SEDAR 70, Gulf of Mexico Greater Amberjack projections
for the November 2021 GMFMC SSC meeting
November 18th, 2021
SEFSC, Sustainable Fisheries Division, Gulf Fisheries Branch

At the September 2021 SSC meeting, the SSC passed a motion "to continue with the 30% SPR reference point rebuilding projections using the spawner curve recruitments and ABC based on the low recruitment scenario for greater amberjack." After clarifying at the meeting, the SEFSC understood that the SSC was requesting the benchmarks (Fspr30 and SSBspr30) be calculated using the spawner recruit curve, but the projections should use the recent (lower than average) recruitments (2009-2018) to forecast catch and rebuilding progress. Council staff also asked for our presentation, demonstrating the effects of both the corrections to the projections provided in January 2021, and the new code that improves our ability to incorporate allocations. Section I. of this report responds to Council staff, and Section II. provides the analytical products requested as a result of the SSC's motion.

Section I.

At the January SSC meeting, we presented some updated projections that had two key misspecifications: $SSB_{30\%}$ was used instead of $SPR_{30\%}$ as a proxy, and the long-term average of recruitment was used for both benchmarks and projections instead of the recent estimated mean. To show the effect of correcting each misspecification, we've provided stepwise projections in Tables 1-4 and Figure 1. The orange line in Figure 1 and Table 1 indicate the base run as presented in January that uses the $SSB_{30\%}$ proxy and the long-term average recruitment. Each correction is then documented in the next two runs. First, the grey line in Figure 1 and Table 2 show the projections using the recent recruitment (2009-2018) to inform benchmarks and the projection period. Second, the dark blue line in Figure 1 and Table 3 show the projections using the $SPR_{30\%}$ proxy. Finally, Table 4 and the yellow line in Figure 1 show the projections that should have been shown to the SSC (called Sept. base run), based on our stated specifications. The stock status and the change in other key quantities are shown in Table 5. With the change in the benchmarks that occurs when a lower recruitment is assumed, the stock is no longer below MSST though overfishing is still occurring.

The other key change was the new code the SEFSC used to run projections that improved on the projection capabilities in SS (see presentation by Nathan Vaughan, Vaughan Analytics). The light blue line in Figure 1, which almost entirely overlaps the yellow line of the Sept. base run, illustrates the effect of the code alone. The Sept. base run with the new code results are shown in Table 6.

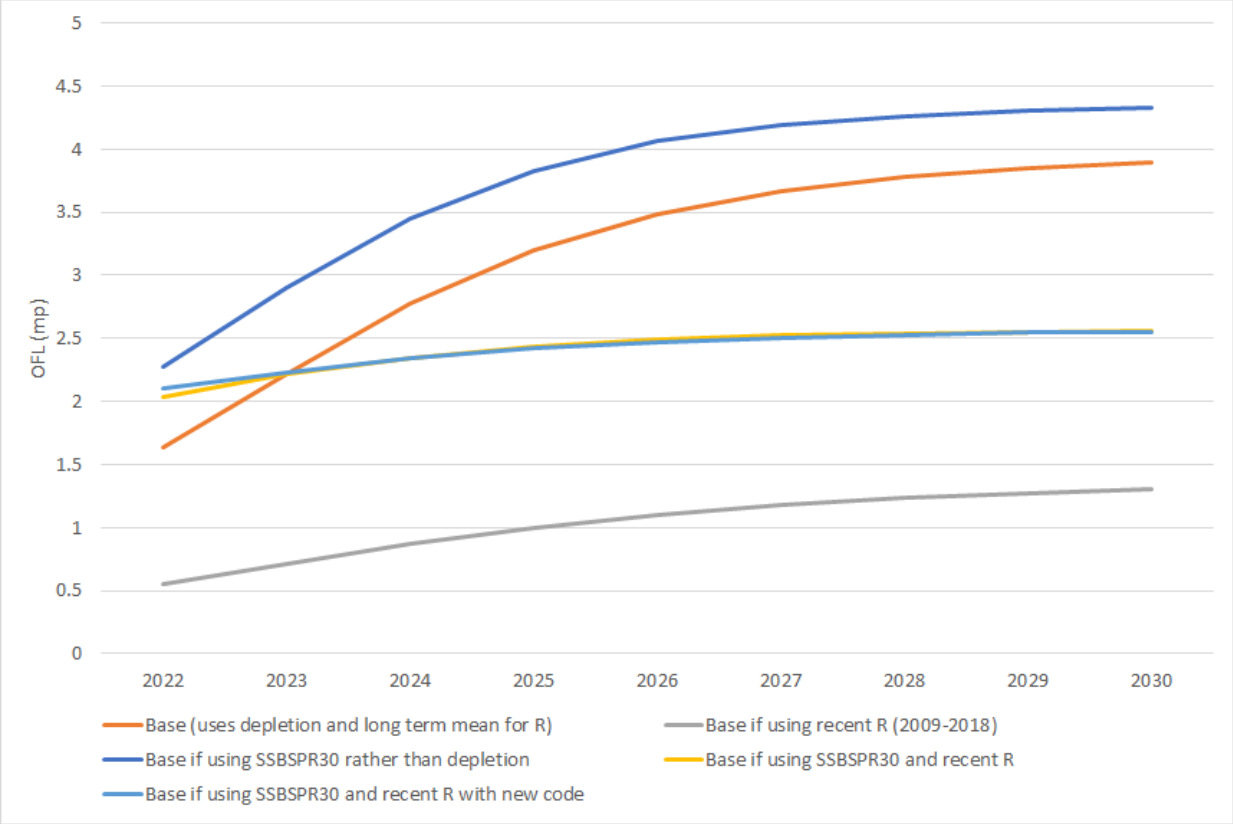

Figure 1. The progression of projection results as corrections are made and new code is used for the SEDAR 70, Gulf of Mexico Greater Amberjack. "Base (uses depletion and long term mean for R) indicates the projection results shown to the SSC in January 2021. "Base if using recent R" shows the former "Base" run with the recent recruits used to inform both the benchmark calculations and the projection period. The "Base if using SSBSPR30 rather than depletion" shows the effect of using SPR30% as the MSY proxy. "Base using SSBSPR30 and recent R" shows the projections of the base model with both corrections to the specifications. "Base if using SSBSPR30 and recent R with new code" uses the Vaughan Analytics code on the "Base using SSBSPR30 and recent R" projections.

Table 1. The projection results shown to the SSC in January 2021. The projection uses $SSB_{30\%}$ as the MSY proxy and calculates benchmarks and projects using the long term mean of recruits. Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Yr	R	F	F_FSSB30	SSB	SSB_SSB30	SSB_MSSTSSB30	SSB_SSB0	OFL_mp
2022	2805.57	0.15	0.87	2755	0.39	0.77	0.12	1.636
2023	2805.57	0.16	0.93	3635	0.51	1.02	0.15	2.221
2024	2805.57	0.17	0.97	4549	0.64	1.28	0.19	2.776
2025	2805.57	0.18	0.99	5314	0.75	1.49	0.22	3.199
2026	2805.57	0.18	1.00	5893	0.83	1.66	0.25	3.485
2027	2805.57	0.18	1.01	6305	0.89	1.77	0.27	3.669
2028	2805.57	0.18	1.01	6590	0.93	1.85	0.28	3.783
2029	2805.57	0.18	1.00	6789	0.95	1.91	0.29	3.854
2030	2805.57	0.18	1.00	6915	0.97	1.94	0.29	3.898

Table 2. Sept. Base with recent recruitment (2009-2018). This run modified the run in Table 1 by using the recent recruitment to inform both the benchmark calculations and the projection period. Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Yr	R	F	F_FSSB30	SSB	SSB_SSB30	SSB_MSSTSSB30	SSB_SSB0	OFL_mp
2022	1650.66	0.06	0.93	2471	0.35	0.69	0.10	0.553
2023	1650.66	0.07	0.97	3204	0.45	0.90	0.14	0.717
2024	1650.66	0.07	0.99	3949	0.56	1.11	0.17	0.87
2025	1650.66	0.07	1.01	4619	0.65	1.30	0.20	1.001
2026	1650.66	0.07	1.02	5196	0.73	1.46	0.22	1.103
2027	1650.66	0.07	1.02	5672	0.80	1.59	0.24	1.18
2028	1650.66	0.07	1.01	6060	0.85	1.70	0.26	1.236
2029	1650.66	0.07	1.01	6350	0.89	1.78	0.27	1.276
2030	1650.66	0.07	1.01	6566	0.92	1.85	0.28	1.305

Table 3. Sept. Base if using $SSB_{SPR30\%}$. This run modified the run in Table 1 by using $SPR_{30\%}$ as the MSY proxy. Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	OFL_mp
2022	2805.57	0.22	0.89	2755	0.51	1.02	0.12	2.277
2023	2805.57	0.23	0.94	3405	0.63	1.26	0.14	2.902
2024	2805.57	0.24	0.97	4047	0.75	1.50	0.17	3.455
2025	2805.57	0.24	0.99	4535	0.84	1.68	0.19	3.832
2026	2805.57	0.24	1.00	4867	0.90	1.80	0.21	4.061
2027	2805.57	0.24	1.00	5078	0.94	1.88	0.21	4.191
2028	2805.57	0.24	1.00	5210	0.97	1.93	0.22	4.264
2029	2805.57	0.24	1.00	5293	0.98	1.96	0.22	4.304
2030	2805.57	0.24	1.00	5341	0.99	1.98	0.23	4.327

Table 4. Sept. Base using $SPR_{30\%}$ and recent recruitment. This run corrects the run in Table 1 to use both the recent recruitment as well as $SPR_{30\%}$ as the MSY proxy. Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	OFL_mp
2022	1650.66	0.23	0.97	2471	0.78	1.56	0.10	2.031
2023	1650.66	0.24	0.98	2677	0.84	1.68	0.11	2.215
2024	1650.66	0.24	0.99	2847	0.90	1.79	0.12	2.347
2025	1650.66	0.24	1.00	2964	0.93	1.87	0.13	2.435
2026	1650.66	0.24	1.00	3045	0.96	1.92	0.13	2.489
2027	1650.66	0.24	1.00	3098	0.98	1.95	0.13	2.521
2028	1650.66	0.24	1.00	3133	0.99	1.97	0.13	2.539
2029	1650.66	0.24	1.00	3152	0.99	1.98	0.13	2.549
2030	1650.66	0.24	1.00	3164	1.00	1.99	0.13	2.555

Table 5. The MSRA table for the Sept. Base run (see also Table 4).

Variable	**Definition**	**Value**
Base M	Fully selected ages of Lorenzen Natural Mortality (M)	0.28
Steepness	Fixed Stock-Recruit (SR) parameter	0.777
Virgin Recruitment	Estimated SR parameter	3,698
Generation Time	Fecundity-weighted mean age	7.59
SSB Unfished	Estimated virgin spawning stock biomass	23,733
	Mortality Rate Criteria	
FMSYproxy	Equilibrium F that achieves SPR30%	0.242
MFMT	Equilibrium F that achieves SPR30%	0.242
FOY	F that rebuilds the stock to SSBSPR30% by 2027	
Fcurrent	0.75 * Directed F at FSPR30%	0.302
Fcurrent/FMSYproxy	Geometric Mean (F2016-2018)=Fcurrent	1.25
Fcurrent/MFMT	Current stock status based on FMSYproxy	1.25
	Current stock status based on MFMT	
	Biomass Criteria	
SSBMSYproxy	Equilibrium SSB at FSPR30%	3,179
MSST	0.5*SSBSPR30%	1,589
SSB at Optimum Yield	Equilibrium SSB when Directed F = 0.75 * Directed F at FSPR30%	
SSB_2018	SSB2018	2,433
SSB_2018/SSBFMSYproxy	Current stock status based on SSBSPR30% (Equil)	0.77
SSB_2018/MSST	Current stock status based on MSSTSPR30%	1.53
SSB_2018/SSBunfished	Depletion	0.1

Table 6. Sept. Base using the new code from Vaughan Analytics. Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	OFL_mp
2022	1650.66	0.24	1.00	2471	0.78	1.56	0.10	2.102
2023	1650.66	0.24	1.00	2652	0.83	1.67	0.11	2.235
2024	1650.66	0.24	1.00	2813	0.89	1.77	0.12	2.342
2025	1650.66	0.24	1.00	2931	0.92	1.84	0.12	2.418
2026	1650.66	0.24	1.00	3017	0.95	1.90	0.13	2.471
2027	1650.66	0.24	1.00	3079	0.97	1.94	0.13	2.507
2028	1650.66	0.24	1.00	3121	0.98	1.96	0.13	2.531
2029	1650.66	0.24	1.00	3146	0.99	1.98	0.13	2.544
2030	1650.66	0.24	1.00	3160	0.99	1.99	0.13	2.552

Section II.

This section addresses the new projections requested by the SSC at their September, 2021 meeting. The SSC asked for the following specs to remain unchanged from the SEDAR 70 specifications: Relative F, $F_{current}$, Selectivity, Retention, landings, and allocation ratios. The landings were updated at the January SSC meeting, and it's important to clarify those settings here. The landings assumptions going into the January SSC meeting can be found in Table 7, and the new assumptions requested by the January SSC can be found in Table 8. The two main differences are that the 2019 year was actual landings queried after the end of the assessment phase of SEDAR 70, and that management was assumed to start in 2022 rather than 2021.

Table 7. Settings used for the Gulf of Mexico Greater Amberjack projections going into the January 2021 SSC meeting.

Parameter	Value
2019 and 2020 Landings	158.11 mt (Commercial Vertical Line), 12.4635 mt (Commercial Longline), 44.9437 thousands of fish (Charter/Private), 1.3209 thousands of fish (Headboat)

Table 8. Settings used for Gulf of Mexico Greater Amberjack projections requested at the January 2021 SSC meeting.

Parameter	Value
2019 Landings	156.907 mt (Commercial Vertical Line), 14.51 mt (Commercial Longline), 22.979 thousands of fish (Charter/Private), 0.99 thousands of fish (Headboat)
2020 and 2021 Landings	184.01 mt (Commercial Vertical Line), 11.891 mt (Commercial Longline), 66.1150 thousands of fish (Charter/Private), 1.377 thousands of fish (Headboat)

In September 2021, the SSC finalized the specifications for the GAJ runs intended for use. They asked that $SPR_{30\%}$ be used as the MSY proxy and that the spawner-recruit curve be used to calculate recruitment for setting benchmarks, which is consistent with the projections used to set the rebuilding plan. The SSC also asked that the new projections use the recent low recruitment for the projection period, assuming low recruitment will continue in the short term. Using those specifications, the SSC asked that OFL, ABC and rebuilding projections be provided using the base run allocations as well as four other allocation scenarios:

- Using the years 1981-2004; 84% recreational: 16% commercial;
- Using the years 1993-2007; 78% recreational: 22% commercial;
- Using the years 1993-2019; 80% recreational: 20% commercial; and,
- Keeping the commercial annual catch limit fixed at 484,380 lbs whole weight, and calculate OFL, ABC, and sector allocation percentages thereafter.

Rebuilding is achieved when SSB reaches $SSB_{SPR30\%}$ by 2027, and ABC is the catch when fishing is at 75% of the $F_{SPR30\%}$. The four alternative scenarios are numbered in order of the bulleted list above in the tables and figures below (1-4). The new projections are indicated with the month they are provided, GAJ for the species, whether we used the base allocations or one of the allocation scenarios, and the catch advice acronym (e.g. Nov_GAJ_base_OFL). The base run allocation results are in Tables 9-11, allocation scenario 1 results are in Tables 12-14, allocation scenario 2 results are in Tables 15-17, allocation scenario 3 results are in Tables 18-20, and allocation scenario 4 results are in Tables 21-23. The OFL and rebuild scenarios for all allocations are illustrated in Figures 2 and 3. Status and other key quantities for the Nov_GAJ_base can be found in Table 24.

Table 9. Gulf of Mexico Greater Amberjack projection results for OFL using the base allocation percentages (73:27 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Nov_GAJ_base_OFL									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
2022	1650.66	0.24	1.00	2471	0.42	0.85	0.10	0.29	2.102
2023	1650.66	0.24	1.00	2652	0.45	0.91	0.11	0.30	2.236
2024	1650.66	0.24	1.00	2813	0.48	0.96	0.12	0.30	2.343
2025	1650.66	0.24	1.00	2930	0.50	1.00	0.12	0.30	2.419
2026	1650.66	0.24	1.00	3017	0.52	1.03	0.13	0.30	2.472
2027	1650.66	0.24	1.00	3078	0.53	1.05	0.13	0.30	2.507
2028	1650.66	0.24	1.00	3121	0.53	1.07	0.13	0.30	2.531
2029	1650.66	0.24	1.00	3145	0.54	1.08	0.13	0.30	2.544
2030	1650.66	0.24	1.00	3160	0.54	1.08	0.13	0.30	2.552

Table 10. Gulf of Mexico Greater Amberjack projection results for ABC using the base allocation percentages (73:27 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_base_ABC									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.18	0.75	2471	0.42	0.85	0.10	0.37	1.583
2023	1650.66	0.18	0.75	2836	0.49	0.97	0.12	0.38	1.779
2024	1650.66	0.18	0.75	3174	0.54	1.09	0.13	0.38	1.945
2025	1650.66	0.18	0.75	3444	0.59	1.18	0.15	0.39	2.072
2026	1650.66	0.18	0.75	3655	0.63	1.25	0.15	0.39	2.166
2027	1650.66	0.18	0.75	3810	0.65	1.31	0.16	0.39	2.233
2028	1650.66	0.18	0.75	3923	0.67	1.34	0.17	0.39	2.279
2029	1650.66	0.18	0.75	3996	0.68	1.37	0.17	0.39	2.309
2030	1650.66	0.18	0.75	4042	0.69	1.38	0.17	0.39	2.327

Table 11. Gulf of Mexico Greater Amberjack projection results for the rebuilding scenario using the base allocation percentages (73:27 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass

age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_base_Rebuild									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.06	0.24	2471	0.42	0.85	0.10	0.69	0.521
2023	1650.66	0.06	0.24	3216	0.55	1.10	0.14	0.70	0.649
2024	1650.66	0.06	0.24	3986	0.68	1.37	0.17	0.70	0.77
2025	1650.66	0.06	0.24	4693	0.80	1.61	0.20	0.71	0.875
2026	1650.66	0.06	0.24	5314	0.91	1.82	0.22	0.71	0.964
2027	1650.66	0.06	0.24	5837	1.00	2.00	0.25	0.71	1.035
2028	1650.66	0.24	1.00	6269	1.07	2.15	0.26	0.31	4.433
2029	1650.66	0.24	1.00	5341	0.91	1.83	0.23	0.31	3.831
2030	1650.66	0.24	1.00	4614	0.79	1.58	0.19	0.30	3.381

Table 12. Gulf of Mexico Greater Amberjack projection results for OFL using allocation scenario 1 (84:16 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Nov_GAJ_allocation_1_OFL									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
2022	1650.66	0.24	1.00	2471	0.42	0.85	0.10	0.29	1.996
2023	1650.66	0.24	1.00	2663	0.46	0.91	0.11	0.30	2.13
2024	1650.66	0.24	1.00	2827	0.48	0.97	0.12	0.30	2.234
2025	1650.66	0.24	1.00	2943	0.50	1.01	0.12	0.30	2.305
2026	1650.66	0.24	1.00	3027	0.52	1.04	0.13	0.30	2.354
2027	1650.66	0.24	1.00	3085	0.53	1.06	0.13	0.30	2.387
2028	1650.66	0.24	1.00	3126	0.54	1.07	0.13	0.30	2.408
2029	1650.66	0.24	1.00	3149	0.54	1.08	0.13	0.30	2.42
2030	1650.66	0.24	1.00	3162	0.54	1.08	0.13	0.30	2.427

Table 13. Gulf of Mexico Greater Amberjack projection results for ABC using allocation scenario 1 (84:16 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_1_ABC									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.18	0.75	2471	0.42	0.85	0.10	0.38	1.503
2023	1650.66	0.18	0.75	2845	0.49	0.97	0.12	0.38	1.695
2024	1650.66	0.18	0.75	3186	0.55	1.09	0.13	0.39	1.857
2025	1650.66	0.18	0.75	3456	0.59	1.18	0.15	0.39	1.979
2026	1650.66	0.18	0.75	3664	0.63	1.26	0.15	0.39	2.069
2027	1650.66	0.18	0.75	3818	0.65	1.31	0.16	0.39	2.133
2028	1650.66	0.18	0.75	3930	0.67	1.35	0.17	0.39	2.177
2029	1650.66	0.18	0.75	4001	0.69	1.37	0.17	0.39	2.205
2030	1650.66	0.18	0.75	4046	0.69	1.39	0.17	0.39	2.223

Table 14. Gulf of Mexico Greater Amberjack projection results for the rebuilding scenario using allocation scenario 1 (84:16 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_1_Rebuild									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.06	0.24	2471	0.42	0.85	0.10	0.69	0.497
2023	1650.66	0.06	0.24	3218	0.55	1.10	0.14	0.70	0.621
2024	1650.66	0.06	0.24	3988	0.68	1.37	0.17	0.71	0.739
2025	1650.66	0.06	0.24	4695	0.80	1.61	0.20	0.71	0.842
2026	1650.66	0.06	0.24	5315	0.91	1.82	0.22	0.71	0.929
2027	1650.66	0.06	0.24	5836	1.00	2.00	0.25	0.71	0.999
2028	1650.66	0.24	1.00	6268	1.07	2.15	0.26	0.31	4.257
2029	1650.66	0.24	1.00	5357	0.92	1.84	0.23	0.31	3.68
2030	1650.66	0.24	1.00	4634	0.79	1.59	0.20	0.30	3.243

Table 15. Gulf of Mexico Greater Amberjack projection results for OFL using allocation scenario 2 (78:22 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Nov_GAJ_allocation_2_OFL									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
2022	1650.66	0.24	1.00	2471	0.42	0.85	0.10	0.29	2.052
2023	1650.66	0.24	1.00	2657	0.46	0.91	0.11	0.30	2.186
2024	1650.66	0.24	1.00	2819	0.48	0.97	0.12	0.30	2.292
2025	1650.66	0.24	1.00	2936	0.50	1.01	0.12	0.30	2.365
2026	1650.66	0.24	1.00	3022	0.52	1.04	0.13	0.30	2.417
2027	1650.66	0.24	1.00	3082	0.53	1.06	0.13	0.30	2.451
2028	1650.66	0.24	1.00	3123	0.53	1.07	0.13	0.30	2.473
2029	1650.66	0.24	1.00	3147	0.54	1.08	0.13	0.30	2.486
2030	1650.66	0.24	1.00	3161	0.54	1.08	0.13	0.30	2.494

Table 16. Gulf of Mexico Greater Amberjack projection results for ABC using allocation scenario 2 (78:22 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_2_ABC									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.18	0.75	2471	0.42	0.85	0.10	0.37	1.546
2023	1650.66	0.18	0.75	2840	0.49	0.97	0.12	0.38	1.74
2024	1650.66	0.18	0.75	3180	0.54	1.09	0.13	0.39	1.904
2025	1650.66	0.18	0.75	3450	0.59	1.18	0.15	0.39	2.029
2026	1650.66	0.18	0.75	3659	0.63	1.25	0.15	0.39	2.121
2027	1650.66	0.18	0.75	3814	0.65	1.31	0.16	0.39	2.186
2028	1650.66	0.18	0.75	3926	0.67	1.35	0.17	0.39	2.232
2029	1650.66	0.18	0.75	3998	0.68	1.37	0.17	0.39	2.26
2030	1650.66	0.18	0.75	4044	0.69	1.39	0.17	0.39	2.278

Table 17. Gulf of Mexico Greater Amberjack projection results for the rebuilding scenario using allocation scenario 2 (78:22 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_2_Rebuild									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.06	0.25	2471	0.42	0.85	0.10	0.69	0.509
2023	1650.66	0.06	0.25	3217	0.55	1.10	0.14	0.70	0.636
2024	1650.66	0.06	0.25	3987	0.68	1.37	0.17	0.70	0.756
2025	1650.66	0.06	0.25	4694	0.80	1.61	0.20	0.71	0.86
2026	1650.66	0.06	0.25	5314	0.91	1.82	0.22	0.71	0.947
2027	1650.66	0.06	0.25	5836	1.00	2.00	0.25	0.71	1.018
2028	1650.66	0.24	1.00	6269	1.07	2.15	0.26	0.31	4.351
2029	1650.66	0.24	1.00	5349	0.92	1.83	0.23	0.31	3.761
2030	1650.66	0.24	1.00	4624	0.79	1.58	0.20	0.30	3.317

Table 18. Gulf of Mexico Greater Amberjack projection results for OFL using allocation scenario 3 (80:20 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Nov_GAJ_allocation_3_OFL									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
2022	1650.66	0.24	1.00	2471	0.42	0.85	0.10	0.29	2.033
2023	1650.66	0.24	1.00	2659	0.46	0.91	0.11	0.30	2.167
2024	1650.66	0.24	1.00	2822	0.48	0.97	0.12	0.30	2.272
2025	1650.66	0.24	1.00	2939	0.50	1.01	0.12	0.30	2.345
2026	1650.66	0.24	1.00	3023	0.52	1.04	0.13	0.30	2.395
2027	1650.66	0.24	1.00	3083	0.53	1.06	0.13	0.30	2.429
2028	1650.66	0.24	1.00	3124	0.54	1.07	0.13	0.30	2.451
2029	1650.66	0.24	1.00	3148	0.54	1.08	0.13	0.30	2.464
2030	1650.66	0.24	1.00	3162	0.54	1.08	0.13	0.30	2.471

Table 19. Gulf of Mexico Greater Amberjack projection results for ABC using allocation scenario 3 (80:20 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_3_ABC									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.18	0.75	2471	0.42	0.85	0.10	0.37	1.531
2023	1650.66	0.18	0.75	2842	0.49	0.97	0.12	0.38	1.725
2024	1650.66	0.18	0.75	3182	0.55	1.09	0.13	0.39	1.888
2025	1650.66	0.18	0.75	3452	0.59	1.18	0.15	0.39	2.012
2026	1650.66	0.18	0.75	3661	0.63	1.25	0.15	0.39	2.103
2027	1650.66	0.18	0.75	3815	0.65	1.31	0.16	0.39	2.168
2028	1650.66	0.18	0.75	3928	0.67	1.35	0.17	0.39	2.213
2029	1650.66	0.18	0.75	3999	0.69	1.37	0.17	0.39	2.242
2030	1650.66	0.18	0.75	4045	0.69	1.39	0.17	0.39	2.259

Table 20. Gulf of Mexico Greater Amberjack projection results for the rebuilding scenario using allocation scenario 3 (80:20 recreational to commercial). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_allocation_3_Rebuild									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.06	0.25	2471	0.42	0.85	0.10	0.69	0.505
2023	1650.66	0.06	0.25	3217	0.55	1.10	0.14	0.70	0.631
2024	1650.66	0.06	0.25	3987	0.68	1.37	0.17	0.70	0.75
2025	1650.66	0.06	0.25	4694	0.80	1.61	0.20	0.71	0.854
2026	1650.66	0.06	0.25	5314	0.91	1.82	0.22	0.71	0.941
2027	1650.66	0.06	0.25	5836	1.00	2.00	0.25	0.71	1.012
2028	1650.66	0.24	1.00	6268	1.07	2.15	0.26	0.31	4.319
2029	1650.66	0.24	1.00	5352	0.92	1.83	0.23	0.31	3.733
2030	1650.66	0.24	1.00	4627	0.79	1.59	0.20	0.30	3.292

Table 21. Gulf of Mexico Greater Amberjack projection results for OFL using allocation scenario 4 (fixed commercial catch). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and OFL is the overfishing limit in millions of pounds whole weight.

Nov_GAJ_fixed_comm_OFL									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
2022	1650.66	0.24	1.00	2471	0.42	0.85	0.10	0.30	2.028
2023	1650.66	0.24	1.00	2670	0.46	0.91	0.11	0.30	2.16
2024	1650.66	0.24	1.00	2846	0.49	0.97	0.12	0.30	2.265
2025	1650.66	0.24	1.00	2973	0.51	1.02	0.13	0.30	2.339
2026	1650.66	0.24	1.00	3065	0.53	1.05	0.13	0.31	2.389
2027	1650.66	0.24	1.00	3128	0.54	1.07	0.13	0.31	2.423
2028	1650.66	0.24	1.00	3171	0.54	1.09	0.13	0.31	2.444
2029	1650.66	0.24	1.00	3195	0.55	1.09	0.14	0.31	2.455
2030	1650.66	0.24	1.00	3209	0.55	1.10	0.14	0.30	2.462

Table 22. Gulf of Mexico Greater Amberjack projection results for ABC using allocation scenario 4 (fixed commercial catch). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_fixed_comm_ABC									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.18	0.75	2471	0.42	0.85	0.10	0.38	1.561
2023	1650.66	0.18	0.75	2851	0.49	0.98	0.12	0.39	1.745
2024	1650.66	0.18	0.75	3206	0.55	1.10	0.14	0.39	1.903
2025	1650.66	0.18	0.75	3491	0.60	1.20	0.15	0.40	2.024
2026	1650.66	0.18	0.75	3712	0.64	1.27	0.16	0.40	2.113
2027	1650.66	0.18	0.75	3873	0.66	1.33	0.16	0.40	2.176
2028	1650.66	0.18	0.75	3989	0.68	1.37	0.17	0.40	2.219
2029	1650.66	0.18	0.75	4061	0.70	1.39	0.17	0.39	2.246
2030	1650.66	0.18	0.75	4107	0.70	1.41	0.17	0.39	2.262

Table 23. Gulf of Mexico Greater Amberjack projection results for the rebuilding scenario using allocation scenario 4 (fixed commercial catch). Recruitment is in 1000s of age-0 fish, SSB is in metric tons, F is a harvest rate (total biomass killed age 1+ / total biomass age 1+), and Yield is the projected catch limit in millions of pounds whole weight.

Nov_GAJ_fixed_comm_Rebuild									
Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	Yield
2022	1650.66	0.06	0.26	2471	0.42	0.85	0.10	0.67	0.641
2023	1650.66	0.06	0.26	3209	0.55	1.10	0.14	0.69	0.757
2024	1650.66	0.06	0.26	3982	0.68	1.36	0.17	0.70	0.87
2025	1650.66	0.06	0.26	4694	0.80	1.61	0.20	0.70	0.97
2026	1650.66	0.06	0.26	5318	0.91	1.82	0.22	0.70	1.055
2027	1650.66	0.06	0.26	5839	1.00	2.00	0.25	0.70	1.124
2028	1650.66	0.24	1.00	6267	1.07	2.15	0.26	0.31	4.195
2029	1650.66	0.24	1.00	5382	0.92	1.84	0.23	0.31	3.647
2030	1650.66	0.24	1.00	4666	0.80	1.60	0.20	0.30	3.229

Table 24. The MSRA table for the Nov Base run (see also Table 9).

Variable	**Definition**	**Value**
Base M	Fully selected ages of Lorenzen Natural Mortality (M)	0.28
Steepness	Fixed Stock-Recruit (SR) parameter	0.777
Virgin Recruitment	Estimated SR parameter	3,698
Generation Time	Fecundity-weighted mean age	7.59
SSB Unfished	Estimated virgin spawning stock biomass	23,733
	Mortality Rate Criteria	
FMSYproxy	Equilibrium F that achieves SPR30%	0.242
MFMT	Equilibrium F that achieves SPR30%	0.242
FOY	F that rebuilds the stock to SSBSPR30% by 2027	
Fcurrent	0.75 * Directed F at FSPR30%	0.302
Fcurrent/FMSYproxy	Geometric Mean (F2016-2018)=Fcurrent	1.25
Fcurrent/MFMT	Current stock status based on FMSYproxy	1.25
	Current stock status based on MFMT	
	Biomass Criteria	
SSBMSYproxy	Equilibrium SSB at FSPR30%	5,838
MSST	0.5*SSBSPR30%	2,919
SSB at Optimum Yield	Equilibrium SSB when Directed F = 0.75 * Directed F at FSPR30%	
SSB_2018	SSB2018	2,433
SSB_2018/SSBFMSYproxy	Current stock status based on SSBSPR30% (Equil)	0.42
SSB_2018/MSST	Current stock status based on MSSTSPR30%	0.83
SSB_2018/SSBunfished	Depletion	0.1

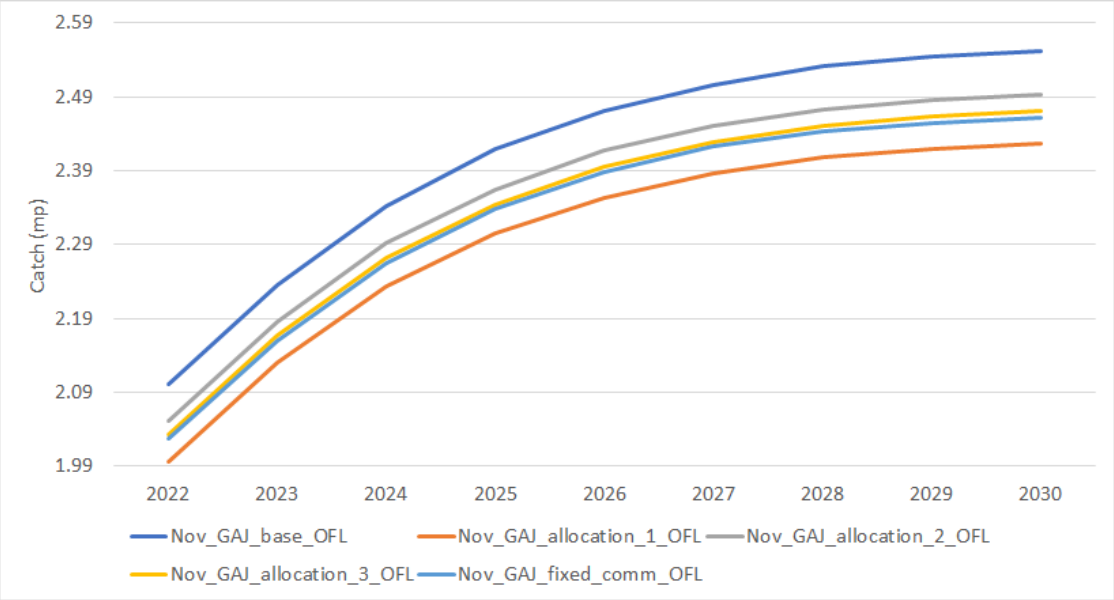

Figure 2. Gulf of Mexico Greater Amberjack projection results for OFLs using each of the allocation scenarios (base plus four requested scenarios)

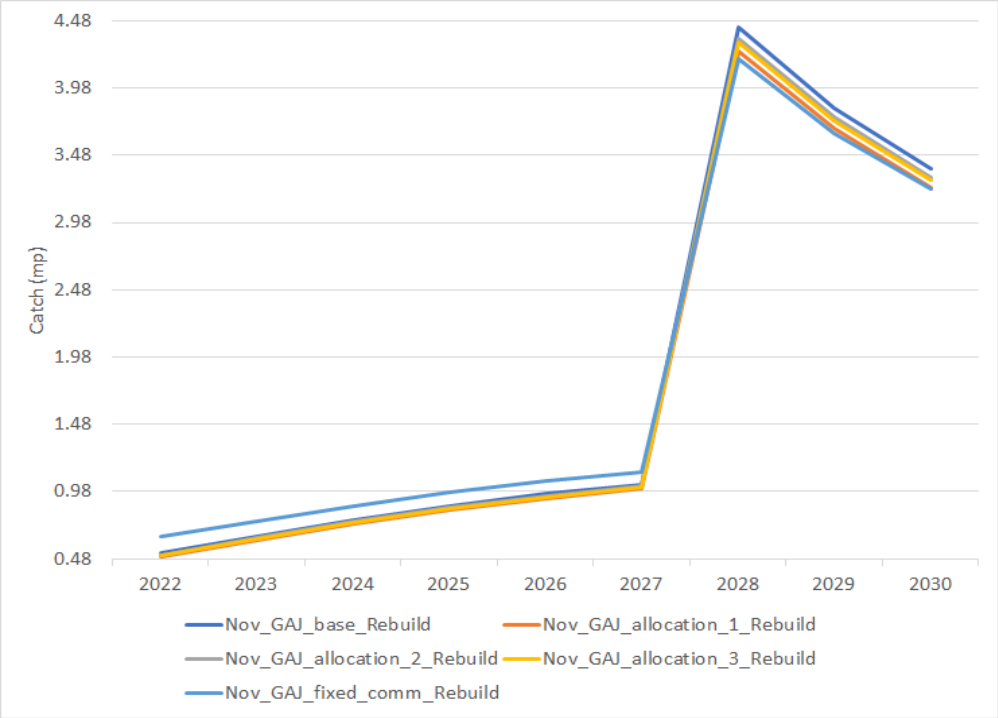

Figure 2. Gulf of Mexico Greater Amberjack projection results for rebuilding by 2027 using each of the allocation scenarios (base plus four requested scenarios).