



SEDAR 68 Gulf of Mexico Scamp Grouper Operational Assessment - Additional Projections

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1. Introduction

The Gulf of Mexico Fishery Management Council’s Scientific and Statistical Committee (GMFMC SSC) reviewed the SEDAR 68 Operational Assessment (OA) for Gulf of Mexico Scamp at their September 2022 meeting. Additional projection requests were made by the SSC. For the benchmarks, projections using a Maximum Sustainable Yield (MSY) proxy of 40% spawning potential ratio (SPR) were requested because the SSC thought this value was more appropriate based on the life history of Scamp. Additional support for an SPR higher than 30% is also provided by simulations conducted by Harford et al. (2019), which suggest that SPR ratios of 40% or 50% led to the highest probabilities of achieving long-term MSY for hermaphroditic stocks. They found that more conservative fishing mortality proxies were required to achieve MSY-based fishery objectives when steepness was “least certain” (i.e., uniform prior). Steepness for Gulf of Mexico Scamp was fixed at a biologically plausible value because it was not estimable within the model and was highly uncertain (see SEDAR 2021 for details).

The SSC recommended using the stock-recruitment relationship for determining the benchmarks but using the recent mean recruitment (last 10 years of estimated recruitment) for projections of the Overfishing Limit (OFL). Specifically, the last 10 years of estimated recruitment (i.e., 2008-2017) were chosen because the model-derived recruitment estimates from the spawner-recruit curve between 2018 and 2020 were overly optimistic.

Lastly, the definition of optimum yield (OY) was corrected so the OY is a fraction of yield ($0.9 F_{MSYproxy}$) and not calculated off an exploitation rate ($0.9 F_{MSYproxy}$).

2. 40% SPR projections for the SEDAR 68 OA Base Model (presented September 2022)

2.1. Projection methods

The simulated dynamics used for projections assumed nearly identical parameter values and population dynamics as the SEDAR 68 OA Base Model. **Table 1** provides a summary of projection settings. Projections were run assuming that relative F , selectivity, discarding and retention associated with the last three years (which fall within the most recent time period, 2010-2020) would remain the same into the future. For benchmarks, forecast recruitment values were derived from the model-estimated Beverton-Holt stock-recruitment relationship.

The terminal year of the SEDAR 68 OA was 2020 and the first year of management advice was 2023. Retained catch for the interim years (2021-2022) used preliminary landings estimates for 2021 and the average of the last three years of retained catches (2019-2021) for 2022 (**Table 1**).

$F_{40\%SPR}$ was determined using a long-term 100-year projection assuming that equilibrium was obtained over the last 10 years (2111-2120). For the OFL projection, the $F_{40\%SPR}$ was applied to the stock starting in 2023. No fleet allocations exist for the other shallow-water grouper complex, which includes Scamp and Yellowmouth Grouper.

The minimum stock size threshold (MSST) was determined by multiplying the reference spawning stock biomass, $SSB_{40\%SPR}$, by 0.75 (per the SSC’s request) and was used to determine

stock status (**Table 2**). The maximum fishing mortality threshold (MFMT) was equivalent to the harvest rate ($F_{40\%SPR}$; total biomass killed all ages / total biomass age 3+) that achieved $SSB_{40\%SPR}$, and was used to assess whether overfishing was occurring in a given year (**Table 2**). A stock is considered overfished when $SSB_{Current} < MSST$ and undergoing overfishing if $F_{Current} > MFMT$, where $F_{Current}$ is defined as the geometric mean of the fishing mortality over the most recent three years (2018-2020).

Once the proxy values were calculated, 2020 stock status was used to determine whether a rebuilding plan was required (i.e., if $SSB < MSST$ then Gulf of Mexico Scamp would be considered overfished and a rebuilding plan would be required).

2.2. Projection results

Benchmarks and reference points were calculated assuming an SSB defined in terms of male and female combined SSB.

2.3. Biological Reference Points

The status determination criteria (SDCs) based on the SSC's requests for Gulf of Mexico Scamp (**Table 2**; **Figure 1**) are summarized below (note differences from the SEDAR 68 TORs and those presented in the SEDAR 68 OA Report):

- MSY proxy = yield at $F_{40\%SPR} = 332,474$ pounds gutted weight
- $MSST = 0.75 * SSB_{40\%SPR} = 923$ metric tons
- $MFMT = F_{MSYproxy} (F_{40\%SPR}) = 0.117$
- $OY = 0.9 * MSY \text{ proxy} = 299,227$ pounds gutted weight

2.4. Stock Status

Benchmarks and reference points are shown in **Table 2**. Detailed time series of derived quantities and benchmarks with SSB defined as male and female combined SSB are presented in **Table 3**. As of 2020, the Gulf of Mexico Scamp stock is not undergoing overfishing ($F_{Current} > MFMT$) and is not overfished ($SSB_{2020} > MSST$) according to the SEDAR 68 OA Base Model using an MSY proxy of 40% SPR (**Table 2**). The terminal year SSB (2020) is above $SSB_{40\%SPR}$ (**Figure 1**) at 106% of the biomass level needed to support MSY (**Table 3**). From 2018 to 2020 the estimated stock harvest rate, using the geometric mean, was 0.092, which was equivalent to 79% of $F_{40\%SPR}$ (**Table 2**).

The Kobe plot (**Figure 2**) indicates that over the time horizon of the assessment (i.e., 1986-2020), the stock experienced overfishing in 2015-2016 but has not been overfished in any year since 1986.

2.5. Overfishing Limit (and Optimum Yield) projection

OFL projection results assuming predicted recruitment follows the spawner-recruit curve are provided in **Table 4** and **Figure 3**. After a relatively large landings estimate in the interim years of 2021 and 2022, the forecasted yield for the OFL scenario declines in 2023 and increases gradually thereafter.

3. Maximum Sustainable Yield projections for the SEDAR 68 OA Base Model (presented September 2022)

In addition to SPR projections, the SSC requested an MSY projection using the model-derived spawner-recruit curve. The purpose of this run was to compare the estimated SPR when MSY was achieved with the reference points under consideration by the SSC, in this case $F_{30\%SPR}$ and $F_{40\%SPR}$.

3.1. Results

Overfishing Limit (OFL) projection results assuming predicted recruitment follows the spawner-recruit curve are provided in **Table 5**. The MSY projections resulted in an SPR of 37.8%.

4. Projections for determining the Overfishing Limit and Acceptable Biological Catch (will be presented March 2023)

4.1. Recent recruitment modeling issue

The SEDAR 68 OA Base Model did not estimate recruitment deviations through the terminal year of 2020 because of a lag in Scamp being captured by the fisheries or surveys. As a result, Stock Synthesis predicted recruitment estimates from the spawner-recruit curve for 2018-2020 (range: 1.26-1.30 million Scamp). When projecting with recent mean recruitment, the SEDAR 68 OA Base Model did not converge because the 2018-2020 recruitment estimates were replaced with the recent mean, which was much lower (0.9 million Scamp). Estimated parameters differed, with 12 parameters differing by $\geq 5\%$ from the SEDAR 68 OA Base Model estimates. These included recruitment deviations, 2020 fishing mortality for the recreational fleets, and charter private selectivity parameters, many of which were identified as uncertain in the SEDAR 68 OA Base Model.

4.2. Modification to the SEDAR 68 OA Base Model for OFL projection

The SEDAR 68 OA Base Model was modified to estimate recruitment deviations through 2020 to ensure projections were carried out as expected. All other projection specifications and methods were identical as reported in **Section 2.1**.

4.3. Comparison

Estimation of recruitment deviations from 2018 through 2020 led to very similar results compared to the SEDAR 68 OA Base Model, with the exception of a slightly higher sigmaR estimate of 0.572 (CV = 0.131) vs 0.562 (CV = 0.126) for the SEDAR 68 OA Base Model (**Table 6**). This result was driven by high uncertainty in the estimated recruitment deviations, particularly for 2020 (CV > 1), because little to no information exists on smaller Scamp in the available datasets. Scamp are first encountered by the recreational fishery at 3 years, which is why the SEDAR 68 OA Base Model stopped estimating recruitment deviations in 2017. All derived quantities remained within the confidence intervals of the SEDAR 68 OA Base Model (**Figure 4**), and no large differences in model performance or diagnostics were identified.

4.4. OFL projections and Optimum Yield

Short-term forecasts assuming recent mean recruitment were conducted to develop catch advice per the SSC recommendation from the September 2022 meeting. The recent mean recruitment projection is not meant to revise stock status (i.e., benchmarks remain unchanged) and should not be used for long-term projections for Gulf Scamp. If a regime shift to lower recruitment was supported, the benchmarks would need to be recalculated (i.e., long-term SSB would be lower compared to the long-term SSB predicted using the spawner-recruit curve).

4.4.1 Starting projections in 2023 (continuity with SEDAR 68 OA report)

OFL projection results assuming recent mean recruitment are provided in **Table 8** and **Figure 5**. After a relatively large landings estimate in the interim years of 2021 and 2022, forecasts indicate that yields will decline from 2023 throughout the near-term time period.

As shown in the SSB estimates in **Table 8**, the assumed recruitment in the first few years of the short-term projection leads to much smaller SSB estimates and status ratios (benchmarks remain unchanged and were plotted in **Figure 1**) compared to the benchmark projection assuming recruitment would follow the spawner-recruit curve.

4.4.2 Starting projections in 2024

Interim landings for 2023 were assumed the same as those for 2022 (**Table 9**). OFL projection results assuming recent mean recruitment and starting projections in 2024 are provided in **Table 10** and **Figure 6**. After a relatively large landings estimate in the interim years of 2021 through 2023, forecasts indicate that yields will decline from 2024 throughout the near-term time period.

4.4.3 Starting projections in 2024 and updating 2021 charter-private landings

While reviewing the most recent MRIP-FES landings for shallow-water groupers (extracted February 2023), a discrepancy was noted in charter-private landings of Scamp/Yellowmouth Grouper in 2021 compared to the landings used in prior SEDAR 68 OA projections (MRIP-FES data received April 2022). The Office of Science and Technology corrected a data issue specific to West Florida charter landings in all waves of 2021

(<https://www.fisheries.noaa.gov/recreational-fishing-data/recreational-fishing-estimate-updates>), and charter-private landings of Scamp/Yellowmouth Grouper were reduced from 96,068 to 83,595 fish (**Table 11**). The 2019-2021 average was recalculated using the updated charter-private landings and used for the interim landings in 2022 and 2023 (**Table 11**).

OFL projection results assuming recent mean recruitment, starting projections in 2024, and updating the 2021 charter-private landings and 3-year average (2019-2021) are provided in **Table 12** and **Figure 7**. After a relatively large landings estimate in the interim years of 2021 through 2023, forecasts indicate that yields will decline from 2024 throughout the near-term time period.

4.5. Acceptable Biological Catch (ABC) projections

For this projection, the Acceptable Biological Catch (ABC) was defined as 75% of the $F_{MSYproxy}$ with a proxy of 40% SPR. ABC projection results assuming recent mean recruitment, starting

projections in 2024, and updating the 2021 charter-private landings and 3-year average (2019-2021) are provided in **Table 13** and **Figure 8**. For the ABC projection, forecasts indicate that yields will increase slightly from 2024 throughout the near-term time period.

6. References

Harford WJ, SR Sagarese and M Karnauskas. 2019. Coping with information gaps in stock productivity for rebuilding and achieving maximum sustainable yield for grouper–snapper fisheries. *Fish and Fisheries* 20(2):303-321.

Southeast Data Assessment and Review (SEDAR). 2021. SEDAR68: Gulf of Mexico Scamp Grouper Research Track Assessment. SEDAR, North Charleston, SC. 601 pp. Available at: <https://sedarweb.org/assessments/sedar-68/>.

7. Tables

Table 1. Settings used for Gulf of Mexico Scamp projections.

Parameter	Value	Comment
Relative F	Average from 2018-2020	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	Average from 2018-2020	Fleet specific selectivity estimated over terminal three years of model
Retention	Average from 2018-2020	Fleet specific retention estimated over terminal three years of model
Recruitment (benchmarks)	Beverton-Holt stock-recruitment relationship	Derived from the model estimated Beverton-Holt stock-recruitment relationship
Recruitment (catch advice)	Average from 2008-2017	Average recruitment over the last ten years where estimated
Interim Landings (2021-2022)	29.14/27.98 mt (Commercial Vertical Line); 30.13/27.02 mt (Commercial Longline); 96.07/75.24 thousands of fish (Recreational Charter Private); 3.13/2.46 thousands of fish (Recreational Headboat)	Landings provided for 2021; For 2022, used 3-year average of landings (2019-2021)
Allocation Ratio	None	

Table 2. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points for the SEDAR 68 Gulf of Mexico Scamp Operational Assessment. Spawning Stock Biomass (SSB) is in metric tons (male and female combined SSB), whereas F is a harvest rate (total biomass killed all ages / total biomass age 3+).

Criteria	Definition	Value
Base M	Target M for fully selected ages in the Lorenzen (2000) scaling	0.155
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (fixed)	0.694
Unfished Recruitment (R0)	Unfished recruitment (1,000s)	1,526
Generation Time	Fecundity-weighted mean age	8.34
Unfished SSB (SSB0)	Unfished spawning stock biomass (mt)	3,779
Mortality Rate Criteria		
FMSYproxy	Equilibrium F that achieves SPR40%	0.117
MFMT	FMSYproxy	0.117
Fcurrent	Geometric mean of the last 3 years of the assessment (F2018-2020)	0.092
Fcurrent/MFMT	Current stock status based on MFMT	0.785
Biomass Criteria		
SSBMSYproxy	Equilibrium SSB at FSPR 40 %	1,230
MSST	$0.75 * \text{SSBSPR40\%}$	923
SSBcurrent	SSB in 2020	1,301
SSBcurrent/SSBFMSYproxy	Current stock status based on SSBSPR40% (Equil)	1.06
SSBcurrent/MSST	Current stock status based on MSST	1.41
SSBcurrent/SSBunfished	SSB ratio in 2020	0.34

Table 3. Time series of fishing mortality (F) and SSB relative to associated biological reference points. SSB is in metric tons (male and female combined SSB), whereas F is a harvest rate (total biomass killed all ages / total biomass age 3+). Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F40%SPR	SSB	SSB/SSB40%SPR	SSB/MSST	SSB ratio
1986	0.108	0.923	1,972	1.603	2.137	0.522
1987	0.098	0.840	1,920	1.561	2.081	0.508
1988	0.084	0.716	1,892	1.538	2.051	0.501
1989	0.085	0.722	1,831	1.489	1.985	0.485
1990	0.078	0.662	1,754	1.426	1.901	0.464
1991	0.099	0.843	1,668	1.356	1.807	0.441
1992	0.096	0.821	1,617	1.315	1.753	0.428
1993	0.104	0.888	1,645	1.337	1.783	0.435
1994	0.065	0.553	1,678	1.364	1.819	0.444
1995	0.059	0.506	1,771	1.440	1.920	0.469
1996	0.060	0.515	1,841	1.497	1.996	0.487
1997	0.070	0.600	1,942	1.579	2.105	0.514
1998	0.054	0.463	2,002	1.627	2.170	0.530
1999	0.069	0.589	2,088	1.697	2.263	0.552
2000	0.048	0.409	2,163	1.758	2.344	0.572
2001	0.063	0.542	2,223	1.807	2.409	0.588
2002	0.064	0.549	2,302	1.872	2.495	0.609
2003	0.086	0.738	2,458	1.998	2.664	0.650
2004	0.097	0.830	2,509	2.040	2.720	0.664
2005	0.066	0.568	2,576	2.094	2.792	0.681
2006	0.063	0.539	2,643	2.149	2.865	0.699
2007	0.077	0.662	2,653	2.157	2.875	0.702
2008	0.092	0.786	2,565	2.085	2.780	0.679

Table 3 Continued. Time series of fishing mortality (F) and SSB relative to associated biological reference points. SSB is in metric tons (male and female combined SSB), whereas F is a harvest rate (total biomass killed all ages / total biomass age 3+). Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F40%SPR	SSB	SSB/SSB40%SPR	SSB/MSST	SSB ratio
2009	0.083	0.711	2,456	1.997	2.662	0.650
2010	0.062	0.534	2,439	1.983	2.644	0.645
2011	0.050	0.425	2,460	2.000	2.666	0.651
2012	0.101	0.865	2,461	2.000	2.667	0.651
2013	0.089	0.758	2,295	1.866	2.488	0.607
2014	0.113	0.961	2,149	1.747	2.329	0.569
2015	0.125	1.070	1,953	1.588	2.117	0.517
2016	0.129	1.101	1,735	1.410	1.880	0.459
2017	0.099	0.843	1,538	1.250	1.667	0.407
2018	0.085	0.725	1,460	1.187	1.583	0.386
2019	0.095	0.811	1,395	1.134	1.512	0.369
2020	0.096	0.823	1,301	1.057	1.410	0.344

Table 4. Results of the OFL projection (fishing set at $F_{40\%SPR}$) for Gulf of Mexico Scamp **assuming predicted recruitment from the spawner-recruit curve**. Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. OY was calculated as $0.9 * MSY_{proxy}$ with a proxy of 40% SPR.

Year	Recr	F	F/ $F_{40\%SPR}$	SSB	SSB/ $SSB_{40\%SPR}$	SSB/ $MSST$	SSB ratio	OFL	OY
2023	1,191	0.117	1	1,069	0.869	1.159	0.283	0.293	0.264
2024	1,195	0.117	1	1,081	0.879	1.172	0.286	0.295	0.266
2025	1,200	0.117	1	1,096	0.891	1.188	0.290	0.298	0.268
2026	1,205	0.117	1	1,109	0.902	1.202	0.294	0.301	0.271
2027	1,208	0.117	1	1,121	0.911	1.215	0.297	0.303	0.273
2028	1,212	0.117	1	1,131	0.920	1.226	0.299	0.306	0.275

Table 5. Results of the MSY projection for Gulf of Mexico Scamp **assuming predicted recruitment from the spawner-recruit curve**. Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{MSY} = 0.127$, $SSB_{MSY} = 1,138$ metric tons, and $MSST_{MSY} = 853$ metric tons which was calculated as $(0.75) * SSB_{MSY}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. OY was calculated as $0.9 * MSY$.

Year	Recr	F	F/ F_{MSY}	SSB	SSB/ SSB_{MSY}	SSB/ $MSST$	SSB ratio	OFL	OY
2023	1,192	0.127	1	1,069	0.940	1.253	0.283	0.317	0.285
2024	1,193	0.127	1	1,071	0.942	1.256	0.283	0.317	0.285
2025	1,195	0.127	1	1,077	0.947	1.263	0.285	0.317	0.285
2026	1,197	0.127	1	1,083	0.952	1.270	0.287	0.318	0.286
2027	1,198	0.127	1	1,088	0.957	1.276	0.288	0.319	0.287
2028	1,200	0.127	1	1,093	0.961	1.281	0.289	0.320	0.288

Table 6. Comparison of convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation) for the sensitivity run estimating recruitment deviations through 2020 for the SEDAR 68 OA Base Model for Gulf of Mexico Scamp.

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
SEDAR 68 OA Base	8,862.70	0.0003	244 (0)	13
Rec Devs Through 2020	8,859.96	0.0181	247 (0)	14

Table 7. Comparison of key estimates and derived quantities (note that steepness was fixed at 0.6935 in both runs) for the sensitivity run estimating recruitment deviations through 2020 for the SEDAR 68 OA Base Model for Gulf of Mexico Scamp. SSB is defined as male and female combined SSB in metric tons (mt), Recr = recruitment, LAmin = length at the minimum age (1 year), and Linf and K = von Bertalanffy asymptotic length and growth rate, respectively.

Description	sigmaR	ln(R0)	Virgin SSB (mt)	Virgin Recr (1,000s)	LAmin	Linf	K
SEDAR 68 OA Base	0.562	7.33	3,779	1,526	24.695	77.289	0.073
Rec Devs Through 2020	0.572	7.33	3,770	1,526	24.628	77.262	0.073

Table 8. Results of the OFL projection (fishing set at $F_{40\%SPR}$) for Gulf of Mexico Scamp **assuming recent mean recruitment (2008-2017)**. Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. OY was calculated as $0.9 * MSY_{proxy}$ with a proxy of 40% SPR.

Year	Recr	F	F/F40%SPR	SSB	SSB/SSB40%SPR	SSB/MSST	SSB ratio	OFL	OY
2023	900	0.117	1	1,076	0.877	1.169	0.285	0.286	0.257
2024	900	0.117	1	1,027	0.837	1.116	0.272	0.276	0.248
2025	900	0.117	1	991	0.808	1.077	0.263	0.267	0.241
2026	900	0.117	1	966	0.787	1.050	0.256	0.261	0.235
2027	900	0.117	1	949	0.773	1.031	0.252	0.256	0.231
2028	900	0.117	1	936	0.762	1.016	0.248	0.253	0.228

Table 9. Settings used for Gulf of Mexico Scamp projections starting in 2024.

Parameter	Value	Comment
Relative F	Average from 2018-2020	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	Average from 2018-2020	Fleet specific selectivity estimated over terminal three years of model
Retention	Average from 2018-2020	Fleet specific retention estimated over terminal three years of model
Recruitment (benchmarks)	Beverton-Holt stock-recruitment relationship	Derived from the model estimated Beverton-Holt stock-recruitment relationship
Recruitment (catch advice)	Average from 2008-2017	Average recruitment over the last ten years where estimated
Interim Landings (2021-2023)	29.14/27.98 mt (Commercial Vertical Line); 30.13/27.02 mt (Commercial Longline); 96.07/75.24 thousands of fish (Recreational Charter Private); 3.13/2.46 thousands of fish (Recreational Headboat)	Landings provided for 2021; For 2022 and 2023 used 3-year average of landings (2019-2021)
Allocation Ratio	None	

Table 10. Results of the OFL projection (fishing set at $F_{40\%SPR}$) for Gulf of Mexico Scamp assuming recent mean recruitment (2008-2017) and starting projections in 2024.

Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. OY was calculated as $0.9 * MSY_{proxy}$ with a proxy of 40% SPR.

Year	Recr	F	F/ $F_{40\%SPR}$	SSB	SSB/ $SSB_{40\%SPR}$	SSB/ $MSST$	SSB ratio	OFL	OY
2024	900	0.117	1	977	0.796	1.061	0.259	0.262	0.236
2025	900	0.117	1	947	0.772	1.029	0.251	0.256	0.230
2026	900	0.117	1	929	0.757	1.009	0.246	0.251	0.226
2027	900	0.117	1	917	0.747	0.997	0.243	0.248	0.223
2028	900	0.117	1	909	0.741	0.988	0.241	0.246	0.221

Table 11. Settings used for Gulf of Mexico Scamp projections starting in 2024 and with updated charter-private landings in 2021.

Parameter	Value	Comment
Relative F	Average from 2018-2020	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	Average from 2018-2020	Fleet specific selectivity estimated over terminal three years of model
Retention	Average from 2018-2020	Fleet specific retention estimated over terminal three years of model
Recruitment (benchmarks)	Beverton-Holt stock-recruitment relationship	Derived from the model estimated Beverton-Holt stock-recruitment relationship
Recruitment (catch advice)	Average from 2008-2017	Average recruitment over the last ten years where estimated
Interim Landings (2021-2023)	29.14/27.98 mt (Commercial Vertical Line); 30.13/27.02 mt (Commercial Longline); 83.6/71.08 thousands of fish (Recreational Charter Private); 3.13/2.46 thousands of fish (Recreational Headboat)	Landings provided for 2021; For 2022 and 2023 used 3-year average of landings (2019-2021)
Allocation Ratio	None	

Table 12. Results of the OFL projection (fishing set at $F_{40\%SPR}$) for Gulf of Mexico Scamp assuming recent mean recruitment (2008-2017), starting projections in 2024, and using the updated 2021 charter-private landings. Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and OFL is the overfishing limit in millions of pounds gutted weight. Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons. OY was calculated as $0.9 * MSY_{proxy}$ with a proxy of 40% SPR.

Year	Recr	F	F/ $F_{40\%SPR}$	SSB	SSB/ $SSB_{40\%SPR}$	SSB/ $MSST$	SSB ratio	OFL	OY
2024	900	0.117	1	1,009	0.822	1.096	0.268	0.271	0.244
2025	900	0.117	1	974	0.794	1.059	0.258	0.263	0.237
2026	900	0.117	1	952	0.776	1.034	0.252	0.257	0.232
2027	900	0.117	1	936	0.763	1.017	0.248	0.253	0.228
2028	900	0.117	1	925	0.754	1.005	0.245	0.250	0.225

Table 13. Results of the ABC projection (fishing set at 75% of $F_{40\%SPR}$) for Gulf of Mexico Scamp assuming recent mean recruitment (2008-2017), starting projections in 2024, and using the updated 2021 charter-private landings. Recruitment (Recr) is in 1,000s of age-0 fish, F is a harvest rate (total biomass killed all ages / total biomass age 3+), SSB is in metric tons (male and female combined SSB), and the yield is in millions of pounds gutted weight. Reference points include $F_{40\%SPR} = 0.117$, $SSB_{F40\%SPR} = 1,230$ metric tons, and $MSST_{F40\%SPR} = 923$ metric tons which was calculated as $(0.75) * SSB_{F40\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where $SSB_0 = 3,779$ metric tons.

Year	Recr	F	F/ $F_{40\%SPR}$	SSB	SSB/ $SSB_{40\%SPR}$	SSB/ $MSST$	SSB ratio	Yield
2024	900	0.088	0.75	1,009	0.822	1.096	0.268	0.203
2025	900	0.088	0.75	1,002	0.817	1.089	0.266	0.203
2026	900	0.088	0.75	1,004	0.818	1.091	0.266	0.203
2027	900	0.088	0.75	1,009	0.822	1.096	0.268	0.204
2028	900	0.088	0.75	1,015	0.827	1.103	0.269	0.205

8. Figures

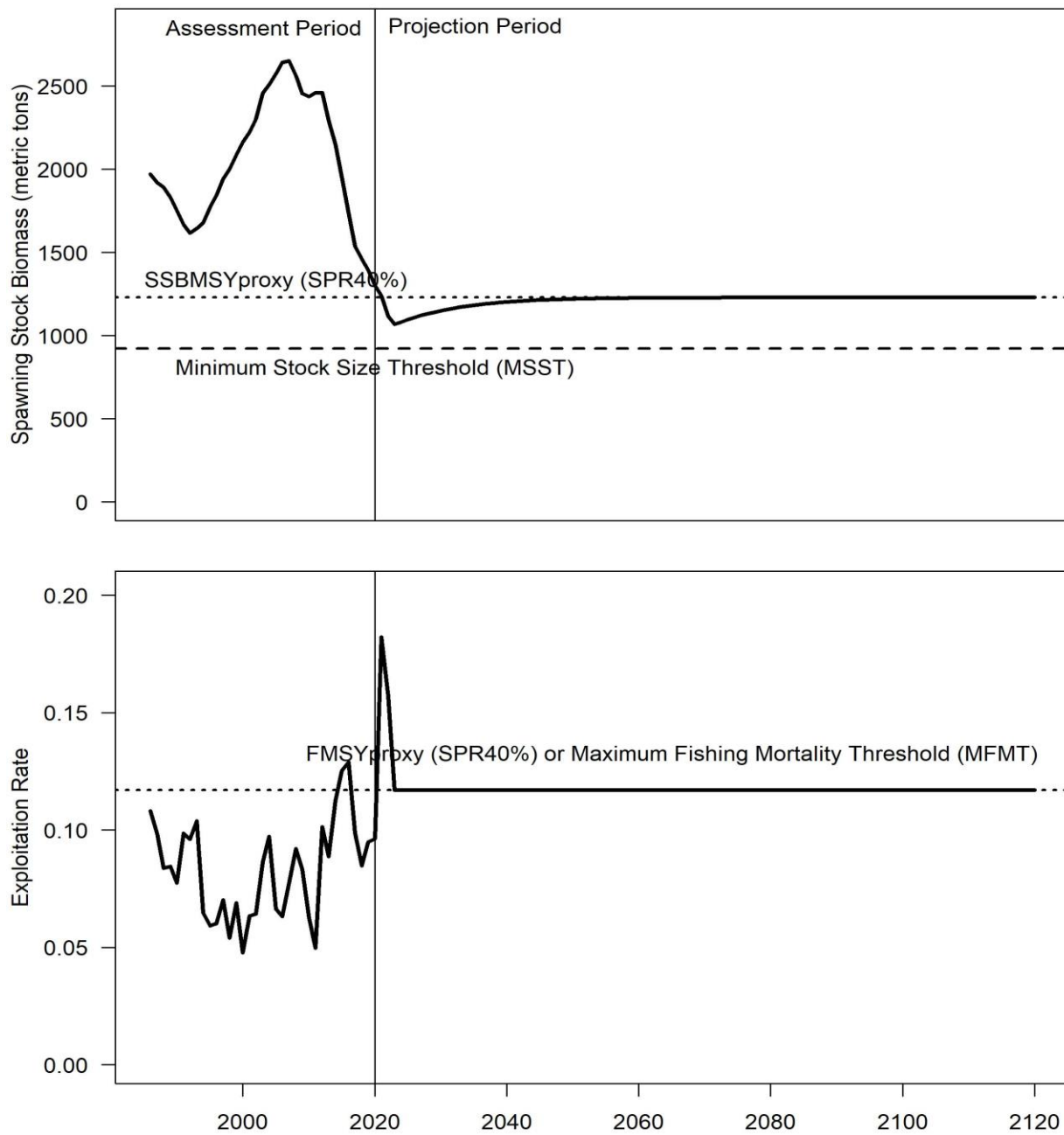


Figure 1. Time series of SSB (male and female combined SSB) and exploitation rate (total biomass killed all ages / total biomass age 3+) with respect to status determination criteria for the SEDAR 68 Gulf of Mexico Scamp Operational Assessment. Results are shown for an MSY_{proxy} of 40% SPR.

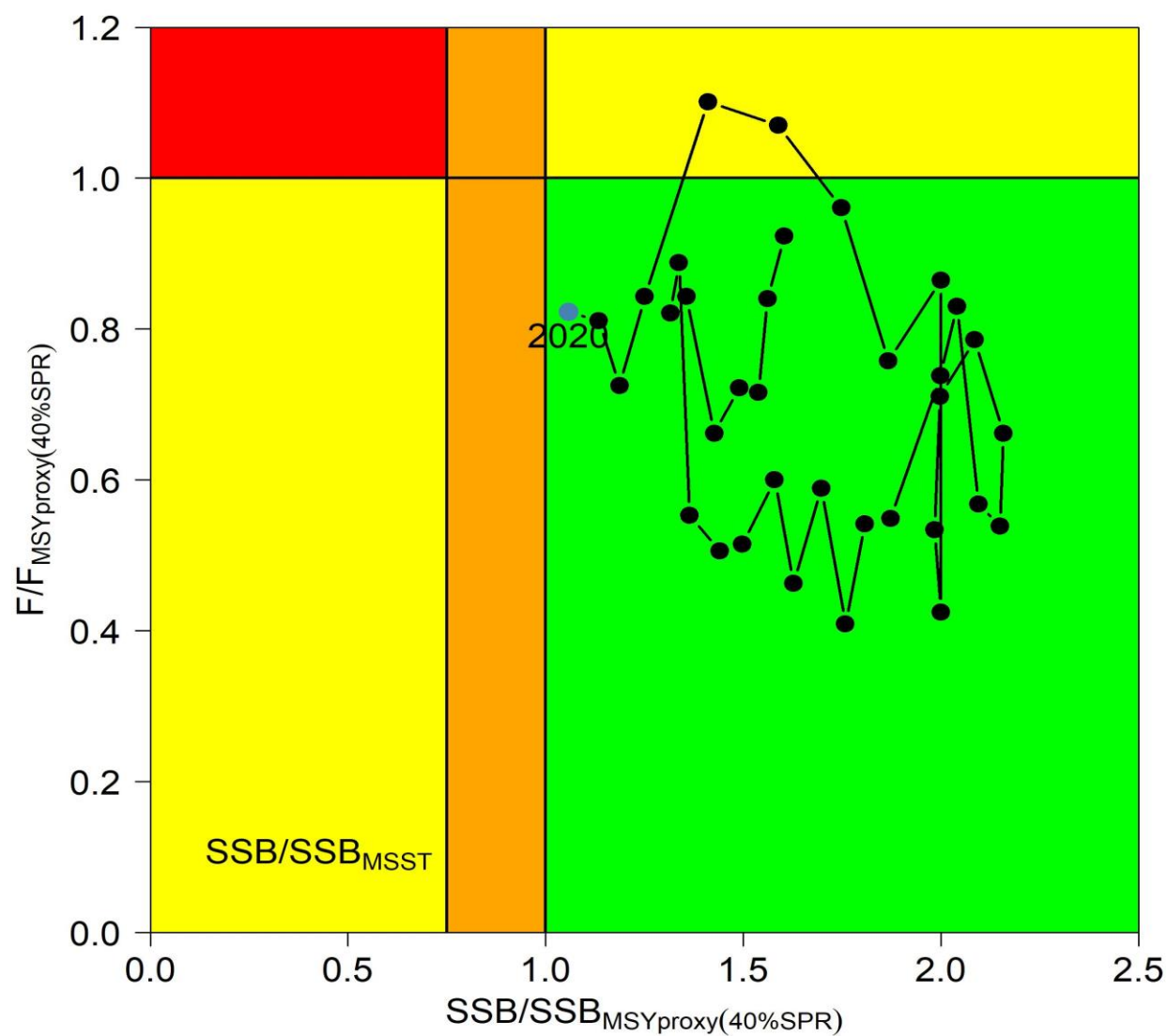


Figure 2. Kobe plot illustrating the trajectory of stock status for Gulf of Mexico Scamp. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold ($MSST = 0.75 \times SSB_{40\%SPR}$). The 2020 terminal year stock status is indicated by the gray dot. See **Table 3** for values. SSB defined as male and female combined SSB. Results are shown for an MSY_{proxy} of 40% SPR.

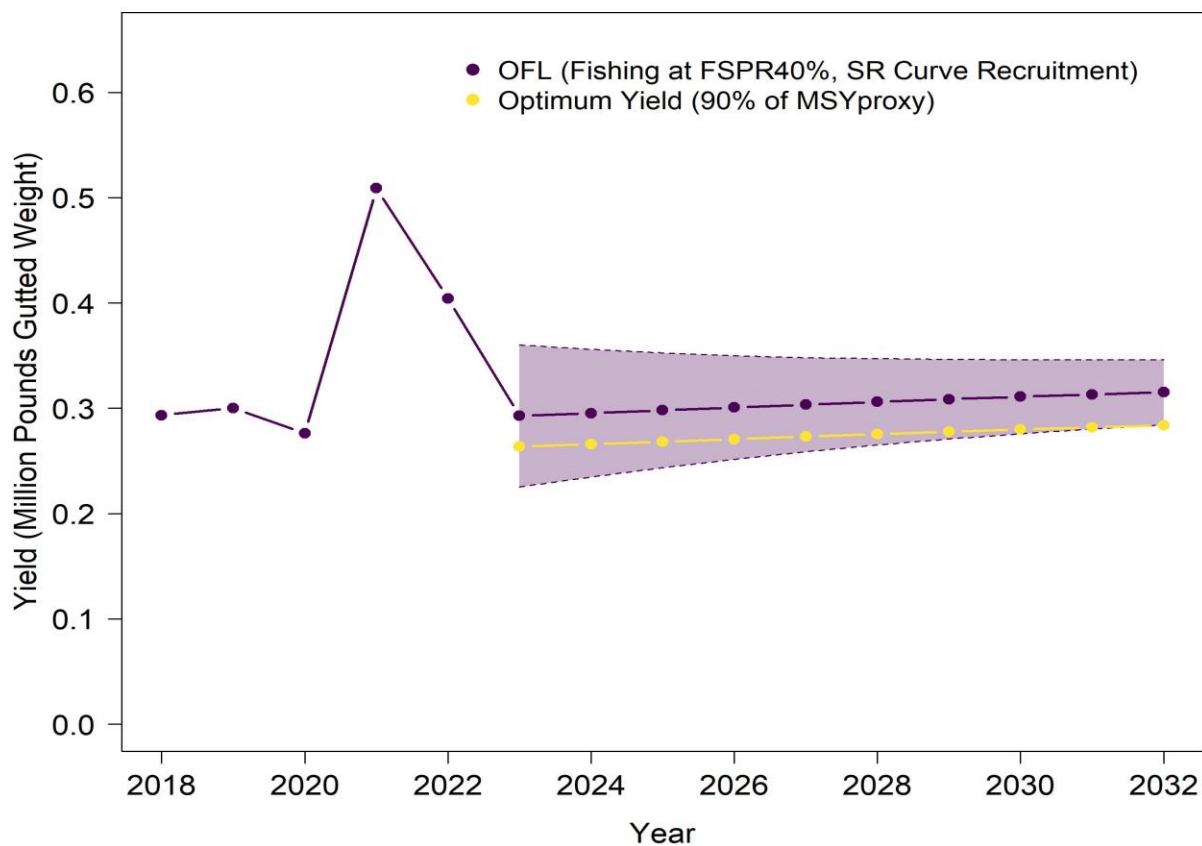


Figure 3. Historic (2018-2020), interim (2021-2022) and forecasted yields (2023+) for the OFL projection for Gulf of Mexico Scamp with recruitment predicted by the spawner-recruit curve. Results are shown for an MSY_{proxy} of 40% SPR.

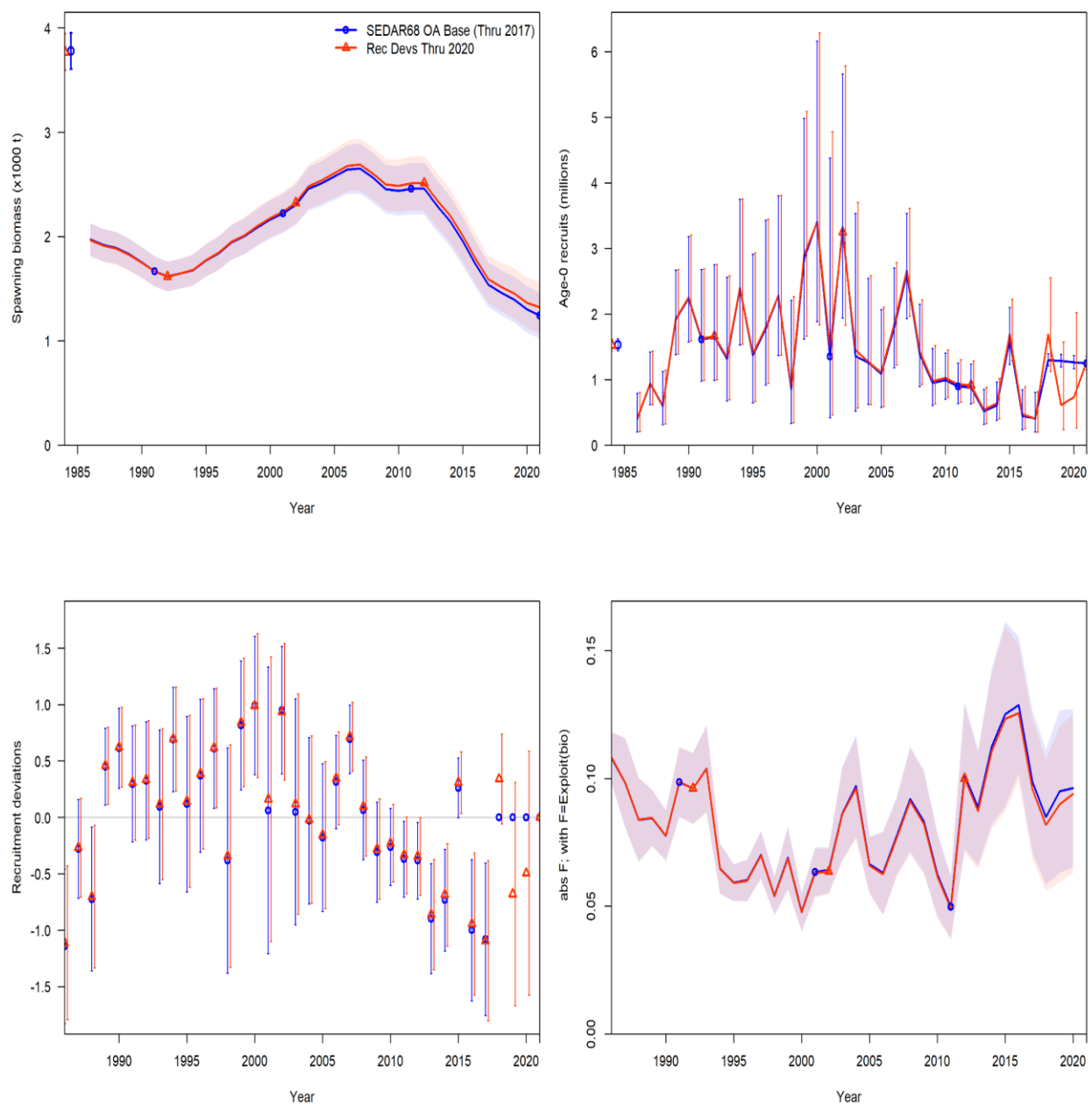


Figure 4. Estimates of spawning stock biomass (male and female combined SSB in 1,000s of metric tons; top left panel), recruitment (millions of fish; top right panel), recruitment deviations (bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 3+; bottom right panel) for the sensitivity run estimating recruitment deviations through 2020 conducted for the SEDAR 68 OA Base Model for Gulf of Mexico Scamp. This sensitivity run was used for final OFL projections for Gulf of Mexico Scamp.

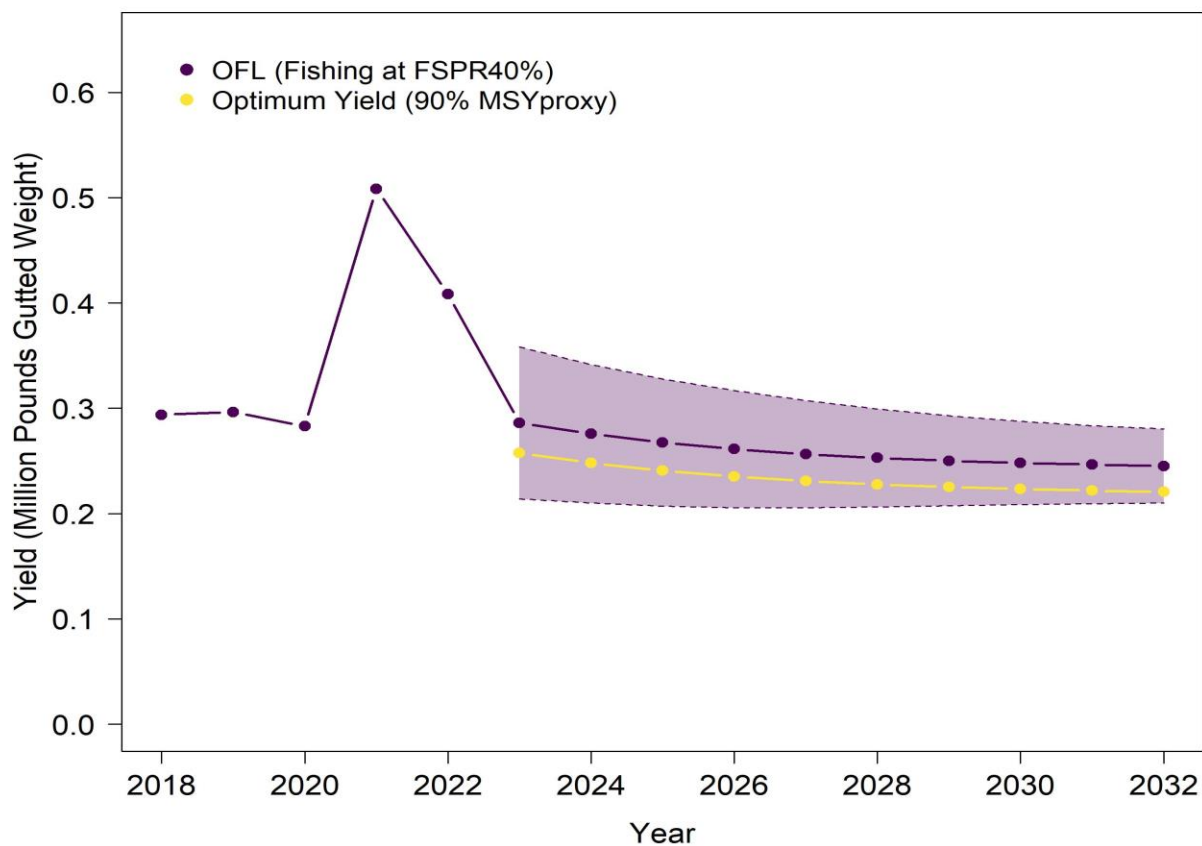


Figure 5. Historic (2018-2020), interim (2021-2022) and forecasted yields (2023+) for the OFL projection for Gulf of Mexico Scamp with recent mean recruitment assumed. Recent mean recruitment was from the last 10 years (2008-2017) where recruitment was estimated. Results are shown for an MSY_{proxy} of 40% SPR.

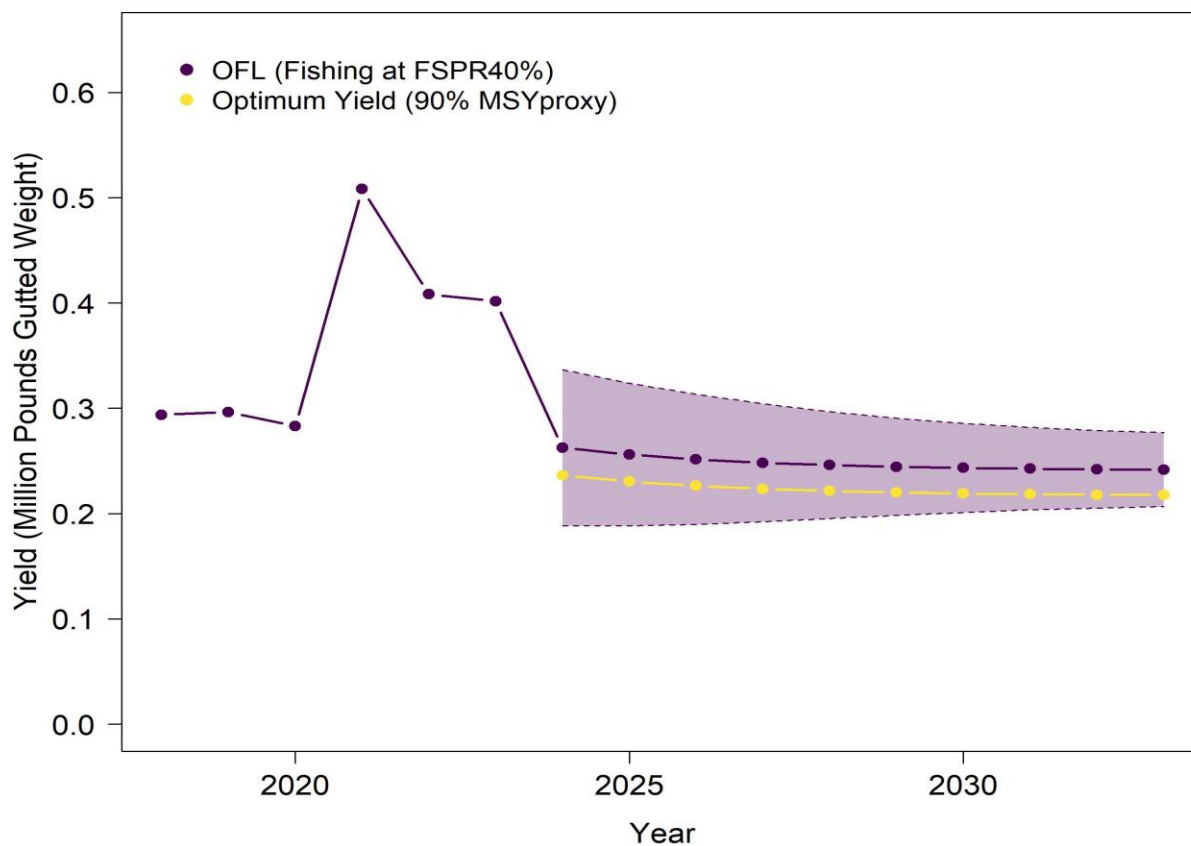


Figure 6. Historic (2018-2020), interim (2021-2023) and forecasted yields (2024+) for the OFL projection for Gulf of Mexico Scamp with recent mean recruitment assumed and starting projections in 2024. Recent mean recruitment was from the last 10 years (2008-2017) where recruitment was estimated. Results are shown for an MSY_{proxy} of 40% SPR.

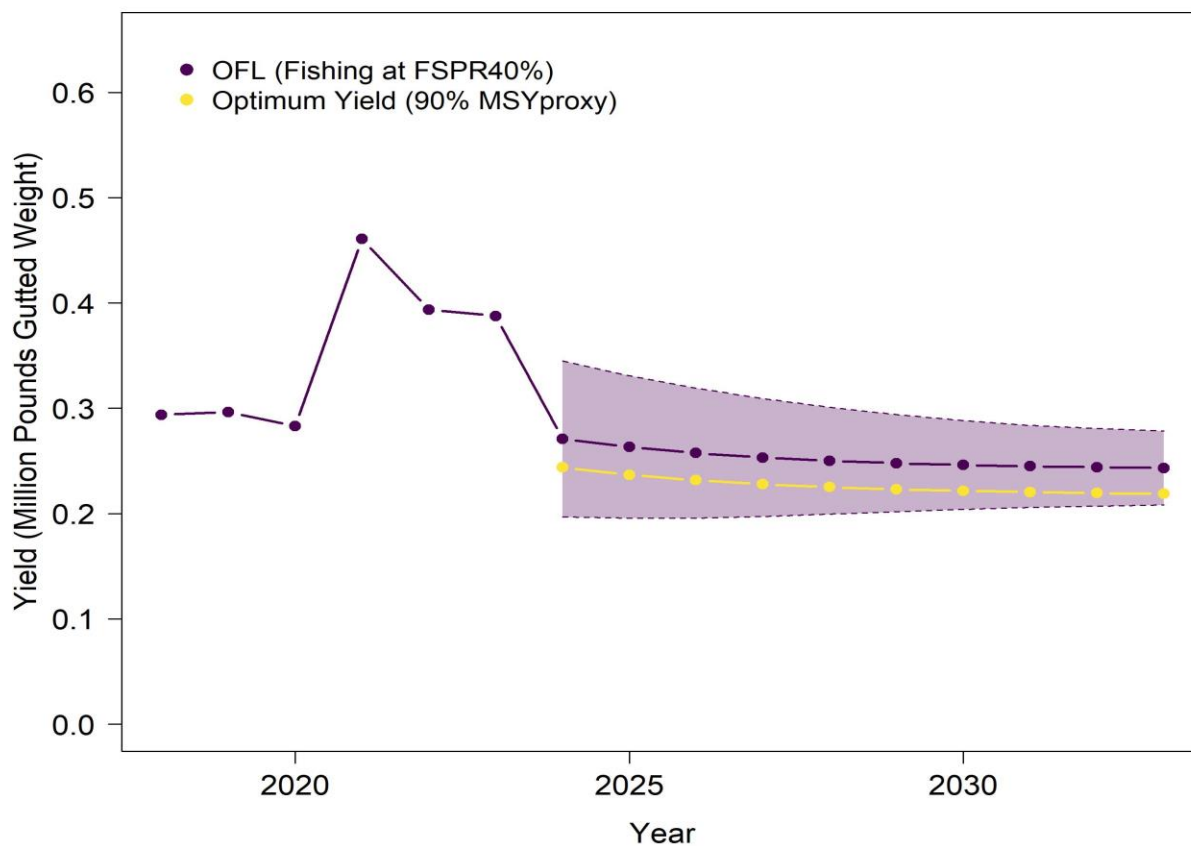


Figure 7. Historic (2018-2020), interim (2021-2023) and forecasted yields (2024+) for the OFL projection for Gulf of Mexico Scamp with recent mean recruitment assumed, starting projections in 2024, and with updated 2021 charter-private landings. Recent mean recruitment was from the last 10 years (2008-2017) where recruitment was estimated. Results are shown for an MSY_{proxy} of 40% SPR.

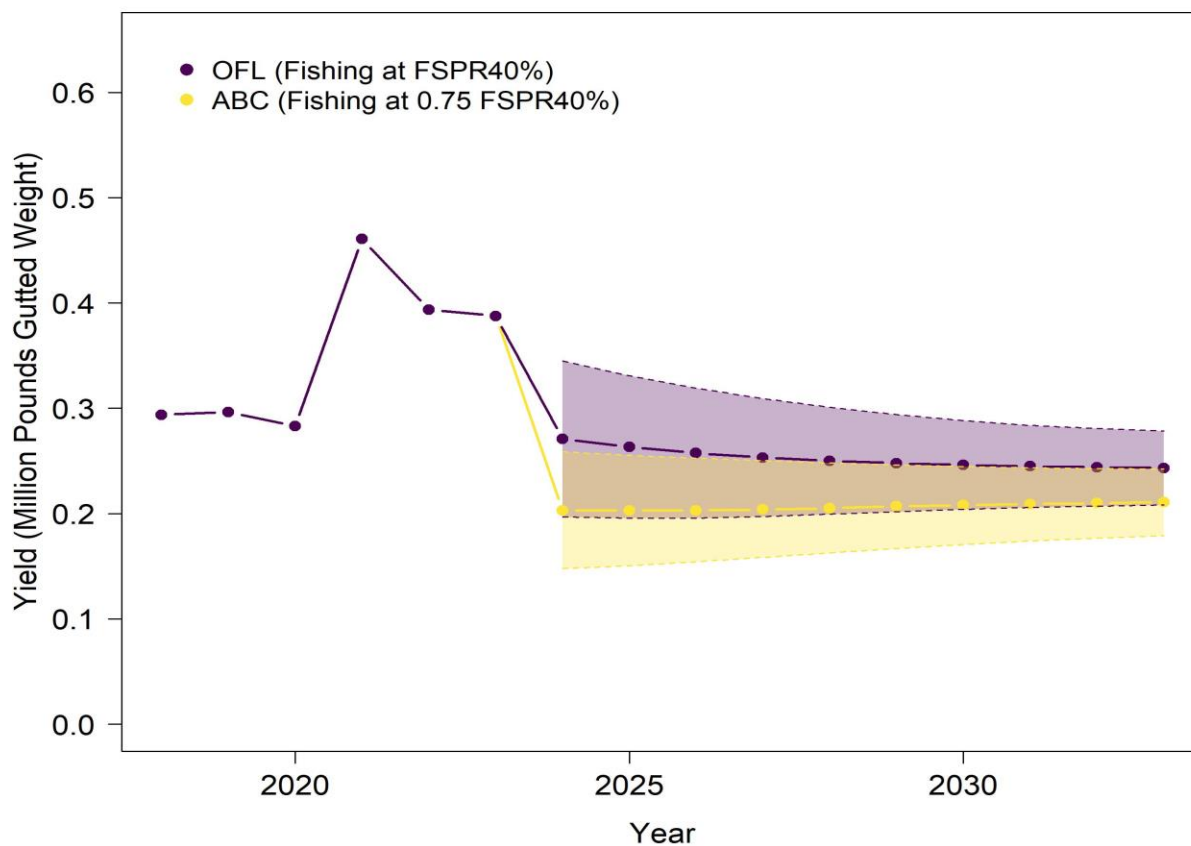


Figure 8. Historic (2018-2020), interim (2021-2023) and forecasted yields (2024+) for the OFL and ABC projections for Gulf of Mexico Scamp with recent mean recruitment assumed, starting projections in 2024, and with updated 2021 charter-private landings. Recent mean recruitment was from the last 10 years (2008-2017) where recruitment was estimated. Results are shown for an MSY_{proxy} of 40% SPR, with the ABC defined as 75% of $F_{40\%SPR}$.