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SEDAR 75 – Gulf Gray Snapper (*Lutjanus griseus*)

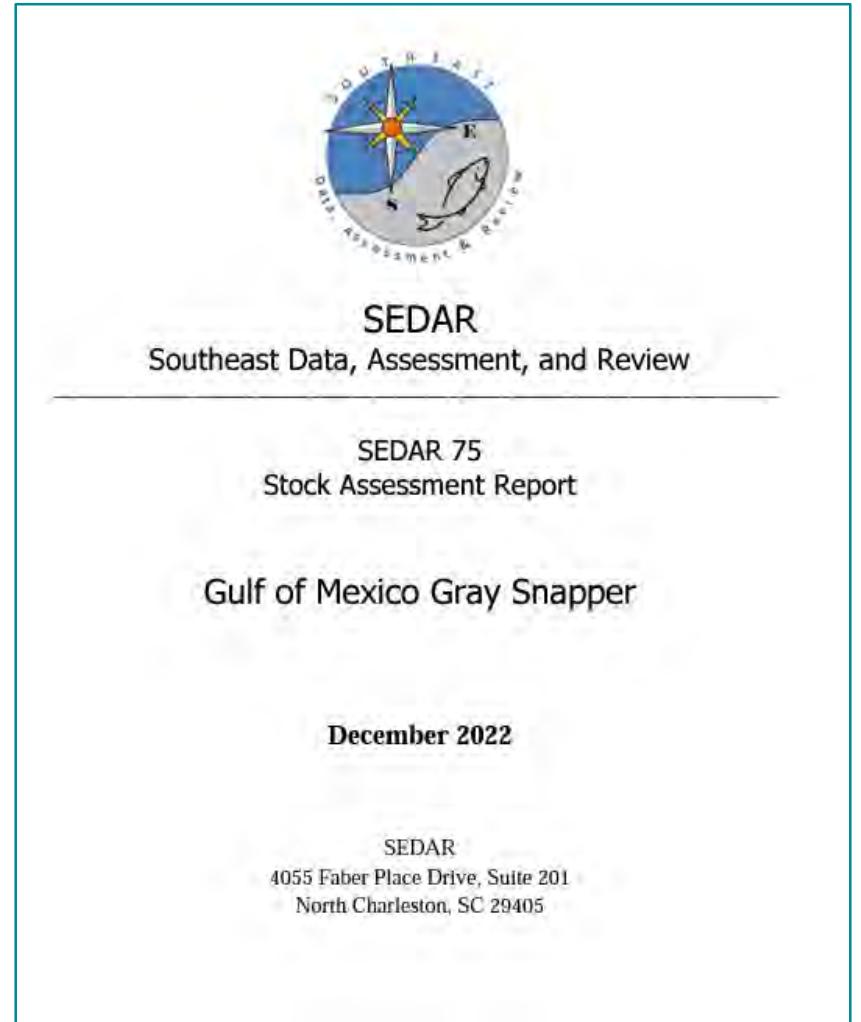


Operational Assessment
SSC Review
January 10-12, 2023

Gulf Branch – Sustainable
Fisheries Division
SEFSC - Miami, FL

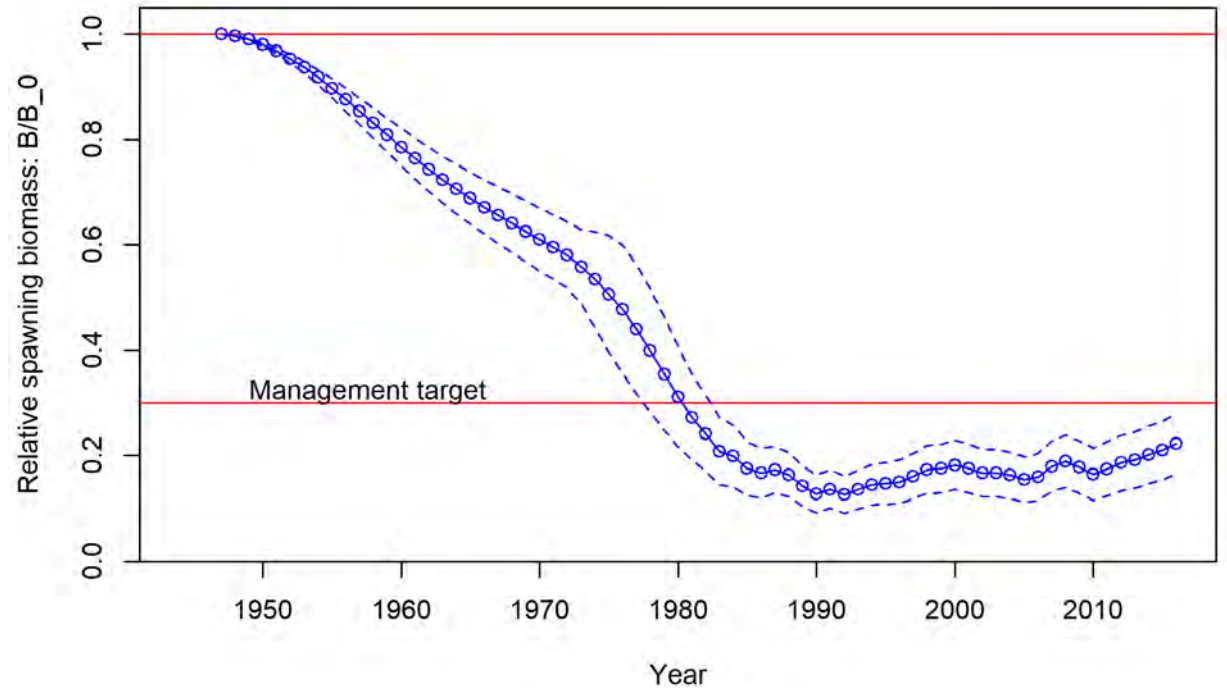
Outline

- Assessment history
- Data Review and updates
- Model Building and configuration
- Assessment results and diagnostics
- Benchmark, stock status and projection
- Research Recommendations



Assessment History

- Last assessed in 2018 under SEDAR process as benchmark assessment (SEDAR51)
 - Data Workshop April 2017
 - Assessment Process June-October 2017
- Terminal year was 2015
- Not overfished:
 - MSST defined as 50% of $SSB_{SPR30\%}$
- Overfished
 - $MSST = (1-M) * B_{SPR30\%}$
- Review Workshop March 20-22, 2018



Stock ID (from SEDAR 51)

S51-DW-09

- Limited adult movement from tagging studies
- Recommendation from Stock ID: **All Monroe County should be included in Gulf**
- Genetics indicate difference between GoM and SA but:
 - Difficult portioning data from GoM Monroe and SA Monroe
- Issues with separating/classifying life history samples in Keys
- MRIP places all Monroe County in Gulf
- No support for east/west split in GoM
- All of grid 748 was assigned to Monroe County and portions of grid 744 (i.e., **744.1 Florida Bay, 744.6 Card Sound and 744.7 Barnes sound**). All Monroe county waters listed above and NMFS statistical zones 1-22 were considered Gulf of Mexico.



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Assessment Process

- SEDAR 75 Operational Assessment TORS called for two Topical Working Groups (TWGs)
 - Life History: December 2021-June 2022
 - Shore Mode: June-July 2022
- Stock Assessment Report submitted December 2022

Gulf Gray Snapper Regulations

- 1990: 12 inches TL Federal waters minimum size limit
- 1990: 10 inches TL Florida waters minimum size limit
- Recreational bag limit: included in the 10-snapper aggregate bag limit

Life History TWG		Shore Mode TWG	
Francesca Forrestal	NMFS Miami	Francesca Forrestal	NMFS Miami
Robert Allman	NMFS Panama City	Chris Bradshaw	FWC
Beverly Barnett	NMFS Panama City	Doug Gregory	SSC
Chris Bradshaw	FWC	Dominique Lazarre	FWC, St. Petersburg
Steve Garner	NMFS Panama City	Vivian Matter	NMFS
Doug Gregory	SSC	Jim Nance	SSC
Dominique Lazarre	FWC, St. Petersburg	Matt Nuttall	NMFS
Heather Moncrief-Cox	NMFS Miami	Beverly Sauls	FWC
Jim Nance	SSC	Eric Schmidt	Industry Representative
Steven Scyphers	SSC	Steven Scyphers	SSC
Katie Siegfried	NMFS Beaufort	Katie Siegfried	NMFS Beaufort
Molly Stevens	NMFS Miami	Molly Stevens	NMFS Miami
Ted Switzer	FWC, St. Petersburg	Ted Switzer	FWC, St. Petersburg
Laura Thornton	NMFS Panama City	Jim Tolan	TPWD/ SSC
Jim Tolan	TPWD/ SSC		



Life History Topical Working Group

- Consider SEDAR 51 recommendations for natural mortality (M):
 - Set the max age = 28 years
 - Apply a Lorenzen age-specific M vector
 - Consider bounding M between 0.13 and 0.17
- Consider SEDAR 51 recommendations for growth:
 - Use all age data regardless of sex
 - Determine whether to predict growth within the model, using the recommended growth parameters as priors, or to use fixed growth parameters
- Consider SEDAR 51 recommendations, and any new information, for reproduction.



Natural Mortality

- Age-specific M vector estimated using Lorenzen
- Target M of 0.15 (Hoenig teleost with max age of 28)
- Sensitivity runs with max age 25 (target M=0.13) as lower bound; max age 32 (target M=0.17) upper bound
- Attempted estimation directly in Stock Synthesis
 - Replicates the SEDAR approach inside SS
 - Accounts for estimated growth curve
- Growth was estimated in SS
 - Poor retrospective patterns
- Used SEDAR 51 M vector with maximum population age of 28

SEDAR 51 M vector

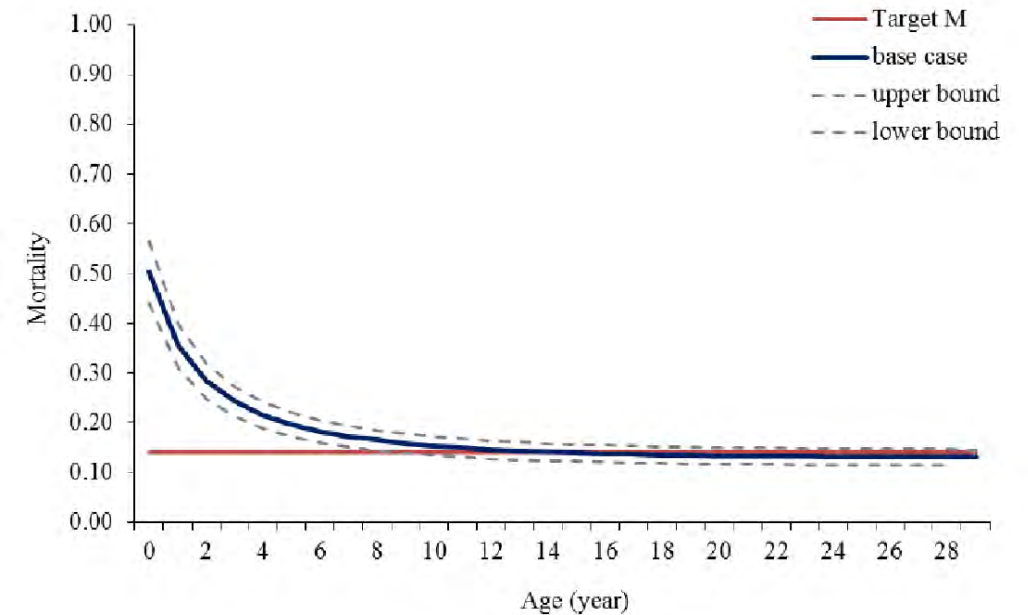


Figure 3.1.2.1 Recommended age-specific natural mortality vector recommended by the Data/Assessment Workshop (red line). The target mortality based on Hoenig et al. (1983) was 0.15 (red line).

Growth

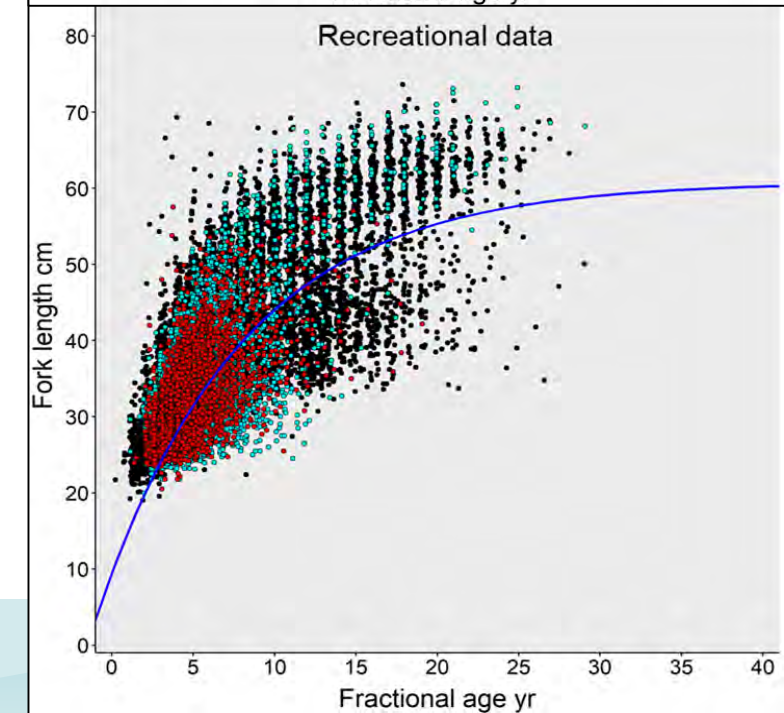
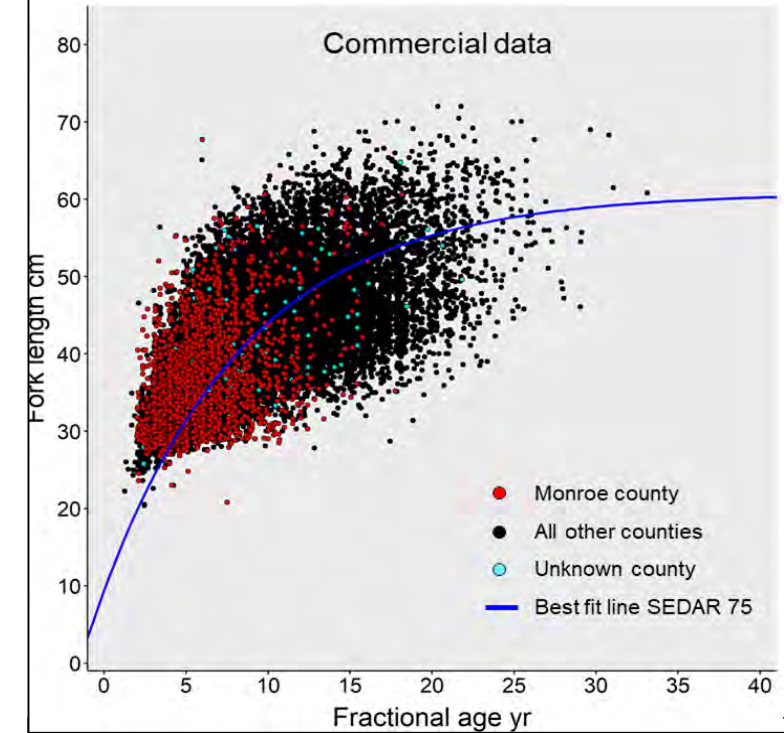
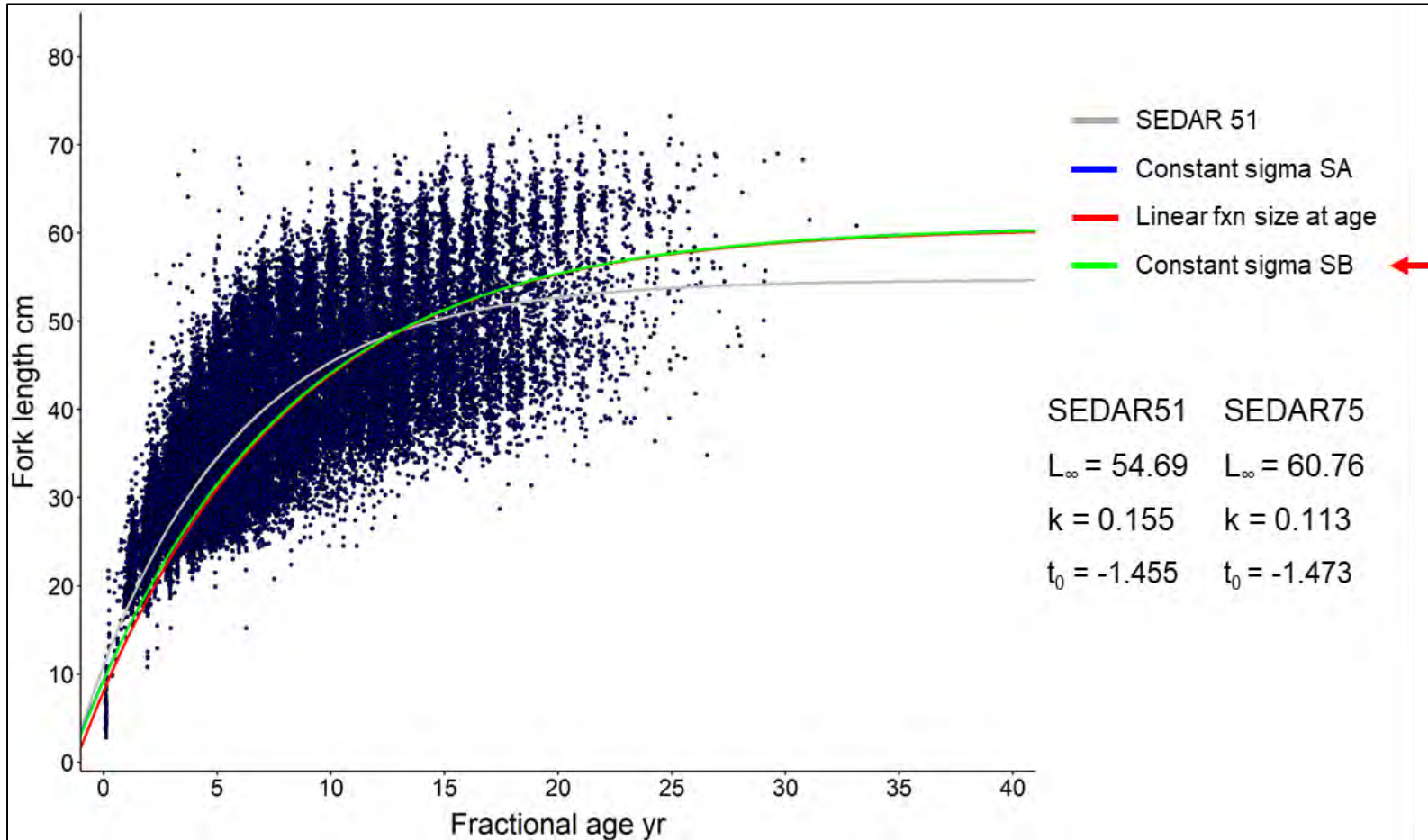
Two scenarios examined for size-adjusted growth models:

- Scenario A: All fishery dependent samples assigned 12" TL size limit
- Scenario B: All recreational samples caught in FL state jurisdictional waters after 1990 assigned 10" TL size limit; all other fishery dependent samples assigned 12" TL size limit

Scenario	Variance model	L_{∞}	k	t_0	Obj. func.	AICc	$\Delta AICc$
A	Constant sigma	60.81	0.112	-1.499	107.04	222.09	0.00
	Constant CV	56.34	0.166	-0.863	109.32	226.64	4.55
	Linear fxn age	62.07	0.104	-1.537	107.26	224.52	2.43
	Linear fxn size-at-age	60.60	0.115	-1.252	106.78	223.56	1.47
B	Constant sigma	60.76	0.113	-1.473	107.93	223.86	1.77
	Constant CV	56.26	0.168	-0.856	110.19	228.37	6.28
	Linear fxn age	62.01	0.105	-1.537	108.13	226.25	4.16
	Linear fxn size-at-age	60.54	0.116	-1.245	107.64	225.28	3.19



Growth



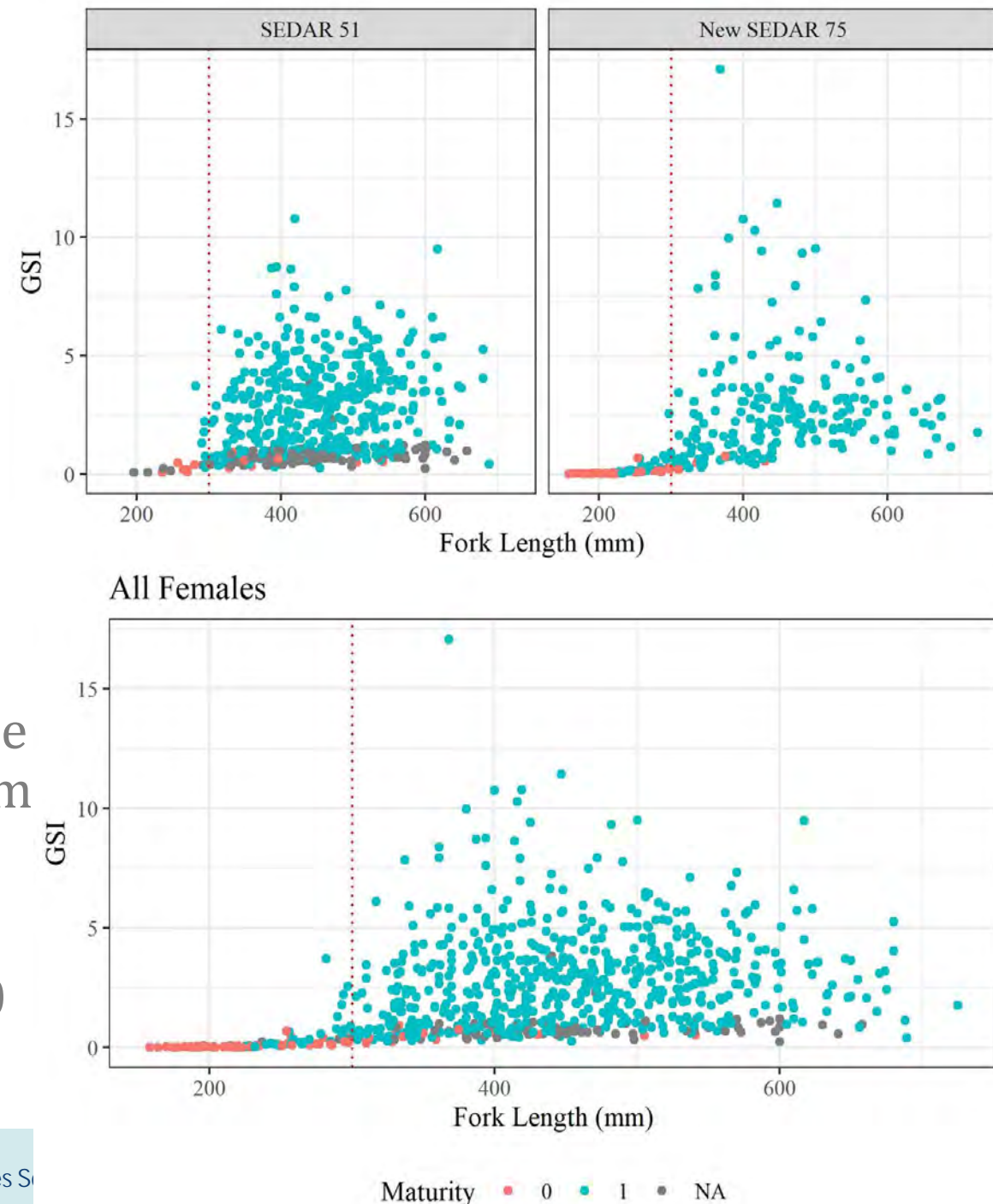
Reproduction

- Fecundity
 - S51: batch fecundity (n=6) or fecundity estimates not available, weight used as proxy for fecundity
 - S75: **Same**
 - very few (n= 12) batch fecundity estimates available, recommend to again use weight as a proxy for fecundity
- Sex ratio
 - S51: 0.48 females most recent estimate, used 50:50 sex ratio
 - S75: **Same**



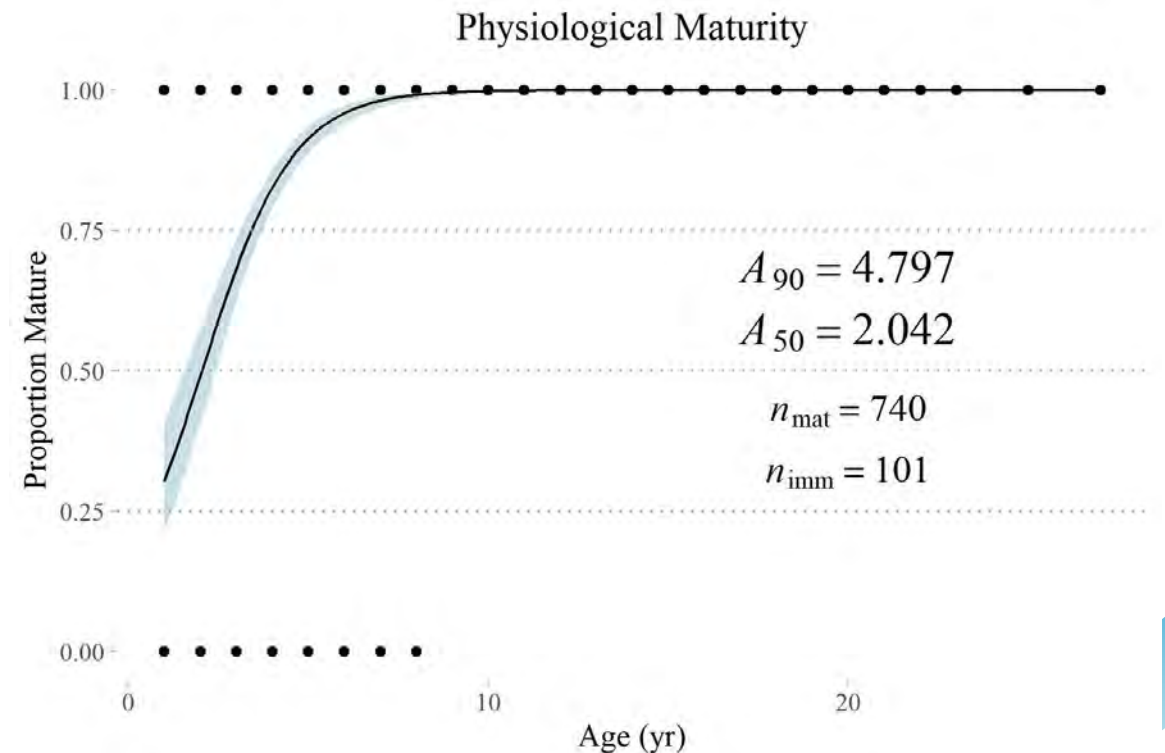
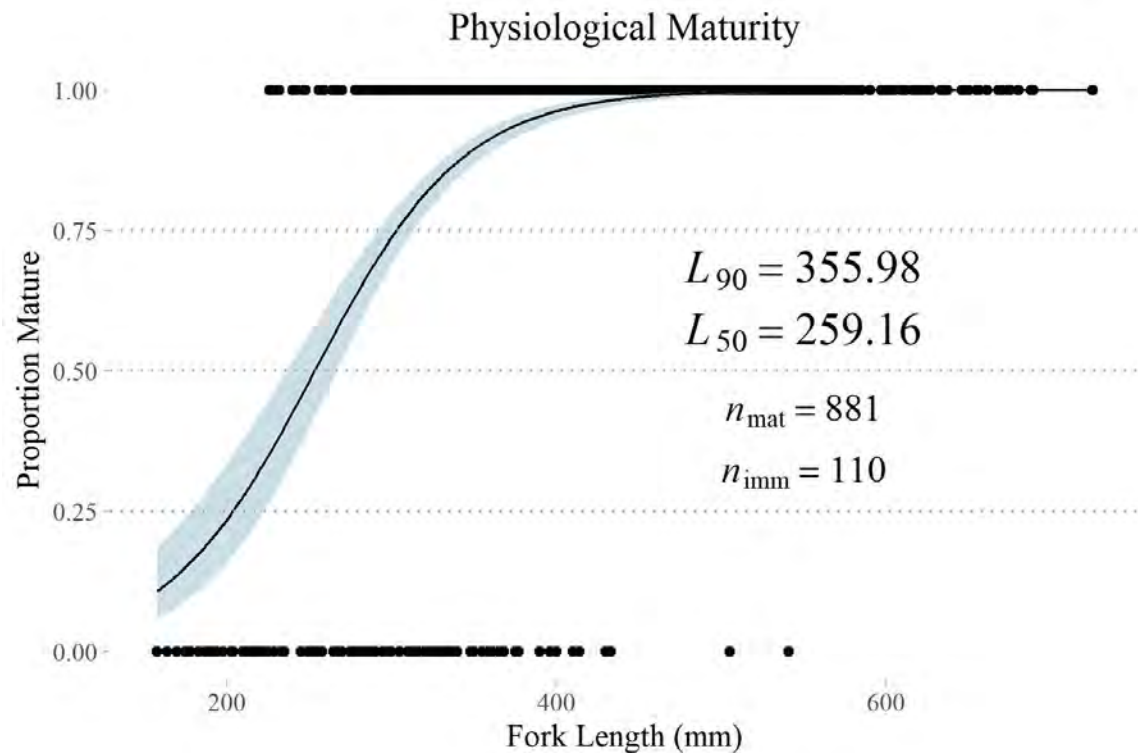
Reproduction

- SEDAR 51:
 - Age and size at 50% maturity : 2.3 years or 253mm FL respectively
 - 90% maturity occurring at 5.2 years or 362mm FL.
- SEDAR51-RD-11 estimated maturity 239-288mm FL.
- Evident that a significant contribution to the spawning stock is not achieved until 300mm FL (SEDAR51 DW-06).
- SEDAR 75
 - Increased number of individuals under 300 mm to 126 females (59 in S51)



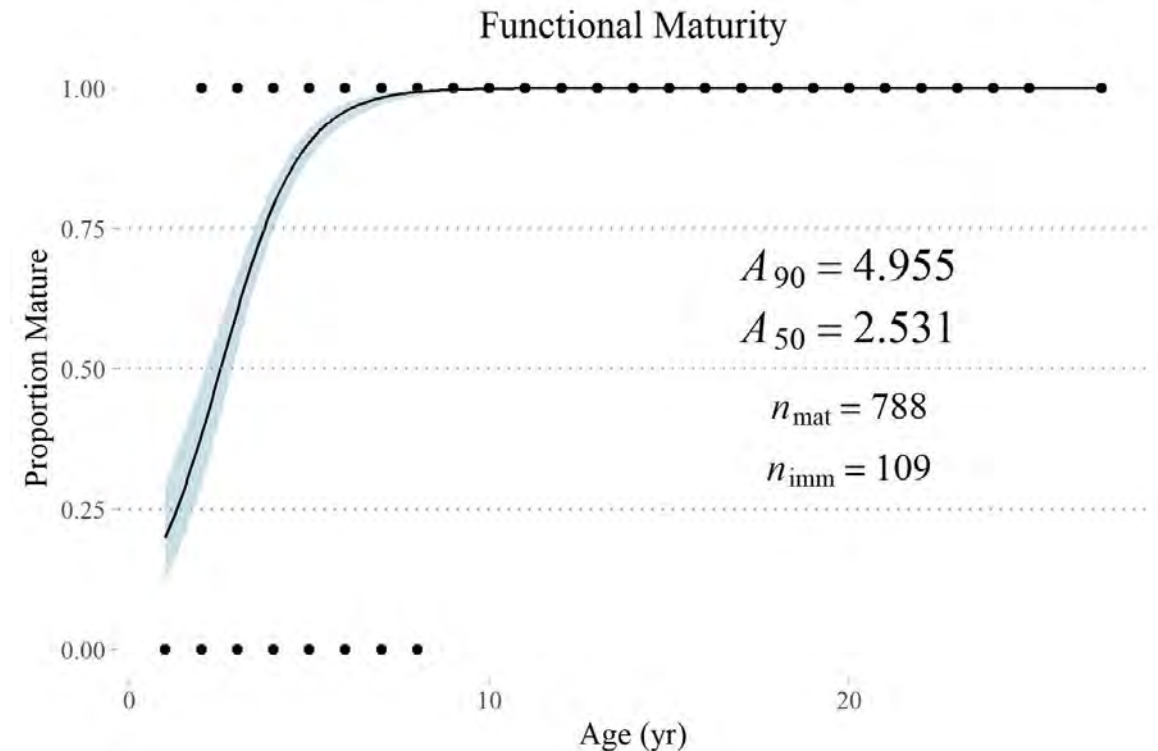
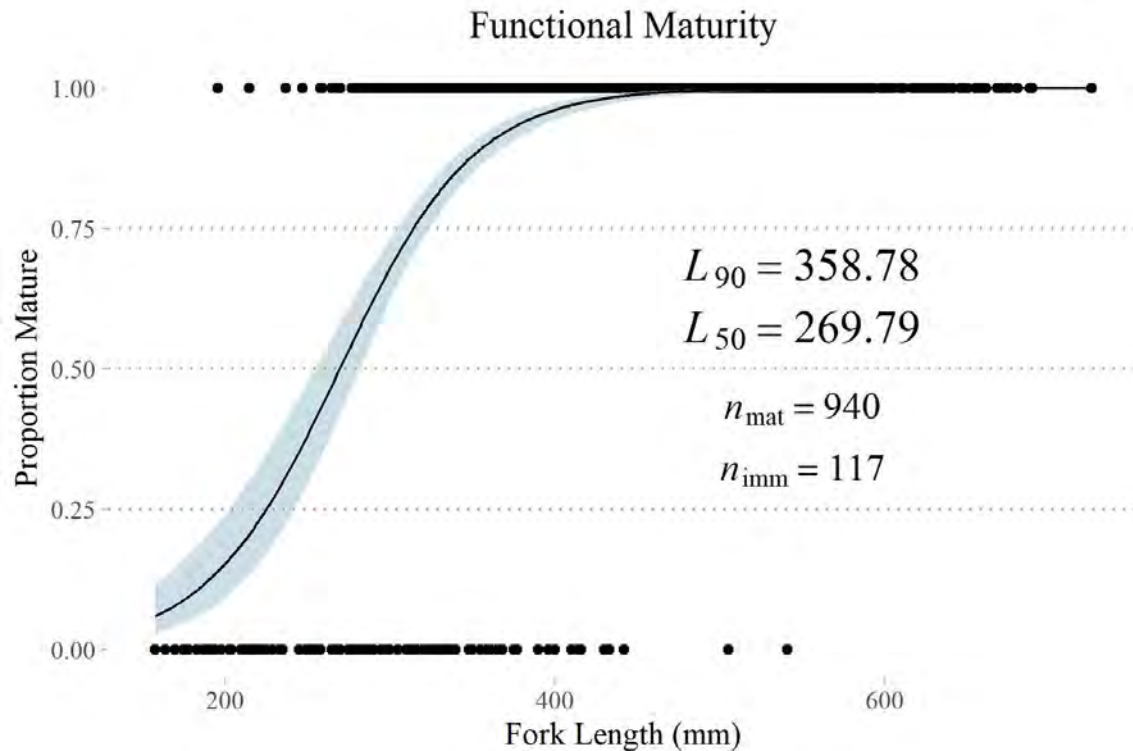
Reproduction

- Age and size at 50% “physiological” maturity: 2.0 years or 259.2 mm FL respectively
- 90% maturity occurring at 4.8 years or 356.0 mm FL.



Reproduction

- Age and size at 50% “functional” maturity: 2.5 years or 269.8 mm FL respectively
- 90% maturity occurring at 5.0 years or 358.8 mm FL.



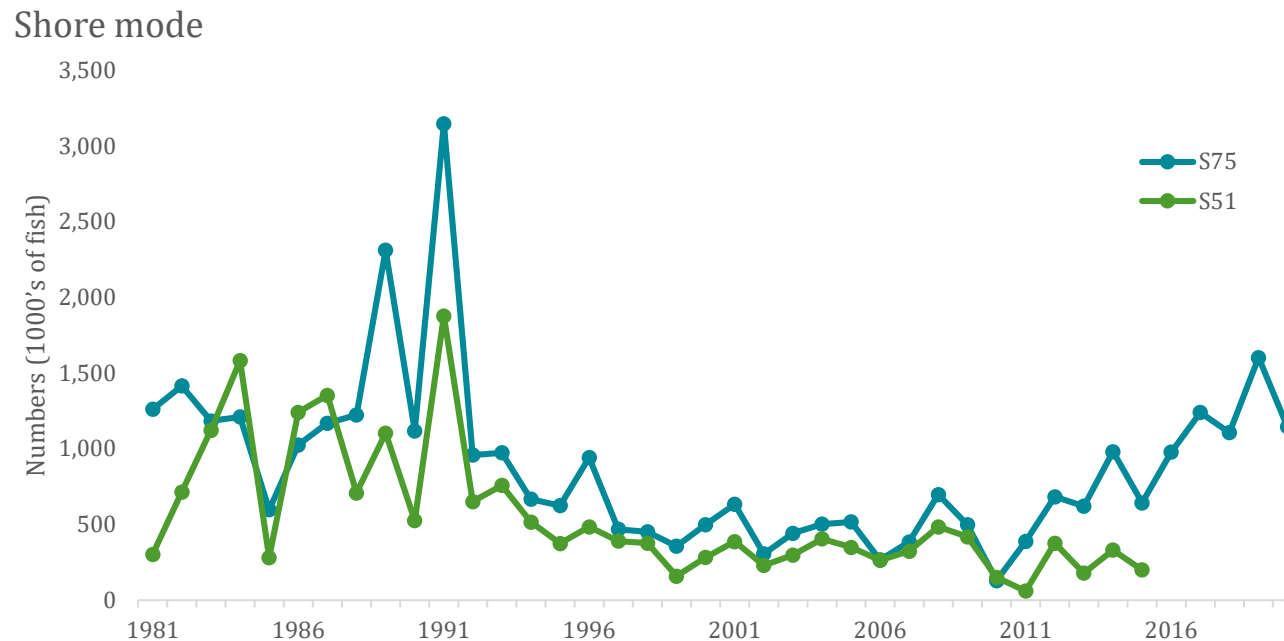
Shore Mode Topical Working Group

- Re-evaluate gear selectivity, retention, and discards for the recreational shore mode.



Terms of Reference

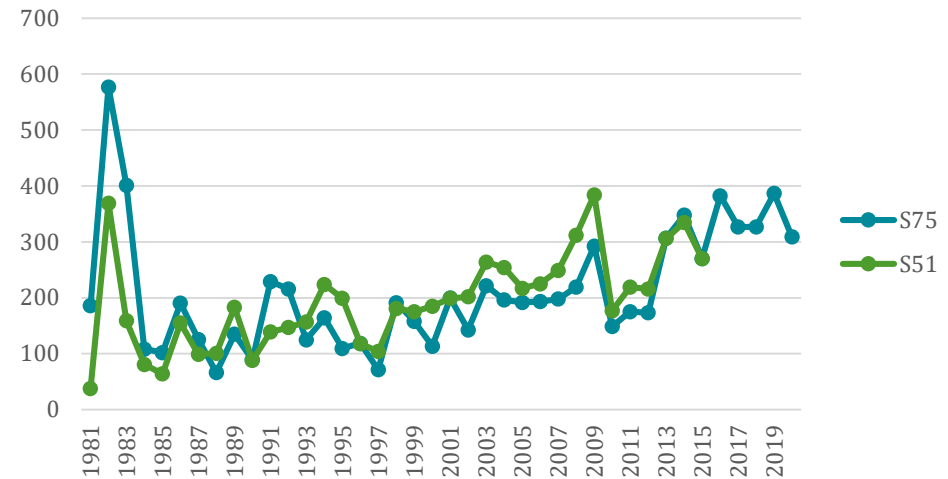
- Rationale behind ToR:
 - Concern as early estimates of FES converted landing were $\sim 9x$ higher
 - However, the final converted landings were $\sim 2-3x$ higher
- Majority of work needed on modeling side, post TWG timeline



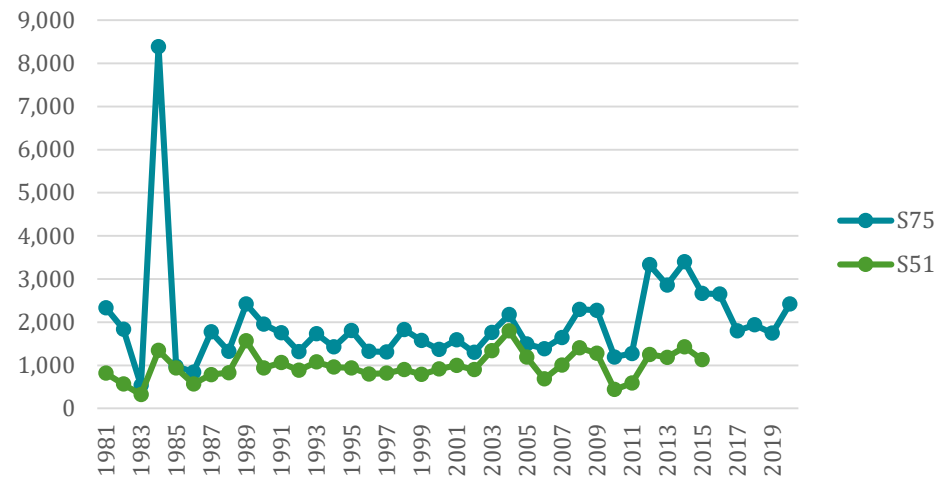
Recreational Fleets

- 3 recreational fleets in model
- For context, other 2 fleets after conversions
- Private mode fleet:
 - 1984 landings estimate: 9,689,657 fish
 - Stratum: western Florida, private, wave 6, and ocean \leq 10 miles
 - Intercept Records: a total of 14 angler trips that resulted in a landings estimate of 5,808,821 fish

Charter & Headboat



Private mode



TWG Recommendations

- Use geometric mean among nearby years' strata to smooth 1984 private fleet landings and use as input for historical catches
- Dirichlet multinomial error structure for length comps
- Explore adding in age composition data (**in assessment model**)
- Explore using provided landings CVs as sensitivity
- Include discard composition data (very sparse and none for shore)

Data Review



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Data Inputs

Inputs	S51	S75
COM Fleets	Monroe County VL, non Monroe County VL, LL	VL, LL, Nets & Traps
REC Fleets	Private, Shore, Hbt & Cbt	Private, Shore, Hbt & Cbt (FES)
Discards	MC VL, nMC VL Private, Shore, Hbt & Cbt (fraction of total catch)	VL, LL Private, Shore, Hbt & Cbt (total magnitude)
Indices	VL, Private, Shore FWRI Age 0, Age1 SEAMAP Trawl FRWI-NMFS Video RFV Census	Private, Shore FWRI Age 0, Age1 SEAMAP Trawl Combined Video RFV Census
Length Comps	MC, nMC, LL Private, Shore, Hbt & Cbt	6 fishing fleets SEAMAP Trawl Combined Video Index Reef Fish Visual Census
Age Comps	ALK attempted	VL weighted LL weighted PR weighted (1992,2002-2020) Hbt & Cbt weighted

Major changes:

- Commercial fleet structure
 - S51 split by region and gear type
 - S75 split by gear type
- No VL index
 - Could not extend past IFQ period
 - VL fleets treated differently in S51
- FI length compositions used
- Age compositions used
 - VL, LL, PR and Headboat & Charterboat



Data updates

- **Landings**

- Vertical line **WWT**: 1962-2020 (+ diving)
- Longline **WWT**: 1962-2020 (+ other)
- Nets & Traps **WWT**: 1962-2020
- Private Mode **Numbers**: 1981-2020
- Shore Mode **Numbers**: 1981-2020
- Charter & Headboat **Numbers**: 1981-2020

- **Discards**

- Vertical line **Numbers**: 1993-2020
- Longline **Numbers**: 1993-2020
- Private **Numbers**: 1981-2020
- Shore **Numbers**: 1981-2020
- Charter & Headboat **Numbers**: 1981-2020

- **Abundance indices**

- ~~Vertical line: 1993-2009*~~
- Private Mode: 1981-2020
- Shore Mode: 1981-2020
- FWRI Age 0: 1998- 2020
- FWRI Age 1: 1996- 2020
- SEAMAP Trawl Survey: 2010-2020
- **Video survey** (FWRI, PC, SEAMAP): 1993-1997, 2004-2020
- RF Visual Survey: 1997-2012, 2014, 2016, 2018

- **Length composition of retained catch**

- Vertical line **Weighted**: 1984-2020
- Longline **Nominal**: 1985-2020
- Nets & Traps **Nominal**: 1986-2018
- Private **Weighted**: 1981-2020
- Shore **Nominal**: 1981-2020
- Charter & Headboat **Weighted**: 1979-2020

- **Age composition of retained catch**

- Vertical line **Weighted**: 1991,1993-2020
- Longline **Nominal** : 1982-83, 1992-2020
- Nets & Traps **Nominal**: 1993-2017*
- Private **Weighted**: 1992-93,1997-98, 2002-2020
- Shore **Nominal**: 2006-2020*
- Charter & Headboat **Weighted**: 1980-82, 1991-2020

- **Length composition of survey data**

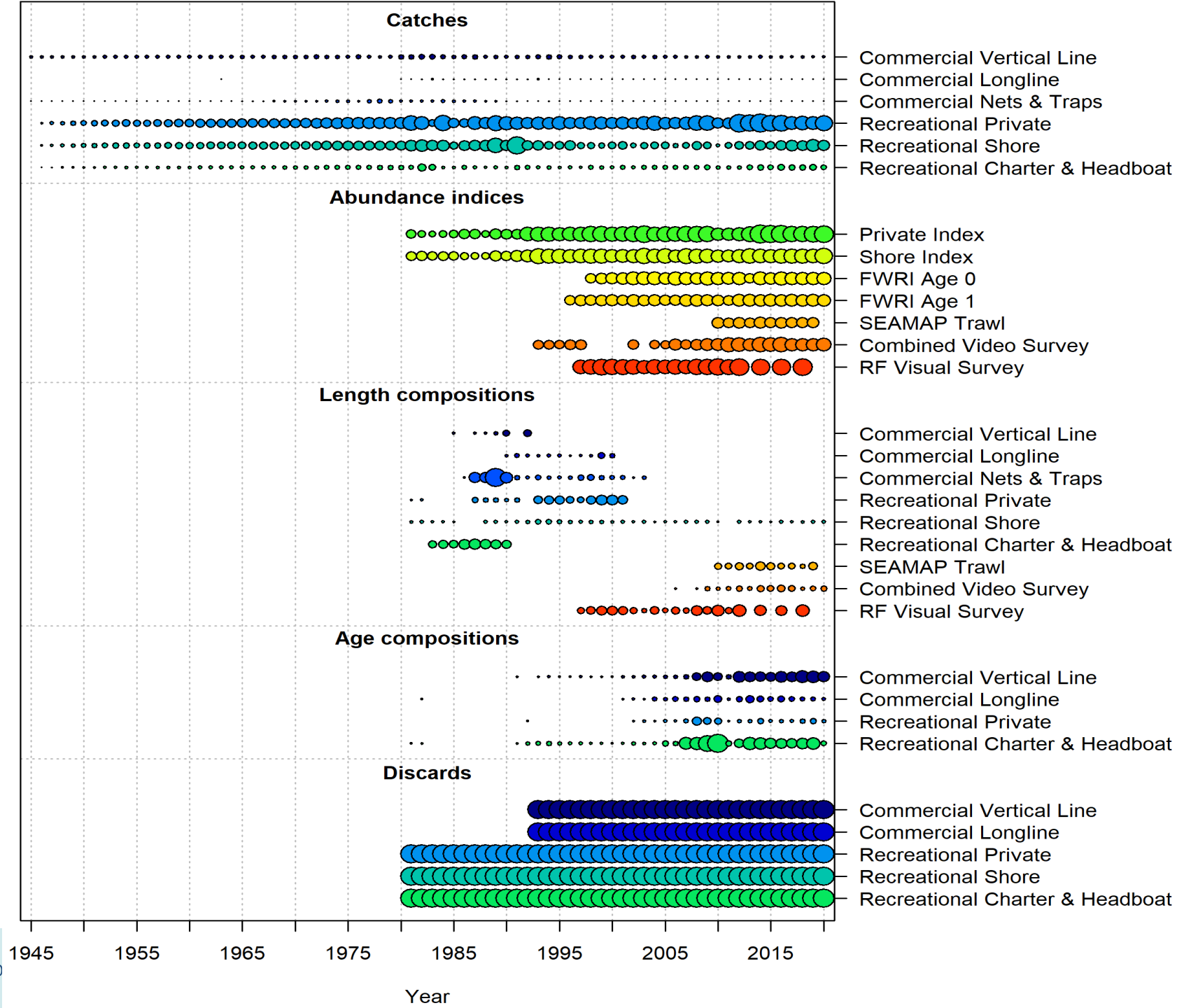
- SEAMAP Trawl: 2010-2019
- Combined video survey: 1996-97, 2002, 2004-2020
- RF Visual Survey: 1997-2012, 2014, 2016, 2018

*insufficient sample sizes for inclusion



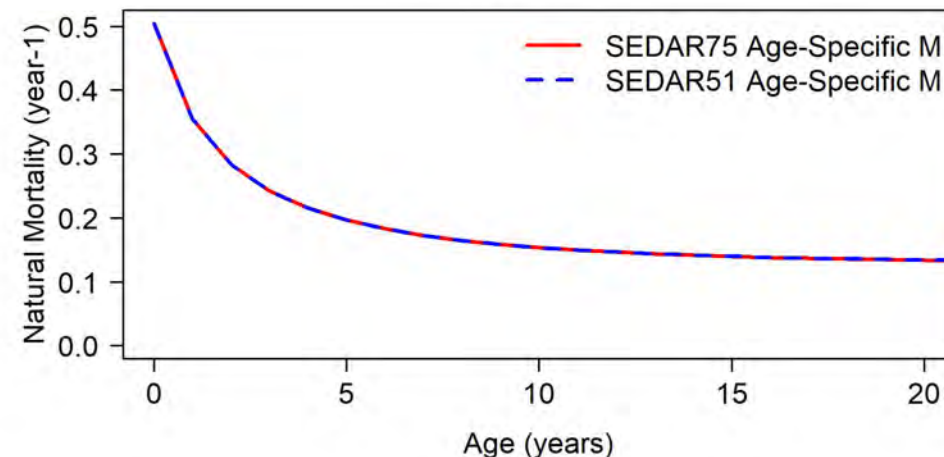
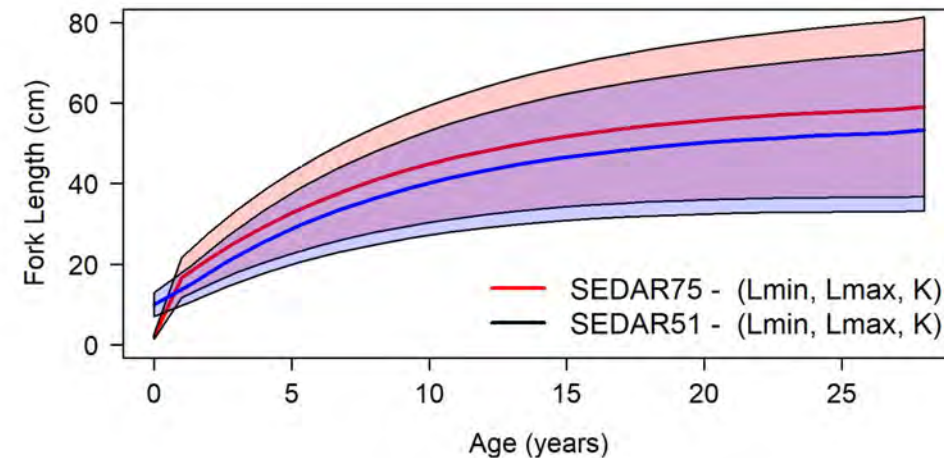
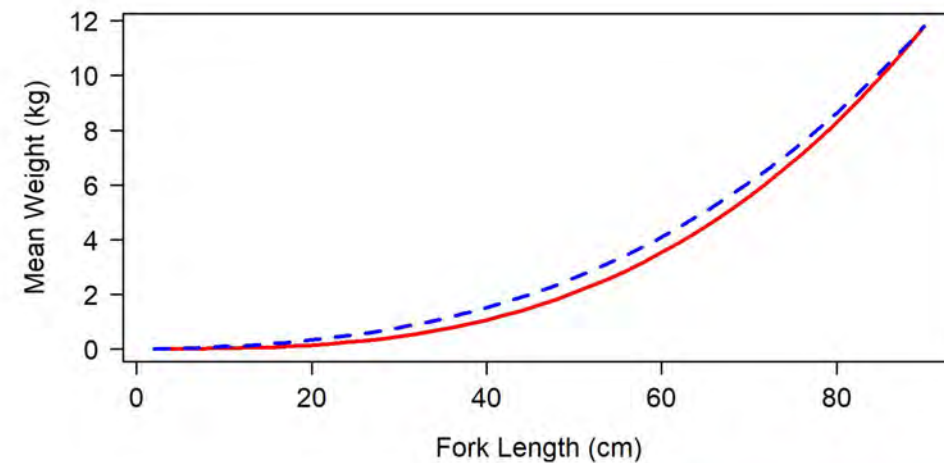
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SEDAR 75 data inputs



Life History

- Updated during Life History TWG
- Changes observed in mean weight to fork length, age and FL relationship
- Natural mortality vector was not changed.



Commercial Fleets

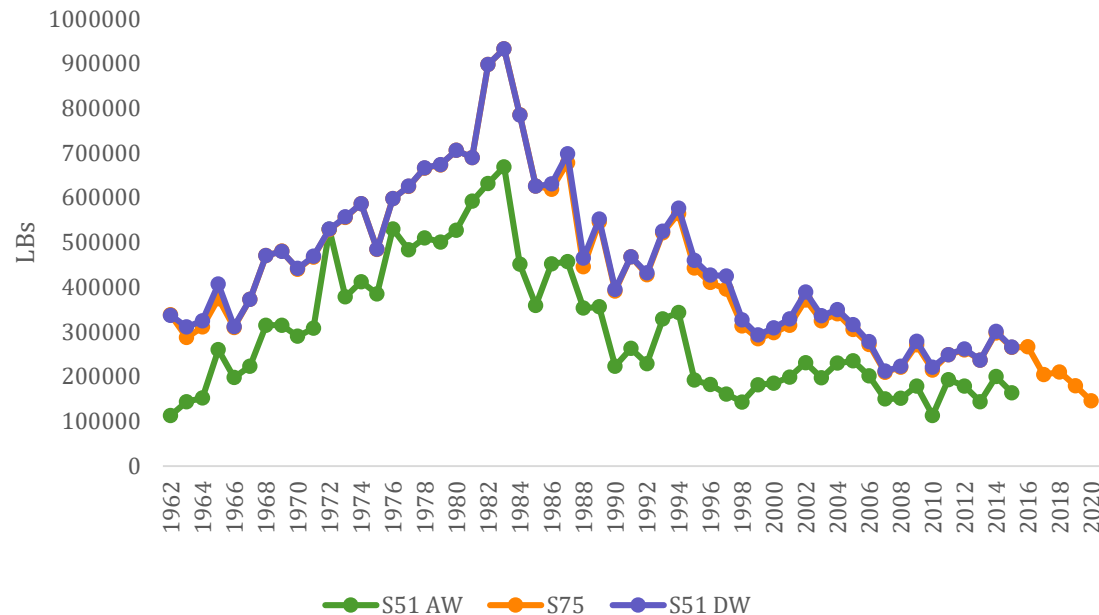
- S51 Data Workshop recommended fleets:
 - Vertical Line (+ diving)
 - Longline (+ other)
 - Nets and Traps
- S51 Assessment fleets:
 - Monroe County Vertical Line
 - Non Monroe County Vertical Line
 - Longline
- Changed during the modeling process due to length composition weighting
- Best practices for data weighting has been updated, S75 assessment uses recommended fleets from S51 DW



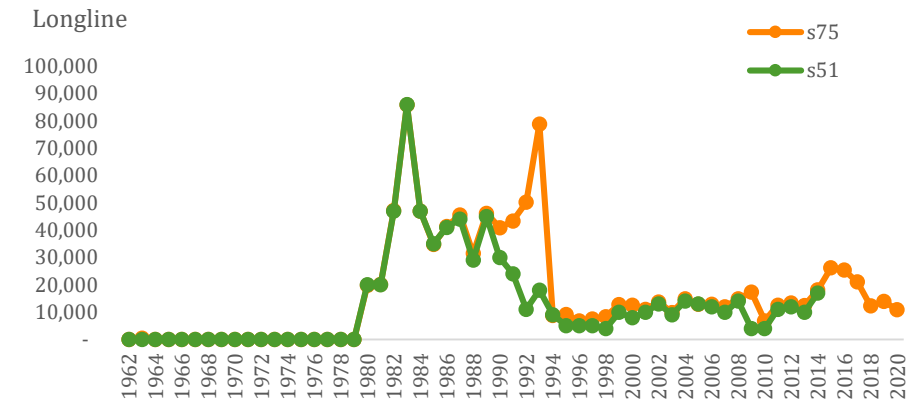
Commercial Landings

- Change in fleet structure led to error in total landings used in S51 assessment model

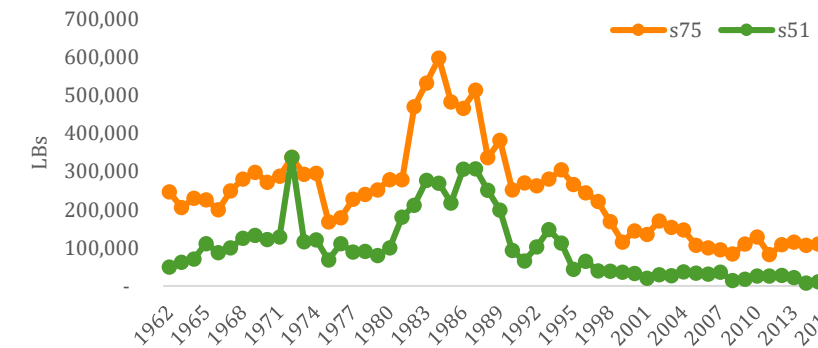
All Commercial Landings



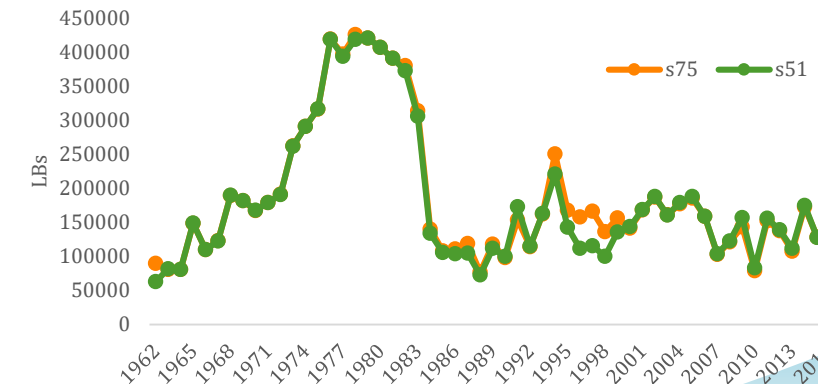
Longline



Monroe County

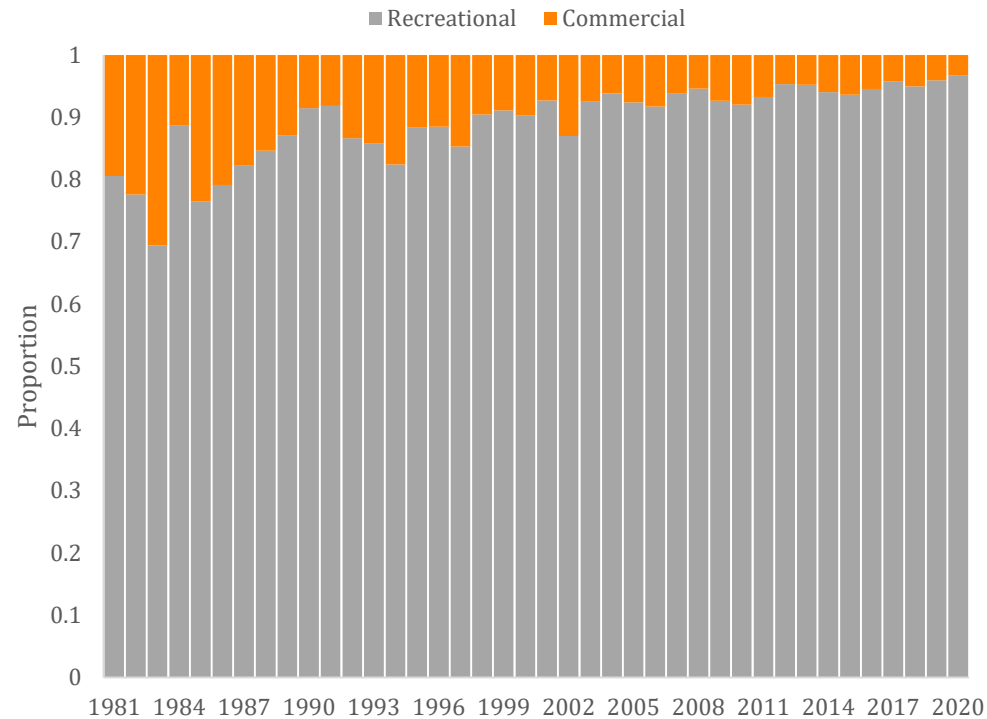


Not Monroe County

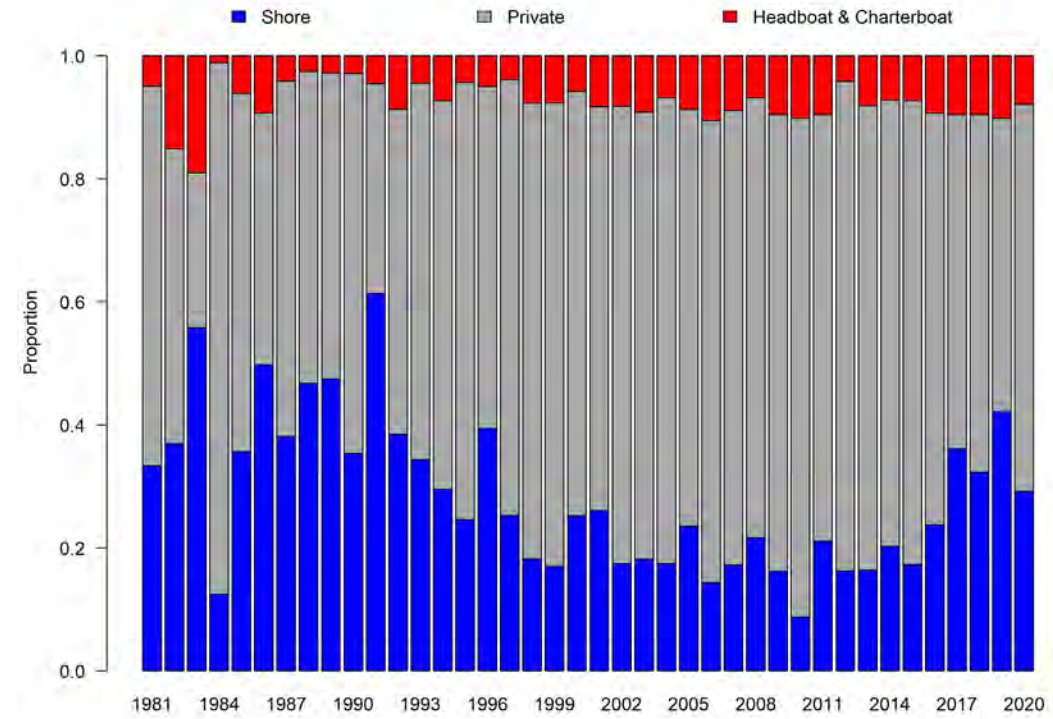


Landings

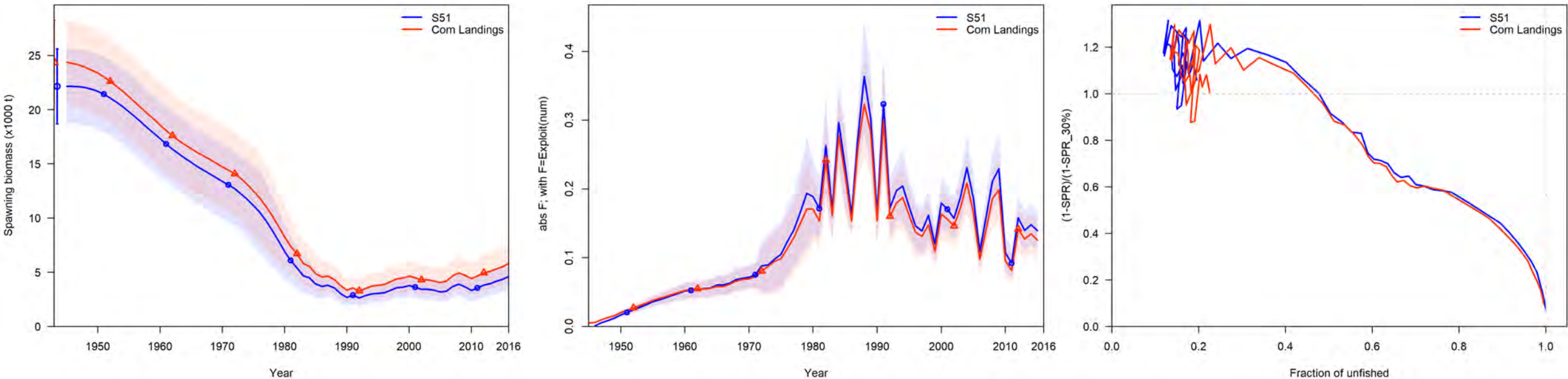
Recreational fleets major component of landings



Private mode is largest component of recreational landings



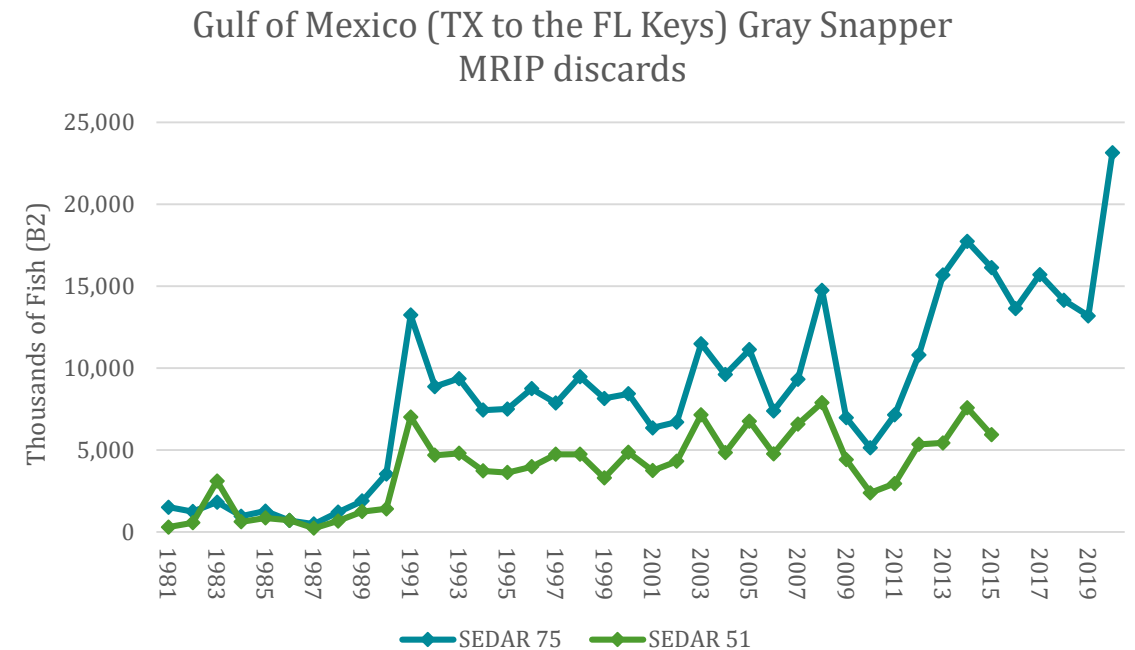
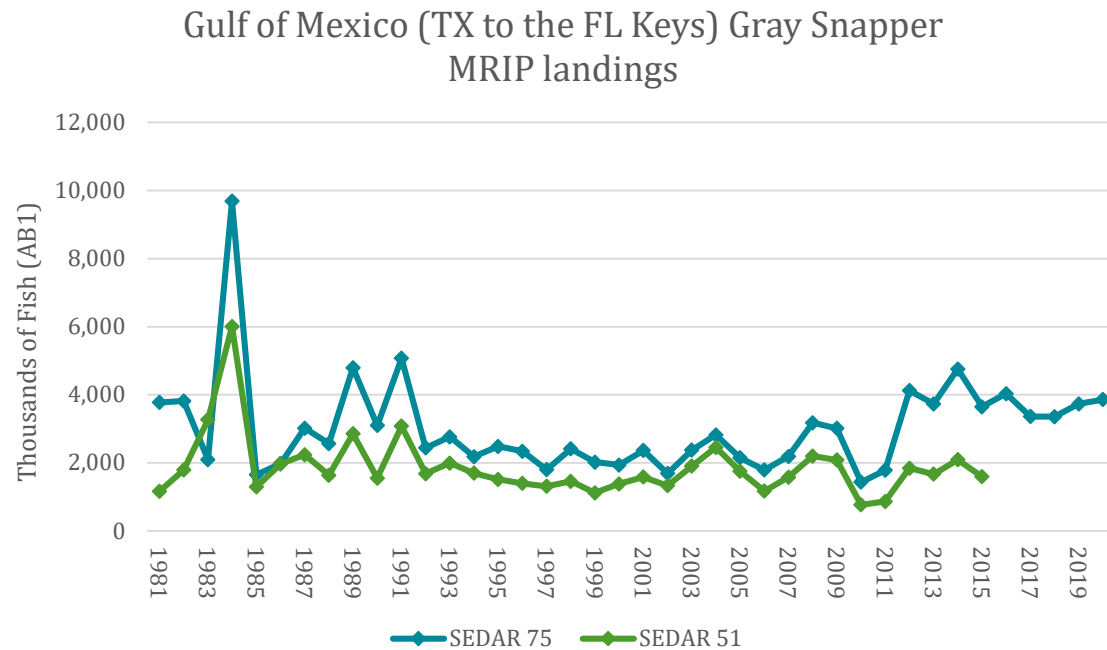
Commercial Landings



- SEDAR 51 assessment model with corrected commercial landings for reference

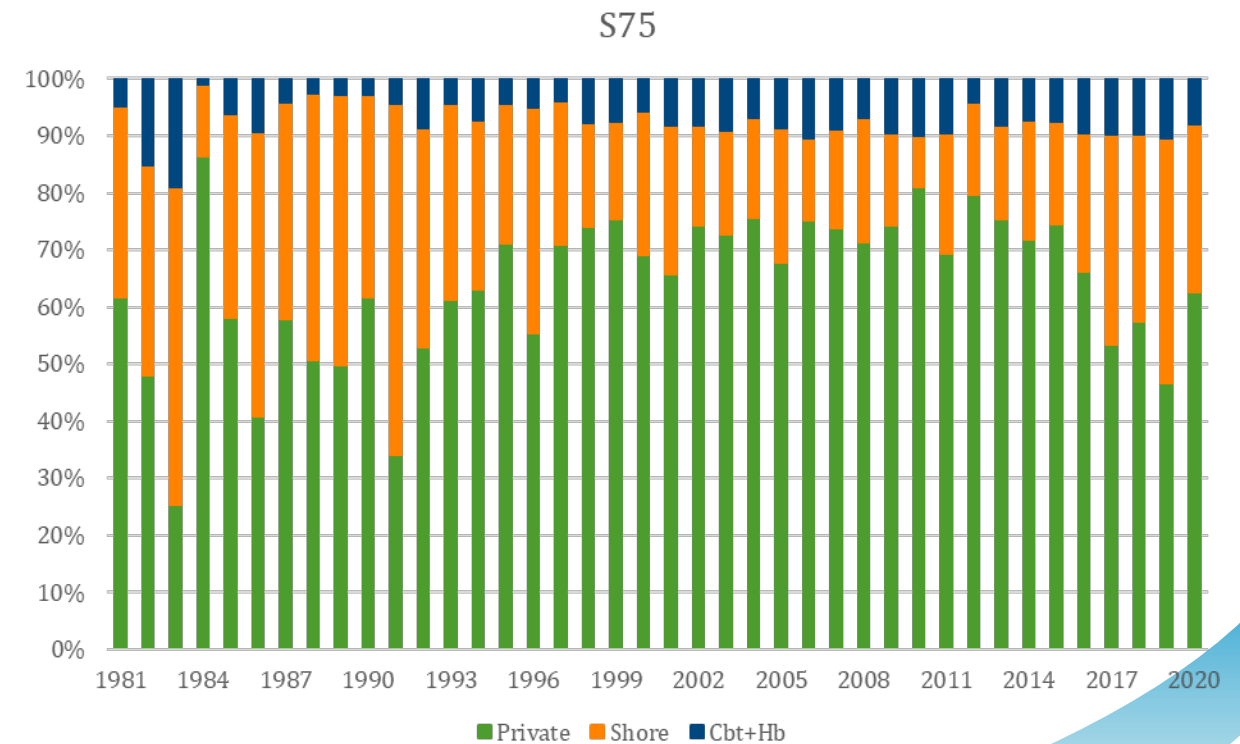
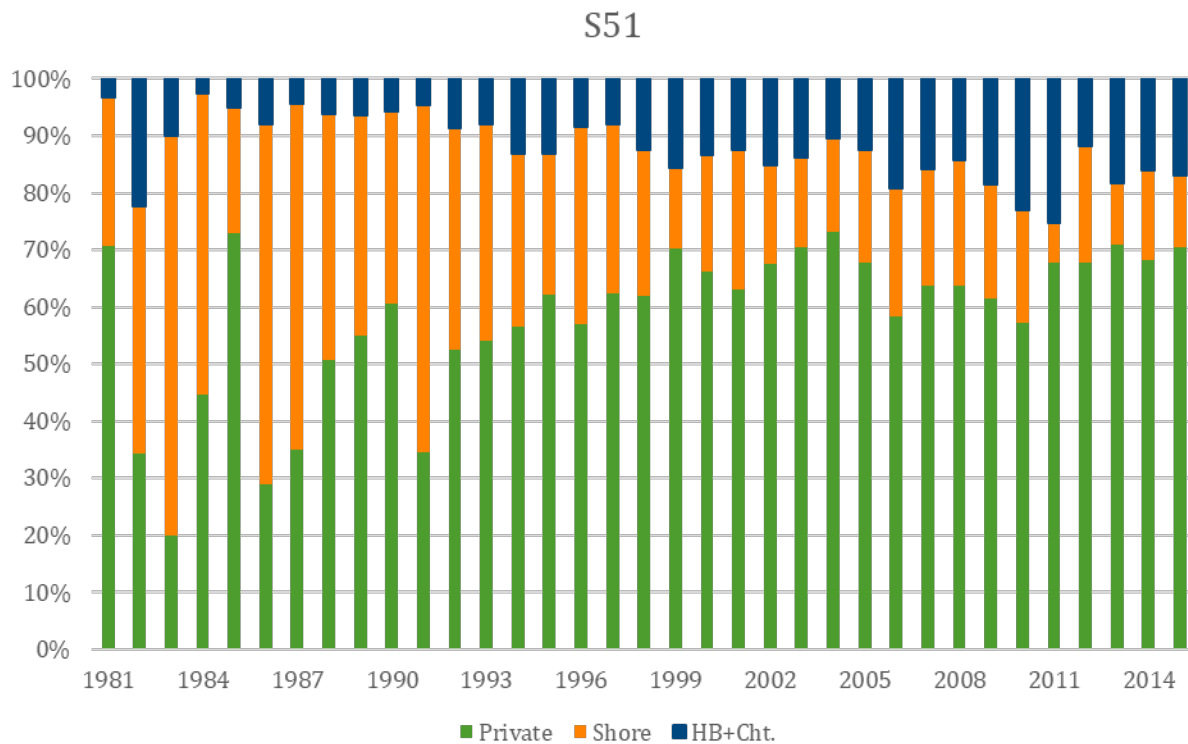
Recreational Fleets

Recreational landings pre-calibration (SEDAR 51) and post-calibration (SEDAR 75)

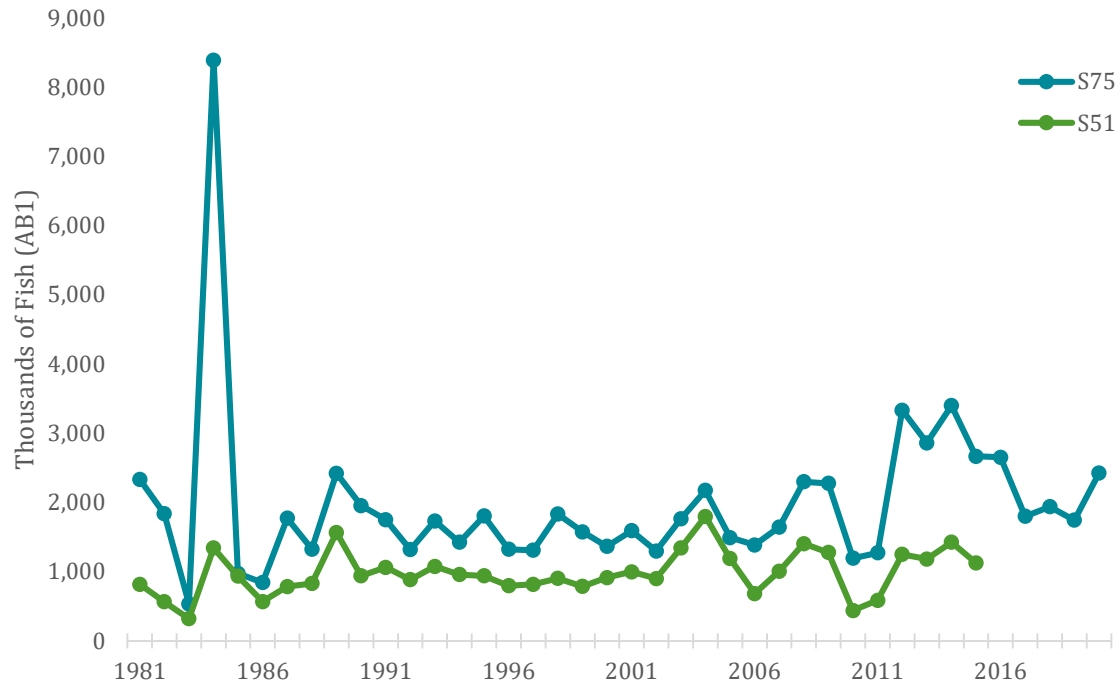


Recreational Fleet Proportions

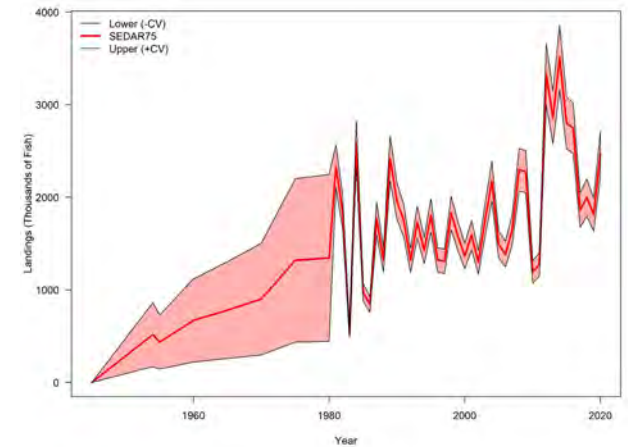
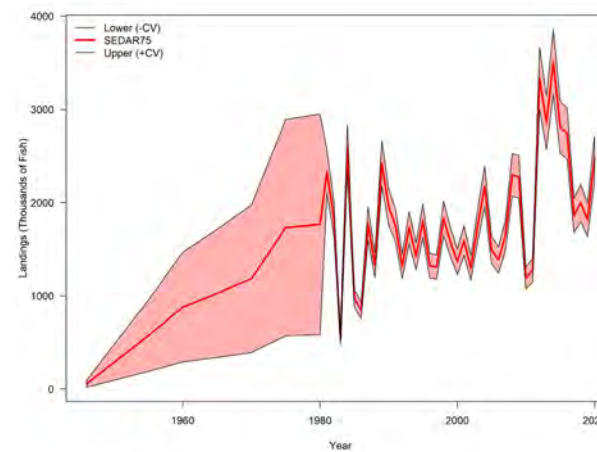
Recreational fleet landings as proportions pre-calibration (S51) and post-calibration (S75)



Private Mode

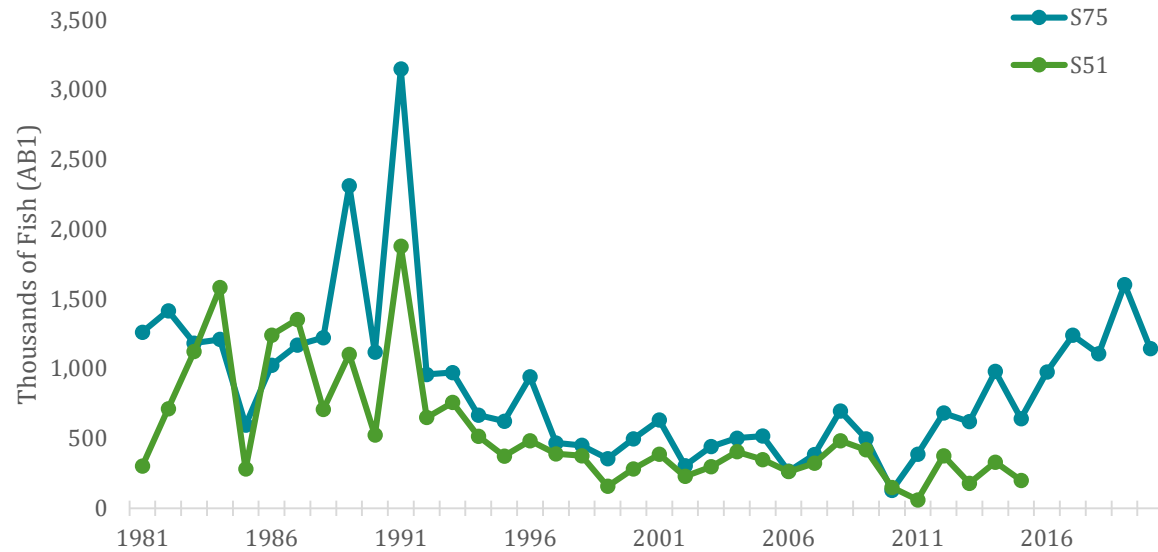


- 1984 landings estimate: 9,689,657 fish
 - Stratum: western Florida, private, wave 6, and ocean \leq 10 miles
 - Intercept Records: a total of 14 angler trips that resulted in a landings estimate of 5,808,821 fish
- Smoothed 1984 landings, used landings from 1986 stratum
 - Geometric mean of surrounding years stratum not feasible as no landings reported in that stratum until 1986
 - Replacement value of 2,578,761 fish

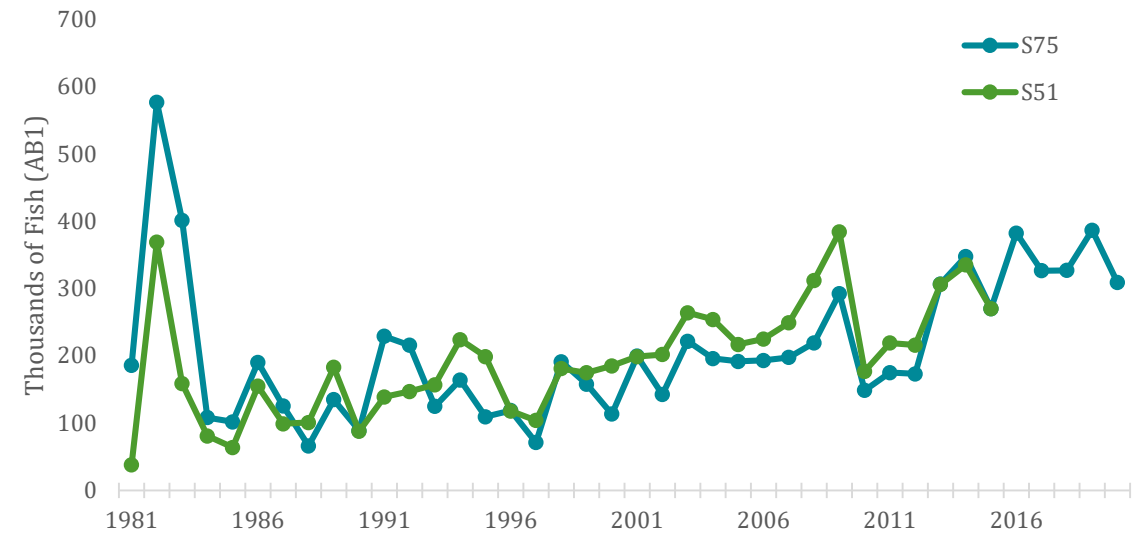


Shore mode and Charter & Headboat

Shore mode

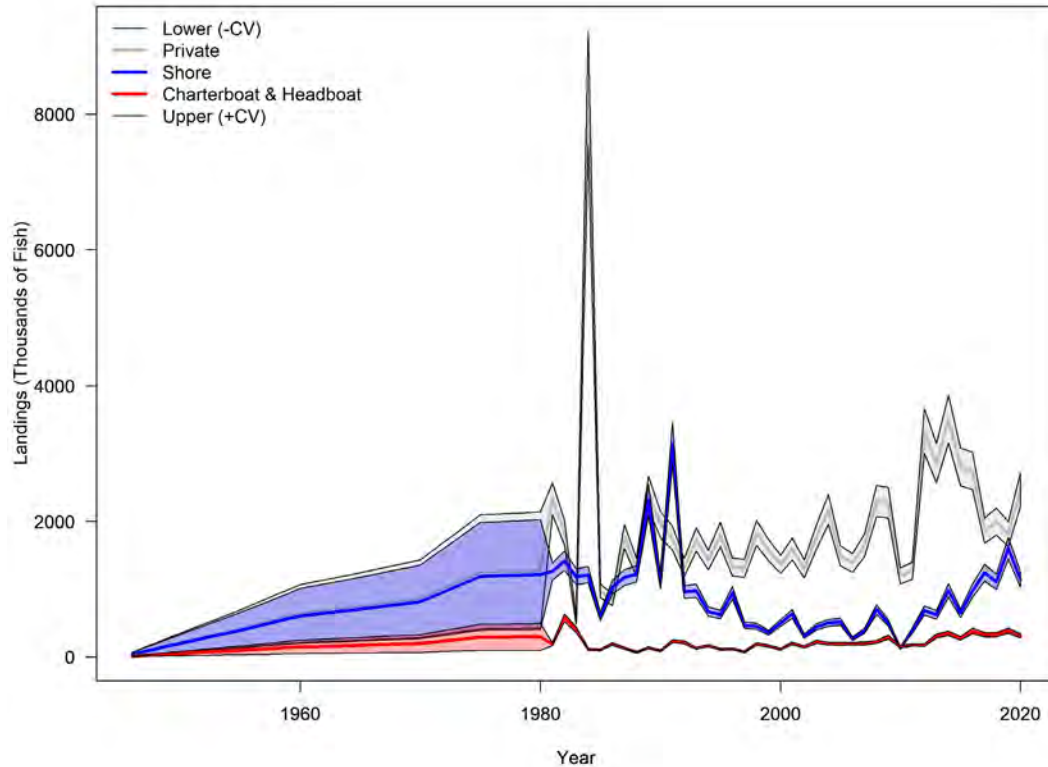


Charterboat & Headboat

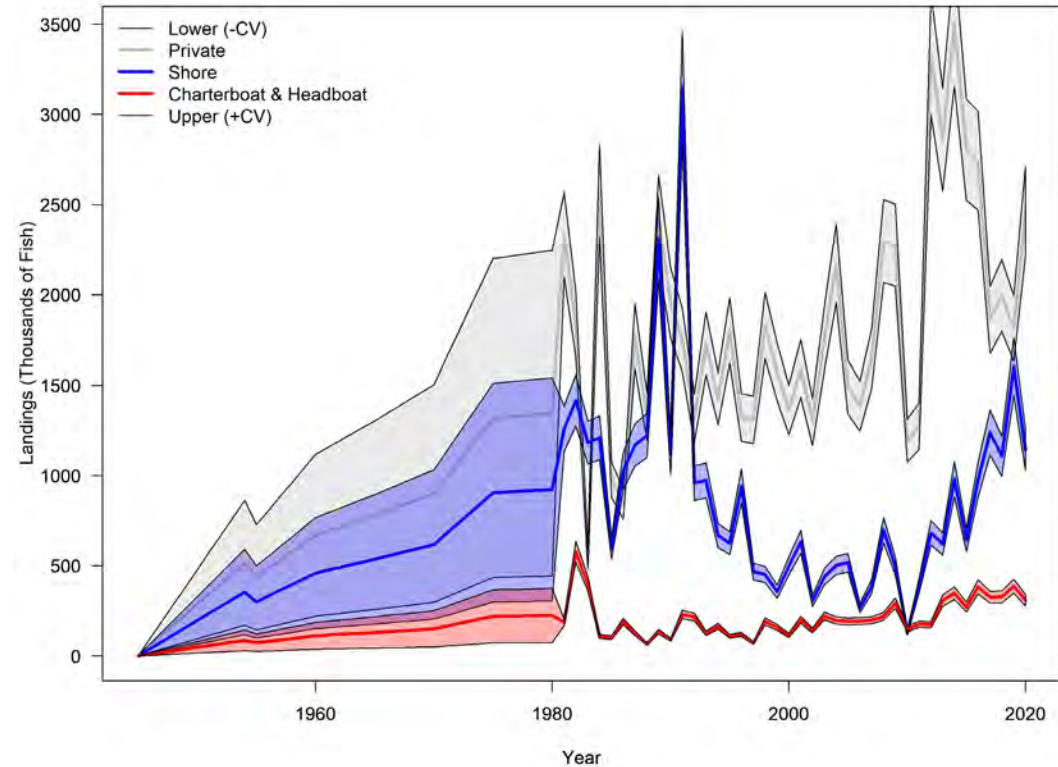


Historical Rec Landings

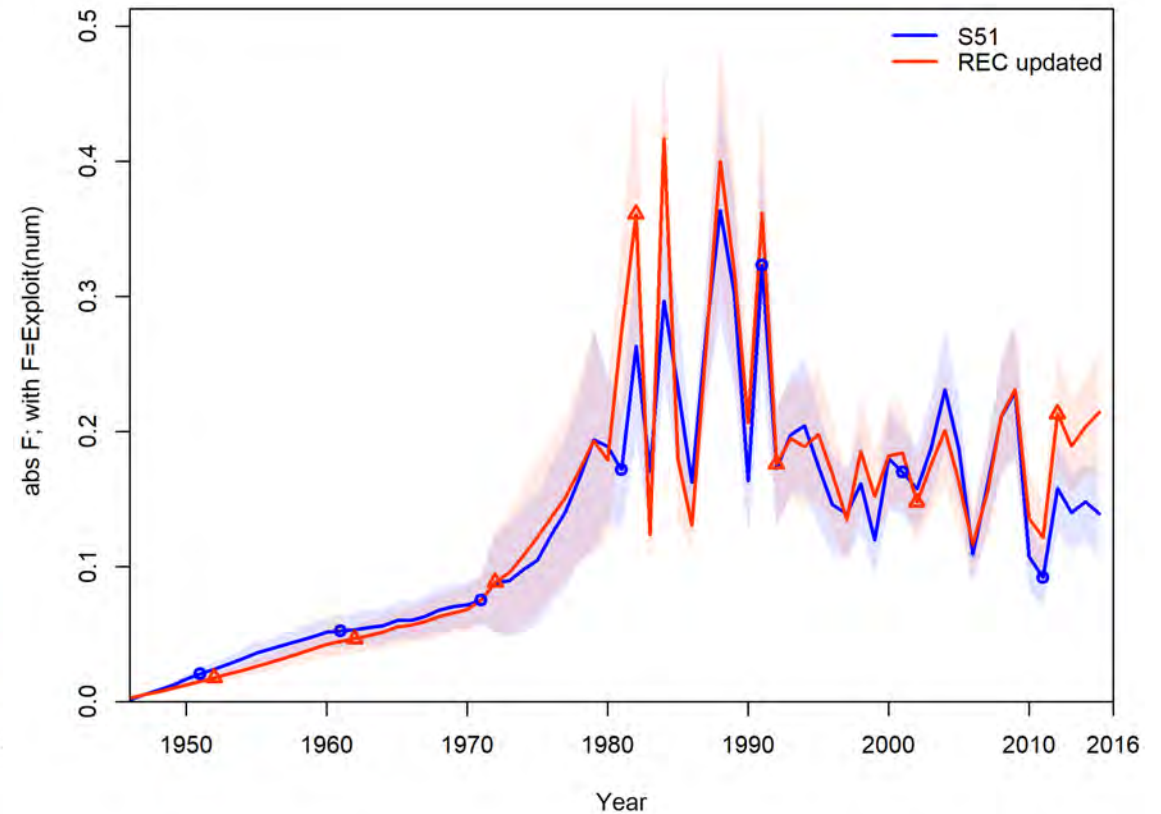
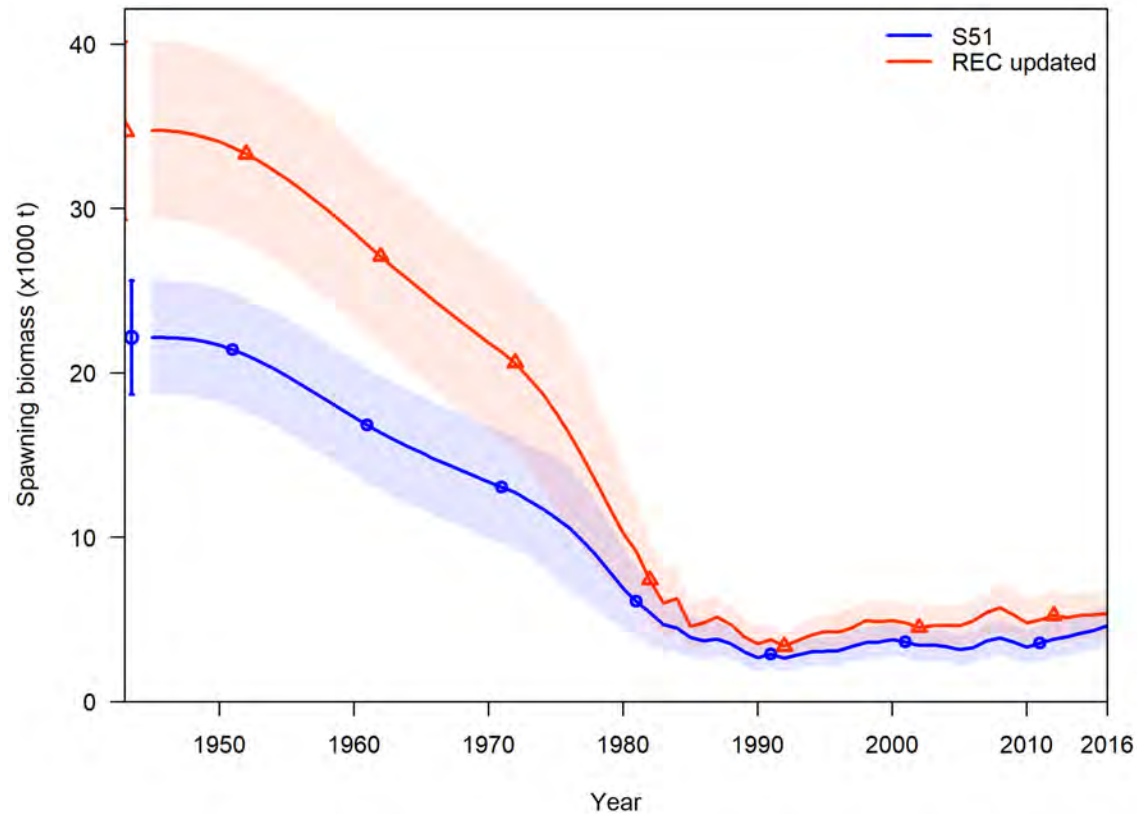
With 1984 stratum



1984 stratum replaced with 1986

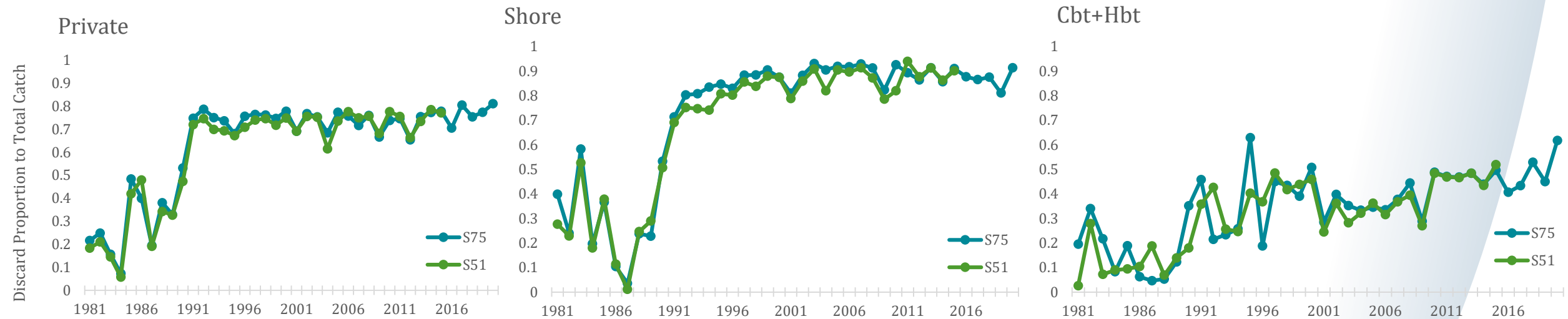


Updated REC landings S51

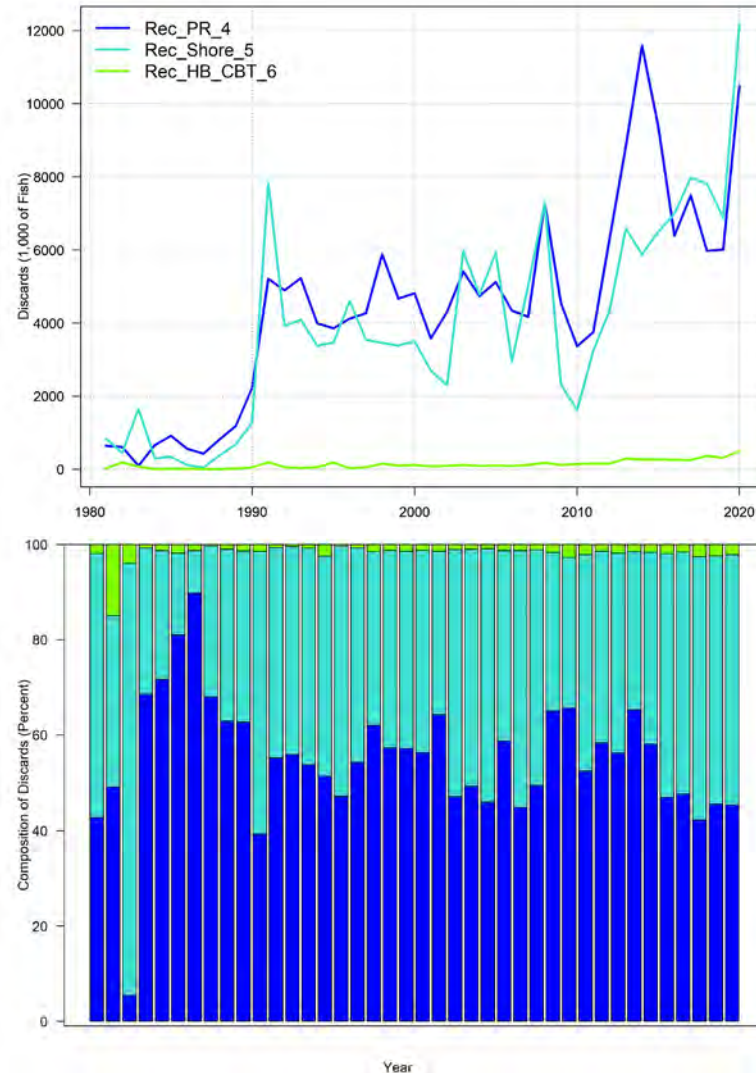
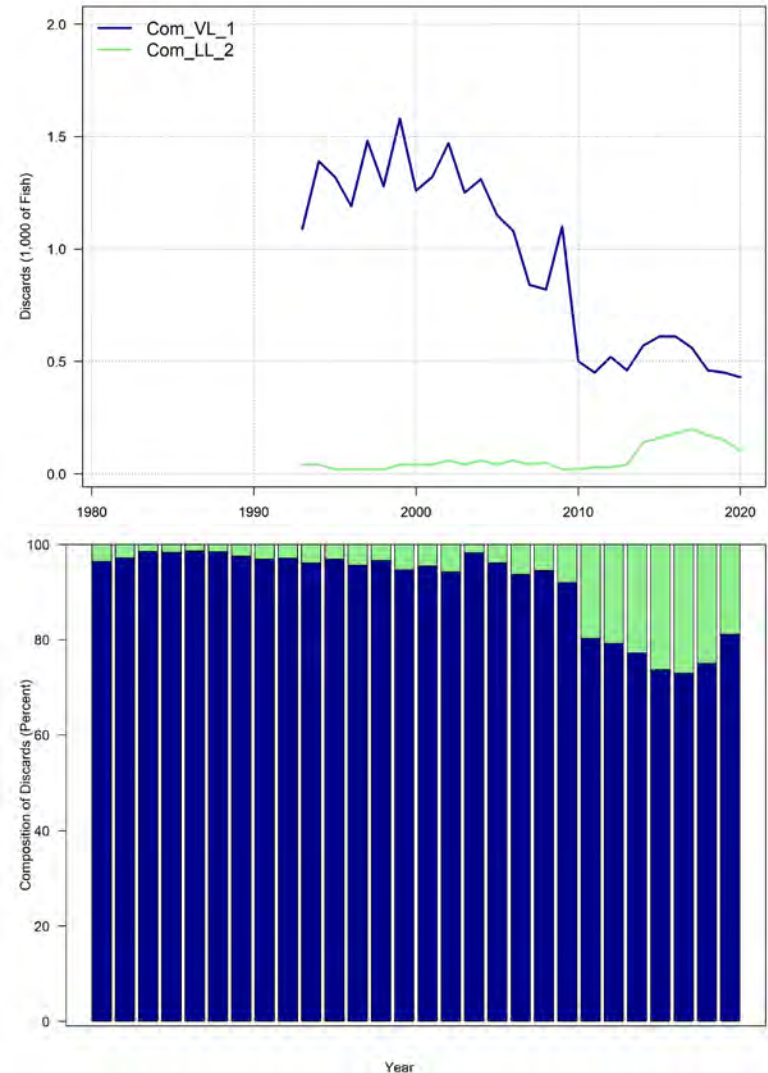


Discards

- S51 assessment model: annual proportion of discards used rather than absolute magnitude
- Minimal differences in proportions after calibration



Discards



Fleet	Discard Mortality Rate
Commercial	14%
Recreational	6.9%

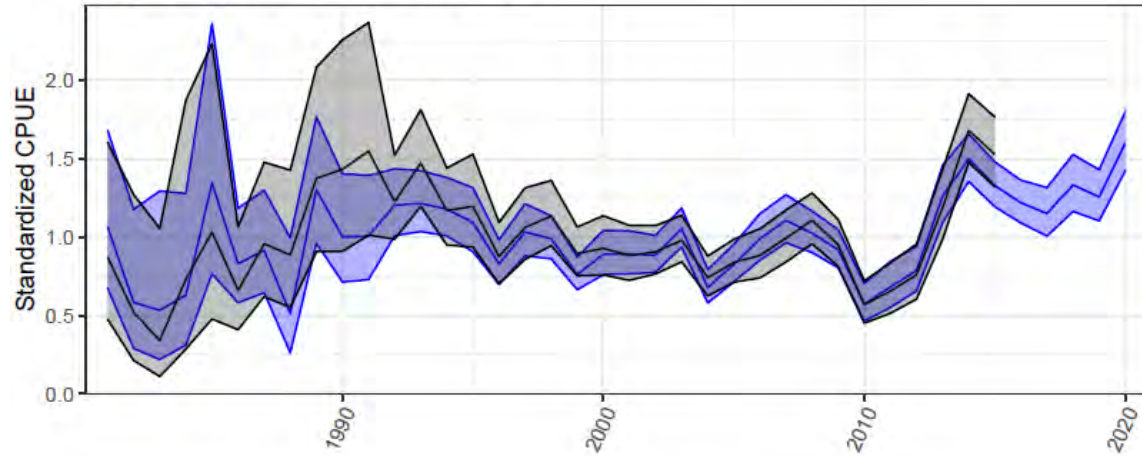
- Insufficient sample size available for discard length composition
- Discard mortality rates from values recommended S51 Data Workshop



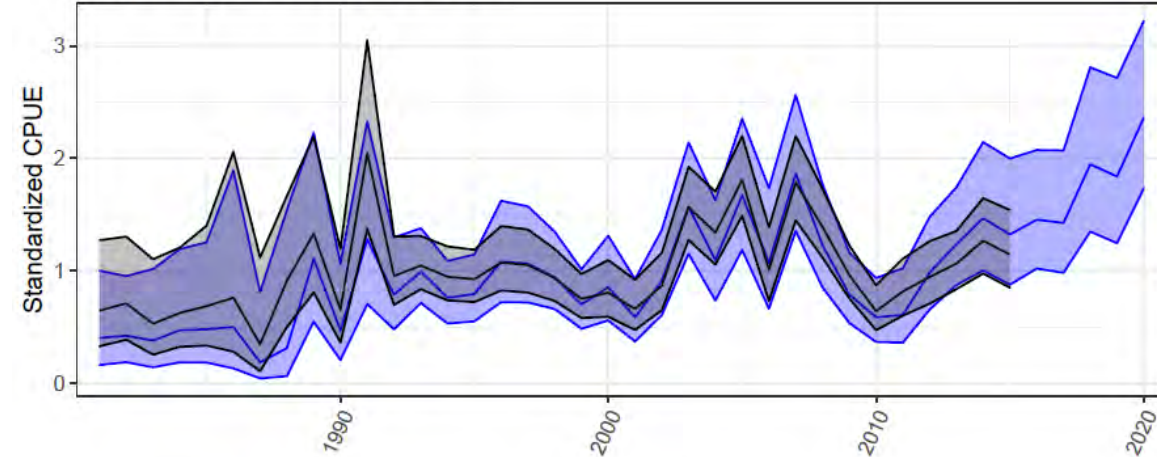
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Indices – Fishery Dependent

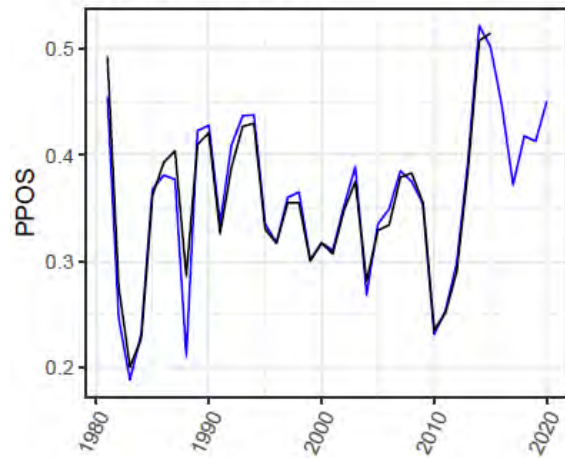
Gray Snapper Private Mode FLW



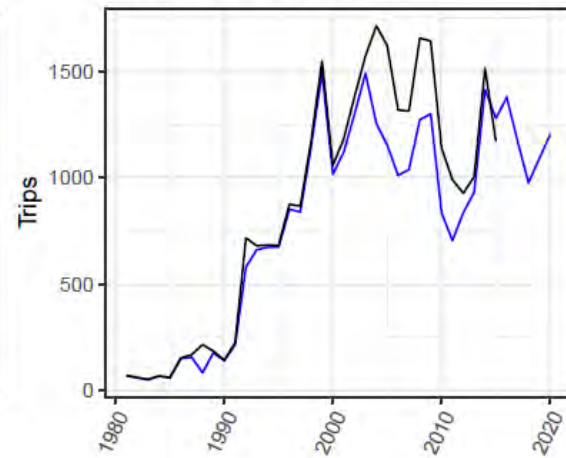
Gray Snapper Shore Mode FLW



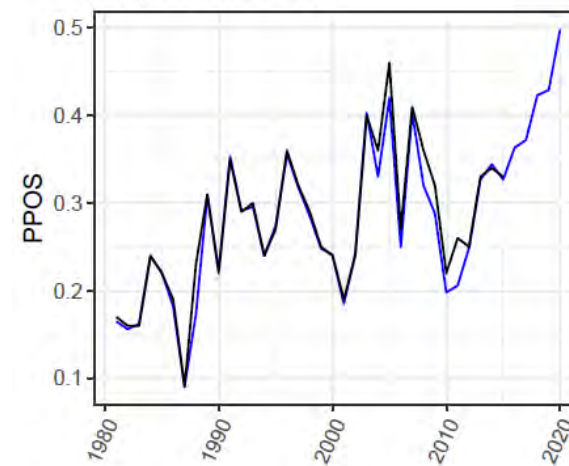
Proportion Positive



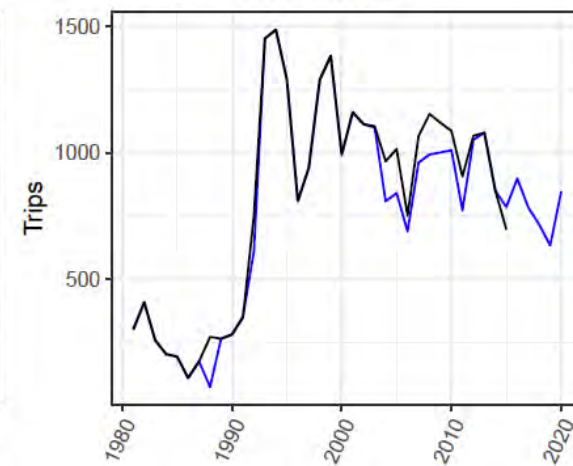
SMAC Selected Trips



Proportion Positive



Guild Selected Trips



Assessment ■ S75 ■ S51

Assessment ■ S75 ■ S51

FWRI Age 0 and Age 1

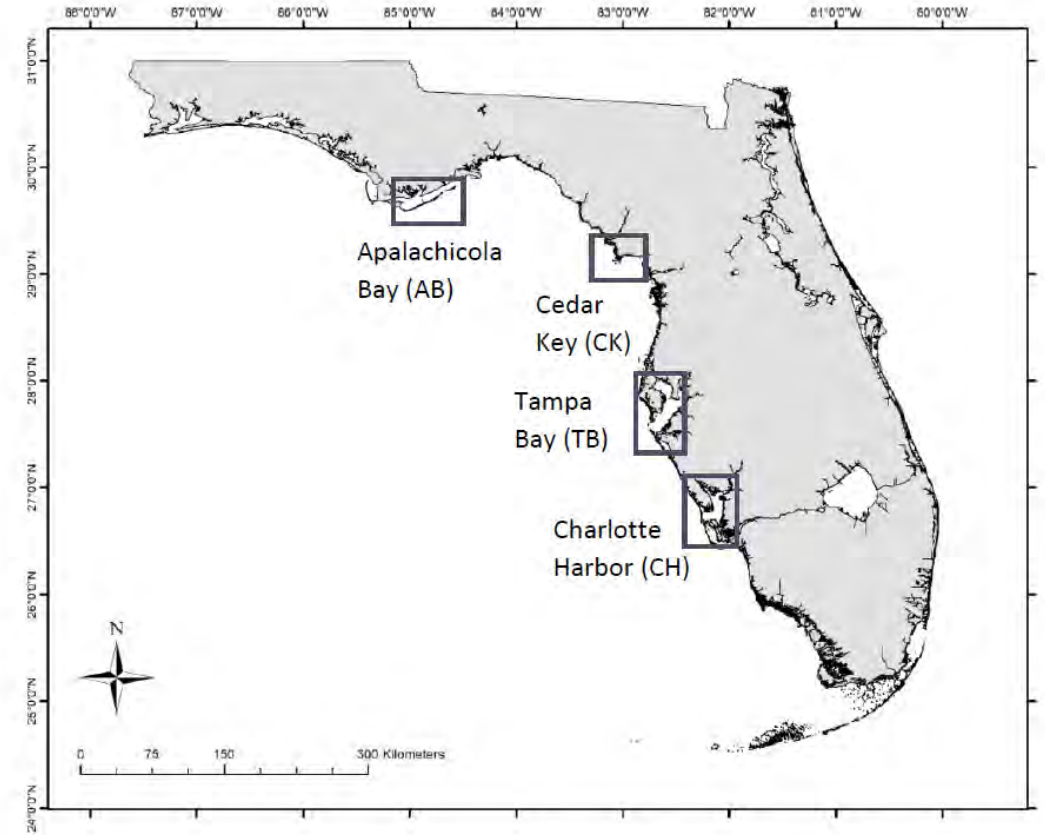
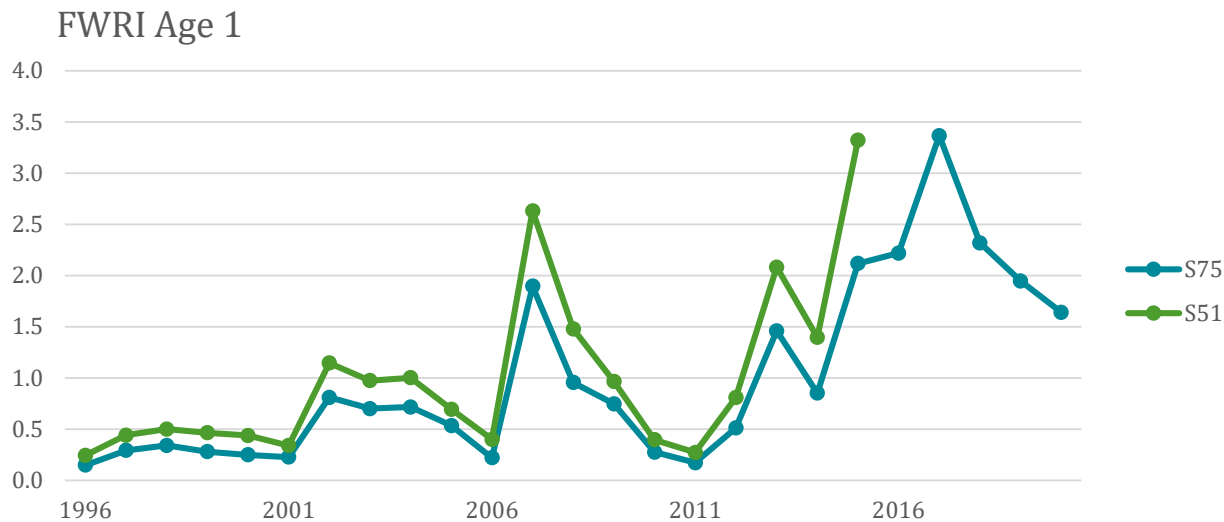
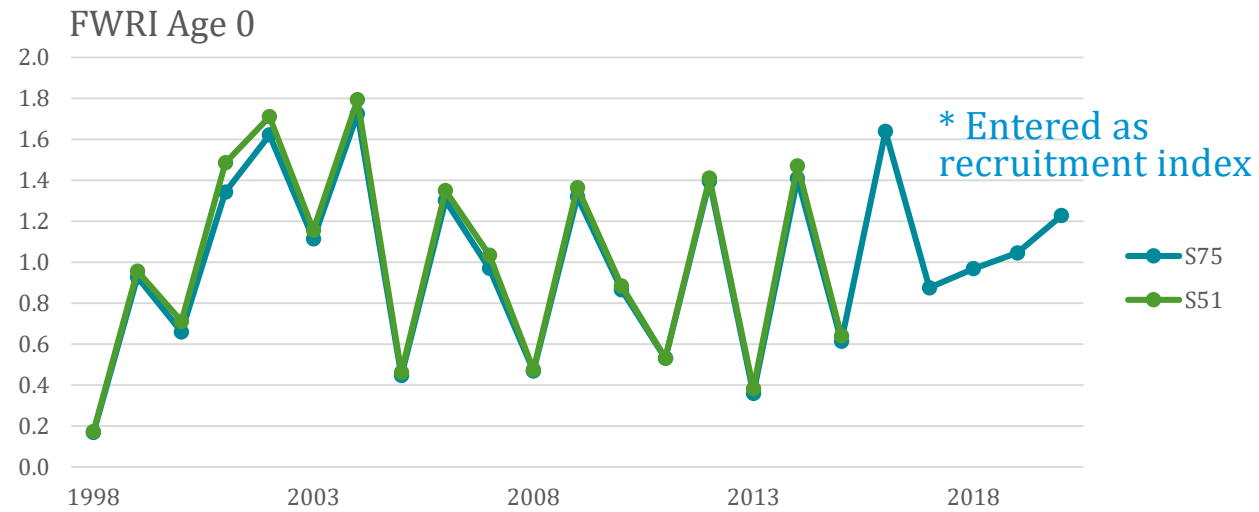


Figure 1. Map of estuaries within which FWRI seine surveys were conducted.

- Working paper: S75-WP-01

SEAMAP Trawl

- Length comps not used in S51
- Working paper: S75-WP-03

SEAMAP Trawl

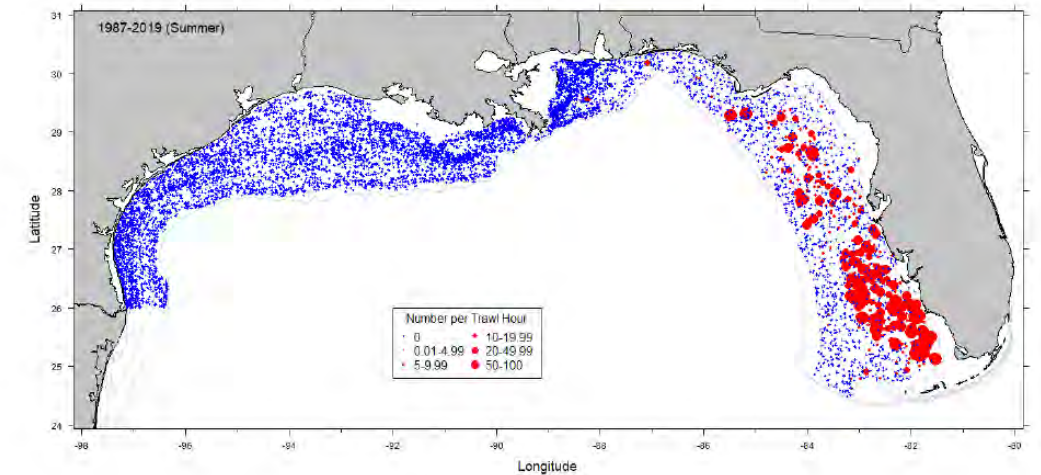
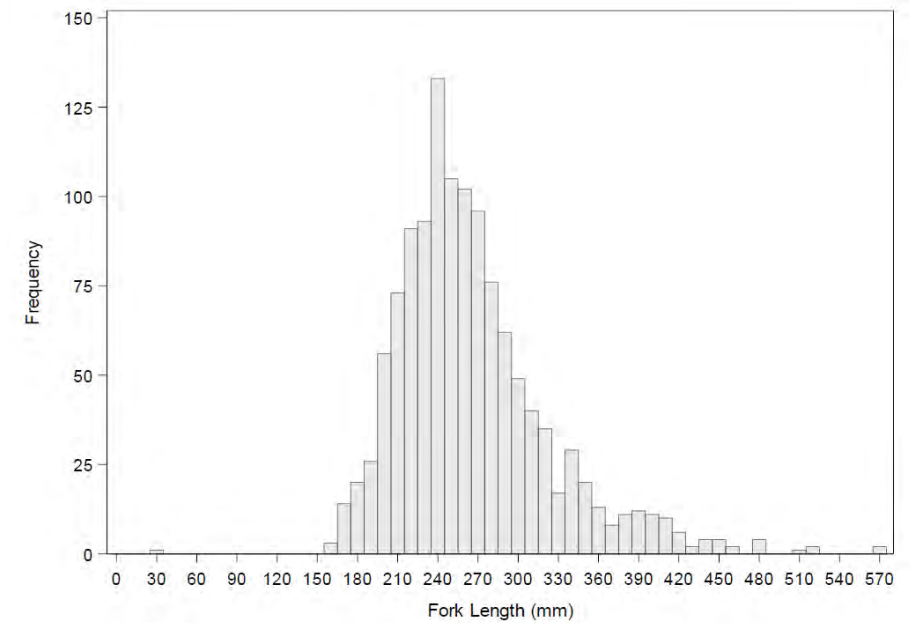
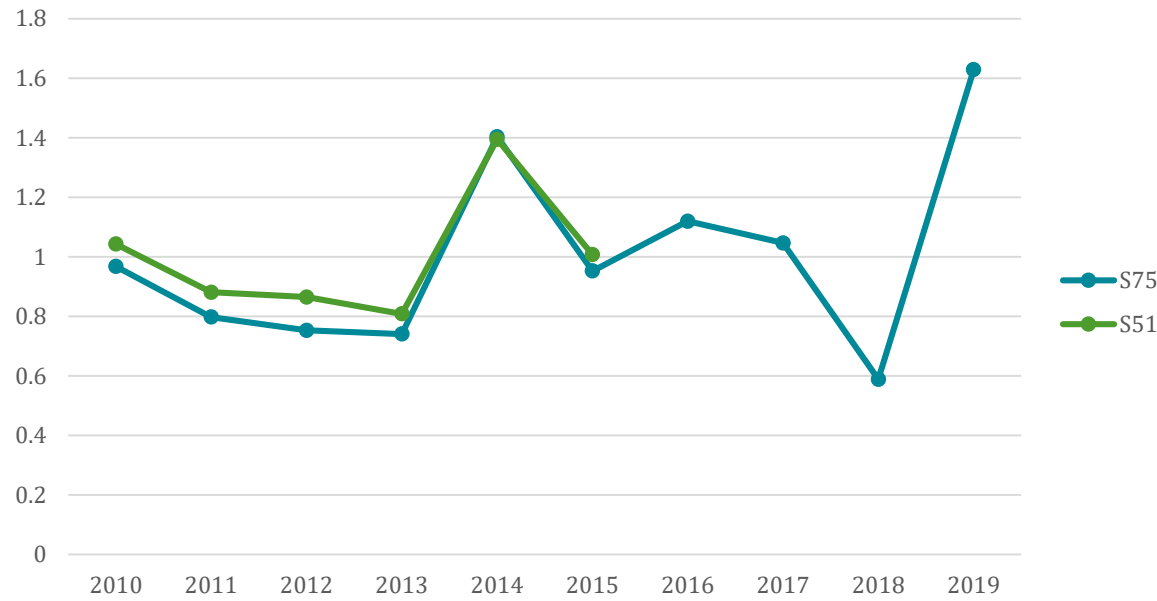
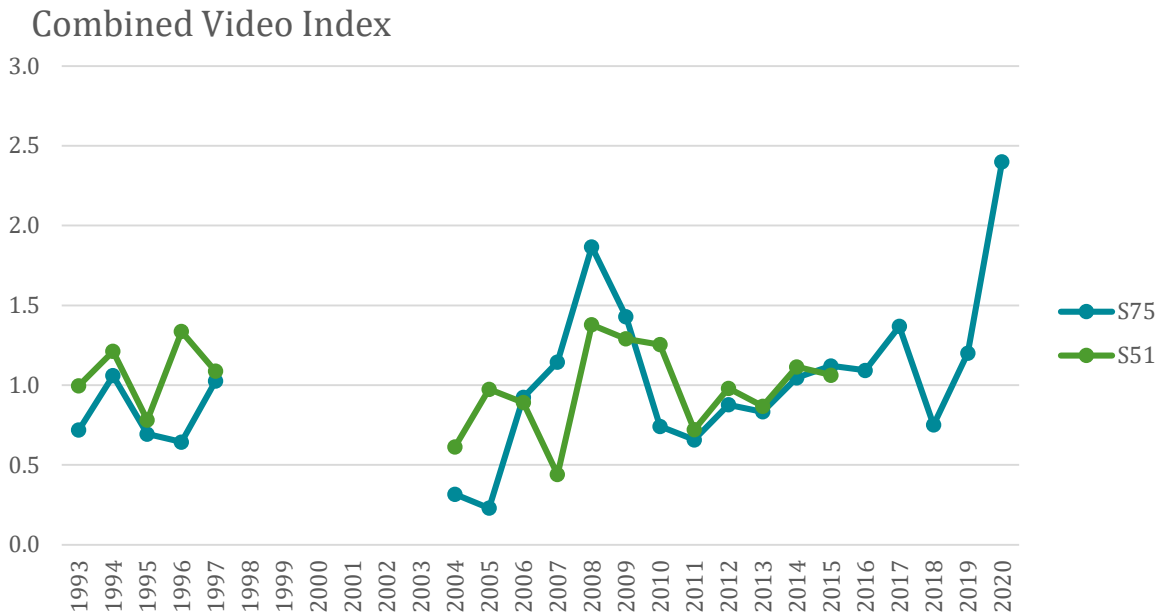


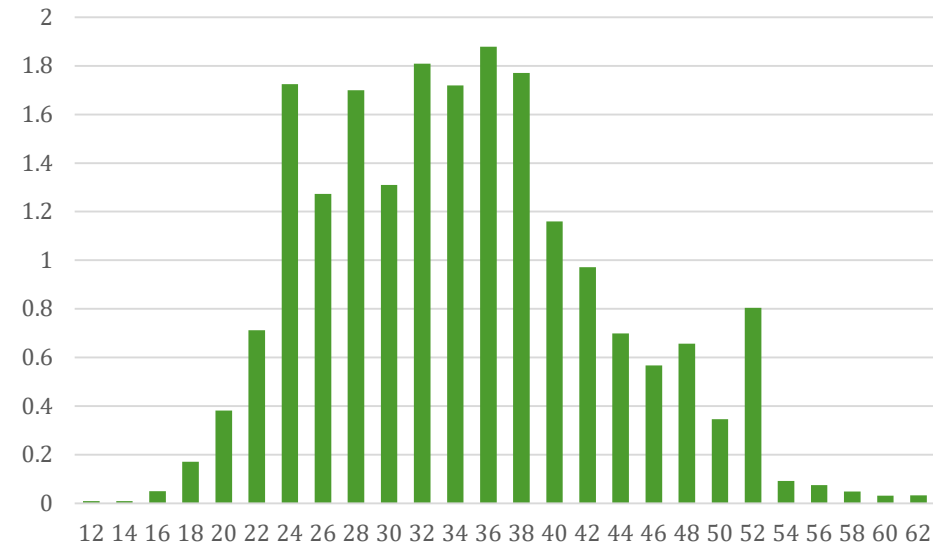
Figure 1. Stations sampled during the Summer SEAMAP Groundfish Survey with the CPUE for gray snapper from 1987-2019.

Combined Video Index

- Combined video index:
 - NMFS SEAMAP reef fish video survey (1993-1997, 2002, and 2004+)
 - NMFS Panama City lab survey (2005+)
 - Florida Fish and Wildlife Research Institute video survey (2010+).



- Length comps not used in S51



Reef Fish Visual Census

- Not conducted in 2013, 2015, 2017, 2019-2020
- Length comps not used in S51
- Working paper: S75-WP-06

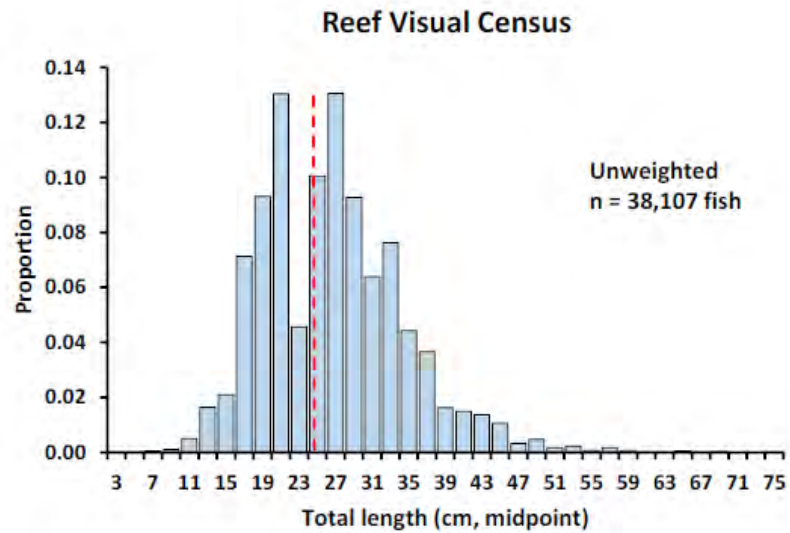


Figure 7. The distribution of total lengths of Gray Snapper estimated *in situ* by Reef Fish Visual Survey divers along the Florida reef track including the Dry Tortugas from 1997 to 2018. The red dashed line is Florida's minimum size limit (10 inches or 25.4 cm).

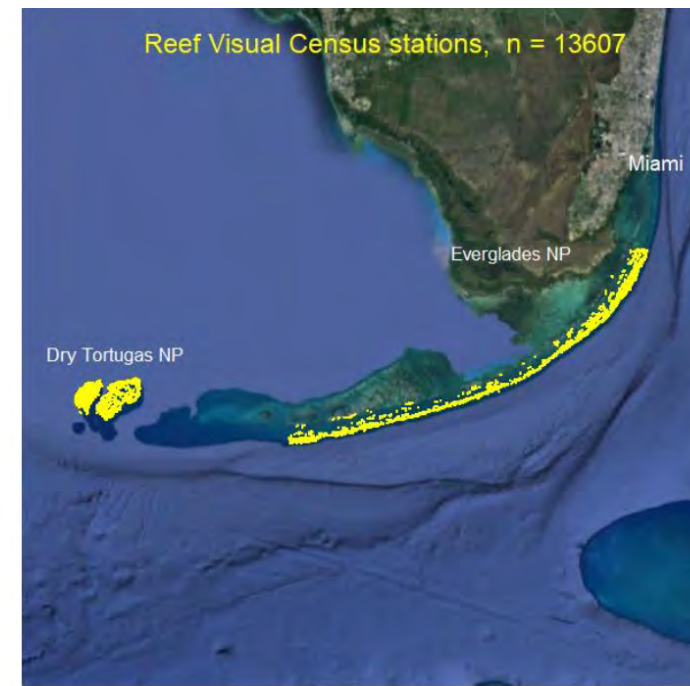
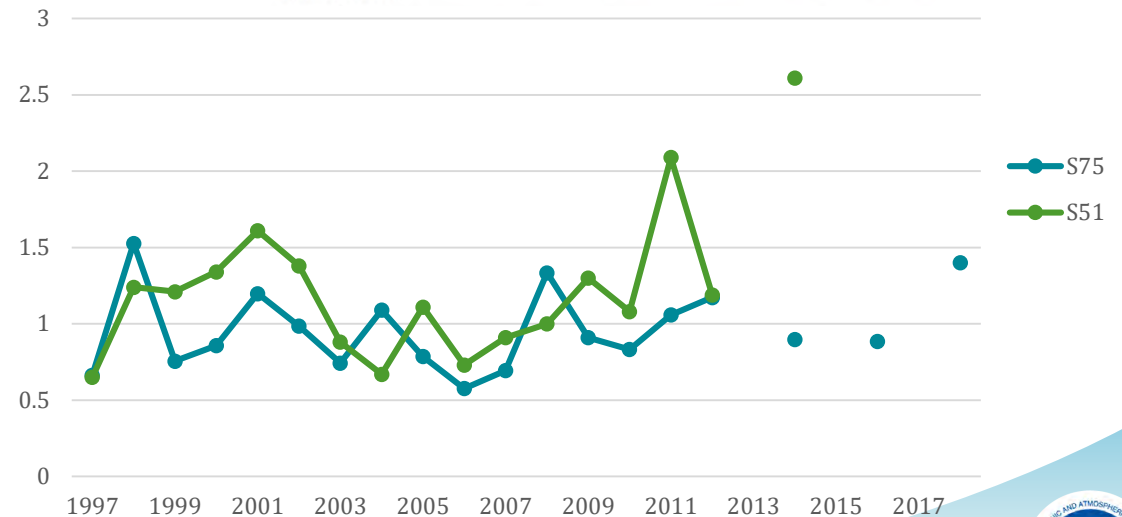
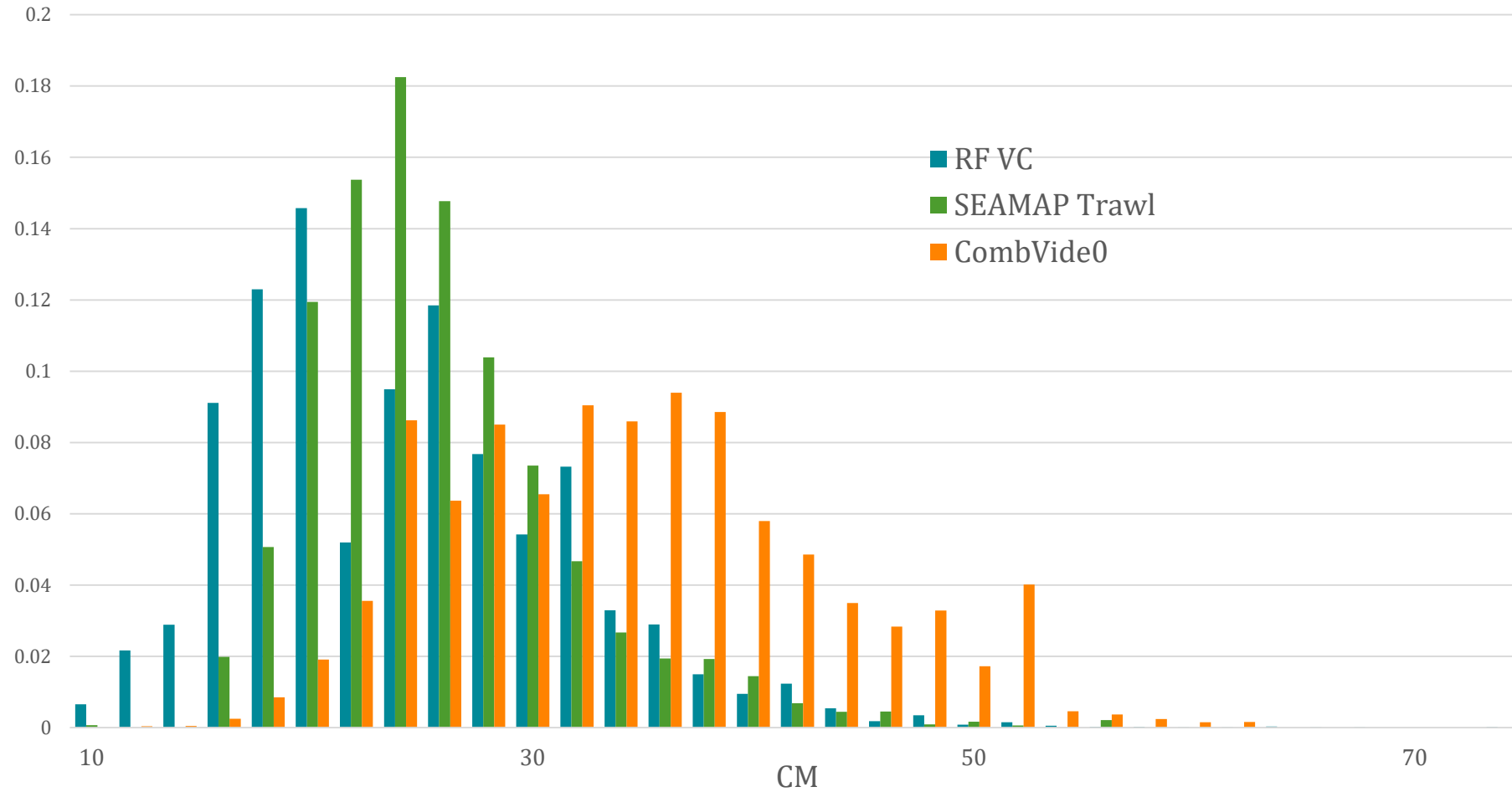


Figure 1. Reef Visual Census station locations sampled in the Florida Keys including the Dry Tortugas from 1997 to 2018.

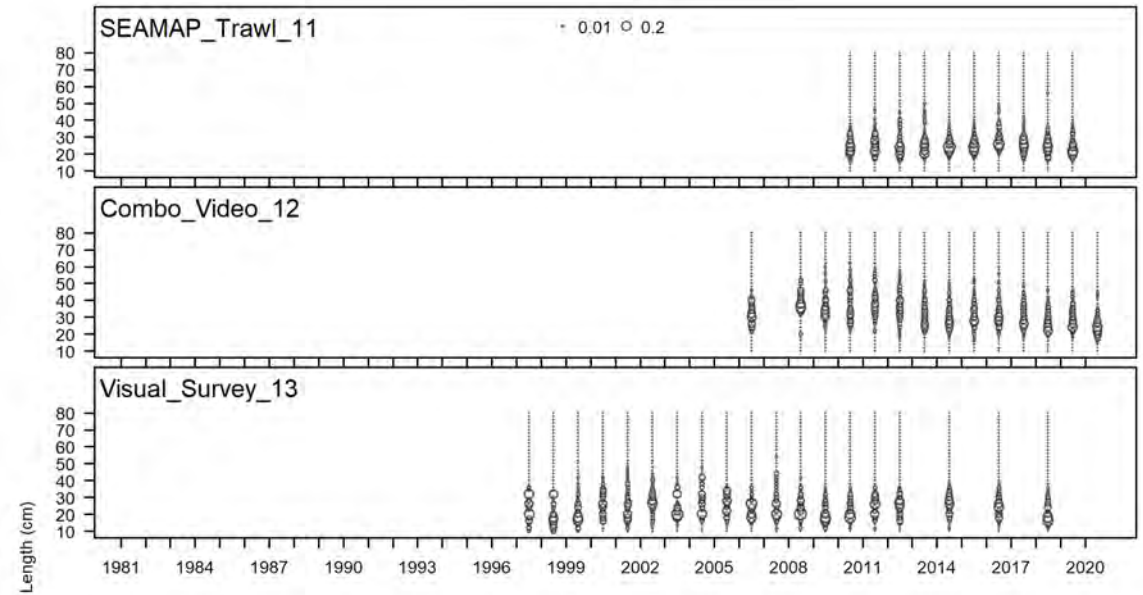
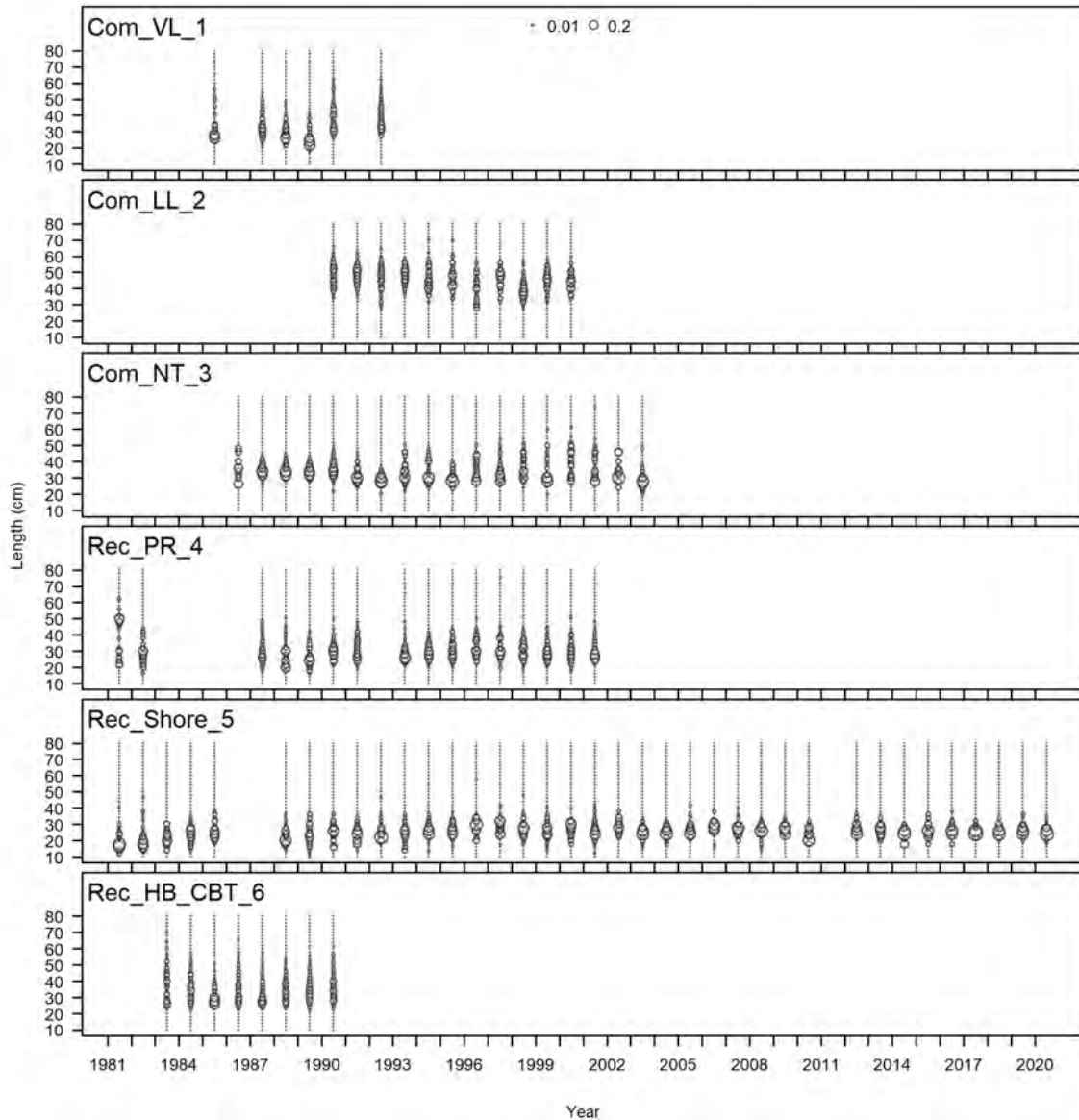


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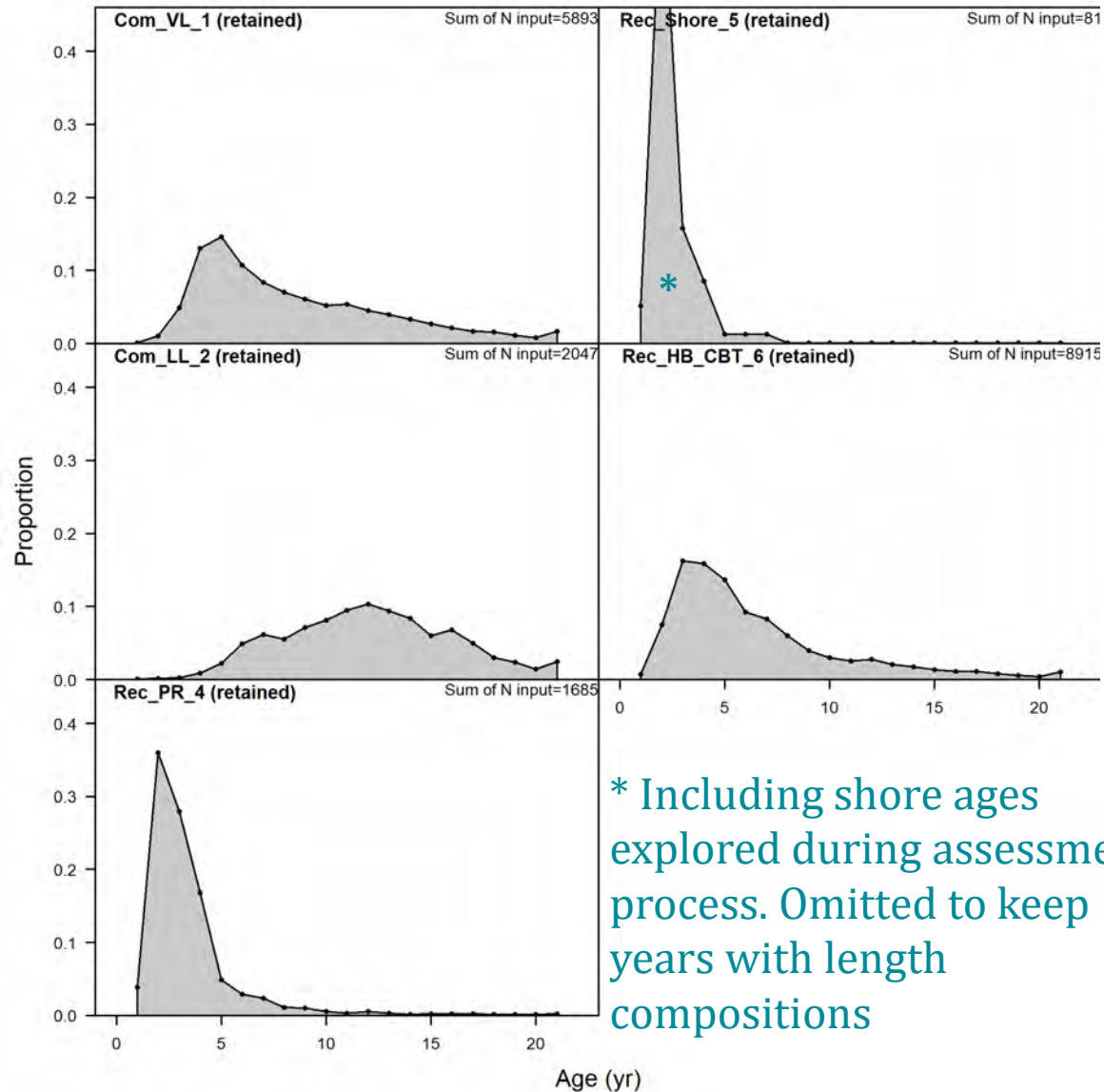
Fishery Independent Length Comps



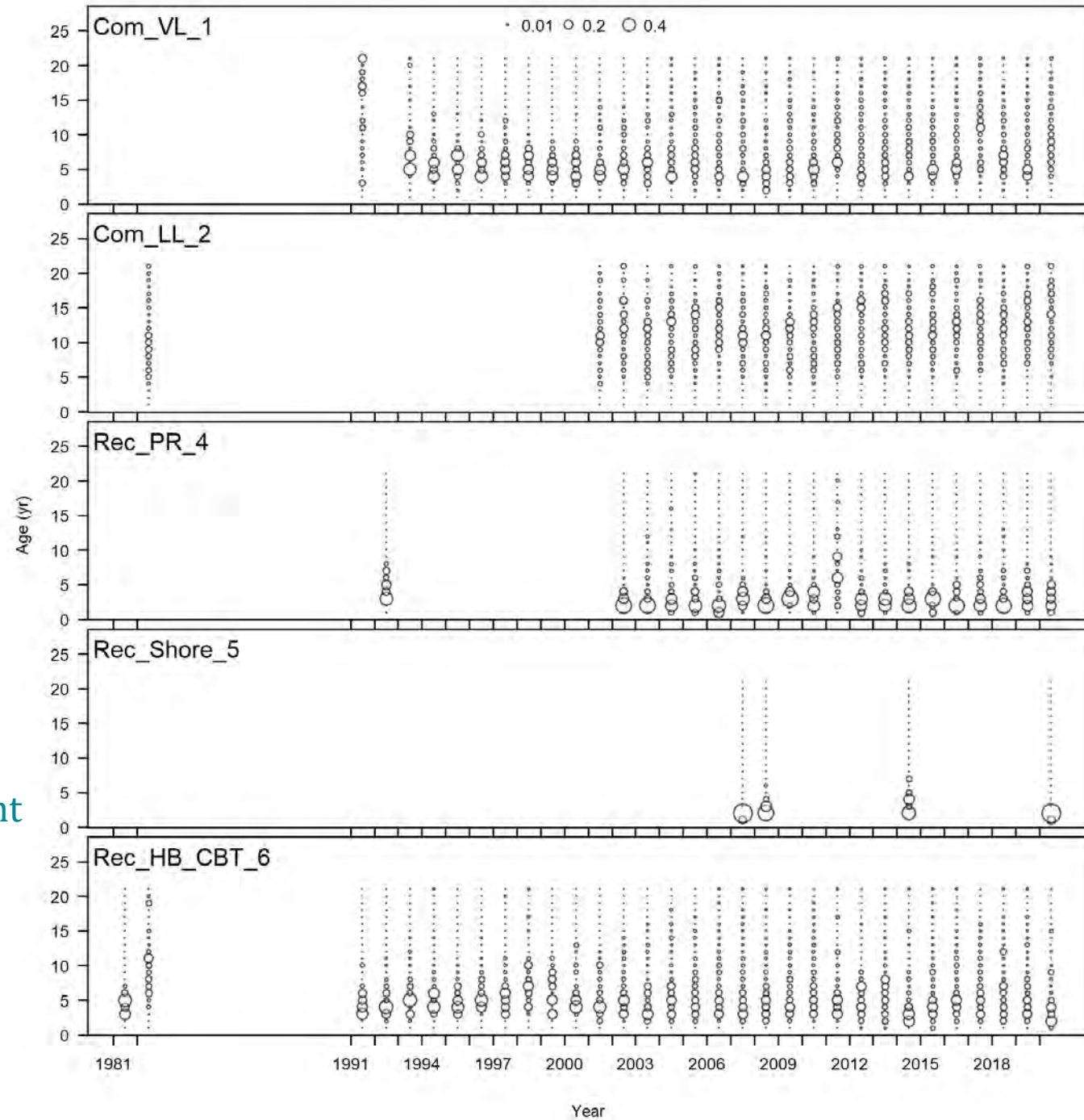
Length Compositions



Age Compositions

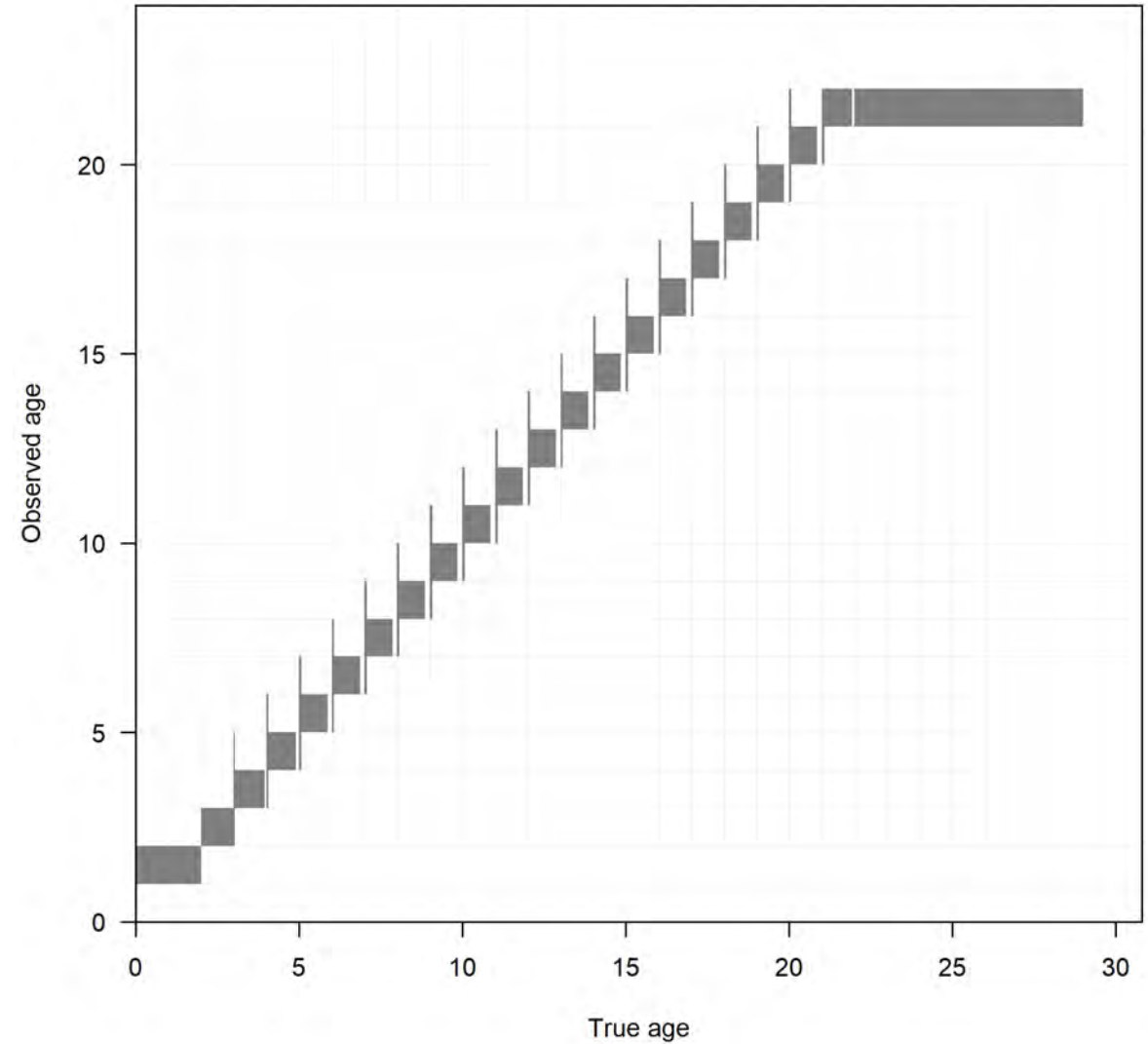


* Including shore ages explored during assessment process. Omitted to keep years with length compositions



Aging Error Matrix

- Assumes error within expert agers
 - No way of knowing whether expert is 100% accurate since no reference set was used with known ages
- Best fitting model chosen based on lowest AIC



SEDAR75 Base Model Development

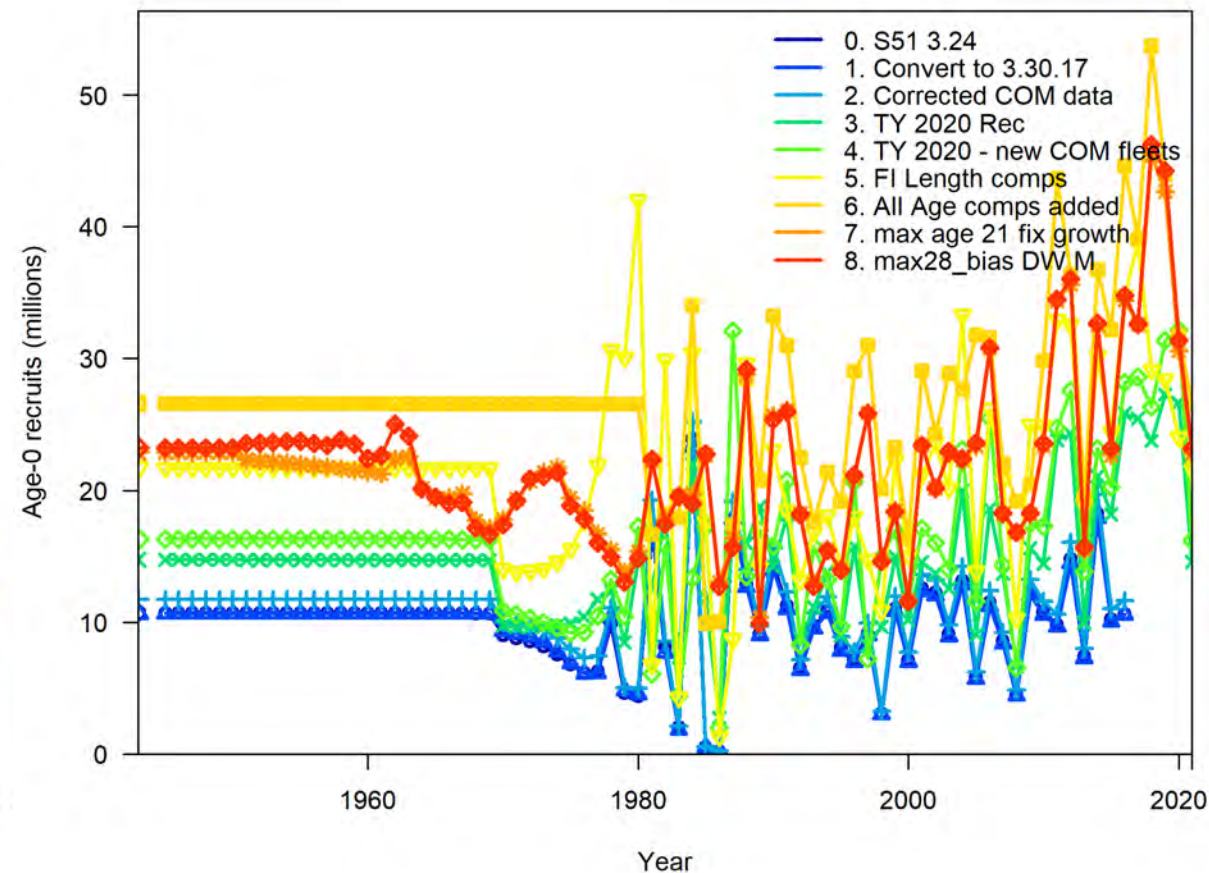
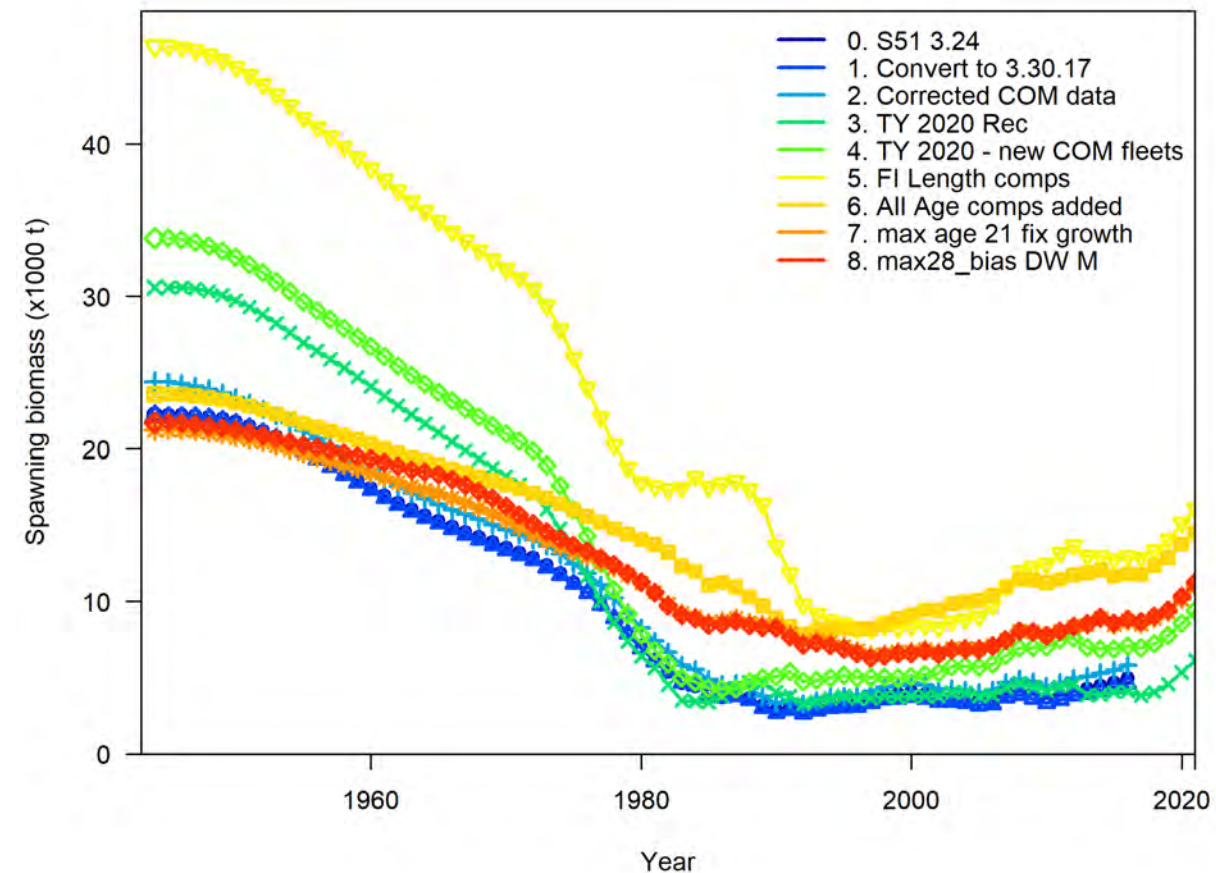


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Updating S51 Assessment Model

Model Details	NLL	Gradient	Estimated Parameters (Bounded)	sigmaR	Ln(R0)
0. SEDAR51 Base Model SS v.3.24	517	0.000	0	0.897	9.28
1. Convert SEDAR51 to SS v.3.30.17	519	0.000	0	0.904	9.27
2. Corrected COM data	513	0.691	0	0.900	9.37
3. Extend Recreational data 2020	2885	0.000	1	0.470	9.6
4. TY 2020 – update COM fleet structure	5962	0.004	2	0.577	9.7
5. Fishery Independent length comps added	12108	0.001	1	0.632	9.99
6. Age comps added	9857	23.400	1	0.313	10.19
7. Max age 21 (growth fixed)	10098	0.011	0	0.322	10.04
8. Max age 28 with bias ramp correction	10096	0.000	0	0.376	10.05

Updating S51 Assessment Model



SEDAR75 Base Model Configuration



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Model Configuration Changes since S51

- Maximum population age of 28 (S51 max population age 21)
 - 21+ group for age compositions
- Estimated Amin, S51 fixed at 15.01
- Recruitment deviations
 - Main recruitment deviations estimated 1981-2020
 - Early recruitment deviations begin 1951
 - S51 estimated 1970-2015
- Time-varying retention to account for changes in size limit regulations
 - Most recent block extended through 2020
- Dirichlet multinomial likelihood used for composition data (Thorson et al. 2017)
 - Francis re-weighting used in S51



Model Configuration Changes since S51

Fleet/Survey	S51	S75	S75 Ages
Vertical Line (MC VL)	Dome	Dome	Dome
Longline	Dome	Dome	Dome
Nets & Traps (nMC VL)	Dome	Dome	
Private	Dome	Dome	Dome
Shore	Dome	Dome	
Charter & Headboat	Dome	Dome	Dome
Age 0	Recruitment	Recruitment	
Age 1	-	Selex = 1 all sizes	
SEAMAP Trawl	Recruitment	Dome	
Combined Video	-	Logistic	
RF Visual Survey	-	Dome	

Mirroring S75/S51:

- Private Index
 - Mirror private age selectivity
 - S51 mirror private length selectivity
- Shore Index
 - Mirror shore length selectivity
- Age 1 mirrored shore length selectivity
- Video index mirrored private length selectivity
- Visual Survey mirrored private length selectivity

SS model configuration

- Age selectivities estimated with loose symmetric beta priors
- Used Continuous F method
 - Recommended where catch is known imprecisely
- Stock assumed to be at unexploited equilibrium level at start of time series, as in S51
- Fishery-dependent indices CV scaled to common mean of 0.2
- Modeled time-varying retention to account for changes in management regulations
- Assumed all fish caught before size limits were retained
- Estimating inflection points and width parameters first time block
- Asymptote:
 - Commercial: assumed full retention above federal size limit
 - Recreational: assumed full retention above FL size limit



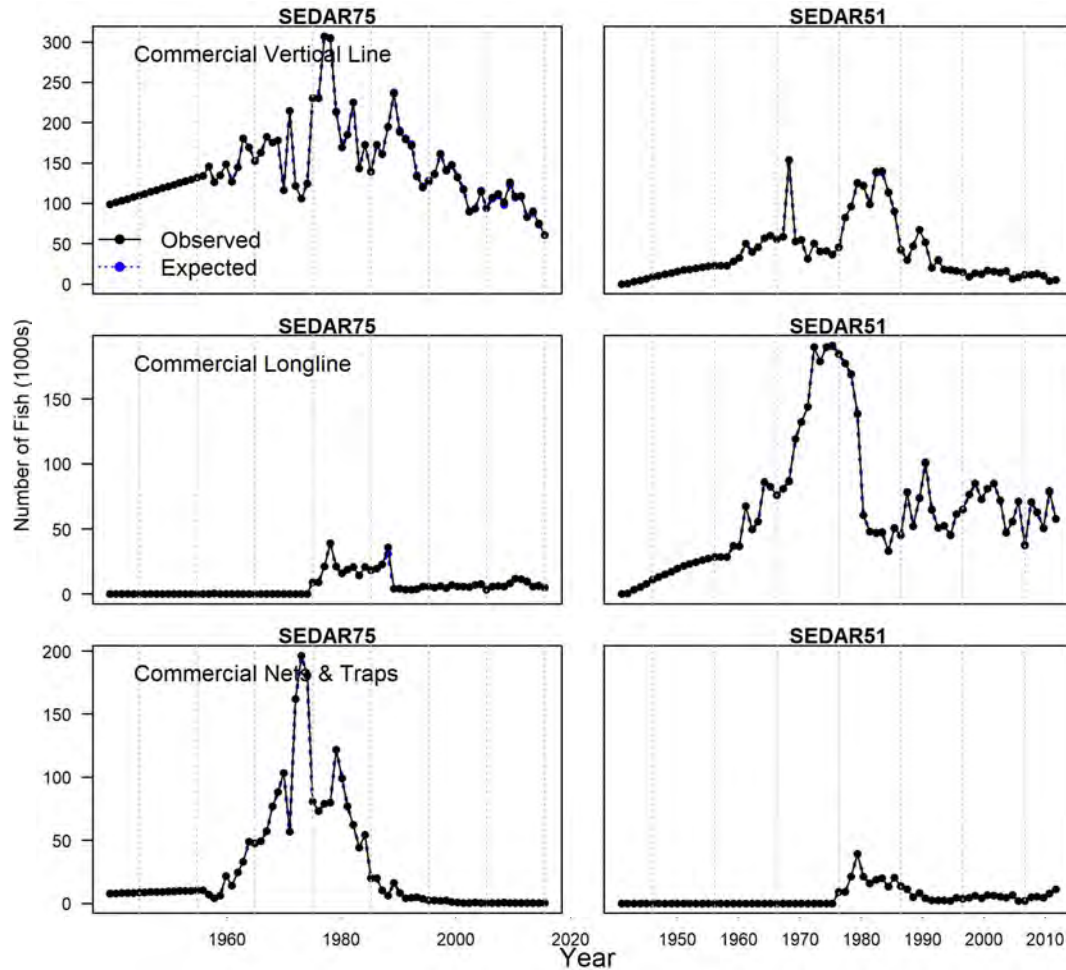
Assessment model results



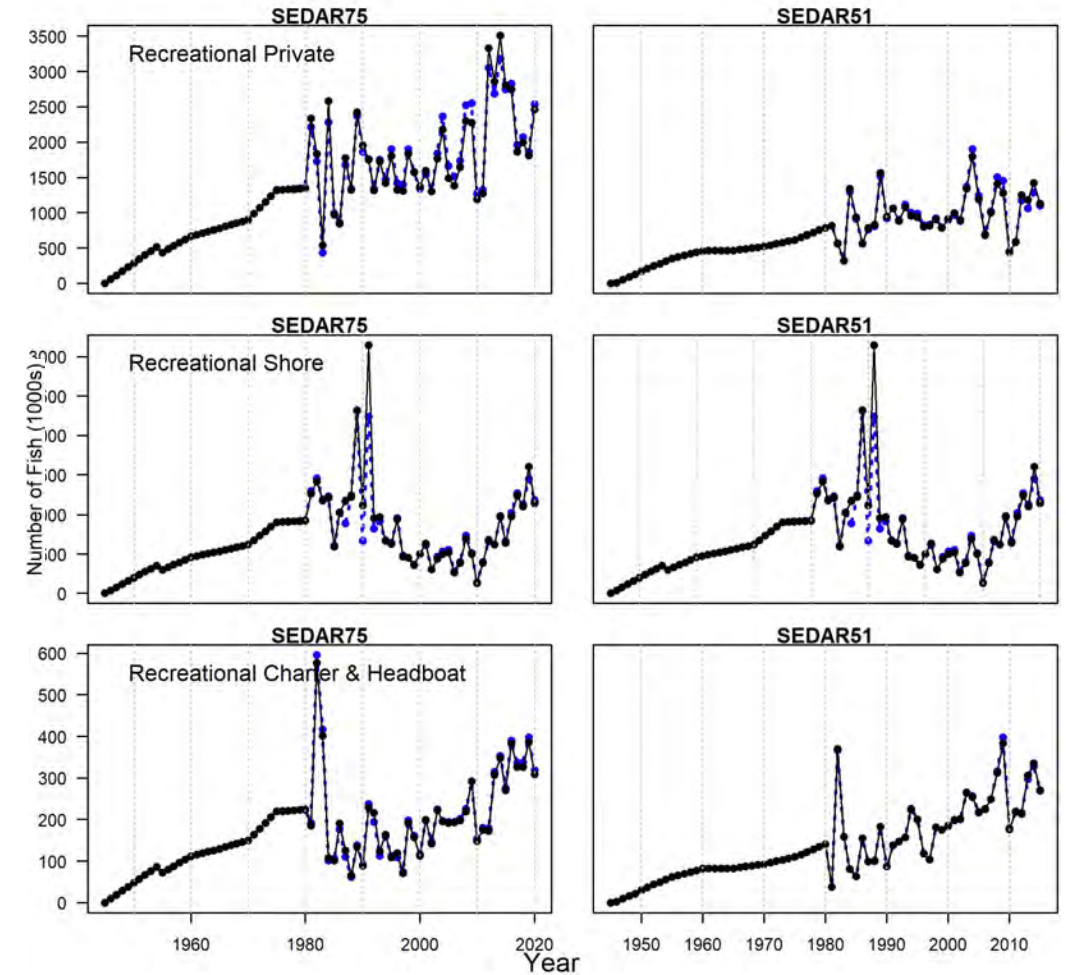
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Landings

- Commercial SE = 0.05
 - Same as S51



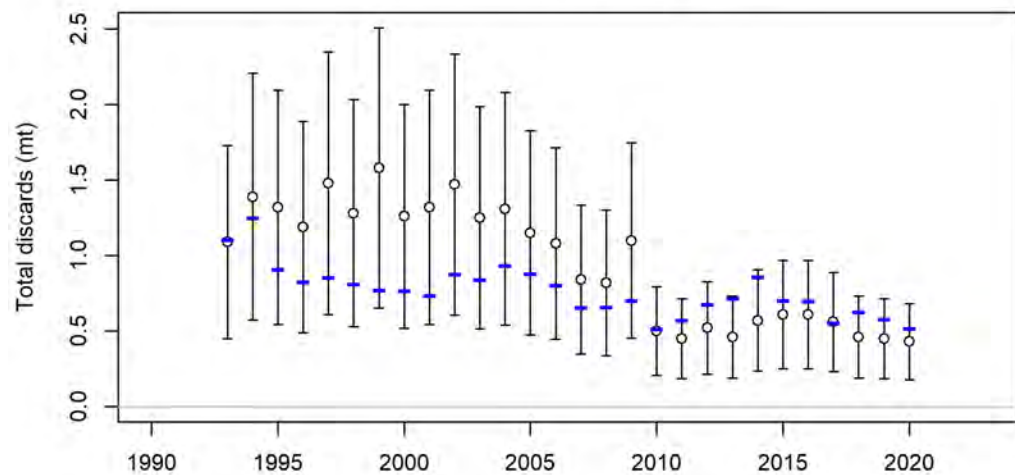
- Recreational SE fixed at 0.1
 - Same as S51



Discards - Commercial

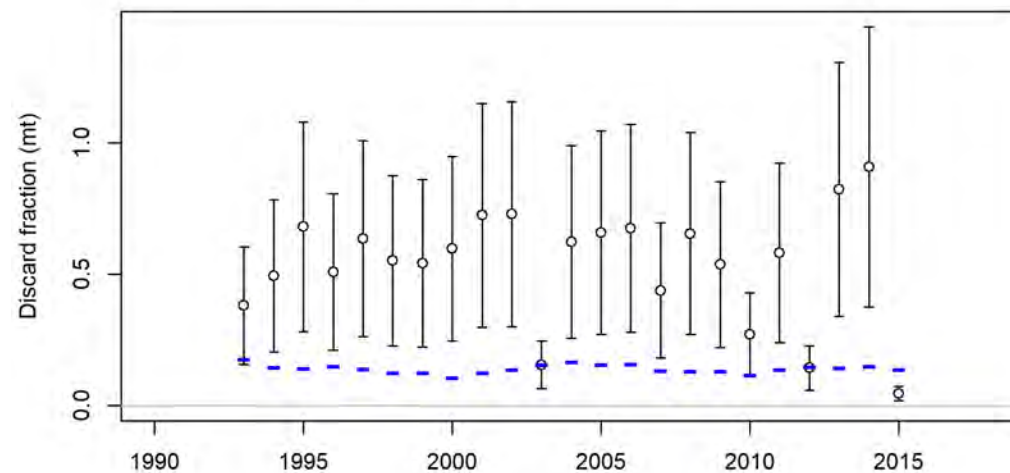
SEDAR75

Total discard for Com_VL_1

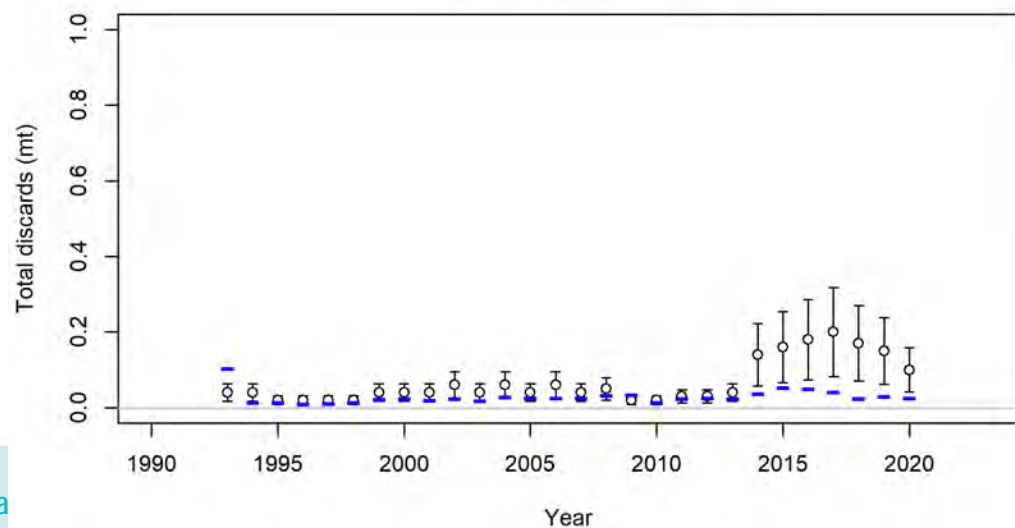


SEDAR51

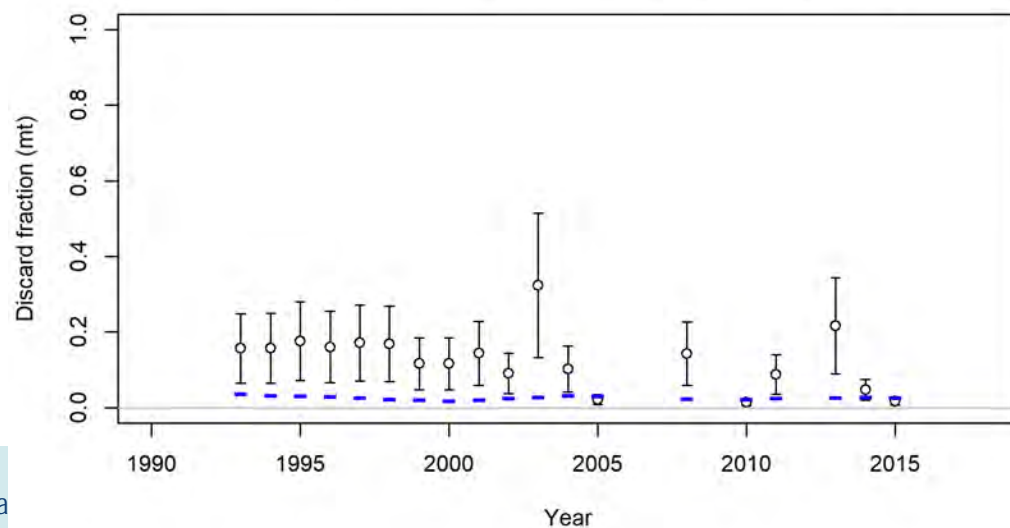
Discard fraction for Commercial Monroe County



Total discard for Com_LL_2



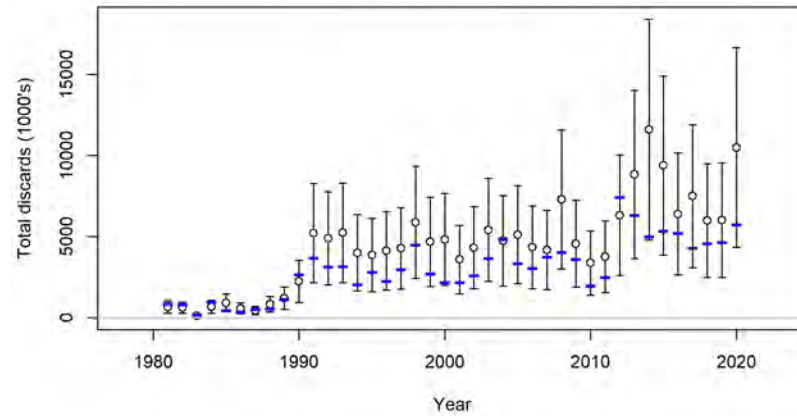
Discard fraction for Commercial not Monroe County



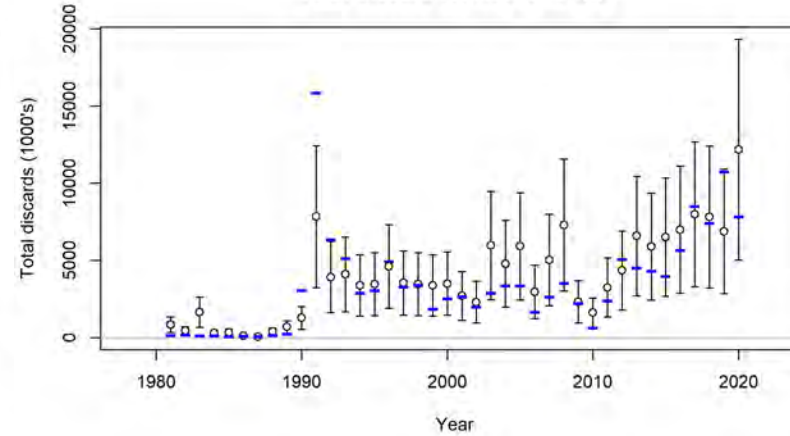
Discards – Recreational

SEDAR75

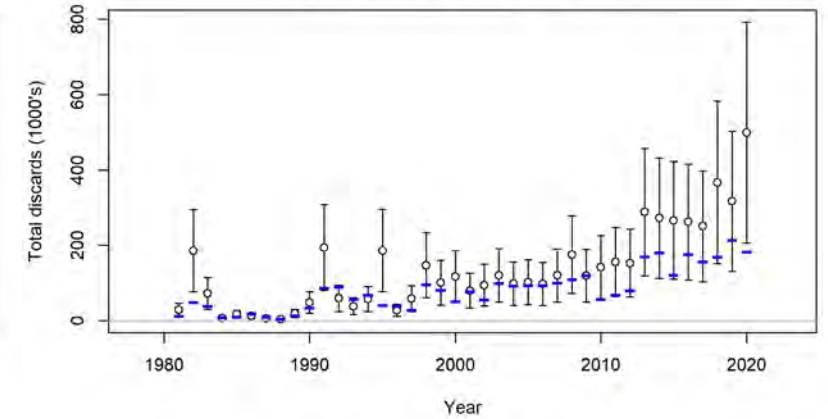
Total discard for Rec_PR_4



Total discard for Rec_Shore_5

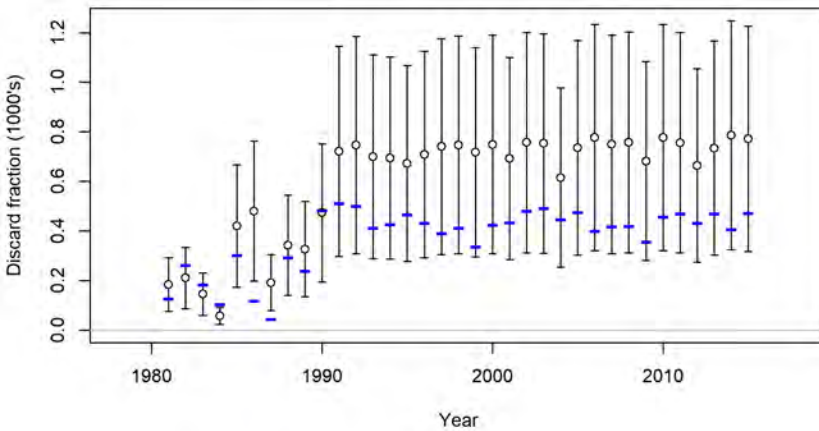


Total discard for Rec_HB_CBT_6

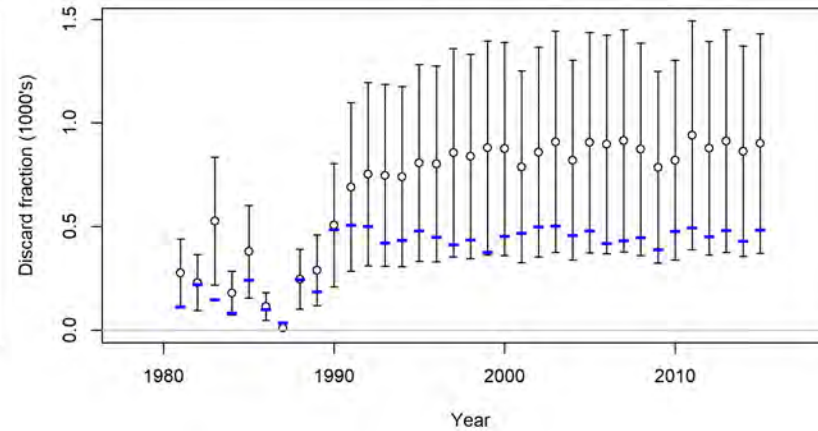


SEDAR51

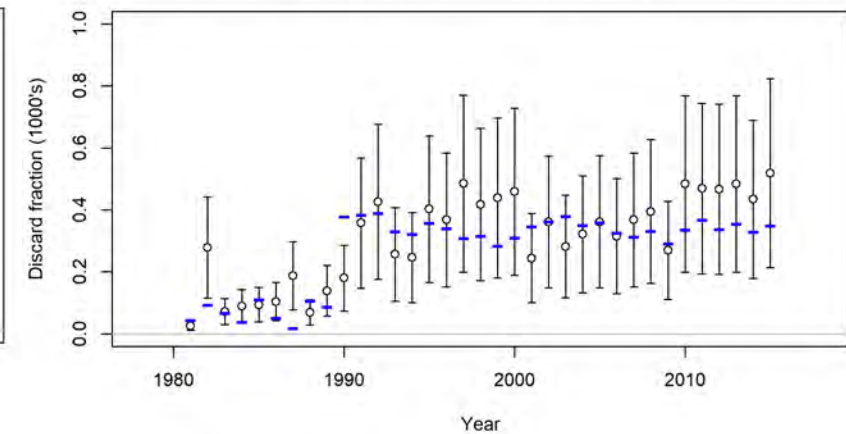
Discard fraction for Recreational Private



Discard fraction for Recreational Shore

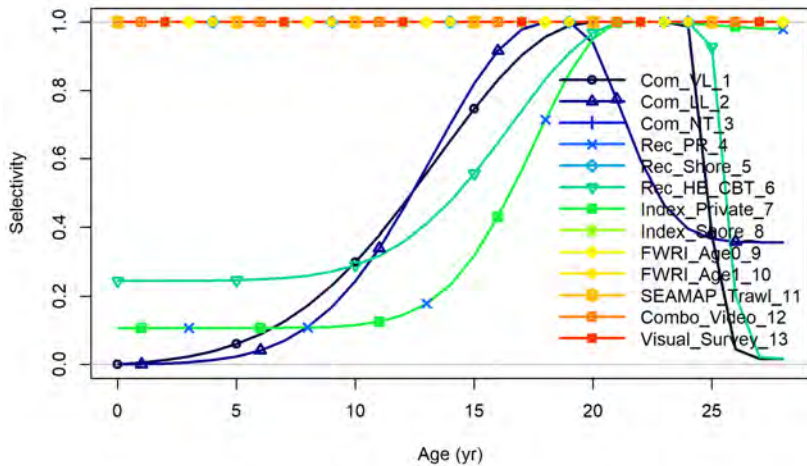
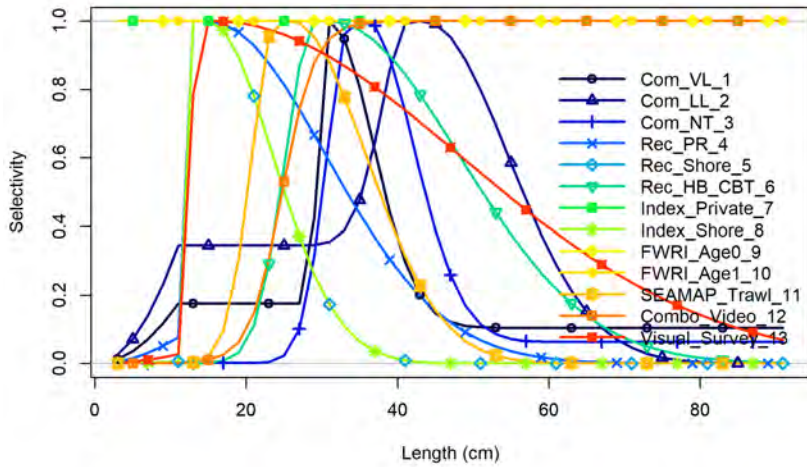


Discard fraction for Recreational Charter & Headboat

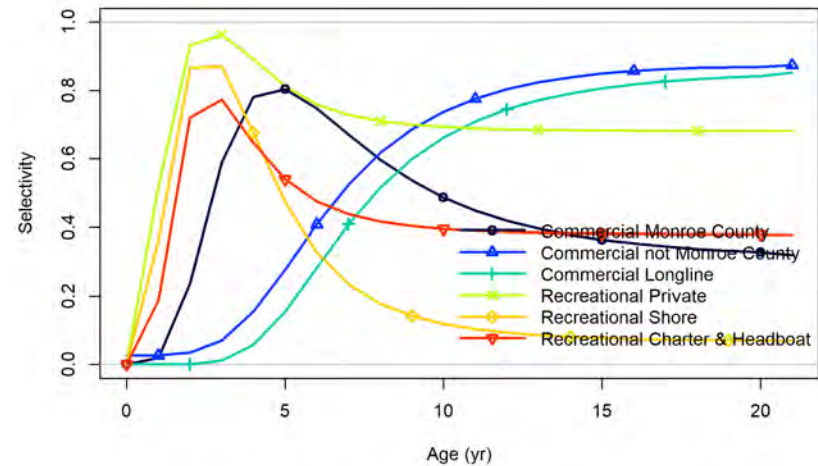
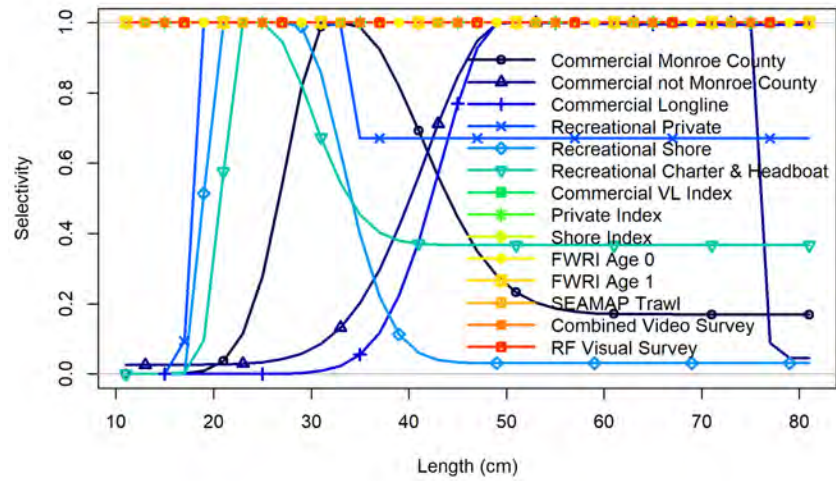


Selectivity

SEDAR75

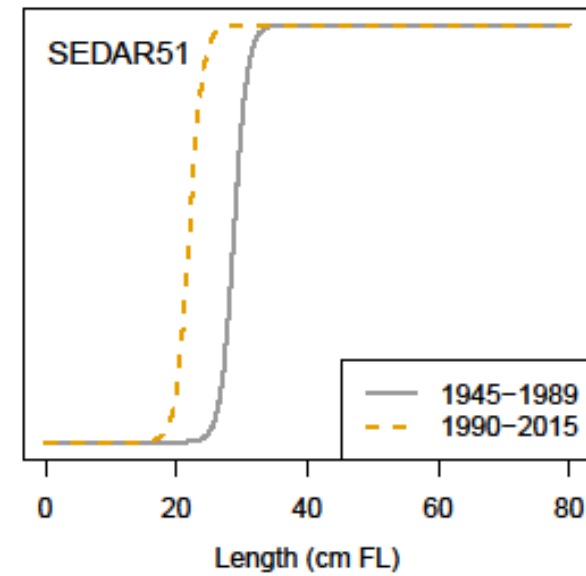
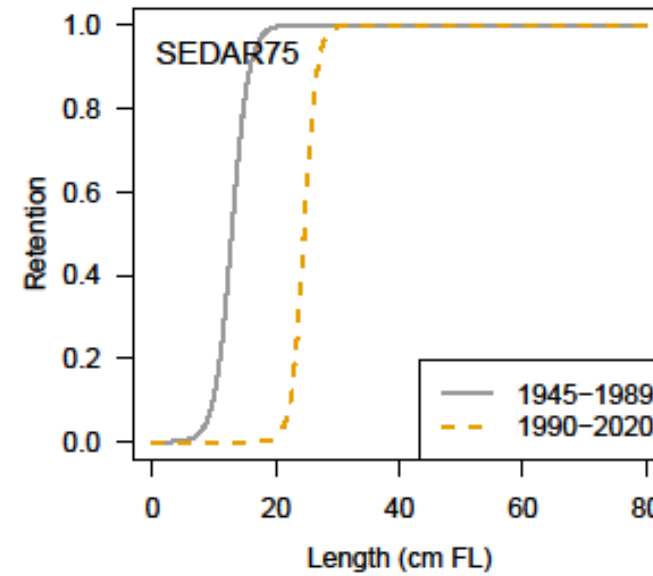


SEDAR51

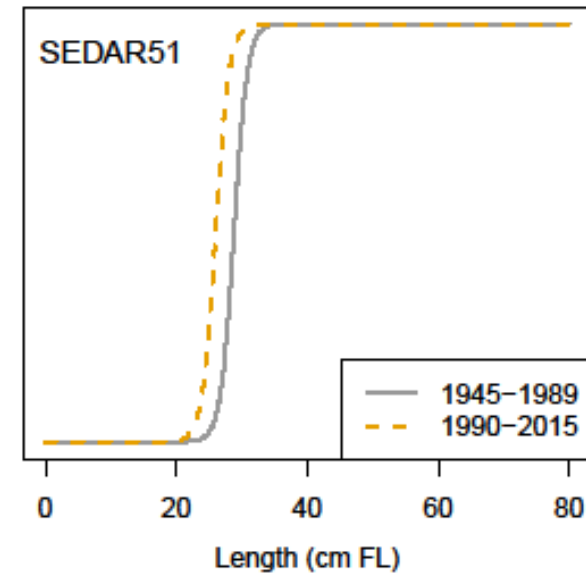
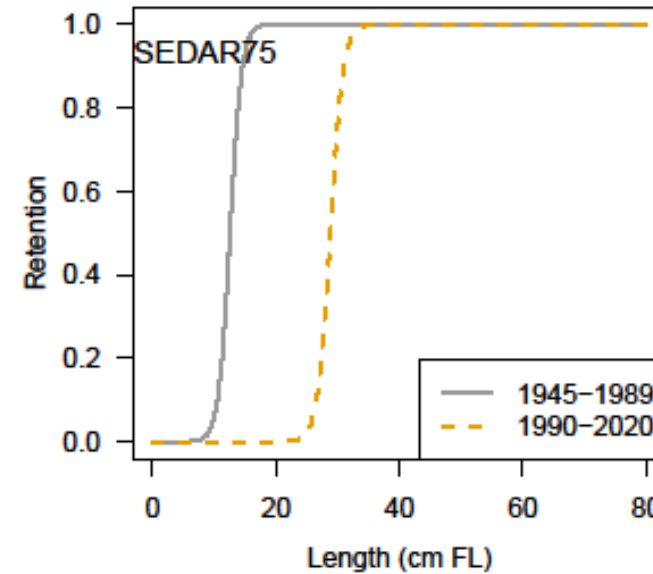


Fleet Retention

Vertical Line/Monroe County VL

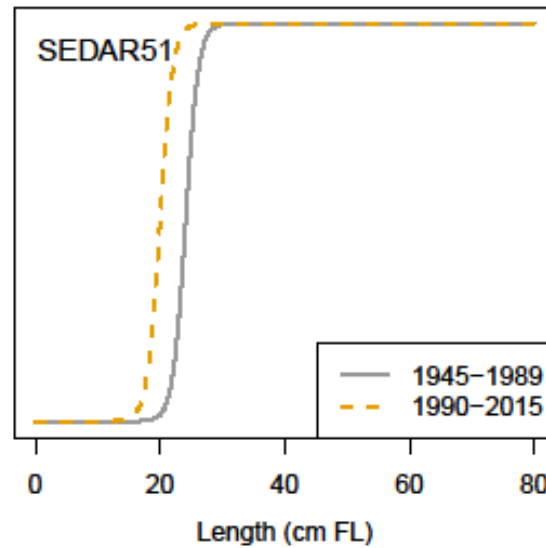
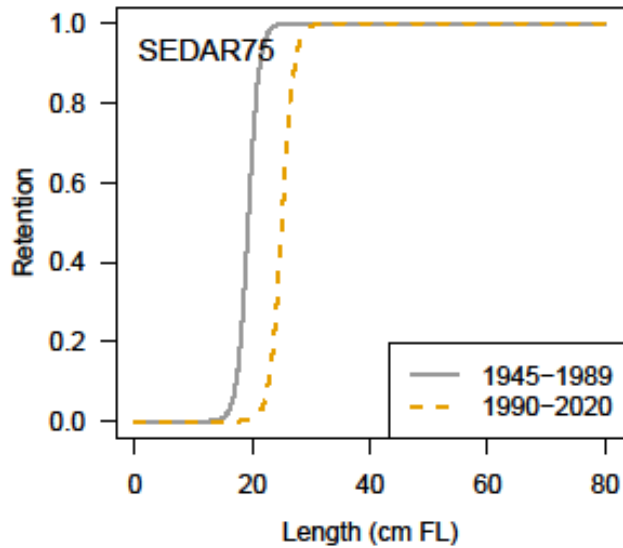


Longline/Not Monroe County VL

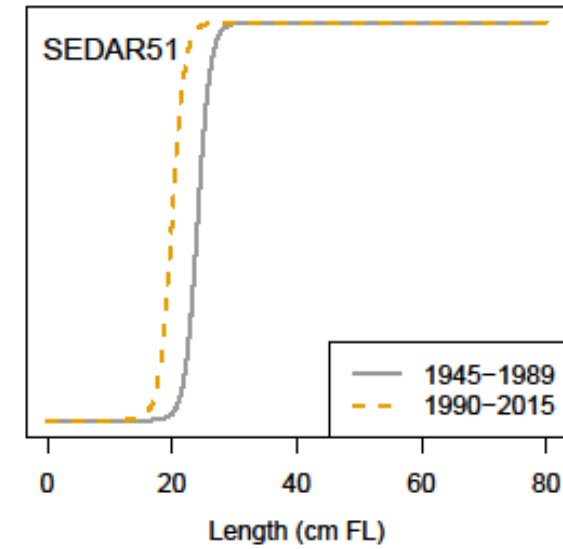
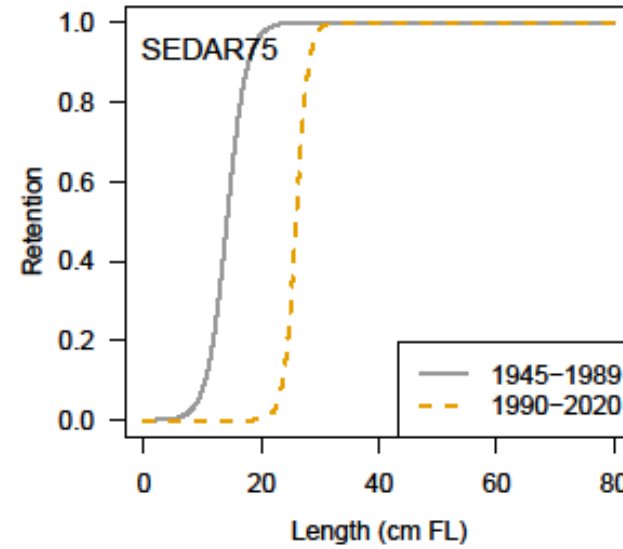


Fleet Retention

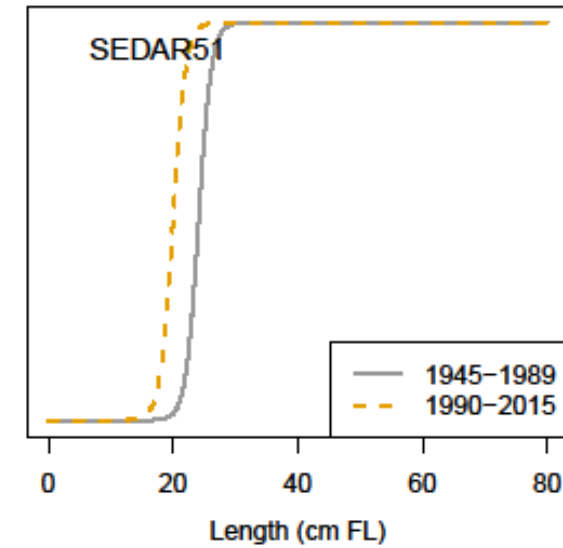
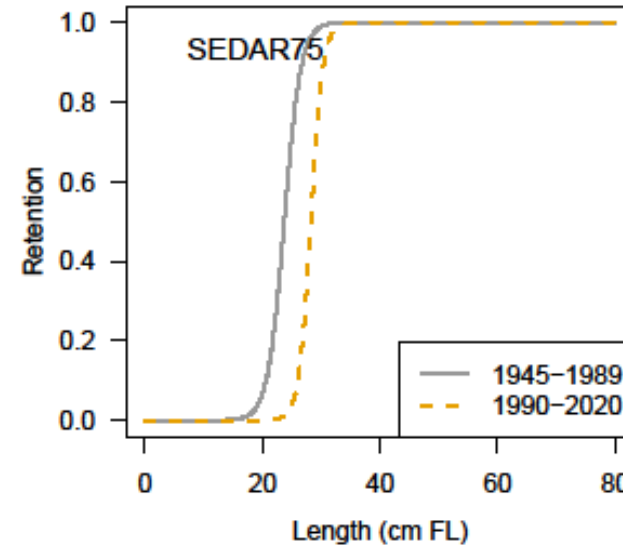
Private



Shore



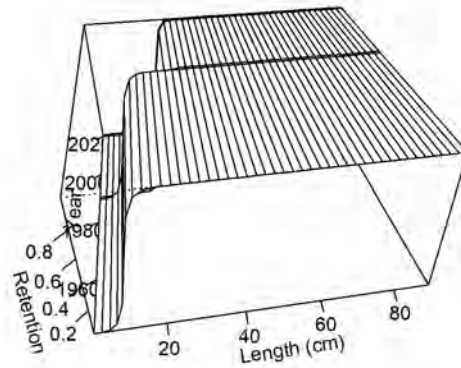
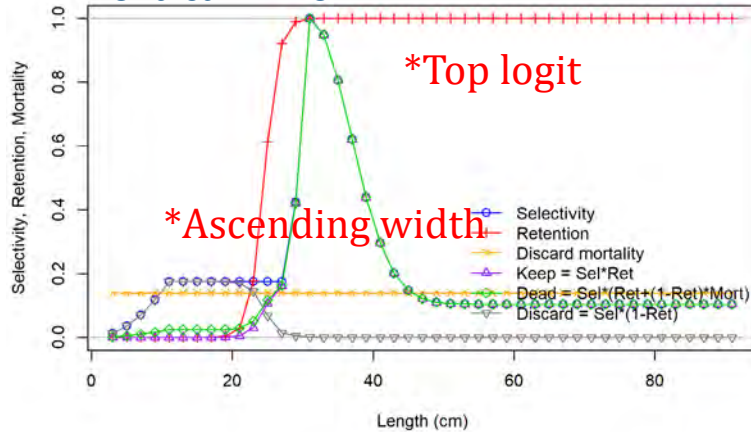
Charter and Headboat



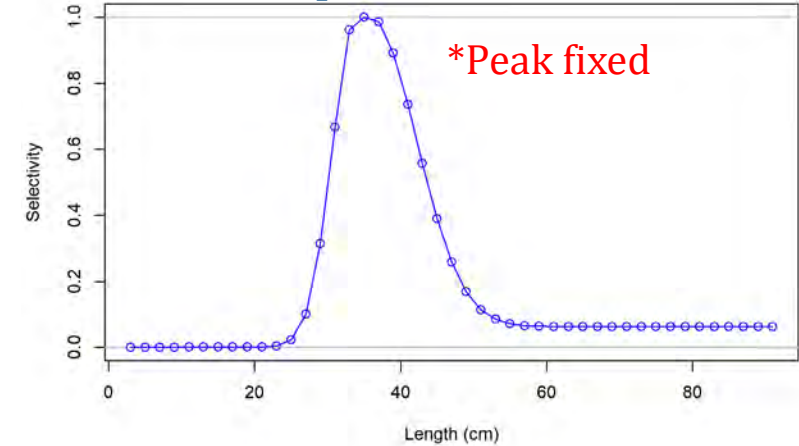
NOAA
FISHERIES

Commercial Lengths

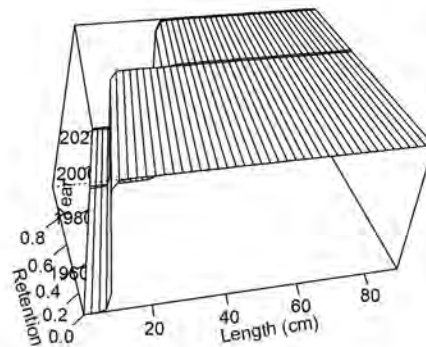
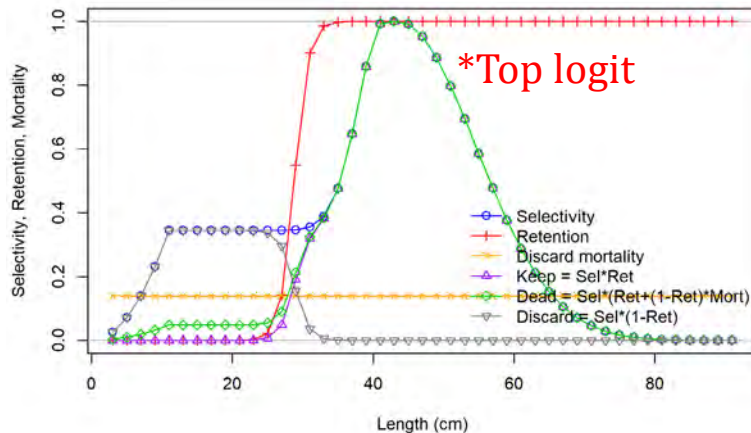
Vertical Line



Nets and Traps



Longline



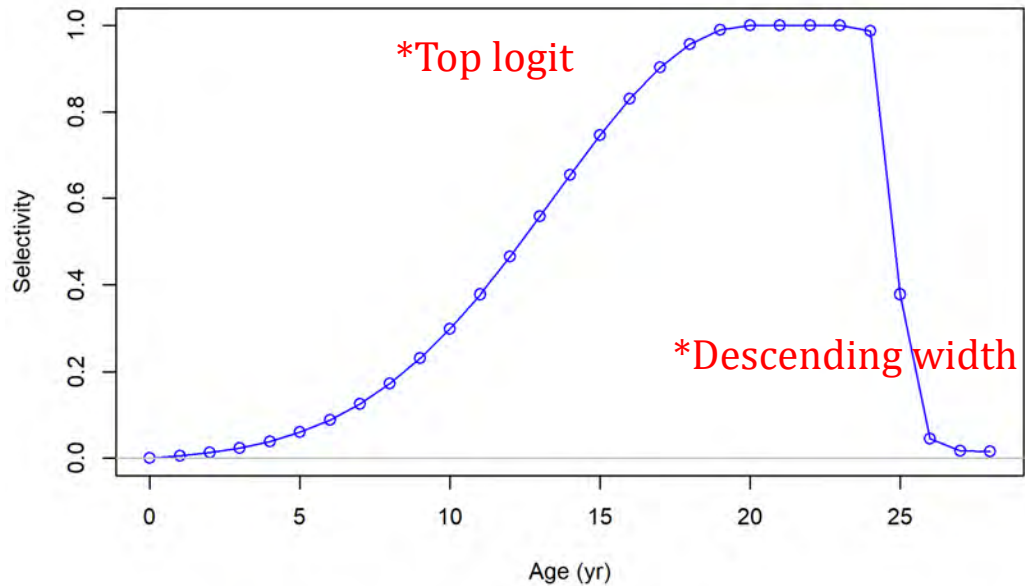
Estimated selectivity parameters & estimated retention parameters $CV > 1$

*Width & inflection 1945-1989

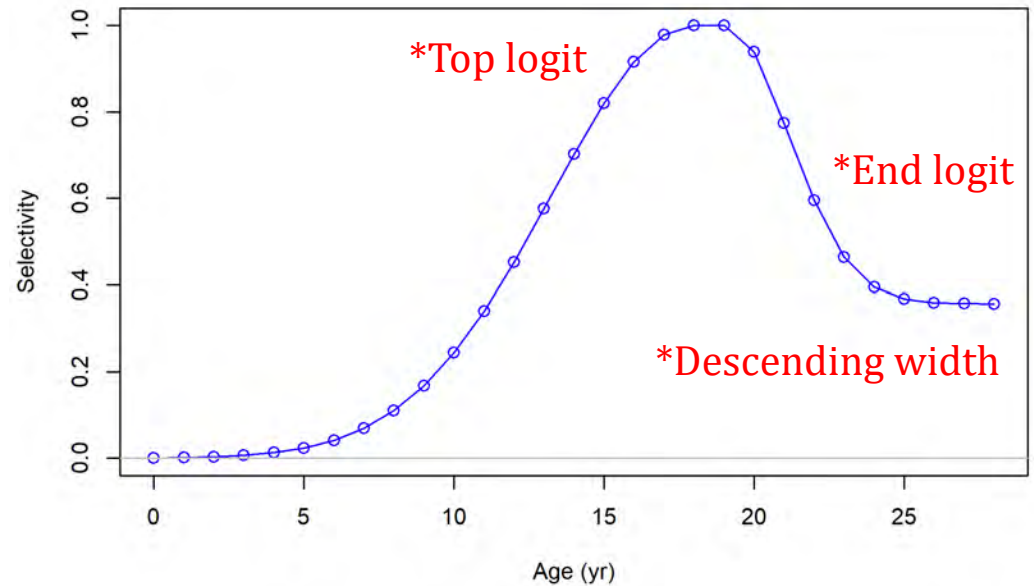
Commercial Ages

Selectivity or retention parameters with $CV > 1$

Vertical Line

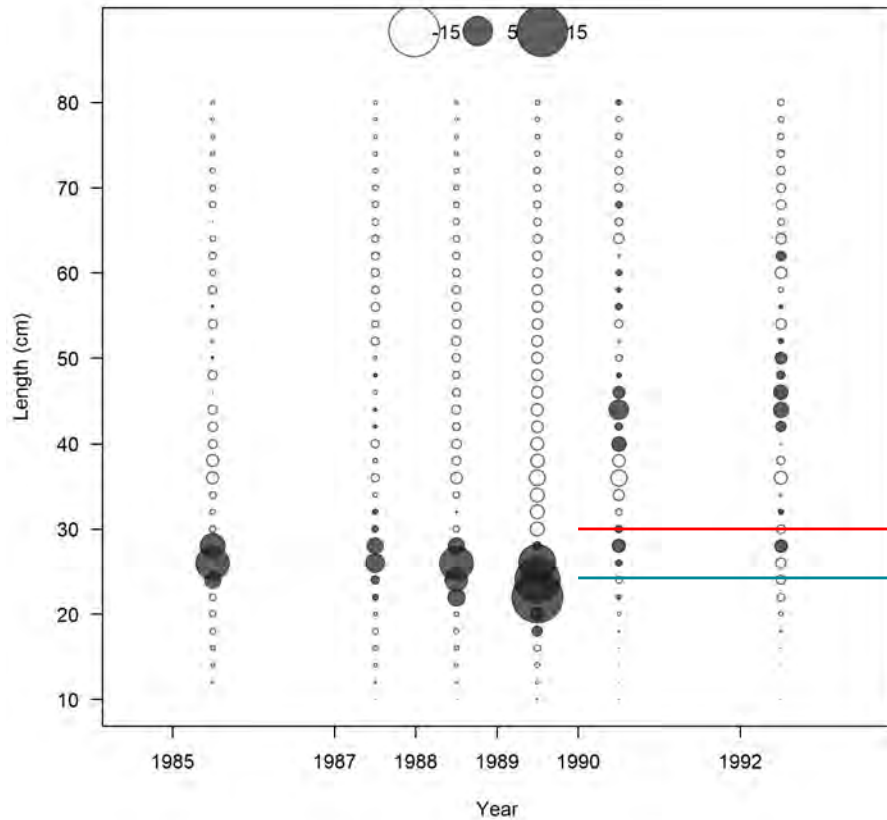


Longline



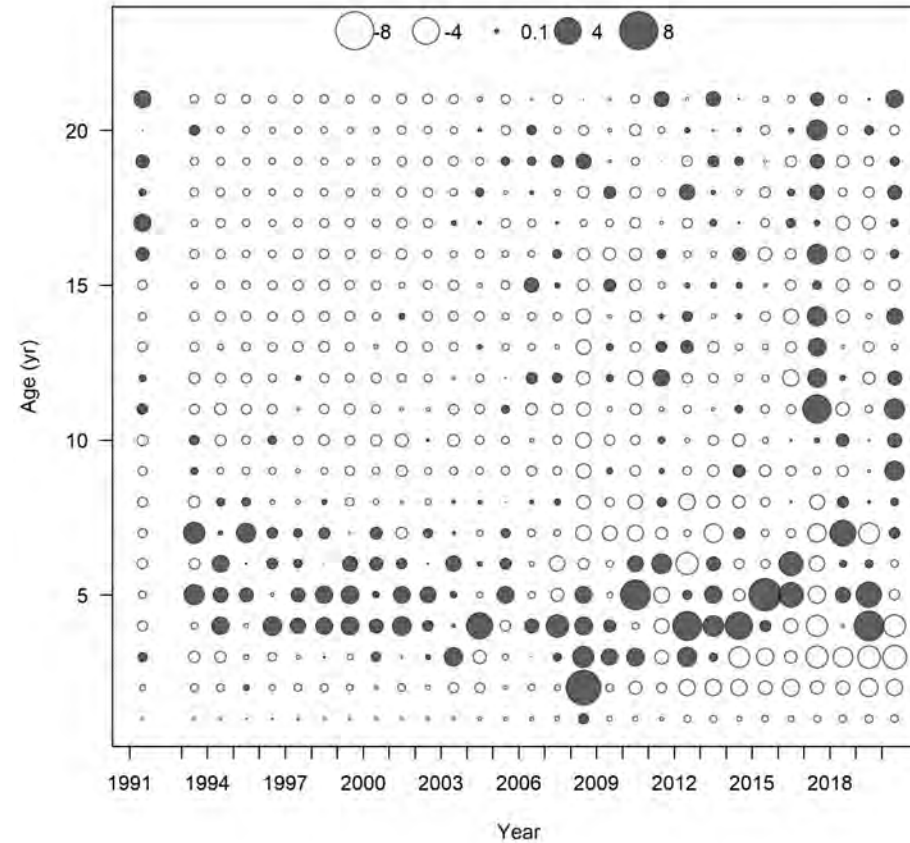
Commercial Vertical Line

Years with available age compositions removed from length compositions



Closed = + (observed > expected)

Open = - (observed < expected)



Federal Size Limit

Florida Size Limit



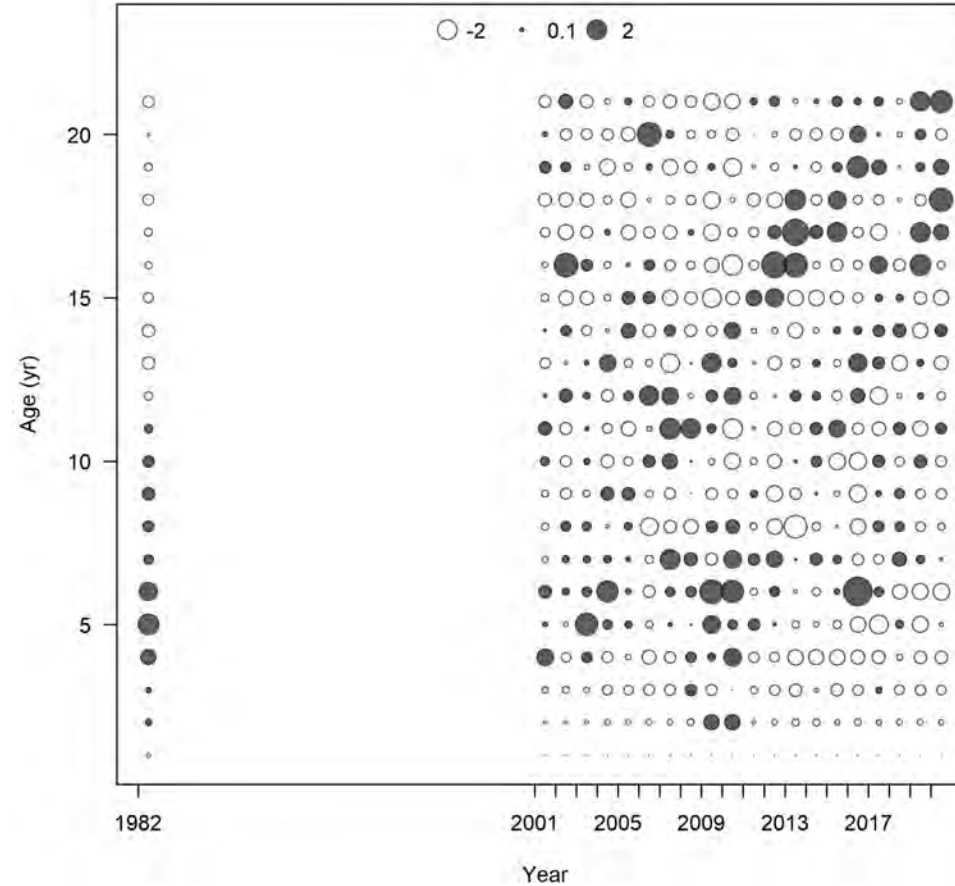
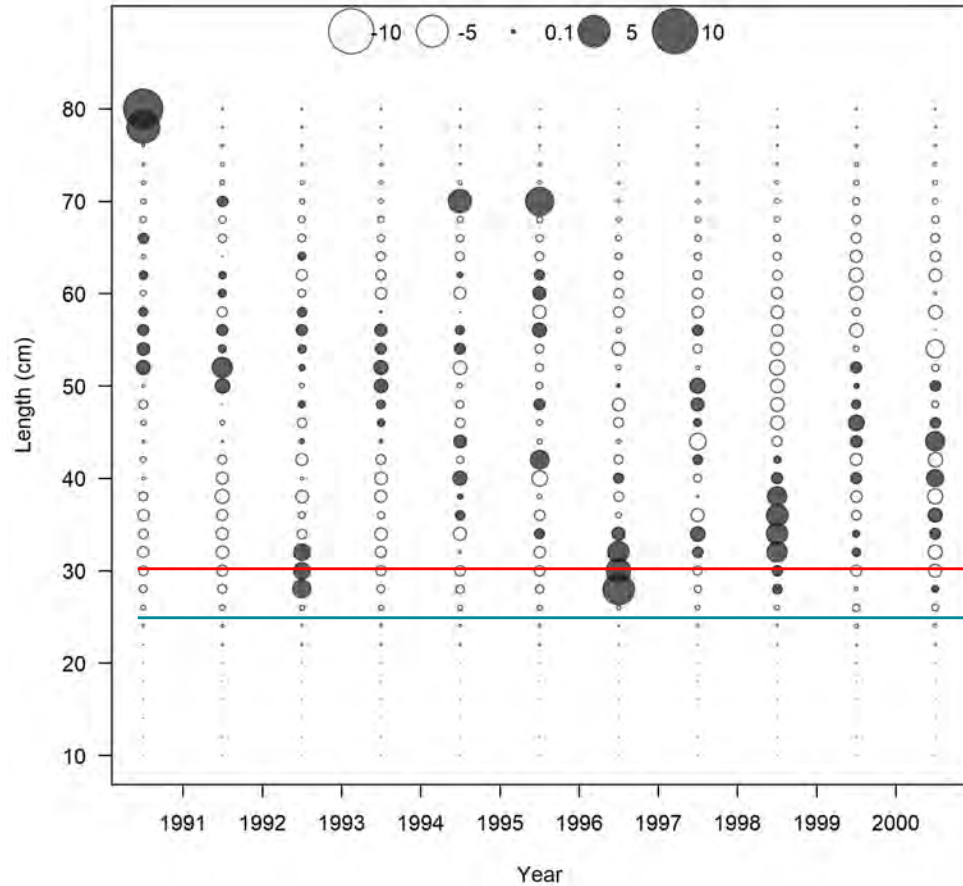
**NOAA
FISHERIES**

Commercial Longline

Years with available age compositions removed from length compositions

Closed = + (observed > expected)

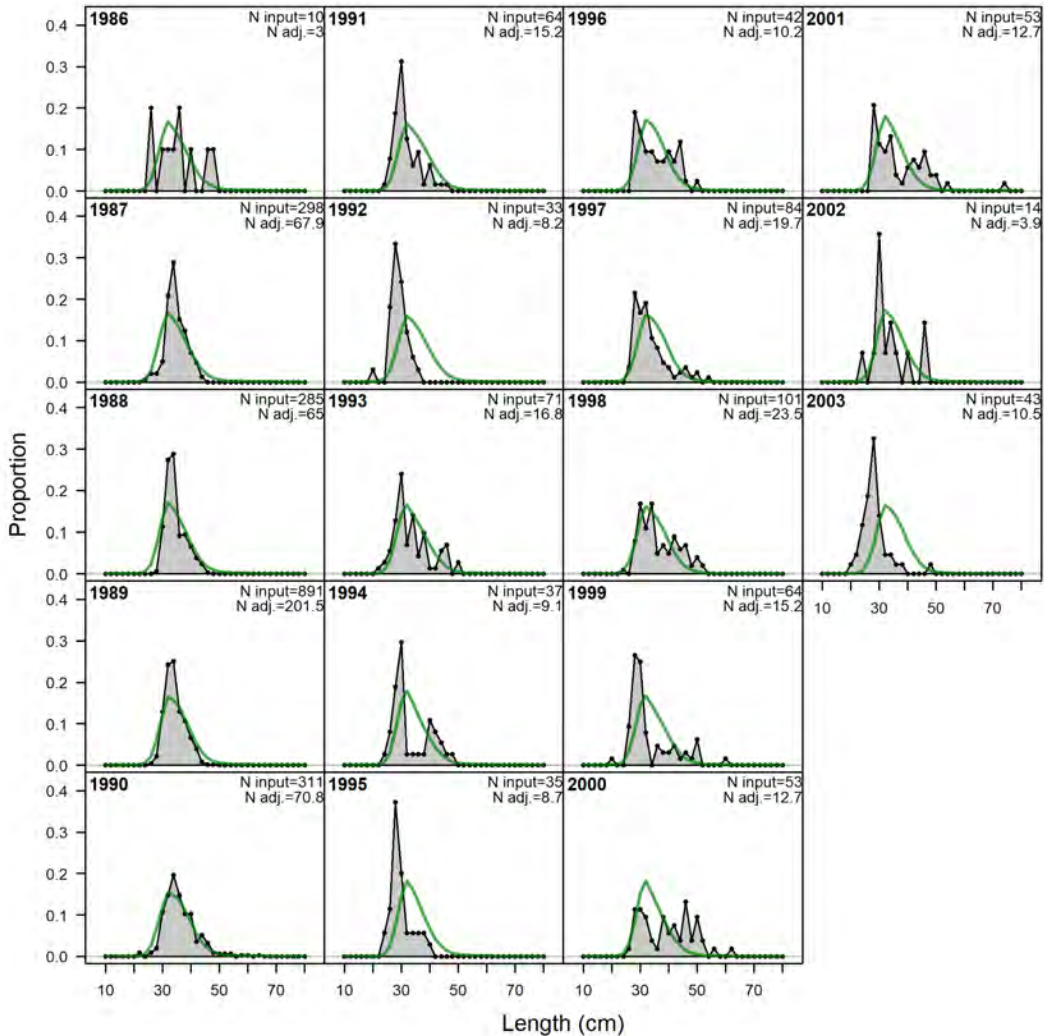
Open = - (observed < expected)



Federal Size Limit

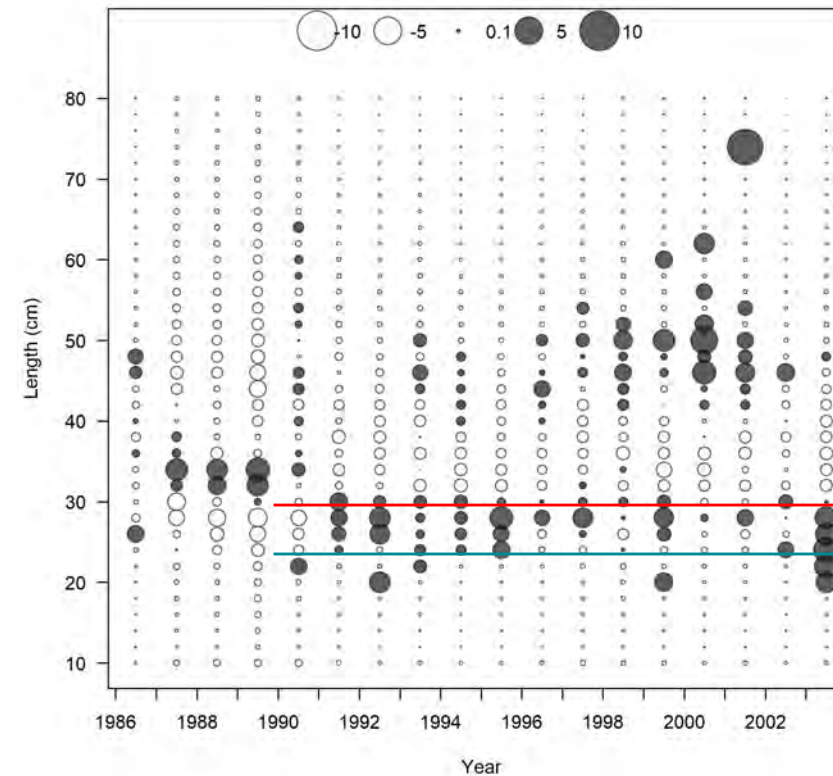
Florida Size Limit

Commercial Nets and Traps



Closed = + (observed > expected)

Open = - (observed < expected)



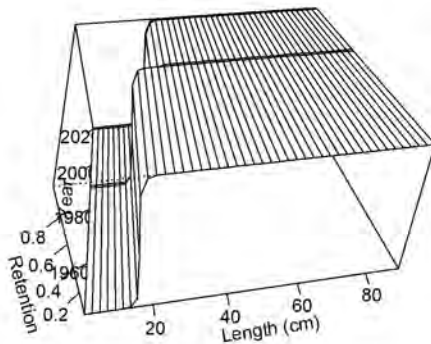
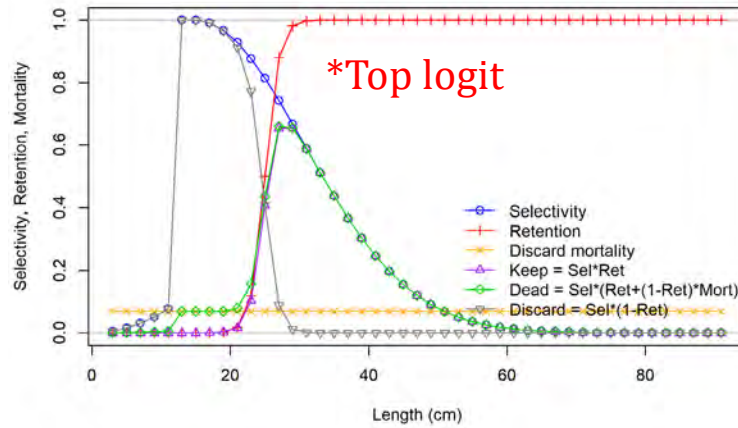
Federal Size Limit

Florida Size Limit

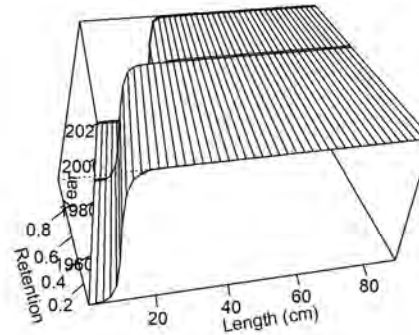
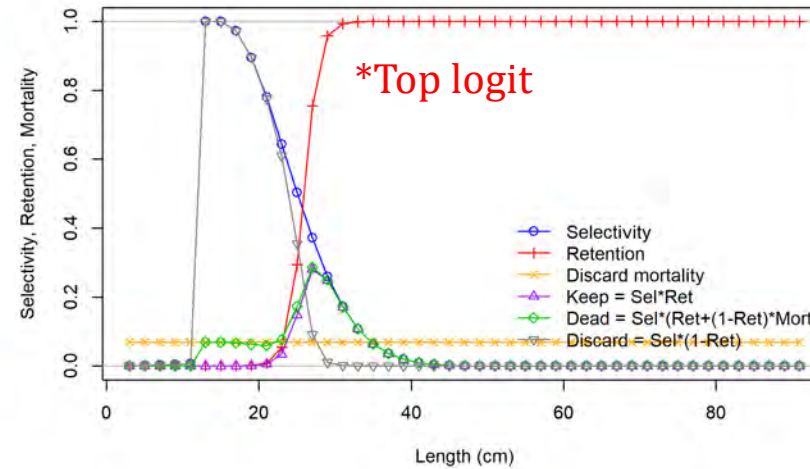
Recreational Lengths

Selectivity or retention parameters with CV > 1

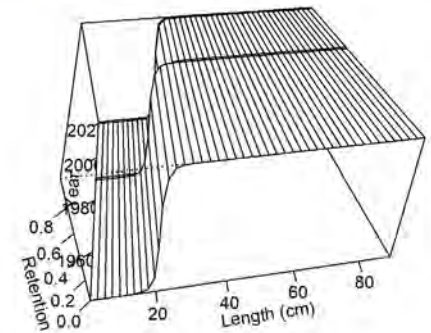
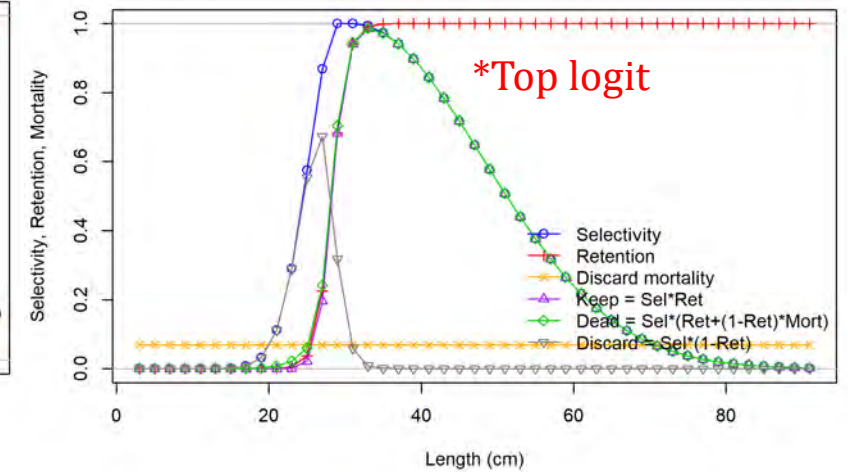
Private



Shore



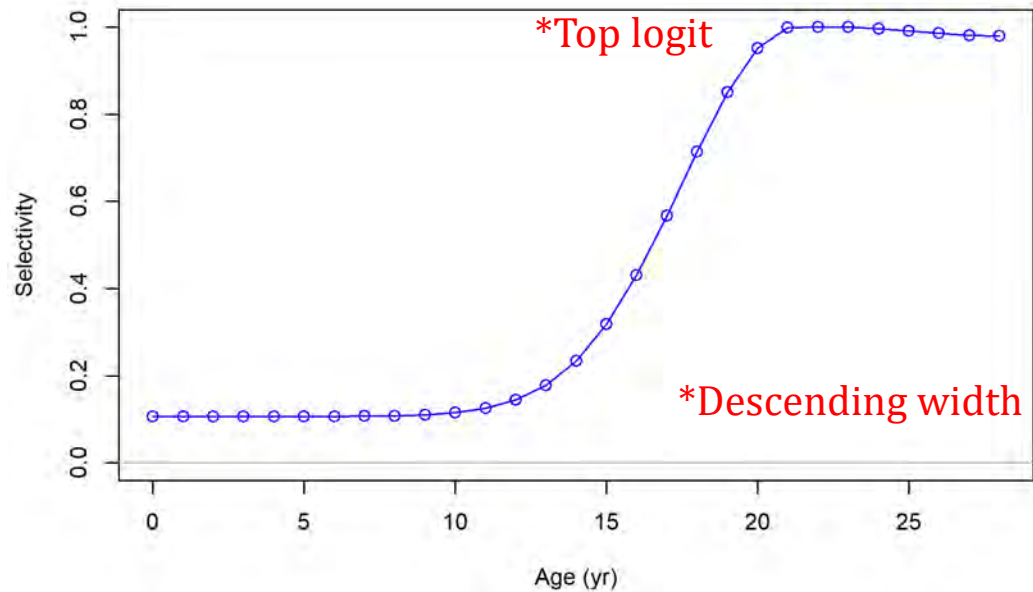
Charter and Headboat



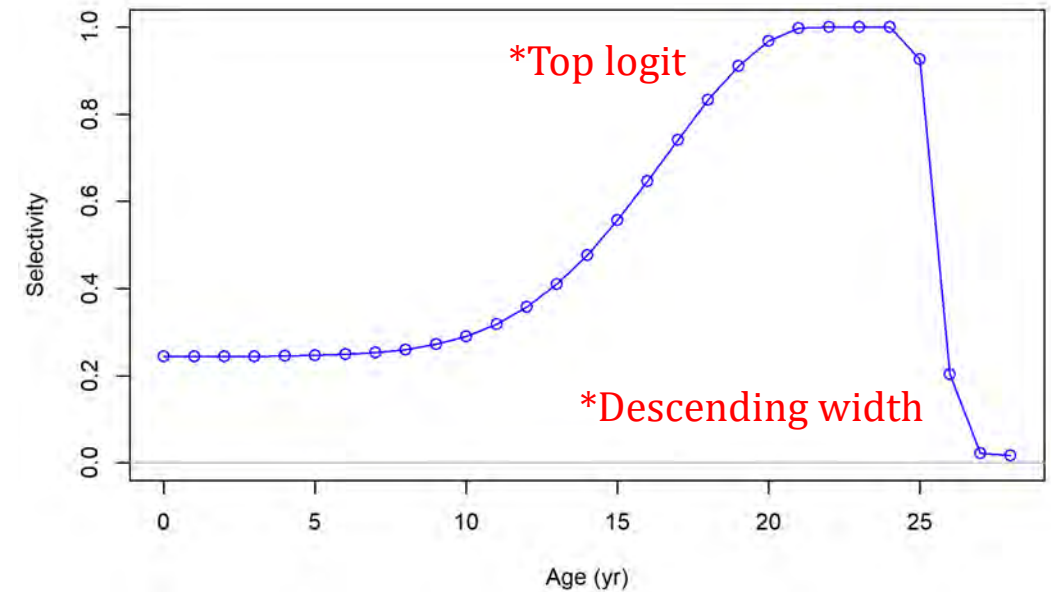
Recreational Ages

Selectivity or retention parameters with $CV > 1$

Private

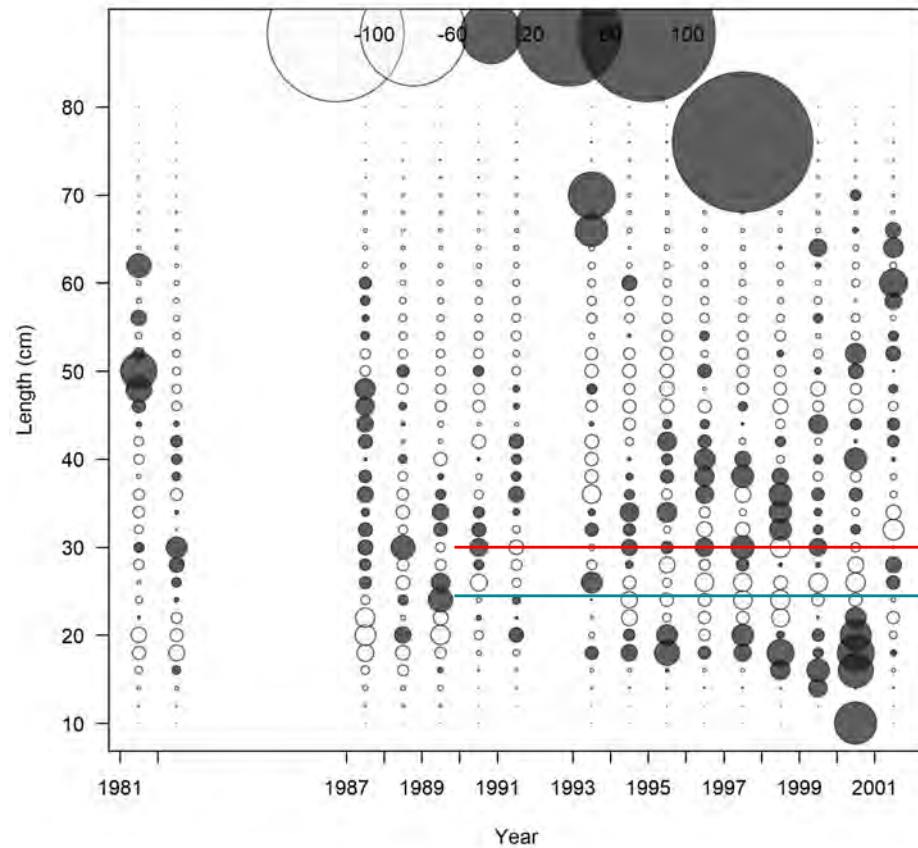


Charter and Headboat



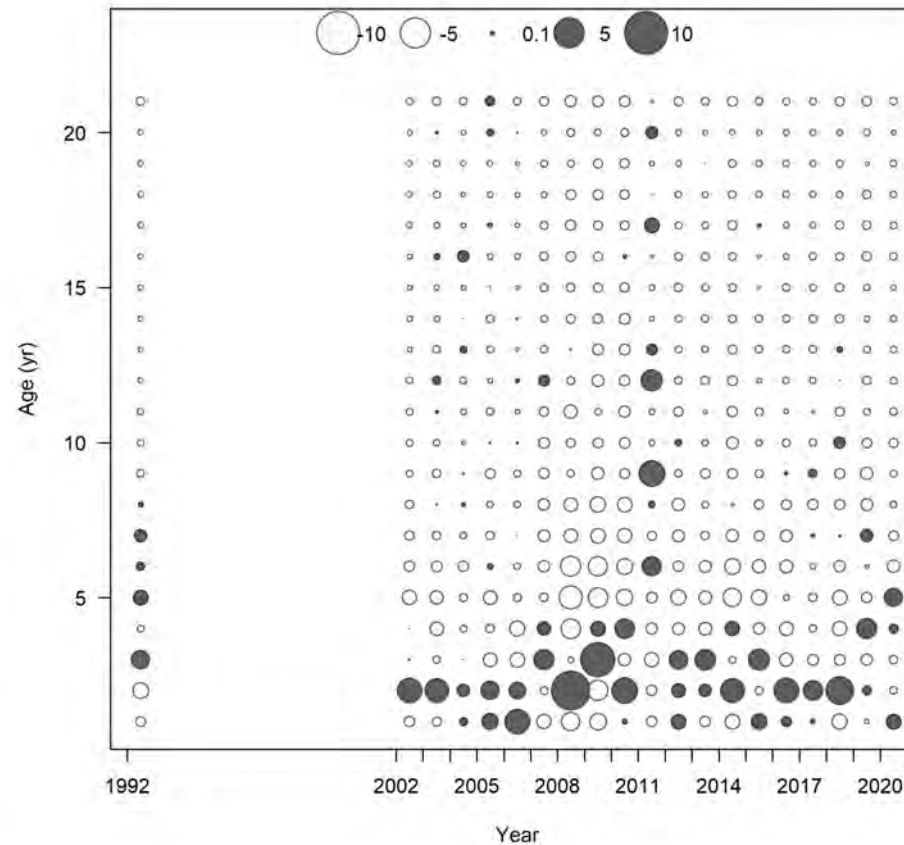
Recreational Private

Years with available age compositions removed from length compositions



Closed = + (observed > expected)

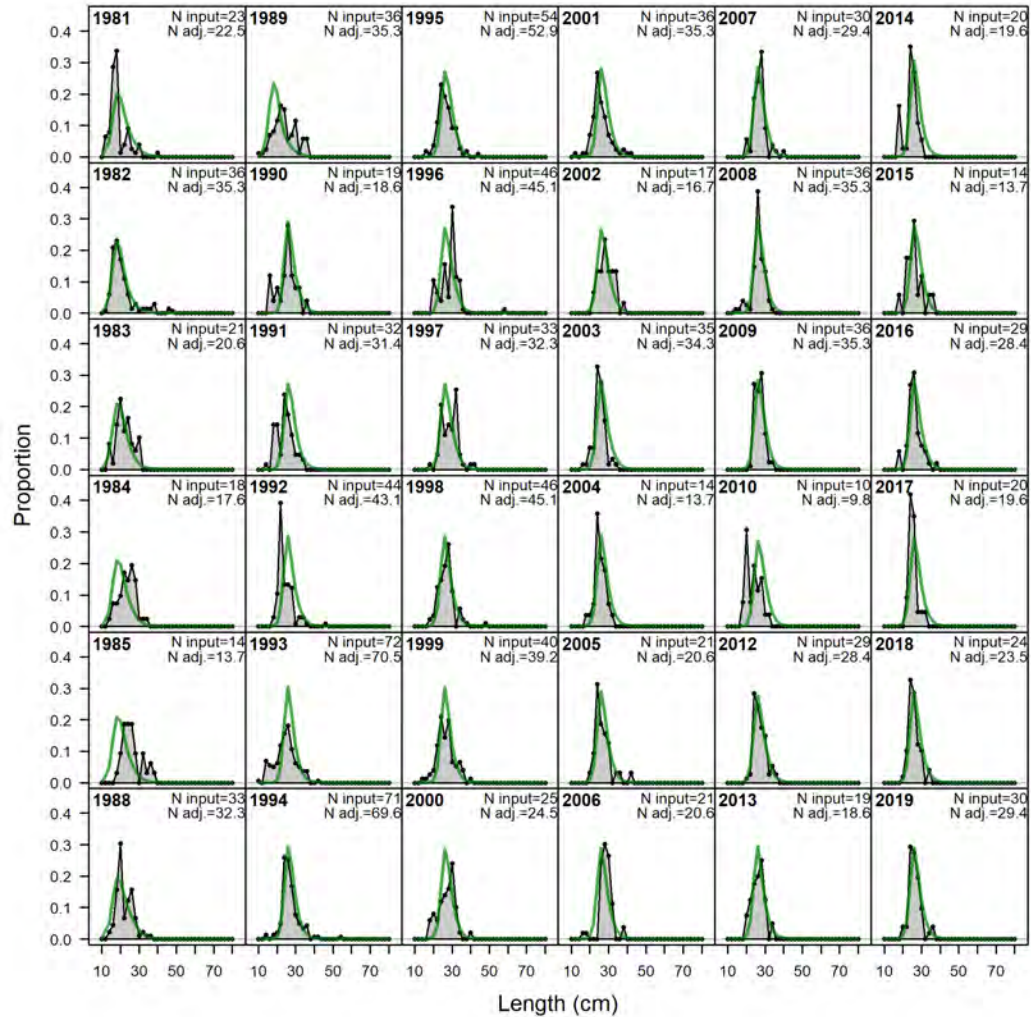
Open = - (observed < expected)



Federal Size Limit

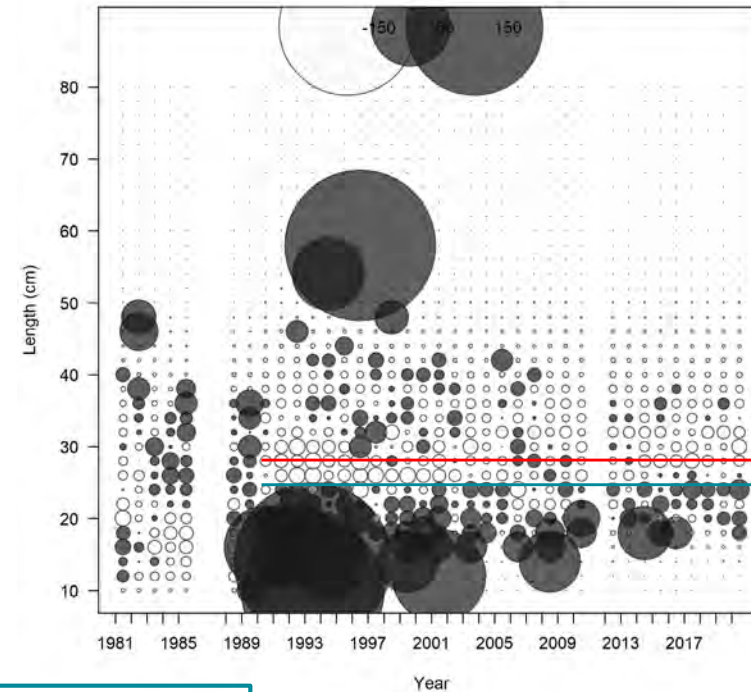
Florida Size Limit

Recreational Shore



Closed = + (observed > expected)

Open = - (observed < expected)



Federal Size Limit

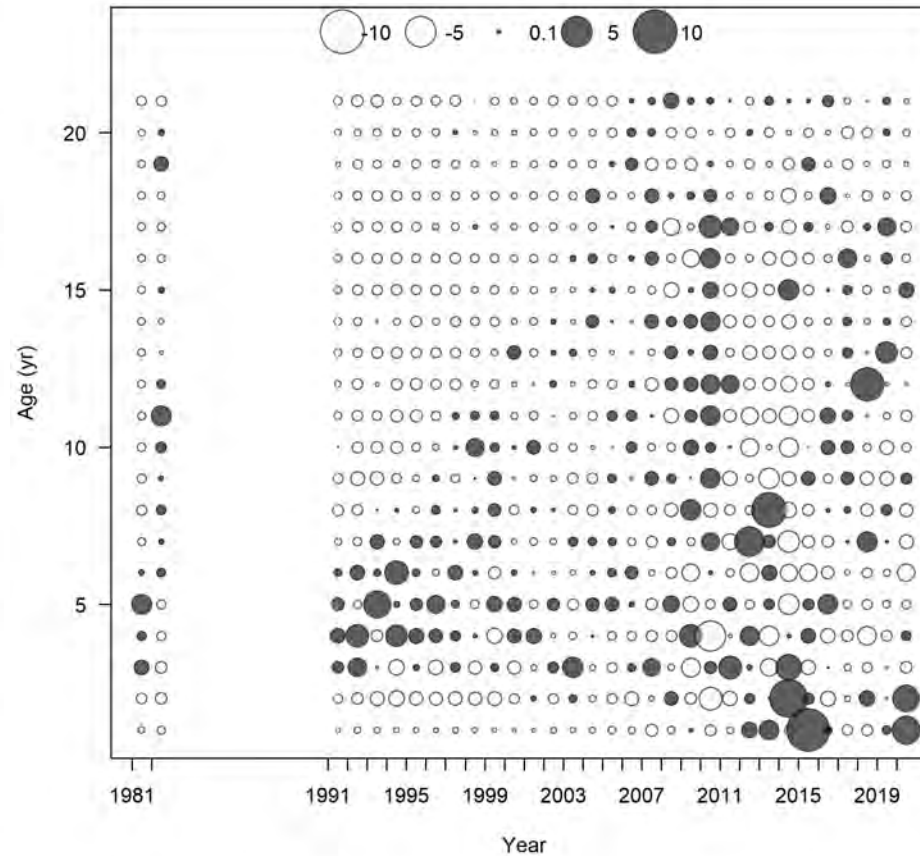
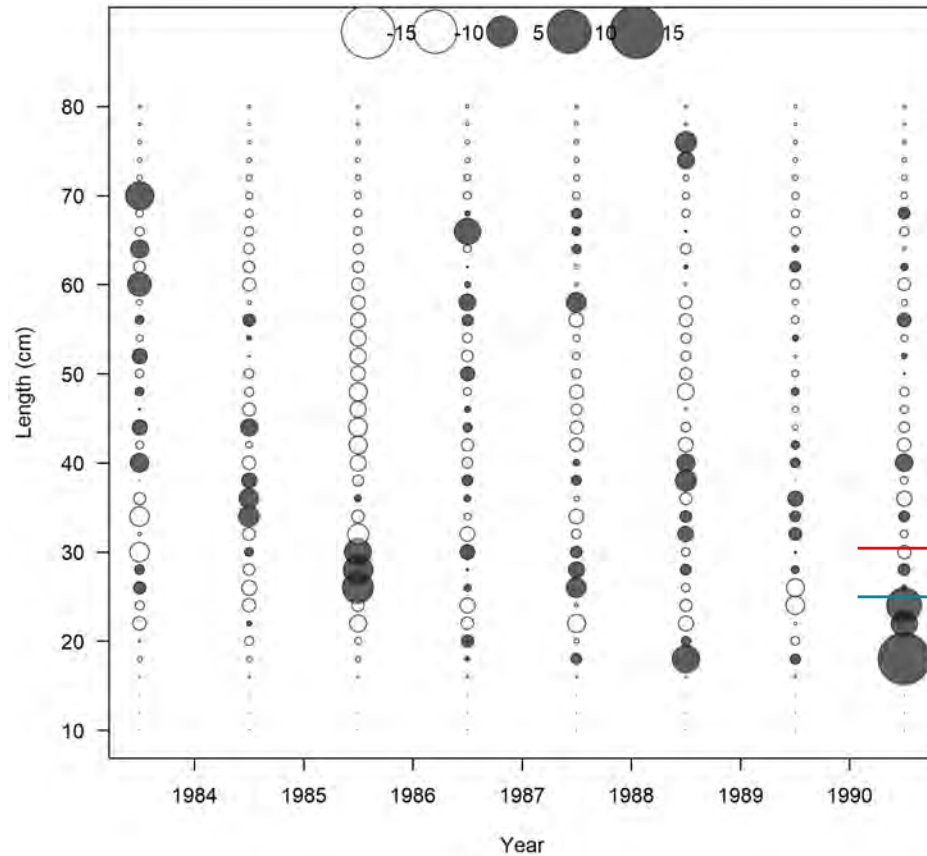
Florida Size Limit

Recreational Charter and Headboat

Years with available age compositions removed from length compositions

Closed = + (observed > expected)

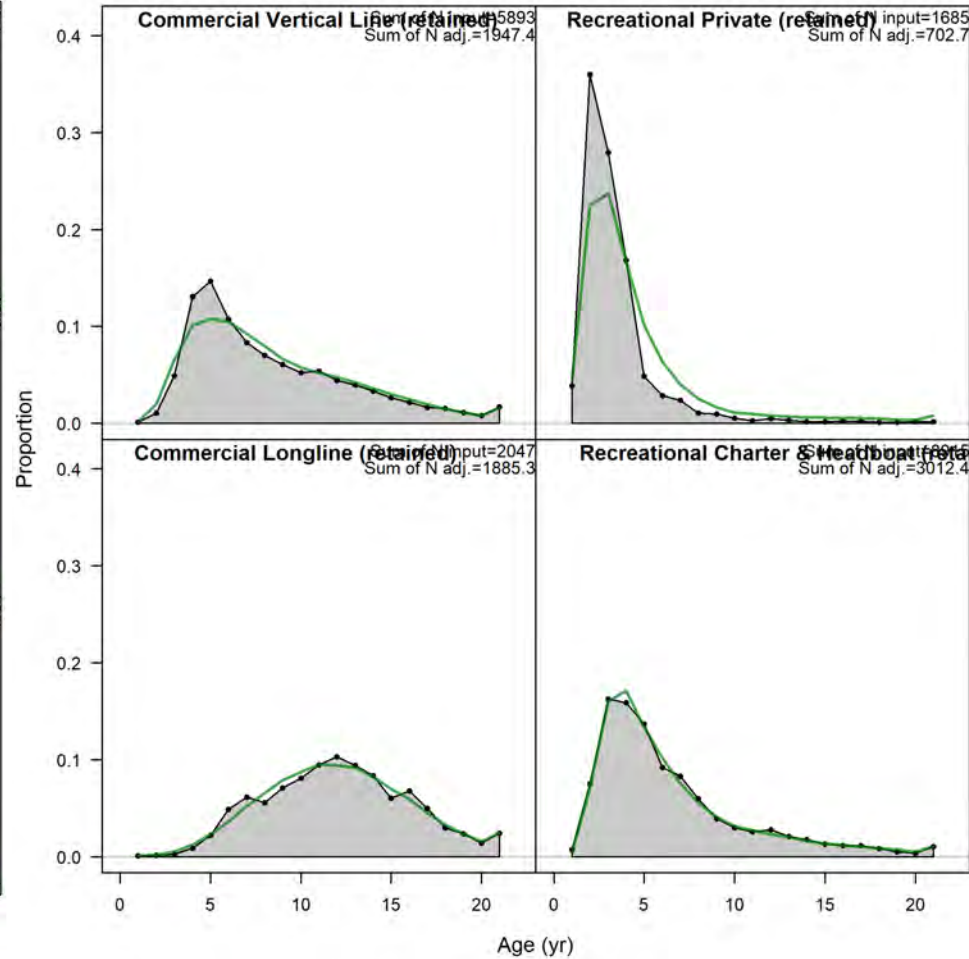
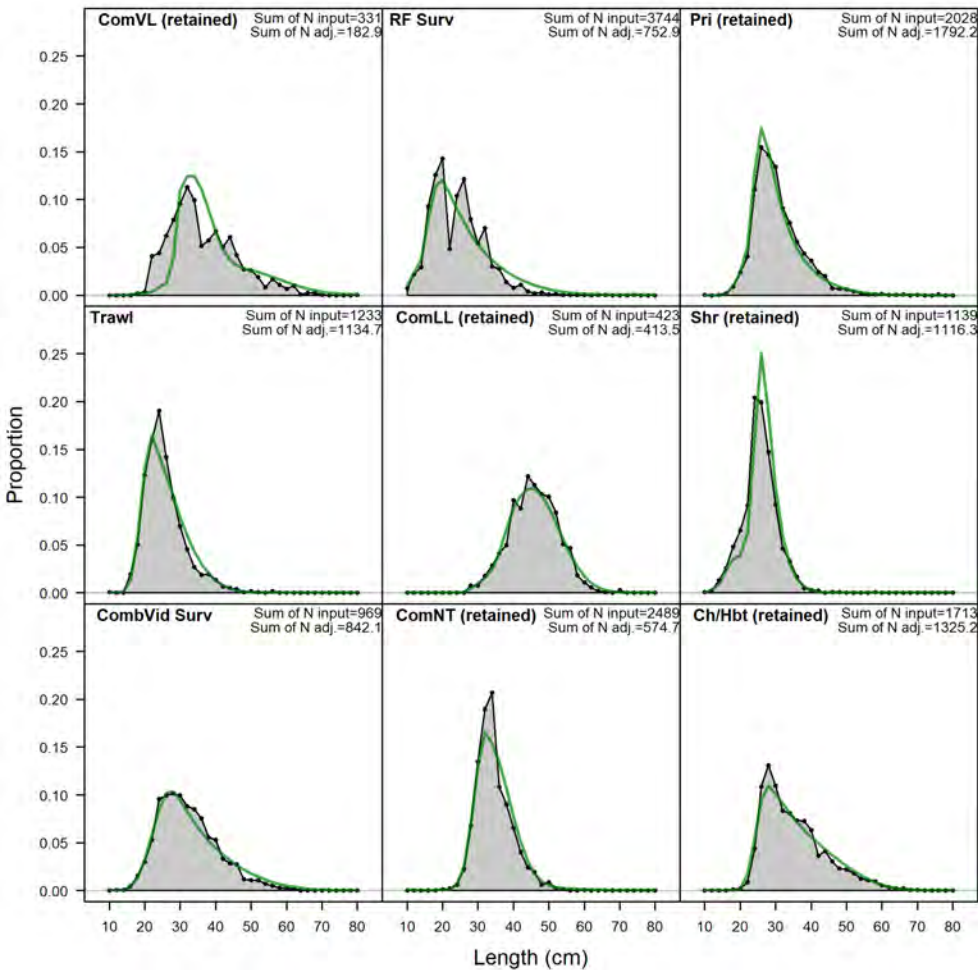
Open = - (observed < expected)



Federal Size Limit

Florida Size Limit

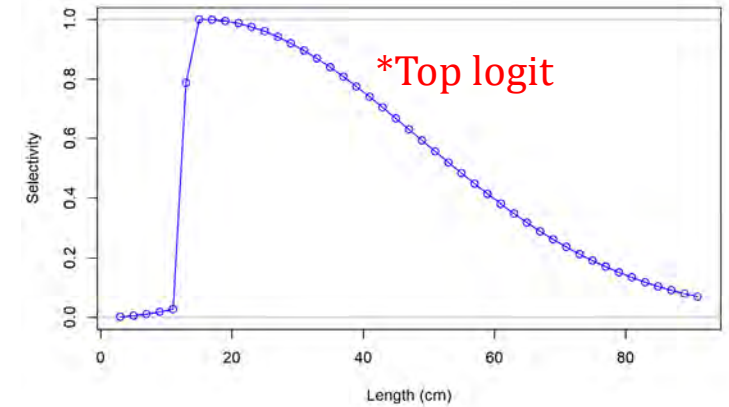
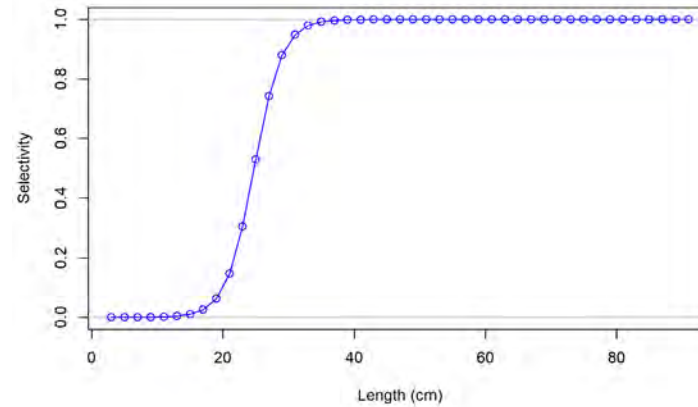
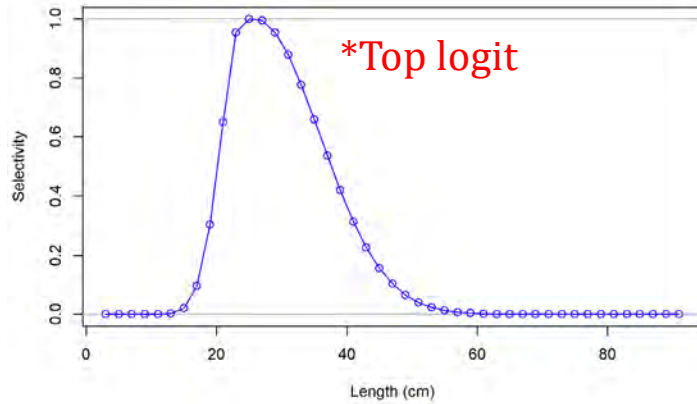
Trade-off between lengths and ages



- Lose years with lengths if use the ages from that year

Surveys

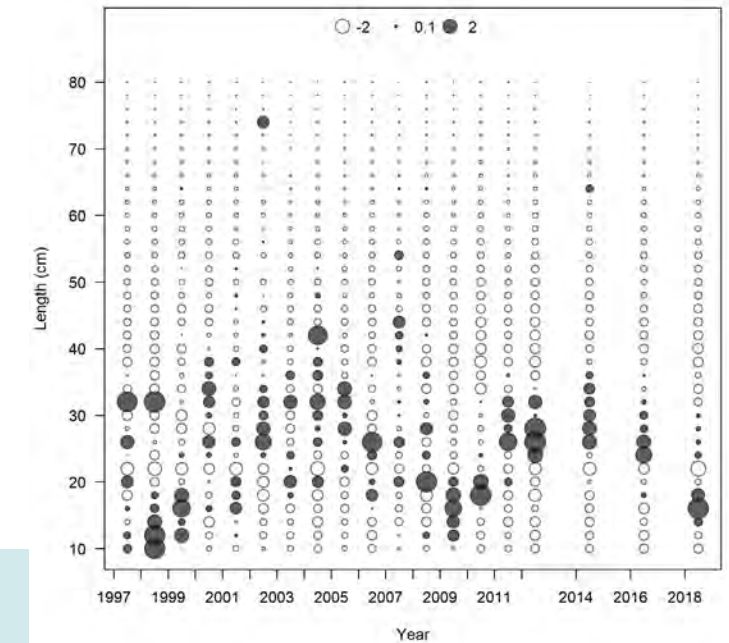
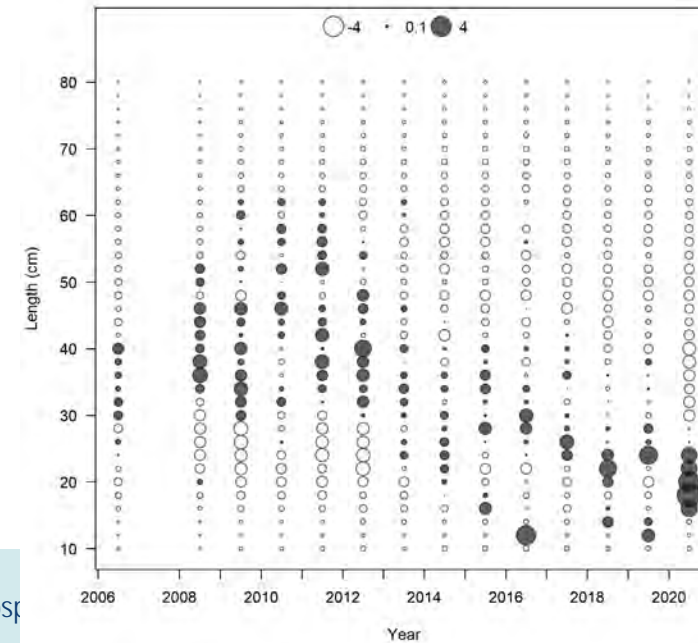
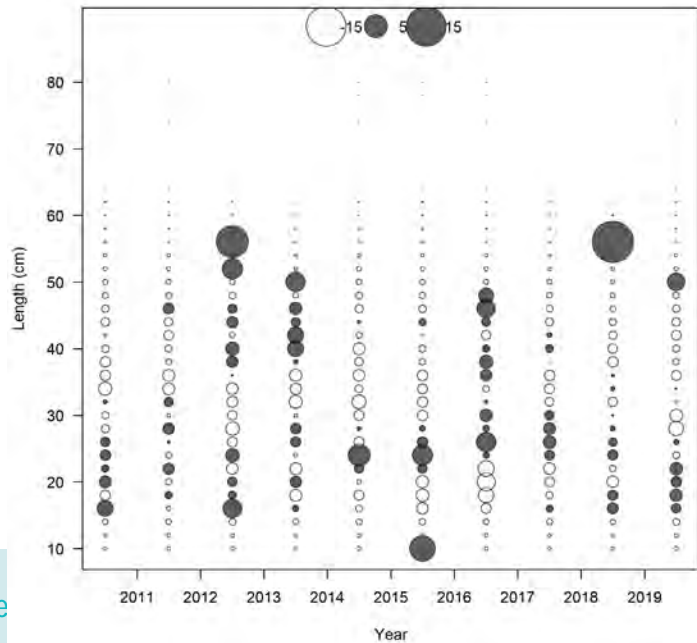
Selectivity or retention parameters with $CV > 1$



SEAMAP Trawl

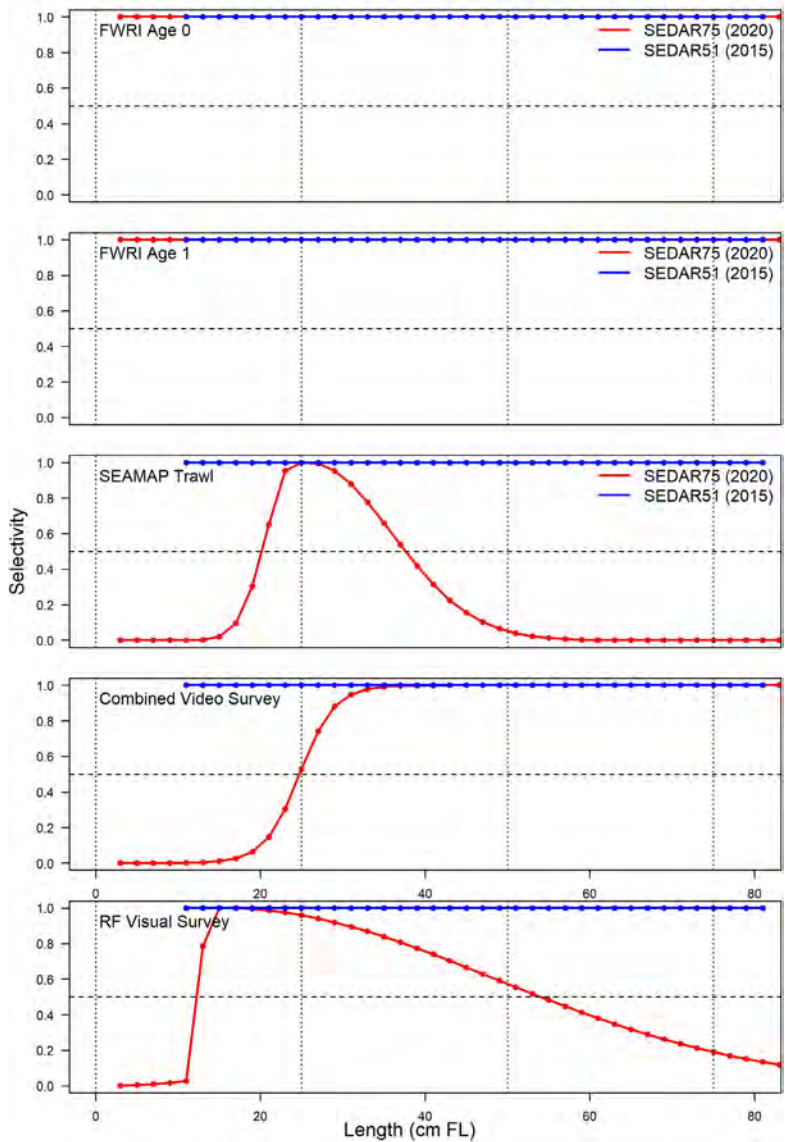
Combined Video

Reef Fish Visual Census

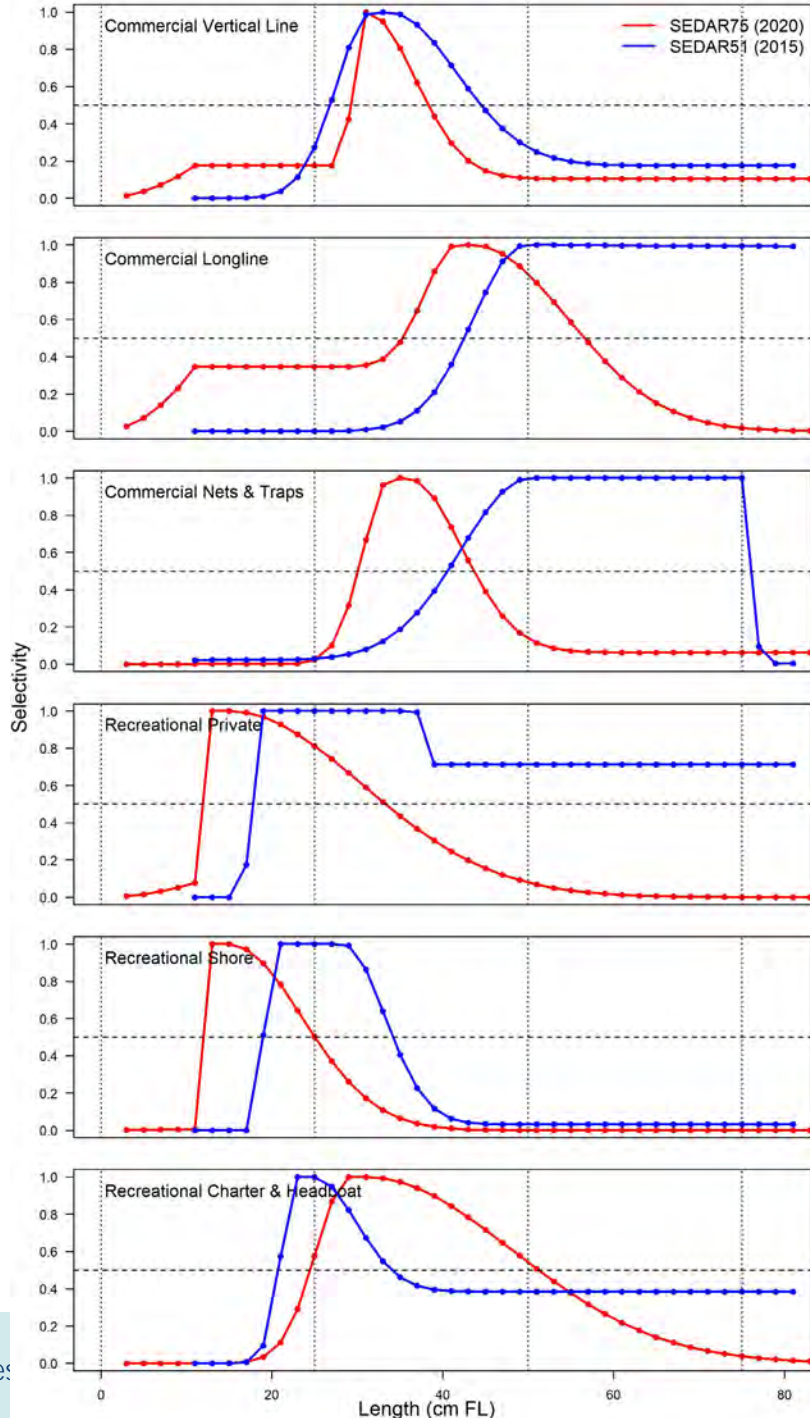


Selectivity Comparisons

Surveys



Fleets



Estimated Dirichlet parameters

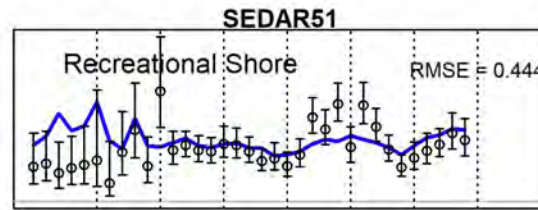
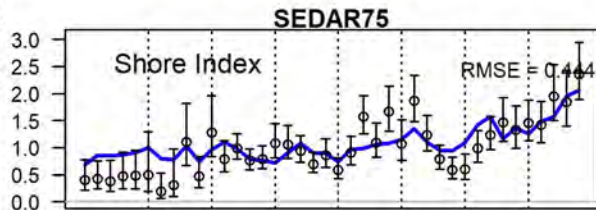
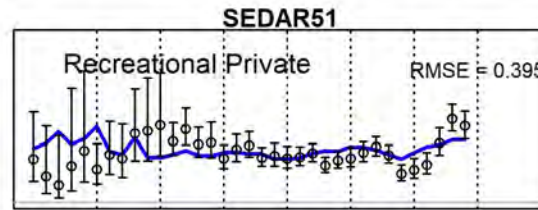
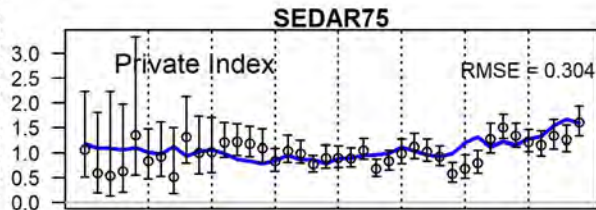
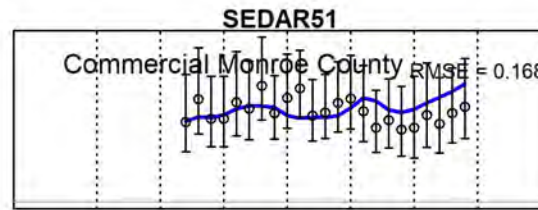
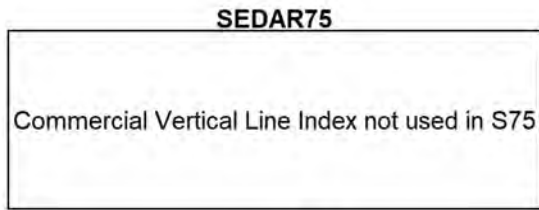
- Lowest for Nets & Traps lengths and RF Visual Survey lengths
- Highest weight for Longline length and age and Shore lengths

ln(DM_theta)	Value (CV)
Vertical Line (length)	0.178 (1.23)
Longline (Length)	3.75 (0.146)
Nets & Traps (Length)	-1.24 (-0.105)
Private (Length)	2.02 (0.231)
Shore (Length)	3.86 (0.092)
Charter & Headboat (Length)	1.22 (0.362)
SEAMAP Trawl (Length)	2.44 (0.222)
Combined Video Survey (Length)	1.88 (0.252)
RF Visual Survey (Length)	-1.4 (-0.068)
Vertical Line (Age)	-0.721 (-0.131)
Longline (Age)	2.44 (0.191)
Private (Age)	-0.364 (-0.408)
Charter & Headboat (Age)	-0.683 (-0.128)

Indices

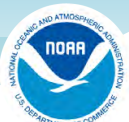
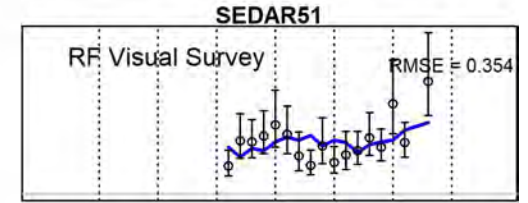
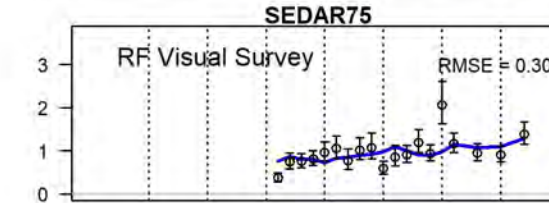
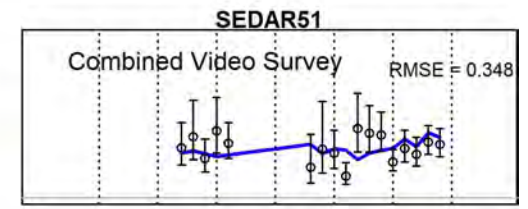
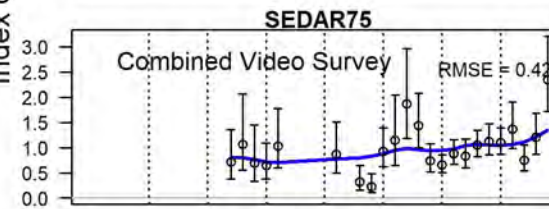
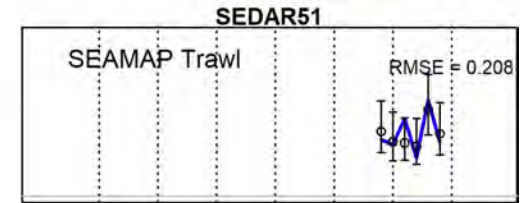
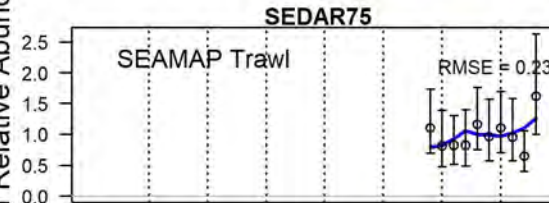
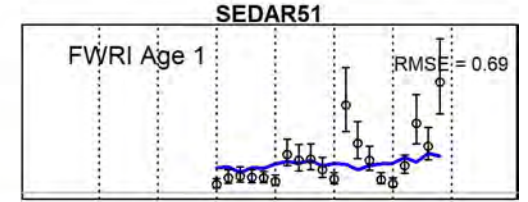
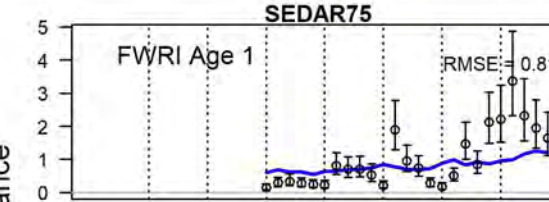
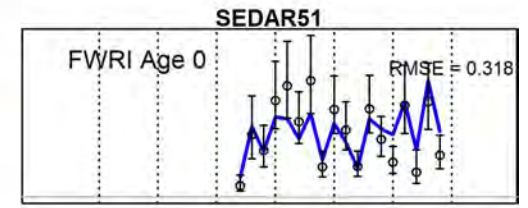
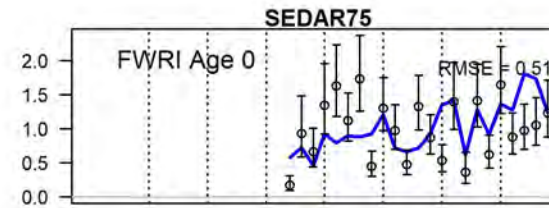
Index of Relative Abundance

Year



Index of Relative Abundance

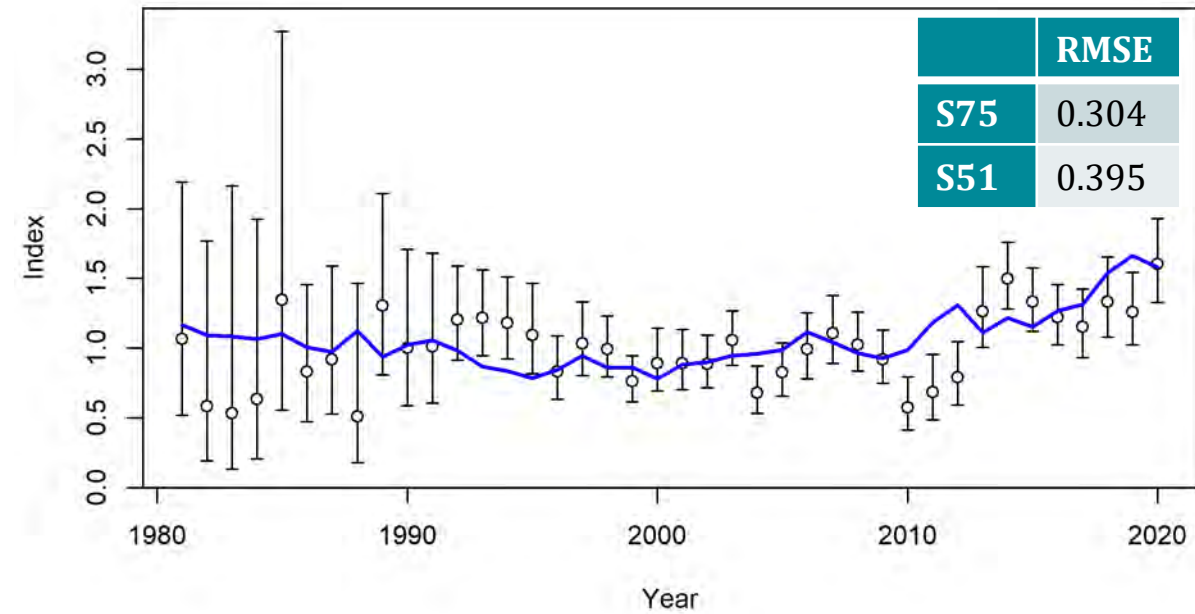
Year



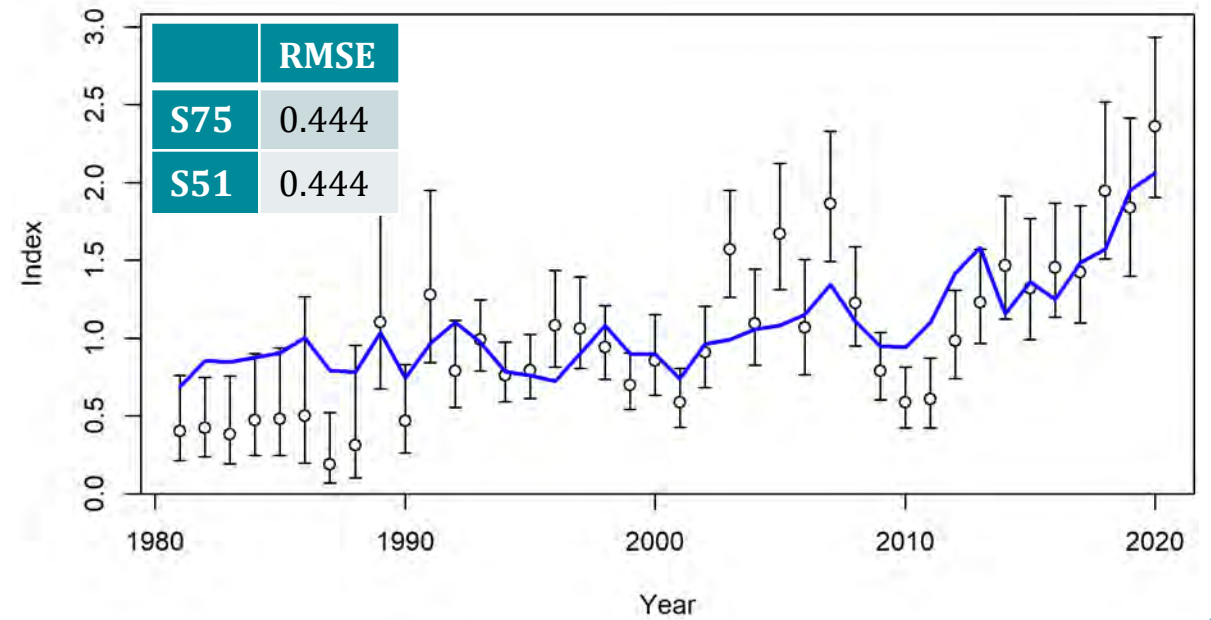
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Fishery Dependent Indices

Private Mode

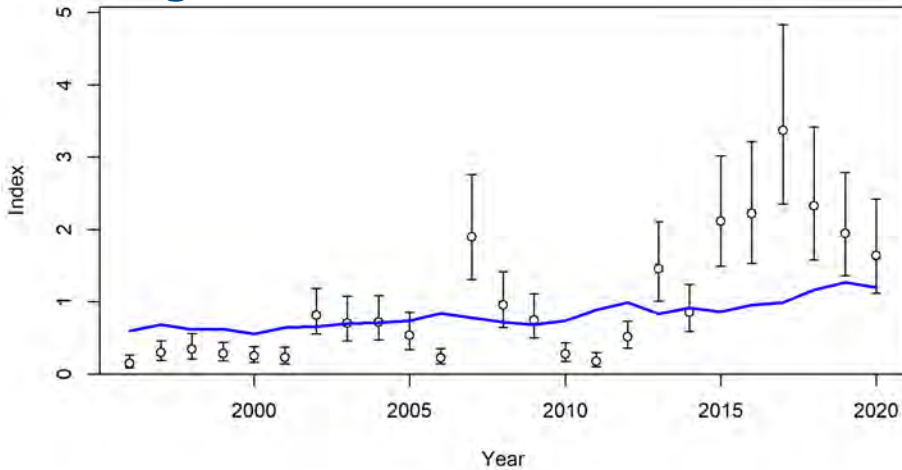


Shore Mode



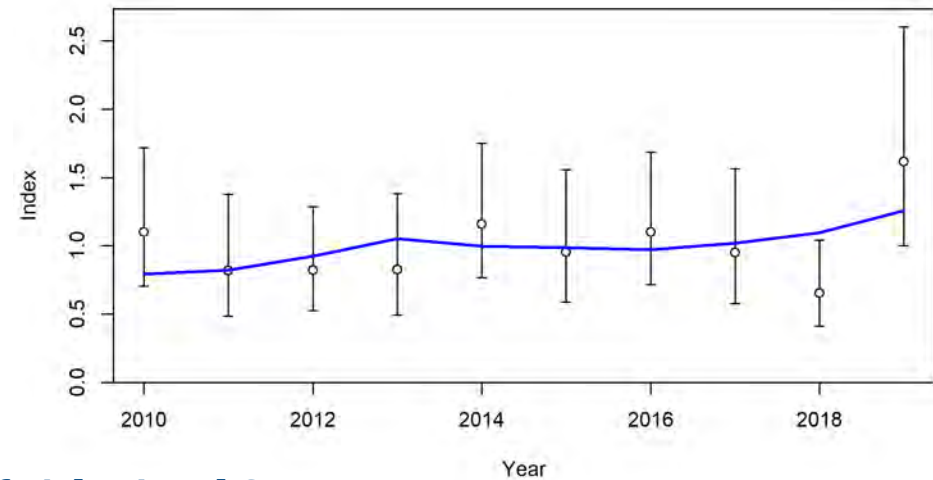
Fishery Independent Indices

FWRI Age 1



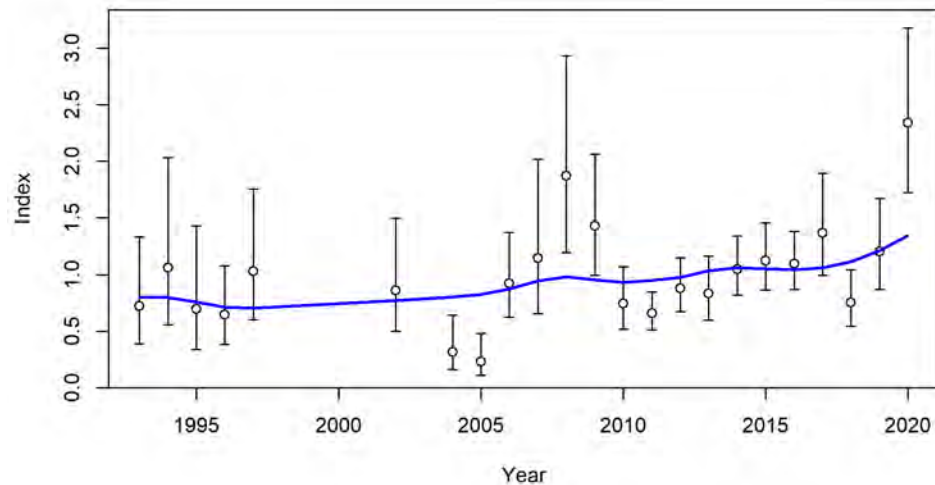
	RMSE
S75	0.81
S51	0.69

SEAMAP Trawl



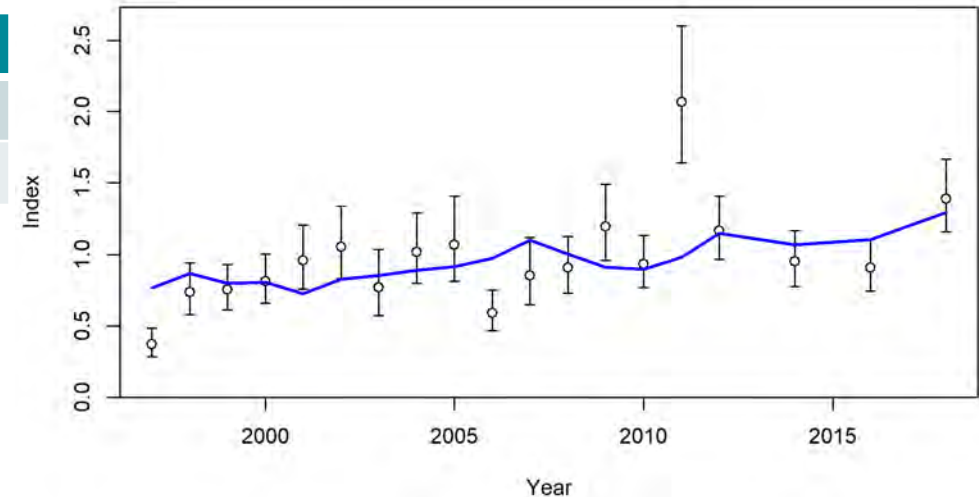
	RMSE
S75	0.236
S51	0.208

Combined Video



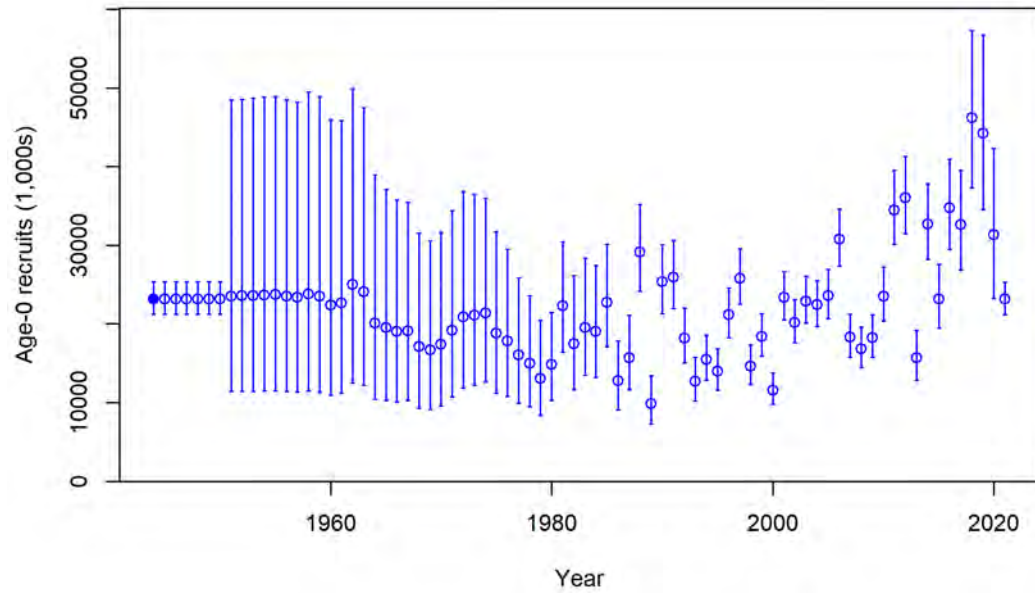
	RMSE
S75	0.425
S51	0.348

Reef Fish Visual Survey

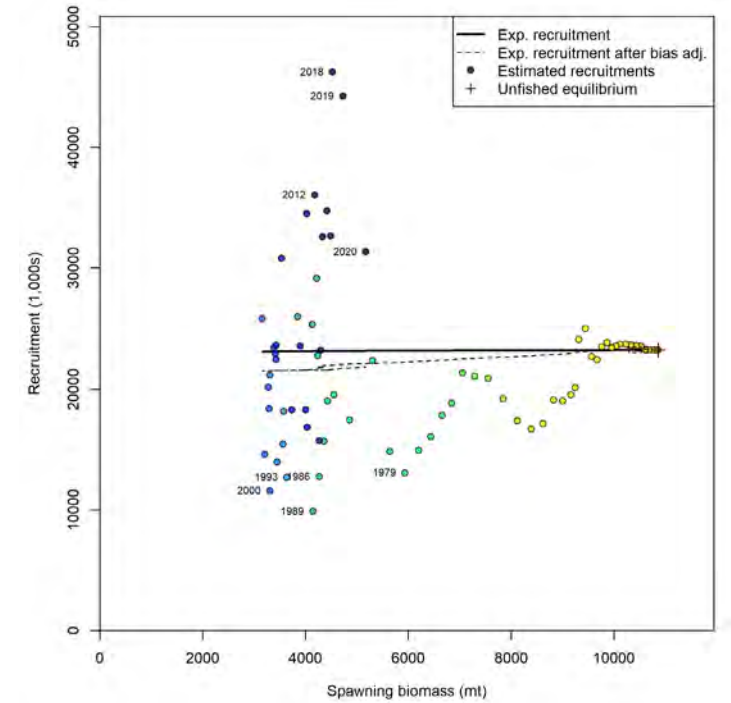
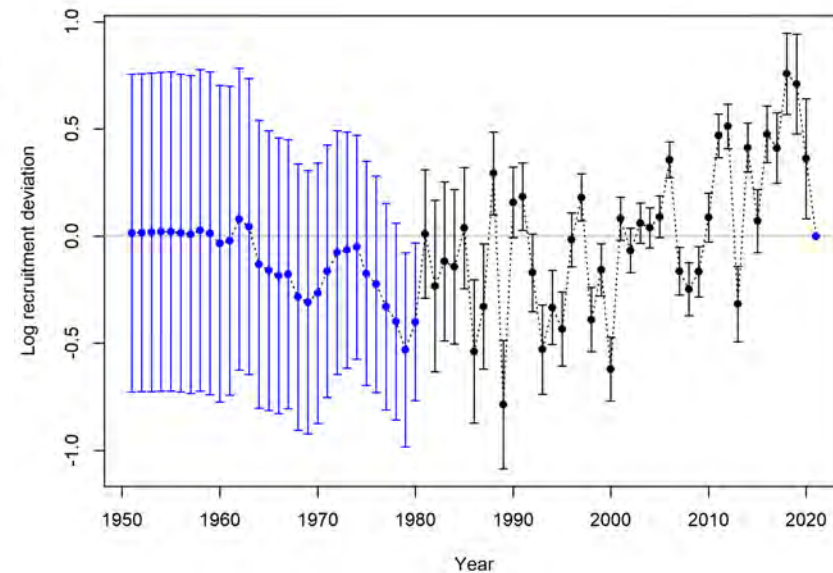


	RMSE
S75	0.304
S51	0.354

Recruitment

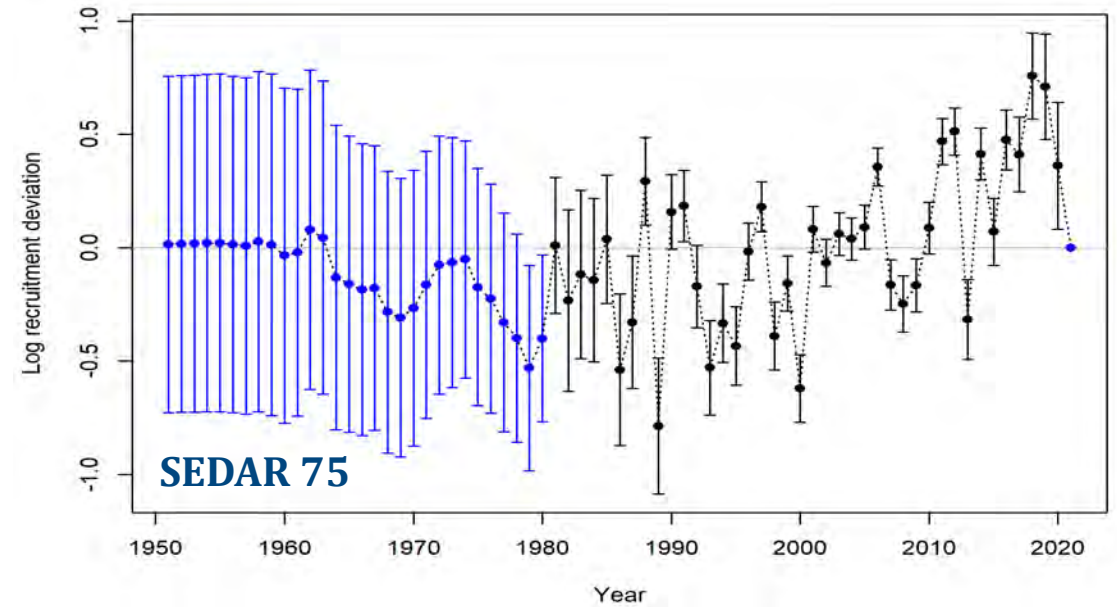
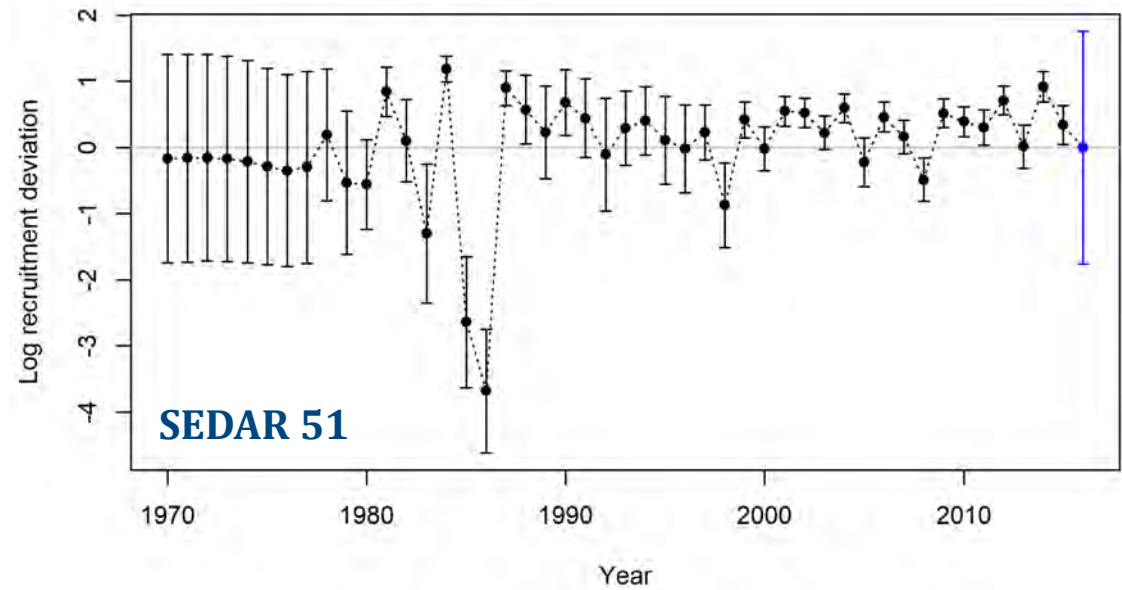


**CV > 1: early rec devs,
1981, 83-85, 1996,
2004, 2015**

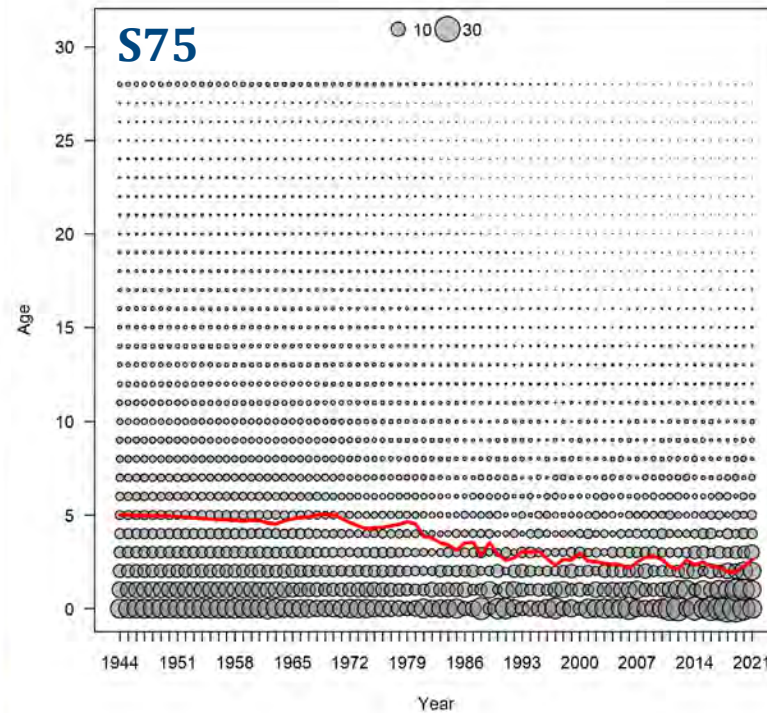
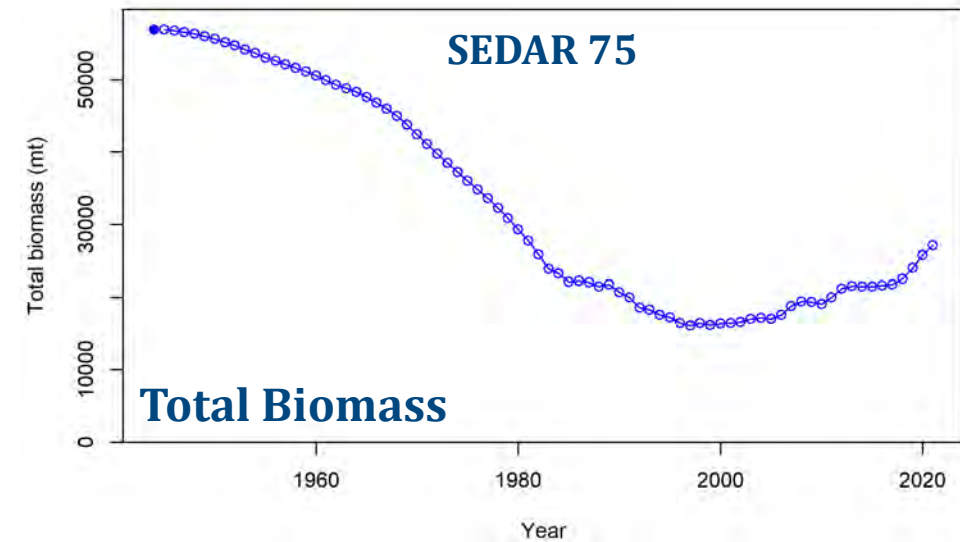
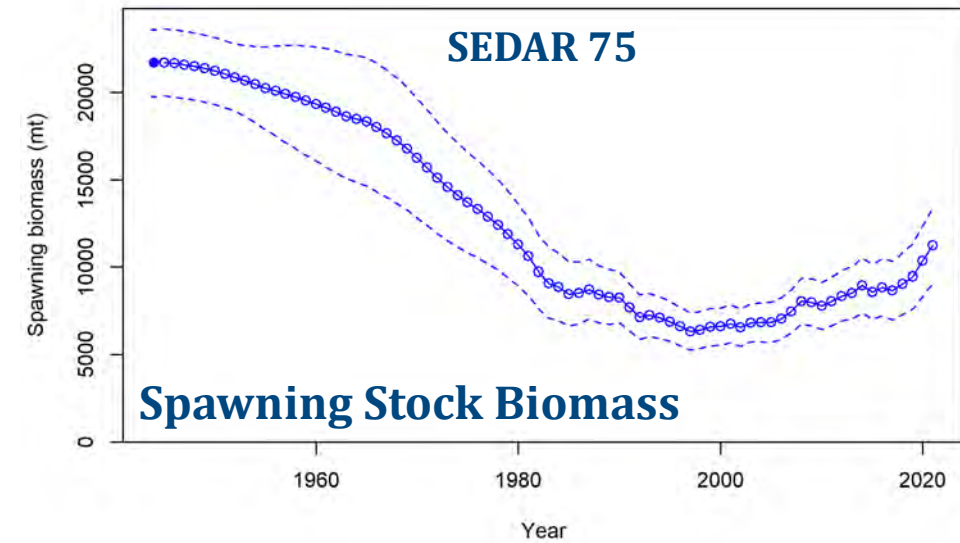


Recruitment

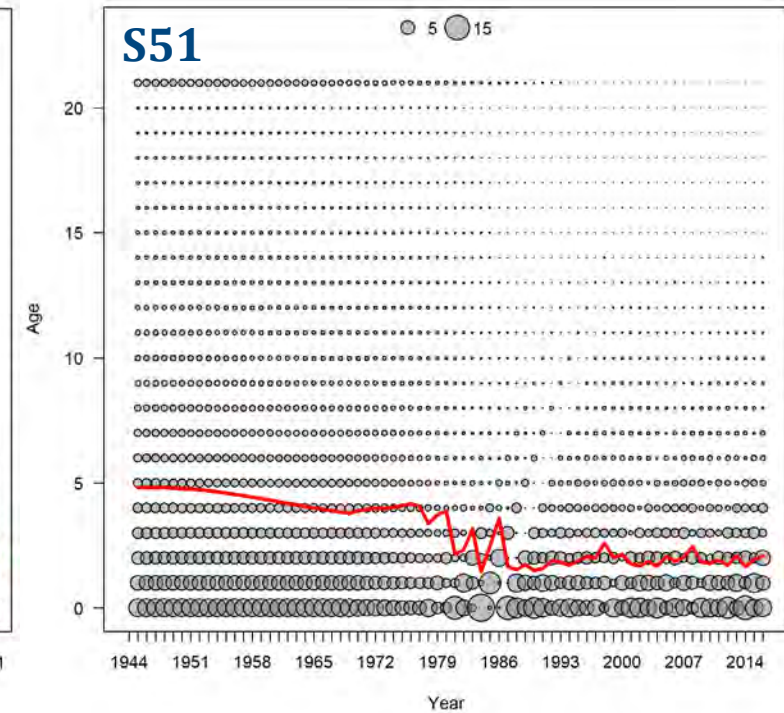
Parameter	S75 Value (CV)	S51 Value (CV)
$\ln(R_0)$	10.052 (0.005)	9.273 (0.009)
R_0	23,190,000	10,683,000
Steepness	0.99 (NA)	0.99 (NA)
σ_R	0.376 (0.123)	0.904 (0.139)



Biomass and Numbers-at-Age

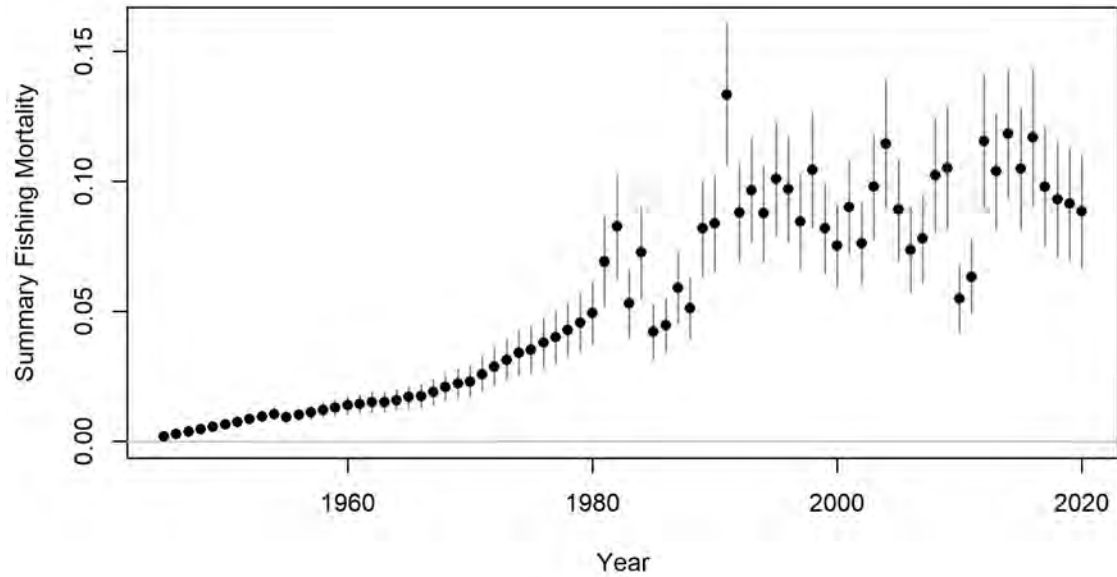


Average 3-5 years

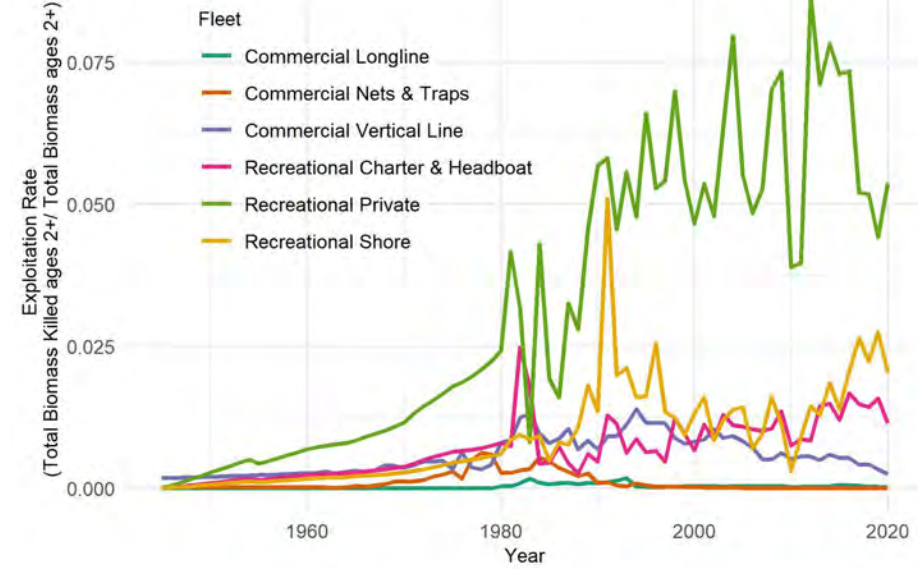


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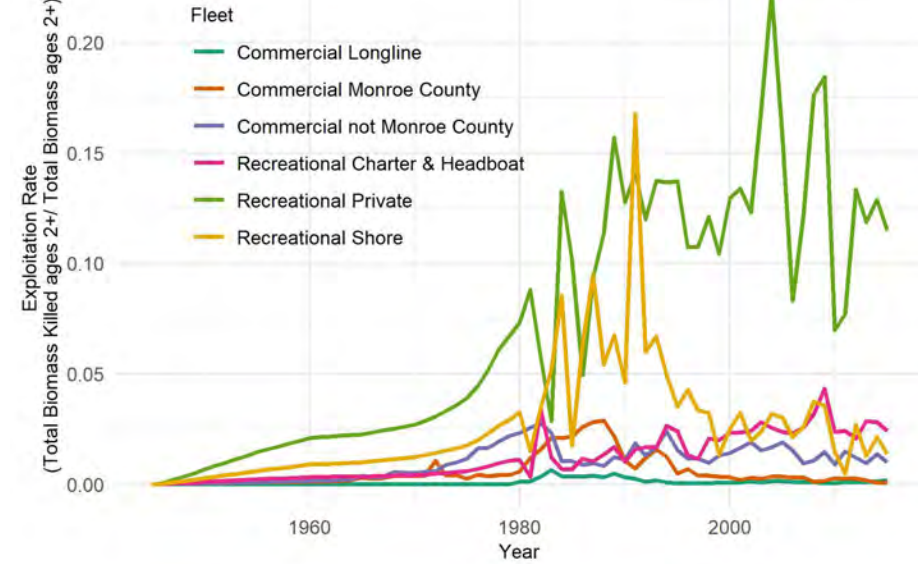
Fishing Mortality



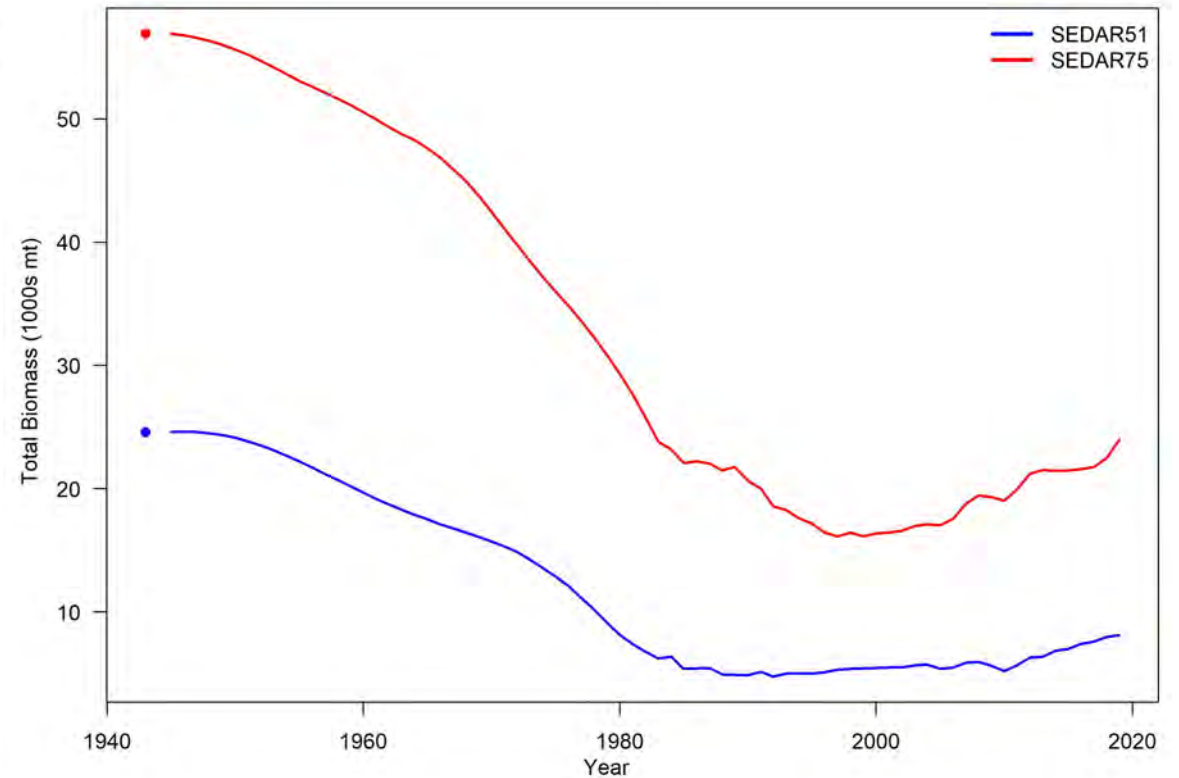
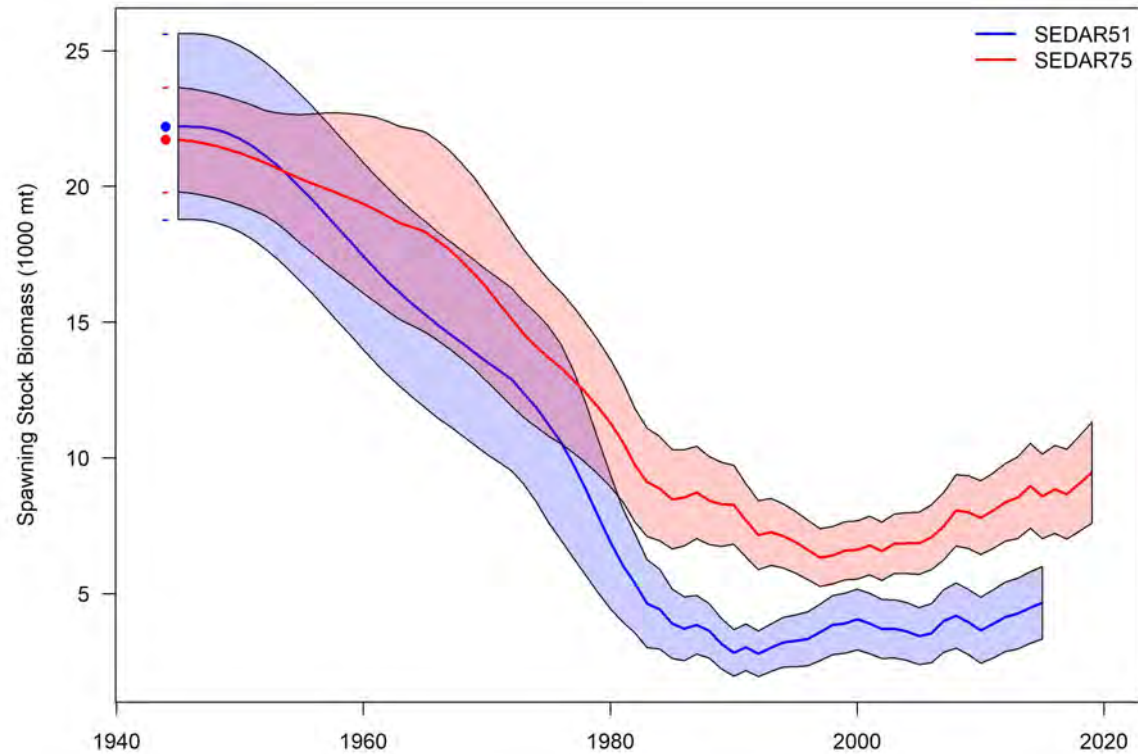
SEDAR75



SEDAR51



Base Model – Estimated Biomass & SSB



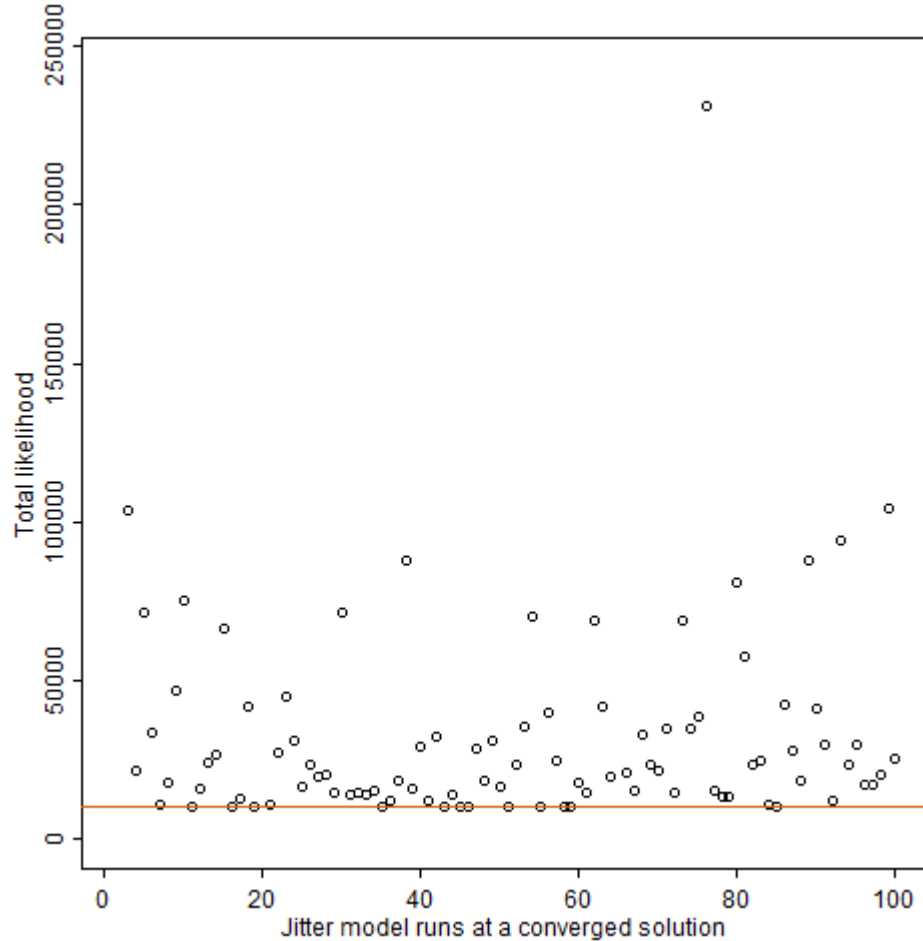
Diagnostics



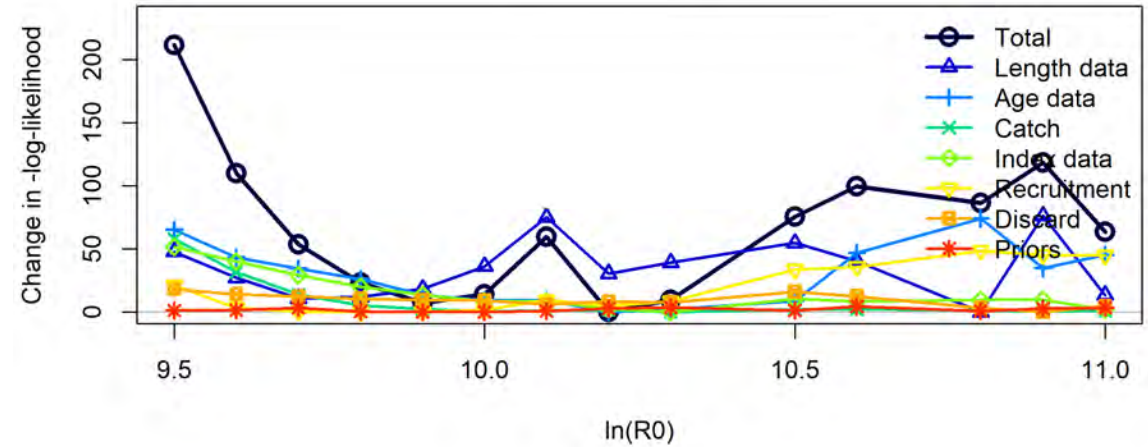
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Jitter & lnR0 profile

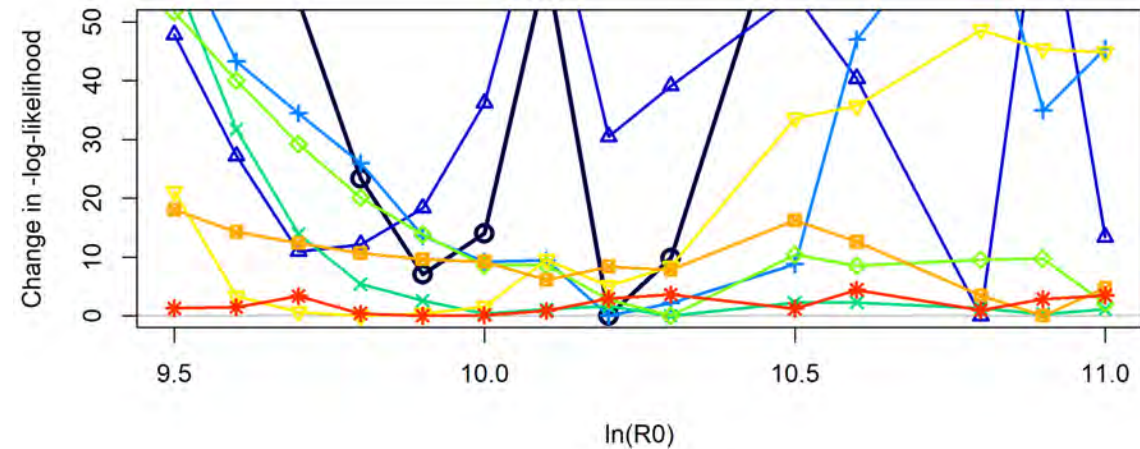
No runs revealed a lower NLL than the base



Likelihood Profile



Likelihood Profile -- Zoom



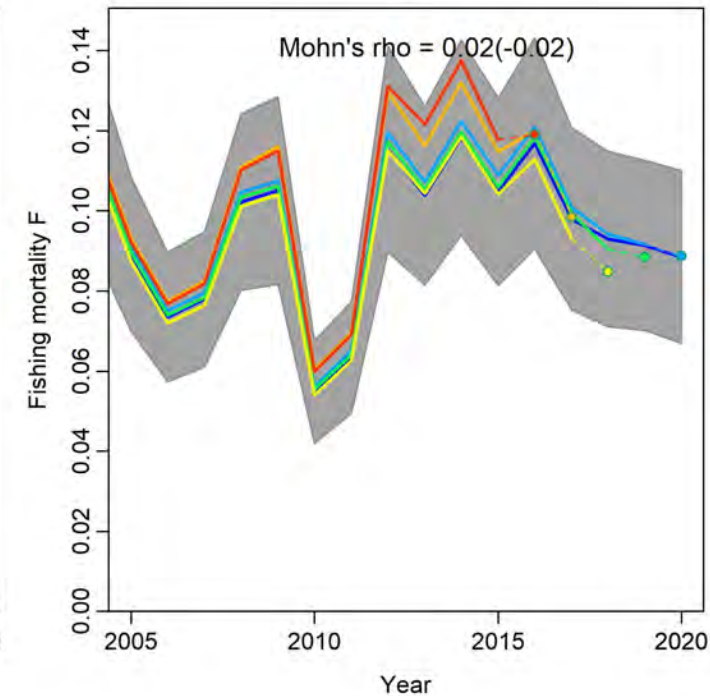
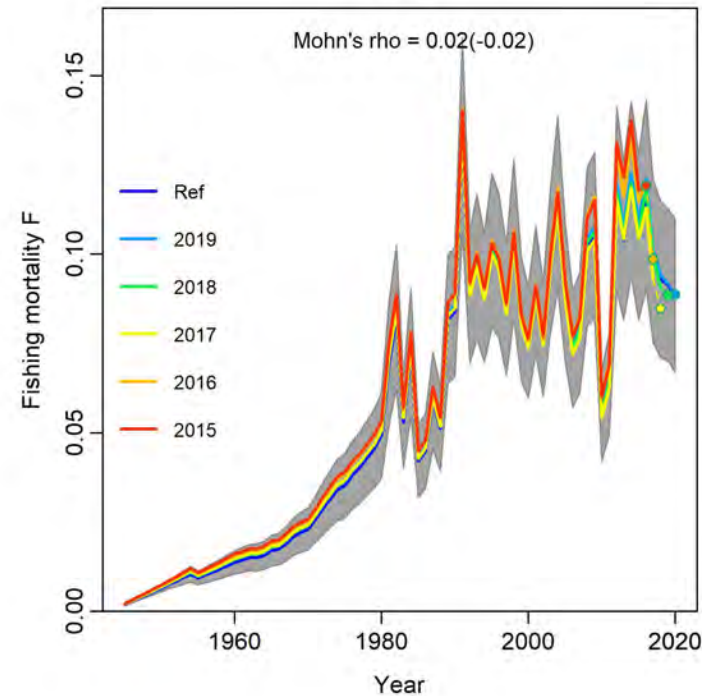
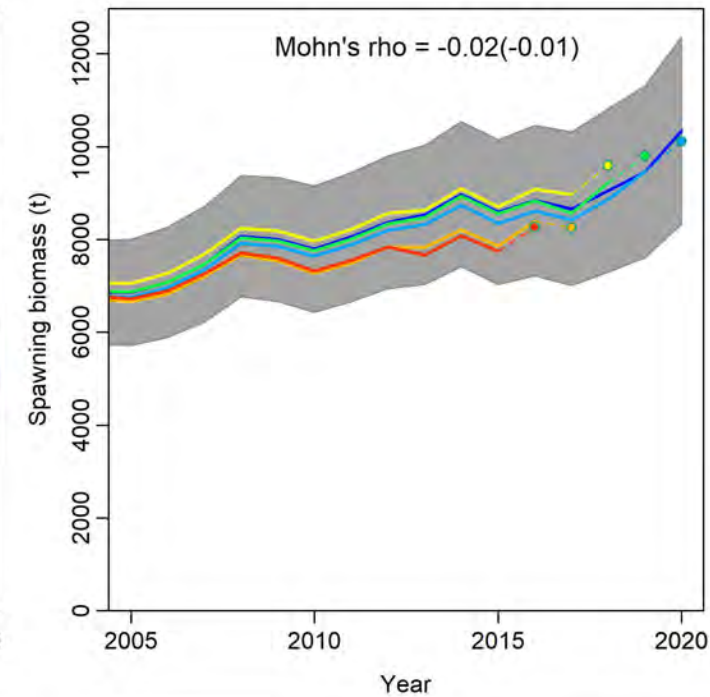
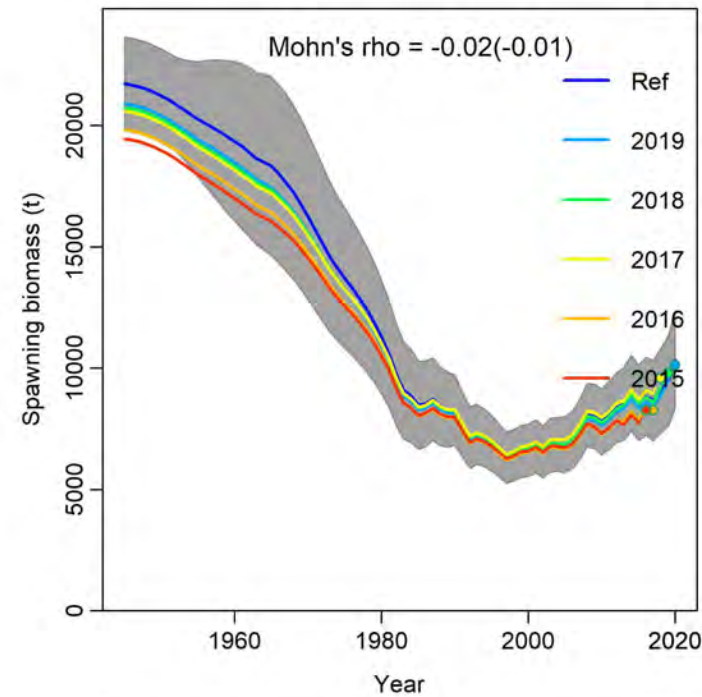
Label	Value	Parm_StDev	CV
SR_LN(R0)	10.052	0.046	0.005



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Retrospective Bias

- Retro bias falls within the acceptable thresholds for long-lived species (-0.15 to 0.2; Hurtado et al. 2015)
- Directional retrospective patterns not observed

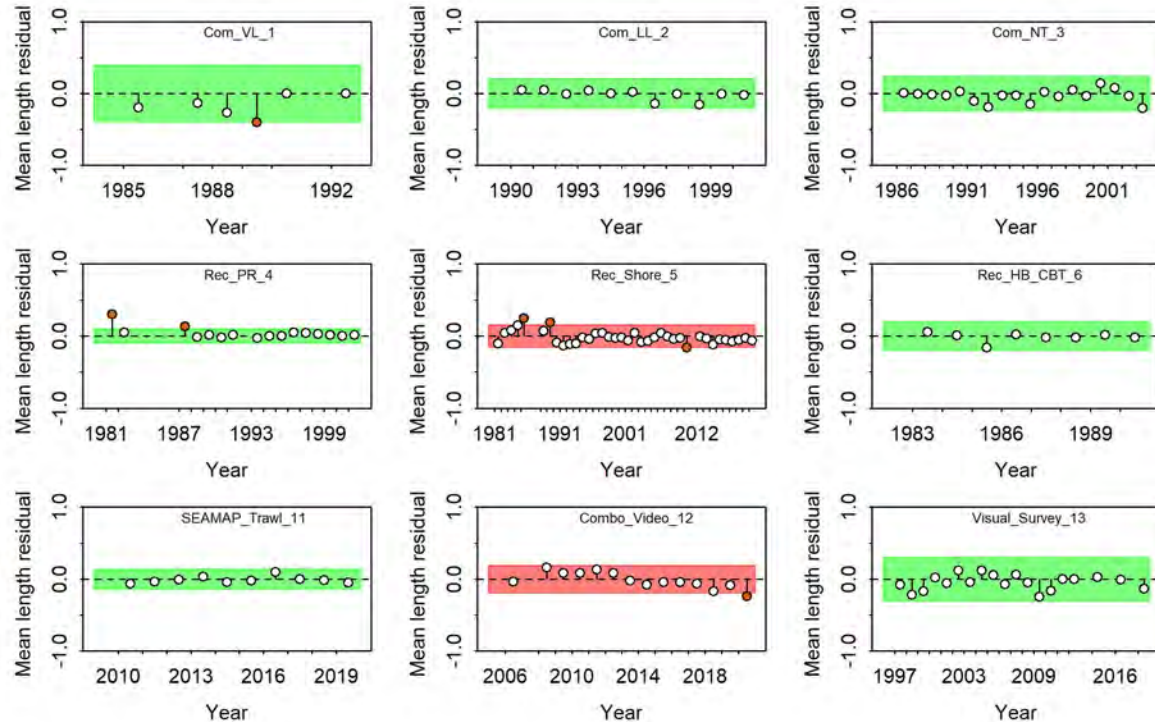


Runs Test

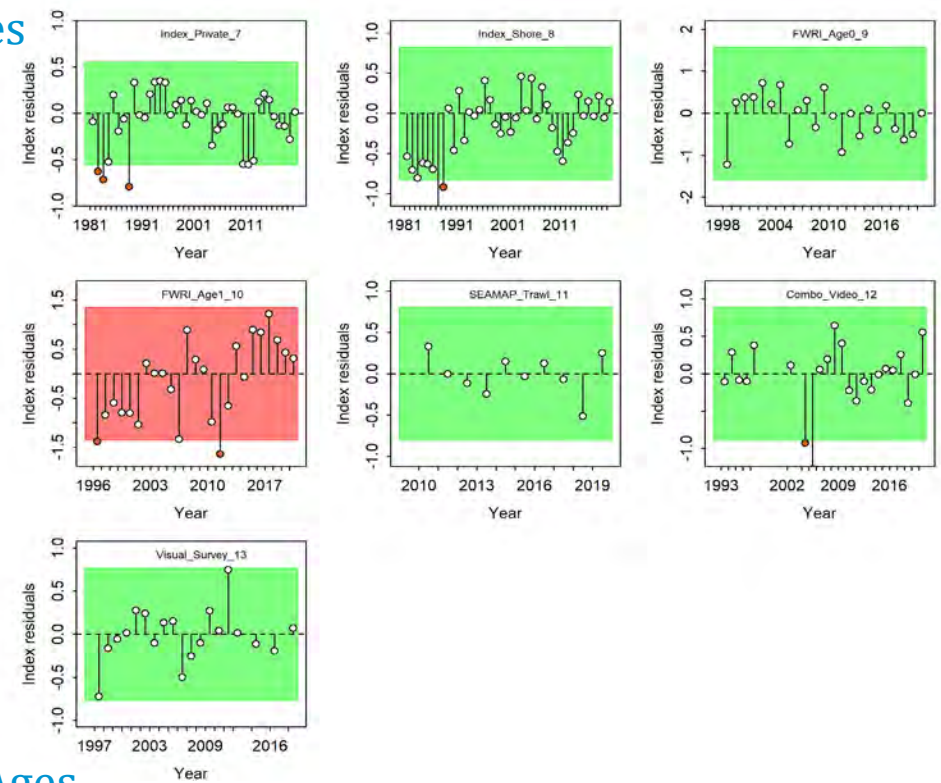
- Non-random patterns in residuals evident

Lengths	Indices	Ages
Shore	FWRI Age 1	Charter & Headboat
Combo Video		

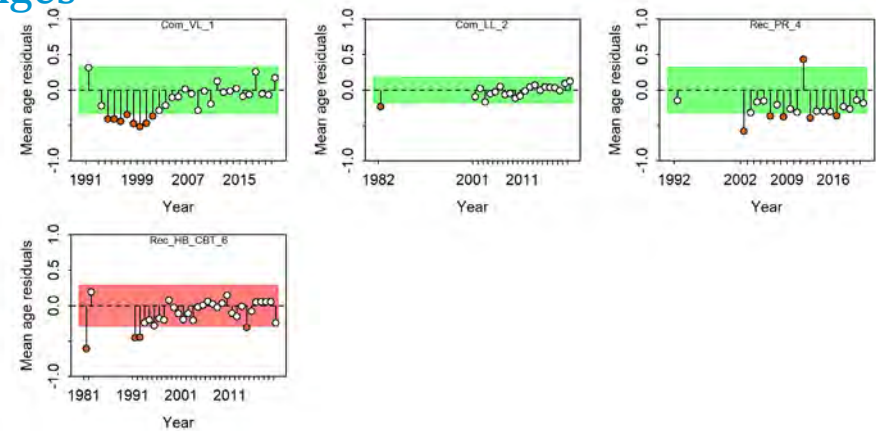
Lengths



Indices



Ages

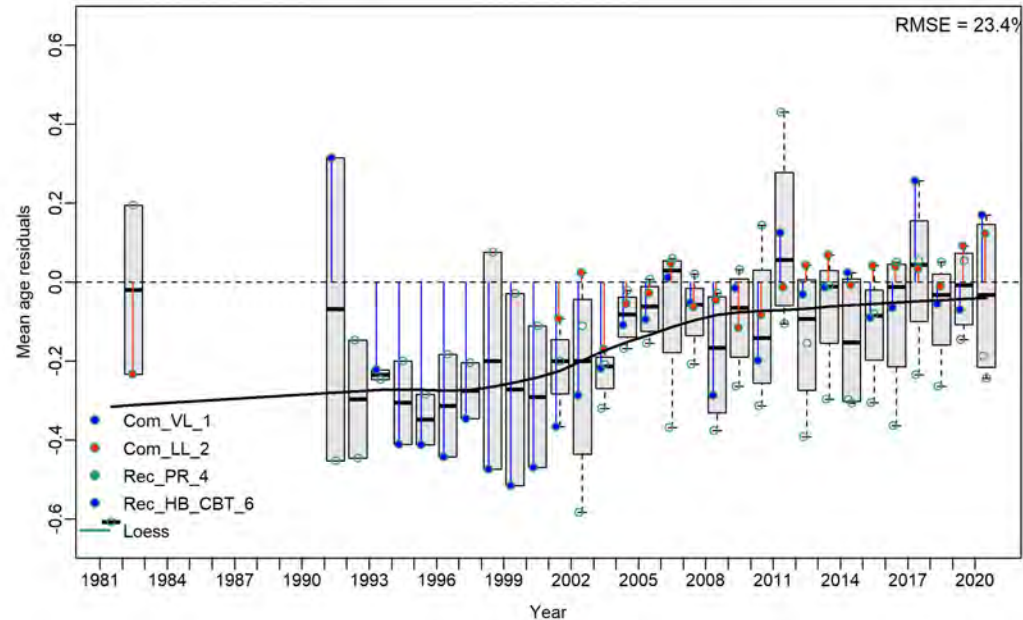


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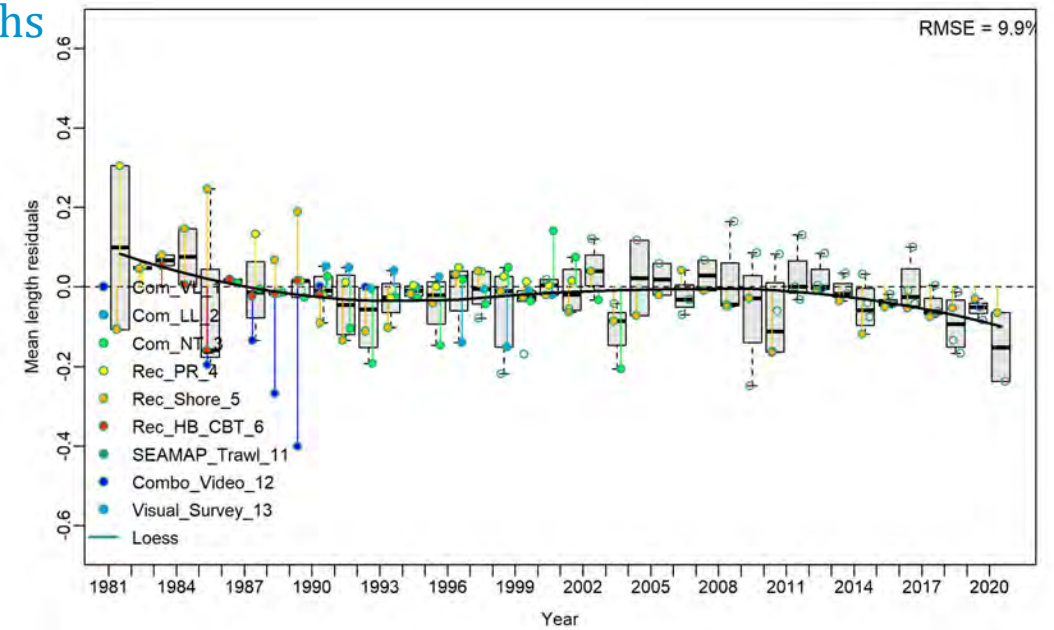
Joint Residual Plots

- Assesses goodness of model fit
 - Identifies conflicting time series and auto-correlation of residual patterns
 - RMSE above 30% undesirable

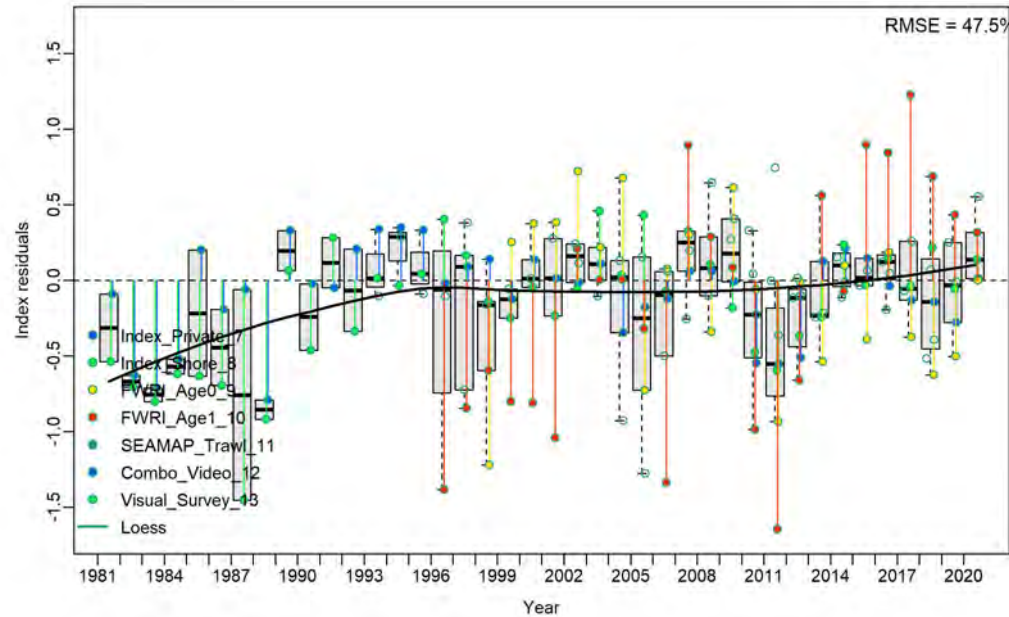
Ages



Lengths

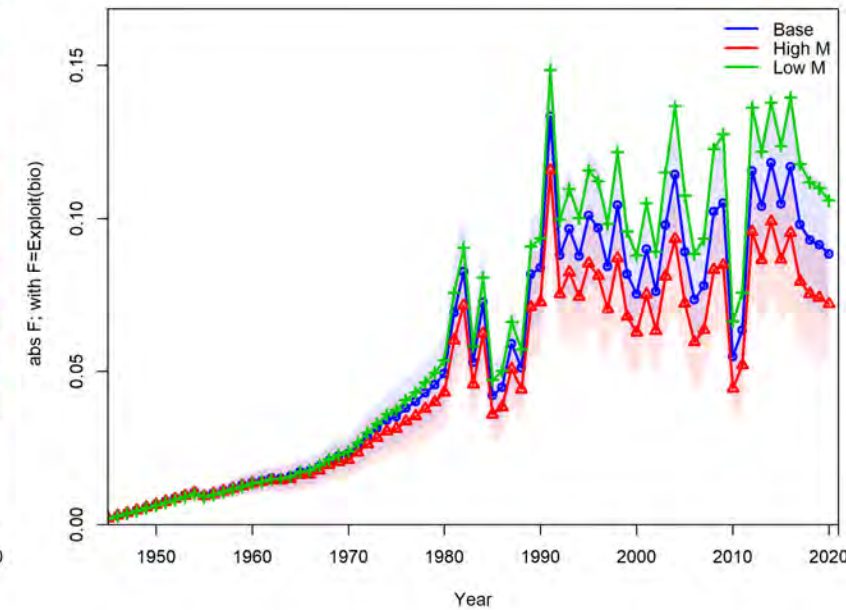
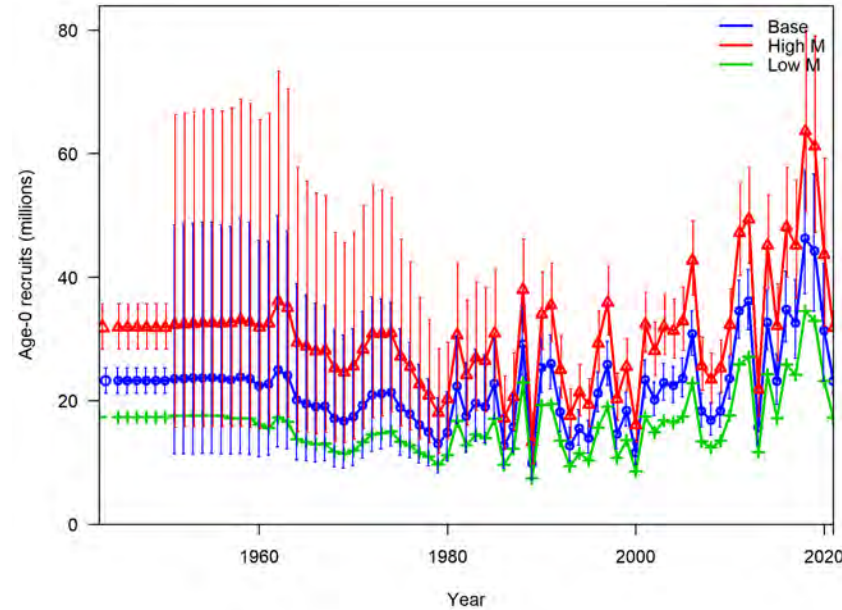
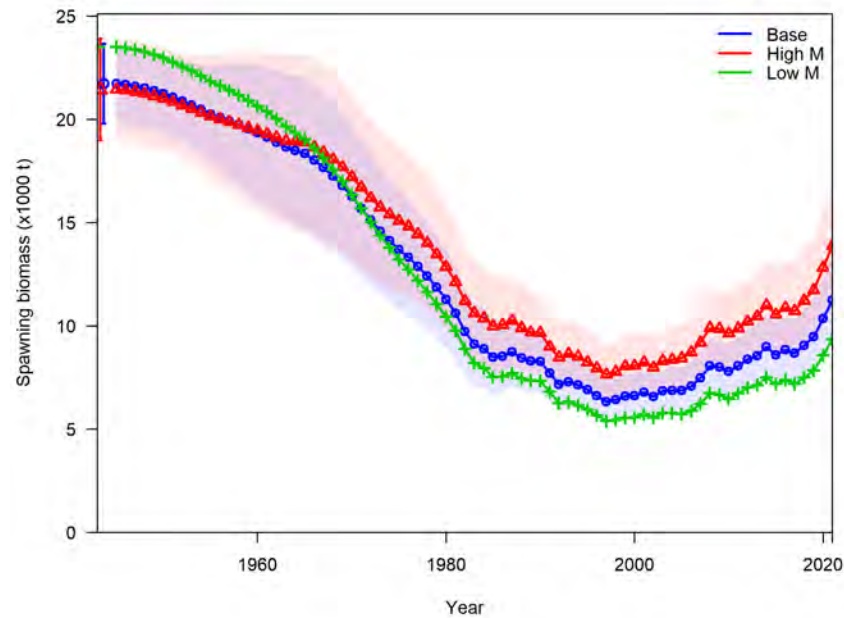


Indices



Sensitivity to Natural Mortality

- Pattern is as expected in recent years, though the low M scenario did not converge.



Benchmarks, Stock Status and Projections



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Terms of Reference

- Use the following status determination criteria (SDC) proposed in Amendment 51:
 - MSY proxy = yield at F_{MSY} or $F_{Rebuild}$ (if overfished)
 - $MSST = 0.5 * B_{MSY}$
 - MFMT = F_{MSY} or $F_{Rebuild}$ (if overfished)
 - If different SDC are recommended, provide outputs for both the current and recommended SDC.
- Unless otherwise recommended, use the geometric mean of the previous three years' fishing mortality to determine $F_{Current}$. If an alternative approach is recommended, provide justification and outputs for the current and alternative approach.
- Provide yield and spawning stock biomass streams for the overfishing limit and acceptable biological catch in pounds:
 - Annually for five years
 - Under a “constant catch” scenario for both three and five years
 - For the equilibrium yield at F_{MSY} , when estimable



Projection Settings

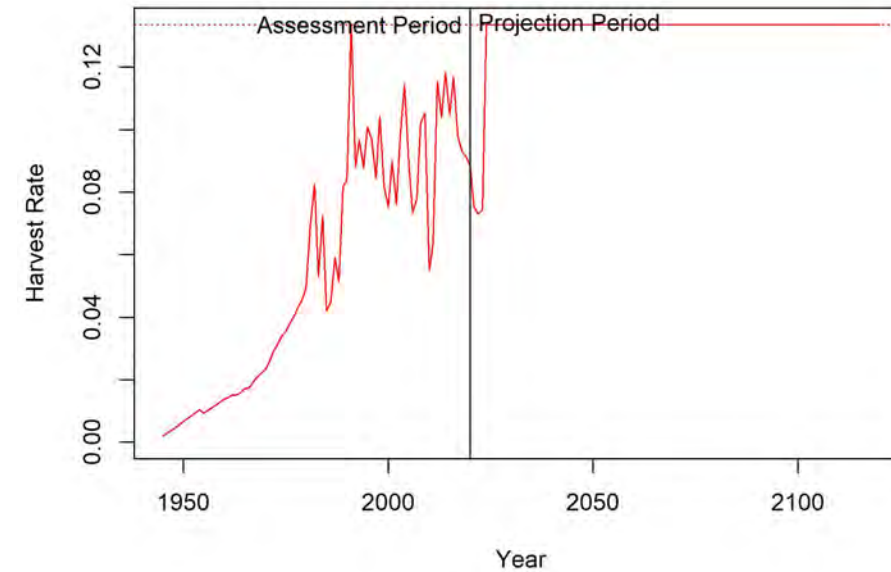
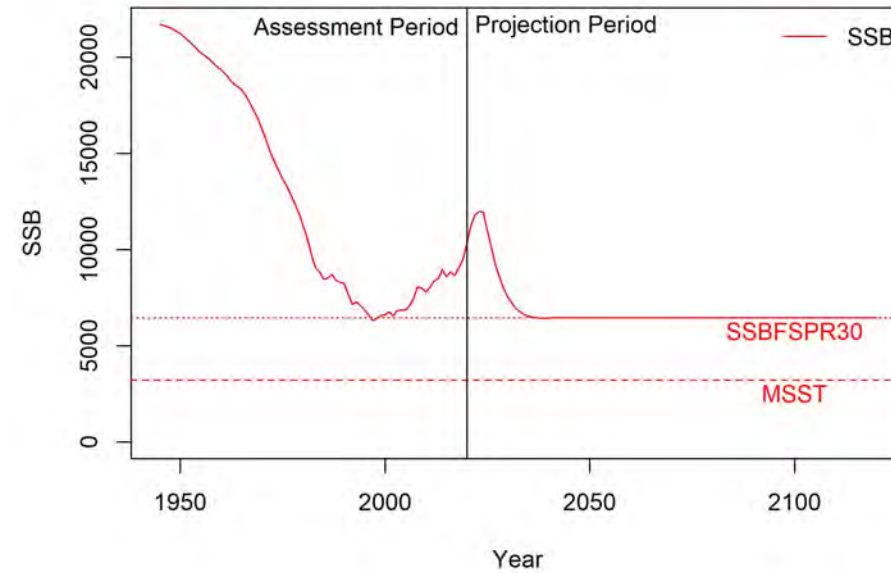
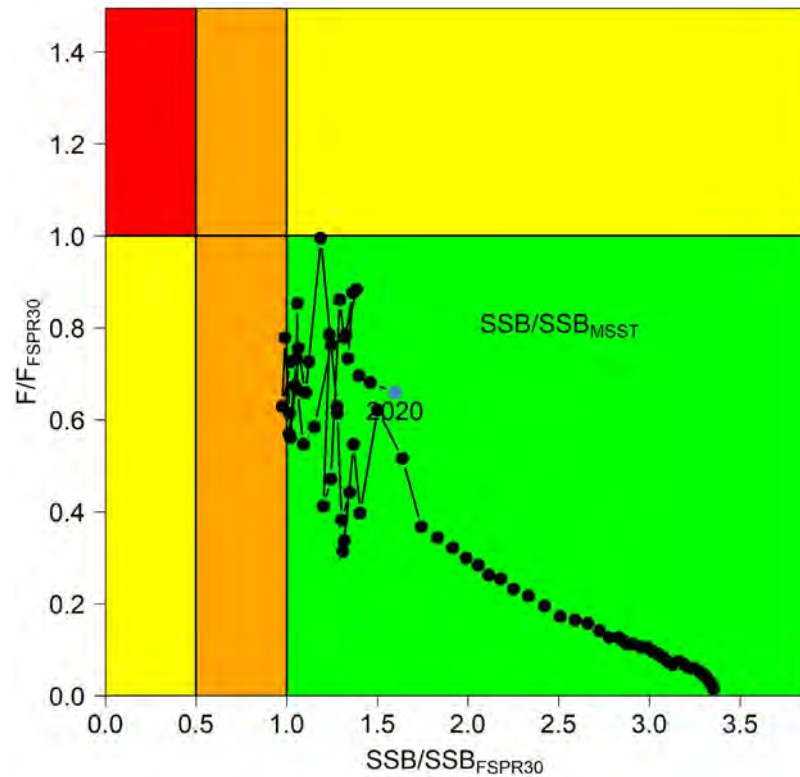
Parameter	Value	Comment
Relative F	Average from 2018 - 2020	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	2020	Fleet specific selectivity estimated in the terminal year of the model
Retention	2020	Fleet specific retention estimated in the terminal year of the model
Recruitment	Beverton-Holt stock-recruitment relationship	Derived from the model estimated Beverton-Holt stock-recruitment relationship
Interim Landings (2021-2023)	75.27/75.27/75.27 mt (Comm. Vertical Line) 5.61/5.61/5.61 mt (Comm. Longline) 0.11/0.11/0.11 mt (Comm. Nets & Traps) 2091.08/2091.08/2091.08 thousands of fish (Private) 1284.62/1284.62/1284.62 thousands of fish (Shore) 340.86/340.86/340.86 thousands of fish (Charter & Headboat)	For 2021-2023, used 3-year average of landings (2018-2020)

Benchmarks and Reference Points

Variable	Definition	Value
Steepness	Steepness of the Beverton-Holt stock recruit relationship (fixed)	0.99
R0	Virgin Recruitment (1000s)	23,191
Generation Time	Fecundity-weighted mean age	12.37
SSB Unfished	Virgin spawning stock biomass (mt)	21,719
	Mortality Rate Criteria	
FMSY proxy	Equilibrium F that achieves 30%SPR	0.134
MFMT	$F_{MSYproxy}$	0.134
FOY	$0.75 * \text{Directed F at } F_{30\%SPR}$	0.088
Fcurrent	Geometric mean of the last 3 years of the assessment (F2018-2020)	0.091
Fcurrent/MFMT	Current stock status based on MFMT	0.659
	Biomass Criteria	
SSBMSYproxy	Equilibrium SSB at F30%SPR	6477
MSST	$0.5 * SSB_{30\%SPR}$	3,239
SSB at Optimum Yield	Equilibrium SSB when Directed F = $0.75 * \text{Directed F at } F_{30\%SPR}$	7,907
SSBcurrent	SSB in 2020	10,345
SSBcurrent/SSBFMSYproxy	Current stock status based on SSB30%SPR (Equil)	1.6
SSB_2020/MSST	Current stock status based on MSST	3.2
SSBcurrent/SSB0	SSB ratio in 2020	0.48

Stock Status

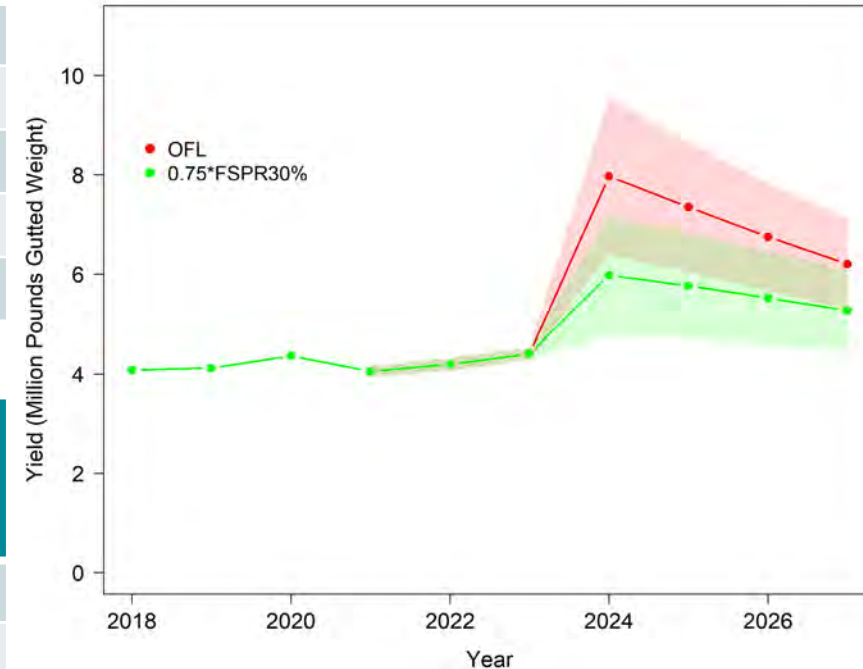
- Gulf of Mexico Gray Snapper is **not overfished or undergoing overfishing**



OFL and ABC projections (mp whole weight)

Year	R	F	F/FSPR30	SSB	SSB/ SSBSPR30	SSB/ MSST	SSB/SSB0	OFL
2024	23,143	0.13	1	11,963	1.8	3.7	0.55	7.970
2025	23,133	0.13	1	10,962	1.7	3.4	0.50	7.348
2026	23,122	0.13	1	10,031	1.5	3.1	0.46	6.746
2027	23,111	0.13	1	9,216	1.4	2.8	0.42	6.202
2028	23,100	0.13	1	8,533	1.3	2.6	0.39	5.735

Year	R	F	F/FSPR30	SSB	SSB/ SSBSPR30	SSB/ MSST	SSB/SSB0	ABC
2024	23,143	0.1	0.75	11,963	1.5	3.7	0.55	5.978
2025	23,138	0.1	0.75	11,446	1.4	3.5	0.53	5.760
2026	23,132	0.1	0.75	10,906	1.4	3.4	0.50	5.514
2027	23,127	0.1	0.75	10,387	1.3	3.2	0.48	5.267
2028	23,121	0.1	0.75	9,912	1.3	3.1	0.46	5.035



SSC Projections



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Projections

Interim commercial landings:

- Pulled from <https://www.fisheries.noaa.gov/gulf-mexico-historical-stock-landings-and-annual-catch-limit-monitoring> (retrieved 1/10/2023)
- Not split by fleets, currency different than used in model
- Applied percent change observed in commercial landing to model commercial fleets (2.8% ↑)

Year	Fishing Year	Commercial Landings
2021		93,275
2020		90,737

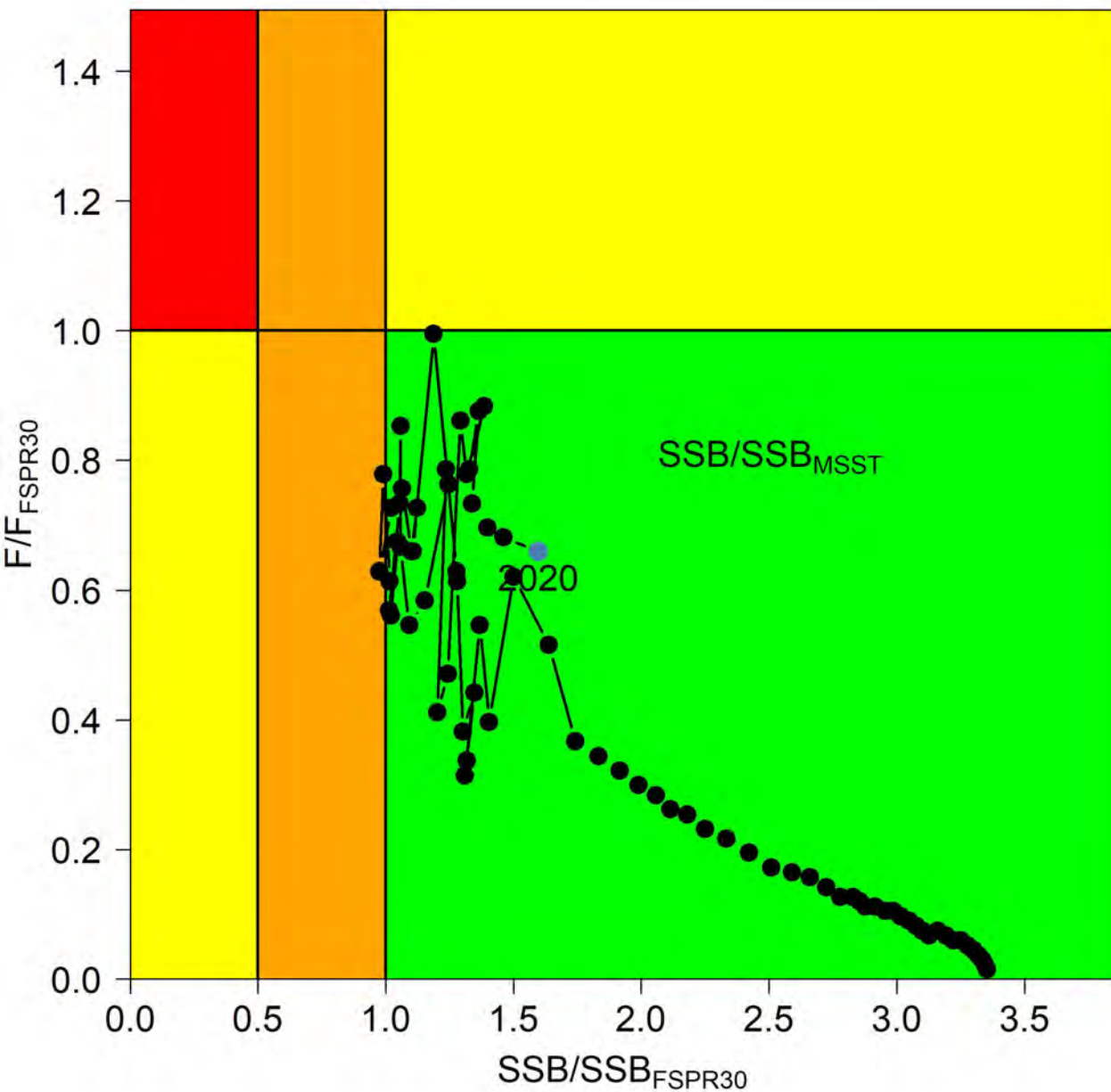
Interim recreational landings:

- FES landing provided for 2021 by M. Larkin in lb whole weight by fleet
 - Applied mean weight from terminal year in model to each fleet to obtain landings in numbers

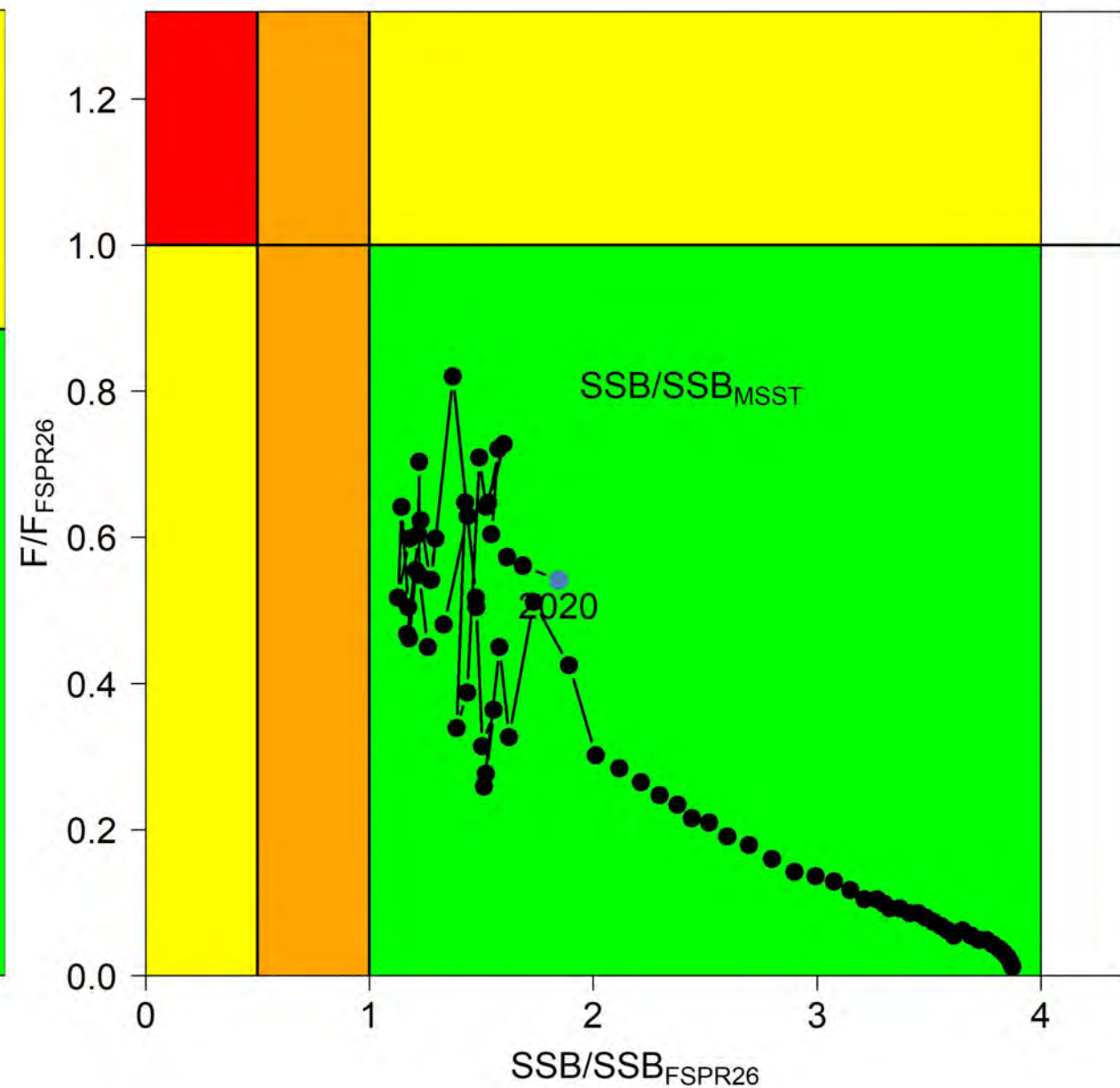
Updated Benchmarks

Variable	Definition	30% SPR	26% SPR
Steepness	Steepness of the Beverton-Holt stock recruit relationship (fixed)	0.99	0.99
R0	Virgin Recruitment (1000s)	23,191	23,191
Generation Time	Fecundity-weighted mean age	12.42	12.42
SSB Unfished	Virgin spawning stock biomass (mt)	21,719	21,719
	Mortality Rate Criteria		
FMSY proxy	Equilibrium F that achieves 30% or 26% SPR	0.134	0.162
MFMT	$F_{MSYproxy}$	0.134	0.162
Fcurrent	Geometric mean of the last 3 years of the assessment (F2018-2020)	0.091	0.091
Fcurrent/MFMT	Current stock status based on MFMT	0.68	0.56
	Biomass Criteria		
SSBMSYproxy	Equilibrium SSB at F30% or 26% SPR	6,477	5,607
MSST	0.5 * SSB at 30% or 26% SPR	3,239	2,803
SSB at Optimum Yield	Equilibrium SSB when Directed F = 0.75 * Directed F at F30% or 26% SPR	7,907	6,929
SSBcurrent	SSB in 2020	10,345	10,345
SSBcur/SSBFMSY	Current stock status based on SSB30%or 26% SPR (Equil)	1.6	1.85
SSB_2020/MSST	Current stock status based on MSST	3.2	3.69
SSBcurrent/SSB0	SSB ratio in 2020	0.48	0.48

MSY Proxy = $F_{\text{SPR30\%}}$



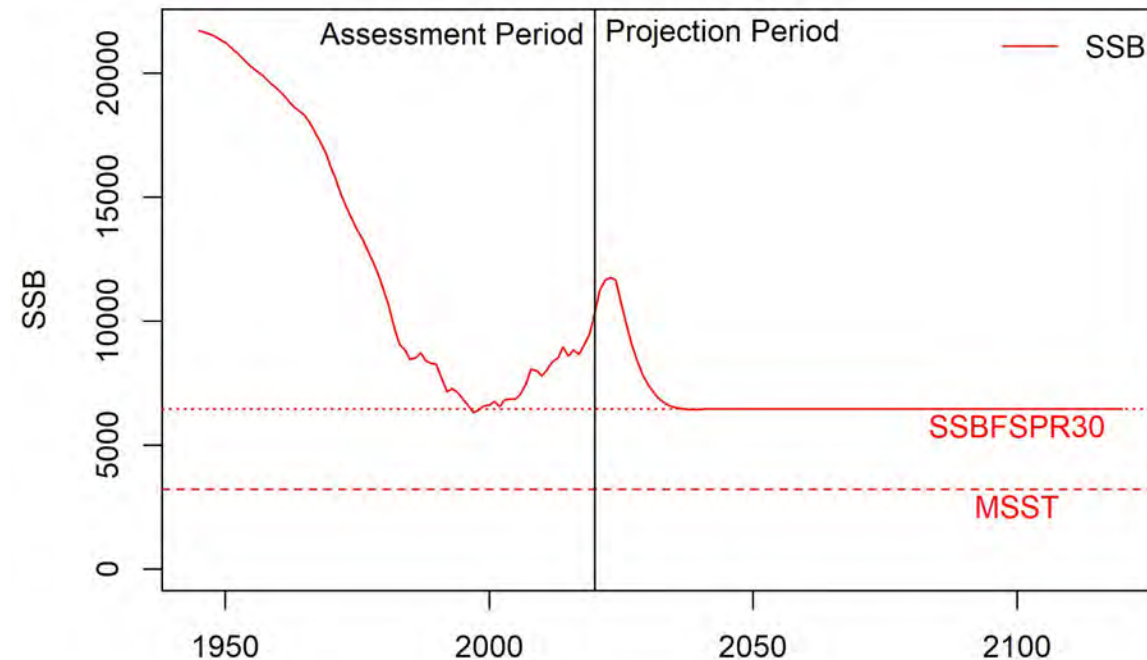
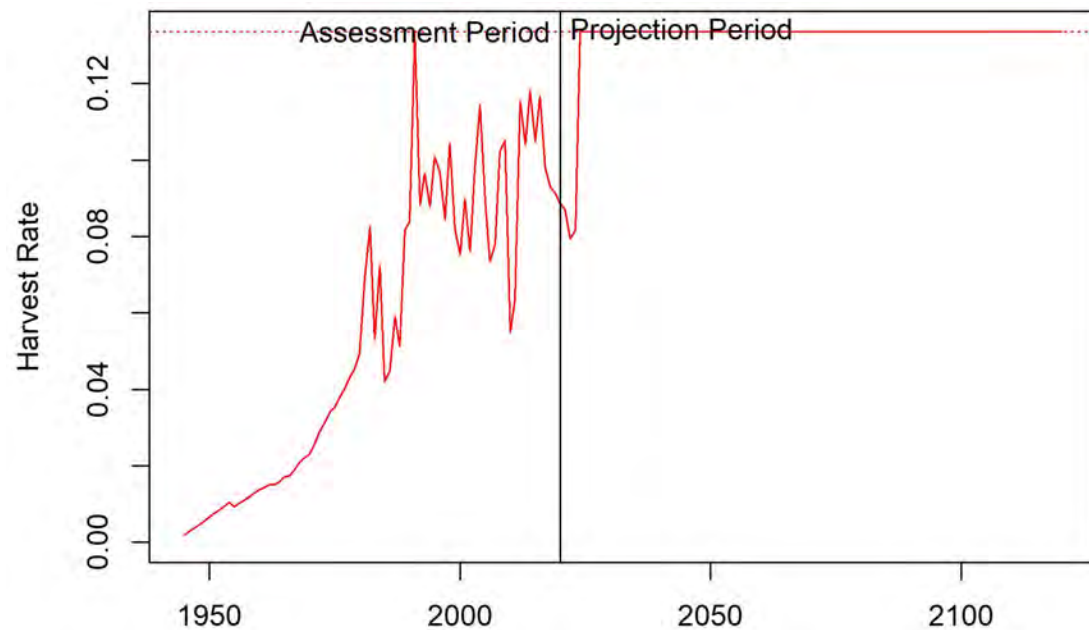
MSY Proxy = $F_{\text{SPR26\%}}$



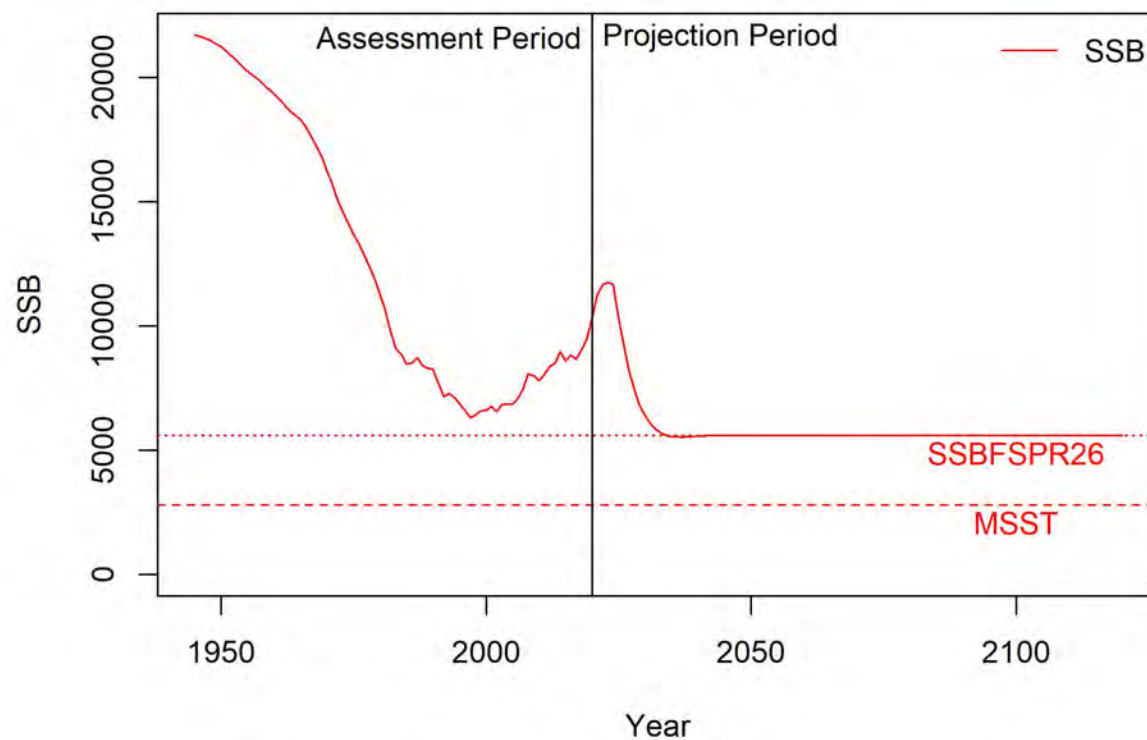
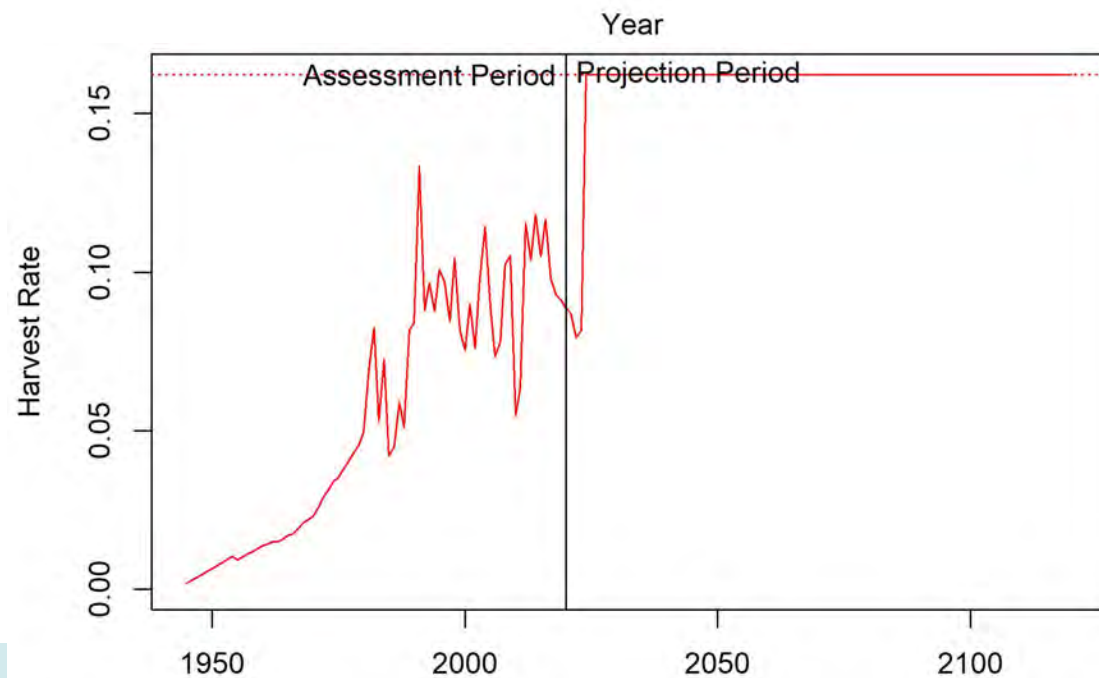
Projection Setting

Parameter	Value	Comment
Relative F	Average from 2018 - 2020	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	2020	Fleet specific selectivity estimated in the terminal year of the model
Retention	2020	Fleet specific retention estimated in the terminal year of the model
Recruitment	Beverton-Holt stock-recruitment relationship	Derived from the model estimated Beverton-Holt stock-recruitment relationship
Interim Landings (2021-2023)	62.61/66.16/66.16 mt (Comm. Vertical Line) 5.10/5.46/5.46 mt (Comm. Longline) 0.17/0.15/0.15 mt (Comm. Nets & Traps) 2974.24/2417.30/2417.30 thousands of fish (Private) 1038.93/1262.03/1262.03 thousands of fish (Shore) 309.65/335.10/335.10 thousands of fish (Charter & Headboat)	2021 interim landings calculated using percent change (commercial) or as converted to fish (recreational) For 2022-2023, used 3-year average of landings (2019-2021)

MSY Proxy = $F_{\text{SPR } 30\%}$



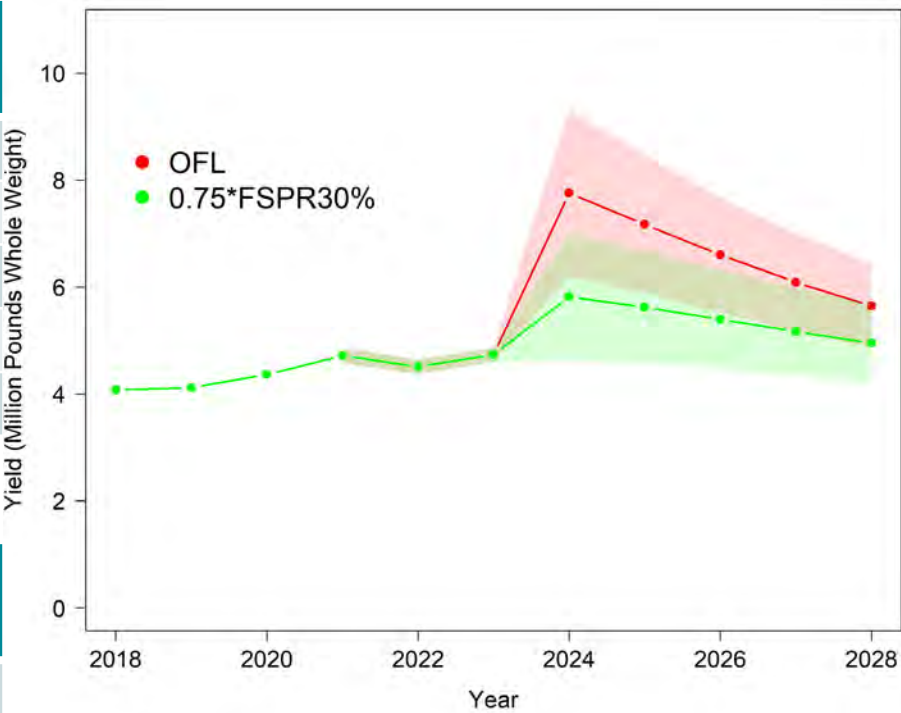
MSY Proxy = $F_{\text{SPR } 26\%}$



FSPR 30% OFL and ABC projections (mp WW)

Year	R	F	F/FSPR30	SSB	SSB/ SSBSPR30	SSB/ MSST	SSB/SSB0	OFL
2024	23139.8	0.134	1.003	11658.1	1.8	3.6	0.537	7.758
2025	23130.2	0.134	1.003	10711.9	1.654	3.308	0.493	7.171
2026	23119.7	0.134	1.003	9832.09	1.518	3.036	0.453	6.601
2027	23108.7	0.134	1.003	9062.74	1.399	2.798	0.417	6.088
2028	23098.1	0.134	1.003	8417.08	1.3	2.599	0.388	5.647

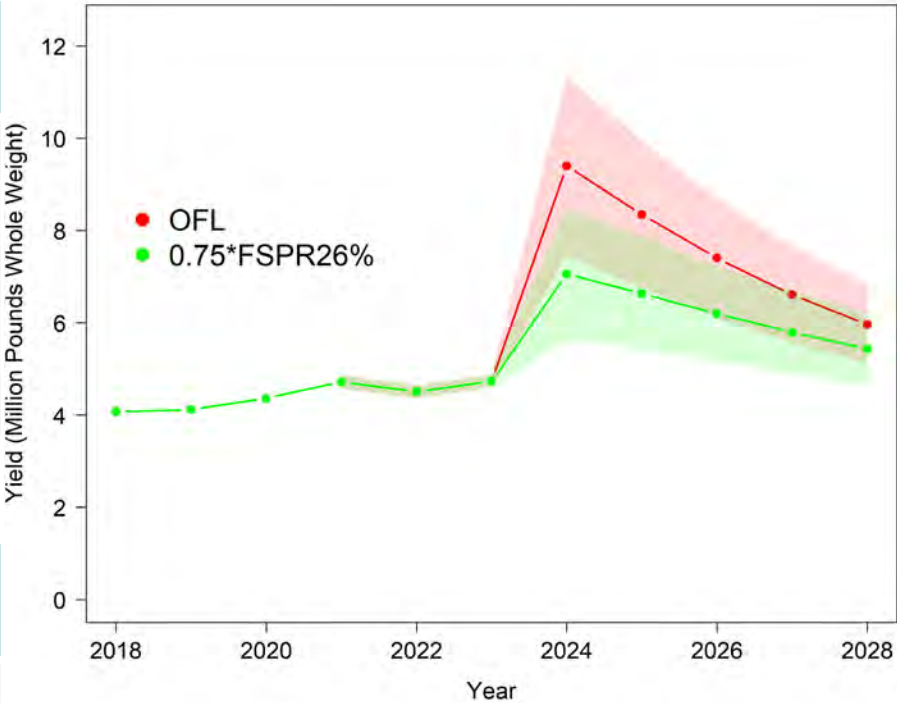
Year	R	F	F/FSPR30	SSB	SSB/ SSBSPR30	SSB/ MSST	SSB/SSB0	ABC
2024	23139.8	0.1	0.748	11658	1.474	3.6	0.537	5.820
2025	23135.2	0.1	0.748	11183	1.414	3.453	0.515	5.620
2026	23129.9	0.1	0.748	10685	1.351	3.299	0.492	5.394
2027	23124.4	0.1	0.748	10206	1.291	3.151	0.47	5.167
2028	23118.8	0.1	0.748	9767	1.235	3.016	0.45	4.952



FSPR 26% OFL and ABC projections (mp WW)

Year	R	F	F/FSPR26	SSB	SSB/SSBSPR26	SSB/MSST	SSB/SSB0	OFL
2024	23139.8	0.162	0.999	11658.1	2.079	4.159	0.537	9.402
2025	23125.6	0.162	0.999	10310.2	1.839	3.678	0.475	8.351
2026	23109.9	0.162	0.999	9135.83	1.629	3.259	0.421	7.405
2027	23093.5	0.162	0.999	8169.39	1.457	2.914	0.376	6.610
2028	23077.6	0.162	0.999	7404.68	1.321	2.641	0.341	5.969

Year	R	F	F/FSPR26	SSB	SSB/SSBSPR26	SSB/MSST	SSB/SSB0	ABC
2024	23139.8	0.122	0.752	11658	1.683	4.159	0.537	7.063
2025	23132.1	0.122	0.752	10881	1.57	3.881	0.501	6.633
2026	23123.5	0.122	0.752	10134	1.463	3.615	0.467	6.199
2027	23114.6	0.122	0.752	9461	1.366	3.375	0.436	5.795
2028	23105.9	0.122	0.752	8880	1.282	3.168	0.409	5.438



Constant Catch

- 5 year average of projected yield in million pounds whole weight

	FSPR30		FSPR26	
Year	OFL	ABC	OFL	ABC
2024	6.653	5.391	7.547	6.226
2025	6.653	5.391	7.547	6.226
2026	6.653	5.391	7.547	6.226
2027	6.653	5.391	7.547	6.226
2028	6.653	5.391	7.547	6.226

Research Recommendations



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Research Recommendations

Recreational Landings and Discards data

- Further develop best practices for correcting for prominent peaks and troughs in the earlier part of the time series where uncertainty is high and catch/discard estimates are driven by few but influential intercept records.
- Develop estimates of uncertainty around Headboat discard estimates.

Age and length composition

- Quantify and evaluate appropriate modeling and weighting procedures of length and age compositions to ensure age and length composition inputs are representative of the segment of the population being modeled.
- Improve sampling programs for shore based recreational fishing modes to obtain length and age data for that mode.

Selectivity and catchability of the commercial fleets

- Further investigate and quantify changes in selectivity/catchability through time to improve fit to the discards and length compositions in recent years.
- Continue data collection from observer programs or electronic monitoring programs.

Selectivity and retention of the recreational fleets

- Further investigate and quantify changes in selectivity/catchability through time to improve fit to the length compositions across the time series.

Landings and Discards

- Explore approaches for assigning uncertainty estimates to commercial landings and revisit estimation of historic landings.
- Further investigate best practices for converting historical recreational landings from numbers to weight.
- Explore possible multiple discard events in same year for same fish, effect on B2 estimates and discard mortality rates

Recreational CPUE indices

- Additional research is needed to investigate if assumptions are appropriate across full time series (e.g., targeting, trip length, effects of various regulations on gray snapper as well on other species i.e. red snapper).

Natural mortality

- Explore ways to better reflect uncertainty about the mortality at age vector.



Questions?

Thank you for your attention!



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