

**Projections for South Atlantic  
Gag Grouper SEDAR 71 Stock Assessment**

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This document responds to a request from the SAFMC (Dec 11, 2021 email) for projections following the SEDAR 71 South Atlantic Gag Grouper stock assessment. The request was for one new projection scenario and for two previously provided projections to be included for comparison:

1. OFL ( $F_{msy}$ ), recruitment conditioned on the spawner-recruit model, and management starting in 2023 (previously provided in the Oct 2021 report)
2. ABC with a Prebuild = 70% in 10 years, recruitment conditioned on the spawner-recruit model, and management starting in 2023 (previously provided in the Oct 2021 report)
3. ABC with a Prebuild = 60% in 10 years, recruitment conditioned on the spawner-recruit model, and management starting in 2023 (new projection provided in this report)

All projections were conducted with the standard methodology reported in the SEDAR 71 assessment report. All MSY-related benchmarks are unchanged and come from the SEDAR 71 stock assessment report, which are based on a freely estimated Beverton-Holt stock-recruit curve (steepness = 0.898 and  $R_0 = 526,309$  fish). The SEDAR 71 stock assessment estimated that overfishing in 2017 – 2019 was more than twice the  $F_{msy}$  value ( $F/F_{msy} = 2.15$ ) and the Gag Grouper stock was at 15% of its  $SSB_{msy}$  level in 2019. Landings during each of the interim years (2020-2022) were assumed to be the average landings during the last three years of the assessment (2017-2019). Management was assumed to start in 2023 and projections were run 10 years after that point (until 2032).

Results for the previously provided  $F_{msy}$  projection (number 1 above) are shown in Table 1 and Figure 1-2. There is a 14.2% probability of recovery in 10 years under  $F_{msy}$ . Results for the previously provided projection with a 70% probability of rebuilding in 10 years and recruitment conditioned on the stock-recruitment curve (number 2 above) are shown in Table 2 and Fig. 3-4. The fishing rate leading to recovery under this scenario is  $F = 0.165$ . Results for rebuilding in 10 years with a 60% probability and recruitment conditioned on the stock-recruitment curve (number 3 above) are shown in Table 3 and Fig. 5-6. The fishing rate leading to recovery under this scenario is  $F = 0.212$ .

Table 1. Projection results with fishing mortality rate fixed at  $F = F_{msy}$ , management starting in 2023, and recruitment conditioned on the stock recruitment curve. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings, and D = dead discards expressed in numbers (n, in 1000s) and in gutted weight (gutted, in 1000 lb). The extension 'base' indicates expected values (deterministic) from the base run. The extension 'med' indicates median values from the stochastic projections.

Year	R.base (1000)	R.med (1000)	F.base	F.med	S.base (mt)	S.med (mt)	L.base (1000)	L.med (1000)	L.base (1000 lb gutted)	L.med (1000 lb gutted)	D.base (1000)	D.med (1000)	D.base (1000 lb gutted)	D.med (1000 lb gutted)	pr.recover
2020	301.18	263.851	1.01	0.98	225.39	223.37	49.313	49.187	539.102	538.888	25.234	22.211	103.89	91.978	0
2021	296.442	254.319	0.95	0.96	211.9	208.41	55.544	54.916	539.102	538.888	24.425	22.735	103.915	97.437	0
2022	287.234	240.482	0.75	0.79	241.1	228.51	55.62	55.697	539.102	538.808	19.07	18.449	82.344	80.336	0
2023	306.491	243.895	0.36	0.35	333.45	304.45	35.621	31.301	367.235	321.842	9.862	8.133	42.474	35.465	0
2024	354.216	275.332	0.36	0.35	472.81	437.19	44.843	40.114	494.338	441.192	11.156	8.99	47.624	39.022	0.003
2025	402.431	314.71	0.36	0.35	602.76	564.43	52.622	47.347	605.227	547.542	12.702	10.283	54.154	44.264	0.007
2026	432.824	342.051	0.36	0.35	715.94	677.47	60.151	54.174	706.366	641.138	13.94	11.3	59.91	49.077	0.016
2027	452.481	359.91	0.36	0.35	822.33	778.93	68.072	61.337	808.266	735.304	14.785	12.032	64.044	52.799	0.027
2028	467.096	375.328	0.36	0.35	930.93	877.11	75.932	68.284	912.033	828.544	15.379	12.598	66.962	55.324	0.046
2029	479.248	387.993	0.36	0.35	1039.41	972.99	83.028	75.175	1011.133	923.094	15.84	13.022	69.172	57.387	0.069
2030	489.309	400.295	0.36	0.35	1138.99	1059.48	88.942	80.622	1098.379	1003.829	16.216	13.378	70.944	59.021	0.092
2031	497.138	412.176	0.36	0.35	1224.3	1134.51	93.683	85.062	1171.12	1072.22	16.516	13.718	72.362	60.479	0.118
2032	502.992	420.363	0.36	0.35	1294.88	1197.59	97.454	88.599	1230.363	1126.44	16.746	14.122	73.46	62.346	0.142

Figure 1. Probability of rebuilding with fishing mortality rate fixed at  $F = F_{msy}$ , management starting in 2023, and recruitment conditioned on the stock recruitment curve. Solid horizontal lines reflect the 50% and 70% rebuilding probabilities.

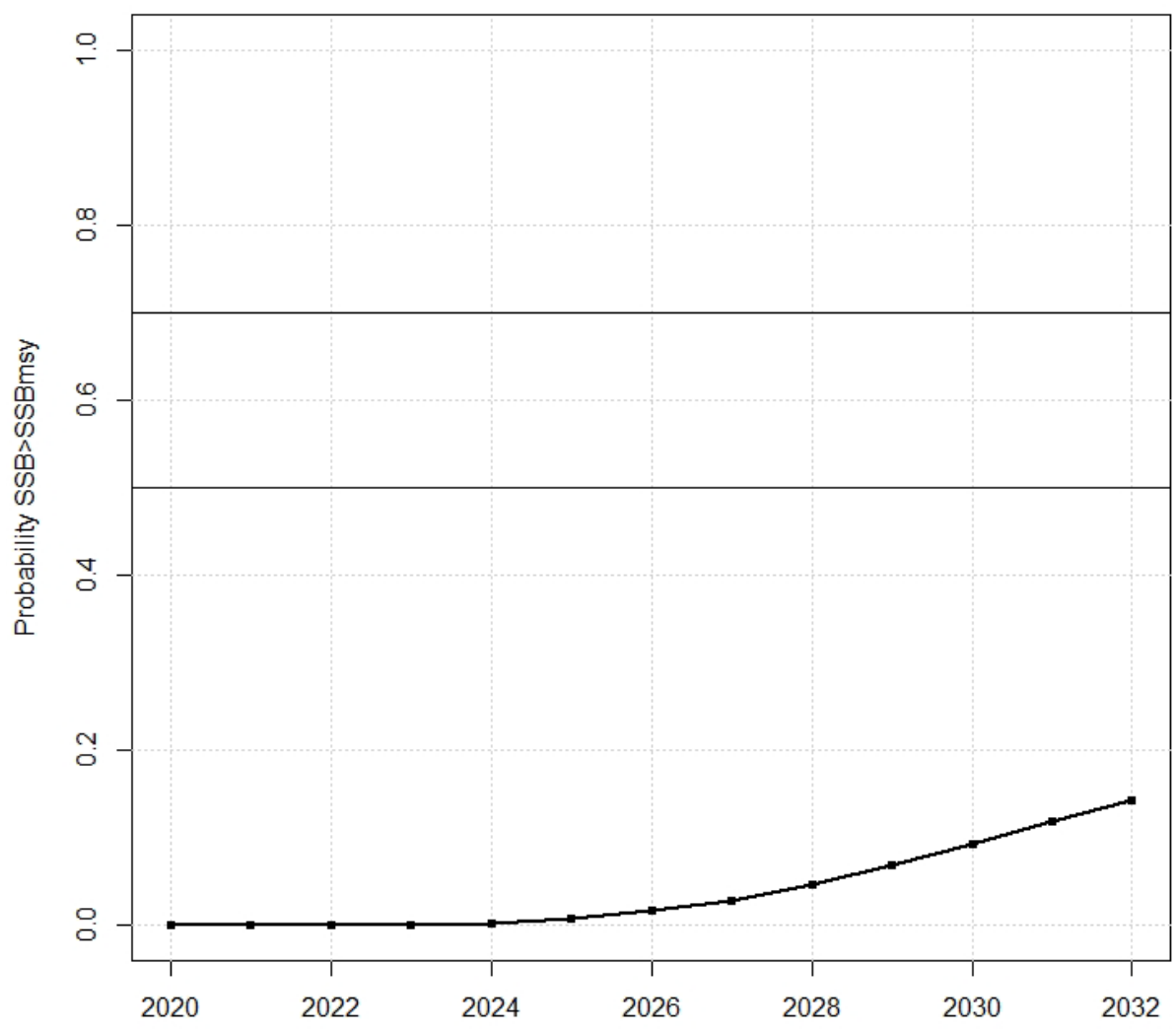


Figure 2. Ten-year projection results with fishing mortality rate at  $F = F_{msy}$  starting in 2023 and recruitment conditioned on the stock-recruitment curve. The interim years (2020-2022) use a mean of the 2017-2019 landings. In the top four panels, expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5<sup>th</sup> and 95<sup>th</sup> percentiles of replicate projections. Solid horizontal lines mark MSY-related quantities from the base run; dashed horizontal lines represent corresponding median values from the replicate projections. Spawning stock (SSB) is at time of peak spawning.

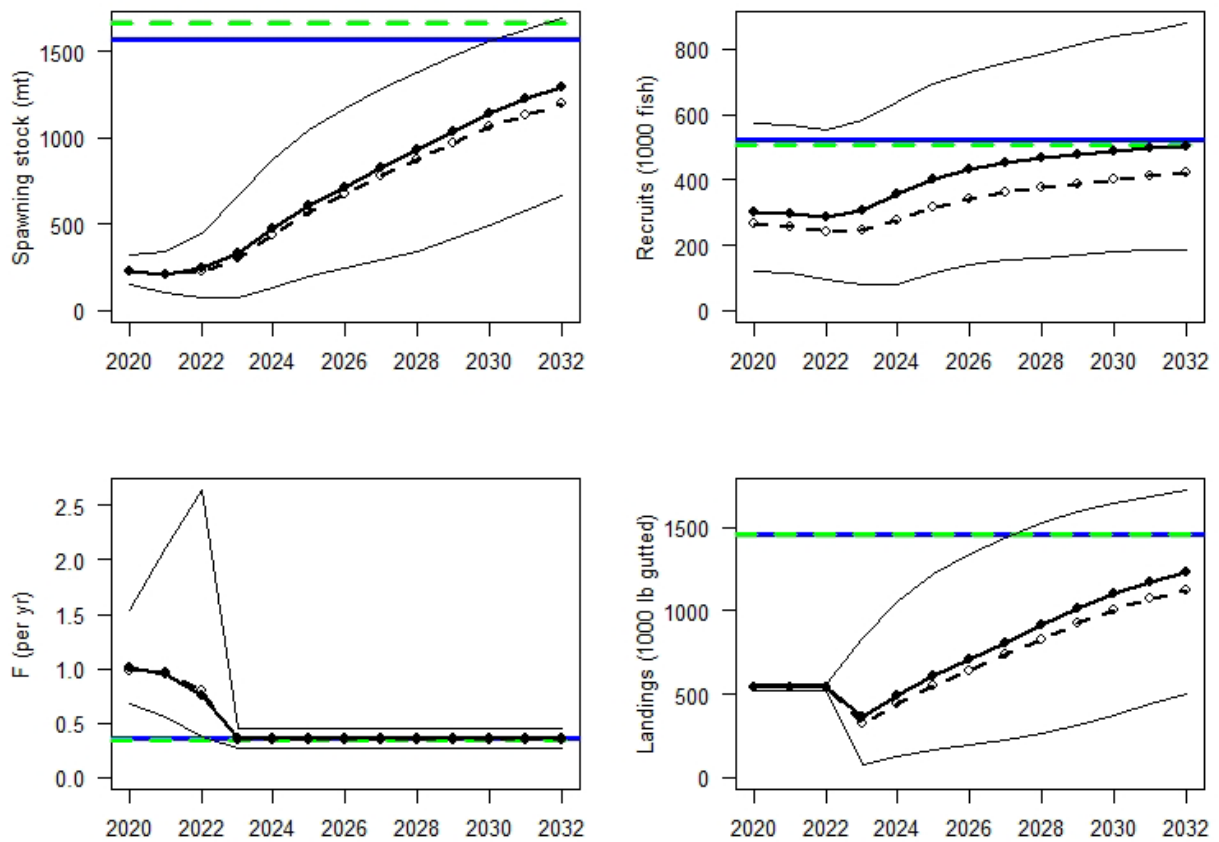


Table 2. Projection results with Prebuild = 70% in 10 years, recruitment conditioned on the stock-recruitment curve, and management starting in 2023. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings, and D = dead discards expressed in numbers (n, in 1000s) and in gutted weight (gutted, in 1000 lb). The extension 'base' indicates expected values (deterministic) from the base run. The extension 'med' indicates median values from the stochastic projections.

Year	R.base (1000)	R.med (1000)	F.base	F.med	S.base (mt)	S.med (mt)	L.base (1000)	L.med (1000)	L.base (1000 lb gutted)	L.med (1000 lb gutted)	D.base (1000)	D.med (1000)	D.base (1000 lb gutted)	D.med (1000 lb gutted)	pr.recover
2020	301.18	263.776	1.01	0.98	225.39	224.39	49.313	49.156	539.102	538.9	25.234	21.922	103.89	91.036	0
2021	296.442	256.188	0.95	0.96	211.9	209.63	55.544	54.863	539.102	538.9	24.425	22.628	103.915	96.657	0
2022	287.234	242.554	0.75	0.79	241.1	229.66	55.62	55.611	539.102	538.855	19.07	18.417	82.344	80.024	0
2023	306.491	247.035	0.16	0.16	346.3	318.03	16.925	15.765	175.632	163.358	4.505	3.885	19.45	16.991	0.001
2024	359.64	277.292	0.16	0.16	545.55	501.69	23.158	21.688	261.171	244.306	5.179	4.308	22.202	18.787	0.014
2025	420.701	328.196	0.16	0.16	765.23	707.54	29.077	27.192	348.352	326.123	6.042	5.003	25.826	21.681	0.069
2026	459.641	360.882	0.16	0.16	984.01	913.66	34.954	32.588	435.081	406.069	6.763	5.638	29.176	24.554	0.168
2027	484.396	386.694	0.16	0.16	1203.36	1115.8	41.129	38.369	524.625	490.171	7.258	6.087	31.627	26.777	0.273
2028	501.62	407.898	0.16	0.16	1432.4	1332.63	47.415	44.367	617.778	578.332	7.596	6.438	33.333	28.5	0.373
2029	514.749	419.62	0.16	0.16	1670.67	1559.54	53.422	50.002	711.419	667.376	7.841	6.728	34.557	29.86	0.465
2030	525.047	435.112	0.16	0.16	1904.94	1779.41	58.772	55.083	800.088	752.284	8.027	6.93	35.475	30.851	0.551
2031	532.929	449.995	0.16	0.16	2122.35	1993.02	63.304	59.391	879.758	829.754	8.17	7.169	36.177	31.953	0.631
2032	538.838	458.191	0.16	0.16	2316.29	2180.5	67.043	62.972	948.911	897.005	8.278	7.324	36.71	32.745	0.704

Figure 3. Probability of rebuilding with 70% probability in 10 years with management starting in 2023 and recruitment conditioned on the stock recruitment curve. Solid horizontal line reflects the 70% probability.

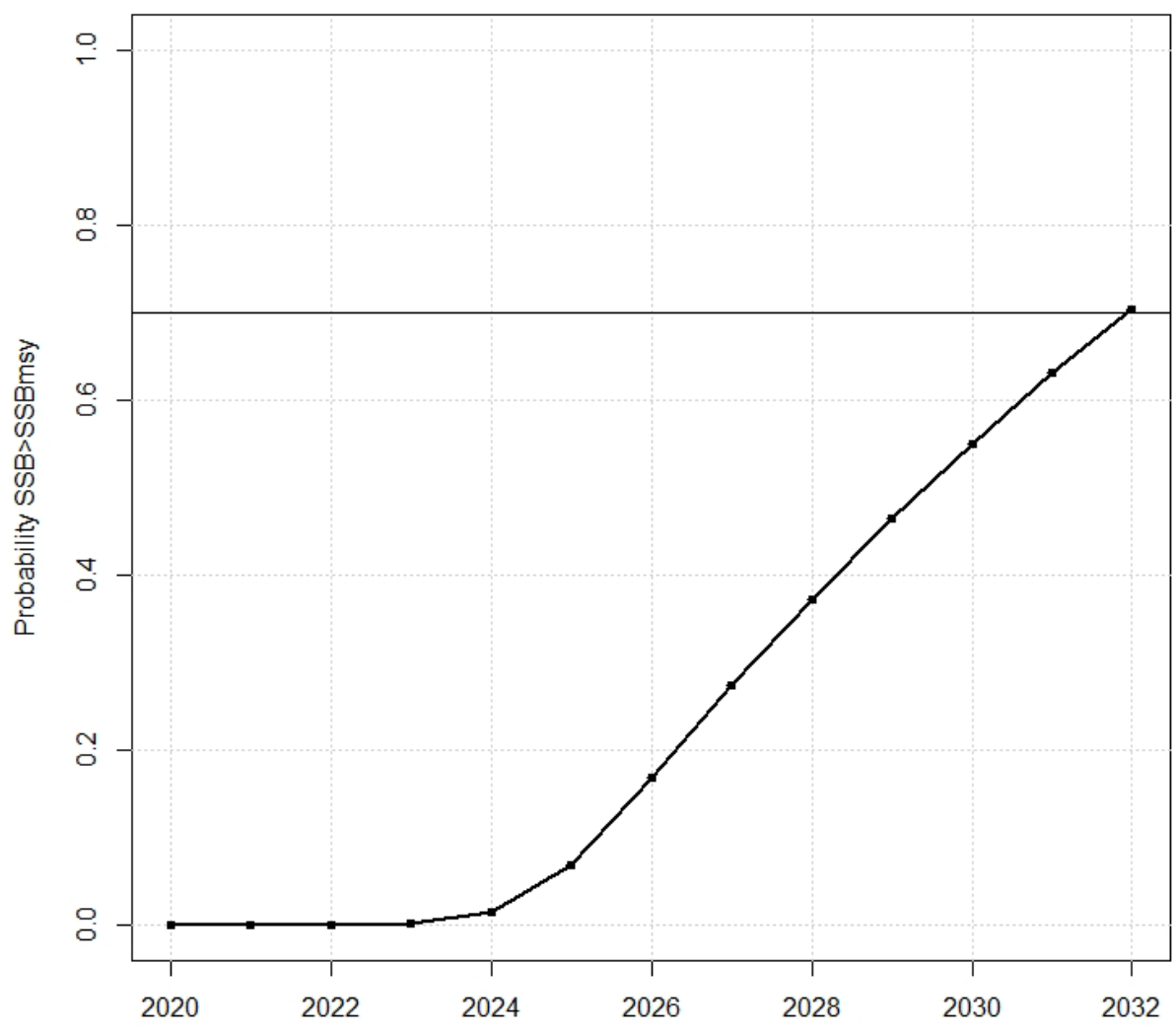


Figure 4. Ten-year projection results with Prebuild = 70%, management starting in 2023 and recruitment conditioned on the stock recruit curve. The interim years (2020-2022) use a mean of the 2017-2019 landings. In the top four panels, expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5<sup>th</sup> and 95<sup>th</sup> percentiles of replicate projections. Solid horizontal lines mark MSY-related quantities from the base run; dashed horizontal lines represent corresponding median values from the replicate projections. Spawning stock (SSB) is at time of peak spawning.

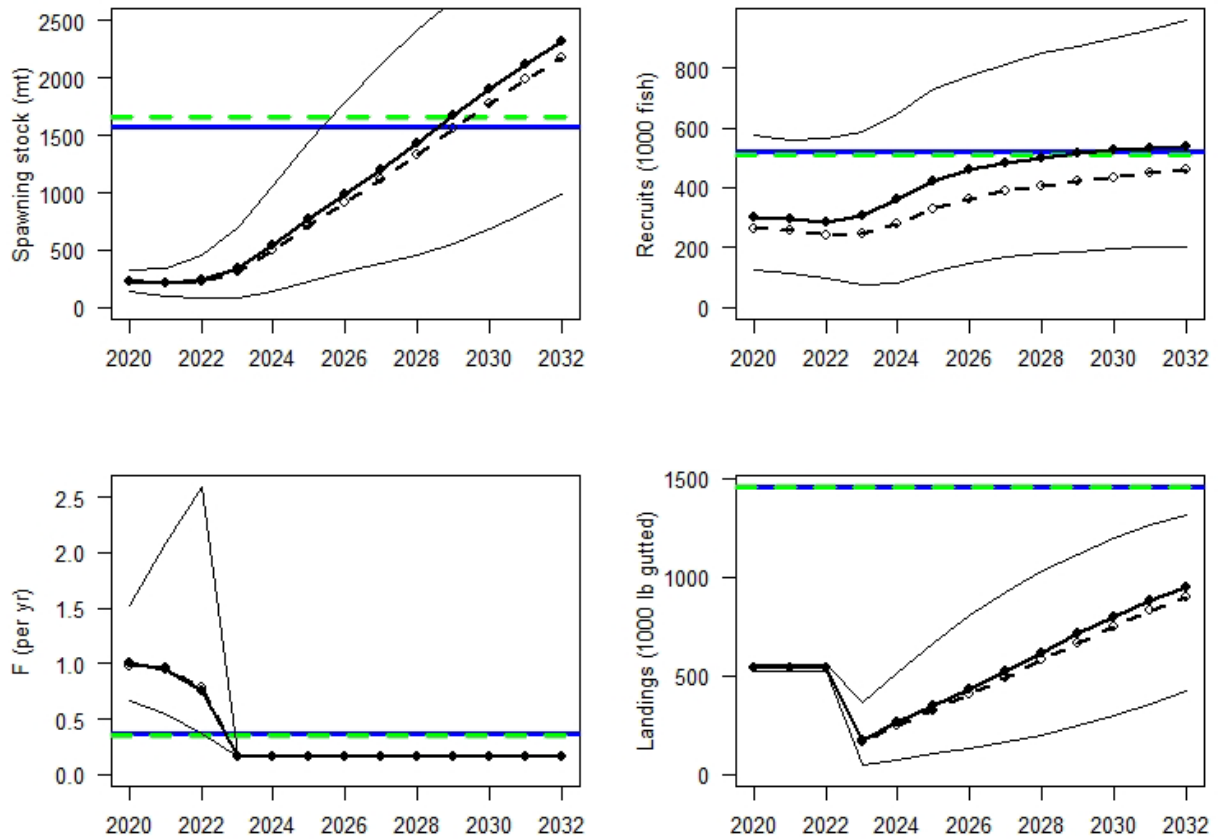




Table 3. Projection results with Prebuild = 60% in 10 years, recruitment conditioned on the stock-recruitment curve, and management starting in 2023. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings, and D = dead discards expressed in numbers (n, in 1000s) and in gutted weight (gutted, in 1000 lb). The extension 'base' indicates expected values (deterministic) from the base run. The extension 'med' indicates median values from the stochastic projections.

Year	R.base (1000)	R.med (1000)	F.base	F.med	S.base (mt)	S.med (mt)	L.base (1000)	L.med (1000)	L.base (1000 lb gutted)	L.med (1000 lb gutted)	D.base (1000)	D.med (1000)	D.base (1000 lb gutted)	D.med (1000 lb gutted)	pr.recover
2020	301.18	263.851	1.01	0.98	225.39	223.37	49.313	49.187	539.102	538.888	25.234	22.211	103.89	91.978	0
2021	296.442	254.319	0.95	0.96	211.9	208.41	55.544	54.916	539.102	538.888	24.425	22.735	103.915	97.437	0
2022	287.234	240.482	0.75	0.79	241.1	228.51	55.62	55.697	539.102	538.808	19.07	18.449	82.344	80.336	0
2023	306.491	243.895	0.21	0.21	343.23	312.59	21.494	19.975	222.694	206.542	5.775	4.956	24.919	21.685	0.001
2024	358.363	277.912	0.21	0.21	527.22	482.64	28.824	26.951	323.318	300.478	6.614	5.531	28.325	24.027	0.011
2025	416.428	322.975	0.21	0.21	722.34	665.12	35.583	33.413	422.183	395.235	7.673	6.382	32.775	27.666	0.049
2026	453.451	355	0.21	0.21	910.28	847.45	42.219	39.559	518.155	485.822	8.551	7.101	36.853	30.969	0.127
2027	477.116	376.688	0.21	0.21	1094.92	1021.6	49.169	45.941	616.153	578.9	9.155	7.644	39.83	33.525	0.219
2028	493.818	394.464	0.21	0.21	1285.75	1194.74	56.199	52.344	717.299	670.778	9.569	8.048	41.908	35.56	0.303
2029	506.801	408.63	0.21	0.21	1482.03	1380.08	62.827	58.675	817.68	766.825	9.874	8.376	43.416	37.14	0.387
2030	517.131	421.421	0.21	0.21	1671.74	1561.5	68.631	63.94	911.028	855.24	10.11	8.66	44.566	38.395	0.465
2031	525.087	434.523	0.21	0.21	1844.22	1723.17	73.469	68.402	993.235	933.087	10.293	8.907	45.455	39.46	0.537
2032	531.057	442.799	0.21	0.21	1994.87	1867.09	77.404	72.115	1063.22	998.598	10.432	9.138	46.135	40.608	0.599

Figure 5. Probability of rebuilding with 60% probability in 10 years with management starting in 2023 and recruitment conditioned on the stock recruitment curve. Solid horizontal line reflects the 60% probability.

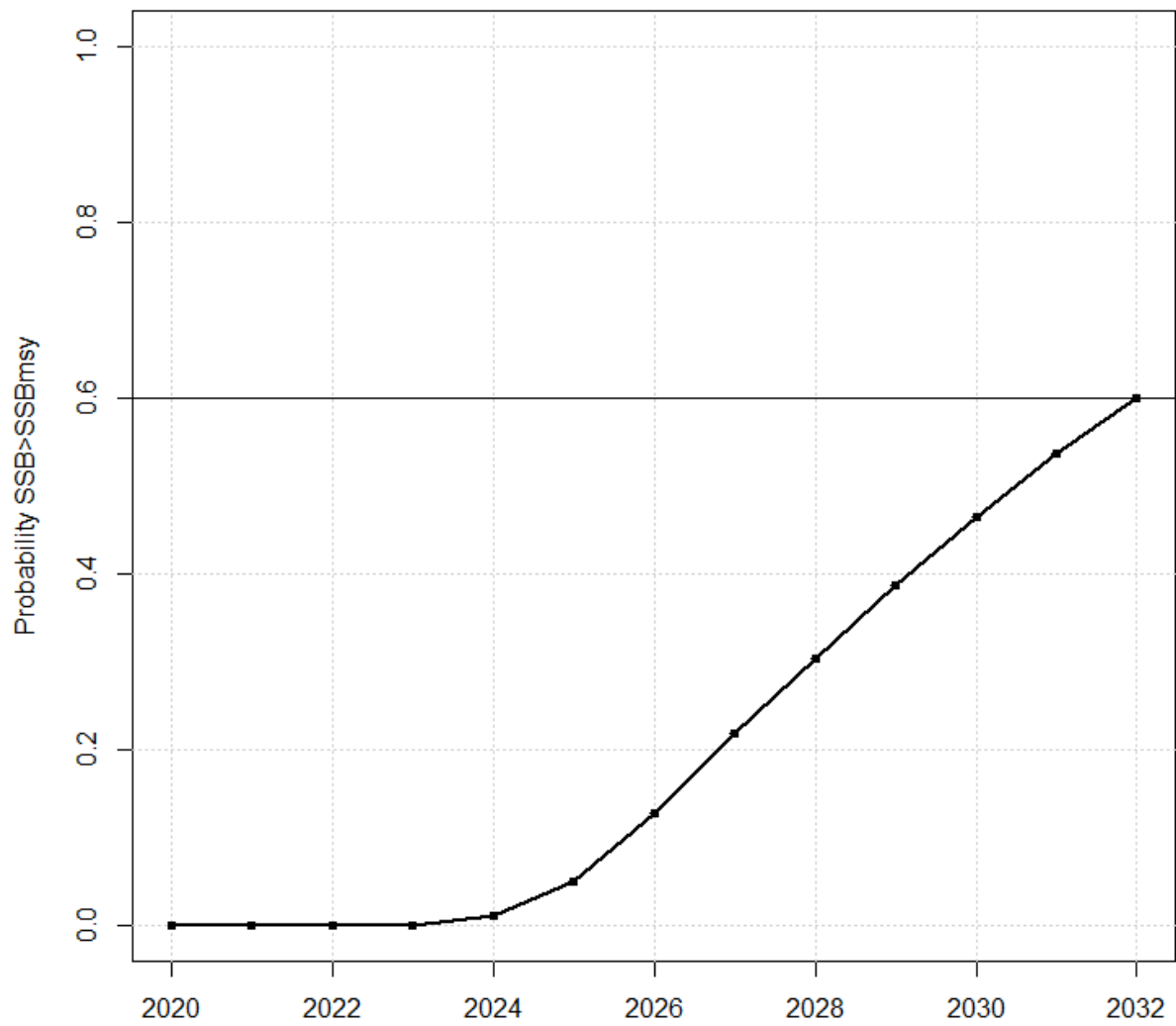


Figure 6. Ten-year projection results with Prebuild = 60%, management starting in 2023 and recruitment conditioned on the stock recruit curve. The interim years (2020-2022) use a mean of the 2017-2019 landings. In the top four panels, expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5<sup>th</sup> and 95<sup>th</sup> percentiles of replicate projections. Solid horizontal lines mark MSY-related quantities from the base run; dashed horizontal lines represent corresponding median values from the replicate projections. Spawning stock (SSB) is at time of peak spawning.

