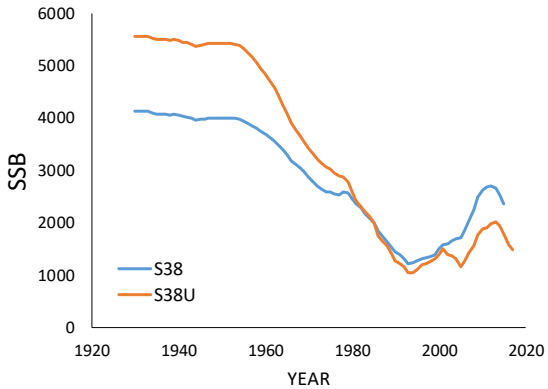
- SSB_{2017} / MSST = 1.12 (0.98 – 1.26)
- The estimated probability the stock is not overfished is 85%
- F_{2017} / MFMT = 0.84 (0.68 – 0.98)
- The estimated probability that overfishing is not occurring is 91%

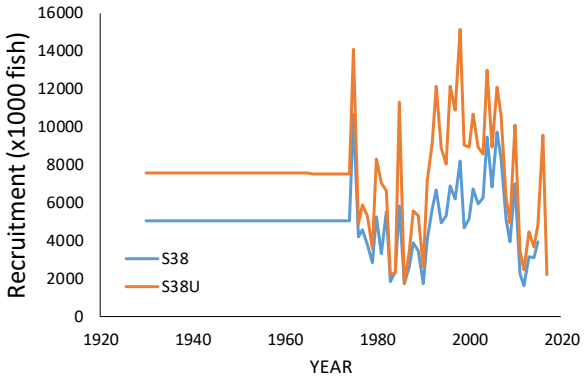


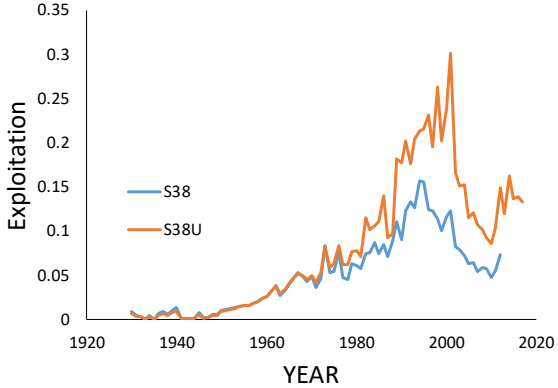


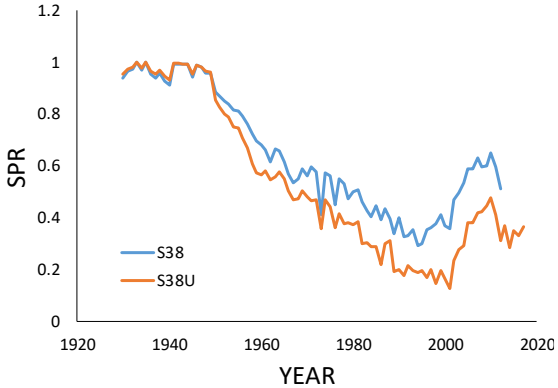
Population and Fishery Trends
SEDAR 38 and 38 Update

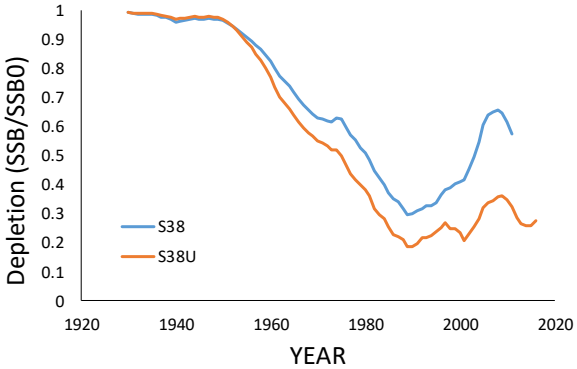
- Larger virgin population size
- Larger recruitment
- Increased exploitation
- Decreased SPR
- More Depleted
- Increased OFL/ABC











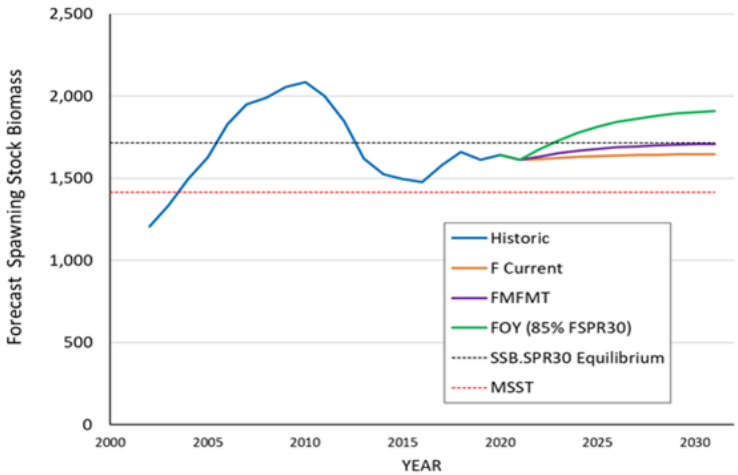
SEDAR 38 Update
Projections

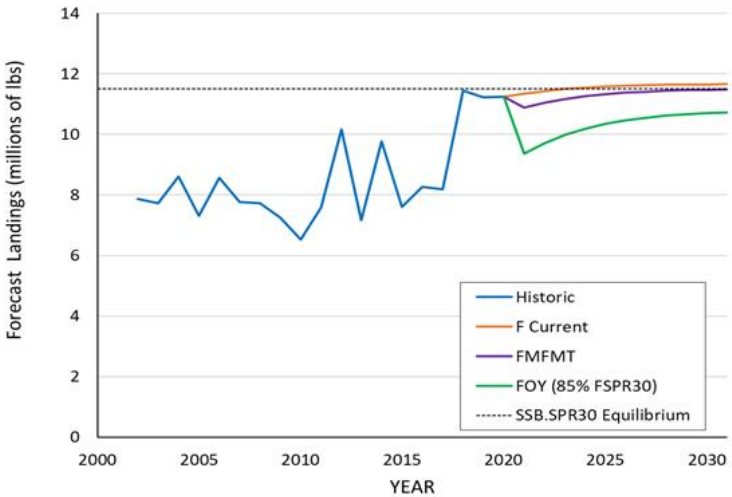
- Terminology
- Terms of Reference
- Overview
- Data
- Base Model
  - Development
  - Fit
  - Results
  - Diagnostics
- **Projections**
  - **Settings**
  - **Results**
- Summary

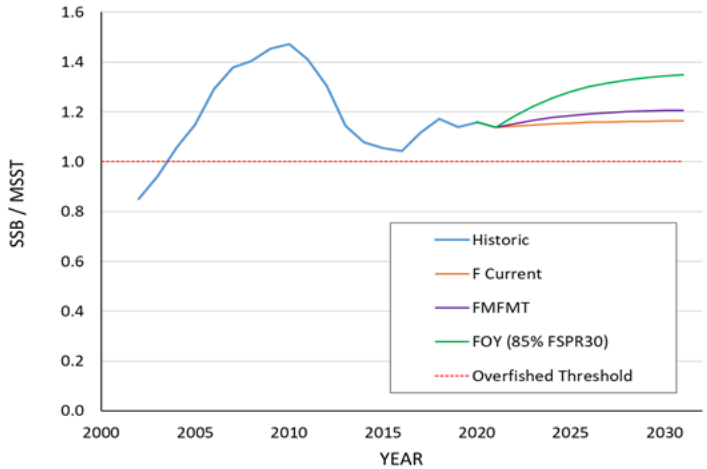
Projections: Settings

- Projections were made from 2021-2030
- Exploitation in 2018-2020 were assumed equal to those in 2017
- Retained catch for 2018-2020 were arrived at by exploiting the estimated stock size in those years by the 2017 exploitation rate
- All future recruitments were equal to the maximum (R0)
- The P* value used in the original assessment (P* = 0.43) was applied to the projections of OFL to arrive at ABC

Projection Results: Projected OFL and SSB/MSST (P* = 0.50)







	Fcurrent		FMFMT		FOY	
Fish. Year	Landings	SSB/MSST	Landings	SSB/MSST	Landings	SSB/MSST
2021	11.34	1.14	10.89	1.14	9.37	1.14
2022	11.43	1.14	11.05	1.15	9.72	1.18
2023	11.50	1.15	11.18	1.17	9.99	1.22
2024	11.55	1.15	11.27	1.18	10.20	1.25
2025	11.59	1.15	11.33	1.19	10.35	1.28
2026	11.61	1.16	11.38	1.19	10.47	1.30
2027	11.63	1.16	11.41	1.20	10.56	1.32
2028	11.64	1.16	11.44	1.20	10.62	1.33
2029	11.65	1.16	11.46	1.20	10.67	1.34
2030	11.66	1.16	11.47	1.21	10.71	1.34
Equilibrium	11.68	1.16	11.51	1.21	10.83	1.36

Projected OFL / ABC for SEDAR 38 and 38 Update Fishing at F_{SPR30} Using P* = 0.43

P* = 0.43 YEAR	LCI	Retained Yield (mt)	UCI	ABC in MT	OFL (million lbs)	ABC (million lbs)
2018		**5196**				
2019		**5096**				
2020		**5104**				
2021	3559	4941	6323	4751	10.89	10.47
2022	3523	5014	6504	4809	11.05	10.60
2023	3524	5070	6617	4857	11.18	10.71
2024	3535	5111	6687	4894	11.27	10.79
2025	3548	5141	6733	4921	11.33	10.85
2026	3560	5162	6765	4942	11.38	10.89
2027	3569	5178	6786	4956	11.41	10.93
2028	3577	5189	6801	4967	11.44	10.95
2029	3584	5198	6812	4976	11.46	10.97
2030	3589	5204	6820	4982	11.47	10.98

	OFL	ABC
P*	0.5	0.43
2015	10.11	9.62
2016	9.61	9.21
2017	9.27	8.88
2018	9.11	8.71
2019	8.95	8.55
2020	8.81	8.43
2021	8.68	8.29
2022	8.60	8.20
2023	8.58	8.19
2024	8.60	8.23

SEDAR 38U
Summary

- In order to maintain the use of “best available data” it was necessary to change three sources of catch data
- The Gulf King Mackerel stock is currently not undergoing overfishing nor is it overfished. The stock size is above the Minimum Stock Size Threshold (MSST), but below the benchmark of $SSB/SSB_{MSYproxy}$
- Forecasts indicate maintaining yields at or below the 2021 overfishing limit of 10.89 million pounds (mp) whole weight (ww) in the near-term will allow the stock to build towards the $SSB_{MSYproxy}$
- Similar data/modeling challenges faced in SEDAR 38 are still evident in this update
- While updates in catch data for 2018-2019 might increase the accuracy of projections somewhat, without updating the indices of abundance these updated projections would be of only limited value

Research Recommendations

- Migration to latest version of Stock Synthesis (3.30)
- Investigate reasons for conflicting signals in the observational data These could include, but are not limited to, reviewing the standardization of the fishery independent indices of abundance as well as reviewing the fishery dependent indices to ensure they are not being overly influenced by management regulations (i.e. quotas, minimum sizes and bag limits).
- Exploration into the use of a BH or other stock-recruitment relation and the estimation of the slope, with or without an informative prior
- Take advantage of the upcoming shrimp bycatch workshop
- A more detailed examination of the effects of the minimum size and bag limit regulations and further research into the length compositions of discarded fish
- Assurances should be made that there is an appropriate match between the sampling design of the biological data (i.e. ages, lengths, etc.) and the assumptions of its use in the assessment model

Questions?

SEDAR 38U – Projections at different P* values

P* = 0.4 YEAR	LCI	Retained Yield (mt)	UCI	ABC in MT	OFL (million lbs)	ABC (million lbs)
2018		**5196**				
2019		**5096**				
2020		**5104**				
2021	3559	4941	6323	4668	10.89	10.29
2022	3523	5014	6504	4719	11.05	10.40
2023	3524	5070	6617	4765	11.18	10.50
2024	3535	5111	6687	4800	11.27	10.58
2025	3548	5141	6733	4826	11.33	10.64
2026	3560	5162	6765	4845	11.38	10.68
2027	3569	5178	6786	4860	11.41	10.71
2028	3577	5189	6801	4871	11.44	10.74
2029	3584	5198	6812	4879	11.46	10.76
2030	3589	5204	6820	4885	11.47	10.77

P* = 0.41 YEAR	LCI	Retained Yield (mt)	UCI	ABC in MT	OFL (million lbs)	ABC (million lbs)
2018		**5196**				
2019		**5096**				
2020		**5104**				
2021	3559	4941	6323	4696	10.89	10.35
2022	3523	5014	6504	4749	11.05	10.47
2023	3524	5070	6617	4796	11.18	10.57
2024	3535	5111	6687	4831	11.27	10.65
2025	3548	5141	6733	4858	11.33	10.71
2026	3560	5162	6765	4878	11.38	10.75
2027	3569	5178	6786	4892	11.41	10.79
2028	3577	5189	6801	4903	11.44	10.81
2029	3584	5198	6812	4911	11.46	10.83
2030	3589	5204	6820	4917	11.47	10.84

P* = 0.43 YEAR	LCI	Retained Yield (mt)	UCI	ABC in MT	OFL (million lbs)	ABC (million lbs)
2018		**5196**				
2019		**5096**				
2020		**5104**				
2021	3559	4941	6323	4751	10.89	10.47
2022	3523	5014	6504	4809	11.05	10.60
2023	3524	5070	6617	4857	11.18	10.71
2024	3535	5111	6687	4894	11.27	10.79
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2026	3560	5162	6765	4942	11.38	10.89
2027	3569	5178	6786	4956	11.41	10.93
2028	3577	5189	6801	4967	11.44	10.95
2029	3584	5198	6812	4976	11.46	10.97
2030	3589	5204	6820	4982	11.47	10.98

P* = 0.45 YEAR	LCI	Retained Yield (mt)	UCI	ABC in MT	OFL (million lbs)	ABC (million lbs)
2018		**5196**				
2019		**5096**				
2020		**5104**				
2021	3559	4941	6323	4805	10.89	10.59
2022	3523	5014	6504	4868	11.05	10.73
2023	3524	5070	6617	4919	11.18	10.84
2024	3535	5111	6687	4957	11.27	10.93
2025	3548	5141	6733	4984	11.33	10.99
2026	3560	5162	6765	5005	11.38	11.03
2027	3569	5178	6786	5020	11.41	11.07
2028	3577	5189	6801	5031	11.44	11.09
2029	3584	5198	6812	5040	11.46	11.11
2030	3589	5204	6820	5046	11.47	11.12