Projections of the South Florida/Florida Keys Hogfish Stock under Various Rebuilding Scenarios

A report to the SAFMC SSC

October 2015

Dustin Addis and Mike Murphy
Florida Fish and Wildlife Research Institute
100 8th Ave. S.E., Saint Petersburg, FL 33701
(727) 502-4935
Dustin.Addis@myfwc.com

Introduction

Projections of Hogfish biomass were approved by the SAFMC at its March 2015 meeting to develop alternatives for rebuilding the Florida Keys including the Dry Tortugas and Eastern Florida (FLK/EFL) hogfish stock. Preliminary projections within the assessment indicated the stock can be rebuilt within 10 years under an F=0 scenario, so the maximum rebuilding time for projections is 10 years (SEDAR 37, 2014). Initial projections were requested by the SAFMC to be presented at the April 2015 SSC meeting, where Hogfish landings for 2015 were assumed to be the average landings for 2013-2014. The recreational fishery for Hogfish was closed recently due to an increase in landings observed during 2015 Wave 2 of the MRIP survey. As a result, preliminary landings for 2015 are above the landings level assumed for initial projections presented at the April SSC meeting. Due to concerns that the initial projections may no longer represent the best scientific information available, the council requested updated Hogfish projections for the East Florida/Florida Keys Hogfish stock using the most recent landings estimates for use in Snapper Grouper FMP Amendment 37.

Methods

Interim Landings

The last year of data in the Hogfish assessment report (SEDAR 37, 2014) was 2012 and changes in regulations will likely impact 2017 landings for the FLK/EFL stock. Therefore, recent catch data were generated for commercial and recreational fleets (2013-2016) by SAFMC staff. In order to generate these landings within the assessment model, the level of fishing mortality rate (F) needed to project the annual total dead biomass (landings and dead discards) for 2013-2016 was estimated and used for all considered projection scenarios.

Projections

Projections for various F scenarios were completed using Stock Synthesis (SS3) base model configurations for the FLK/EFL hogfish stock (SEDAR 37, 2014):

- F=0: no directed fishing scenario (constant discard mortality)

- $F=F_{Current}$: total fishing rate was held constant during 2017-2027 at the geometric mean rate for 2013-2015
- Constant F at F=75% F_{MSY}: a constant fishing mortality rate at 75% of F_{MSY}
- Constant F at $F=F_{MSY}$: a constant fishing mortality rate at MSY
- Constant F that rebuilds to the spawning stock biomass at MSY level in 10 years and F's associated with 72.5% probability of rebuilding in 10 years
- Constant F that rebuilds to the spawning stock biomass at MSY level in 7 years and F's associated with 72.5% probability of rebuilding in 7 years

Projection results are based on year 1 = 2017 and extending through 2027. The probability that SSB exceeds SSB_{MSY} was calculated as one minus the "Norm.Dist" function in MS Excel, which returns the normal distribution using the value for the distribution (SSB_{MSY} = 2300.39, in 1000's lbs), and the specified mean and standard deviation of projected SSB estimates by year.

Within SS3 forecasting, projections were run assuming that biology, recruitment, selectivity, and relative apical F's among fleets are the same as the last three years of the assessment (2010-2012). The predicted fleet (commercial: spear, hook-and-line, trap; recreational spear and hook-and-line) catch allocations reflected the average distribution of apical F's among fleets during 2013-2015. These allocations were also applied to 2013-2016 interim catch totals. Forecast catches within the projections were total dead fish (biomass or numbers) because hogfish discards were included in the landings in the assessment model. The predicted discarded portions of the forecasted total dead catches were estimated using observed landings and discards during 2010-2012. The base model estimates of 2010-2012 fleet-specific exploitation rates were partitioned into landed and discarded components by dividing observed discards by the total biomass or numbers to estimate fleet-specific discard exploitation rates. These discard rates were subtracted from the corresponding fleet-specific total exploitation rates estimated within all projections and applied to the stock biomass or abundance to calculate discards. Retained catch was then calculated by subtracting these predicted discards from the total dead biomass or numbers.

All projection analyses involved iterative searches used to solve for annual scalars applied to fleet-specific exploitations to match the target exploitation rate for each projection scenario. Similar iterative searches were run for rebuild projections but the F was found by matching to the target spawning biomass at MSY. These scalars changed through time to keep the overall force of fishing constant despite the changing age structure of the stock encountered by fisheries with different selectivity patterns.

Results

The total interim landings and discards (2013-2016) are presented in pounds (in 1000s) and numbers (in 1000s) in Table 1. Projection results under scenarios: F_0, $F_{Current}$, 75% F_{MSY}, and F_{MSY} for 2017-2027 are presented in Tables 2,3,4, and 5, respectively in terms of fishing mortality rate applied, spawning stock biomass, annual stock biomass, and yield expressed in pounds (in 1000s) and numbers (in 1000s) for landings and discards. Projection results under

rebuilding scenarios for constant F projections that rebuild in 10 years are presented for Prebuild=50% (Table 6) and Prebuild=72.5% (Table 7). Projection results under Prebuild scenarios for constant F projections that rebuild in 7 years are presented for Prebuild=50% (Table 8) and Prebuild=72.5% (Table 9).

References

SEDAR 37. 2014. The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston, SC. 295 p.

Tables

Table 1. SAFMC staff recommended FLK/EFL Hogfish combined landings and dead discards for commercial and recreational fisheries by gear for 2013-2016.

Pounds in 1000's

Year	Landings	Discards	Total
2013	143.097	6.049	149.146
2014	287.042	12.686	299.728
2015	414.080	5.124	419.204
2016	281.764	7.759	289.523

Numbers in 1000's

Year	Landings	Discards	Total
2013	56.764	2.359	59.123
2014	153.903	5.637	159.540
2015	217.675	2.263	219.938
2016	142.458	3.435	145.893

Table 2. Projection results from the FLK/EFL stock for the F_0 rebuilding scenario. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.001	466.101	0.000	559.762	0	0	0.595	0.283
2018	0.001	656.236	0.000	767.982	0	0	0.816	0.361
2019	0.001	885.847	0.000	1016.392	0	0	1.080	0.442
2020	0.001	1154.361	0.003	1304.632	0	0	1.386	0.536
2021	0.001	1460.854	0.049	1630.762	0	0	1.732	0.641
2022	0.001	1802.857	0.201	1991.380	0	0	2.115	0.753
2023	0.001	2176.072	0.427	2381.761	0	0	2.530	0.866
2024	0.001	2575.173	0.642	2796.428	0	0	2.970	0.979
2025	0.001	2994.447	0.798	3229.460	0	0	3.431	1.089
2026	0.001	3427.809	0.894	3674.594	0	0	3.903	1.194
2027	0.001	3869.461	0.946	4126.057	0	0	4.383	1.294

Table 3. Projection results from the FLK/EFL stock for the $F_{Current}$ rebuilding scenario, where $F_{Current}$ is the geometric mean of the terminal three years of observed landings (2013-2015). Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.344	466.101	0.000	559.762	192.138	90.620	0.595	0.283
2018	0.344	493.416	0.000	588.133	201.877	91.912	0.625	0.313
2019	0.344	513.277	0.000	608.812	208.976	92.687	0.647	0.329
2020	0.344	526.966	0.000	623.793	214.118	94.100	0.663	0.347
2021	0.344	537.927	0.000	636.165	218.364	95.721	0.676	0.367
2022	0.344	547.661	0.000	647.193	222.149	97.223	0.687	0.387
2023	0.344	556.404	0.001	657.080	225.543	98.545	0.698	0.407
2024	0.344	564.209	0.003	665.897	228.569	99.713	0.707	0.426
2025	0.344	571.131	0.007	673.708	231.251	100.750	0.716	0.444
2026	0.344	577.192	0.014	680.542	233.597	101.660	0.723	0.460
2027	0.344	582.494	0.026	686.514	235.646	102.460	0.729	0.475

Table 4. Projection results from the FLK/EFL stock for the 75% F_{MSY} rebuilding scenario. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.104	466.101	0.000	559.762	57.475	26.890	0.595	0.283
2018	0.104	607.011	0.000	713.666	73.278	31.916	0.758	0.346
2019	0.104	760.757	0.000	880.137	90.370	36.831	0.935	0.406
2020	0.104	922.999	0.000	1055.546	108.382	42.452	1.121	0.473
2021	0.104	1091.807	0.007	1237.319	127.046	48.640	1.314	0.546
2022	0.104	1264.951	0.036	1422.584	146.069	55.003	1.511	0.622
2023	0.104	1439.271	0.094	1607.887	165.095	61.256	1.708	0.696
2024	0.104	1611.407	0.174	1789.770	183.771	67.242	1.901	0.767
2025	0.104	1778.262	0.260	1965.064	201.770	72.872	2.087	0.835
2026	0.104	1937.054	0.341	2130.953	218.803	78.088	2.264	0.897
2027	0.104	2085.738	0.411	2285.463	234.670	82.865	2.428	0.953

Table 5. Projection results from the FLK/EFL stock for the F_{MSY} rebuilding scenario. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.138	466.101	0.000	559.762	76.834	35.986	0.595	0.283
2018	0.138	590.523	0.000	695.461	95.460	41.810	0.739	0.342
2019	0.138	721.263	0.000	837.017	114.891	47.335	0.889	0.394
2020	0.138	854.127	0.000	981.056	134.663	53.574	1.042	0.453
2021	0.138	988.036	0.003	1125.950	154.552	60.324	1.196	0.517
2022	0.138	1121.737	0.019	1269.877	174.308	67.119	1.349	0.582
2023	0.138	1253.088	0.053	1410.452	193.604	73.662	1.498	0.646
2024	0.138	1379.819	0.103	1545.339	212.120	79.808	1.642	0.707
2025	0.138	1499.935	0.160	1672.500	229.575	85.486	1.777	0.764
2026	0.138	1611.740	0.217	1790.237	245.737	90.657	1.902	0.817
2027	0.138	1714.178	0.269	1897.567	260.470	95.311	2.016	0.865

Table 6. Projection results from the FLK/EFL stock for the Rebuild 10 scenario, referring to a constant fishing rate that will rebuild the stock in 10 years associated with a probability of rebuilding (Prebuild) of 50%. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.087	466.101	0.000	559.762	48.026	22.457	0.595	0.283
2018	0.087	615.078	0.000	722.569	61.994	26.929	0.768	0.349
2019	0.087	780.517	0.000	901.690	77.363	31.367	0.958	0.412
2020	0.087	958.225	0.001	1093.573	93.826	36.477	1.162	0.483
2021	0.087	1145.995	0.010	1295.324	111.135	42.153	1.376	0.561
2022	0.087	1341.203	0.049	1503.628	129.008	48.052	1.597	0.642
2023	0.087	1540.211	0.125	1714.531	147.103	53.910	1.821	0.722
2024	0.087	1739.110	0.224	1924.009	165.076	59.601	2.044	0.771
2025	0.087	1934.221	0.327	2128.292	182.603	65.008	2.261	0.814
2026	0.087	2122.134	0.421	2323.934	199.389	70.070	2.469	0.852
2027	0.087	2300.212	0.500	2508.350	215.211	74.752	2.664	0.885

Table 7. Projection results from the FLK/EFL stock for the Rebuild 10 scenario, referring to a constant fishing rate that will rebuild the stock in 10 years associated with a probability of rebuilding (Prebuild) of 72.5%. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.070	466.101	0.000	559.762	38.367	17.930	0.595	0.283
2018	0.069	623.334	0.000	731.680	49.449	21.421	0.777	0.351
2019	0.068	801.673	0.000	924.754	61.982	24.996	0.982	0.418
2020	0.068	997.357	0.001	1135.772	75.710	29.200	1.206	0.494
2021	0.068	1208.116	0.014	1361.710	90.469	33.965	1.446	0.577
2022	0.067	1430.997	0.067	1598.863	106.059	39.027	1.698	0.664
2023	0.067	1661.827	0.167	1842.710	122.197	44.162	1.957	0.751
2024	0.067	1896.011	0.293	2088.511	138.566	49.254	2.219	0.806
2025	0.067	2129.079	0.417	2331.672	154.851	54.183	2.477	0.855
2026	0.068	2356.761	0.525	2567.875	170.750	58.878	2.728	0.898
2027	0.068	2575.569	0.613	2793.672	186.018	63.295	2.968	0.936

Table 8. Projection results from the FLK/EFL stock for the Rebuild 7 scenario, referring to a constant fishing rate that will rebuild the stock in 7 years associated with a probability of rebuilding (Prebuild) of 50%. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.027	466.101	0.000	559.762	14.352	6.695	0.595	0.283
2018	0.027	643.910	0.000	754.386	19.342	8.320	0.801	0.357
2019	0.027	853.516	0.000	981.219	25.157	10.015	1.042	0.433
2020	0.027	1092.682	0.002	1238.377	31.751	12.023	1.315	0.520
2021	0.027	1359.505	0.030	1523.051	39.049	14.329	1.618	0.616
2022	0.027	1650.910	0.133	1831.318	46.953	16.823	1.945	0.718
2023	0.027	1962.295	0.306	2158.166	55.333	19.402	2.293	0.820
2024	0.027	2288.307	0.494	2498.077	64.049	22.028	2.654	0.889

Table 9. Projection results from the FLK/EFL stock for the Rebuild 7 scenario, referring to a constant fishing rate that will rebuild the stock in 7 years associated with a probability of rebuilding (Prebuild) of 72.5%. Pounds and numbers are in thousands. The calculated SSB_{MSY} = 2300.39. Probability of SSB exceeding SSB_{MSY} was calculated using the Norm.Dist function in MS Excel.

Year	F	SSB (pounds)	Probability of SSB > SSB_{MSY}	Annual Stock Biomass (pounds)	Yield (pounds)	Yield (numbers)	Discards (pounds)	Discards (numbers)
2017	0.022	466.101	0.000	559.762	11.858	5.530	0.595	0.283
2018	0.022	646.051	0.000	756.747	15.774	6.780	0.804	0.358
2019	0.022	859.315	0.000	987.529	20.469	8.136	1.049	0.434
2020	0.022	1103.904	0.002	1250.438	25.906	9.787	1.328	0.523
2021	0.022	1378.000	0.031	1542.725	32.042	11.725	1.639	0.621
2022	0.022	1678.512	0.145	1860.424	38.810	13.861	1.976	0.724
2023	0.022	2000.728	0.329	2198.414	46.106	16.110	2.335	0.829
2024	0.022	2339.124	0.523	2551.010	53.809	18.441	2.710	0.899