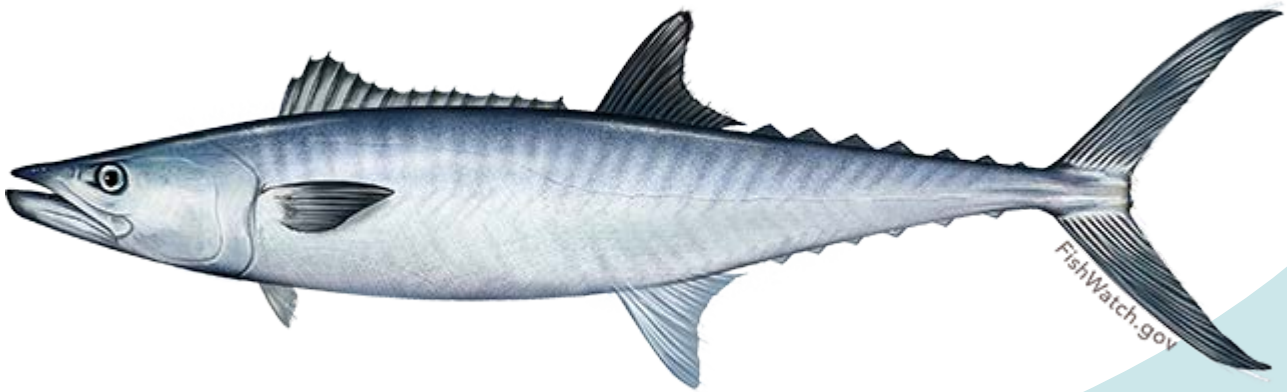
NOAA FISHERIES

South Atlantic King Mackerel Stock Assessment

SEDAR 38 Update

April 29, 2020
SEFSC staff
Webinar



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Executive Summary – South Atlantic King Mackerel

- Five years of data added to Stock Synthesis (Mar 2013 to Feb 2018), model peer-reviewed during SEDAR 38
- Current Stock Status: NOT OVERFISHED
- Current Fishery Status: NOT OVERFISHING
- All fishery indicators (landings, fleet CPUEs and scientific survey) showed increasing trends since SEDAR 38
- Estimated biomass trending up beginning in 2013
- Exploitation rate steady since 2010 (0.04 and 0.05/year)
- Average recruitment estimate = 9.8 million age-0 fish/year
- Equilibrium landings at target exploitation (F_{SPR30} = 0.14/year) = 18.3 million pounds
- Period of high recruitments in 2013 to 2016, following the 2008 to 2012 low recruitments detected during SEDAR 38
- Overfishing limits of 34 million pounds in 2021 decreasing to 20 million pounds by 2025, tracking recent high recruitment

Presentation Agenda

I. Brief review of life history, stock structure, and assessment model assumptions

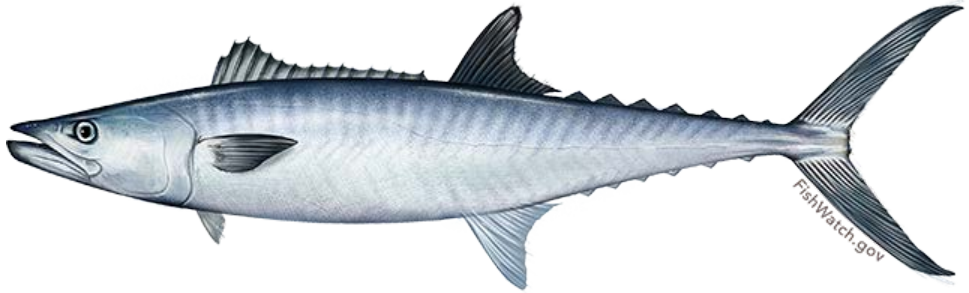
II. Data updates since SEDAR 38

III. Effects of the Recreational Fishing Effort Survey on the stock assessment

IV. Stock status updates

V. Projected landings for 2021 to 2025

I. Life history, stock structure, and assessment model assumptions



Life history overview

King Mackerel, *Scomberomorus cavalla*

- Large coastal-pelagic carnivore
- Females grow faster and to larger sizes than males, a fully grown female averages 4-ft
- Mature early in life, age-2
- Multiple stocks - Gulf and Mexico and South Atlantic
  - Migrations occur spring and fall
  - Stocks mix in S. Florida during winter months
  - Spawn during late-spring to summer in the Atlantic and Gulf of Mexico
  - Mixing zone removals split between the stocks

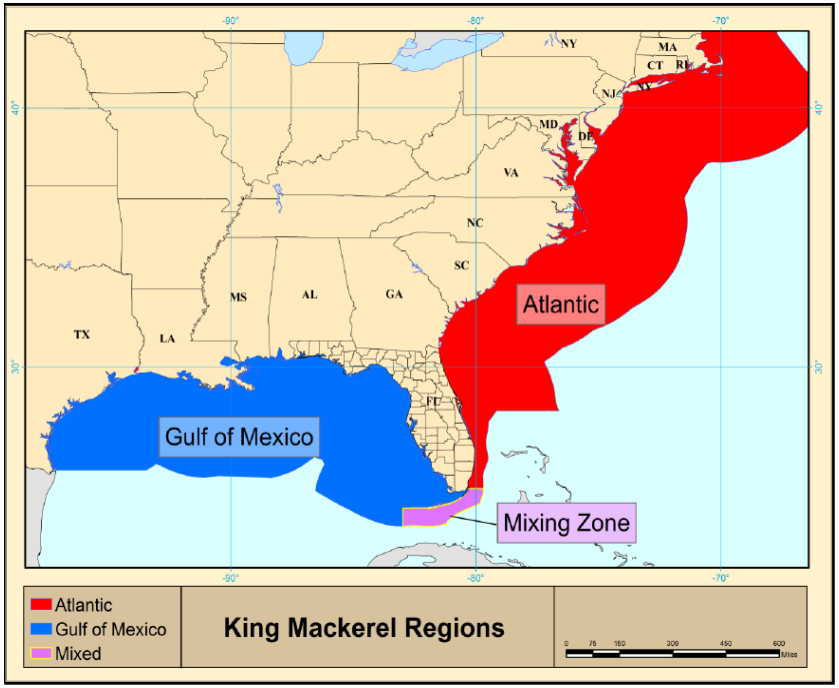


Image: SEDAR 38 SAR

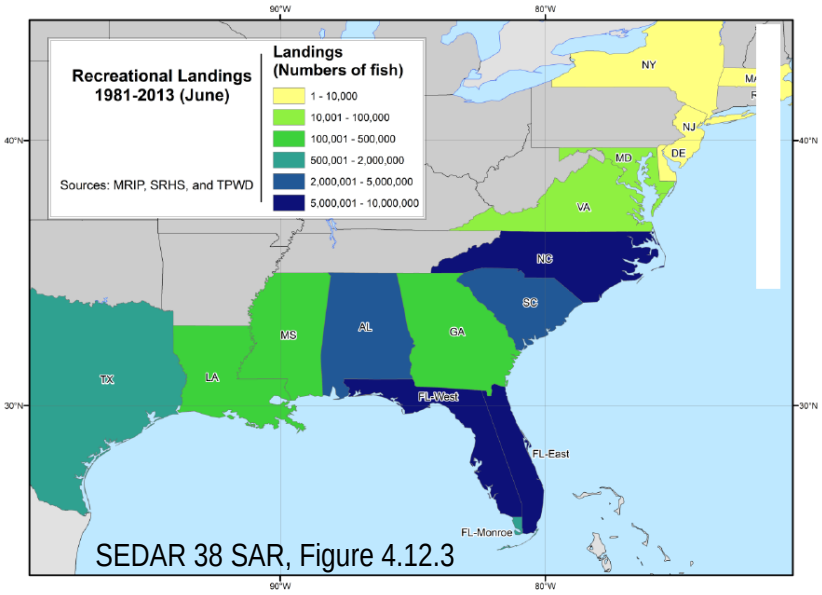
Commercial Fisheries (33% of landings)

- Handlines (97% Com landings)
  - Mostly caught by trolling
- Gillnets (3% Com landings)
  - Historically high landings
- Primarily smaller vessels
- Juveniles caught as bycatch in shrimp trawl
  - <1% of recent biomass removal are shrimp discards

Photo credits: Fishwatch.gov

Recreational Fisheries (67% of landings)

- Charters/Private Vessels
  - 94% of Recreational Landings
- Headboats
  - 1% of Recreational Landings
- Tournaments
  - 5% of Recreational Landings
  - Target the largest king mackerel
- Mostly rod and reel/other hook and line
- Approx 1% fleet recent biomass removals are dead discards
  - Minimum size and bag-limit releases

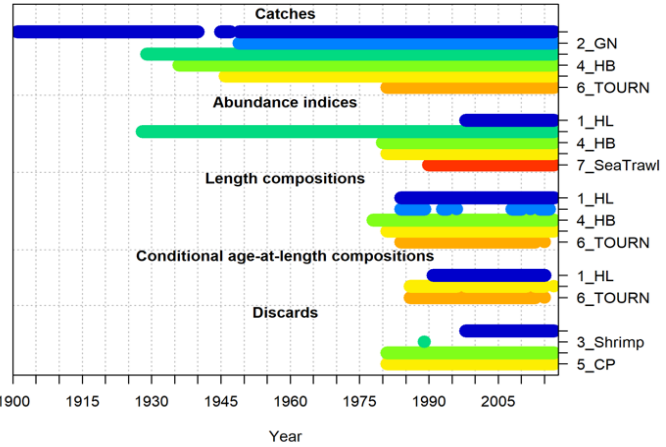


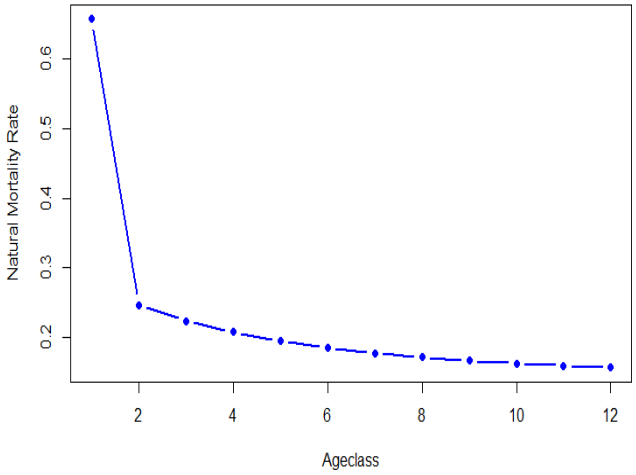
SEDAR 38 SAR, Figure 4.12.3


http://www.sportfishingmag.com/files/imagecache/enlarged_image/_images/201307/kingfish-boat-prep-01.jpg

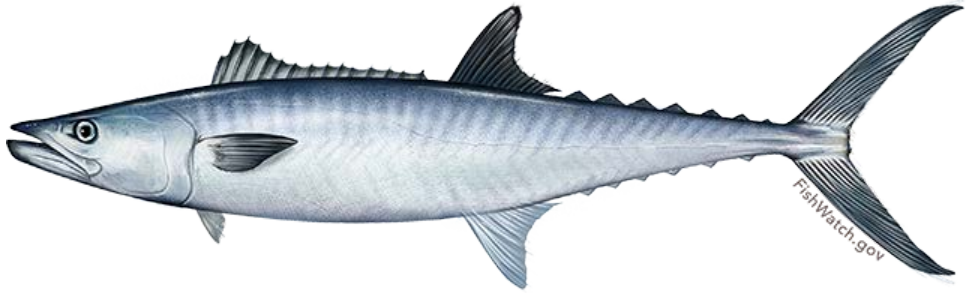
Stock Synthesis – SEDAR 38

- Data by Fishing Year (Mar 1-Feb 28)
- Gender-specific growth (von Bertalanffy)
- Fixed natural mortality (length-based Lorenzen)
- Beverton-Holt recruitment, steepness fixed at 0.99
- Start year = 1900 (unfished state), End year = 2017
- Fleet structure: Com HL, Com GN, Shrimp bycatch, Rec HB, Rec CP, Rec TRN
- Domed selectivity for all fleets except TRN (asymptotic)
- Indices of relative abundance: Com HL-trolling logbooks, Rec HB survey, SEAMAP trawl juvenile survey
- Shrimp bycatch effort driven
- Regulation-based (size limits) time blocks of retention-at-length
- Stock Benchmark: Spawning Potential Ratio = 30% Unfished Egg Production (SPR30)
- Fishing mortality target = Exploitation rate (by numerical abundance) that achieves SPR30 at equilibrium



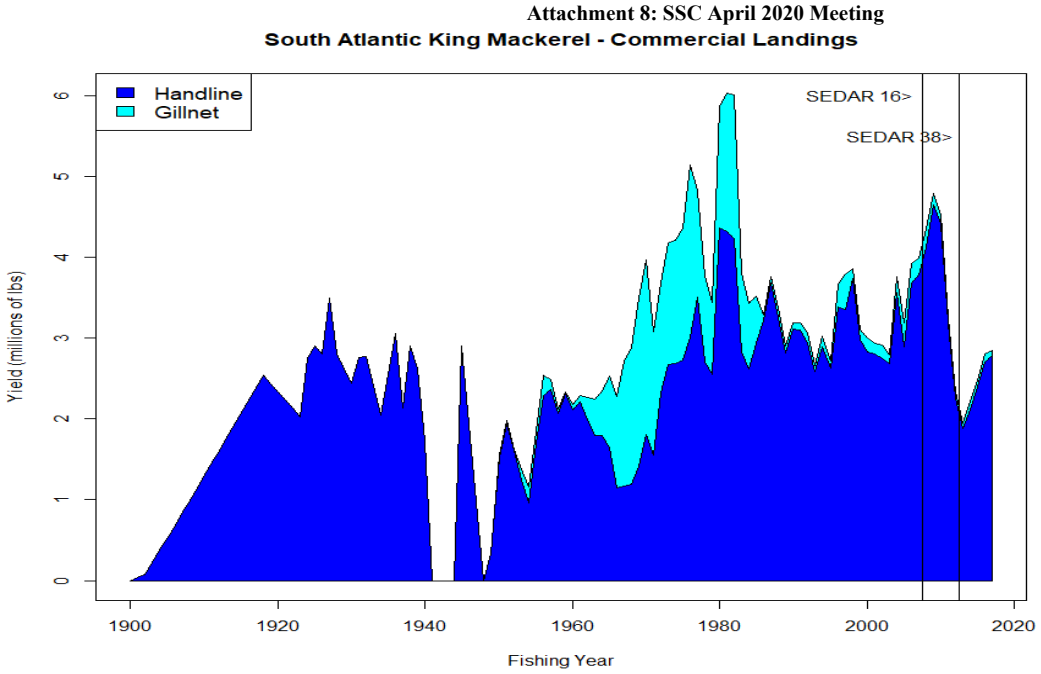


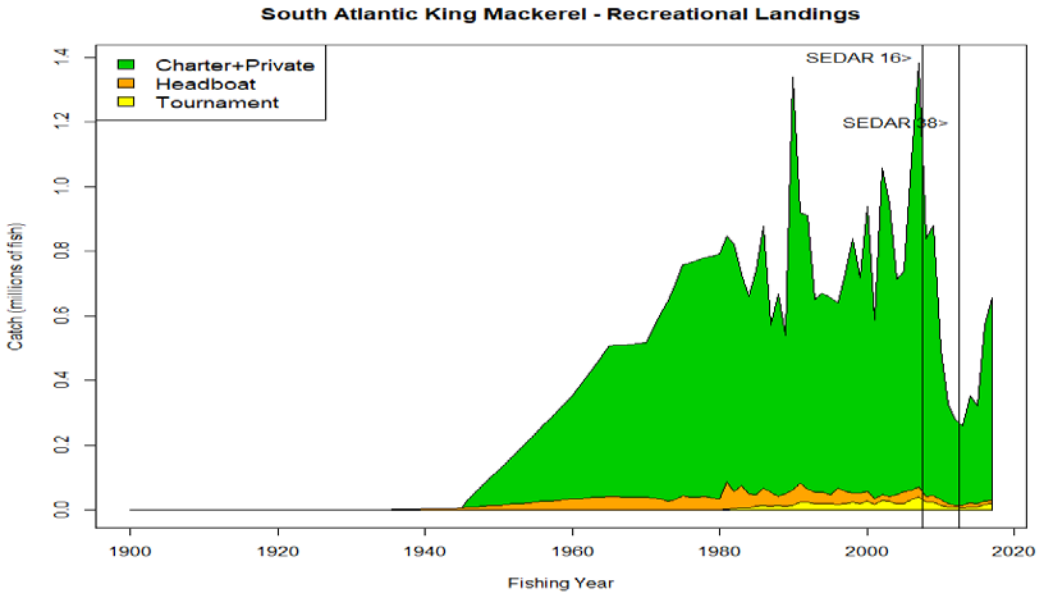
II. Data updates since SEDAR 38



Fisheries Landings

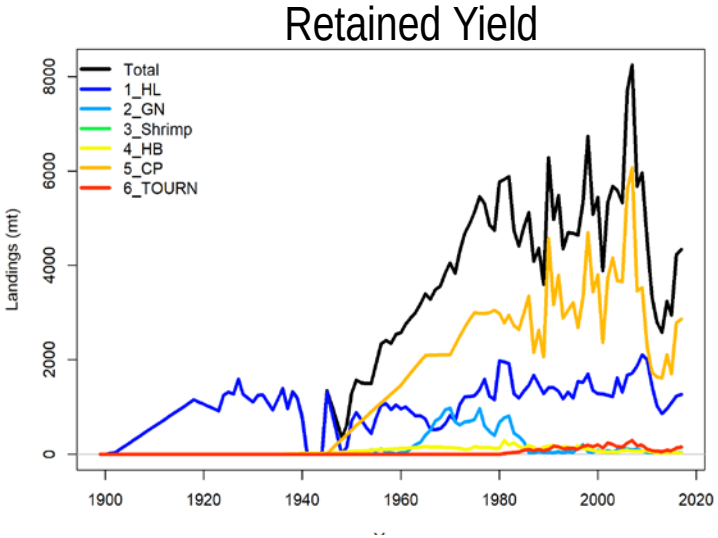
- SEDAR 38 observed steep decline in landings
- Lowest catches since fishery development period (1950s)
- Both commercial and recreational landings have increased since 2013

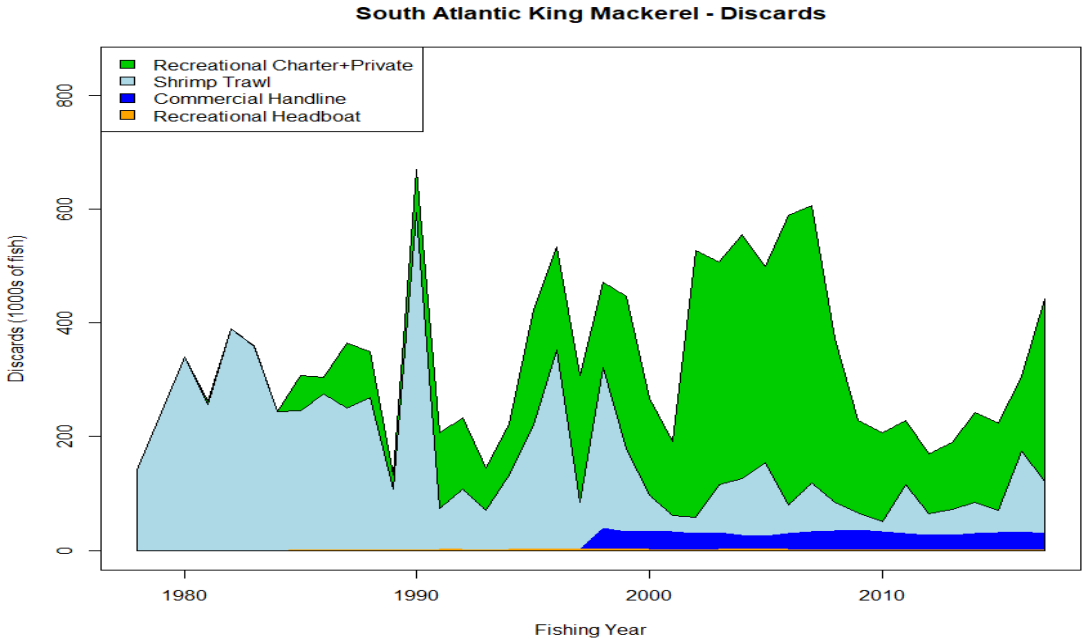


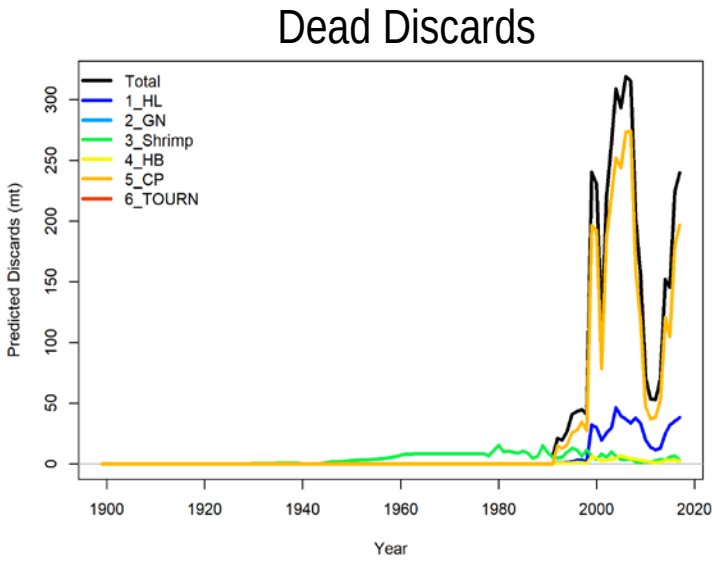


Fishery Discards

- Mostly juveniles discarded by the shrimp fishery in the early period
- More recently, recreational charter and private discards – size and bag limits
- Low dead discard:landing biomass ratio

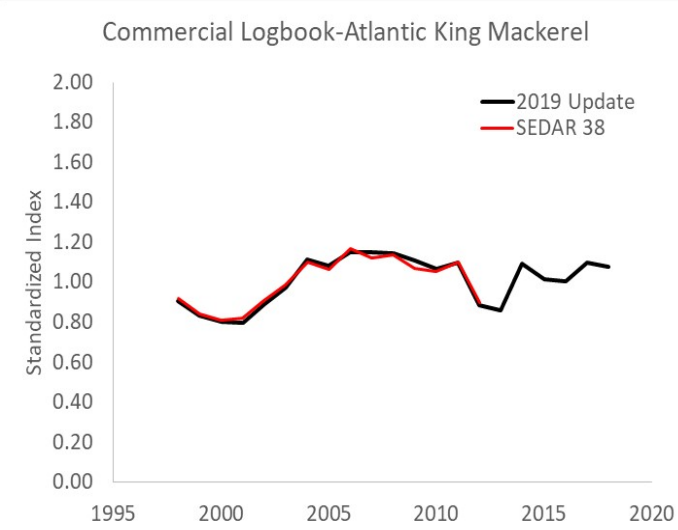


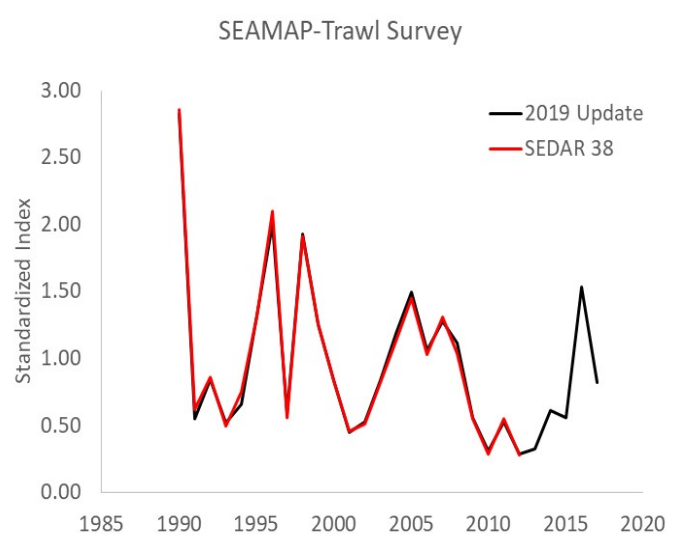


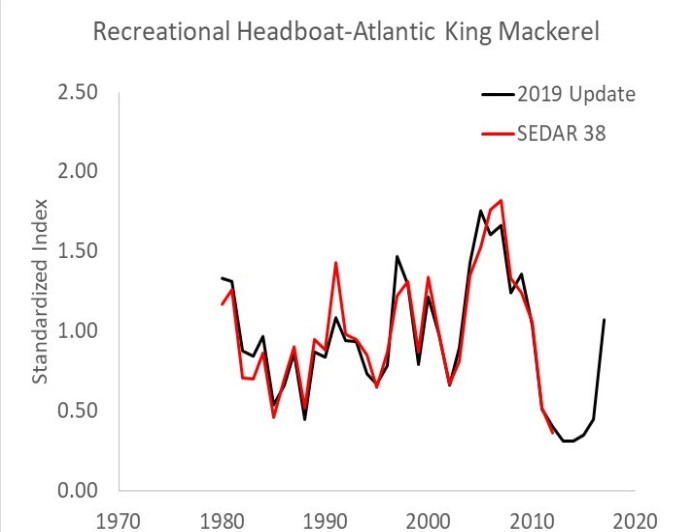


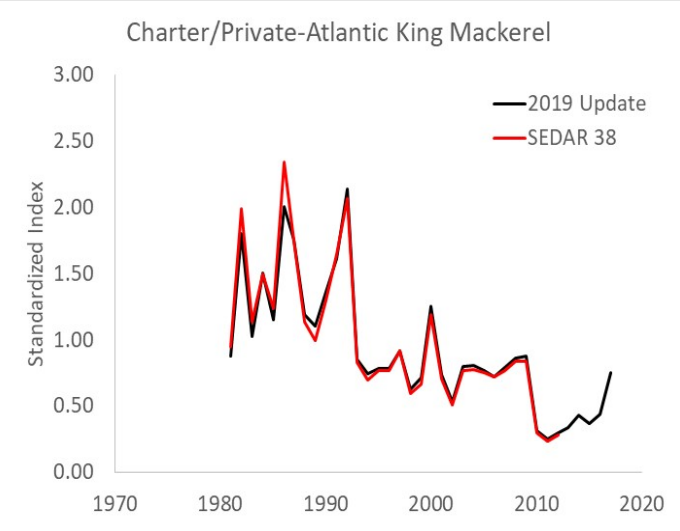
Indices of Relative Abundance

- SEDAR 38 methods replicated
- All indices showed positive trend since SEDAR 38
- Observed recent peak in the recruitment index in 2016 (SEAMAP survey)
- Sharp positive turn in headboat CPUE
- Charter/Private shown for comparison (not modeled in SS3)



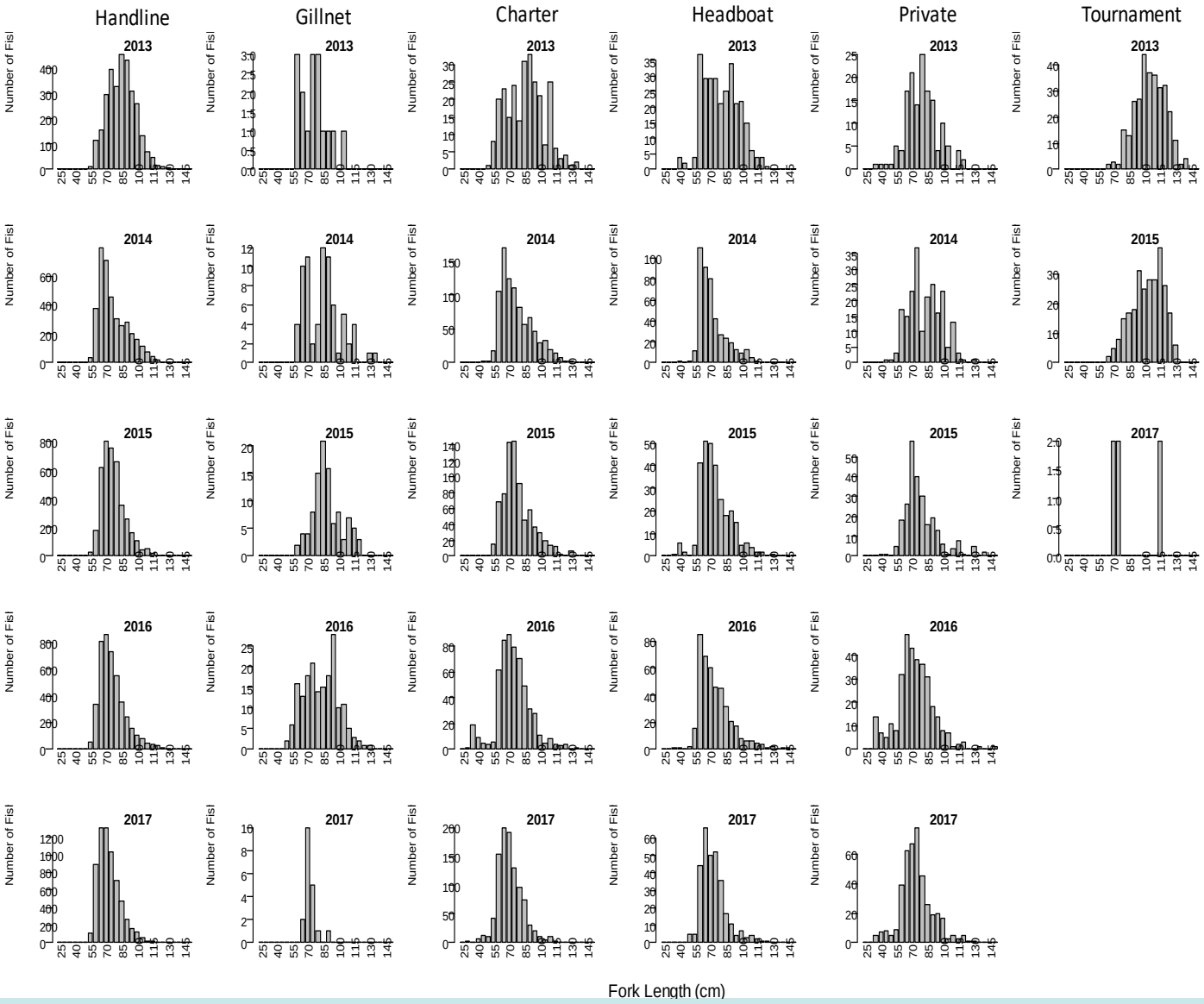






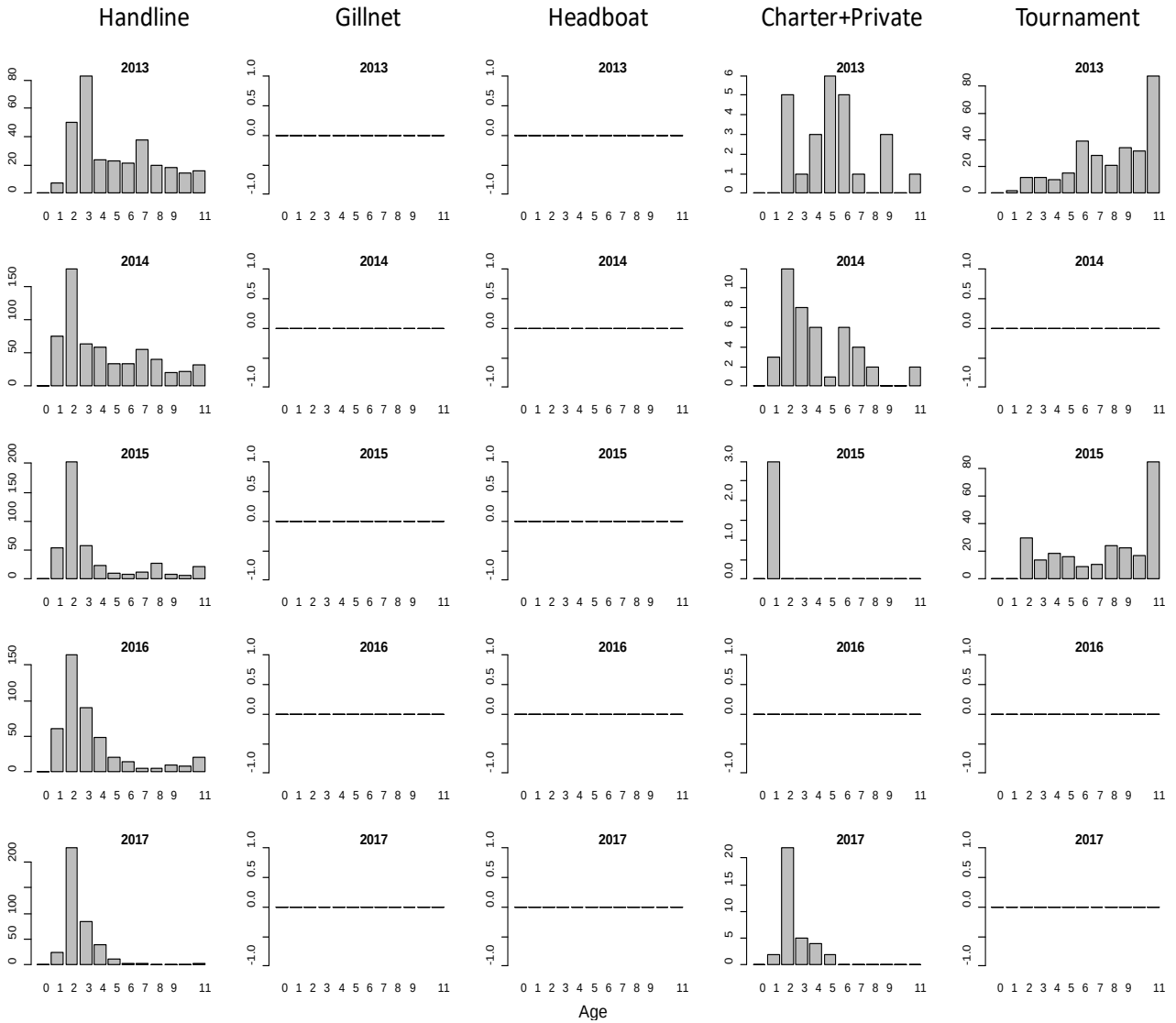
Fisheries Length Compositions

- Thousands of fish measured annually
- Primarily commercial handline caught
- All fleets observed for most years



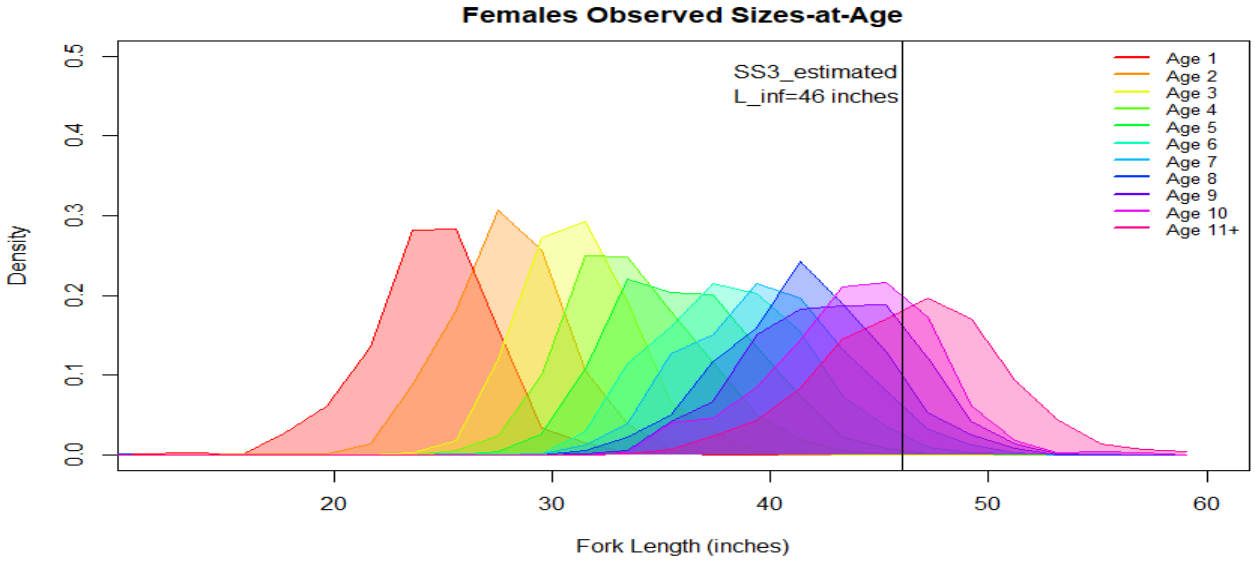
Aged catches

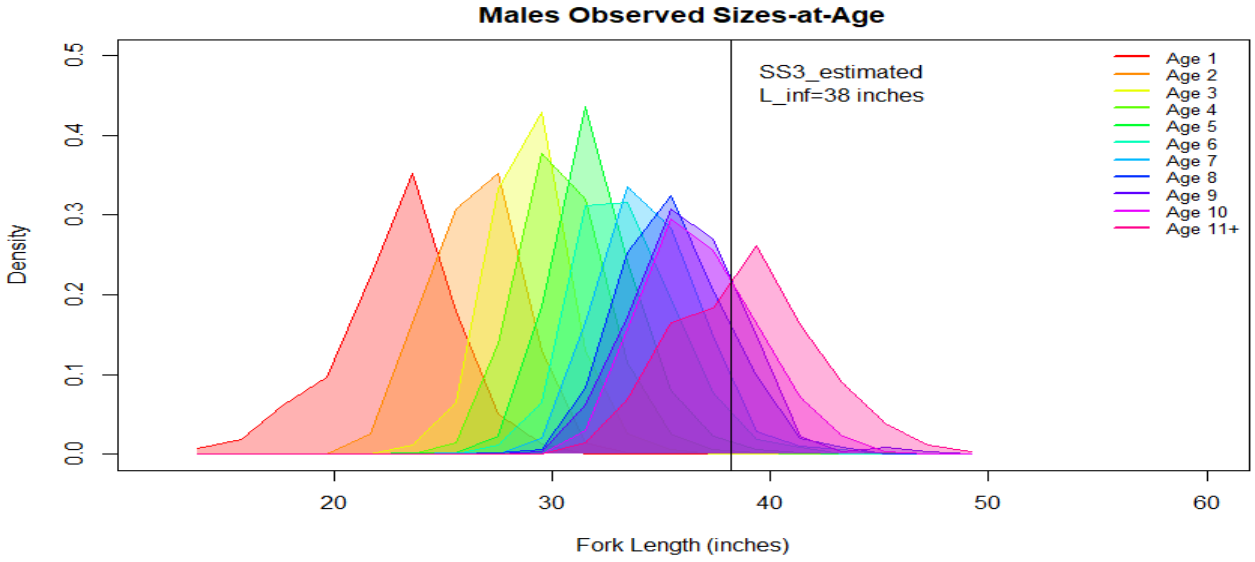
- A couple of hundred of fish measured in recent years
- Primarily commercial handline caught
- Notable truncation in handline ages in the recent years
- Hurricane Matthew effects?
- FISHMART provided age information for SEDAR 38



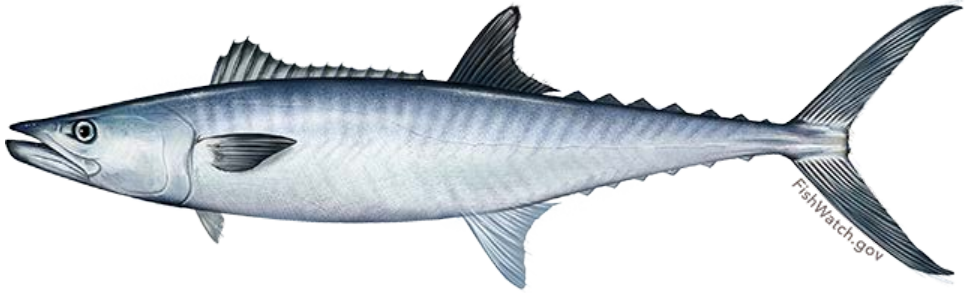
Observed Size-at-Age

- Clear growth difference between genders
- Approx. juvenile sizes:
  - Age 1: 24-inch
  - Age 2: 28-inch
- M-F sizes diverge fast at age 3 and older
- Ave. fully grown female = 46 inches
- Ave. fully grown male = 38 inches
- Fish > 4ft are older, larger females



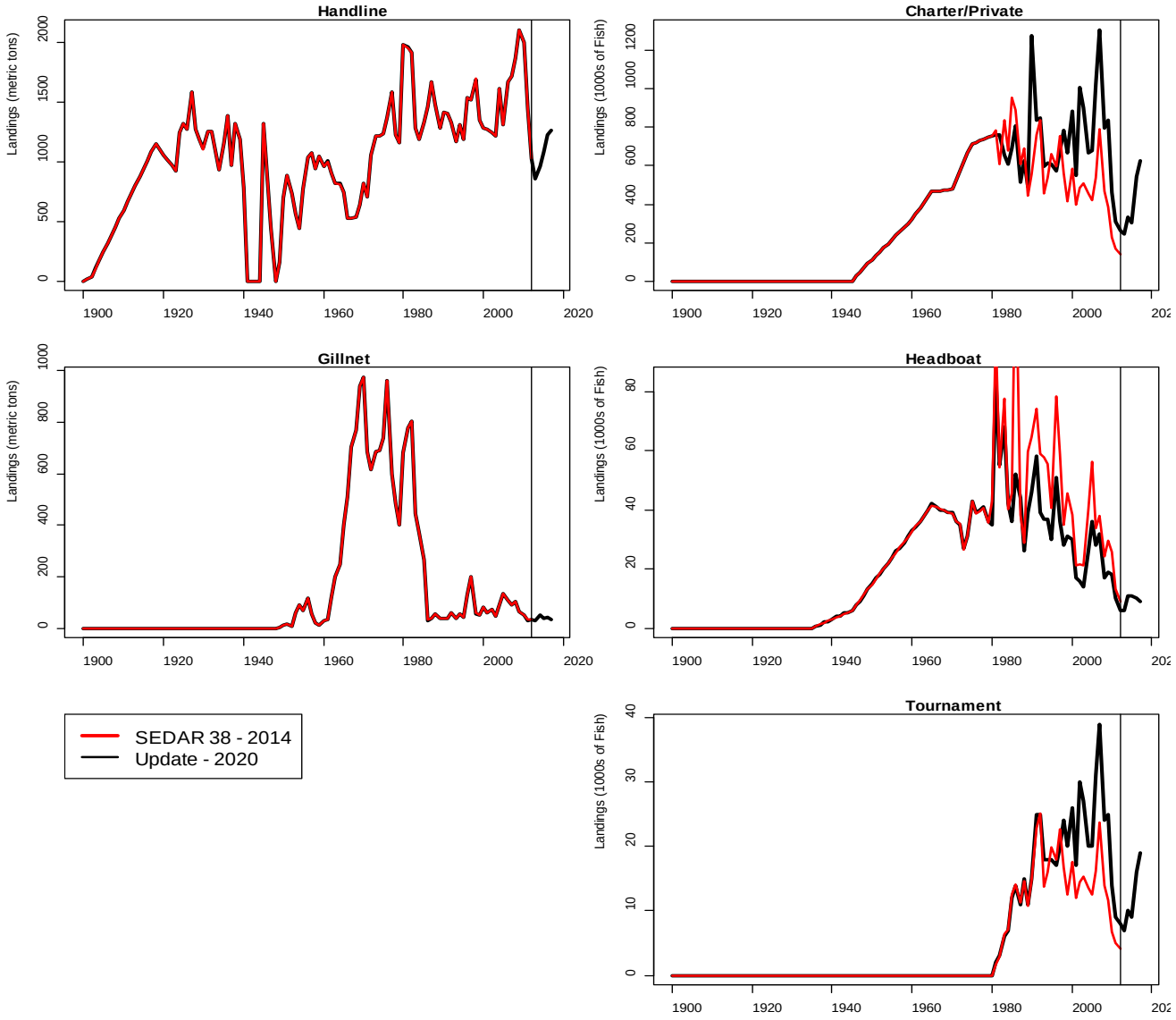


III. Effects of the Recreational Fishing Effort Survey (FES) on the stock assessment



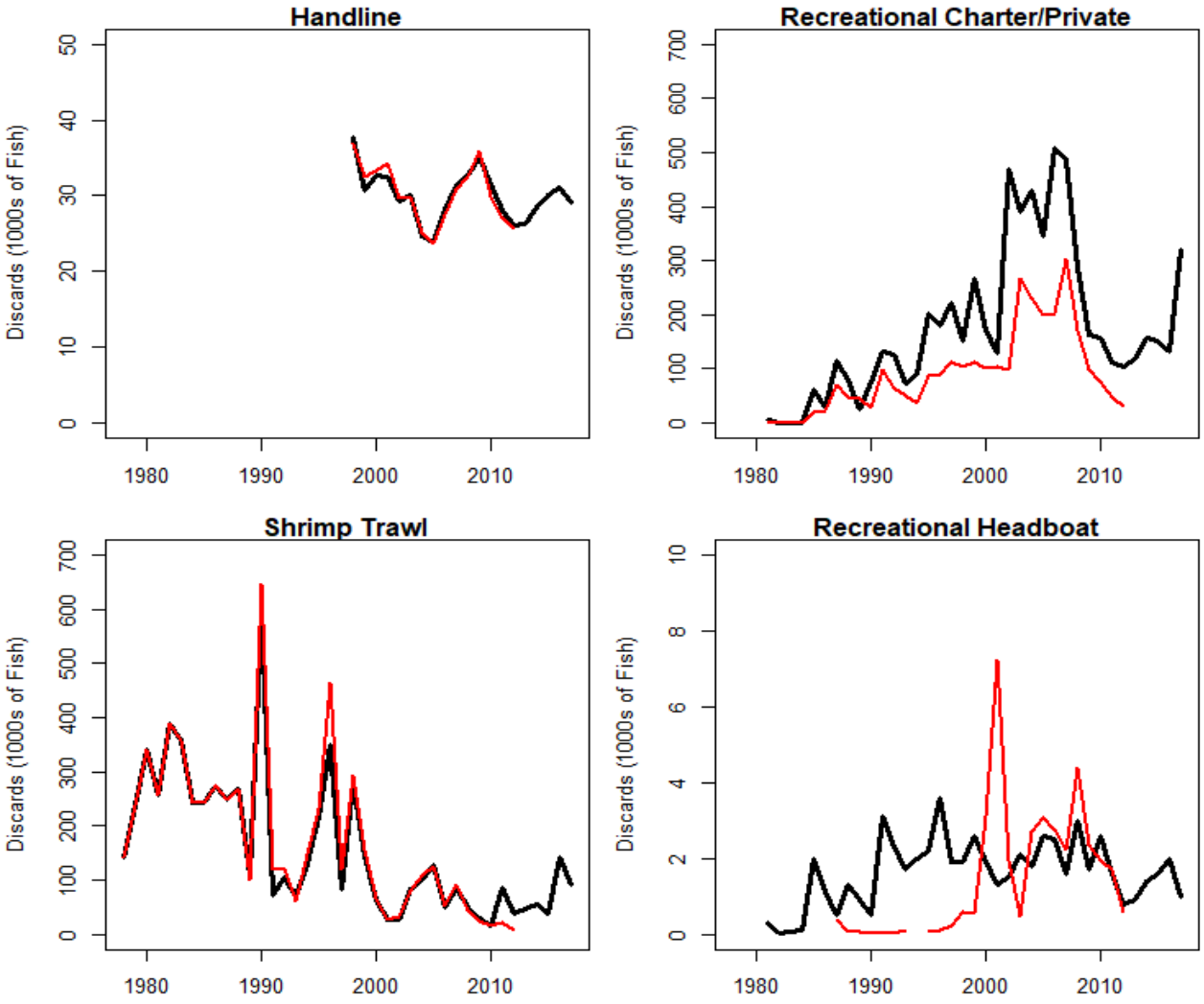
Effects of FES on Landings Estimates

- No effect on commercial estimates
- Increased recreational Charter/Private landings and discards (38% ave increase)
- Decreased Headboat dead discards
- Tournament approximated from the Charter/Private



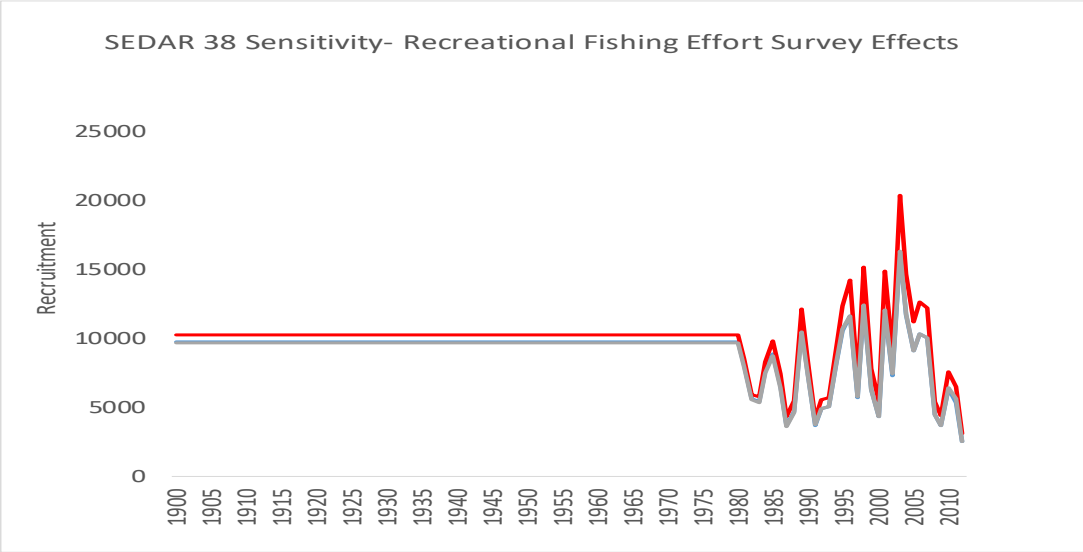
Effects of FES on Live Discard Estimates

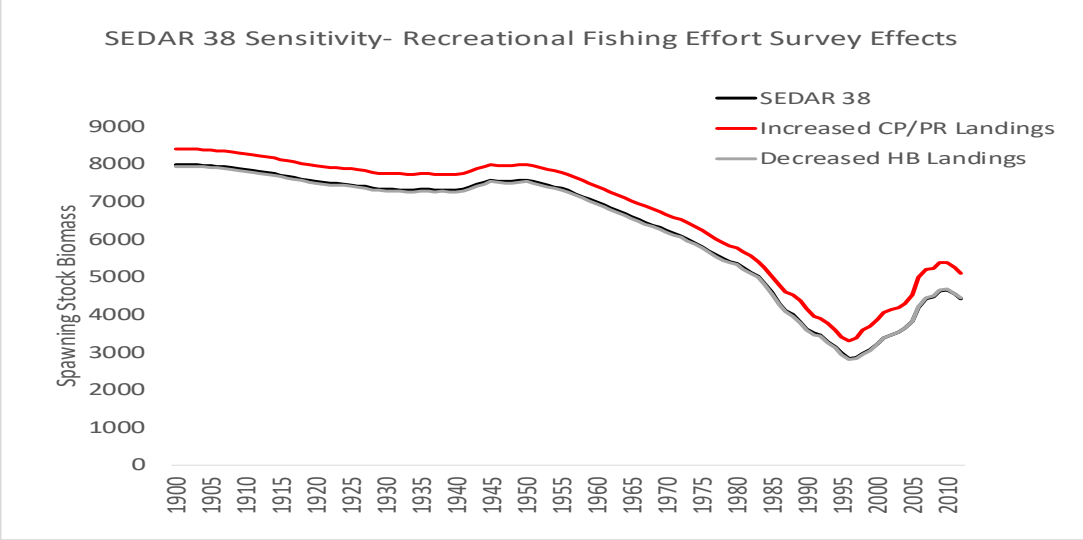
- No effect on commercial or bycatch estimates
- Increased recreational Charter/Private
- Headboat discards negligible



Effects of the FES on the Stock Assessment

- Higher recreational landings estimates resulted in increased recruitment and scaled up spawning biomass series accordingly
- Mean unfished recruitment 5% higher with new CP/PR landings, 0.5% lower with new HB discards
- SSB benchmark scaled by the same percentages
- Target F_{SPR30} did not change substantially

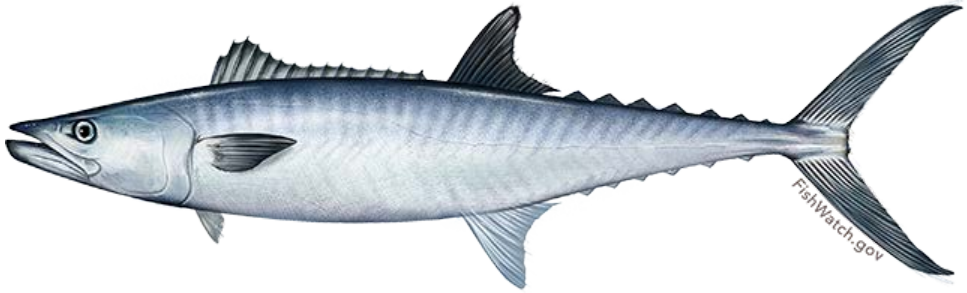




Effects of the FES on Stock Benchmarks

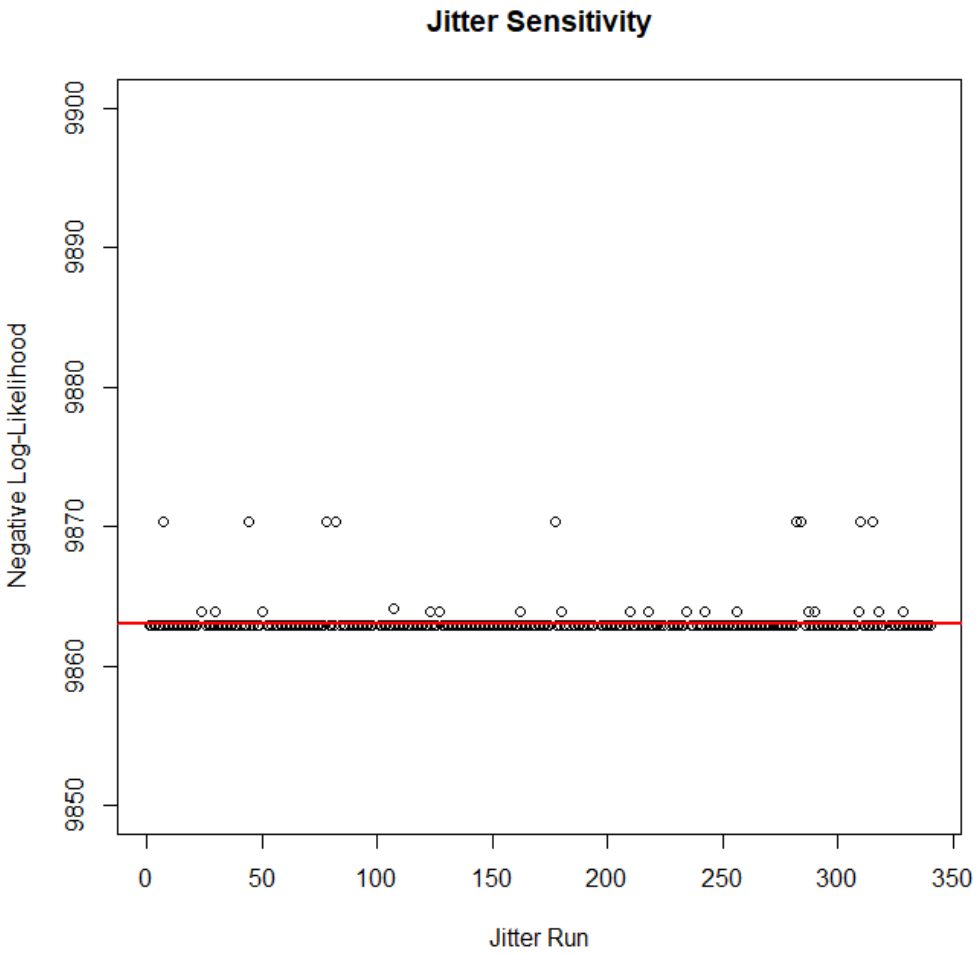
	SEDAR 38	Increased CP/PR Landings	Decreased HB Landings
Spawning Biomass Unfished	7973	8389	7929
Total Biomass Unfished	134213	141173	133479
Recruitment Unfished	9719	10239	9671
SPR target	0.30	0.30	0.30
Spawning Biomass at SPR30	2378	2502	2365
F at SPR30	0.15	0.15	0.15
Total Yield at SPR30%	17.7 mil lbs	18.9 mil lbs	17.6 mil lbs

IV. Stock status updates



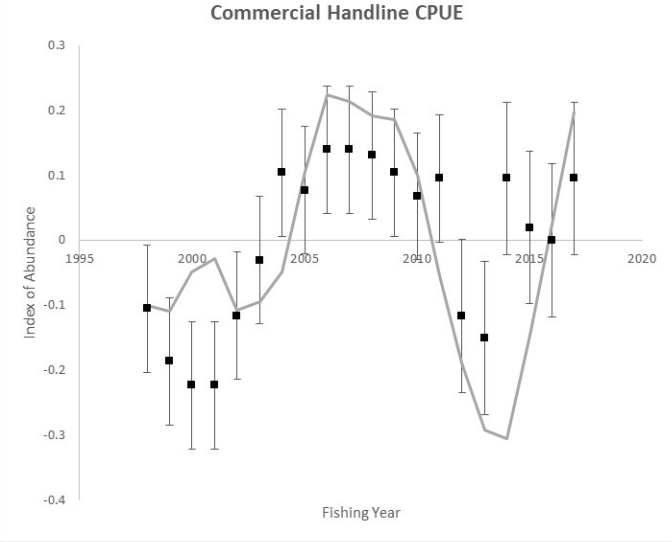
Model Convergence

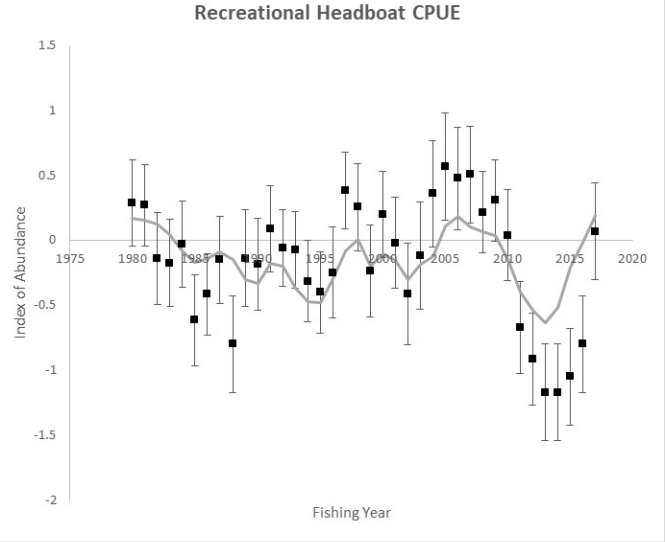
- Stable model solution found across jittered parameter iterations
- Good agreement with SEDAR 38 time series and benchmarks
- Hessian solved, parameter variance-covariances estimated
- Base model solution determined to be at maximum likelihood estimates (red line)

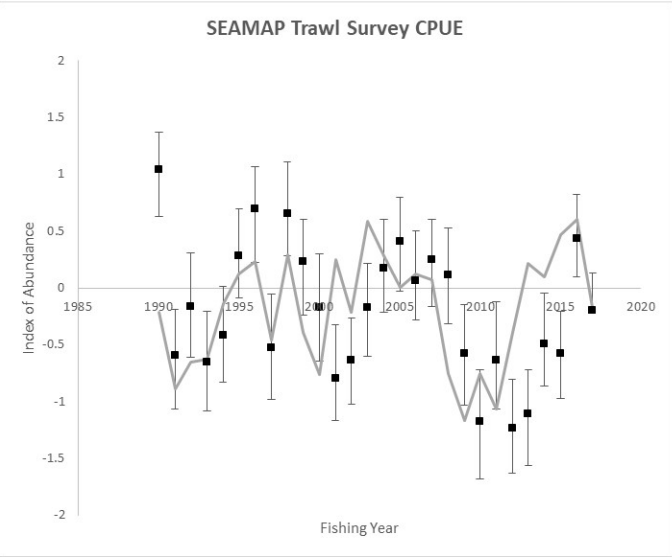


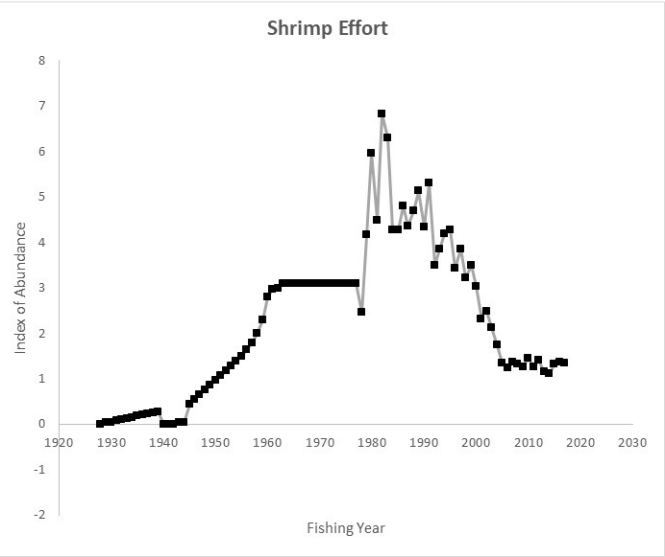
Fits to the Indices of Abundance

- SS3 modeled the index trends
- Missed the magnitude of change in some periods
- Shrimp series effort driven, perfect match to the series
- SEAMAP trawl showed some offset in the series, research recommendation on ages 0 vs 1 index

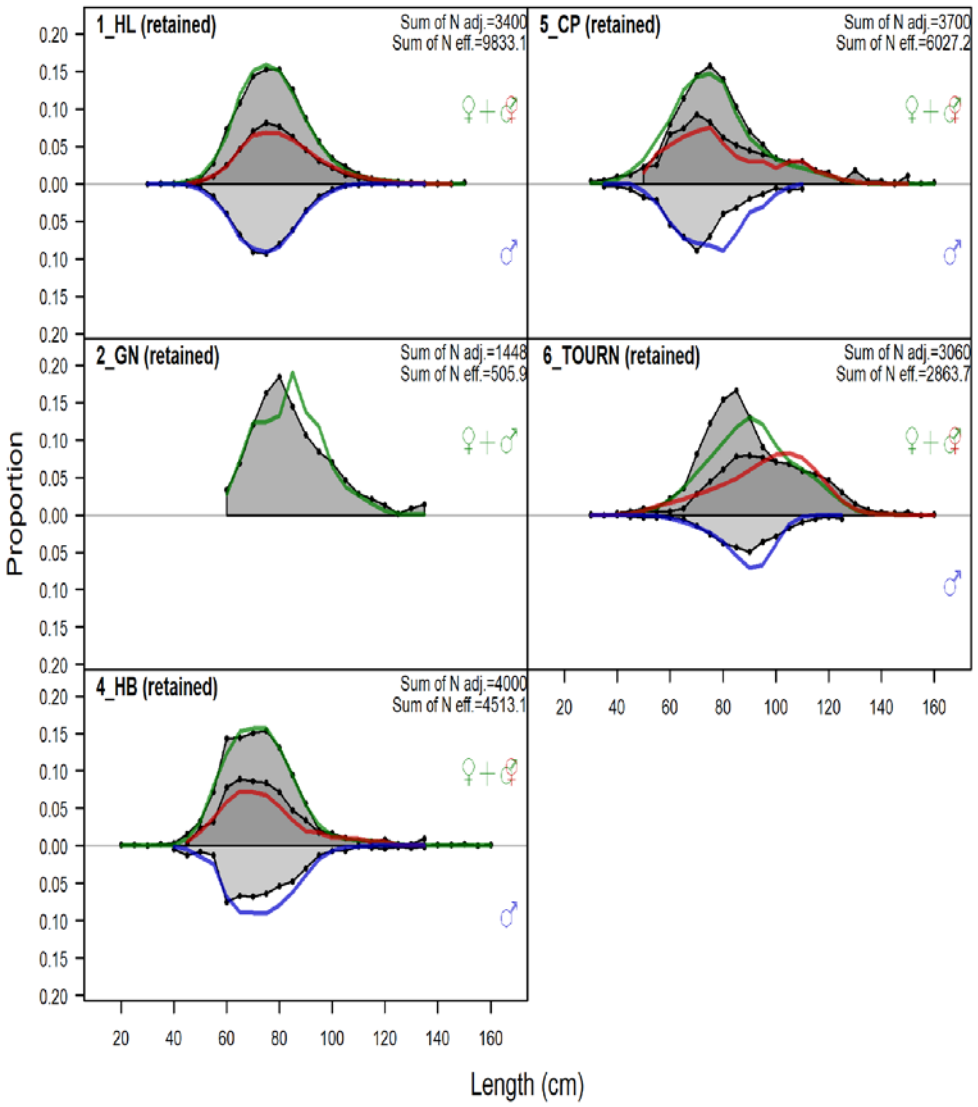


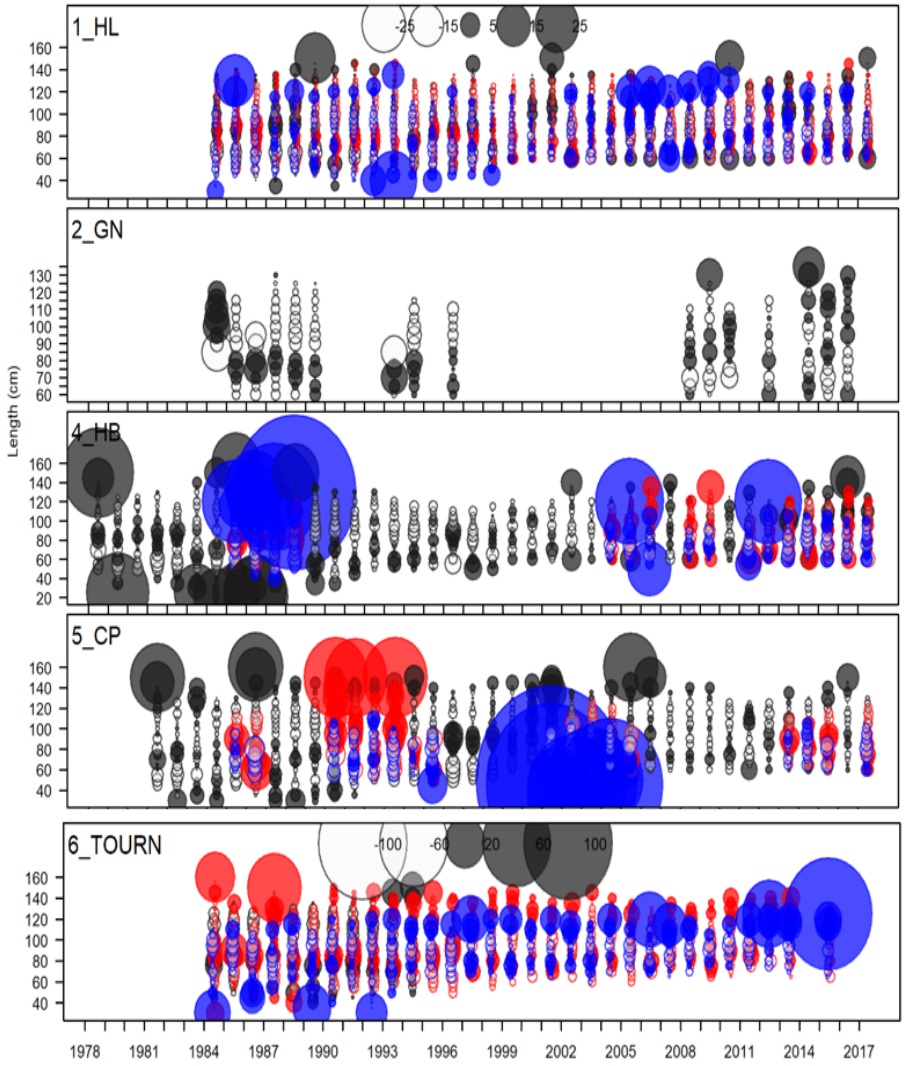






Fits to the Fleet Length Compositions

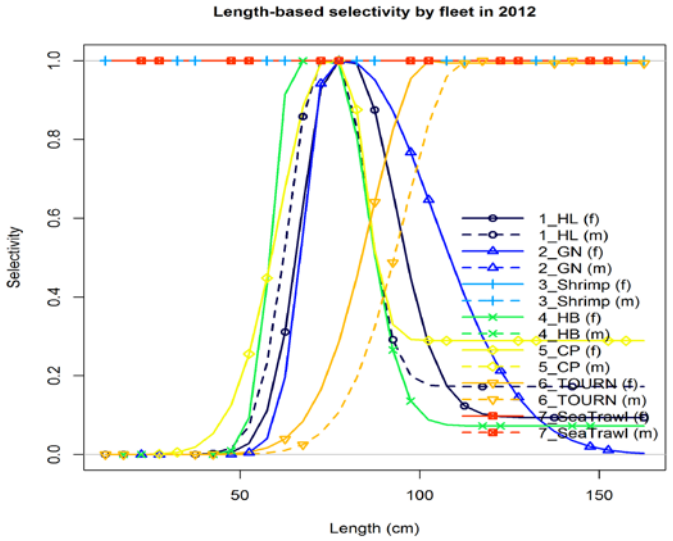


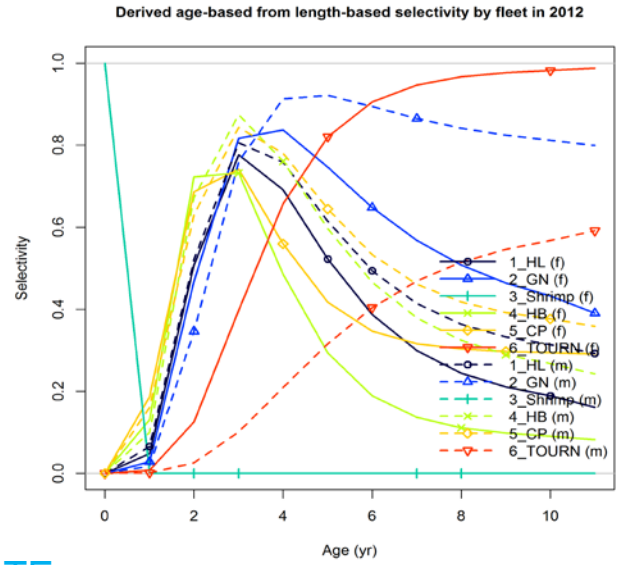


Fleet Selectivities

- Consistent selectivity estimates between SEDAR 38 and the Update
- Domed selectivities for commercial and recreational CP/PR+HB
- Fish enter the fisheries around 24-inches, age 2
- Tournaments get the largest/oldest fish, about 3ft and bigger, ages 5 and older

SEDAR 38





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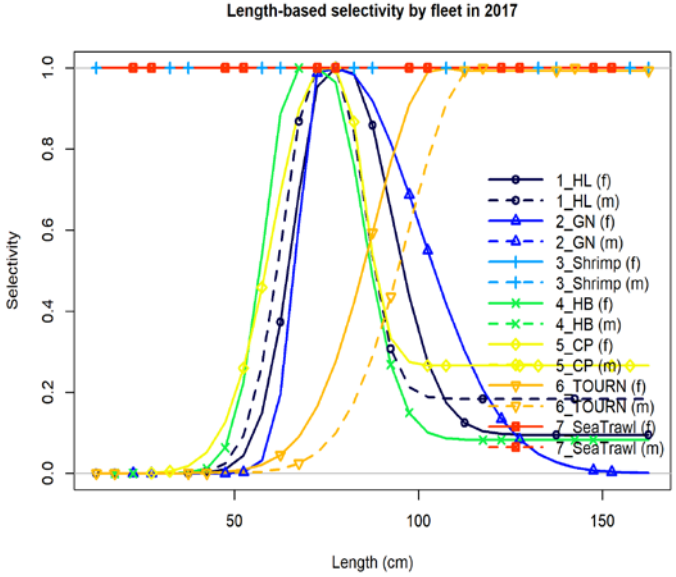
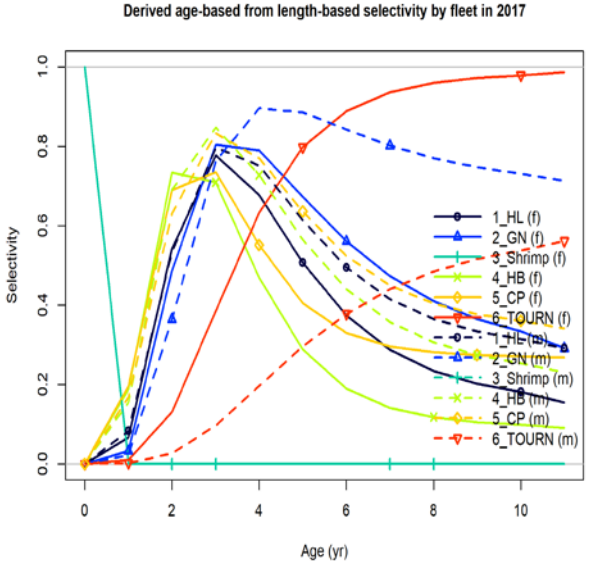
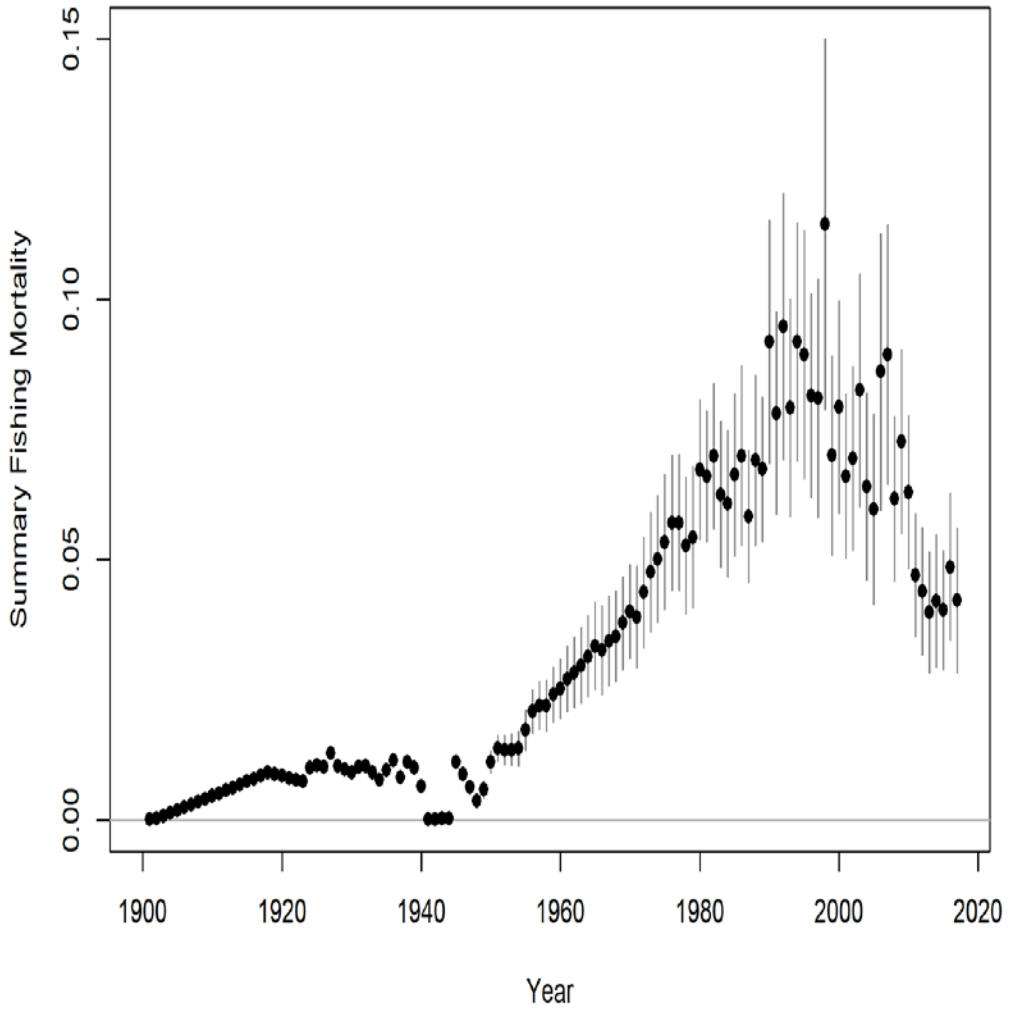




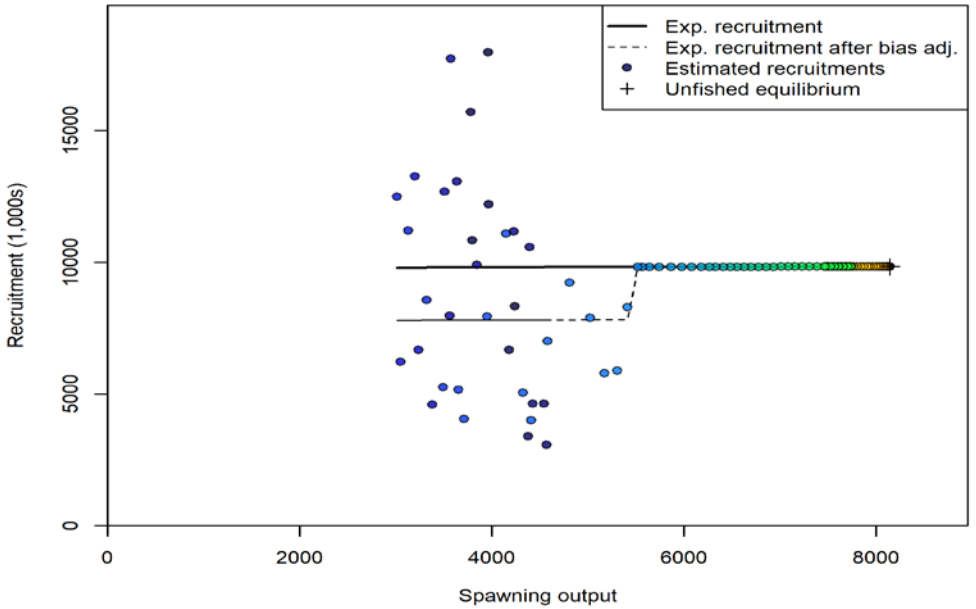
Fishing Mortality

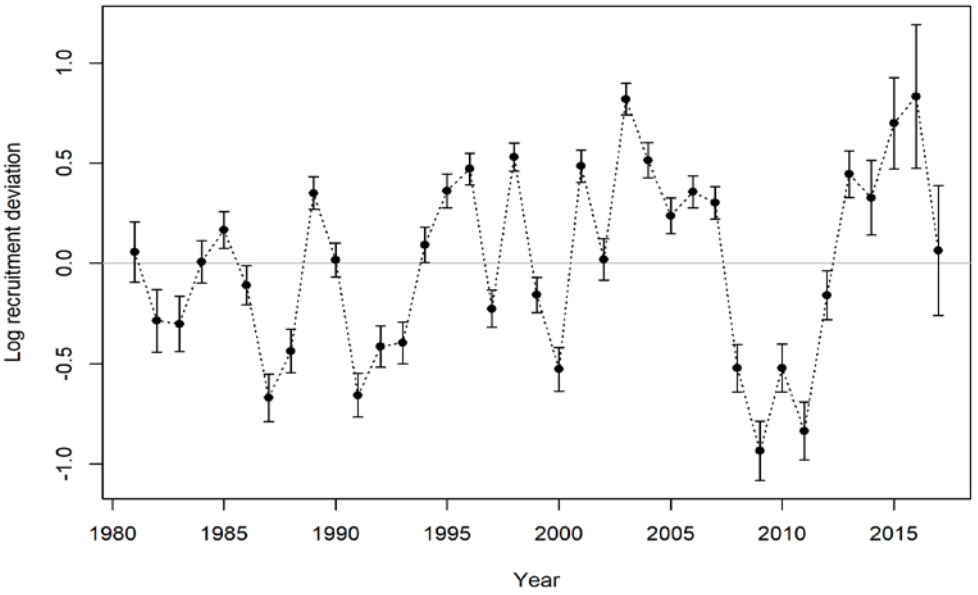
- Consistent F estimates and benchmark between SEDAR 38 and the Update
- F relatively constant since 2010 at 0.04-0.05/year
- Lowest exploitation of the stock since the 1970s.
- Well below target F_{SPR30}=0.14
- The fisheries are NOT OVERFISHING



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 = 9.8 million age-0 recruits/year
- Cyclical pattern in recruitment deviations detected
- Flip in recruitment trends from SEDAR 38, 5-years of below average to recent above average period (2013 to 2016)

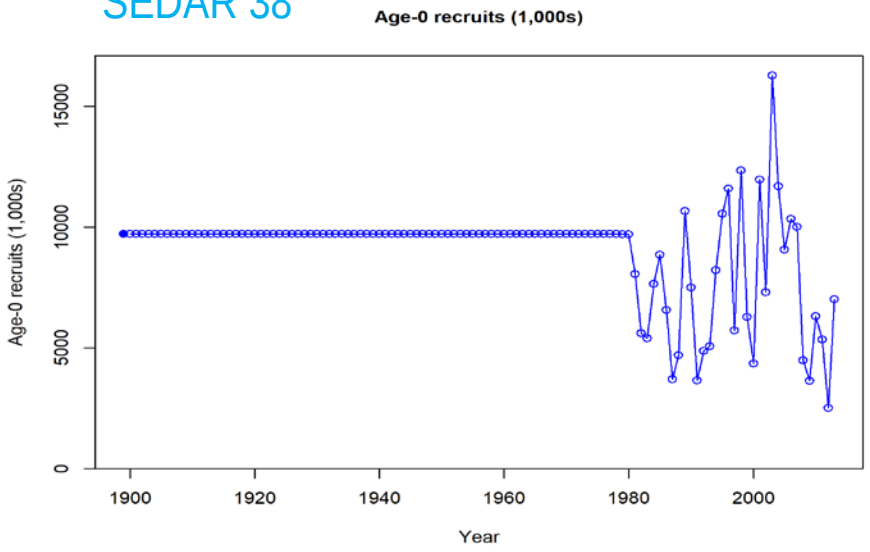




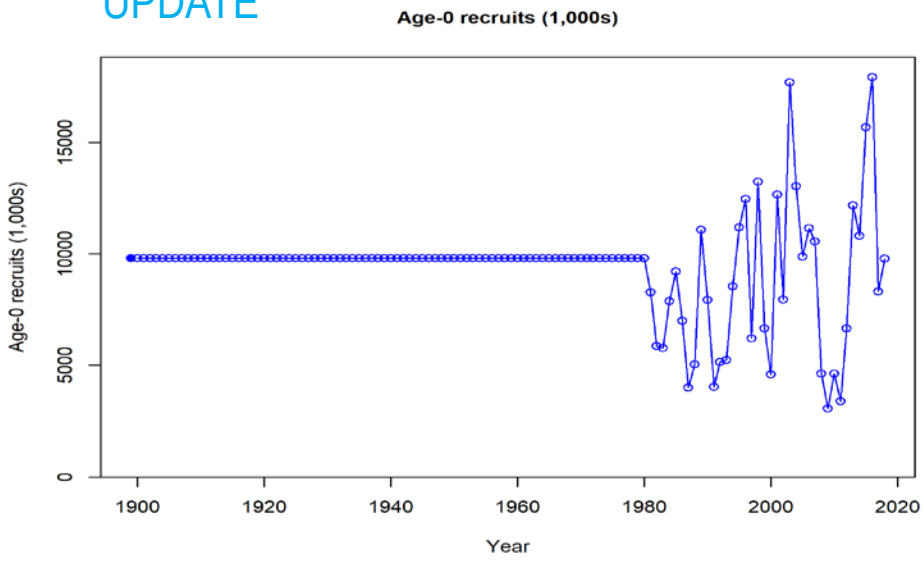
Estimated Recruitments

- Consistent recruitment scale and time series trends between SEDAR 38 and the update
- Recent (2015 and 2016) estimated recruitments some of the highest on record
- Stakeholder feedback during SEDAR 38 indicated high juvenile abundance compared to previous years
- SS3 showed a similar signal to the observations on the water

SEDAR 38



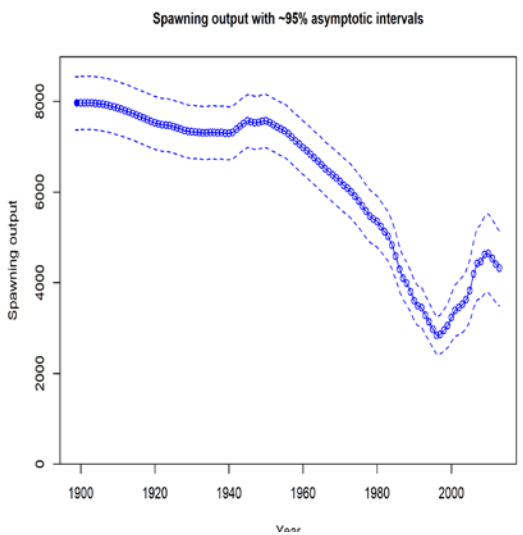
UPDATE

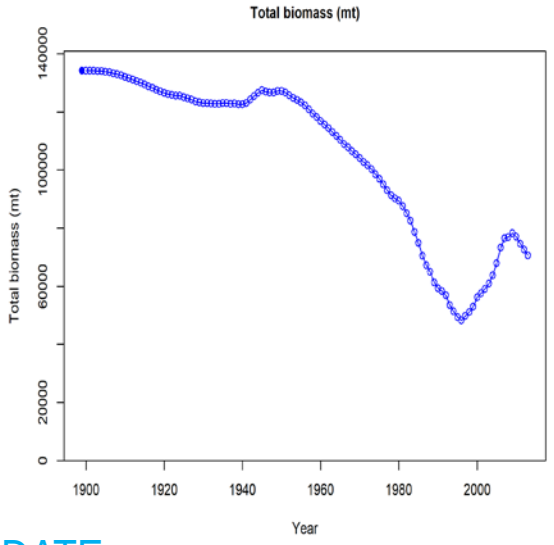


Stock Biomass

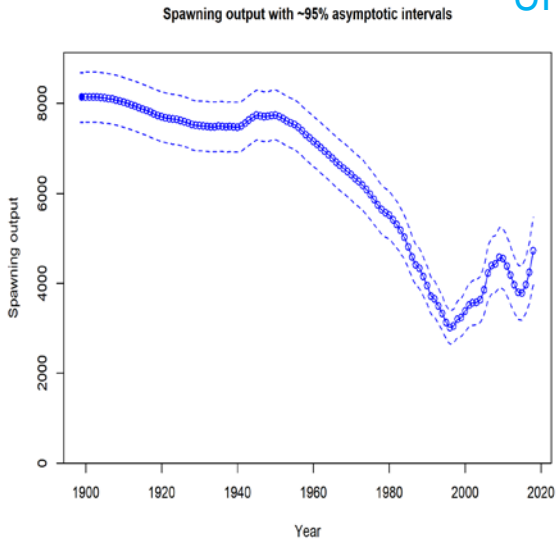
- Consistent biomass scale and time series trends between SEDAR 38 and the update
- Stock determined to be not overfished during SEDAR 38
- Total and spawning biomass increased steadily since 2013
- Spawning biomass is 1.7 times the SPR30% target
- The stock is NOT OVERFISHED

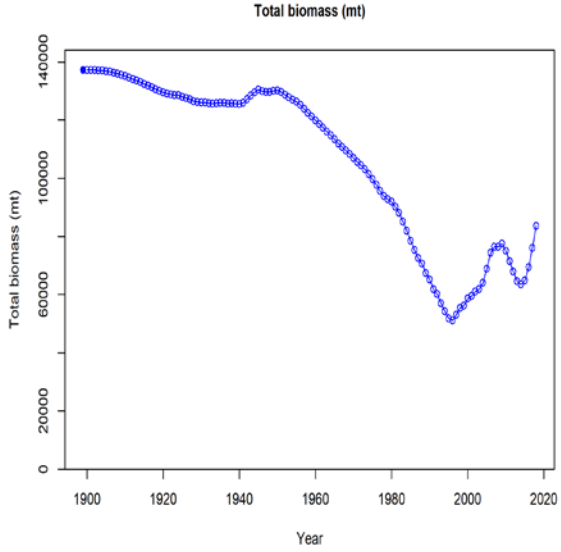
SEDAR 38





UPDATE



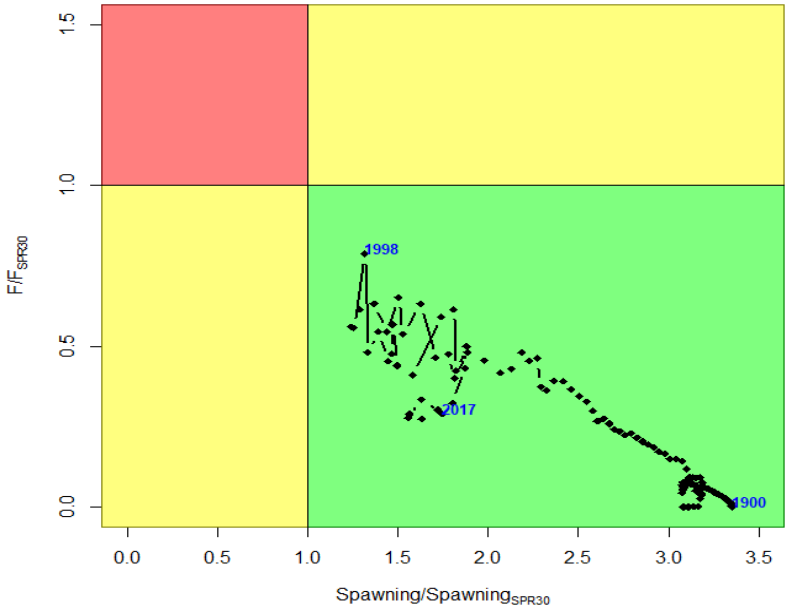


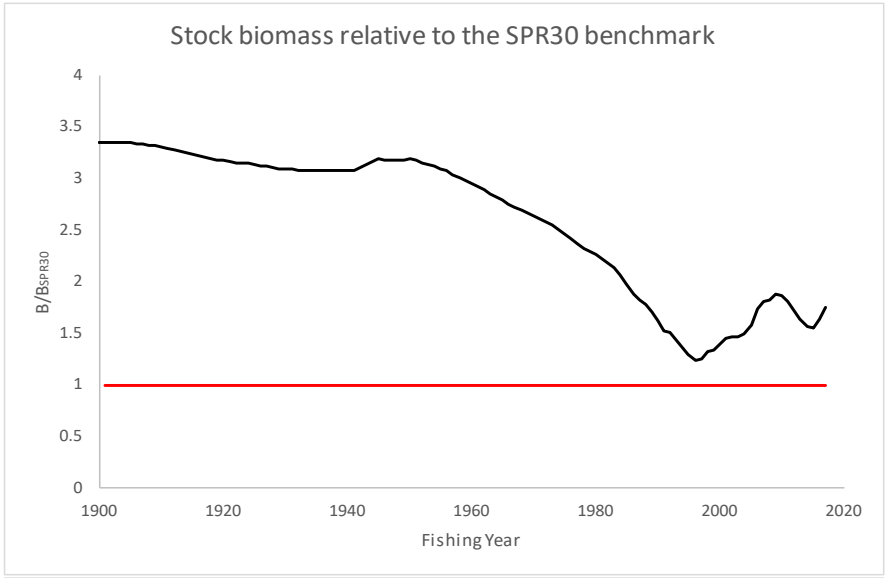
Stock Status Overview

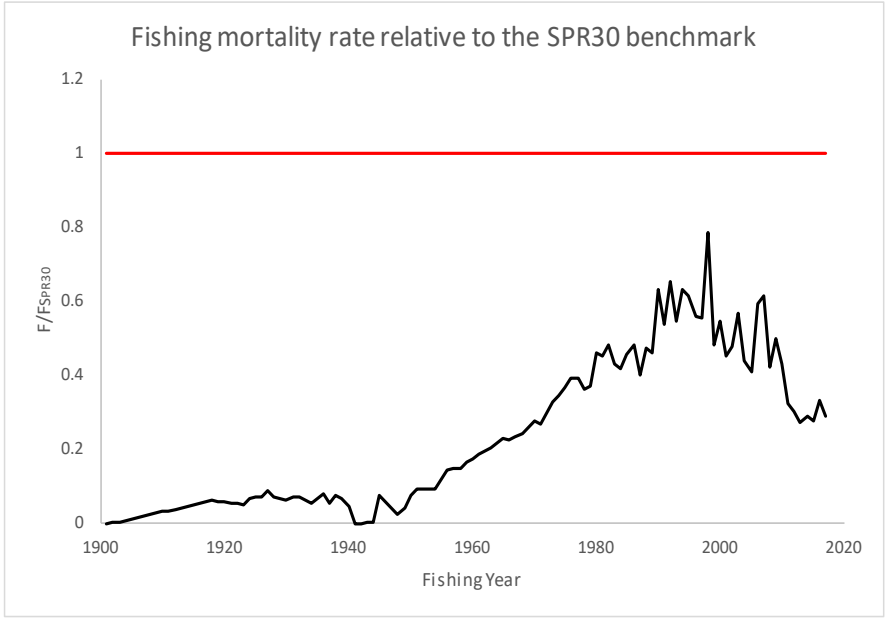
Metric	Value/Determination
$Fishing\ mortality_{2017}$	0.04
$Fishing\ mortality_{SPR30}$	0.14
F_{2017}/F_{SPR30}	0.29 (0.19-0.39)
$Recruitment_{Unfished}$	9,815,000
$Spawning\ Stock\ Biomass_{Unfished}$	8,130
$Spawning\ Stock\ Biomass_{SPR\ target}$	2,439
$Spawning\ Stock\ Biomass_{2017}$	4,232
SSB_{2017}/SSB_{SPR30}	1.7 (1.6-1.8)
$Yield_{\ 2017}$	9.5 million lbs
$Yield_{\ SPR\ target}$	18.3 million lbs
$Optimum\ Yield_{SPR\ target}$	16.7 million lbs
Stock Status	Not Overfished
Fishery Status	Not Overfishing

Stock Status Estimates

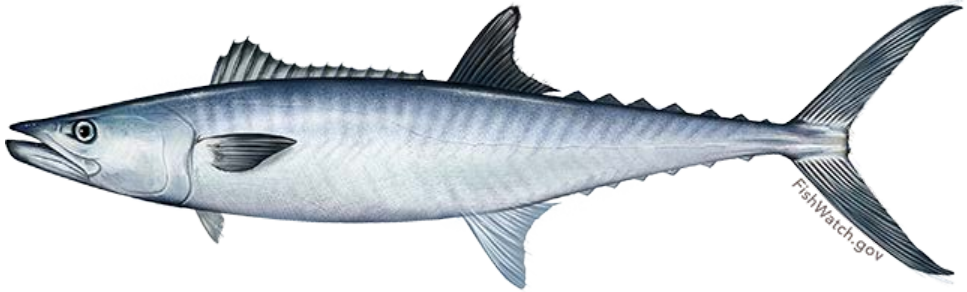
- SS3 indicates the stock was never fished to SPR30 target
- The highest exploitation occurred during 1998, the stock remained above SPR30
- Are these results consistent with the historic state of the fisheries?







V. Projected Landings for 2021 to 2025



Projection Specifications

1. Future recruitment equal to R0

2. Selectivity and relative F among fleets averaged over FYs 2016 and 2017.

3. Fishing Year 2018 to 2020 landings = 2017 Fishing Year estimates

4. Four Constant Exploitation Rate Scenarios:

   $F = 0$

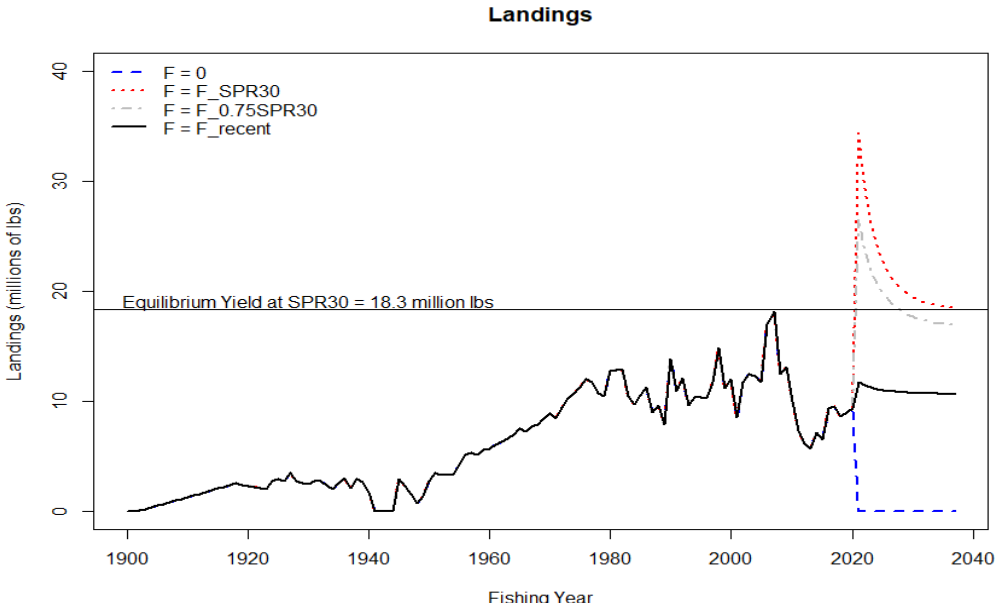
   $F_{current} = 0.05$

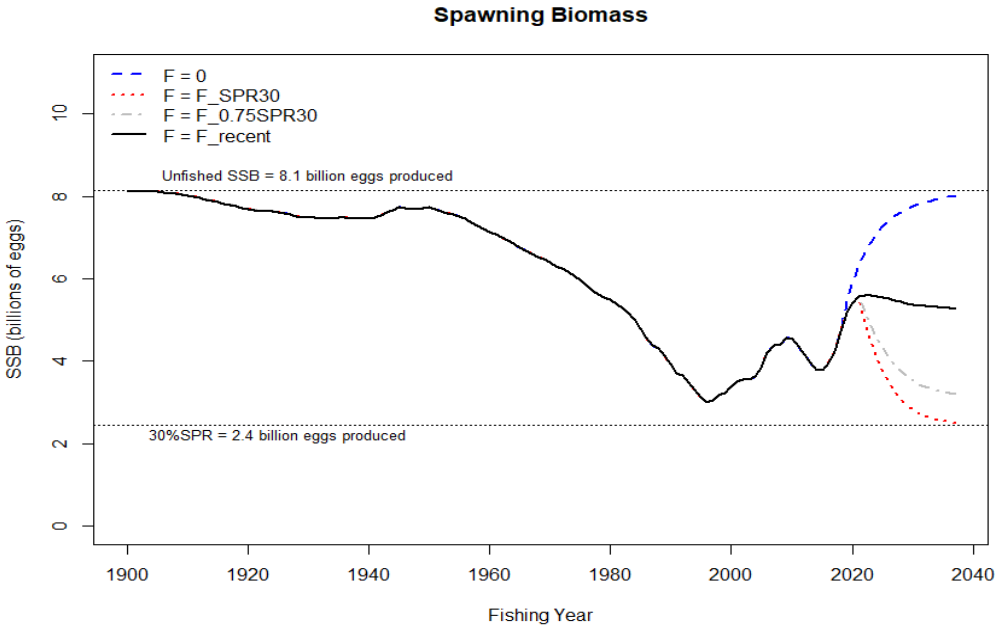
   $F=75\%F_{SPR30} = 0.11$

   $F_{SPR30} = 0.14$

Constant F Projections

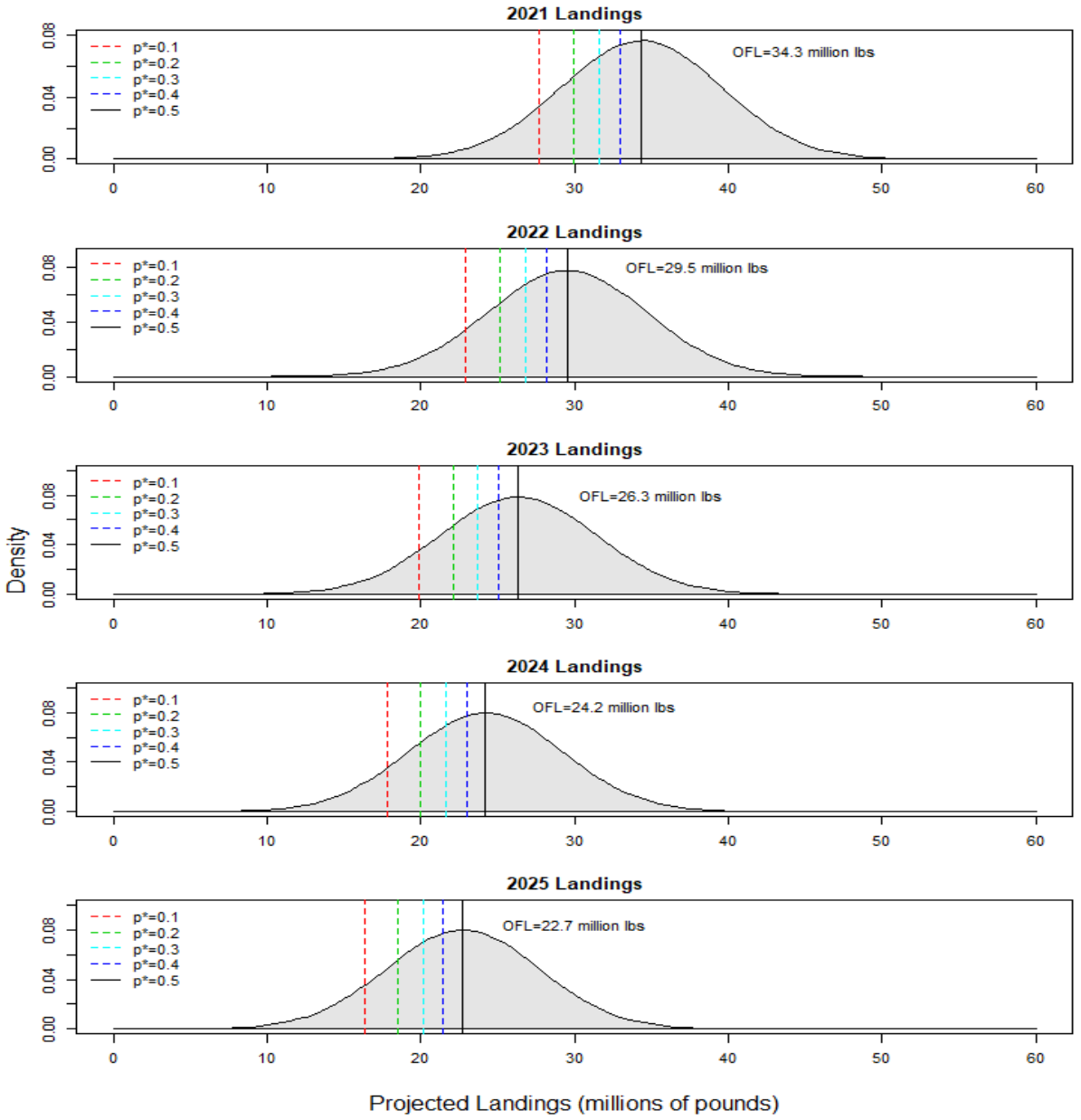
- Fishing at F_{SPR30} results in a sharp increase in projected landings, followed by gradual decline toward the equilibrium yield
- Fishing at $F_{current}$ results in relatively constant yield and biomass near current levels
- Fishing at 75%Ftarget also significantly increases landings, lower equilibrium yield, higher long-term SSB





Projections at Target F_{SPR30}

- Forecasted yields for the next five years much higher than current yields
- The large increase is a result of the recent high recruitment plus low current F compared to the target
- Catches decline each year as the strong cohorts move through the fisheries



Projected Yields

Fishing Year	p*=0.1	p*=0.2	p*=0.3	p*=0.4	OFL
2021	27.7	30.0	31.6	33.0	34.3
2022	22.9	25.2	26.8	28.2	29.5
2023	19.8	22.1	23.7	25.1	26.3
2024	17.8	20.0	21.6	22.9	24.2
2025	16.3	18.5	20.1	21.5	22.7

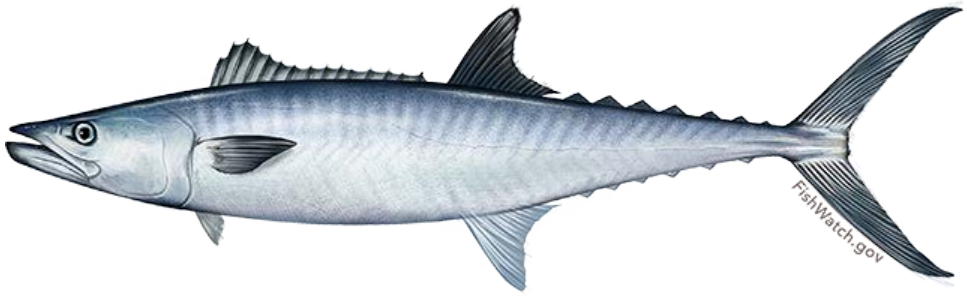
Summary and Conclusions

- South Atlantic King Mackerel are NOT OVERFISHED and the fisheries are NOT OVERFISHING
- Current exploitation rate much lower than the target F_{SPR30}
- SS3 (as configured) proved stable in long-term trend estimates, yet responsive to current data
- Recruitment cycled from 5-year low up to SEDAR 38 to 4-year high recently (2013-2016)
- The high-recent recruitment leads to a large increase in near-term catch projections
  - If fully exploited at the target F, landings in 2021 increase sharply followed by steady reduction toward 18.3 mil pounds

Acknowledgements

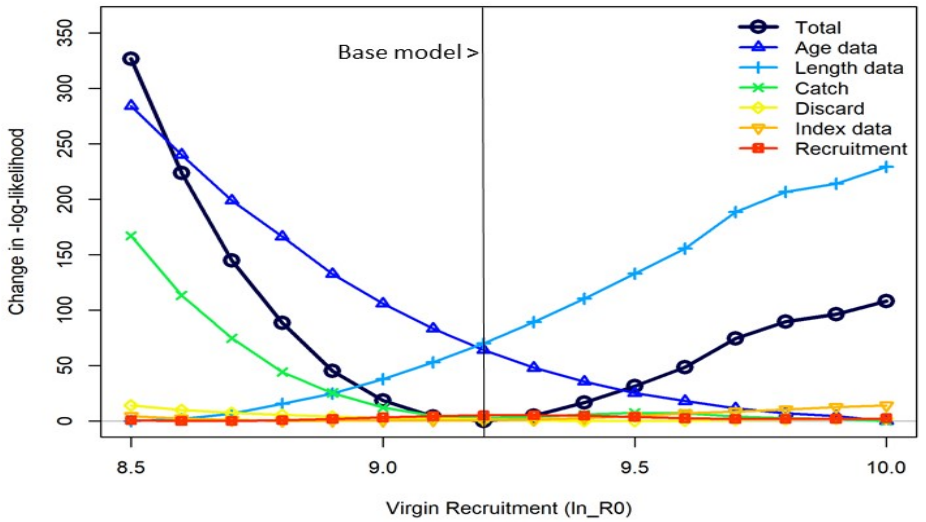
Many people at various state and federal agencies assisted with assembling the data sources included in this stock assessment. The FISHSMART project PIs (Tom Idhe, Tom Miller, David Secor and Mike Wilberg) provided substantial assistance and data for how to model the tournament fishery. Harvey Walsh, Jon Hare, Katrin Marancik and Dave Richardson provided NEFSC larval data. Chris Bonzek at VIMS provided NEAMAP trawl survey data. Ian Taylor has greatly improved the R code for plotting and diagnostics of Stock Synthesis models with which many of the figures in this document were created.

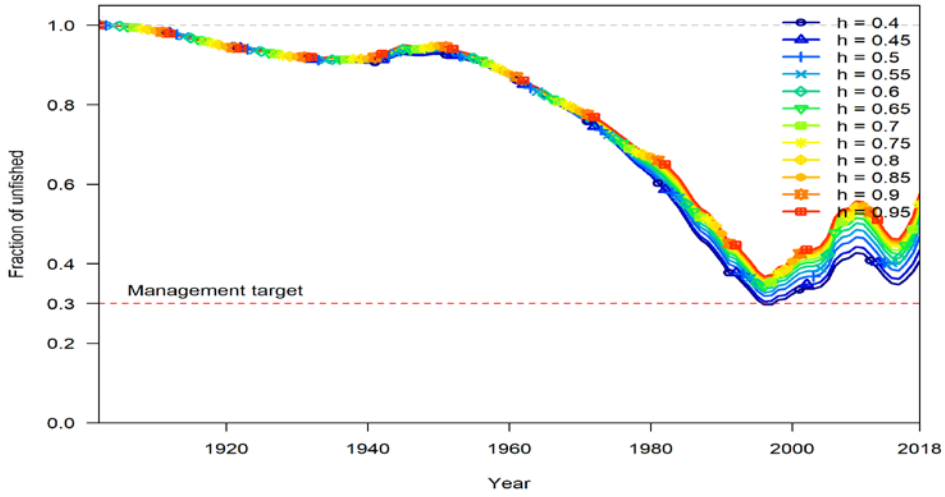
Supplemental Information



Profiles of Parameter Uncertainty

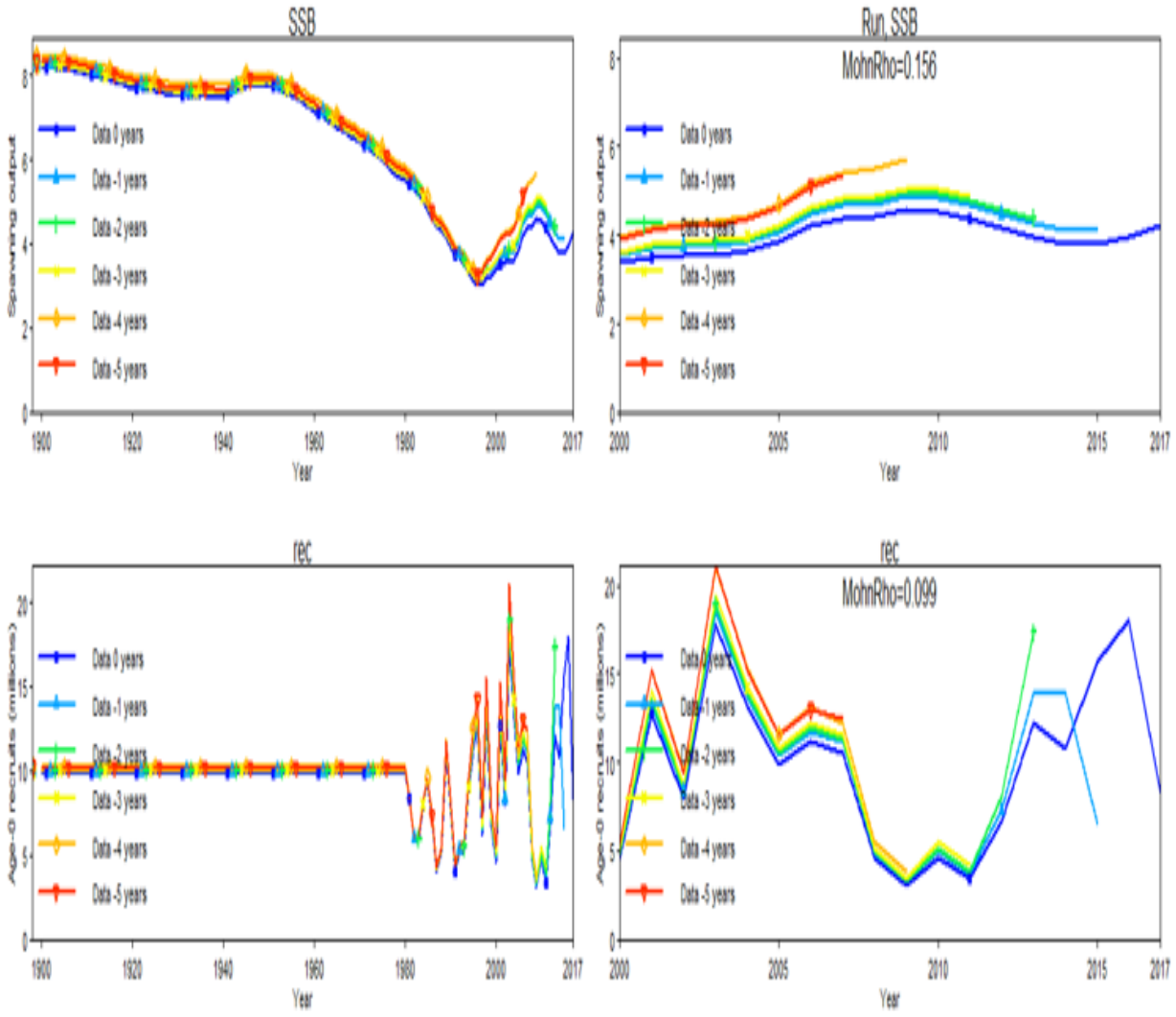
- Plot of recruits vs spawners shows no clear pattern
- R0 profile showed model at the minimum objective function
- The MLE mean average unfished recruitment = 9.8 million fish [LN(R0)=9.2]
- Sensitivity runs with steepness ranging 0.4 to 1.0 showed no change in stock status determination



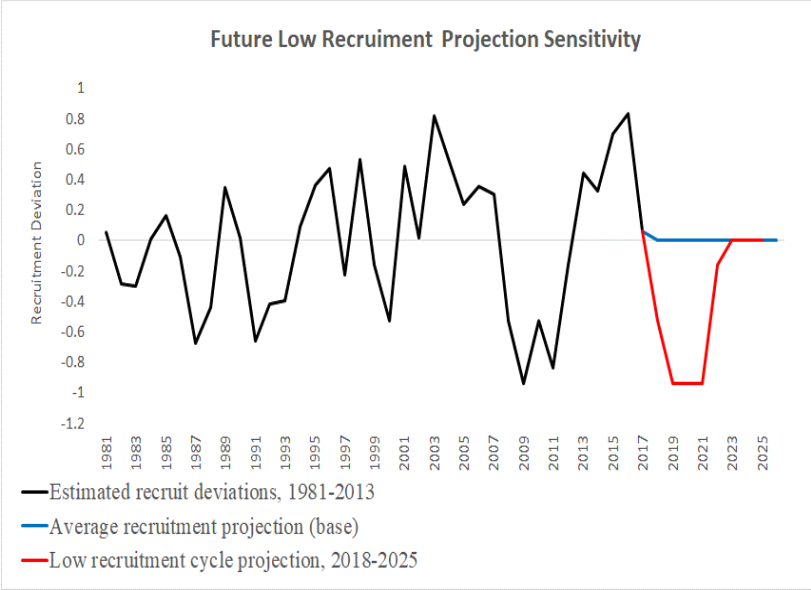


Retrospectives

- No severe patterns or systematic bias revealed
- Diagnostic statistics (Mohn's rho) below threshold (<0.2)
- Evidence for caution interpreting terminal years' recruitments



Future Low Recruitment Sensitivity



Fishing Year	OFL_average recruitment	OFL_Low recruitment	Difference
2021	34.3	29.3	-0.15
2022	29.5	22.4	-0.24
2023	26.3	18.2	-0.31
2024	24.2	17.2	-0.29
2025	22.7	17.8	-0.21