



NOAA
FISHERIES

SEFSC



SEDAR 72: US Gulf of Mexico Gag Grouper

Operational Assessment

GMFMC Reef Fish AP
Presentation January 2022

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

Modified by Ryan Rindone for the Reef Fish AP

SEDAR 72 Changes

- Notable changes compared with the SEDAR 33 Update model include:

TOR →

- New **MRIP Fishing Effort Survey (FES)** catch and discard time series

TOR →

- Improved **commercial discard** estimates

TOR →

- Updated information on **red tide** mortality

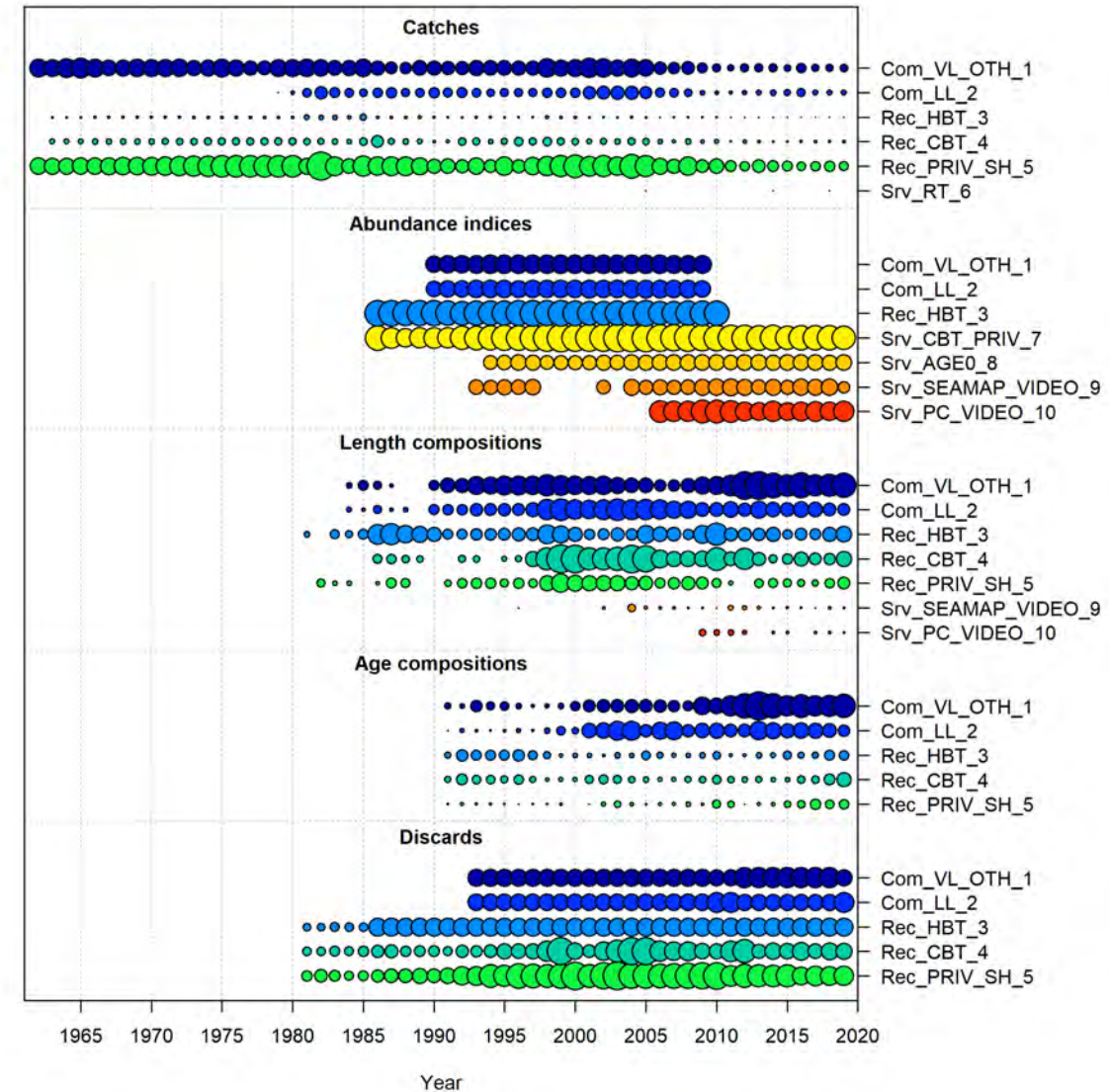
TOR →

- Refining of the **recreational fleets' selectivity & retention** functions
- Updated information on **maturity** and the **hermaphroditism** transition function
- A new **combined private/charter index** (replacing the individual time series)
- Re-estimation of **growth** and updated variances
- Improved Southeast Region Headboat Survey (**SRHS**) **discard** proxy estimates
- New **black/gag grouper correction factors** for commercial landings and discards
- A new fishery-independent **combined video survey** (*sensitivity run*)

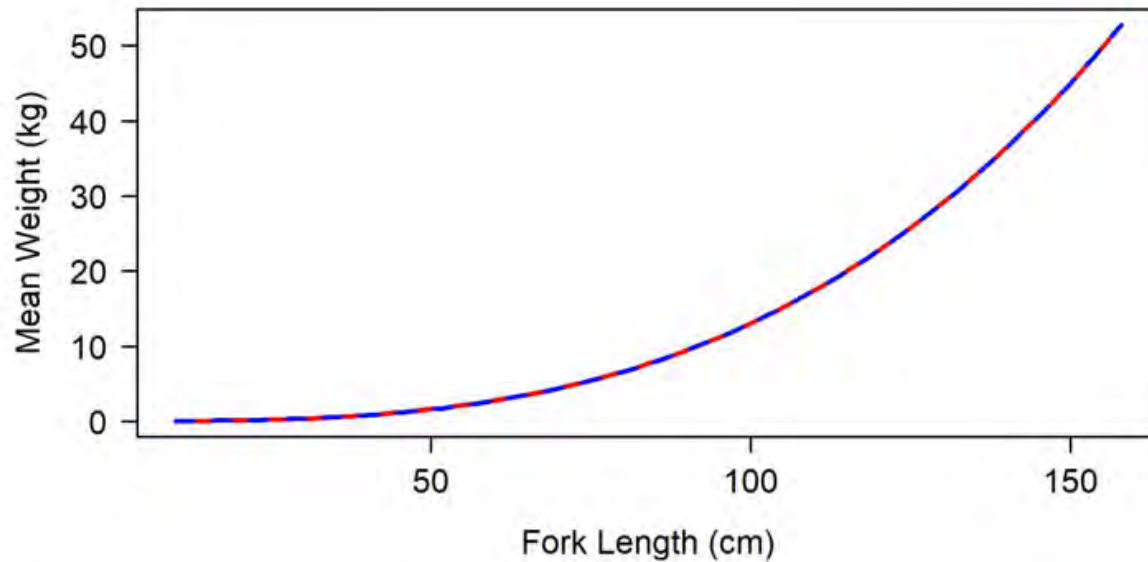
-

Data – Overall Structure

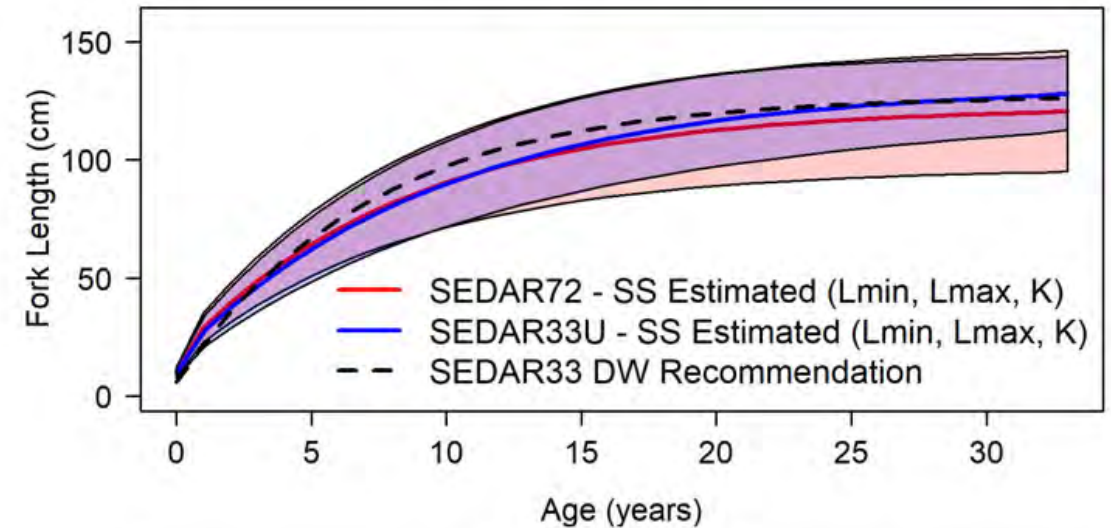
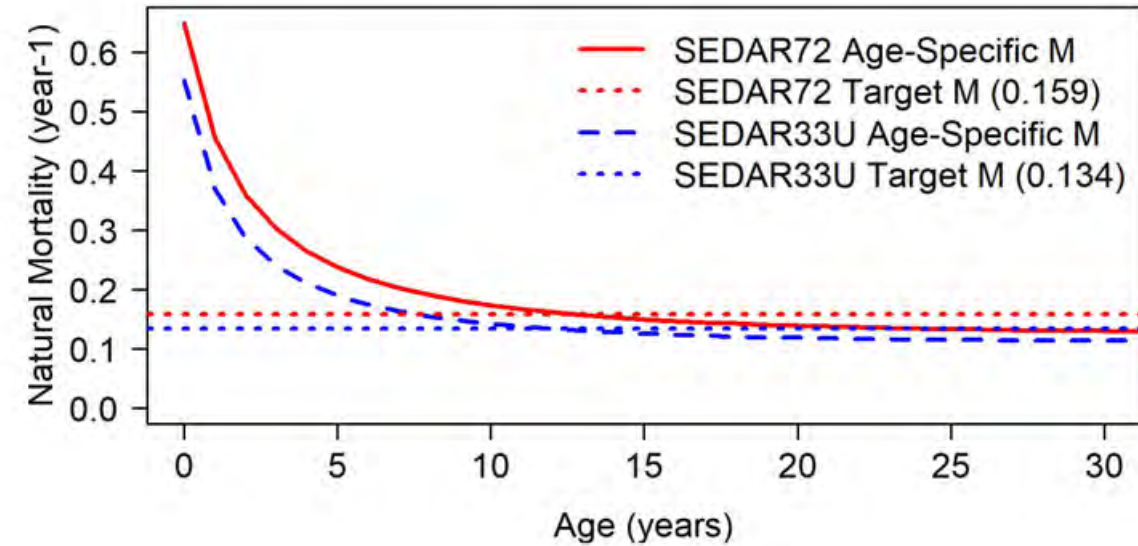
- Years: 1963-2019
- Fleets
 - Commercial: Vertical Line & Longline
 - Recreational: Headboat, Charter, Private
- Red tide "bycatch fleet"
- Abundance Indices
 - Fishery-dependent: directed fleets
 - Fishery-Independent: SEAMAP video, PC video, Age-0



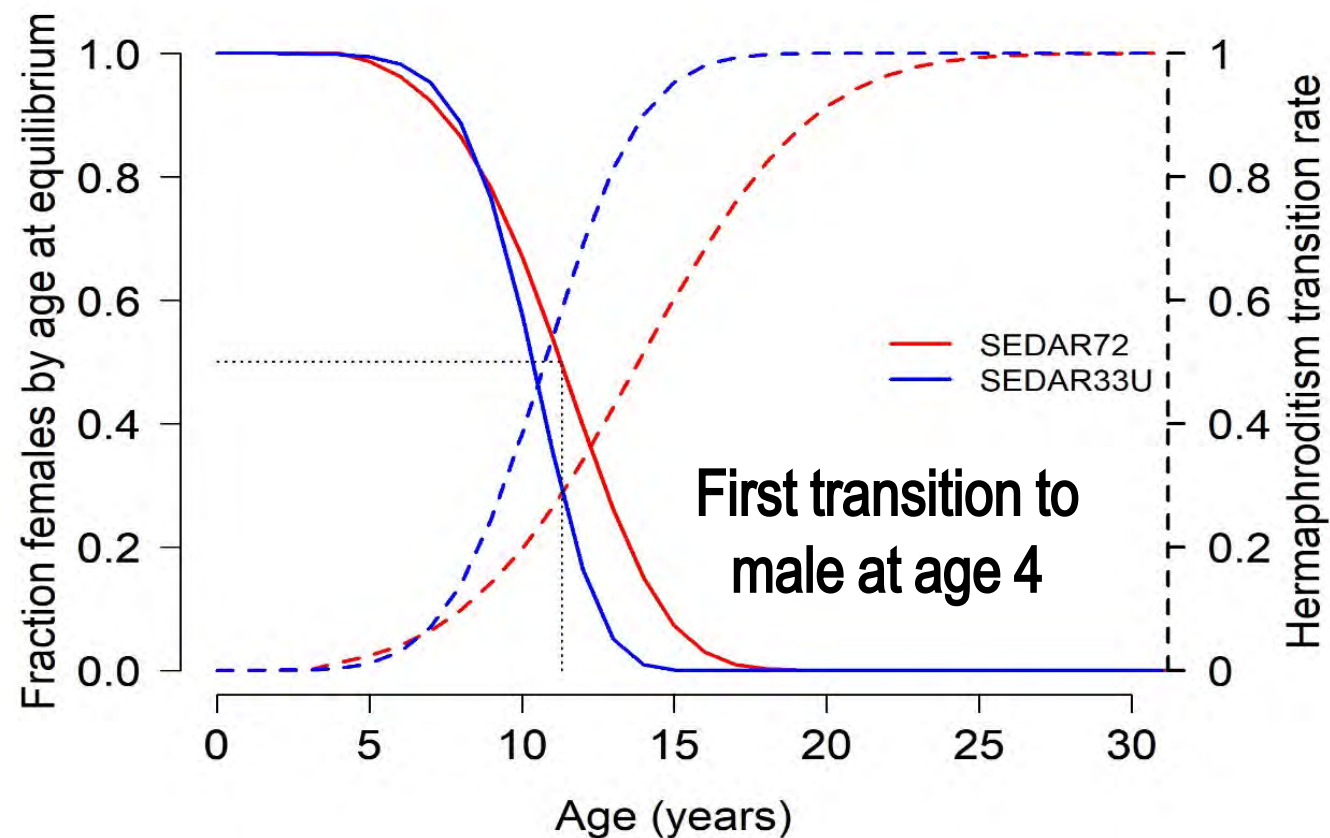
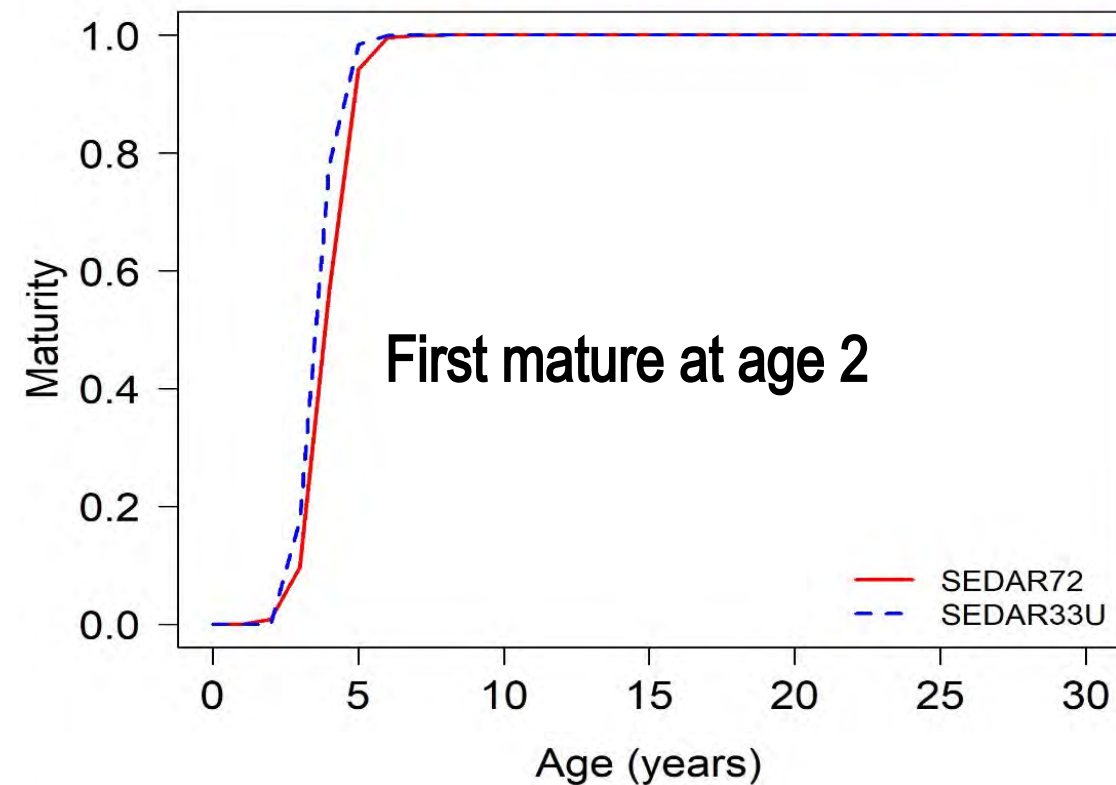
Data – Life History



Max age = 33 years



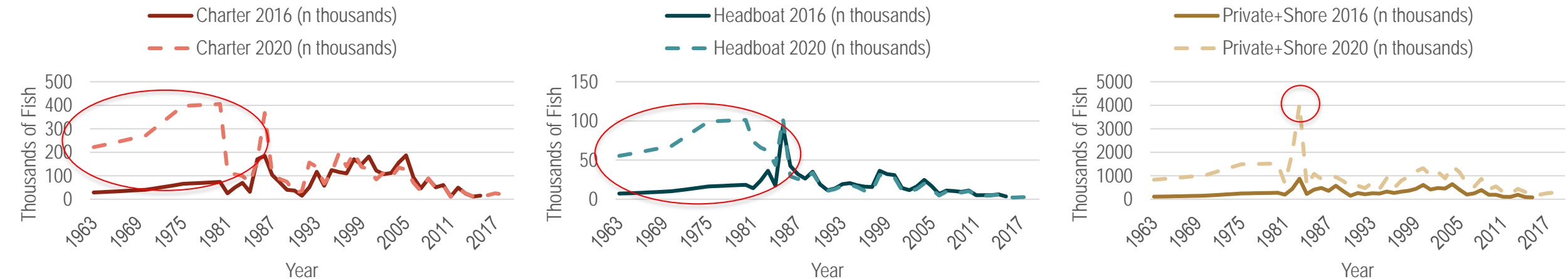
Data – Life History



Data – Recreational Landings

Data Component	Decision
Recreational Landings	Use new fully calibrated (APAIS+FES) MRIP estimates (WP-02) with a CV=0.2. Replaced 1983 private mode landings with geometric mean of 1981, 1982, 1984, and 1985. Recalculated historical catch ratios

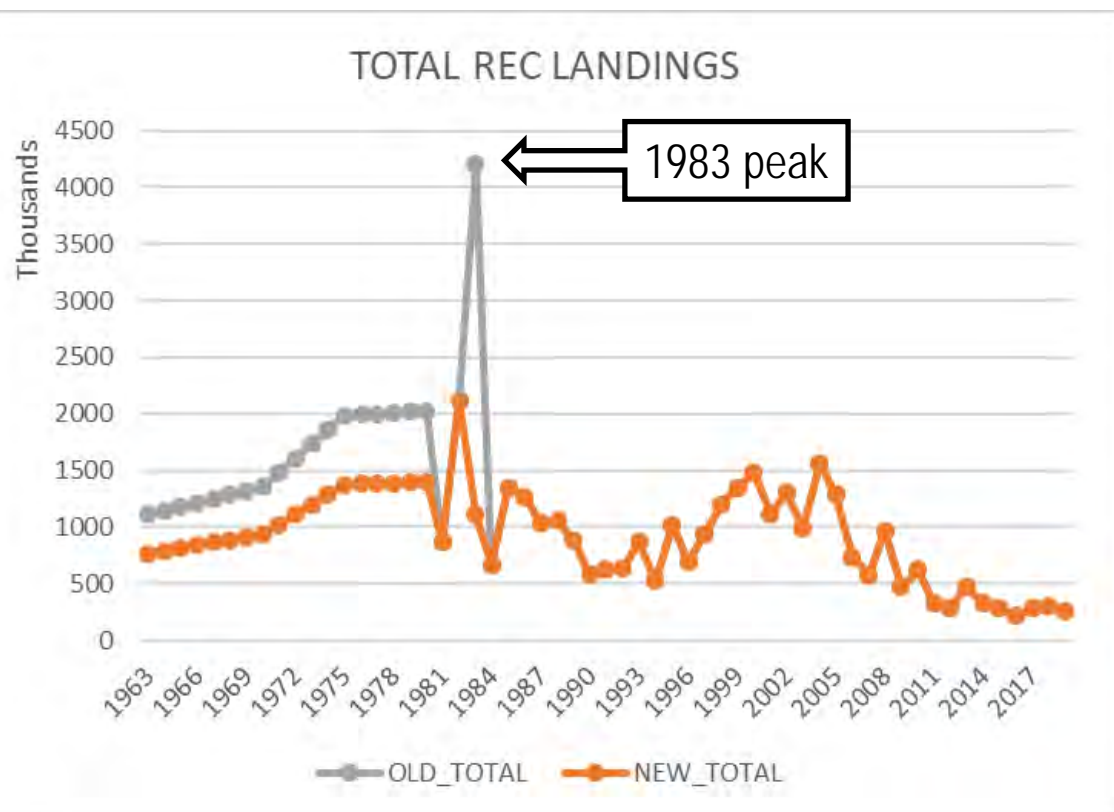
Original attempt :



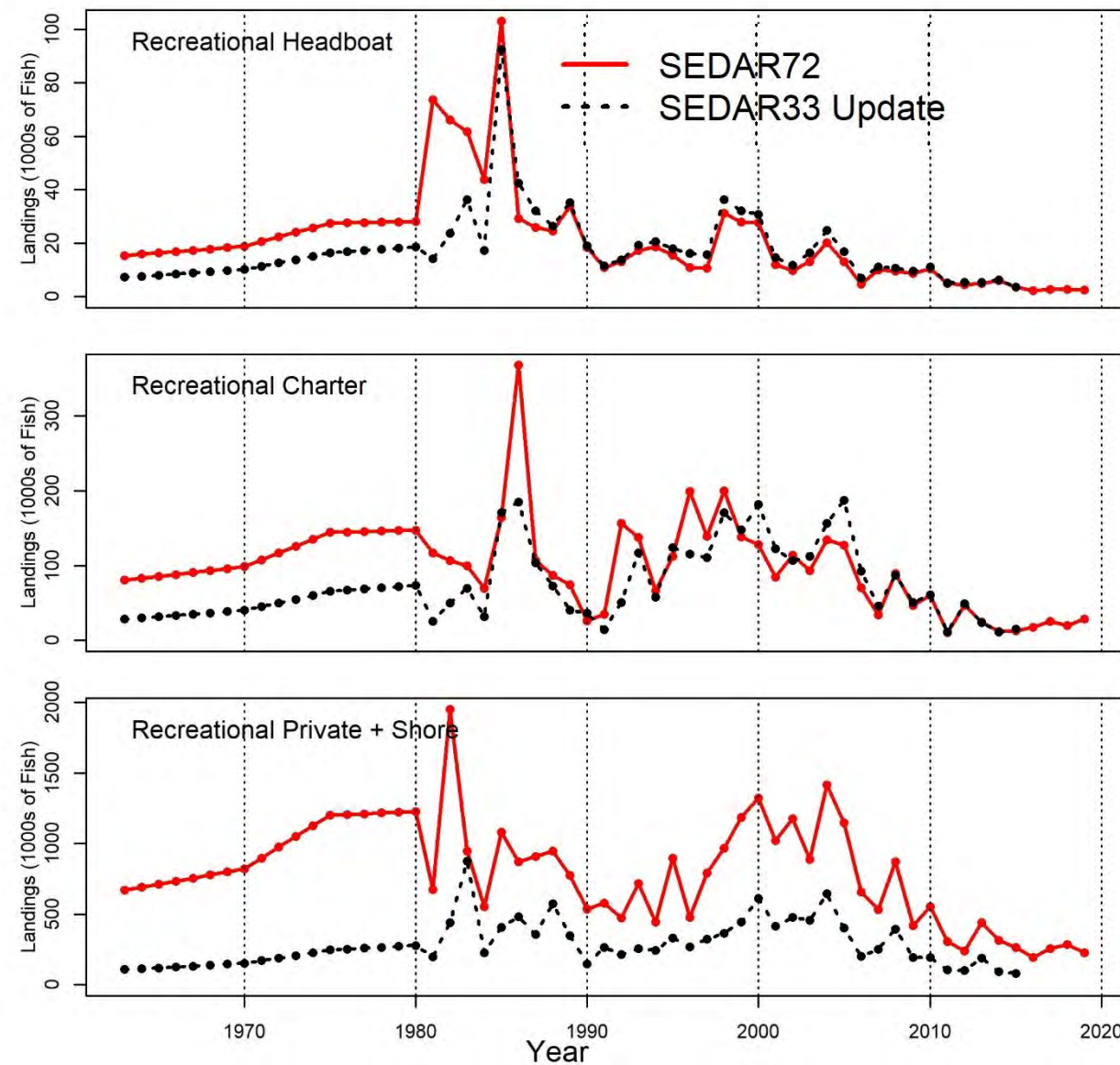
TOR

Document changes in MRIP data, both pre- and post-recalibration, in terms of the magnitude of changes to catch and effort.

Data – Recreational Landings

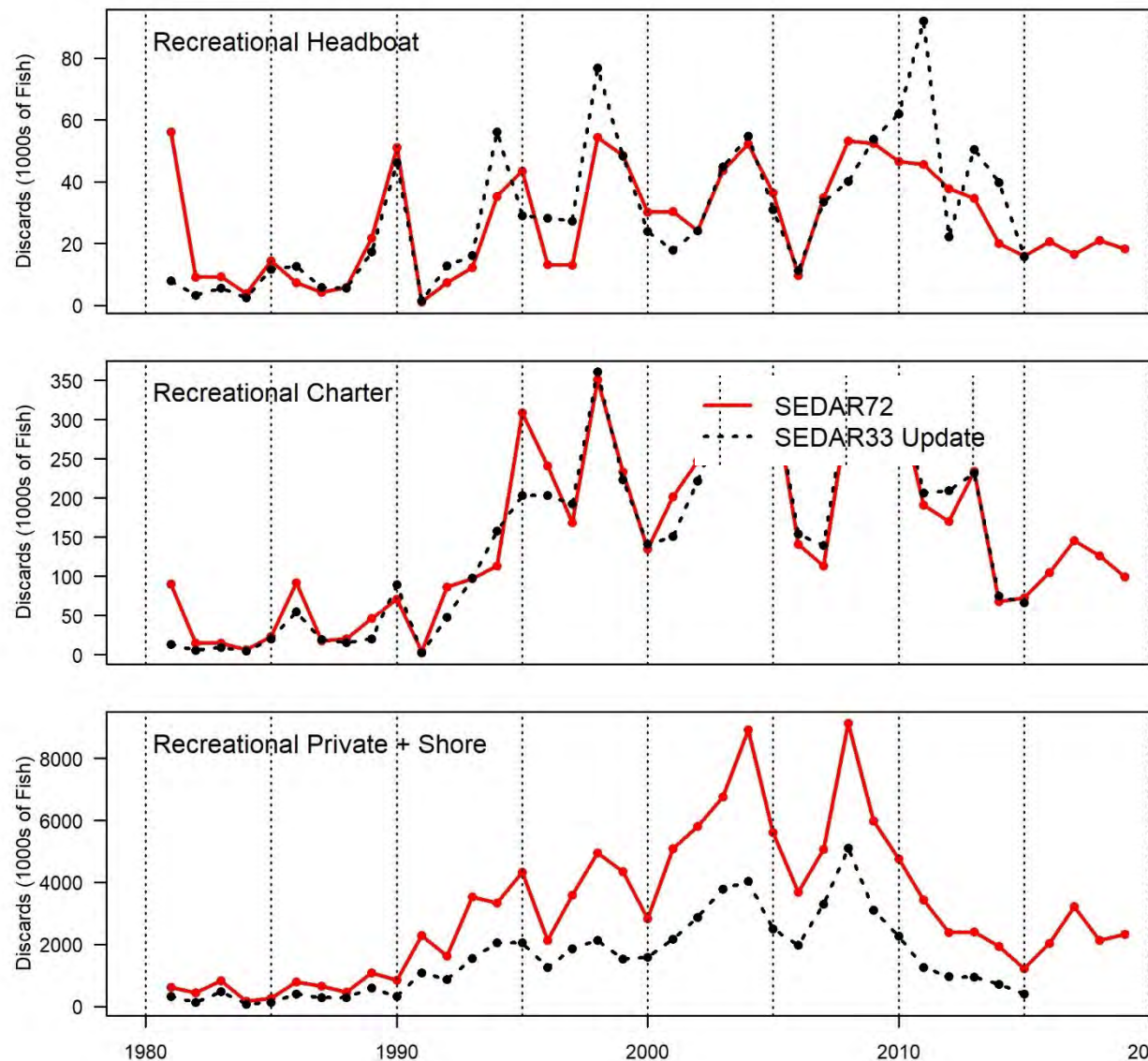


SS inputs



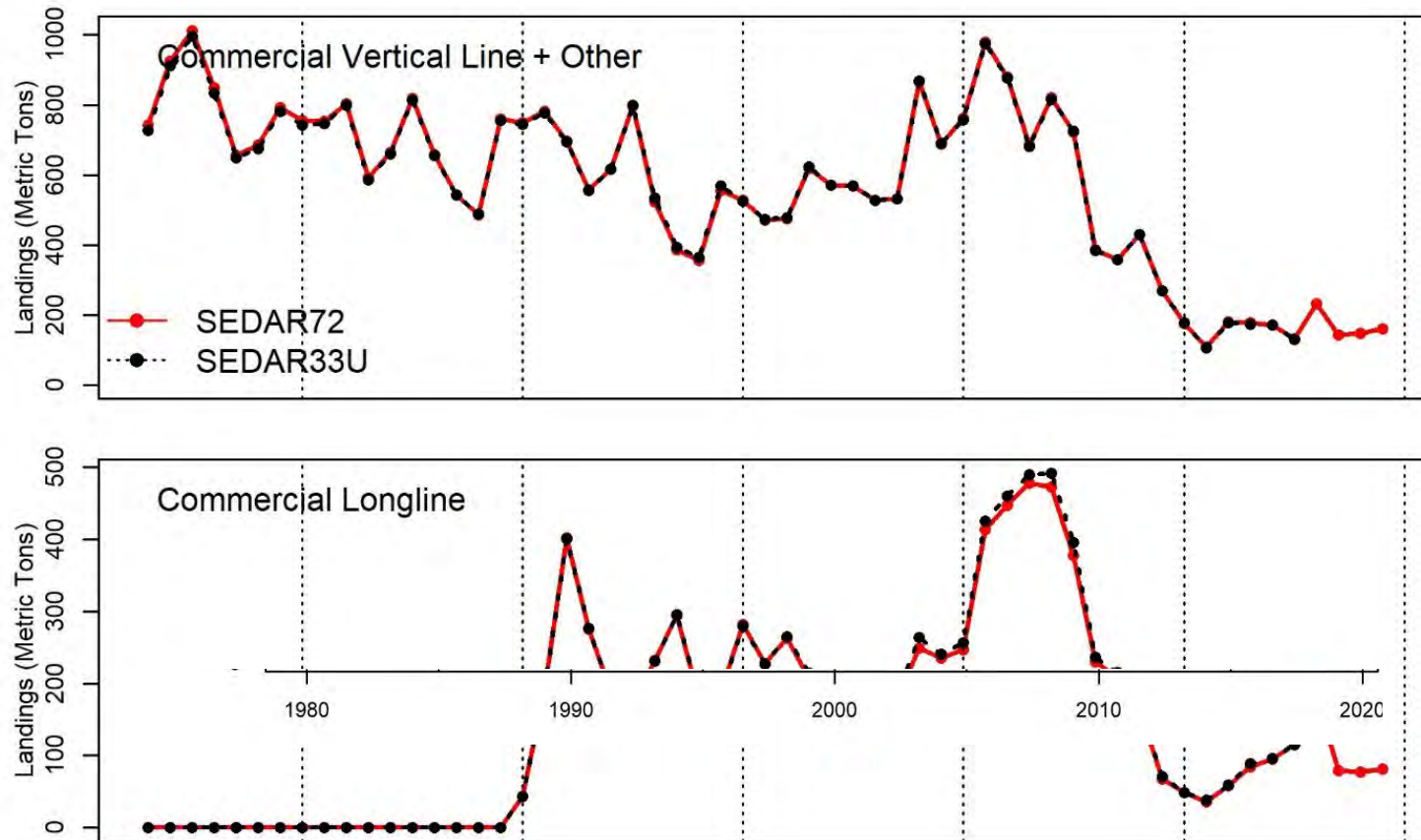
Data – Recreational Discards

Recreational Discard
Mortality = 12%



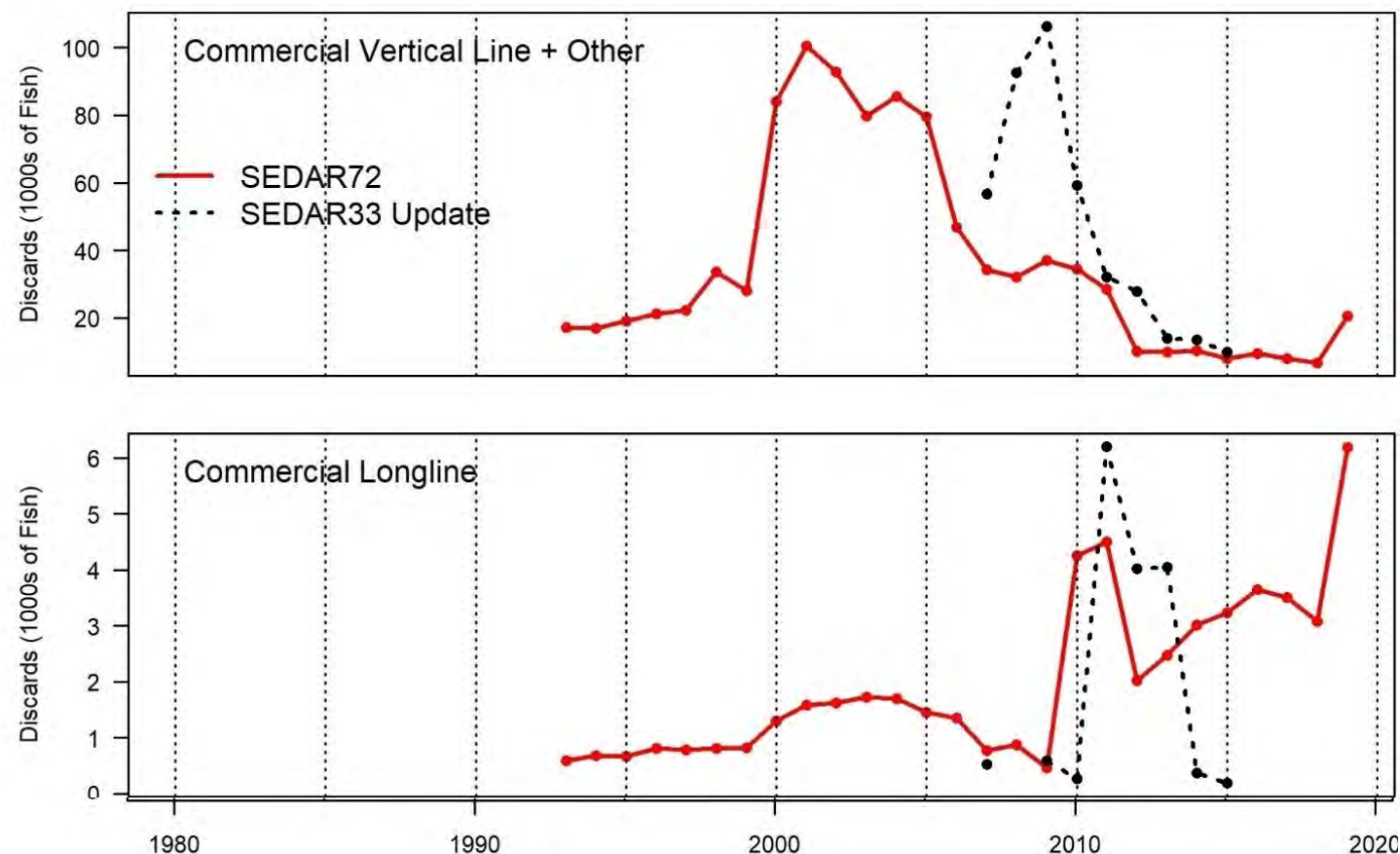
Data – Commercial Landings

Data Component	Decision
Commercial Landings	Use the new set of Gag/Black Grouper correction factors. CV of 0.05 used pre-IFQ. CV of 0.01 used post-IFQ.



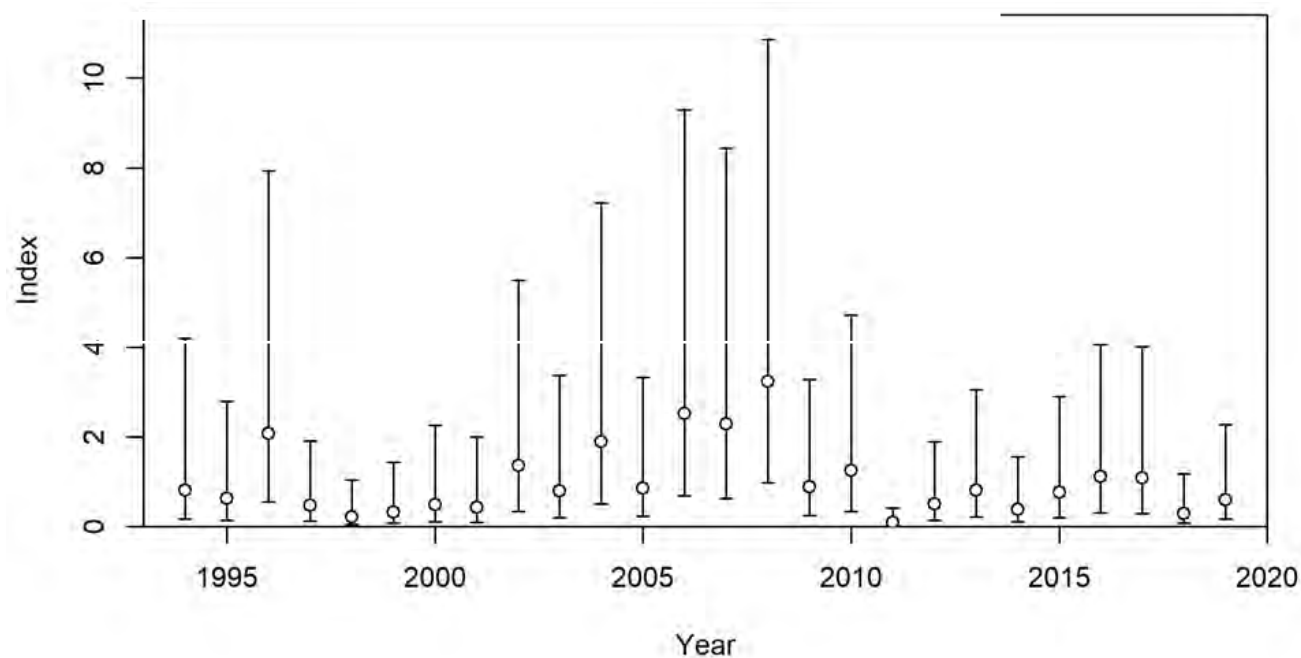
Data – Commercial Discards

Commercial Discard
Mortality = 25%



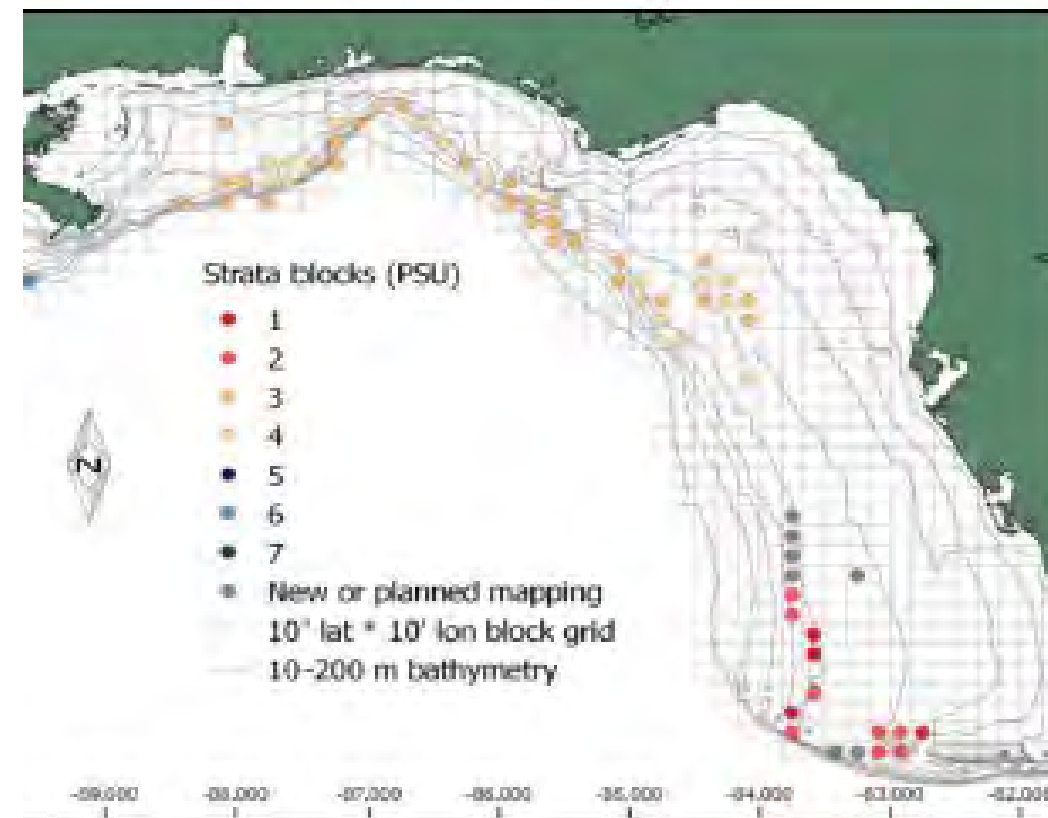
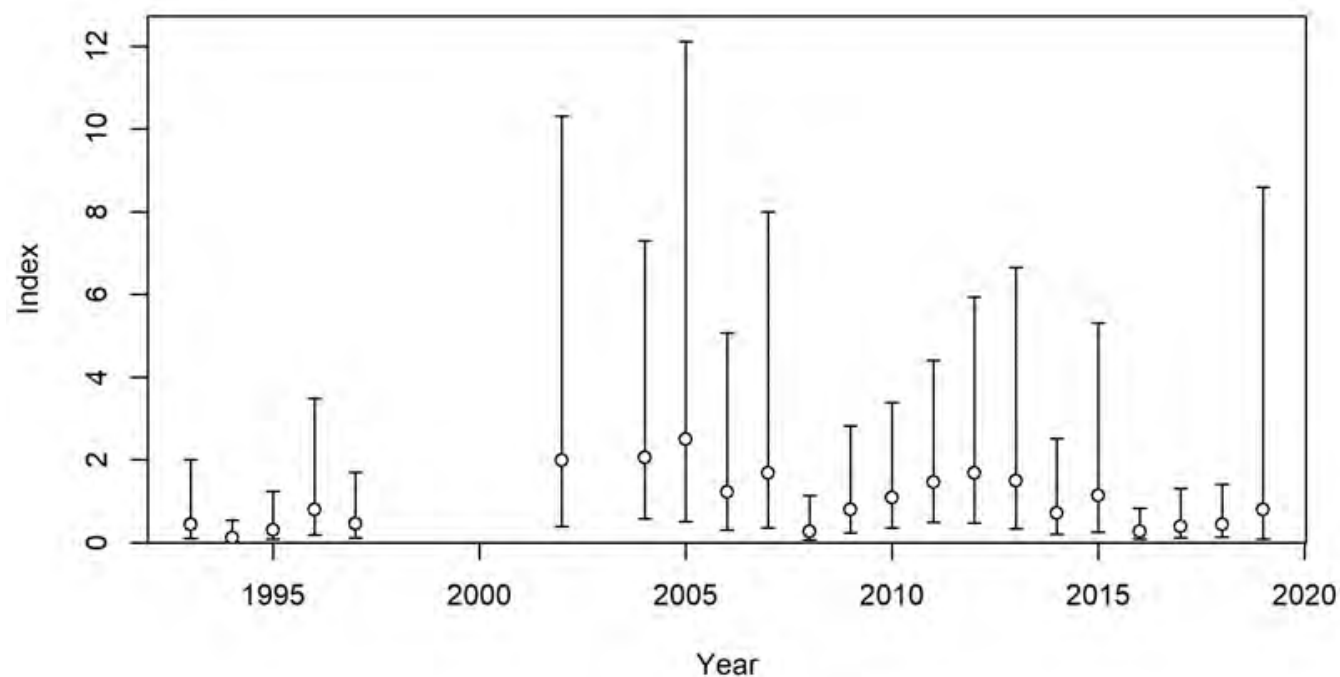
TOR Consider the SEFSC's improved approach for estimating commercial discards.

Data – Age-0 Survey



Data – SEAMAP video srvy

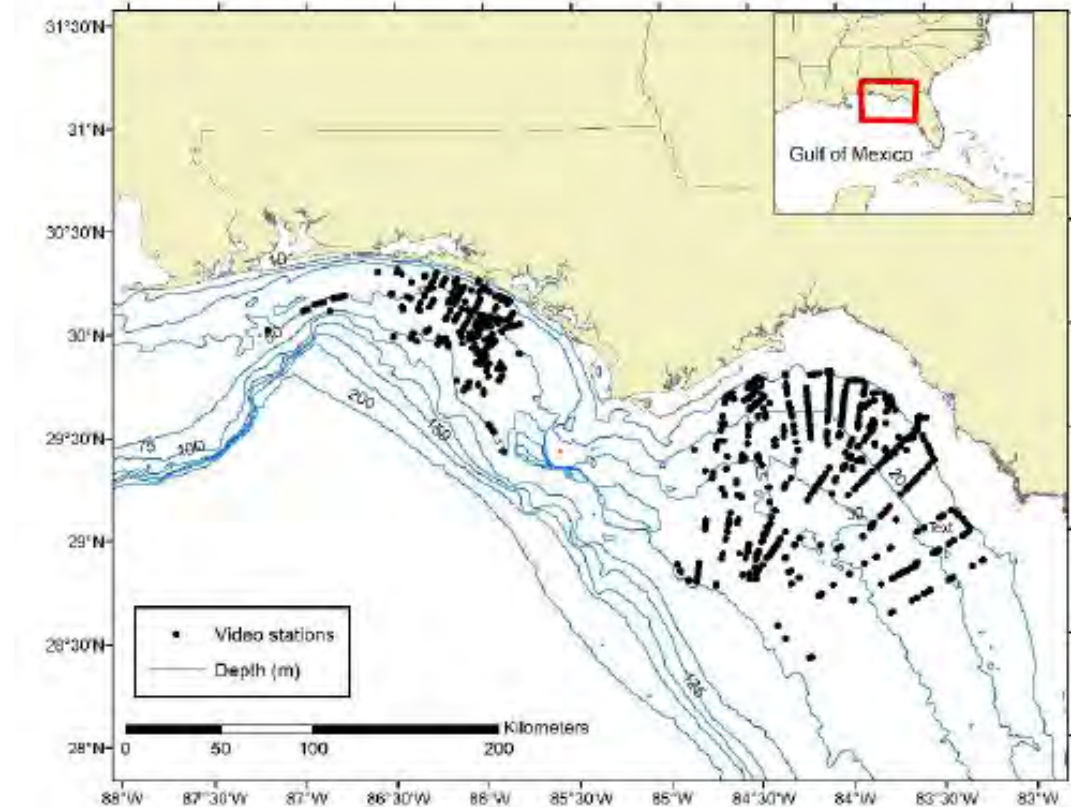
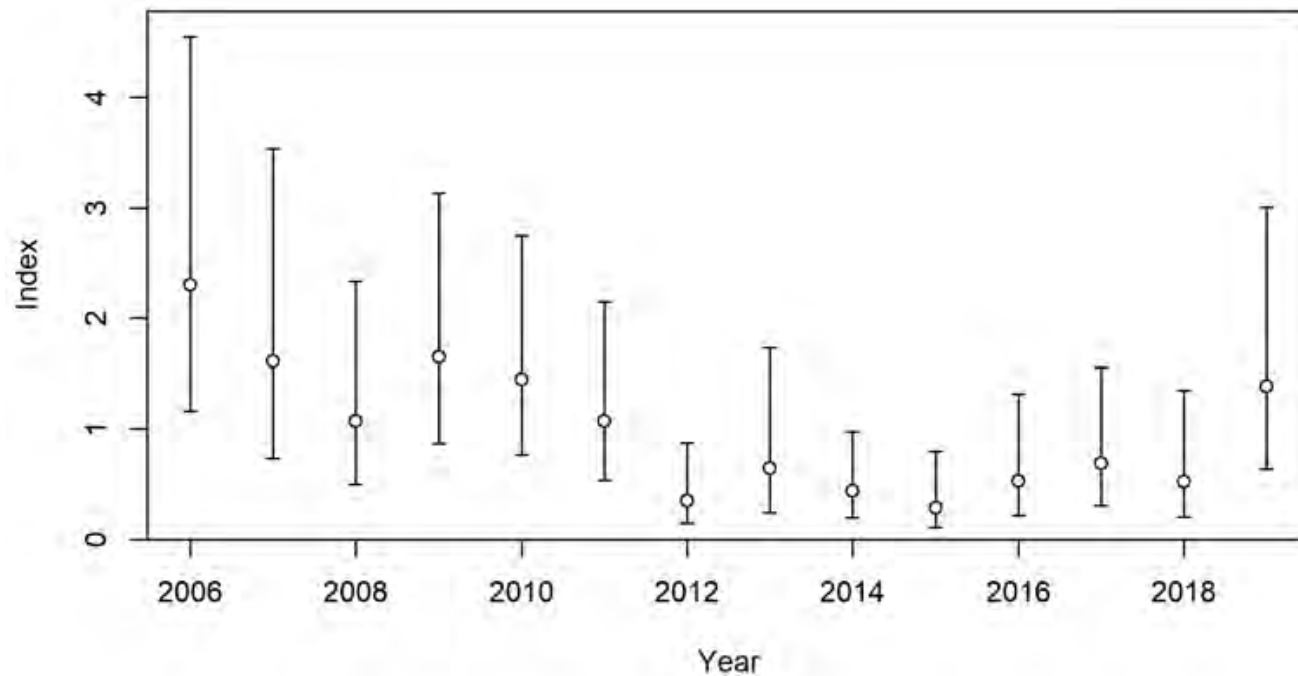
Total 148 individuals measured



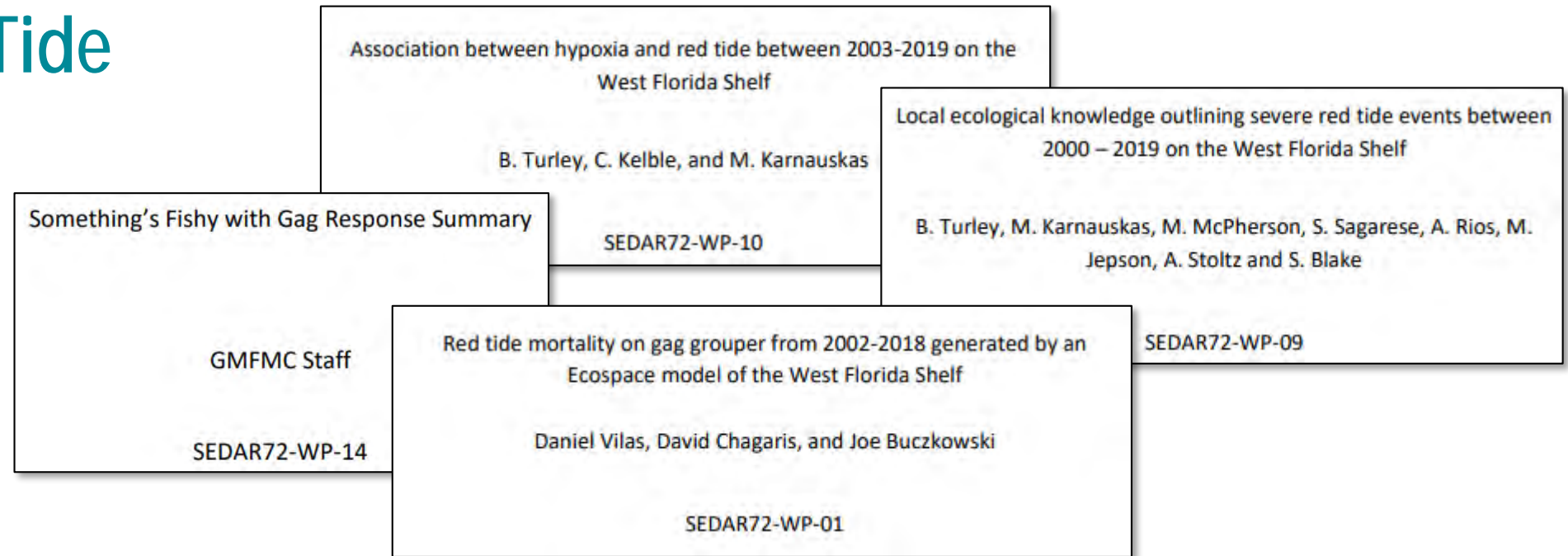
Data – PC video survey

2005 dropped from the index.

Total 122 individuals measured



Data – Red Tide



Data Component	Decision
Red Tide Mortality	<p>"Bycatch-only fleet" as in SEDAR33 Update</p> <p>Years added : 2014, 2018 (in addition to 2005)</p> <p>Selectivity modified from 1+ to 0+</p> <p>Information from the Ecospace model used in sensitivity runs.</p>

TOR

Re-evaluate the potential effects of red tide on gag, with consideration of past red tide events through 2018.

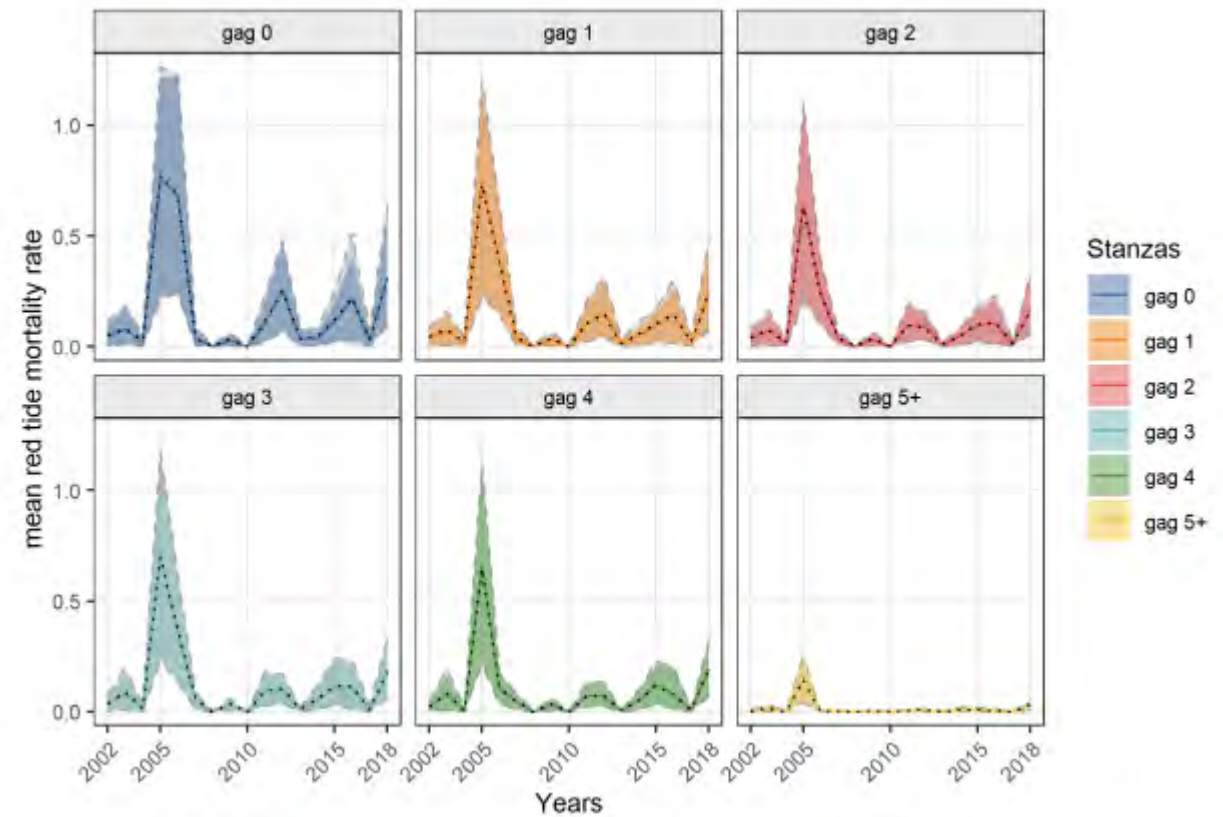
Red Tide Sensitivity Runs

1. Red Tide Selectivity

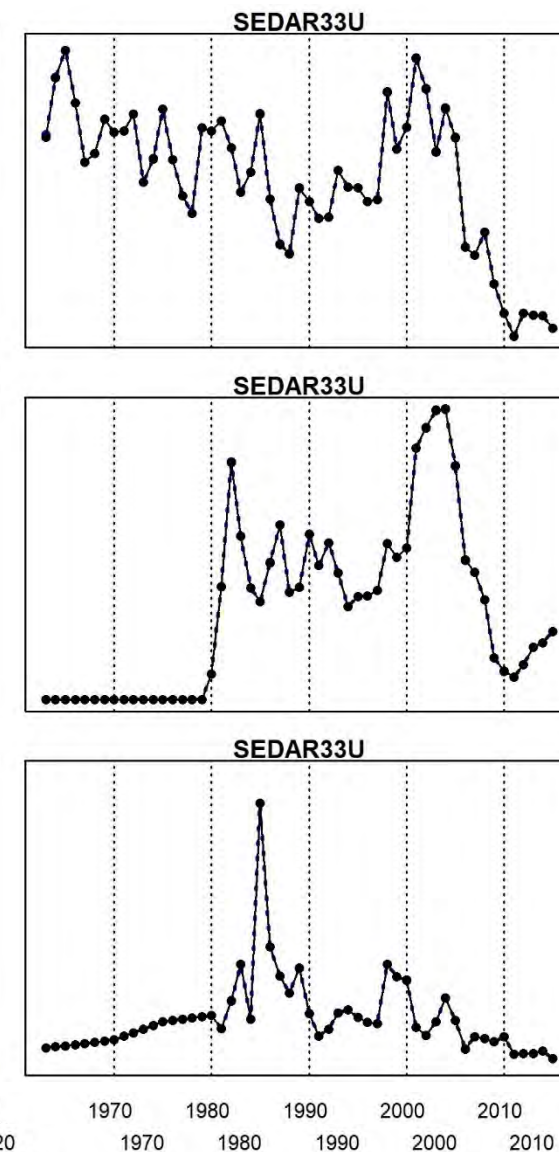
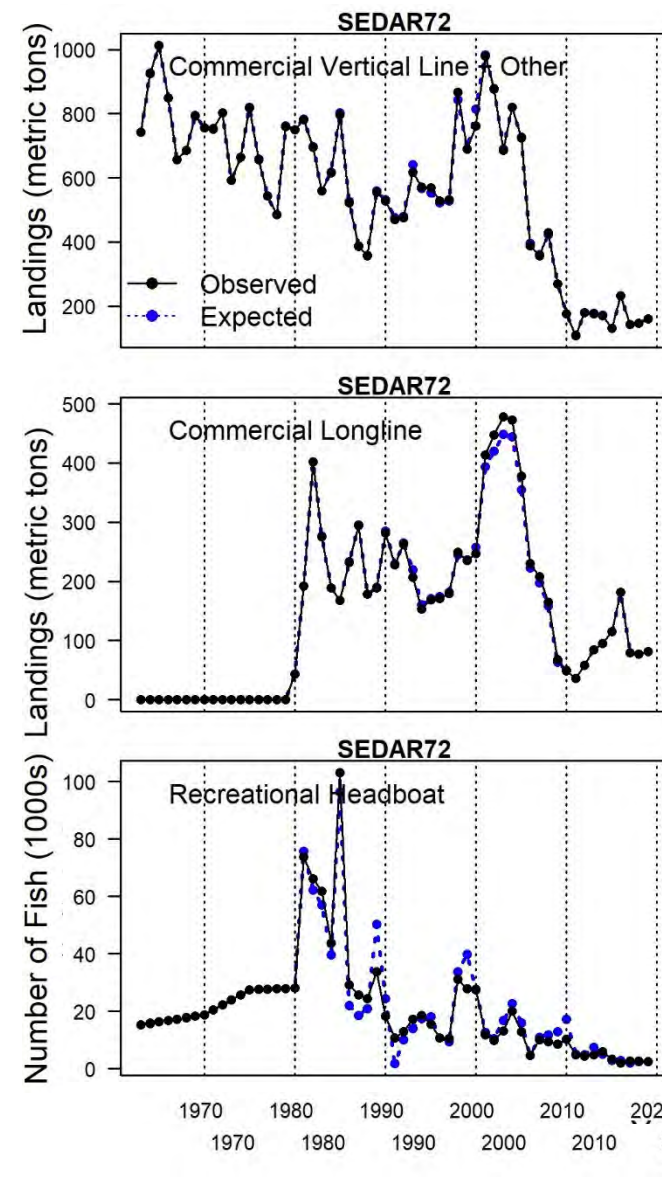
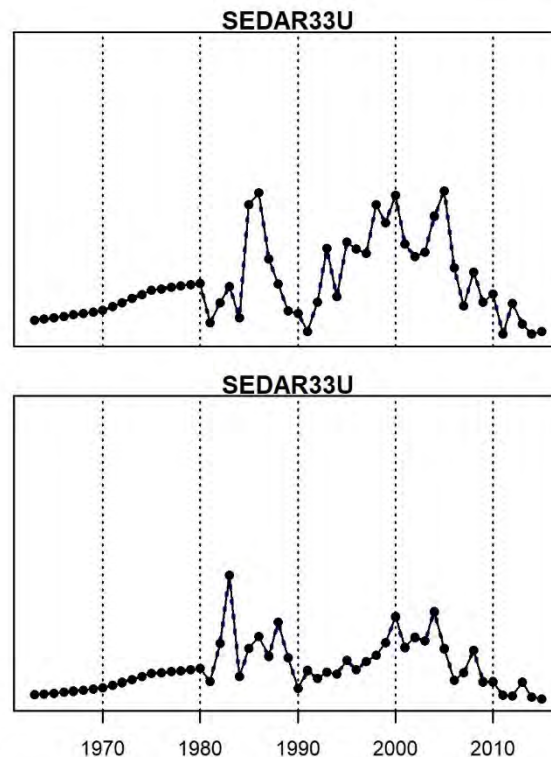
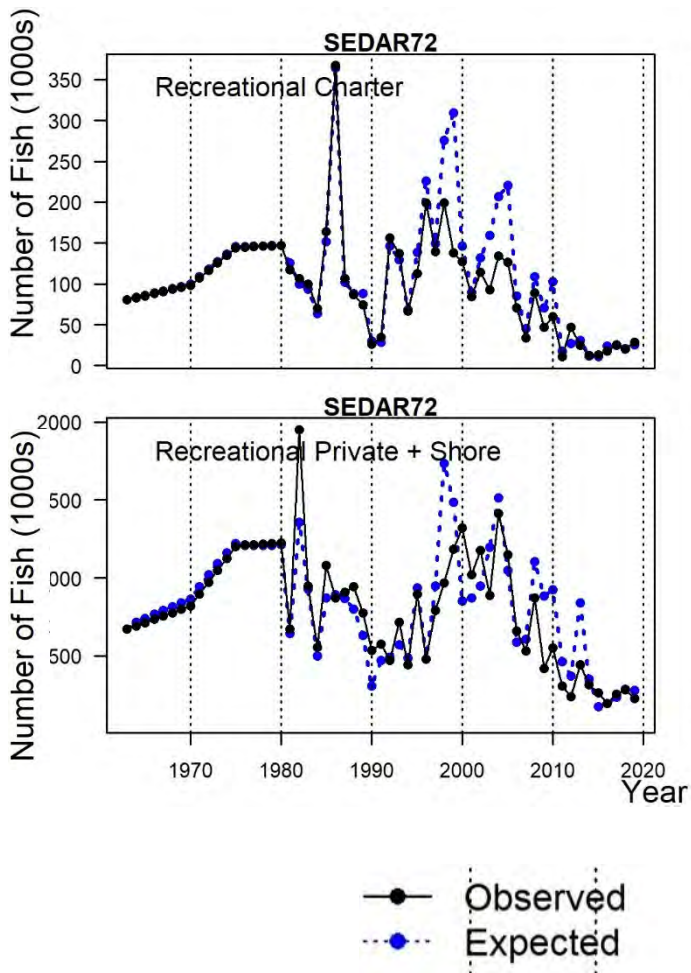
Ecospace estimated mean red tide mortality estimates for each age in each year for ages 0-5+

2. Red Tide Time Blocks on M

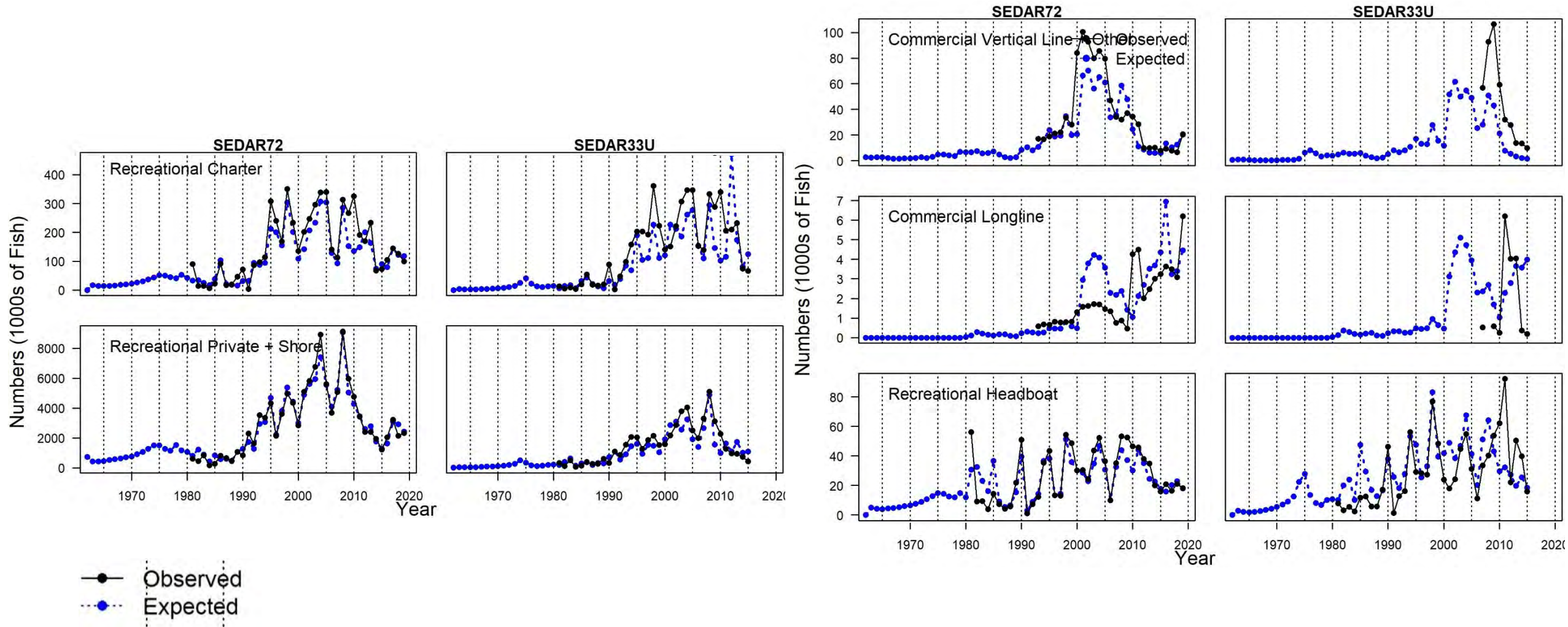
Set of 1-year time blocks on ages 0-5 (no red tide on ages 6+).



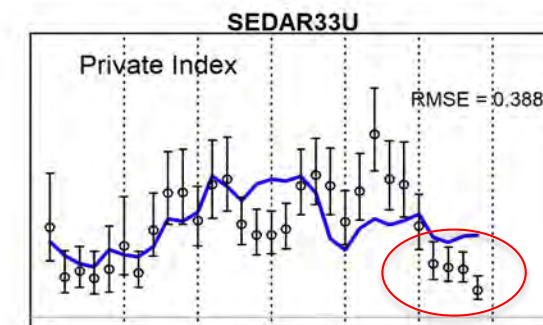
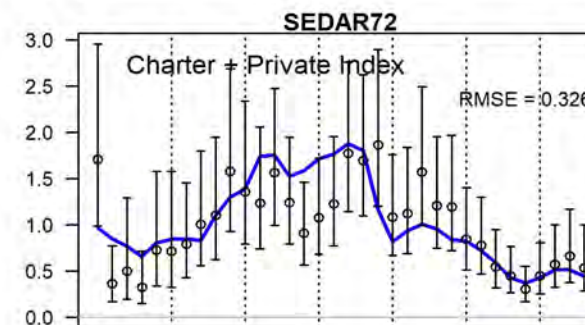
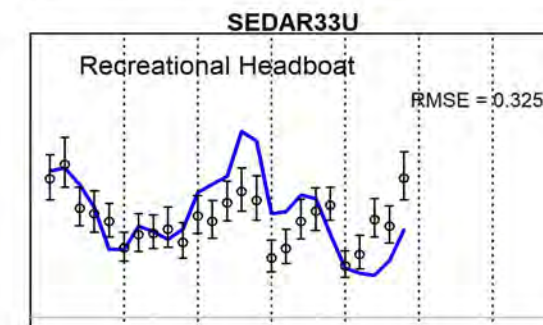
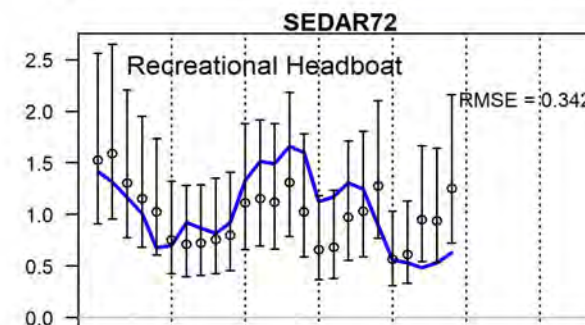
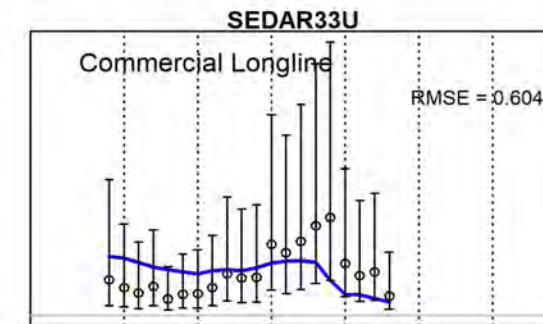
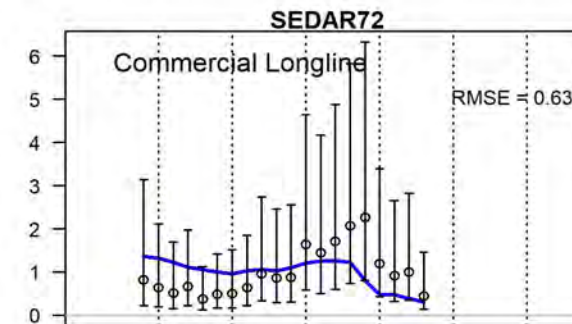
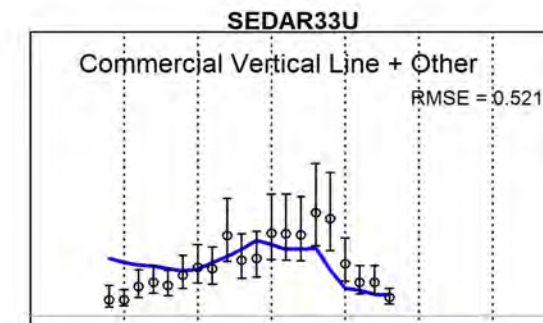
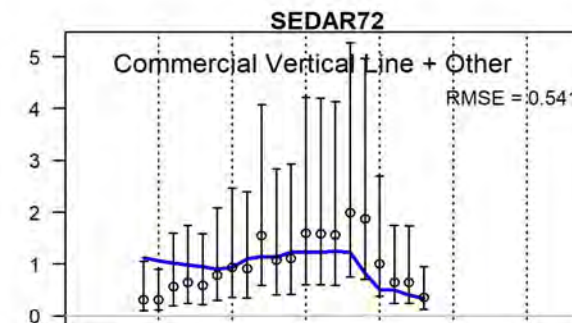
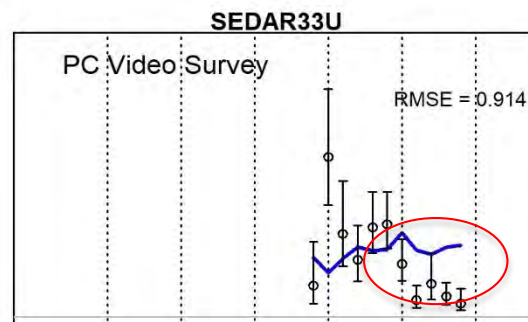
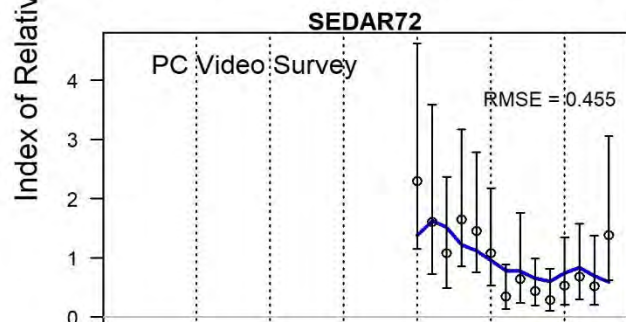
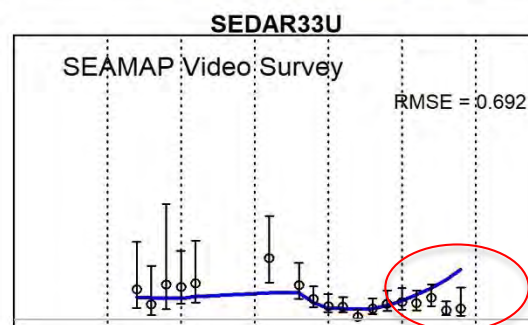
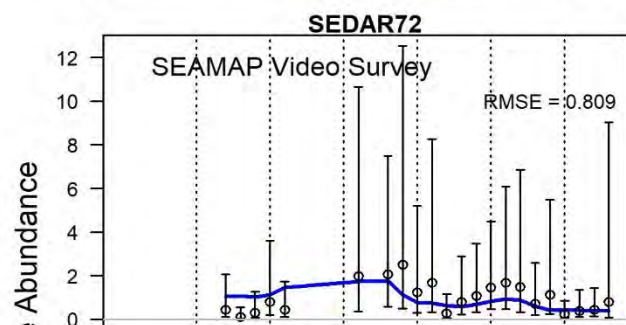
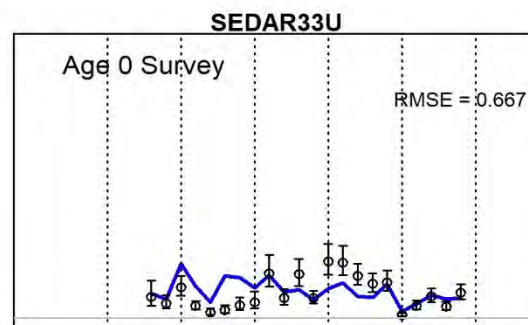
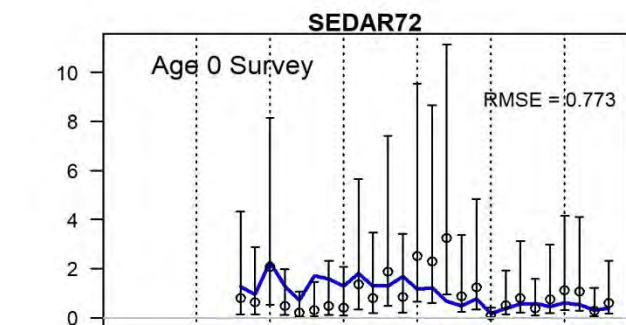
Base Model Fits - Landings



Base Model Fits - Discards

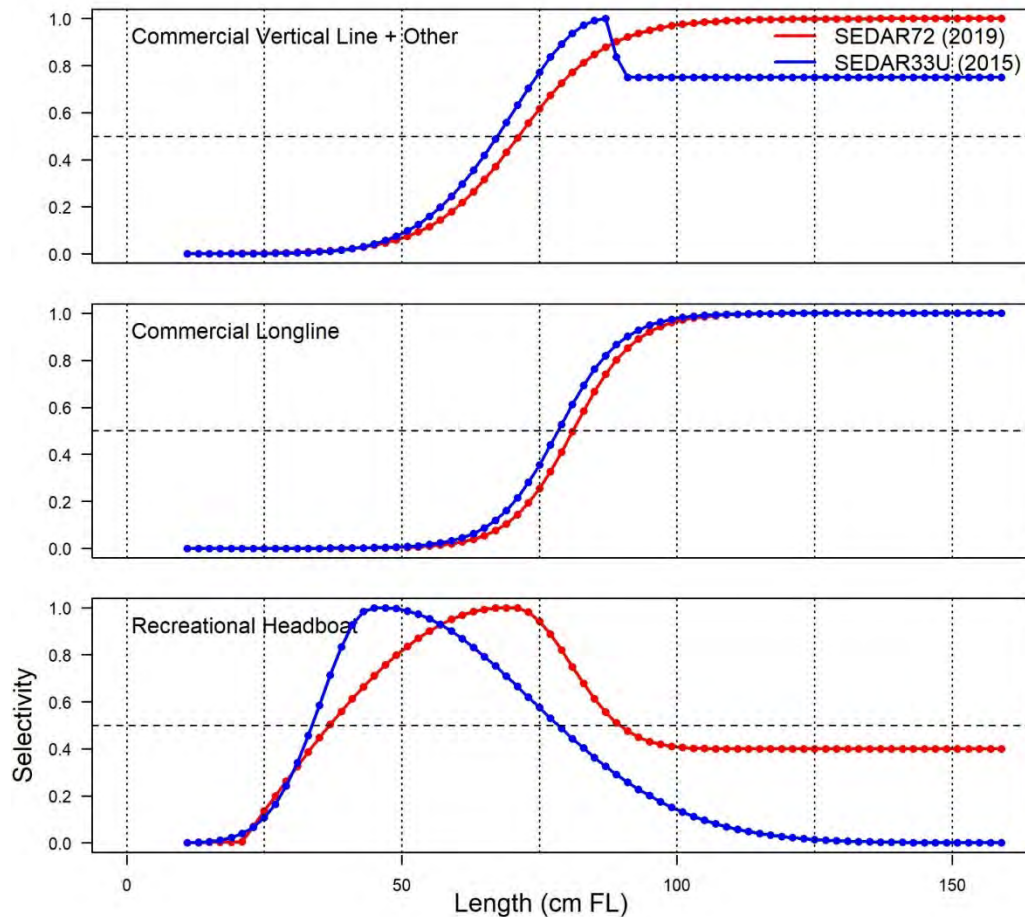


Base Model Fits - Indices

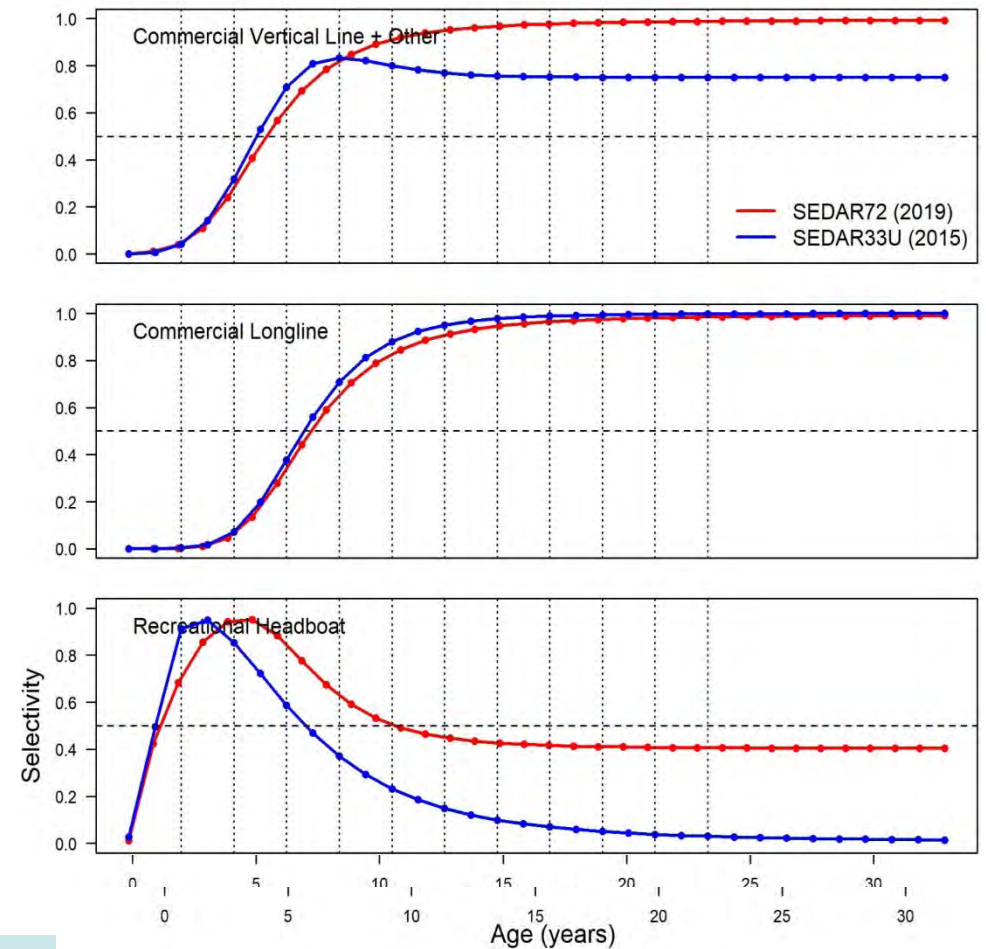


Base Model – Selectivity of Fleets

Selectivity-at-length

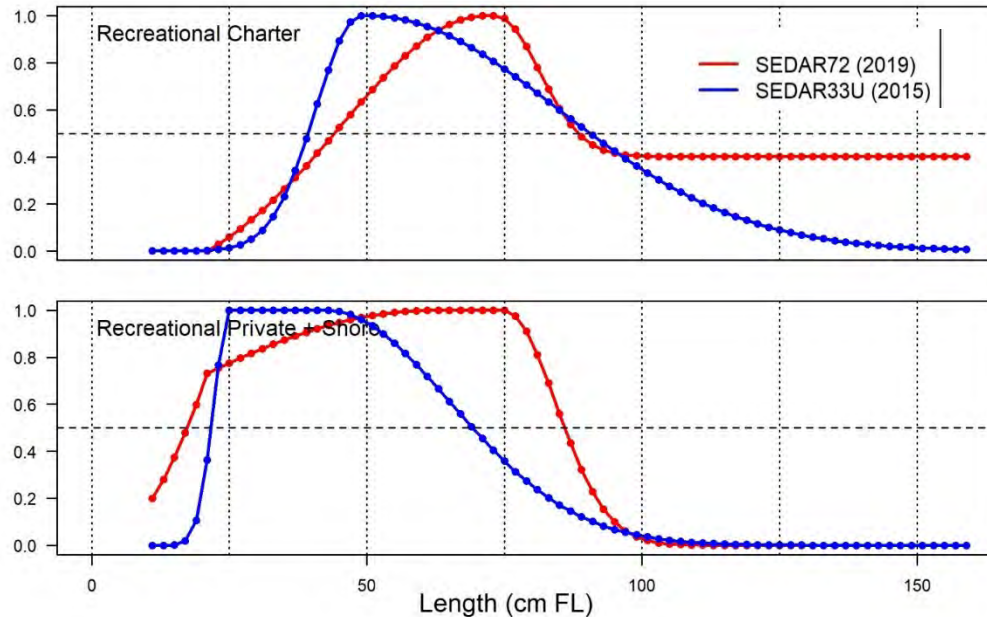


Selectivity-at-age (derived)

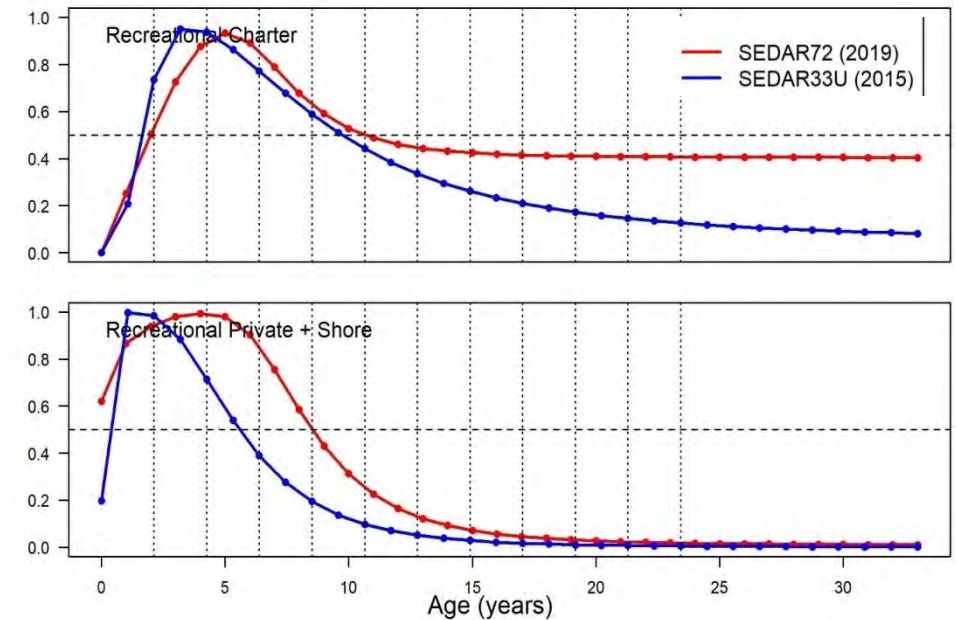


Base Model – Selectivity of Fleets: Rec

Selectivity-at-length



Selectivity-at-age (derived)

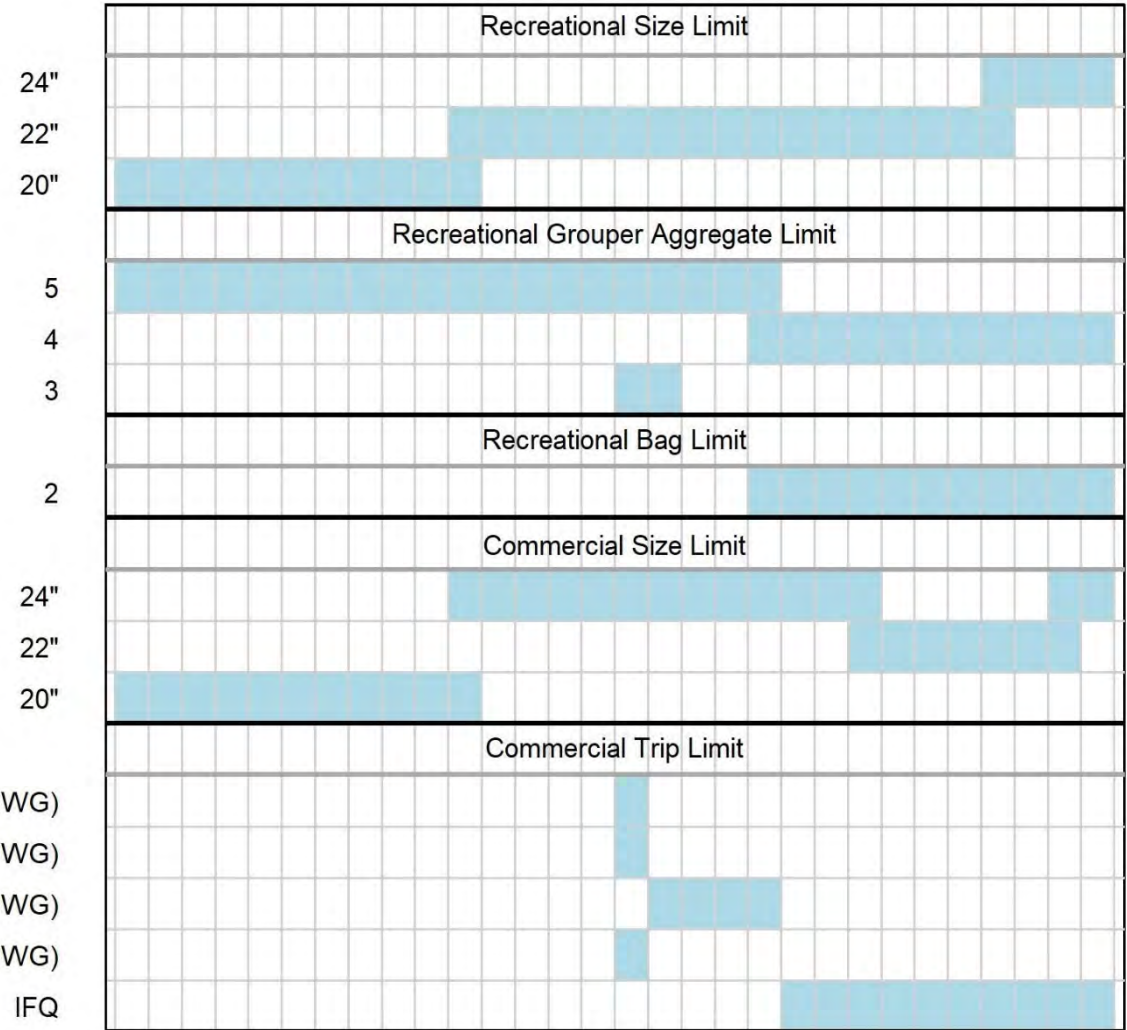


1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

Base Model – Fleet Retention

- Time blocks based on changes in **minimum size limits**, the implementation of the **IFQ** program in 2010 and post-2011 **restrictions on the recreational fishing season** (2011-12 most restrictive, 2013-15 mildly restrictive, 2016-19 least restrictive).

10,000 lbs gw (D&SWG)
7,500 lbs gw (D&SWG)
6,000 lbs gw (D&SWG)
5,500 lbs gw (SWG)
IFQ

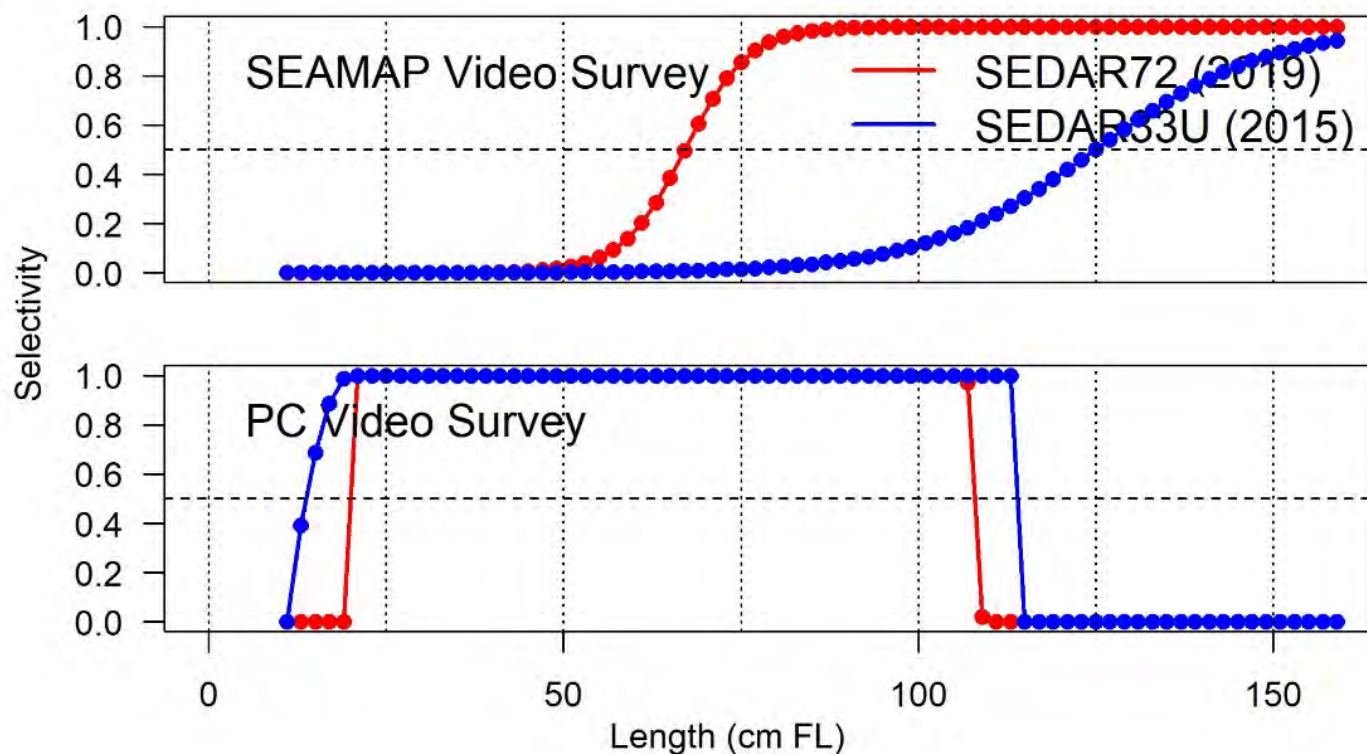


TOR

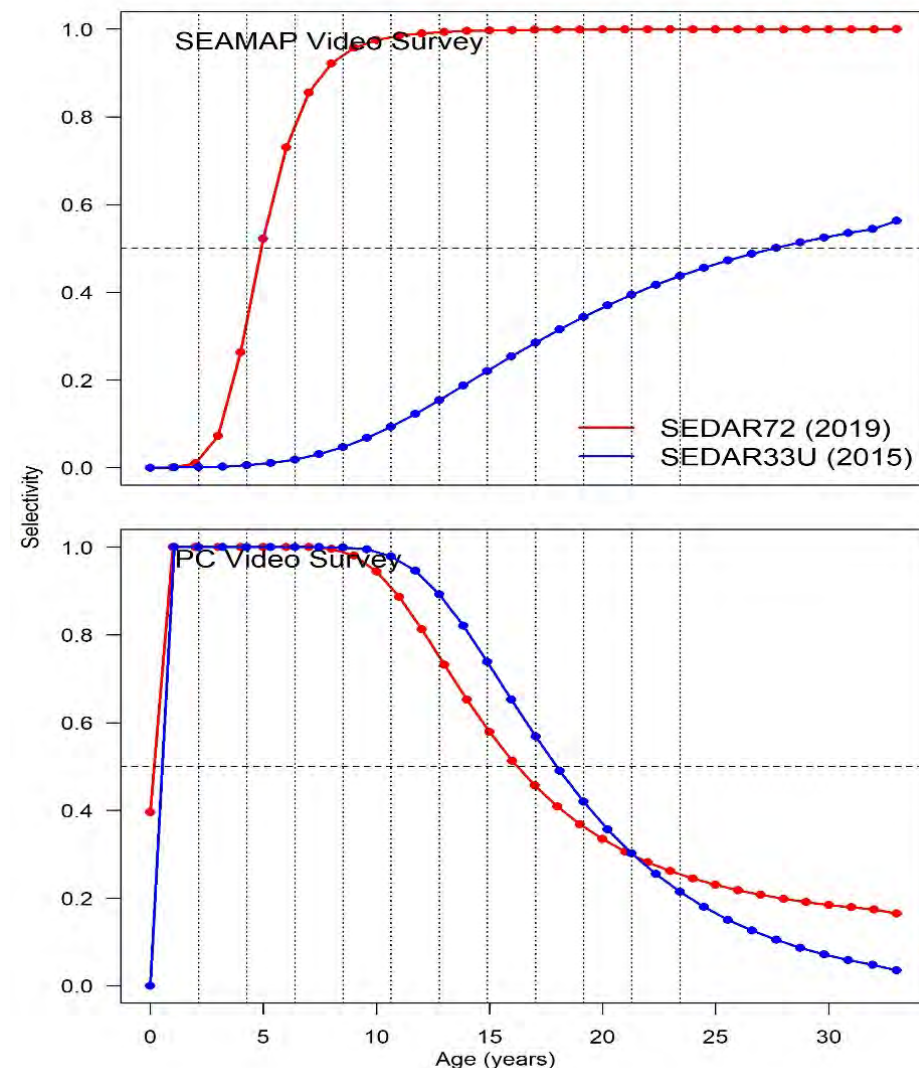
Reconsider the way the retention and selectivity parameters were specified for recreational fleets based on past work with gag grouper.

Base Model – Selectivity of Surveys

Selectivity-at-length

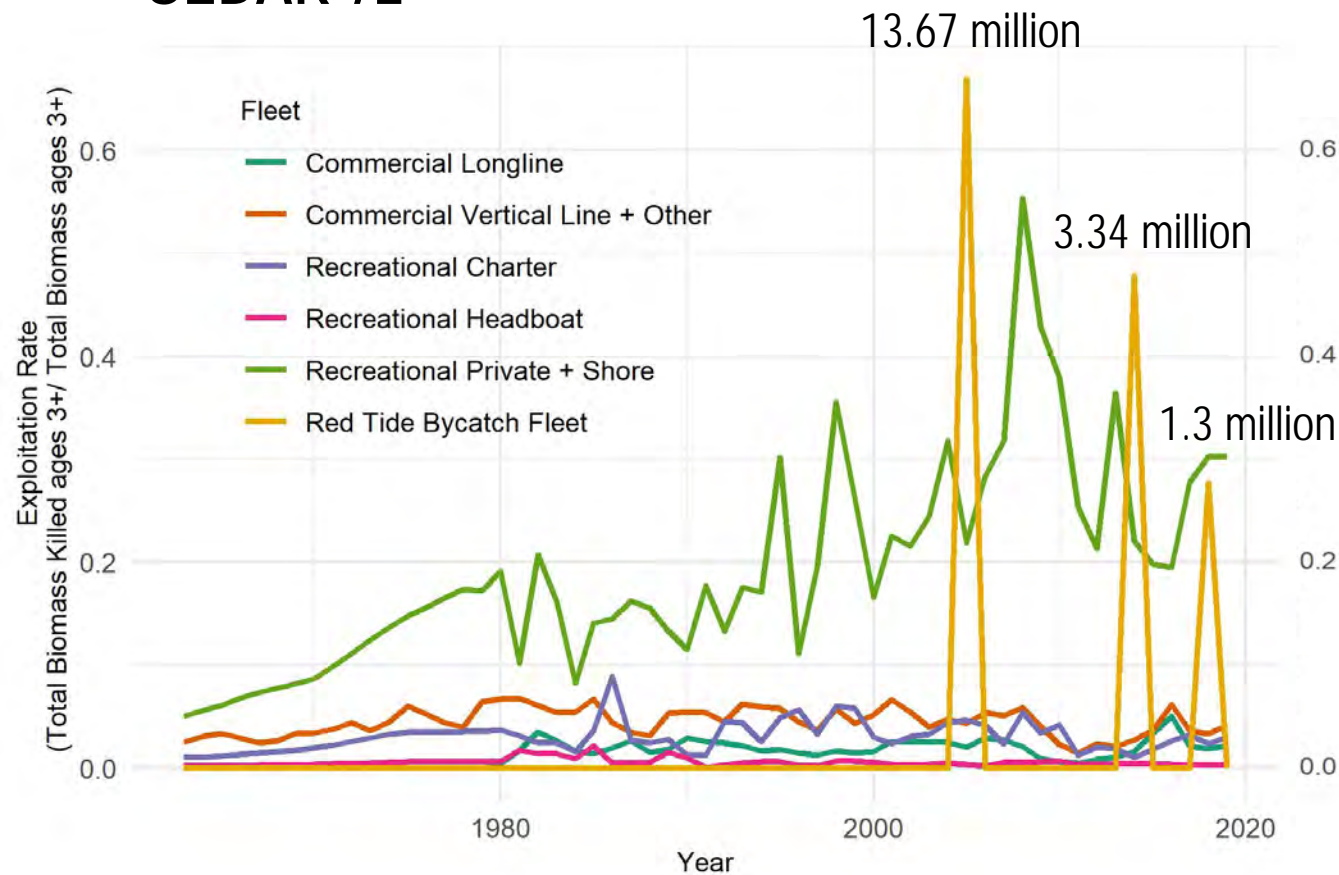


Selectivity-at-age (derived)

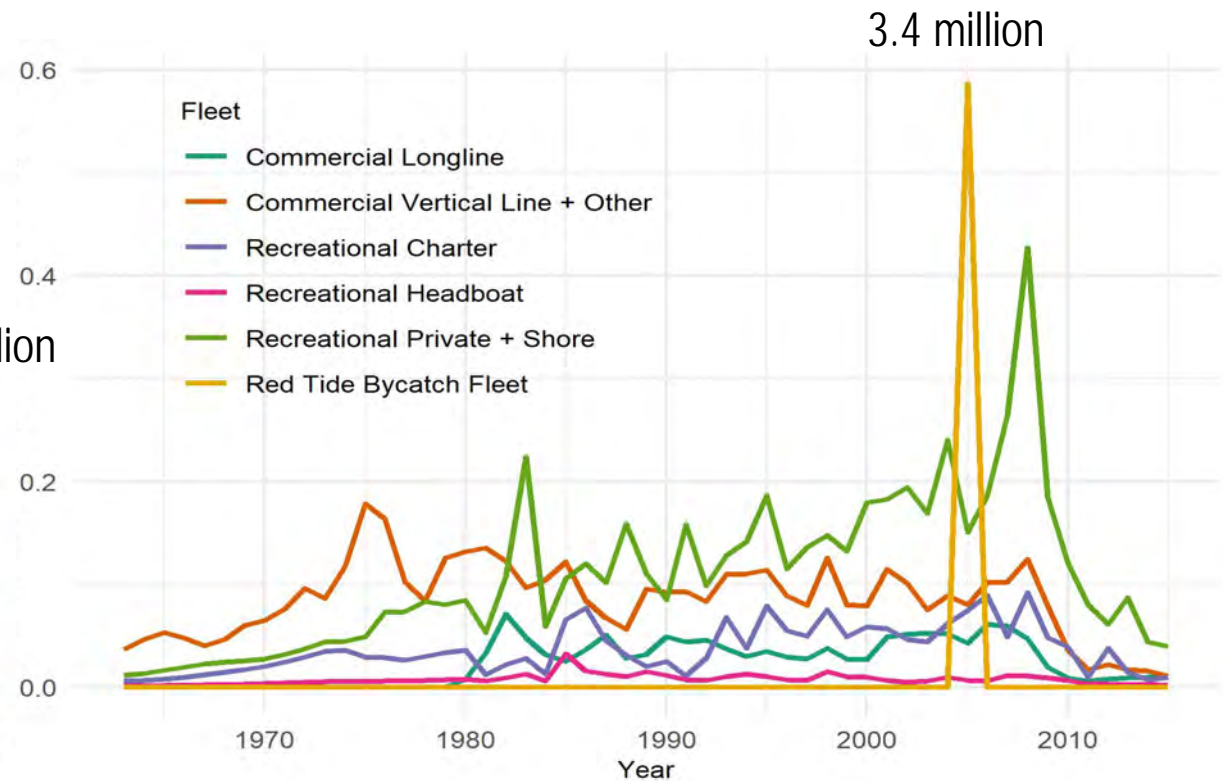


Base Model – Fleet-specific Annual Exploitation Rates

SEDAR 72

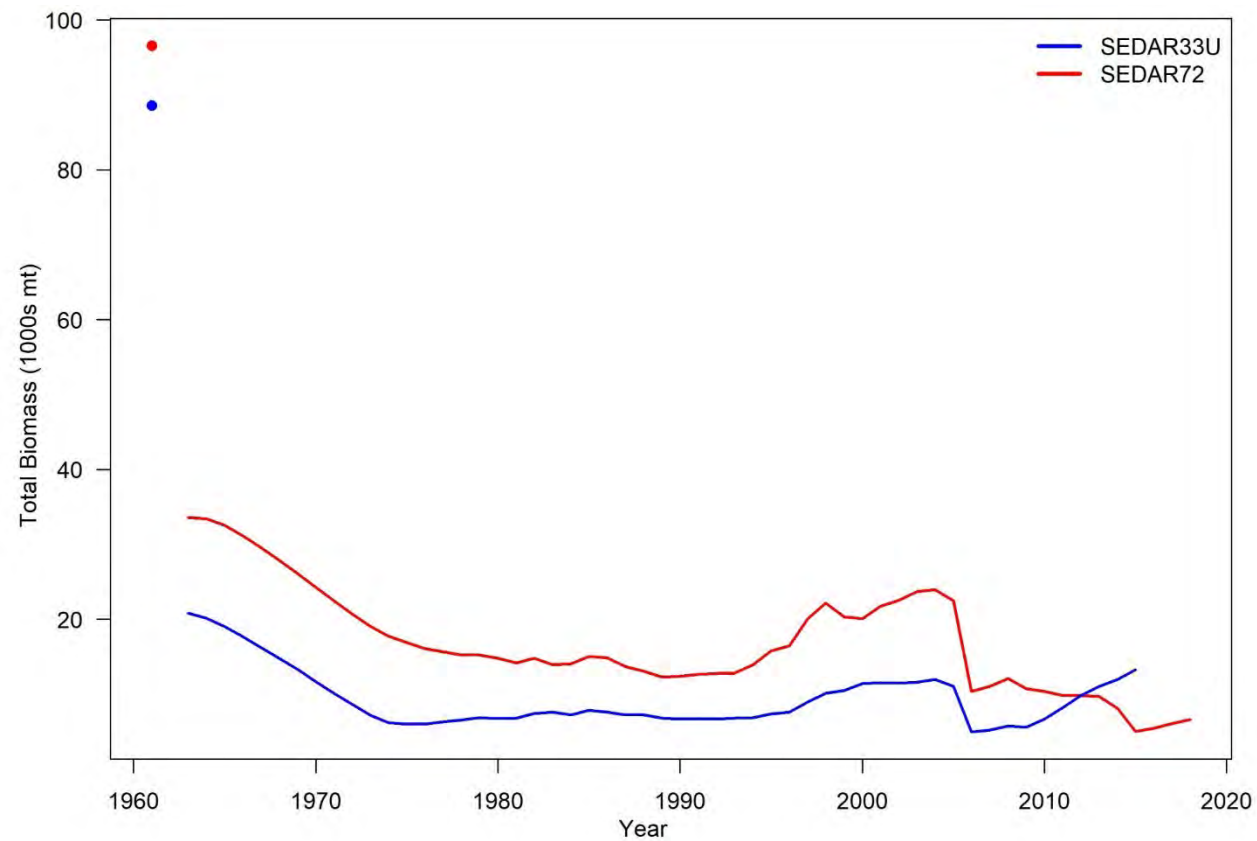


SEDAR33 Update

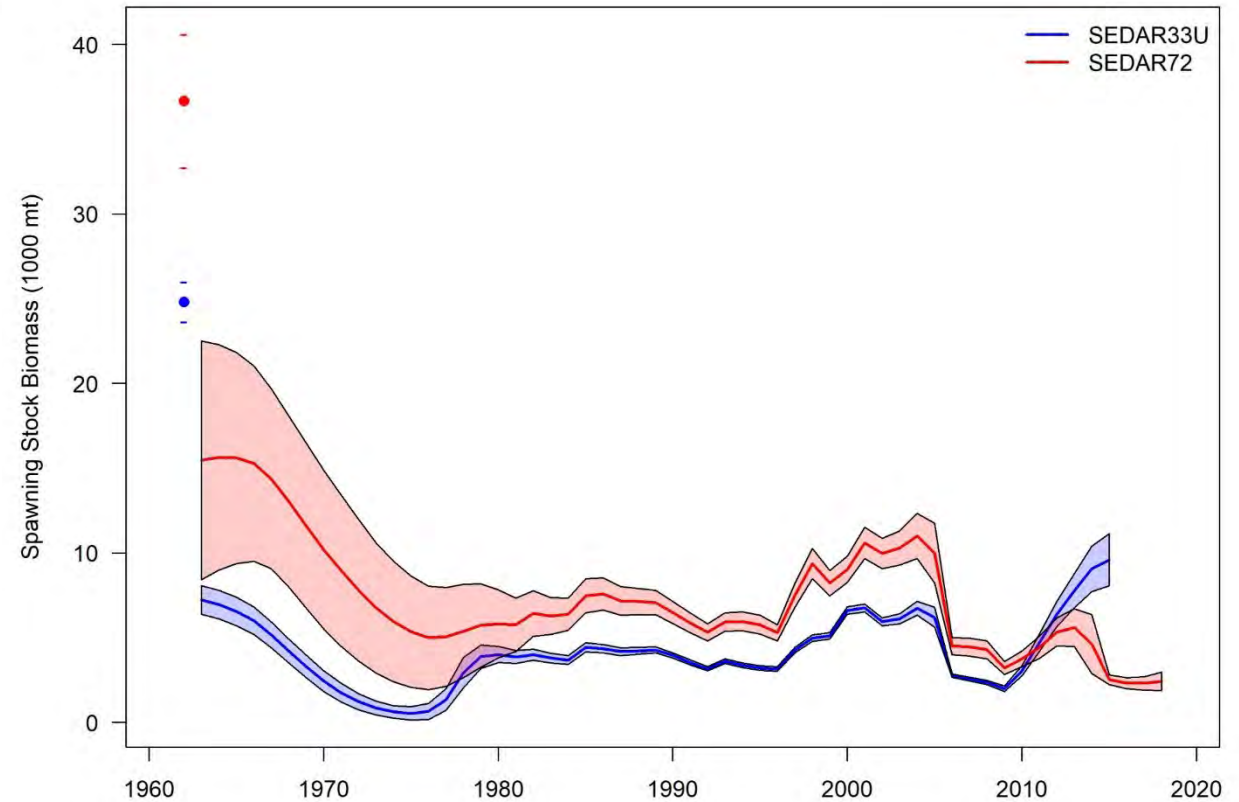


Base Model – Estimated Biomass & SSB

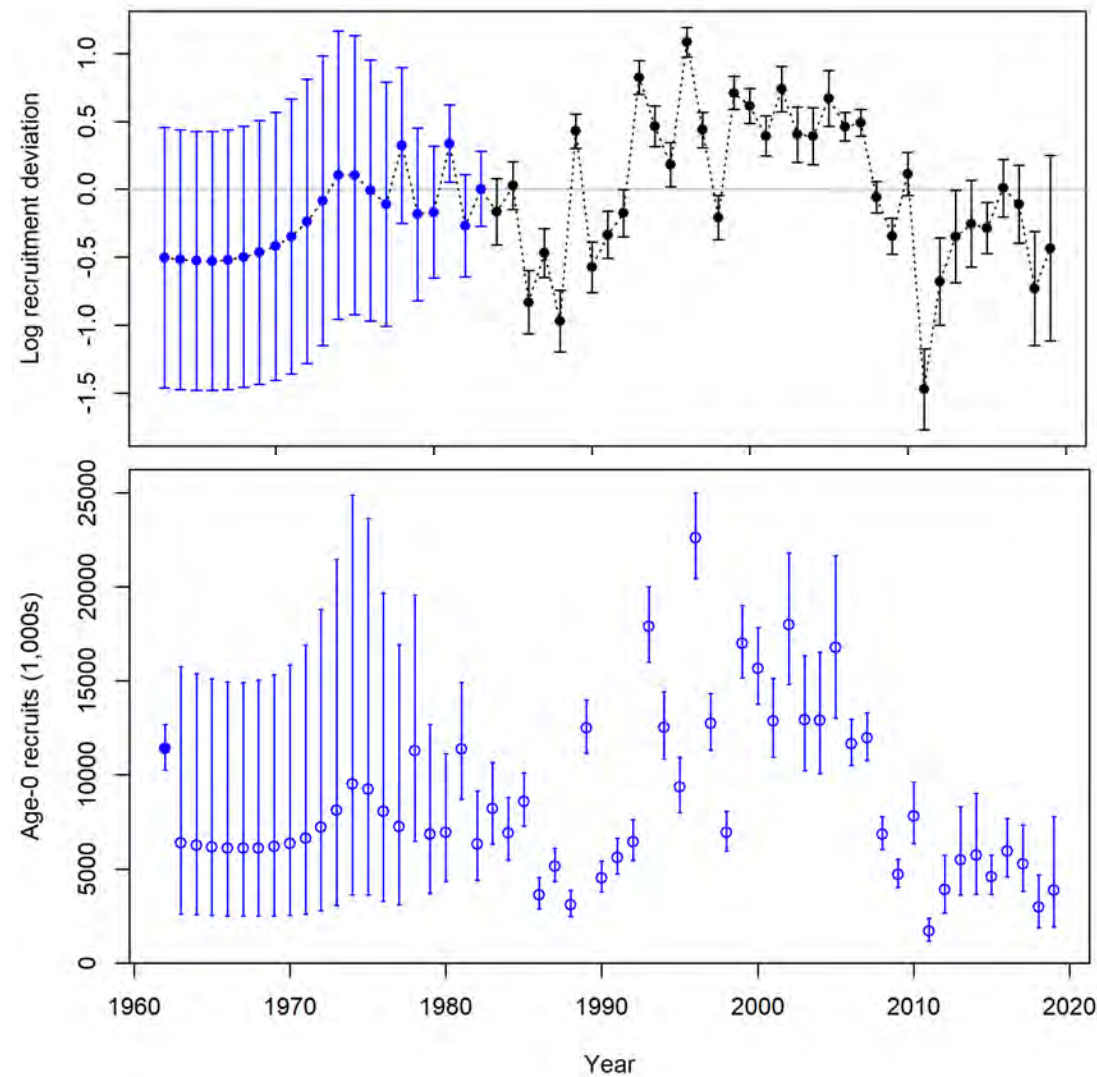
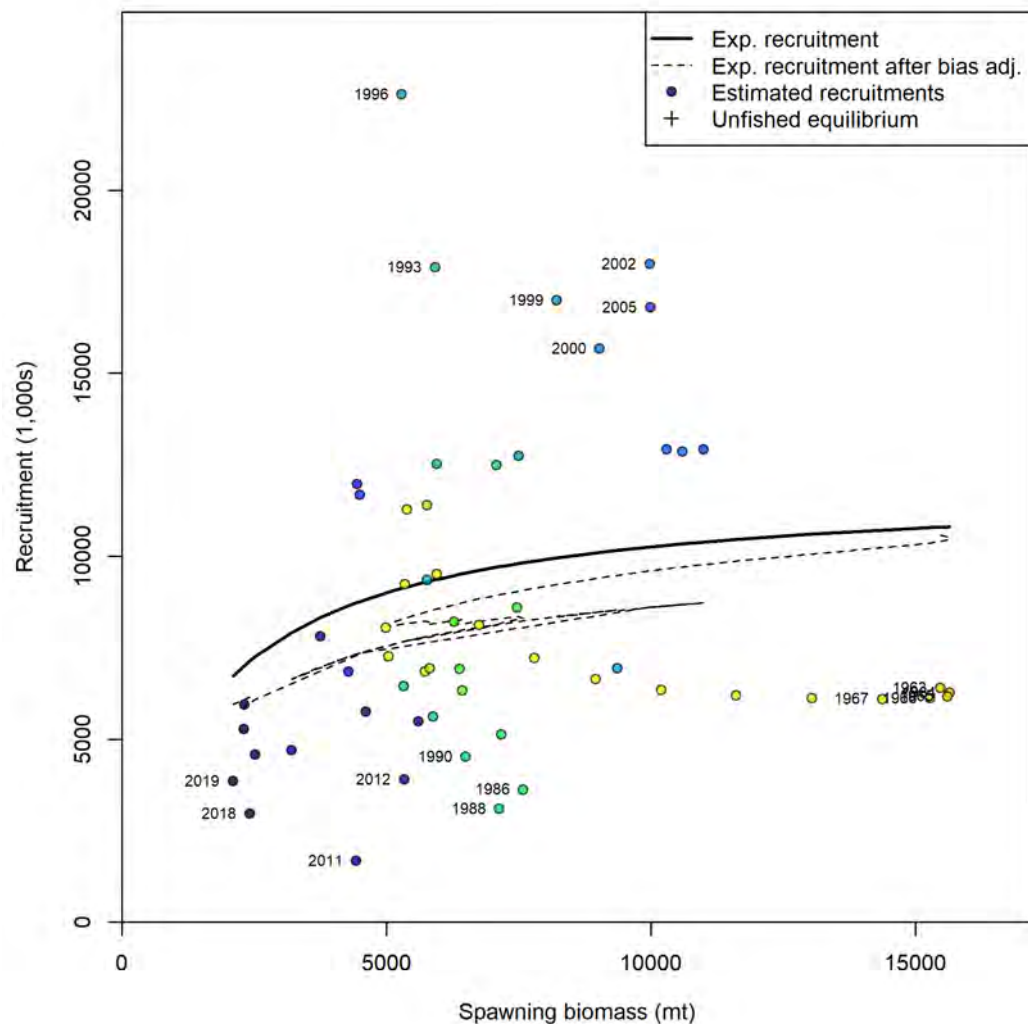
Total Biomass



Female-only SSB



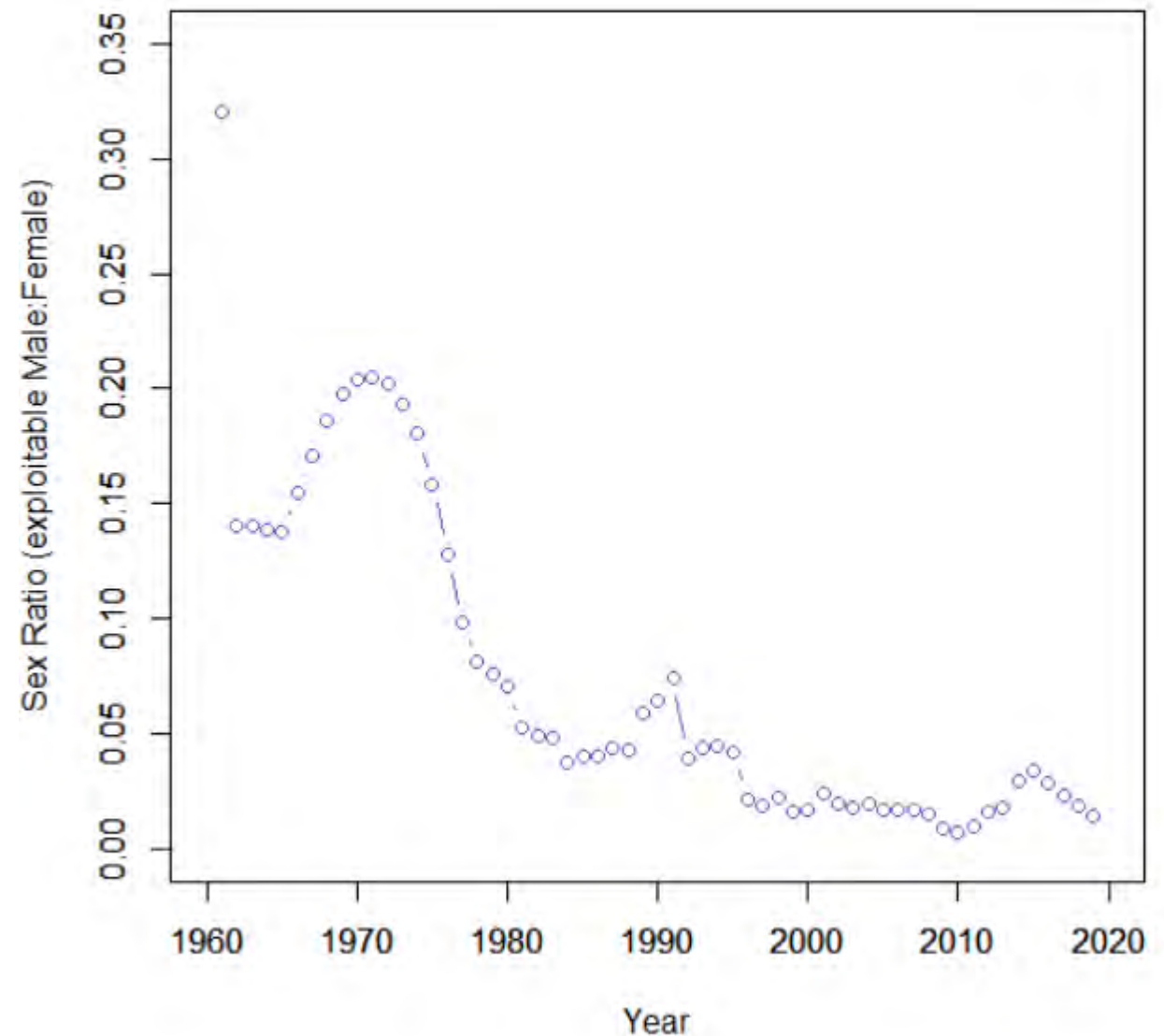
Base Model – S-R



Fixed parameters:
Steepness $h = 0.855$; $\sigma_r = 0.6$

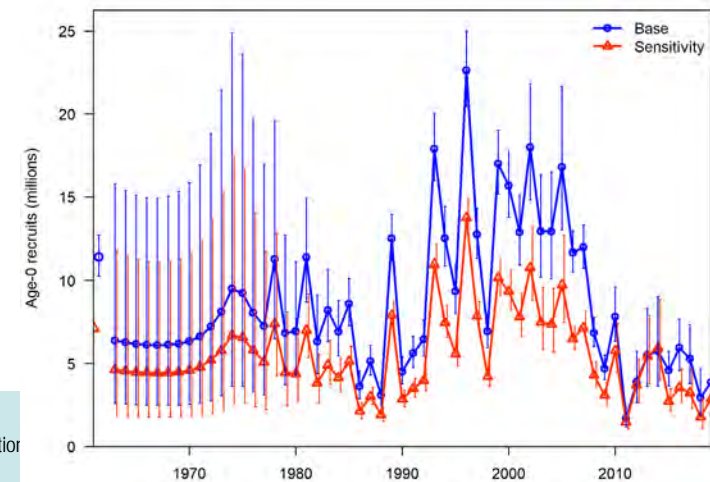
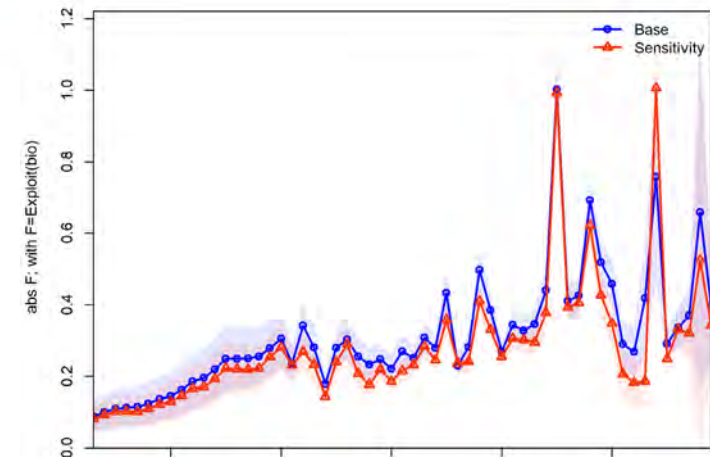
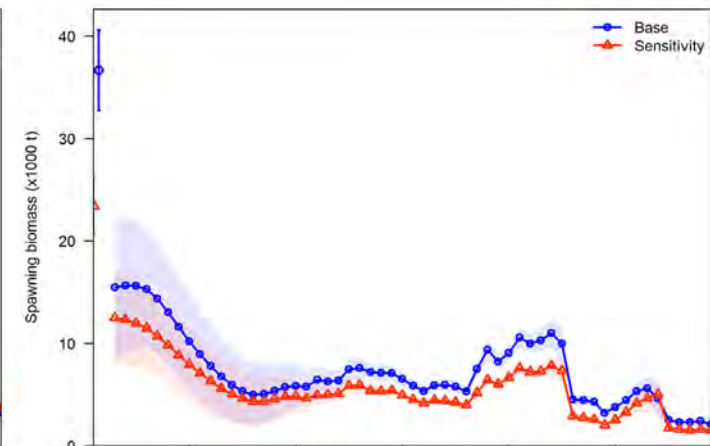
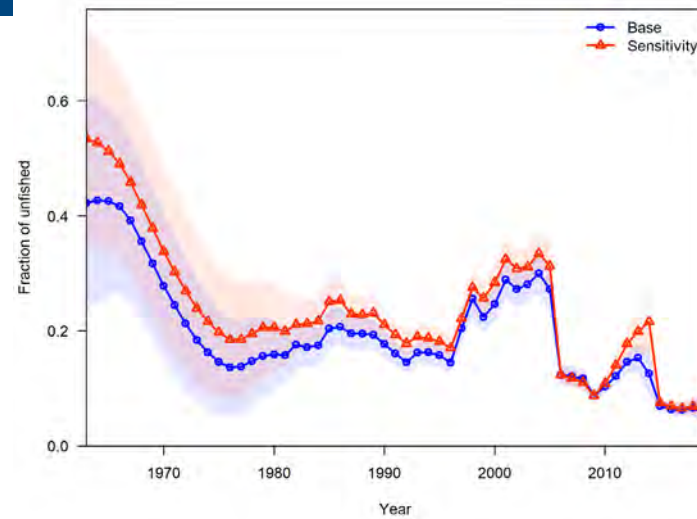
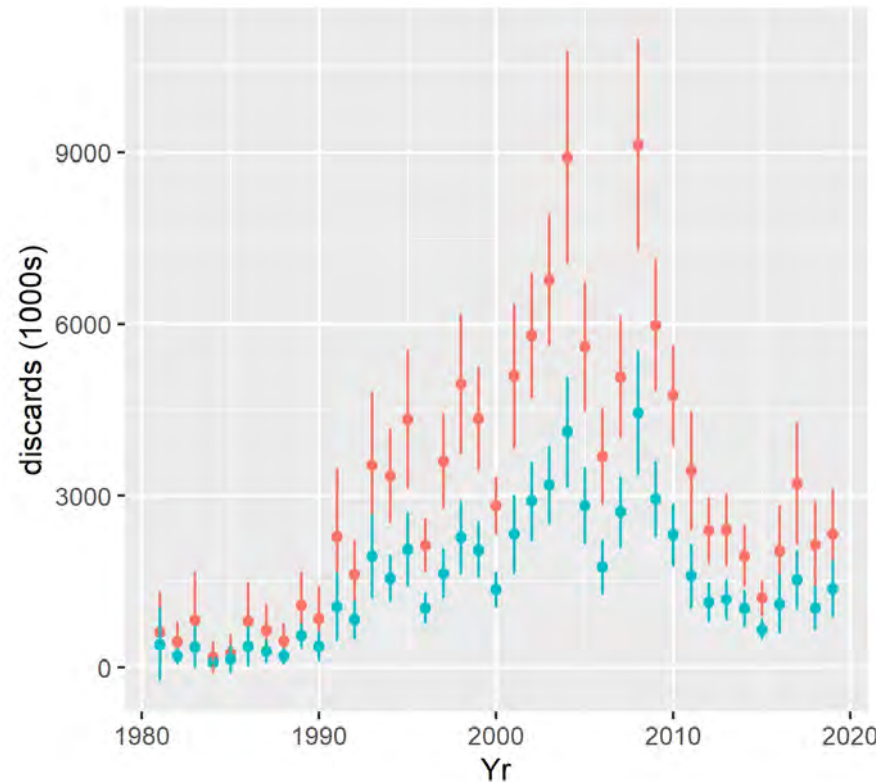
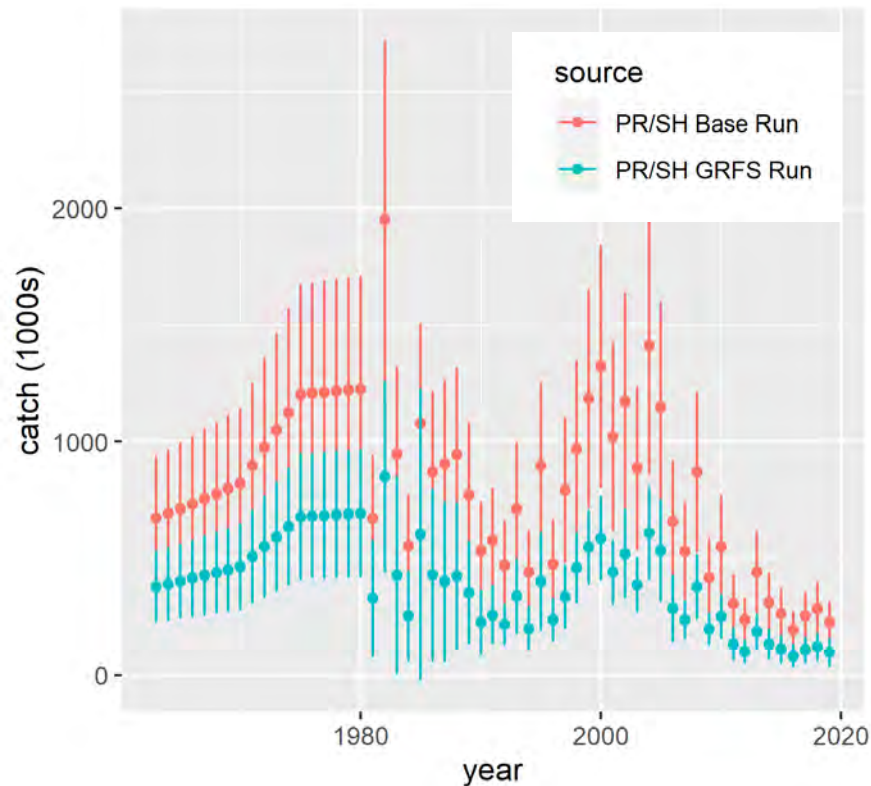
Base Model – Sex Ratios

- Virgin conditions:
32% male
- Terminal year:
1.4% male



Sensitivity Run GRFS

- Inputted catches/discards and CVs for private fleet
- Adjusted historical time series



SSC Review of the SEDAR 33 Update Assessment:

The SSC thought there was considerable uncertainty with the results of the gag update assessment. The strong retrospective pattern indicated previous management advice may have been optimistic. Also, there is uncertainty about the level of discards in the private recreational fleet. An alternative sensitivity model was run that assumed retention of gag in the recreational private fleet mirrored the retention of the headboat fleet. This simple change resulted in large changes in the model outputs, and would have indicated that the stock was overfished and experiencing overfishing. This indicated that the model is highly sensitive to its inputs.

SEDAR 72 incorporates the **best available data, addressed the TORs and fixed modeling issues** evident in the prior assessment. Diagnostics show a more **stable model with improved fits**.

A number of **research questions** were raised during the SEDAR72 assessment process. The SEFSC **strongly recommends that these topics be more thoroughly examined during a future Research Track assessment**.

Male contribution to reproductive potential

- SSB: **female-only** mature biomass or **combined** male and female mature biomass
- **Female-only SSB** best if the **potential for decreased fertilization is weak**
- **Combined SSB** is best when the **potential for decreased fertility is moderate or unknown** (Brooks et al. 2008)
- Increasingly **skewed sex ratios** may result in reduced fertilization rates and **reduced population growth**
- Gag Grouper:
 - ~1% male sex ratio in the fished stock and ~5% in Madison Swanson (Barbieri et al. 2021)
 - Last **strong year class** observed 2006/2007
 - Relationship between sex ratio and fertilization success **poorly understood**

TOR

Examine spawning stock biomass with respect to females only, and males and females combined, as the data allow.

Projection Settings

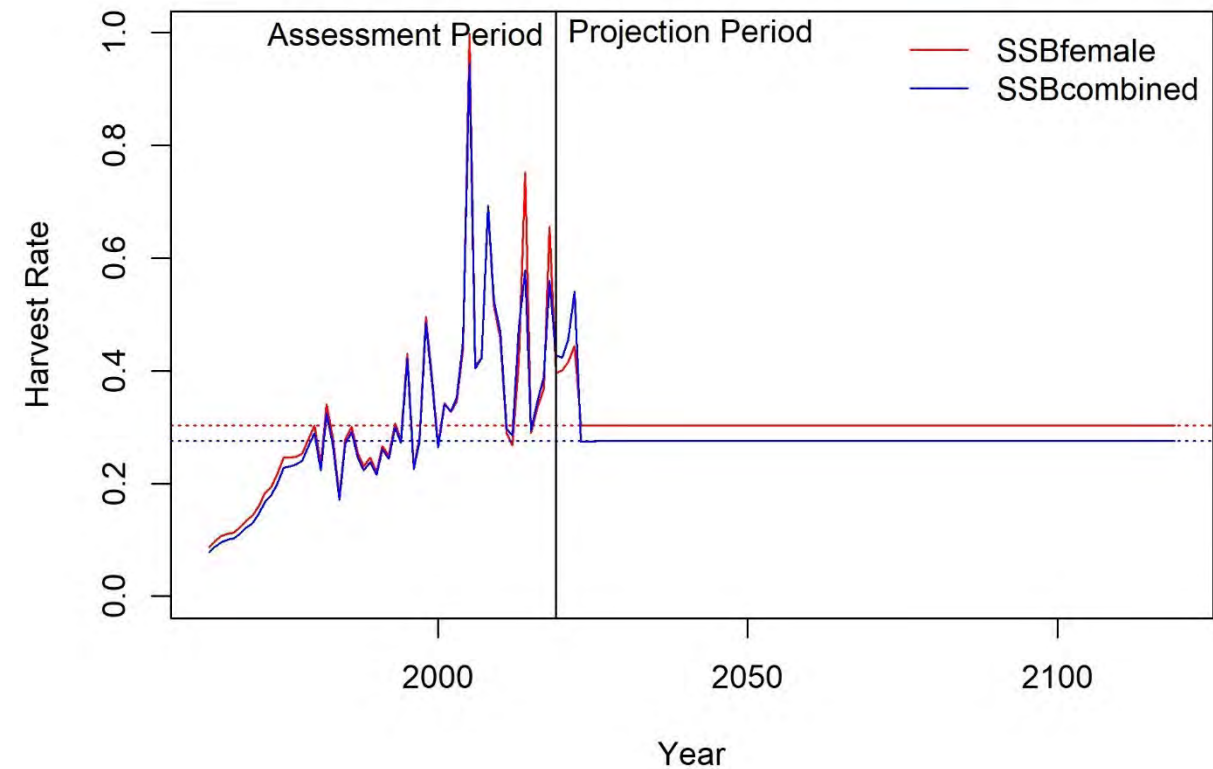
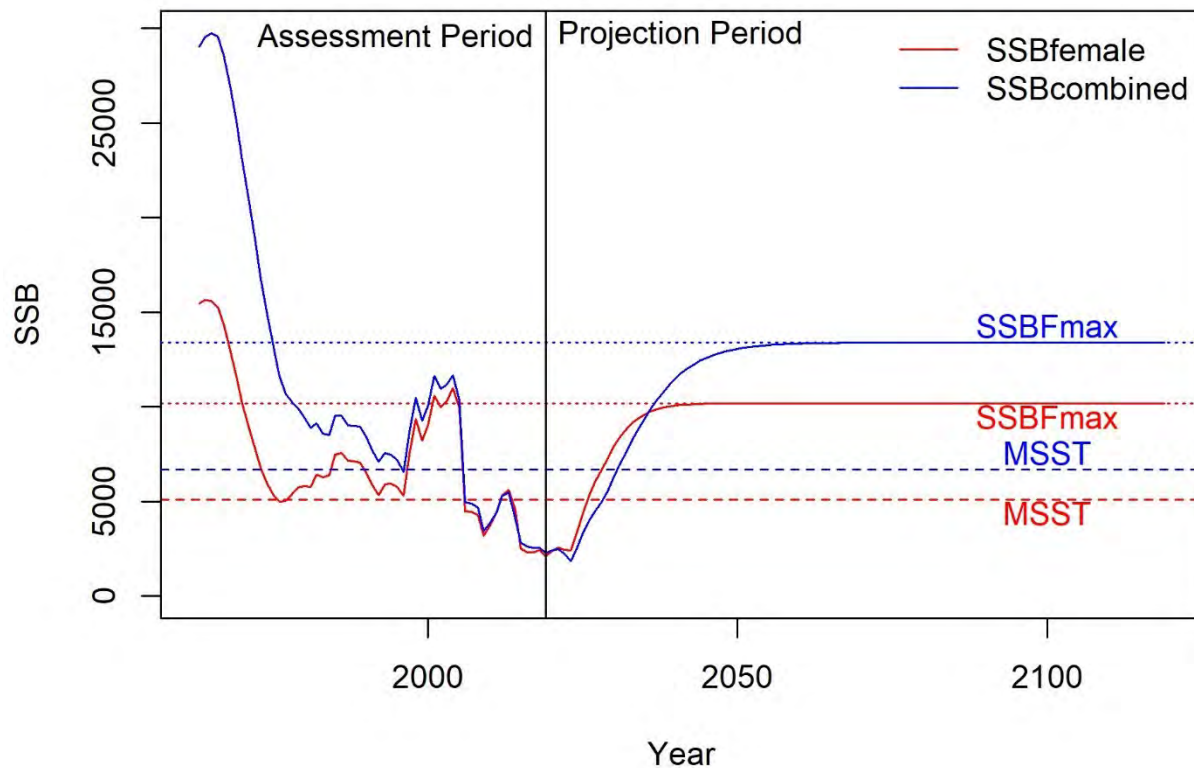
Parameter	Value	Comment
Relative F	Average from 2017 - 2019	(Red Tide F excluded)
Selectivity	2019	Fleet specific selectivity (2019)
Retention	2019	Fleet specific retention (2019)
Recruitment	Beverton-Holt stock-recruitment relationship	Model estimated
Interim Landings (2020-2022)	73.79/126.72/126.72 mt (Comm. Vertical Line) 133.69/97.41/97.41 mt (Comm. Longline) 2.61/2.54/2.54 thousands of fish (Headboat) 37.61/28.66/28.66 thousands of fish (Charter) 305.4/271.68/271.68 thousands of fish (Private)	Landings provided for 2020; For 2021-2022, used 3-year average of landings (2018-2020)
Allocation Ratio	39:61	Commercial:Recreational

Benchmarks & Reference Points

Criteria	Definition	Female-only SSB	SSB combined
R0	Virgin Recruitment (1000s)	11,417	14,292
Generation Time	Fecundity-weighted mean age	7.9	7.9
SSB0	Virgin spawning stock biomass (mt)	36,666	105,978
Fmsy proxy	Fmax - fishing mortality rate that achieves maximum yield per recruit	0.303	0.275
MFMT	Fmax	0.303	0.275
%SPR equivalent of Fmsy proxy	%SPR equivalent of Fmax	31	16
Fcurrent	Geometric mean of the last 3 years of the assessment (F2017-2019), including red tide mortality	0.457	0.453
Fcurrent/MFMT	Current stock status based on MFMT	1.512	1.647
SSBmsy proxy	Equilibrium SSB at Fmax	10,186	13,401
MSST	0.5*SSBFmax	5,093	6,701
SSBcurrent	SSB2019	2,102	2,295
SSBcurrent/SSBFmax	Current stock status based on SSBFmax	0.206	0.171
SSBcurrent/MSST	Current stock status based on MSST	0.413	0.343
SSBcurrent/SSB0	SSB ratio in 2019	0.057	0.022

Base Model – Stock Status

- Gulf of Mexico Gag Grouper is overfished and undergoing overfishing under both female-only SSB and SSB combined scenarios



Research Recommendations

Recreational Landings and Discards data

- Improve treatment of peaks and troughs in highly uncertain catch/discard estimates driven by few but influential intercept records.
- Estimate uncertainty around headboat discards.
- Estimate uncertainty around recreational landings in weight.

Age and length composition

- Ensure age and length composition inputs are representative of the population being modeled.

Research Recommendations Continued

Selectivity and catchability of the commercial fleets

- Evaluate changes in selectivity/catchability to improve fits to discards and length composition data.
- Model changes in fishing behavior from the IFQ programs using time-varying selectivity and retention.
- Continue data collection from observer programs or electronic monitoring programs.

Selectivity and retention of the recreational fleets

- Evaluate changes in selectivity/catchability to improve fits to length composition data.

Research Recommendations Continued

Combined Video Index

- Continue developing the Gulf Gag Combined Video Index. Account for the survey and habitat effects. Explore developing a separate index for the shallow/inshore and deep/offshore components of the surveys, to track the Gulf Gag population through time.

Landings and Discards

- Evaluate uncertainty estimates for commercial landings and revisit estimation of historic landings.
- Determine the best way to convert historical recreational landings from numbers to weight.

Research Recommendations Continued

Recreational CPUE indices

- Research whether assumptions are appropriate across full time series (e.g., targeting, trip length, effects of various regulations, red snapper).

Natural mortality

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

Red Tide and other sources of episodic mortality

- Continue to improve the way red tide mortality is modeled, explore whether additional historical red tide years should also be modeled, and investigate other potential sources of episodic mortality (e.g., cold snaps).



NOAA
FISHERIES

SEFSC

SEDAR 72: US Gulf of Mexico Gag Grouper Operational Assessment

Updated Projections

GMFMC Reef Fish AP
Presentation January 2021

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

Modified by Ryan Rindone for the Reef Fish AP



NOAA FISHERIES

Fmsy Proxy

- Why ?
 - Source: Turner et al. 2001. Status of Gag in the Gulf of Mexico, Assessment 3.0.
https://www.researchgate.net/publication/265279249_Status_of_Gag_in_the_Gulf_of_Mexico_Assessment_30
 - **“Because the female reproductive-potential function reaches a maximum at age 8, long-term fishing at F30% and F40% will generally result in the relatively low biomass levels of males. A bench mark that maximizes the yield from the entire population, given estimated recruitments, is Fmax. Fmax would achieve greater long-term yields and a higher SPR (43% - 65%) than would policies based on F30% or F40%.”**
 - All contingent on female-only biomass, assuming little potential for decreased fertilization from low % males

Fmsy Proxy

- F_{max} VS. $F_{\%SPR}$
 - 2001 assessment (VPA): $F_{max}^{SSB\ female} \sim F_{45-60\%SPR}$
 - SEDAR 10: $F_{max}^{SSB\ female} \sim F_{31-33\%SPR}$
 - SEDAR 33: $F_{max}^{SSB\ female} \sim F_{40\%SPR}$; $F_{max}^{SSB\ combined} \sim F_{30\%SPR}$
 - SEDAR 33 update: $F_{max}^{SSB\ female} \sim F_{29\%SPR}$
 - SEDAR 72: $F_{max}^{SSB\ female} \sim F_{30\%SPR}$; $F_{max}^{SSB\ combined} \sim F_{13\%SPR}$

Projection Settings

SEDAR 72 – SSB combined

Parameter	Value	Comment
Relative F	Average from 2017 - 2019	Red Tide F excluded
Selectivity	2019	Fleet specific selectivity for 2019
Retention	2019	Fleet specific retention for 2019
Recruitment	Beverton-Holt stock-recruitment relationship	Derived from the model
Interim Landings (2020-2022)	73.79/126.72/126.72 mt (Comm. Vertical Line) 133.69/97.41/97.41 mt (Comm. Longline) 2.61/2.54/2.54 thousands of fish (Headboat) 37.61/28.66/28.66 thousands of fish (Charter) 305.4/271.68/271.68 thousands of fish (Private)	Landings provided for 2020; For 2021-2022, used 3-year average of landings (2018-2020)
Allocation Ratio	39:61	Commercial:Recreational

Projection Scenarios – 2021 Red Tide

- Ecosystem model (updated with data up to the end of October) :
 $\hat{M}_{2021_redtide} = 0.103$; 95% CI (0.027, 0.290)
- We take the **mean** estimate as the “Medium Red Tide” scenario and the limits of the **95% confidence interval** as the “Low” and “High” scenarios

Low = 6% the strength of the 2005 red tide

Med = 24% the strength of the 2005 red tide

High = 68% the strength of the 2005 red tide

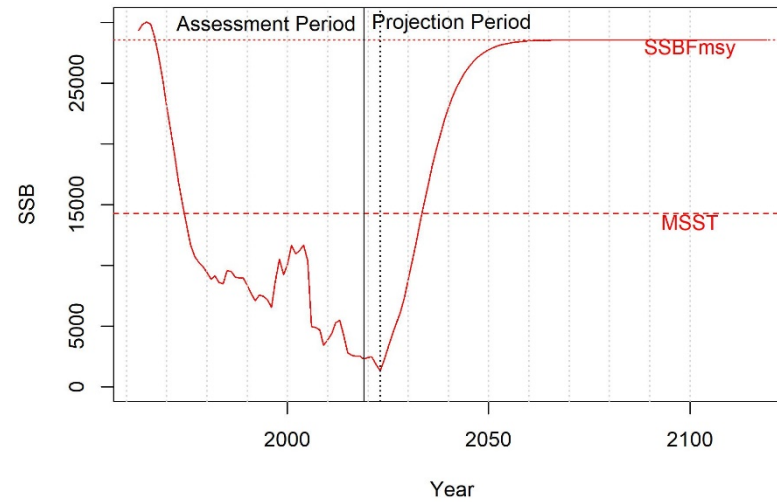
Projection Scenarios

	Fspr30			Fmax		
	LOW	HIGH	MED	LOW	HIGH	MED
Base M	0.159	0.159	0.159	0.159	0.159	0.159
Steepness	0.855	0.855	0.855	0.855	0.855	0.855
R0	14319.2	14319.2	14319.2	14319.2	14319.2	14319.2
Generation Time	7.88	7.88	7.88	7.88	7.88	7.88
SSB0	106178	106178	106178	106178	106178	106178
Proxy	Fspr30	Fspr30	Fspr30	Fmax	Fmax	Fmax
Fmsy proxy	0.148	0.148	0.148	0.328	0.328	0.328
MFMT	0.148	0.148	0.148	0.328	0.328	0.328
%SPR equivalent of Fmsy proxy	30	30	30	13	13	13
Fcurrent	0.412	0.412	0.412	0.412	0.412	0.412
Fcurrent/MFMT	2.784	2.784	2.784	1.256	1.256	1.256
SSBmsy proxy	28559.6	28559.8	28559.4	9956.4	9956.53	9957.26
MSST	14279.8	14279.9	14279.7	4978.2	4978.265	4978.63
SSBcurrent	2296.24	2296.24	2296.24	2296.24	2296.24	2296.24
SSBcurrent/SSBFmsy_proxy	0.08	0.08	0.08	0.231	0.231	0.231
SSBcurrent/MSST	0.161	0.161	0.161	0.461	0.461	0.461
First year mgmt	2023	2023	2023	2023	2023	2023
Yr rebuilt at F=0	2033	2035	2034	2028	2030	2029
SSBcurrent/SSB0	0.022	0.022	0.022	0.022	0.022	0.022
SSByrrebuilt/SSB0	0.139	0.128	0.143	0.038	0.028	0.036

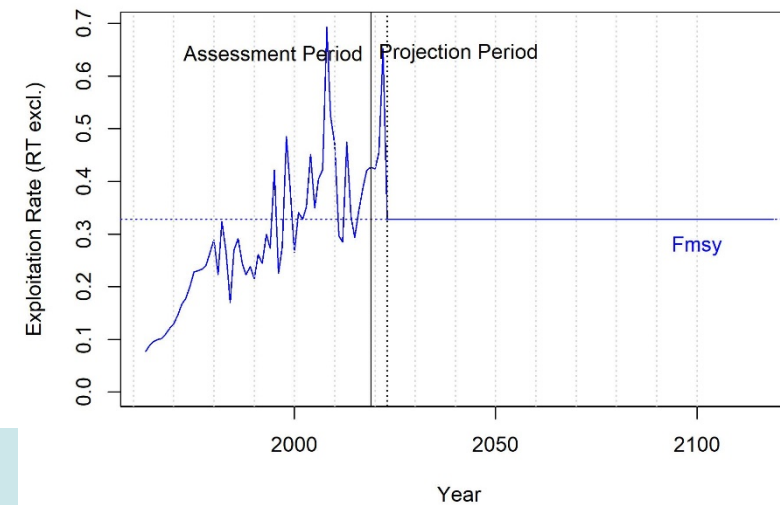
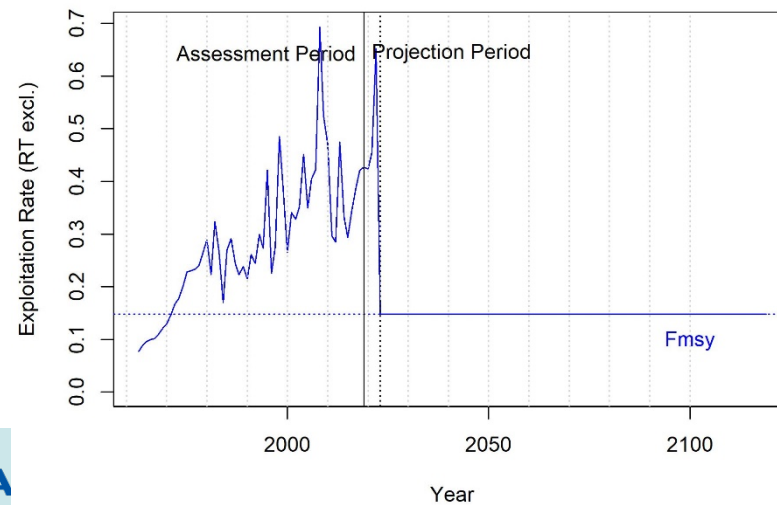
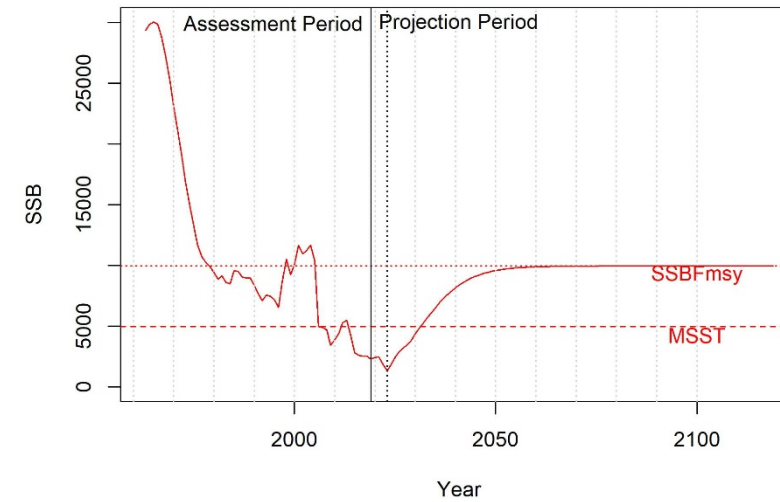
FSPR30%

Fmax

Fmsy_proxy = Fspr30% ; Med 2021 Red Tide



Fmsy_proxy = Fmax ; Med 2021 Red Tide



Frebuild

Calculate **Tmin**, the amount of time the stock is expected to take to rebuild to its MSY biomass level in the absence of any fishing mortality (**F=0**).

Tmin < 10yrs

Tmin
No fishing

10yrs

Halfway in between Tmin and 10 years

Tmin > 10yrs

Tmin*2

Tmin+1 generation time

Amount of time stock expected to take
to rebuild to Bmsy proxy if fished at
75% MFMT

Tmin = 10yrs
No fishing

Fspr30_medRT

F=0

Year	R (1000s)	F	Yield (mp gwt)	SSB (mt)	SSB/ SSBFmsy	SSB/ MSST	F/ MFMT	SSB/ SSB0
2020	5,098	0.424	3.31	2,432	0.09	0.17	2.86	0.02
2021	5,170	0.454	3.10	2,484	0.09	0.17	3.07	0.02
2022	4,221	0.652	3.15	1,849	0.06	0.13	4.40	0.02
2023	3,312	0.000	0.00	1,337	0.05	0.09	0.00	0.01
2024	5,134	0.000	0.00	2,458	0.09	0.17	0.00	0.02
2025	6,927	0.000	0.00	4,057	0.14	0.28	0.00	0.04
2026	8,274	0.000	0.00	5,824	0.20	0.41	0.00	0.05
2027	9,226	0.000	0.00	7,573	0.27	0.53	0.00	0.07
2028	10,035	0.000	0.00	9,591	0.34	0.67	0.00	0.09
2029	10,808	0.000	0.00	12,257	0.43	0.86	0.00	0.12
2030	11,483	0.000	0.00	15,557	0.54	1.09	0.00	0.15
2031	12,029	0.000	0.00	19,340	0.68	1.35	0.00	0.18
2032	12,458	0.000	0.00	23,471	0.82	1.64	0.00	0.22
2033	12,795	0.000	0.00	27,865	0.98	1.95	0.00	0.26
2034	13,061	0.000	0.00	32,449	1.14	2.27	0.00	0.31



Fspr30_medRT

Frebuild Tmin*2

Year	R (1000s)	F	Yield (mp gwt)	SSB (mt)	SSB/ SSBF _{msy}	SSB/ MSST	F/ MFMT	SSB/ SSB0
2020	5,098	0.424	3.31	2,432	0.09	0.17	2.86	0.02
2021	5,170	0.454	3.10	2,484	0.09	0.17	3.07	0.02
2022	4,221	0.652	3.15	1,849	0.06	0.13	4.40	0.02
2023	3,312	0.135	0.66	1,337	0.05	0.09	0.91	0.01
2024	4,753	0.135	1.02	2,190	0.08	0.15	0.91	0.02
2025	6,195	0.135	1.39	3,325	0.12	0.23	0.91	0.03
2026	7,255	0.135	1.65	4,430	0.16	0.31	0.91	0.04
2027	7,974	0.135	1.98	5,370	0.19	0.38	0.91	0.05
2028	8,595	0.135	2.41	6,354	0.22	0.44	0.91	0.06
2029	9,267	0.135	2.92	7,660	0.27	0.54	0.91	0.07
2030	9,912	0.135	3.48	9,244	0.32	0.65	0.91	0.09
2031	10,466	0.135	4.05	10,965	0.38	0.77	0.91	0.10
2032	10,918	0.135	4.64	12,721	0.45	0.89	0.91	0.12
2033	11,288	0.135	5.22	14,477	0.51	1.01	0.91	0.14
2034	11,593	0.135	5.79	16,217	0.57	1.14	0.91	0.15
2035	11,845	0.135	6.33	17,915	0.63	1.25	0.91	0.17
2036	12,053	0.135	6.84	19,536	0.68	1.37	0.91	0.18
2037	12,223	0.135	7.32	21,049	0.74	1.47	0.91	0.20
2038	12,363	0.135	7.75	22,437	0.79	1.57	0.91	0.21
2039	12,477	0.135	8.13	23,691	0.83	1.66	0.91	0.22
2040	12,571	0.135	8.47	24,808	0.87	1.74	0.91	0.23
2041	12,648	0.135	8.77	25,792	0.90	1.81	0.91	0.24
2042	12,711	0.135	9.02	26,649	0.93	1.87	0.91	0.25
2043	12,763	0.135	9.25	27,389	0.96	1.92	0.91	0.26
2044	12,805	0.135	9.43	28,022	0.98	1.96	0.91	0.26
2045	12,840	0.135	9.59	28,560	1.00	2.00	0.91	0.27



Fspr30_medRT

F fixed at 75%MFMT

Year	R (1000s)	F	Yield (mp gwt)	SSB (mt)	SSB/ SSBFmsy	SSB/ MSST	F/ MFMT	SSB/ SSB0
2020	5,098	0.424	3.31	2,432	0.09	0.17	2.86	0.02
2021	5,170	0.454	3.10	2,484	0.09	0.17	3.07	0.02
2022	4,221	0.652	3.15	1,849	0.06	0.13	4.40	0.02
2023	3,312	0.111	0.54	1,337	0.05	0.09	0.75	0.01
2024	4,822	0.111	0.85	2,237	0.08	0.16	0.75	0.02
2025	6,327	0.111	1.17	3,448	0.12	0.24	0.75	0.03
2026	7,441	0.111	1.42	4,656	0.16	0.33	0.75	0.04
2027	8,204	0.111	1.72	5,715	0.20	0.40	0.75	0.05
2028	8,864	0.111	2.11	6,842	0.24	0.48	0.75	0.06
2029	9,560	0.111	2.58	8,333	0.29	0.58	0.75	0.08
2030	10,218	0.111	3.10	10,143	0.36	0.71	0.75	0.10
2031	10,776	0.111	3.64	12,127	0.42	0.85	0.75	0.11
2032	11,230	0.111	4.19	14,177	0.50	0.99	0.75	0.13
2033	11,598	0.111	4.75	16,247	0.57	1.14	0.75	0.15
2034	11,899	0.111	5.30	18,312	0.64	1.28	0.75	0.17
2035	12,146	0.111	5.82	20,336	0.71	1.42	0.75	0.19
2036	12,348	0.111	6.32	22,279	0.78	1.56	0.75	0.21
2037	12,513	0.111	6.78	24,104	0.84	1.69	0.75	0.23
2038	12,648	0.111	7.20	25,788	0.90	1.81	0.75	0.24
2039	12,758	0.111	7.59	27,320	0.96	1.91	0.75	0.26
2040	12,848	0.111	7.92	28,694	1.00	2.01	0.75	0.27



Fspr30_medRT

Frebuild Tmin + 1 generation

Year	R (1000s)	F	Yield (mp gwt)	SSB (mt)	SSB/ SSBFmsy	SSB/ MSST	F/ MFMT	SSB/ SSB0
2020	5,098	0.424	3.31	2,432	0.09	0.17	2.86	0.02
2021	5,170	0.454	3.10	2,484	0.09	0.17	3.07	0.02
2022	4,221	0.652	3.15	1,849	0.06	0.13	4.40	0.02
2023	3,312	0.124	0.60	1,337	0.05	0.09	0.84	0.01
2024	4,785	0.124	0.95	2,212	0.08	0.15	0.84	0.02
2025	6,256	0.124	1.29	3,381	0.12	0.24	0.84	0.03
2026	7,341	0.124	1.55	4,533	0.16	0.32	0.84	0.04
2027	8,080	0.124	1.87	5,527	0.19	0.39	0.84	0.05
2028	8,719	0.124	2.28	6,575	0.23	0.46	0.84	0.06
2029	9,403	0.124	2.77	7,964	0.28	0.56	0.84	0.08
2030	10,054	0.124	3.32	9,648	0.34	0.68	0.84	0.09
2031	10,611	0.124	3.88	11,486	0.40	0.80	0.84	0.11
2032	11,064	0.124	4.45	13,373	0.47	0.94	0.84	0.13
2033	11,433	0.124	5.02	15,267	0.53	1.07	0.84	0.14
2034	11,736	0.124	5.58	17,151	0.60	1.20	0.84	0.16
2035	11,986	0.124	6.12	18,992	0.67	1.33	0.84	0.18
2036	12,192	0.124	6.63	20,753	0.73	1.45	0.84	0.20
2037	12,360	0.124	7.10	22,402	0.78	1.57	0.84	0.21
2038	12,497	0.124	7.52	23,919	0.84	1.68	0.84	0.23
2039	12,610	0.124	7.91	25,292	0.89	1.77	0.84	0.24
2040	12,702	0.124	8.25	26,520	0.93	1.86	0.84	0.25
2041	12,777	0.124	8.55	27,604	0.97	1.93	0.84	0.26
2042	12,839	0.124	8.81	28,552	1.00	2.00	0.84	0.27
2043	12,890	0.148	10.78	29,372	1.03	2.06	1.00	0.28

