Supplementary Material

How fisher behavior can affect stock assessment: insights from an agent-based modeling approach

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Note to Reader

The supplemental material contains simulation model input parameters, stock assessment model configuration and functions used, and detailed species-specific simulation model results. The authors acknowledge the temptation for readers, especially those familiar with the Gulf of Mexico reef fish complex, to extrapolate presented trends to the real system. However, readers are reminded that study results are from a simulation model and are cautioned not to extrapolate stock status or projection results to the real fisheries in the present day. Although the simulation contained significant realism in its representation of population and fishery dynamics, regulatory conditions during the 20-year long simulation were held constant and reflected the policies in place between 2005 and 2006. This was done because the purpose of this study was to see how fisher behavior alone (in the absence of regulatory changes) affects stock assessment. Since that time, the fishery experienced significant changes in regulatory structure which likely changed the behavior of the fishers. This included the implementation of an individual transferable fishing quota system, gear modifications, and the implementation of a vessel monitoring system. For purposes of this study, we wanted to understand how fisher behavior could affect fishery-dependent data in the absence of regulatory changes.

Simulation Model Input Parameters and Functional Forms

Table S.1: Simulation model input parameters and associated biological functions for red grouper.

Process	Parameter	Red Grouper	Equation
Spherical Variogram: Spatial Distribution of Abundance (kilometers)	σ_0^2 (partial sill)	0.31	$\gamma_z(h) = \begin{cases} c_n + \sigma_0^2\left[\frac{3}{2}\frac{h}{a_0} - \frac{1}{2}\left(\frac{h}{a_0}\right)^3\right], & 0 < h \leq a_0 \\ c_0, & a_0 < h \end{cases}$ where: $c_0 = c_n + \sigma_0^2$
	a_0 (range)	0.95	
	c_n (nugget)	0	
von Bertalanffy Growth (mm)	L_∞	854	$L_t = L_\infty(1 - e^{-k(t-t_0)})$
	K	0.16	
	t_0	-0.19	
Sequential Hermaphroditism (proportion female)	δ	8.02	$P_{female} = \frac{\omega}{\Phi_{0,1}\left(\frac{a_{max}-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right)} \times \left(\Phi_{0,1}\left(\frac{a-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right)\right)$
	σ	5.34	
	ω	0.77	
	$\Phi_{\mu,\sigma^2}(x)$	Cumulative normal distribution	
Logistic Maturity at Length (mm)	M_∞	0.99	$M_L = \frac{M_\infty}{1 + e^{-k(L-\gamma)}}$
	K	0.03	
	γ	307.63	
Spawning Stock Biomass (grams of gonad weight)	A	4.79	$\mathrm{SS_{RG}} = \sum_{t=0}^{n} \mathrm{N_t}(a * t^b)$
	B	1.56	
Beverton and Holt Recruitment (Number of Age 1 Fish)	A	10,691,500	$\mathrm{R_{RG}} = \frac{a * \mathrm{SS_{RG}}}{b + \mathrm{SS_{RG}}}$
	B	83,148,000	
Length (mm) to Weight (kg) Relationship	A	0.000000006	$W = aL^b$
	B	3.14	
Probability Female At Age	b_0	-0.051	$Female = b_0 t + b_1$
	b_1	1.053	
Migration Speed (in grid cells per simulation day): gamma distribution	α	0.7	$S = \beta^\alpha \frac{1}{(\alpha-1)!} x^{\alpha-1} e^{-\beta x}$ where $x = \mathrm{U}(0,1)$
	β	0.2	
Biased Random Walk Exponential Distribution Shape Parameter	C	0.9	
Terminal Age (years)		40	
Starting Abundance (number of fish)		19,239,164	
Fraction of Fishing Mortality Not Explicitly Modeled (includes recreational fishing mortality)		0.303	

Table S.2: Simulation model input parameters and associated biological functions for gag grouper.

Process	**Parameter**	**Gag Grouper**	**Equation**
Spherical Variogram: Spatial Distribution of Abundance (kilometers)	σ_0^2 (partial sill)	0.14	$\gamma_z(h) = \begin{cases} c_n + \sigma_0{}^2\left[\frac{3}{2}\frac{h}{a_0} - \frac{1}{2}\left(\frac{h}{a_0}\right)^3\right], & 0 < \mathrm{h} \le a_0 \\ c_0, & a_0 < \mathrm{h} \end{cases}$ where: $c_0 = c_n + \sigma_0{}^2$
	a_0 (range)	0.9	
	c_n (nugget)	0	
von Bertalanffy Growth (mm)	L_∞	1,310	$L_t = L_\infty(1 - e^{-k(t-t_0)})$
	k	0.14	
	t_0	-0.37	
Sequential Hermaphroditism (proportion female)	δ	12.46	$P_{female} = \frac{\omega}{\Phi_{0,1}\left(\frac{a_{max}-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right)} \times \left(\Phi_{0,1}\left(\frac{a-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right)\right)$
	σ	3.12	
	ω	1.00	
	$\Phi_{\mu,\sigma^2}(x)$	Cumulative normal distribution	
Female Maturity and Gender Assignment (L in millimeters)	k	-9.02	$M_L = e^{-e^{-(k+\beta L)}}$
	β	0.016	
Male Maturity and Gender Assignment (L in millimeters)	k	14.387	$M_L = 1 - e^{-e^{-(k+\beta L)}}$
	β	-0.013	
Spawning Stock Biomass (W in pounds of mature female fish)			$\mathrm{SS_{GG}} = \sum_{i=0}^{n} \mathrm{W_i}$ *where i represents mature female fish*
Beverton and Holt Recruitment (Number of Age 1 Fish)	h	0.840	$R_{GG} = \frac{4hR_0SS_{GG}}{R_0\emptyset(1-h) + (5h-1)SS_{GG}}$
	R_0	2,151,073.742	
	φ	0.0151	
Length (mm) to Weight (kg) Relationship	a	0.00000001	$W = aL^b$
	b	3.03	
Migration Speed (in grid cells per simulation day): gamma distribution	α	0.7	$S = \beta^\alpha \frac{1}{(\alpha-1)!} x^{\alpha-1} e^{-\beta x}$ where $x = \mathrm{U}(0,1)$
	β	0.3	
Biased Random Walk Exponential Distribution Shape Parameter	C	0.9	
Terminal Age (years)		30	
Starting Abundance (number of fish)		3,436,938	

Fraction of Fishing Mortality Not Explicitly Modeled (includes recreational fishing mortality)	0.598	

Table S.3: Simulation model input parameters and associated biological functions for mutton snapper.

Process	Parameter	Mutton Snapper	Equation
Spherical Variogram: Spatial Distribution of Abundance (kilometers)	σ_0^2 (partial sill)	0.31	$\gamma_z(h) = \begin{cases} c_n + {\sigma_0}^2\left[\frac{3}{2}\frac{h}{a_0} - \frac{1}{2}\left(\frac{h}{a_0}\right)^3\right], & 0 < \mathrm{h} \leq a_0 \\ c_0, & a_0 < \mathrm{h} \end{cases}$ where: $c_0 = c_n + {\sigma_0}^2$
	a_0 (range)	0.87	
	c_n (nugget)	0	
von Bertalanffy Growth (millimeters)	L_∞	874.44	$L_t = L_\infty(1 - e^{-k(t-t_0)})$
	k	0.16	
	t_0	-1.32	
Maturity (L in millimeters)	R	-9.02	$M_L = \frac{1}{1 + e^{-R(L-L_{50})}}$
	L_{50}	0.016	
Spawning Stock Biomass (W in kilograms of mature female fish)			$\mathrm{SS_{GG}} = \sum_{\mathrm{i}=0}^{\mathrm{n}} \mathrm{W_i}$ *where i represents mature female fish*
Beverton and Holt Recruitment (Number of Age 1 Fish)	h	0.75	$R_{GG} = \frac{4hR_0SS_{GG}}{R_0\emptyset(1-h) + (5h-1)SS_{GG}}$
	R_0	1,842,399	
	φ	7.488	
Length (mm) to Weight (kg) Relationship	a	0.00000006	$W = aL^b$
	b	2.867	
Migration Speed (in grid cells per simulation day): gamma distribution	α	0.8	$S = \beta^\alpha \frac{1}{(\alpha-1)!} x^{\alpha-1} e^{-\beta x}$ where $x = \mathrm{U}(0,1)$
	β	0.3	
Biased Random Walk Exponential Distribution Shape Parameter	C	0.9	
Terminal Age (years)		40	
Starting Abundance (number of fish)		1,038,780	

Table S.4: Simulation model input parameters and associated biological functions for red snapper.

Process	Parameter	Red Snapper	Equation
Spherical Variogram: Spatial Distribution of Abundance (kilometers)	σ_0^2 (partial sill)	0.00001	$\gamma_z(h) = \begin{cases} c_n + \sigma_0^2\left[\frac{3}{2}\frac{h}{a_0} - \frac{1}{2}\left(\frac{h}{a_0}\right)^3\right], & 0 < \mathrm{h} \leq a_0 \\ c_0, & a_0 < \mathrm{h} \end{cases}$ where: $c_0 = c_n + \sigma_0^2$
	a_0 (range)	0	
	c_n (nugget)	0	
von Bertalanffy Growth (inches)	L_∞	34.522	$L_t = L_\infty(1 - e^{-k(t-t_0)})$
	k	0.220	
	t_0	0.366	
Logistic Maturity at Length (mm)	M_∞	1.000	$M_L = \frac{M_\infty}{1 + e^{-k(L-\gamma)}}$
	k	0.012	
	γ	199.214	
Spawning Stock Biomass (batch fecundity, using length L in inches)	a	0.1681	$\mathrm{SS_{RS}} = \sum_{\mathrm{N}=0}^{\mathrm{n}} (\mathrm{aL_N}^{\mathrm{b}})$
	b	5.57	
Spawning Stock Biomass at the Terminal Age (batch fecundity, using the length L in inches at age 30)	a	0.1681	$\mathrm{SS30_{RS}} = \sum_{\mathrm{N}=0}^{\mathrm{n}} (\mathrm{aL30_N}^{\mathrm{b}})$ where: $\mathrm{L30} = L_\infty(1 - e^{-k(30-t_0)})$
	b	5.57	
Beverton and Holt Recruitment (Number of Age 0 Fish)	R_0	6,585,000	$\mathrm{R_{RS}} = \mathrm{R_0}\frac{\frac{\alpha * \mathrm{SS_{RS}}}{\mathrm{SS30_{RS}}}}{1 + \frac{(\alpha - 1) * \mathrm{SS_{RS}}}{\mathrm{SS30_{RS}}}}$
	α	151	
Length (inches) to Weight (pounds) Relationship	a	0.0004398	$W = aL^b$
	b	3.056	
Migration Speed (in grid cells): gamma distribution	α	0.6	$S = \beta^\alpha \frac{1}{(\alpha - 1)!} x^{\alpha-1} e^{-\beta x}$ where $x = \mathrm{U}(0{,}1)$
	β	0.2	
Biased Random Walk Exponential Distribution Shape Parameter	C	0.9	
Terminal Age (years)		24	
Starting Abundance (number of fish)		2,203,860	
Fraction of Fishing Mortality Not Explicitly Modeled (includes recreational fishing mortality)		0.786	

Table S.5: Age specific input parameters for red grouper. This was used to generate numbers at age using the starting abundance in the previous table and provide vectors of natural mortality and other fishing mortality at age.

Age	Probability of N at Age	M at Age	Total F at Age
1	0.26949	0.4943	0.001
2	0.21067	0.3391	0.015
3	0.15864	0.2681	0.027
4	0.11549	0.2277	0.038
5	0.08161	0.2018	0.071
6	0.05604	0.1840	0.118
7	0.03638	0.1712	0.116
8	0.02364	0.1616	0.132
9	0.01522	0.1542	0.124
10	0.00977	0.1484	0.114
11	0.00644	0.1438	0.112
12	0.00423	0.1401	0.113
13	0.00288	0.1371	0.113
14	0.00207	0.1347	0.114
15	0.00153	0.1327	0.115
16	0.00118	0.1310	0.115
17	0.00094	0.1296	0.115
18	0.00078	0.1284	0.116
19	0.00066	0.1274	0.116
20	0.00024	0.1266	0.116
21	0.00022	0.1266	0.116
22	0.00020	0.1266	0.116
23	0.00018	0.1266	0.116
24	0.00017	0.1266	0.116
25	0.00015	0.1266	0.116
26	0.00014	0.1266	0.116
27	0.00013	0.1266	0.116
28	0.00011	0.1266	0.116
29	0.00010	0.1266	0.116
30	0.00009	0.1266	0.116
31	0.00009	0.1266	0.116
32	0.00008	0.1266	0.116
33	0.00007	0.1266	0.116
34	0.00006	0.1266	0.116
35	0.00006	0.1266	0.116
36	0.00005	0.1266	0.116
37	0.00005	0.1266	0.116
38	0.00004	0.1266	0.116
39	0.00004	0.1266	0.116

40	0.00004	0.1266	0.116

Table S.6: Age specific input parameters for gag grouper. This was used to generate numbers at age using the starting abundance in the previous table and provide vectors of natural mortality and other fishing mortality at age.

Age	Probability of N at Age	M at Age	Total F at Age
1	0.27957	0.5255	0.04
2	0.21053	0.3734	0.25
3	0.15284	0.292	0.56
4	0.10375	0.2394	0.79
5	0.06573	0.2018	0.92
6	0.04011	0.1733	0.91
7	0.02623	0.1507	0.79
8	0.01785	0.1324	0.63
9	0.01263	0.1171	0.49
10	0.00994	0.1041	0.39
11	0.00815	0.0931	0.31
12	0.01000	0.0834	0.25
13	0.00871	0.075	0.25
14	0.00759	0.0677	0.25
15	0.00662	0.0611	0.25
16	0.00578	0.0553	0.25
17	0.00505	0.0501	0.25
18	0.00441	0.0455	0.25
19	0.00385	0.0413	0.25
20	0.00336	0.0375	0.25
21	0.00294	0.0341	0.25
22	0.00257	0.0311	0.25
23	0.00225	0.0283	0.25
24	0.00196	0.0258	0.25
25	0.00172	0.0235	0.25
26	0.00150	0.0214	0.25
27	0.00131	0.0195	0.25
28	0.00115	0.0178	0.25
29	0.00100	0.0163	0.25
30	0.00088	0.0149	0.25

Table S.7: Age specific input parameters for mutton snapper. This was used to generate numbers at age using the starting abundance in the previous table and provide vectors of natural mortality and other fishing mortality at age.

Age	Probability of N at Age	M at Age	Recreational F at Age Only
1	0.29631	0.273	0.0116
2	0.20209	0.216	0.0634
3	0.13122	0.184	0.1656
4	0.08556	0.163	0.0449
5	0.06019	0.148	0.0314
6	0.04472	0.138	0.0254
7	0.03297	0.130	0.0206
8	0.02412	0.124	0.0154
9	0.01747	0.120	0.0123
10	0.01360	0.116	0.0117
11	0.01088	0.113	0.0110
12	0.00873	0.111	0.0110
13	0.00708	0.109	0.0104
14	0.00592	0.107	0.0096
15	0.00514	0.106	0.0093
16	0.00447	0.105	0.0091
17	0.00404	0.104	0.0090
18	0.00381	0.103	0.0090
19	0.00382	0.102	0.0090
20	0.00384	0.102	0.0089
21	0.00347	0.101	0.0086
22	0.00343	0.101	0.0086
23	0.00319	0.100	0.0086
24	0.00277	0.100	0.0084
25	0.00251	0.100	0.0084
26	0.00227	0.100	0.0084
27	0.00205	0.099	0.0084
28	0.00186	0.099	0.0084
29	0.00168	0.099	0.0084
30	0.00153	0.099	0.0084
31	0.00138	0.099	0.0084
32	0.00125	0.099	0.0084
33	0.00113	0.099	0.0084
34	0.00103	0.099	0.0084
35	0.00093	0.099	0.0084
36	0.00084	0.099	0.0084
37	0.00076	0.099	0.0084
38	0.00069	0.099	0.0084
39	0.00063	0.099	0.0084

40	0.00057	0.099	0.0084

Table S.8: Age specific input parameters for red snapper. This was used to generate numbers at age using the starting abundance in the previous table and provide vectors of natural mortality and other fishing mortality at age.

Age	Probability of N at Age	M at Age	Total F at Age
1	0.4449	0.59	0.05
2	0.2573	0.10	0.06
3	0.1297	0.10	0.32
4	0.0499	0.10	1.03
0	0.0250	0.10	1.26
6	0.0153	0.10	1.04
7	0.0110	0.10	1.01
8	0.0107	0.10	0.77
9	0.0089	0.10	0.72
10	0.0072	0.10	0.63
11	0.0058	0.10	0.38
12	0.0049	0.10	0.39
13	0.0041	0.10	0.37
14	0.0036	0.10	0.39
15	0.0033	0.10	0.39
16	0.0030	0.10	0.39
17	0.0027	0.10	0.39
18	0.0024	0.10	0.39
19	0.0022	0.10	0.39
20	0.0020	0.10	0.39
21	0.0018	0.10	0.39
22	0.0016	0.10	0.39
23	0.0015	0.10	0.39
24	0.0013	0.10	0.39

Table S.9: Fishing vessel characteristic parameters and probability distributions or formulas.

Process and Distribution	Parameter	Handline Vessels	Longline Vessels	Distribution/Formula
Vessel Length	mean	3.51	3.77	Lognormal
	st. dev.	0.19	0.16	
Fuel Capacity	a	0.0028	0.0028	
	b	3.32	3.32	
Fish Hold Capacity	mean	6.88	8.81	Lognormal
	st. dev.	0.98	0.18	
Cruise Speed	mean	2.44	2.44	Lognormal
	st. dev.	0.18	0.18	
Red Grouper Fishing Power	mean	1.11	0.56	Exponential
Gag Grouper Fishing Power	b0	-0.39	0.2	
	b1	0.8	0.77	
Red Snapper Fishing Power	mean	0.71	0.71	Exponential
Mutton Snapper Fishing Power (Handline)	mean	0.69		Exponential
Mutton Snapper Fishing Power (Longline)	b0		1.49	
	b1		0.68	
Explainatory Effort	mean	3.46	3.18	Lognormal
	st. dev.	0.43	0.28	
Sites Fished in a Day	mean	2.42	1.3	Lognormal
	st. dev.	0.78	0.67	
Distance Between Sites	mean	1.95	3.45	Exponential
Daily Catch of Other Species	mean	112.7586	288.19	Exponential
Red Snapper Allocation Probabilities	Zero Allocation	0.51	0.31	Uniform
	200 Pounds	0.13	0.36	
	2000 Pounds	0.36	0.32	
Probability of catching an individual fish	Red Grouper	0.08	0.5	See formulas and derivations on how this is calculated and used
	Gag Grouper	0.24	0.42	
	Red Snapper 200	0.14	0.21	

	Pound Allocation			
	Red Snapper 2000 Pound Allocation	0.83	0.76	
	Mutton Snapper	0.02	0.3	
Discard Mortality Probability	Red Grouper	0.10	0.10	
	Gag Grouper	See depth dependent formula	See depth dependent formula	$p = \frac{1}{1 + e^{-0.05865*((d*0.3048-45.5))}}$ *Where d = depth in feet*
	Red Snapper	0.71	0.71	
	Mutton Snapper	0.15	1.0	
Size Limit (mm)	Red Grouper	508	508	
	Gag Grouper	610	610	
	Red Snapper	330	330	
	Mutton Snapper	406	406	
Number of Vessels in Fleet	N	290	74	

Table S.10: Final binomial logistic best model fit for the decision when to fish for the handline fleet in the Florida Panhandle. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.14.

Coefficient	Estimate	Std. Error
Intercept	-2.149	0.344
Vessel Length	0.014	0.004
Shallow Water And Red Grouper Closed	-0.578	0.104
Red Snapper Closed	-0.983	0.058
Grouper Spawning Closure	-0.740	0.128
CPI Adjusted Diesel Price	-0.517	0.100
Vessel Use Frequency	0.024	0.001
Wind Speed Knots	-0.027	0.004

Table S.11: Final binomial logistic best model fit for the decision when to fish for the handline fleet on Florida's West Coast (not including the Florida Panhandle). Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.17.

Coefficient	Estimate	Std. Error
Intercept	-2.847	0.228
Spring	0.846	0.070
Summer	0.773	0.071
Winter	0.755	0.079
Shallow Water And Red Grouper Closed	-0.746	0.109
Red Snapper Closed	-0.108	0.043
Grouper Spawning Closure	-1.159	0.097
CPI Adjusted Diesel Price	-0.355	0.075
Vessel Use Frequency	0.049	0.001
Wind Speed Knots	-0.043	0.004
Weekend	-0.148	0.043

Table S.12: Final binomial logistic best model fit for the decision when to fish for all longline vessels. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.83.

Coefficient	Estimate	Std. Error
Intercept	-3.626	0.136
Summer	0.439	0.108
Shallow Water And Red Grouper Closed	-1.406	0.189
Deep Water Grouper Closed	-0.380	0.103
Grouper Spawning Closure	-0.522	0.133
Vessel Use Frequency	0.050	0.005

Table S.13: Final multinomial logistic best model fit for the decision where to fish for all handline vessels in the Florida Panhandle. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.159.

Coefficient	Estimate	Std. Error	Significance
Site 37	0.136	0.139	
Site 38	0.389	0.144	**
Site 39	-0.887	0.269	***
Site 40	-0.052	0.169	
Site 41	-0.154	0.154	
Site 42	-0.977	0.256	***
Site 43	-0.316	0.192	.
Site 44	-1.989	0.472	***
Site 45	-1.331	0.263	***
Site 46	-0.071	0.196	
Site 47	-1.611	0.445	***
Site 48	-1.881	0.481	***
Site 49	-3.077	1.016	**
Site 50	-1.346	0.367	***
Distance	-0.004	0.001	***
Expected Revenue: Red Grouper	0.075	0.034	*
Expected Revenue: Gag Grouper	-0.087	0.023	***
Habit	3.205	0.090	***

Table S.14: Final multinomial logistic best model fit for the decision where to fish for all handline vessels in the Florida West coast proper (not including the Florida Panhandle). Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.204. Numbered locations for site choice correspond to the areas presented in Figure S.1 below, and represent the intersection of 20-meter depth contours with bands of equal, integer latitude and longitude.

Coefficient	Estimate	Std. Error	Significance
Site 2	-1.421	3.463	
Site 3	0.419	3.493	
Site 5	3.723	2.145	.
Site 6	4.398	2.049	*
Site 7	4.193	2.781	
Site 8	2.301	2.397	
Site 9	1.045	2.442	
Site 10	4.922	2.027	*
Site 11	2.593	2.163	
Site 12	3.283	2.432	
Site 13	3.758	2.056	.
Site 14	4.079	2.183	.

Site 15	3.501	2.262	
Site 16	3.780	2.029	.
Site 17	3.502	2.104	.
Site 18	4.811	2.042	*
Site 19	3.666	2.096	.
Site 20	4.453	2.065	*
Site 21	4.914	2.051	*
Site 22	5.124	2.038	*
Site 23	5.722	2.032	**
Site 24	4.581	2.069	*
Site 25	5.208	2.115	*
Site 26	5.412	2.014	**
Site 27	5.538	2.024	**
Site 28	5.666	2.025	**
Site 29	5.341	2.080	*
Site 30	5.591	2.022	**
Site 31	5.813	2.013	**
Site 32	4.967	2.033	*
Site 33	5.466	2.034	**
Site 33	3.047	2.139	
Site 35	6.012	2.019	**
Distance	-0.009	0.000	***
Expected Revenue: Red Grouper	-0.011	0.002	***
Habit	2.926	0.051	***
Site 2:Wind Speed	0.036	0.152	
Site 3:Wind Speed	-0.058	0.184	
Site 5:Wind Speed	-0.146	0.109	
Site 6:Wind Speed	-0.118	0.099	
Site 7:Wind Speed	-0.212	0.170	
Site 8:Wind Speed	-0.049	0.119	
Site 9:Wind Speed	0.009	0.115	
Site 10:Wind Speed	-0.098	0.098	
Site 11:Wind Speed	-0.100	0.106	
Site 12:Wind Speed	-0.159	0.131	
Site 13:Wind Speed	-0.094	0.100	
Site 14:Wind Speed	-0.150	0.111	
Site 15:Wind Speed	-0.130	0.116	
Site 16:Wind Speed	-0.127	0.098	
Site 17:Wind Speed	-0.132	0.105	
Site 18:Wind Speed	-0.160	0.100	
Site 19:Wind Speed	-0.119	0.103	
Site 20:Wind Speed	-0.151	0.101	
Site 21:Wind Speed	-0.237	0.102	*
Site 22:Wind Speed	-0.204	0.100	*
Site 23:Wind Speed	-0.231	0.099	*

Site 24:Wind Speed	-0.186	0.102	.
Site 25:Wind Speed	-0.244	0.109	*
Site 26:Wind Speed	-0.185	0.097	.
Site 27:Wind Speed	-0.193	0.098	*
Site 28:Wind Speed	-0.182	0.098	.
Site 29:Wind Speed	-0.224	0.105	*
Site 30:Wind Speed	-0.158	0.098	
Site 31:Wind Speed	-0.160	0.097	.
Site 32:Wind Speed	-0.166	0.099	.
Site 33:Wind Speed	-0.197	0.099	*
Site 33:Wind Speed	-0.121	0.106	
Site 35:Wind Speed	-0.193	0.098	*

Table S.15: Final multinomial logistic best model fit for the decision where to fish for all longline vessels. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.889. Numbered locations for site choice correspond to the areas presented in Figure S.1 below, and represent the intersection of 20-meter depth contours with bands of equal, integer latitude and longitude.

Coefficient	Estimate	Std. Error	Significance
Site 7	-8.332	6.950	
Site 8	-8.507	4.878	.
Site 9	-7.292	4.412	.
Site 10	-6.000	4.272	
Site 11	-4.334	4.374	
Site 12	-4.484	5.047	
Site 13	-8.561	4.867	.
Site 14	-3.518	4.287	
Site 15	-2.152	4.572	
Site 16	-2.281	4.037	
Site 17	-5.930	4.110	
Site 18	-2.561	4.646	
Site 19	-5.182	4.277	
Site 20	-4.349	4.131	
Site 21	-3.287	4.045	
Site 22	-5.477	4.055	
Site 23	-5.114	4.155	
Site 24	-2.888	4.150	
Site 25	-2.721	4.174	
Site 26	-4.642	4.240	
Site 27	-10.873	4.350	*
Site 28	-6.086	4.499	
Site 29	-7.383	5.103	

Site 30	-3.964	4.624	
Site 31	-12.951	6.222	*
Site 32	-8.980	5.957	
Site 35	-23.085	14.035	.
Site 36	-112.490	72.028	
Site 40	-10.668	8.340	
Site 45	-9.633	11.078	
Site 47	-21.708	15.143	
Distance	-0.006	0.001	***
Habit	2.166	0.074	***
Site 7:Real Fuel Price	2.665	2.472	
Site 8:Real Fuel Price	4.227	1.773	*
Site 9:Real Fuel Price	3.186	1.640	.
Site 10:Real Fuel Price	3.142	1.597	*
Site 11:Real Fuel Price	2.433	1.632	
Site 12:Real Fuel Price	2.346	1.864	
Site 13:Real Fuel Price	3.555	1.779	*
Site 14:Real Fuel Price	2.237	1.615	
Site 15:Real Fuel Price	1.434	1.712	
Site 16:Real Fuel Price	1.762	1.530	
Site 17:Real Fuel Price	3.193	1.551	*
Site 18:Real Fuel Price	1.686	1.746	
Site 19:Real Fuel Price	2.825	1.605	.
Site 20:Real Fuel Price	2.438	1.555	
Site 21:Real Fuel Price	2.034	1.532	
Site 22:Real Fuel Price	3.070	1.535	*
Site 23:Real Fuel Price	2.645	1.564	.
Site 24:Real Fuel Price	2.169	1.567	
Site 25:Real Fuel Price	2.141	1.574	
Site 26:Real Fuel Price	2.434	1.597	
Site 27:Real Fuel Price	4.856	1.617	**
Site 28:Real Fuel Price	3.238	1.669	.
Site 29:Real Fuel Price	2.998	1.857	
Site 30:Real Fuel Price	3.966	1.718	*
Site 31:Real Fuel Price	4.982	2.156	*
Site 32:Real Fuel Price	4.098	2.145	.
Site 35:Real Fuel Price	7.401	4.303	.
Site 36:Real Fuel Price	31.096	18.480	.
Site 40:Real Fuel Price	3.676	2.867	
Site 45:Real Fuel Price	6.333	3.663	.
Site 47:Real Fuel Price	7.835	4.660	.
Site 7:Wind Speed	0.033	0.097	
Site 8:Wind Speed	-0.145	0.087	.
Site 9:Wind Speed	-0.004	0.068	
Site 10:Wind Speed	-0.052	0.067	

Site 11:Wind Speed	-0.093	0.074	
Site 12:Wind Speed	-0.113	0.089	
Site 13:Wind Speed	-0.054	0.078	
Site 14:Wind Speed	-0.087	0.069	
Site 15:Wind Speed	-0.069	0.074	
Site 16:Wind Speed	-0.081	0.062	
Site 17:Wind Speed	-0.109	0.065	.
Site 18:Wind Speed	-0.142	0.086	.
Site 19:Wind Speed	-0.117	0.068	.
Site 20:Wind Speed	-0.072	0.063	
Site 21:Wind Speed	-0.103	0.062	.
Site 22:Wind Speed	-0.133	0.063	*
Site 23:Wind Speed	-0.099	0.066	
Site 24:Wind Speed	-0.145	0.067	*
Site 25:Wind Speed	-0.144	0.067	*
Site 26:Wind Speed	-0.108	0.068	
Site 27:Wind Speed	-0.137	0.070	.
Site 28:Wind Speed	-0.147	0.075	.
Site 29:Wind Speed	-0.053	0.084	
Site 30:Wind Speed	-0.501	0.118	***
Site 31:Wind Speed	-0.097	0.108	
Site 32:Wind Speed	-0.188	0.126	
Site 35:Wind Speed	-0.010	0.177	
Site 36:Wind Speed	0.471	0.389	
Site 40:Wind Speed	-0.022	0.126	
Site 45:Wind Speed	-0.771	0.556	
Site 47:Wind Speed	-0.096	0.257	

Table S.16: Final binomial logistic best model fit for the decision when to return to port for the handline fleet in the Florida Panhandle. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.38. Numbered locations for site choice correspond to the areas presented in Figure S.1 below, and represent the intersection of 20-meter depth contours with bands of equal, integer latitude and longitude.

Coefficient	**Estimate**	**Std. Error**
Intercept	-1.665	0.506
Vessel Length	-0.043	0.005
Shallow Water And Red Grouper Closed	0.748	0.150
Red Snapper Closed	-0.238	0.082
Deep Water Grouper Closed	-0.226	0.085
Grouper Spawning Closure	0.516	0.184
CPI Adjusted Price of Red Grouper	0.423	0.179
Ratio Catch To Fish Hold	3.679	0.149
Weekend	-0.316	0.086

Table S.17: Final binomial logistic best model fit for the decision when to return to port for the handline fleet in the Florida west coast proper (excluding the Florida Panhandle). Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.16.

Coefficient	**Estimate**	**Std. Error**
Intercept	-2.441	0.374
Vessel Length	-0.022	0.005
Shallow Water And Red Grouper Closed	0.447	0.119
Red Snapper Closed	0.092	0.049
Grouper Spawning Closure	0.346	0.122
CPI Adjusted Diesel Price	-0.295	0.075
CPI Adjusted Price of Red Grouper	0.201	0.112
Ratio Catch To Fish Hold	4.643	0.088
Weekend	-0.221	0.051

Table S.18: Final binomial logistic best model fit for the decision when to return to port for all longline vessels. Likelihood ratio test for whether there was a difference between the initial full and final best model fits: p=0.737.

Coefficient	**Estimate**	**Std. Error**
Intercept	-2.766	0.249
Vessel Length	-0.032	0.005
Shallow Water And Red Grouper Closed	0.582	0.223
Tilefish Closed	-0.402	0.103
Deep Water Grouper Closed	0.416	0.091
Grouper Spawning Closure	0.572	0.168
Ratio Catch To Fish Hold	4.797	0.150

Stock Synthesis Assessment Model Technical Components Utilized

The following is a description of the Stock Synthesis (version 3.24P) assessment model developed for each species (i.e. the functions selected, how population was structured, etc.). Table S.19 and the equations that follow describe the options and mathematics that were selected for its implementation in this study. A complete description of all functions within Stock Synthesis and their generalizable forms can be found in the Appendix of:

Methot, R. D. & Wetzel, C. R. (2013). Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142, 86-99. doi:10.1016/j.fishres.2012.10.012.

Table S.19: Various configurations of the Stock Synthesis assessment model trialed for each species to determine a base model.

Red Grouper Stock Synthesis Model Selection						
Run	**Negative Log-likelihood**	**Number of Parameters**	**Number of Data Points**	**AIC**	**AICc**	**Delta AICc**
Used a double-normal function to represent both handline and longline selectivity at length; estimated steepness stock-recruitment function parameter (h), virgin recruits (R_0), and sequential hermaphroditism function parameters.	3,464	79	1,040	7,086	7,099	4,106
Same as above except fixed steepness stock-recruitment function parameter (h) to the value used in the simulation.	3,470	79	1,040	7,098	7,111	4,119
Same as above except estimated stock-recruitment function error and estimated steepness stock-recruitment function parameter (h).	3,353	80	1,040	6,866	6,879	3,887
Same as above except fixed steepness stock-recruitment function parameter (h) to the value used in the simulation, fixed stock-recruitment function error, estimated virgin recruits (R_0).	1,412	78	1,040	2,980	2,992	0
Gag Grouper Stock Synthesis Model Selection						

Run	Negative Log-likelihood	Number of Parameters	Number of Data Points	AIC	AICc	Delta AICc
Estimated sequential hermaphroditism function parameters, virgin recruits (R_0), and steepness stock-recruitment function parameter (h); used double-normal function to represent handline selectivity and logistic function to represent longline selectivity at length.	10,455	69	1,040	21,047	21,057	9,435
Same as above except fixed steepness stock-recruitment function parameter (h); Estimated L_{min} and L_{∞} growth parameters.	9,287	74	1,040	18,721	18,733	7,111
Same as above except estimated gender specific L_{min} growth parameters.	8,144	75	1,040	16,438	16,450	4,828
Same as above except fixed gender specific L_{min} and L_{∞} growth parameters and estimated steepness stock-recruitment function parameter (h).	7,623	71	1,040	15,387	15,398	3,776
Same as above except estimated the same L_{min} and L_{∞} growth parameters for both genders.	5,728	77	1,040	11,609	11,622	0
Red Snapper Stock Synthesis Model Selection						
Run	**Negative Log-likelihood**	**Number of Parameters**	**Number of Data Points**	**AIC**	**AICc**	**Delta AICc**
Fixed growth parameters and steepness stock-recruitment function parameter (h); estimated virgin recruits (R_0); used the double normal function to estimate selectivity at length for both handline and longline fleets.	6,479	65	1,040	13,089	13,097	8,914

Same as above except used logistic selectivity for longline fleet.	2,613	77	1,040	5,381	5,393	1,209
Estimated L_{min} and L_{∞} growth parameters, virgin recruits (R_0), and steepness stock-recruitment function parameter (h); Used double-normal function to represent handline and longline selectivity at length.	2,064	73	1,040	4,274	4,285	102
Fixed L_{min} and L_{∞} growth parameters, and fixed steepness stock-recruitment function parameter (h); estimated virgin recruits (R_0); used double-normal function to represent handline and longline selectivity at length.	2,022	65	1,040	4,175	4,184	0
Mutton Snapper Stock Synthesis Model Selection						
Run	**Negative Log-likelihood**	**Number of Parameters**	**Number of Data Points**	**AIC**	**AICc**	**Delta AICc**
Fixed L_{min} and L_{∞} growth parameters; estimated virgin recruits (R_0) and steepness stock-recruitment function parameter (h); used double normal to estimate selectivity at length for both handline and longline fleets.	75,396	144	1,040	151,080	151,127	148,037
Same as above, except used exponential-logistic distribution for handline selectivity and logistic function for longline selectivity.	38,047	68	1,040	76,231	76,240	73,151
Same as above, except used double normal to estimate selectivity at length for both handline and longline fleets.	4,380	78	1,040	8,916	8,929	5,839
Same as above except estimated stock-recruitment function error, and used exponential-logistic	1,616	69	1,040	3,370	3,379	290

distribution for handline selectivity and double-normal function for longline selectivity						
Fixed steepness stock-recruitment function parameter (h), L_{min} and L_{∞} growth parameters, and stock-recruitment function error; estimated virgin recruits (R_0); used double normal to estimate selectivity at length for both handline and longline fleets.	1,470	70	1,040	3,079	3,090	0

When following the notation below, please note that neither time varying components to processes (such as growth, catchability, selectivity and retention) nor time varying parameters were used in the assessment because they were not represented in the simulation model. In addition, although two genders were modeled, no differences in selectivity or retention were considered between genders, and no growth morphs were modeled.

Population Model

Population Structure and Mortality

The Stock Synthesis assessment model represents the population numbers-at-age at the start of the time series, numbers of recruits each year, and the survival of each age group as it moves through the population. In our application, fishing mortality (F) was modeled at age (a) for each fishery (j) and year (y) and adjusted by selectivity (s) at age and for each fishery (Equation S.1). Fishing mortality was modeled as continuous F.

$$F_{yaj} = f_{yj} s_{aj} \tag{S.1}$$

Total mortality rate at age each year was the sum of natural mortality at age and fishing mortality at age for each fleet (Equation S.2). A vector of natural mortality at age was provided to the stock assessment from empirical studies and was the same vector at age used in the agent-based simulation model.

$$Z_{ya} = M_a + F_{yaj} \tag{S.2}$$

If the population numbers at the start of year y for age a was equal to N_{ya}, then the mean numbers of fish each age and year was equal to Equation S.3.

$$\bar{N}_{ya} = N_{ya}(1 - e^{-Z_{ya}})/Z_{ya} \tag{S.3}$$

Catch in numbers c was equal to the product of average abundance and fishing mortality at age each year (Equation S.4), while catch in biomass C was the product of catch in numbers and the average weight at age W that year for that fishery or survey (Equation S.5).

$$c_{yaj} = \bar{N}_{ya_a} F_{yaj} \tag{S.4}$$

$$C_{yaj} = c_{yaj} W_{yaj} \tag{S.5}$$

Survival to the next year and age, was represented by Equation S.6 for ages a that are not the maximum age modeled, and Equation S.7 when calculating survivors to the maximum age modeled, A.

$$N_{y+1,a+1} = N_{ya}e^{-Z_{ya}} \tag{S.6}$$

$$N_{y+1,A} = N_{y,A-1}e^{-Z_{y,A-1}} + N_{yA}e^{-Z_{yA}} \tag{S.7}$$

Within Stock Synthesis, numbers at length and/or age were modeled in discrete length or age groups. The age group assumed for the implementation of Stock Synthesis in this study was a year (annual) while the length group or bin size selected was two centimeters. The abundance of fish at age and size within the population was represented within each of these groups. An age-length key ($\varphi_{a,l}$) was used within Stock Synthesis to distribute the proportion of fish in each age group (a) across different the length groups (l) that occupy that age group. The user defines the length and age groups, and fish were distributed across length groups following a normal distribution. Let L_{min} represent the lower limit of the smallest length group (l_{min}), L_{max} represent the lower limit of the largest length group (l_{max}), Φ the standard normal cumulative density function, $\bar{L}$ the mean size in the middle of the season at age a, and σ_a equal to the standard deviation of the length of a fish of age a (i.e. the variation in size at age as a function of age; Equation S.8).

$$\varphi_{a,l} = \begin{cases} \Phi\left(\frac{L_{min}-\overline{L_a}}{\sigma_a}\right) & \text{for } l = 1 \\ \Phi\left(\frac{L_{l+1}-\overline{L_a}}{\sigma_a}\right) - \Phi\left(\frac{L_l-\overline{L_a}}{\sigma_a}\right) & \text{for } 1 < l < l_{max} \\ \Phi\left(\frac{L_{max}-\overline{L_a}}{\sigma_a}\right) & \text{for } l = l_{max} \end{cases} \tag{S.8}$$

Life History

Growth was assumed to be continuous throughout the year and followed a von Bertalanffy function (Equation S.9), where L_t was the length at age t, L_∞ was the asymptotic length, k was the growth rate, t_0 was the y-intercept of the curve, and L_1 was the length at age t_0.

$$L_t = L_\infty + (L_1 - L_\infty)e^{-k(t-t_0)} \tag{S.9}$$

Weight at age was estimated from the mean length at each age group, where α and β are parameters (Equation S.10).

$$W_a = \alpha {L_a}^{\beta} \tag{S.10}$$

Maturity was modeled using a length-based logistic function (Equation S.11), where M_L was the maturity at length L, M_∞ was the asymptotic maturity, k was the maturity rate, and γ was the y-intercept of the curve.

$$M_L = \frac{M_\infty}{1+e^{-k(L-\gamma)}} \tag{S.11}$$

Spawning stock biomass was measured as the total weight of mature female fish, and the stock-recruitment function followed a Beverton-Holt relationship (Equation S.12), where R was the number of recruited fish, h was the steepness parameter, R_0 was the number of recruited fish when the population is at virgin, and SS was the spawning stock biomass.

$$R = \frac{4hR_0SS}{R_0\emptyset(1-h)+(5h-1)SS} \tag{S.12}$$

The parameter $\emptyset$ represented the virgin spawning fish per recruit (Equation S.13), such that E_{age} was the product of maturity and fecundity at each age, a_r was the age of recruitment, $MaxAge$ was the maximum age modeled, and M was natural maturity at age j. A fecundity at age vector was provided to the assessment model from empirical studies.

$$\phi = \sum_{age=a_r}^{MaxAge} E_{age} \prod_{j=a_r}^{age-1} e^{-M_j} \tag{S.13}$$

Sequential hermaphroditism was modeled in both the simulation and the assessment for the two grouper species studied, red grouper and gag grouper. For these two grouper species, sequential hermaphroditism was modeled in Stock Synthesis by fitting a three-parameter logistic function (Equation S.14) to determine the proportion female (P_{female}) at age (a), where δ represented the inflection point, σ represented the standard deviation, ω represented the maximum value, a_{max} is the maximum age modeled, a_{min} is the minimum age modeled, and $\Phi_{\mu,\sigma^2}(x)$ is the cumulative normal distribution of x, where x is the value of whatever expression is inside the parenthesis.

$$P_{female} = \frac{\omega}{\Phi_{0,1}\left(\frac{a_{max}-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right)} \Phi_{0,1}\left(\frac{a-\delta}{\sigma}\right) - \Phi_{0,1}\left(\frac{a_{min}-\delta}{\sigma}\right) \tag{S.14}$$

Selectivity and Retention

Three different functions were used to represent selectivity at length (S_L), depending on the fleet and species being modeled (see Table 1 in the main text): a logistic function, exponential-logistic, or double normal function. Logistic selectivity (Equation S.15) was a two-parameter function where β_1 represented the intercept and β_2 represented the slope.

$$S_L = \frac{1}{1+e^{(-\ln(19)*((L-\beta_1)/\beta_2))}} \tag{S.15}$$

The exponential-logistic selectivity function was a four-parameter function (Equation S.16) bounded by an *a priori* selected minimum fish size (L_{min}) and maximum fish size (L_{max}). Let ρ_1 represent the ascending rate, ρ_2 represent the peak as a fraction of the way between L_{min} and L_{max}, $\rho_3 = L_{min} + (\rho_2 * (L_{max} - L_{min}))$, and ρ_4 represent the descending rate.

$$S_L = \frac{e^{\rho_4 * \rho_1 * (\rho_3 - L)}}{1-\rho_3 * (1-e^{\rho_1 * (\rho_3 - L)})} \tag{S.16}$$

The double normal selectivity function (Equation S.17) provided flexible options to shape selectivity as either dome-shaped (asymptotic), plateaued, or with a descending limb.

$$S_L = asc_L\left(1-J_{1,L}\right) + J_{1,L} * (\left(1-J_{2,L}\right) + J_{2,L} * dsc_L) \tag{S.17}$$

This was accomplished using a series of separate sub-functions that define the ascending (*asc*) and descending limbs (*dsc*) separately and connects them using two logistic joiner functions (*J*). Six parameters defined this relationship: υ_1 was the peak size for the plateau, υ_2 was the width of the plateau, υ_3 was the ascending limb width, υ_4 was the descending limb width, υ_5 was the selectivity at the first bin, and υ_6 was the selectivity at the last bin. First, we needed to compute the L_{peak} value, which was the length at which selectivity equaled one (Equation S.18), where L_{width} represented the width of the population length bins that the user defined.

$$L_{peak} = \rho_1 + L_{width} + \left(\frac{0.99L_{max}-\rho_1-L_{width}}{1+e^{-\rho_1}}\right) \tag{S.18}$$

With this value calculated, the ascending and descending limbs of the curve were calculated as per Equations S.19 and S.20.

$$asc_L = (1+e^{-\rho_5})^{-1} + (1-(1+e^{-\rho_5})^{-1}) \frac{e^{\left(\frac{-(L-\rho_1)^2}{e^{\rho_3}}\right)} - e^{\left(\frac{(L_{min}-\rho_1)^2}{e^{\rho_3}}\right)}}{1-e^{\left(\frac{(L_{min}-\rho_1)^2}{e^{\rho_3}}\right)}} \tag{S.19}$$

$$dsc_L = 1 + ((1+e^{-\rho_6})^{-1} - 1) \frac{e^{\left(\frac{-(L-L_{peak})^2}{e^{\rho_4}}\right)} - 1}{e^{\left(\frac{-(L_{max}-L_{peak})^2}{e^{\rho_4}}\right)} - 1} \tag{S.20}$$

The joiner functions for the ascending and descending components were calculated in Equations S.21 and S.22 respectfully.

$$J_{1,L} = \frac{1}{1+e^{\left(-20*\frac{L-v_1}{1+|L-v_1|}\right)}} \tag{S.21}$$

$$J_{2,L} = \frac{1}{1+e^{\left(-20*\frac{L-L_{peak}}{1+|L-L_{peak}|}\right)}} \tag{S.22}$$

A logistic fishery retention function was used to proportion the catch into discarded and retained components ($P_{retention}$), where ς_1 represented the inflection, ς_2 represented the slope, and ς_3 represented the asymptote (Equation S.23).

$$P_{retention} = \frac{\varsigma_3}{1+e^{\left(-\frac{(L-\varsigma_1)}{\varsigma_2}\right)}} \tag{S.23}$$

Observation Model

The observation model within Stock Synthesis generated expected values for the sampled data by adjusting the parameters and functions that relate the population model to the sampled data. The sampled data from the agent-based model included in the Stock Synthesis implementations were total landings time series for each fishery (commercial handline, commercial longline, and recreational), indices of biomass for the commercial handline and longline fisheries, discard data in numbers of fish per year, and the catch at length from the simulated commercial handline and longline fisheries.

The catch at length for each year (*y*), fleet (*f*), and length group (*l*) was the product of selectivity ($S_{l,f}$), age-length key ($\varphi_{a,l}$), and the numbers at age for that year as represented in Equation S.24, where the *timing* represented when that survey occurred during the year and was specified by the user. In our implementation of the assessment model, all surveys were assumed to take place in the middle of the year because in the simulation, the fishing operations that generated the catch per unit effort survey indices occurred year-round.

$$C_{y,f,l} = S_{l,f}\varphi_{a,l}N_{a,y}e^{-timing(Z_{y,a,f})} \tag{S.24}$$

In order to fit to the biomass indices, the biomass available for observation each year (*y*) by each fleet (*f*) as a function of their catch was represented by Equation S.25.

$$B_{y,f} = \sum_{l=1}^{L_{max}} w_l \sum_{a=0}^{A} C_{y,f,a} \tag{S.25}$$

The expected biomass to be observed by each fishery or survey was related to the available population abundance by the catchability coefficient for that fishery or survey (Q_f) as per Equation S.26. The catchability coefficient in all applications of Stock Synthesis in this study was modeled as directly proportional to biomass. The catchability parameter was set as a scaling factor such that the estimate was median unbiased.

$$E(B_{y,f}) = Q_f B_{y,f} \tag{S.26}$$

The expected value for the length composition observation was derived from the age and length population predictions by filtering the population at length and age through retention and selectivity processes. Data and population length bins in the implementation of Stock Synthesis used in this study were selected to be the same for each species modeled and were both divided into two-centimeter increments. The expected size compositions of fish catch within a given length bin *l* during year *y* for fishery or survey *f*, is represented by Equation S.27 where *A* was the maximum age, l_{min} was the minimum length bin, l_{max} was the maximum length bin, and x was a small constant added to each bin specified by the user.

$$E(P_{y,f,a,l}) = \frac{\sum_{a=0}^{A} C_{y,f,a,l}+x}{\sum_{l=1}^{l_{max}} \sum_{a=0}^{A} C_{y,f,a,l}+x} \tag{S.27}$$

The expected size compositions were compressed at the tails according to Equation S.28 in order to properly fit the compositions from the data.

$$E(P_{y,f,a,l}) = \begin{cases} 0 & \text{for } l < l_{min} \\ \sum_{l \le l_{min}} E(P_{y,f,a,l}) & \text{for } l = l_{min} \\ E(P_{y,f,a,l}) & \text{for } l_{min} < l < l_{max} \\ \sum_{l \le l_{max}} E(P_{y,f,a,l}) & \text{for } l = l_{max} \\ 0 & \text{for } l > l_{max} \end{cases} \tag{S.28}$$

Statistical Model

The likelihood function for Stock Synthesis included the contributions from catch, abundance indices, discards, length composition, and recruitment. No priors were used on any parameters in this implementation, and parameters were not allowed to vary as random deviates over time. The objective function (L) was the weighted sum of the individual likelihood components ($L_{i,f}$), where each component reflected model fits to each data vector (i) and each fishery or survey (f). Deviations in recruitment were allowed to be estimated by the model and were represented in the likelihood function by the term L_R. In this study, catch, biomass indices, discards, length composition, and recruitment were all likelihood components, and all were weighted equally ($\omega_{i,f}$) in their likelihood contribution (Equation S.29).

$$L = \sum_{i=0}^{I} \sum_{f=1}^{A_f} \omega_{i,f} L_{i,f} + \omega_R L_R \tag{S.27}$$

Individual likelihood components (i) for fits to indices of biomass (I), discards (D), length composition (LC), catch (C), initial equilibrium catch ($C_{t=0}$), and recruitment deviations (RD) were provided in Equations S.28 through S.32 respectfully. The contribution of the biomass or abundance indices to the log-likelihood function was not bias corrected in our implementation (as some versions of Stock Synthesis provide this option), and was represented in Equation S.28, where I was an observed index of abundance for year y and fishery f, Q was catchability, B was biomass available to that fishery or survey, and σ^2 represented the standard deviation of the index estimate each year. This study assumed a lognormal error distribution for catch per unit effort index observations.

$$L_{I,f} = N(\ln(\sigma)) + \sum_{y=1}^{N_y} \frac{\left(\ln(I_{y,f}) - \ln(Q_f B_{y,f})\right)^2}{2\sigma^2} \tag{S.28}$$

The contribution of the discard fit to the log-likelihood was based on the assumption of a t-distribution where df is the degrees of freedom, $d_{y,f}$ was the observed discard for year y and fleet f, $\widehat{d_{y,f}}$ was the expected discard for year y and fleet f, $\sigma_{y,f}$ was the standard deviation of the discard observations, and $\tilde{\sigma}$ was the standard deviation offset value specified by the user as an additional amount of variance to add to the coefficient of variation; this would be added to the standard error if specified. In our implementation, we did not assume any additional variance so $\tilde{\sigma}$ was assumed to be zero. The error distribution for the discard observations was assumed in this implementation to be normally distributed where the error value inputs were interpreted as coefficient of variations (Equation S.29).

$$L_{D,f} = \sum_{f=1}^{A_f} 0.5\left(df_f + 1\right) \ln\left(\frac{1+\left(d_{y,f} - \widehat{d_{y,f}}\right)^2}{df_f \sigma^2{}_{y,f}}\right) + \tilde{\sigma} \ln\left(\sigma_{y,f}\right) \tag{S.29}$$

The catch at size distribution log-likelihood contribution was specified in Equation S.30, where $n_{y,f}$ was the user specified sample size, $p_{y,f,l}$ ias the observed proportion by length in the sample during year y for fishery f, and $\widehat{p_{y,f,l}}$ was the expected proportion. The error between observed and fitted catch at size observations was assumed to be lognormally distributed.

$$L_{LC,f} = \sum_{y=1}^{N_y} \sum_{l=1}^{L_{max}} n_{y,f} p_{y,f,l} \frac{p_{y,f,l}}{\widehat{p_{y,f,l}}} \tag{S.30}$$

The observed and fitted catch for each year and fleet that contributes to the log-likelihood was represented by Equation S.31, where $C_{y,f}$ was the catch each year and fleet, and x represented a small added constant equal to 10^{-6}. The contribution of the initial equilibrium catch ($C_{t=0,f}$) to the log-likelihood used the same function, by substituting initial equilibrium catch for $C_{y,f}$. The landings error distribution was assumed to be lognormally distributed.

$$L_{C,f} = \sum_{y=1}^{N_y} \frac{\left(\ln\left(C_{y,f}\right) - \ln\left(\widehat{C_{y,f} + x}\right)\right)^2}{2\sigma_{y,f}{}^2} \tag{S.31}$$

Recruitment deviations contributed to the log-likelihood as per Equation S.32, where the second term (b_y times the natural log of the variance) scaled according to the bias recruitment adjustment parameter, which was fixed at 0.01 for all implementations of Stock Synthesis in this study.

$$L_R = \frac{1}{2} \sum_{y=1}^{N_y} \frac{\widetilde{R_y^2}}{\sigma_R^2} + b_y \ln\left(\sigma_R^2\right) \tag{S.32}$$

Stock Synthesis Assessment Model Inputs, Standard Errors and Effective Sample Sizes

Red Grouper

Table S.20: Simulated red grouper landings (in metric tons) included in this study's implementation of Stock Synthesis for the simulated handline and longline fishing fleets, and the removals from applying the recreational fishing mortality rate.

Simulation Year	Handline	Longline	Recreational
1	458	488	520
2	509	418	582
3	557	470	659
4	582	386	736
5	597	454	817
6	585	391	895
7	678	499	1,004
8	712	446	1,099
9	756	542	1,203
10	809	476	1,288
11	844	592	1,359
12	845	563	1,435
13	897	573	1,488
14	880	523	1,544
15	913	621	1,593
16	952	510	1,630
17	944	622	1,666
18	956	487	1,696
19	966	681	1,735
20	959	545	1,748

Table S.21: Simulated red grouper indices of biomass and assumed CV values for the handline and longline fleets.

Simulation Year	Typical Standardization				Extended Standardization				Perfect Information			
	Handline Index	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*
1	0.609	0.01	1.169	0.01	0.621	0.01	1.236	0.01	0.437	0.01	0.437	0.01
2	0.687	0.01	1.065	0.01	0.662	0.01	1.087	0.01	0.499	0.01	0.499	0.01
3	0.728	0.01	0.871	0.01	0.734	0.01	0.920	0.01	0.561	0.01	0.561	0.01
4	0.762	0.01	0.824	0.01	0.753	0.01	0.862	0.01	0.620	0.01	0.620	0.01
5	0.765	0.01	0.733	0.01	0.782	0.01	0.771	0.01	0.656	0.01	0.656	0.01
6	0.780	0.01	0.813	0.01	0.782	0.01	0.781	0.01	0.712	0.01	0.712	0.01
7	0.835	0.01	0.808	0.01	0.847	0.01	0.795	0.01	0.794	0.01	0.794	0.01
8	0.948	0.01	0.862	0.01	0.933	0.01	0.850	0.01	0.876	0.01	0.876	0.01
9	0.958	0.01	0.981	0.01	0.986	0.01	0.946	0.01	0.950	0.01	0.950	0.01
10	1.060	0.01	0.946	0.01	1.042	0.01	0.966	0.01	1.021	0.01	1.021	0.01
11	1.060	0.01	1.005	0.01	1.082	0.01	1.025	0.01	1.084	0.01	1.084	0.01
12	1.119	0.01	1.085	0.01	1.100	0.01	1.034	0.01	1.142	0.01	1.142	0.01
13	1.123	0.01	1.027	0.01	1.149	0.01	1.039	0.01	1.193	0.01	1.193	0.01
14	1.175	0.01	1.013	0.01	1.153	0.01	1.040	0.01	1.244	0.01	1.244	0.01
15	1.170	0.01	1.076	0.01	1.179	0.01	1.048	0.01	1.285	0.01	1.285	0.01
16	1.259	0.01	1.109	0.01	1.235	0.01	1.075	0.01	1.325	0.01	1.325	0.01
17	1.211	0.01	1.224	0.01	1.236	0.01	1.162	0.01	1.358	0.01	1.358	0.01
18	1.261	0.01	1.082	0.01	1.229	0.01	1.132	0.01	1.390	0.01	1.390	0.01
19	1.191	0.01	1.177	0.01	1.220	0.01	1.128	0.01	1.415	0.01	1.415	0.01
20	1.300	0.01	1.130	0.01	1.276	0.01	1.102	0.01	1.438	0.01	1.438	0.01

Table S.22: Simulated red grouper discards in metric tons for the handline and longline fleets and the assumed coefficients of variation.

Simulation Year	Handline	Handline CV	Longline	Longline CV
1	26	0.1	22	0.1
2	26	0.1	17	0.1
3	25	0.1	17	0.1
4	25	0.1	14	0.1
5	30	0.1	17	0.1
6	31	0.1	18	0.1
7	34	0.1	26	0.1
8	32	0.1	18	0.1
9	33	0.1	20	0.1
10	35	0.1	19	0.1
11	34	0.1	26	0.1
12	32	0.1	21	0.1
13	34	0.1	23	0.1
14	33	0.1	22	0.1
15	33	0.1	23	0.1
16	34	0.1	20	0.1
17	34	0.1	28	0.1
18	33	0.1	18	0.1
19	35	0.1	27	0.1
20	32	0.1	25	0.1

Table S.23: Red grouper effective sample sizes used for catch at length observations. Effective sample sizes were determined by dividing the actual sample sizes by 1,000.

Simulation Year	**Catch At Length From Simulated Fishery**		
	Handline	*Longline*	*Recreational*
1	290	147	2,291
2	276	124	2,496
3	309	139	2,844
4	307	115	3,191
5	320	129	3,502
6	305	115	3,817
7	349	147	4,199
8	354	137	4,495
9	370	160	4,782
10	372	143	4,996
11	389	170	5,154
12	375	165	5,319
13	393	164	5,432
14	384	154	5,526
15	394	170	5,628
16	392	147	5,688
17	398	170	5,753
18	388	143	5,794
19	404	184	5,884
20	386	154	5,890

Gag Grouper

Table S.24: Simulated gag grouper landings (in metric tons) included in this study's implementation of Stock Synthesis for the simulated handline and longline fishing fleets, and the removals from applying the recreational fishing mortality rate.

Simulation Year	Handline	Longline	Recreational
1	812	350	2,707
2	543	158	2,030
3	406	111	1,660
4	292	55	1,593
5	278	58	1,677
6	261	36	1,784
7	263	41	1,840
8	248	26	1,857
9	243	30	1,856
10	230	24	1,852
11	232	28	1,837
12	216	23	1,838
13	222	24	1,825
14	210	22	1,821
15	216	24	1,819
16	214	20	1,817
17	211	23	1,812
18	207	20	1,809
19	215	24	1,809
20	210	21	1,806

Table S.25: Simulated red grouper indices of biomass and the CV values assumed for the handline and longline fleets.

Simulation Year	**Typical Standardization**				**Extended Standardization**				**Perfect Information**			
	Handline Index	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*
1	2.571	0.010	4.567	0.010	2.586	0.010	6.213	0.010	1.569	0.010	1.569	0.010
2	1.773	0.010	2.738	0.010	1.757	0.010	2.847	0.010	1.273	0.010	1.273	0.010
3	1.277	0.010	1.634	0.010	1.265	0.010	1.652	0.010	1.126	0.010	1.126	0.010
4	0.944	0.010	1.137	0.010	0.929	0.010	0.951	0.010	1.069	0.010	1.069	0.010
5	0.886	0.010	0.838	0.010	0.885	0.010	0.722	0.010	1.041	0.010	1.041	0.010
6	0.902	0.010	0.790	0.010	0.898	0.010	0.573	0.010	1.018	0.010	1.018	0.010
7	0.885	0.010	0.757	0.010	0.891	0.010	0.579	0.010	0.992	0.010	0.992	0.010
8	0.898	0.010	0.677	0.010	0.890	0.010	0.505	0.010	0.969	0.010	0.969	0.010
9	0.852	0.010	0.662	0.010	0.857	0.010	0.520	0.010	0.951	0.010	0.951	0.010
10	0.848	0.010	0.612	0.010	0.843	0.010	0.541	0.010	0.936	0.010	0.936	0.010
11	0.838	0.010	0.614	0.010	0.848	0.010	0.494	0.010	0.924	0.010	0.924	0.010
12	0.827	0.010	0.585	0.010	0.826	0.010	0.484	0.010	0.916	0.010	0.916	0.010
13	0.820	0.010	0.525	0.010	0.830	0.010	0.479	0.010	0.909	0.010	0.909	0.010
14	0.819	0.010	0.549	0.010	0.812	0.010	0.496	0.010	0.905	0.010	0.905	0.010
15	0.797	0.010	0.542	0.010	0.807	0.010	0.486	0.010	0.902	0.010	0.902	0.010
16	0.832	0.010	0.514	0.010	0.825	0.010	0.495	0.010	0.901	0.010	0.901	0.010
17	0.804	0.010	0.527	0.010	0.810	0.010	0.464	0.010	0.900	0.010	0.900	0.010
18	0.806	0.010	0.570	0.010	0.804	0.010	0.493	0.010	0.901	0.010	0.901	0.010
19	0.792	0.010	0.569	0.010	0.811	0.010	0.490	0.010	0.899	0.010	0.899	0.010
20	0.829	0.010	0.592	0.010	0.826	0.010	0.515	0.010	0.899	0.010	0.899	0.010

Table S.26: Simulated gag grouper discards in metric tons for the handline and longline fleets and the assumed coefficients of variation.

Simulation Year	Handline	Handline CV	Longline	Longline CV
1	23	0.1	17	0.1
2	16	0.1	7	0.1
3	14	0.1	4	0.1
4	17	0.1	2	0.1
5	19	0.1	3	0.1
6	18	0.1	2	0.1
7	19	0.1	3	0.1
8	18	0.1	1	0.1
9	18	0.1	2	0.1
10	19	0.1	1	0.1
11	19	0.1	2	0.1
12	17	0.1	1	0.1
13	18	0.1	2	0.1
14	17	0.1	2	0.1
15	18	0.1	1	0.1
16	18	0.1	1	0.1
17	17	0.1	2	0.1
18	17	0.1	1	0.1
19	19	0.1	2	0.1
20	18	0.1	2	0.1

Table S.27: Gag grouper effective sample sizes used for catch at length observations. Effective sample sizes were determined by dividing the actual sample sizes by 1,000.

Simulation Year	**Catch At Length Effective Sample Size**		
	Handline	*Longline*	*Recreational*
1	88	25	5,810
2	58	11	4,784
3	45	8	4,907
4	32	4	5,632
5	40	4	6,291
6	43	4	6,662
7	46	4	6,820
8	45	3	6,890
9	45	4	6,920
10	44	4	6,930
11	45	4	6,935
12	43	3	6,943
13	45	4	6,926
14	42	3	6,946
15	44	4	6,956
16	43	3	6,950
17	43	3	6,932
18	42	3	6,937
19	44	4	6,948
20	43	3	6,931

Red Snapper

Table S.28: Simulated red snapper landings (in metric tons) included in this study's implementation of Stock Synthesis for the simulated handline and longline fishing fleets, and the removals from applying the recreational fishing mortality rate.

Simulation Year	Handline	Longline	Recreational
1	100	6	718
2	87	6	582
3	107	4	591
4	115	6	716
5	132	4	1,016
6	121	6	1,129
7	127	4	1,095
8	121	5	1,059
9	131	4	1,048
10	117	6	1,074
11	128	4	1,073
12	116	5	1,076
13	121	4	1,077
14	118	6	1,068
15	126	4	1,063
16	110	5	1,072
17	122	3	1,061
18	110	5	1,065
19	126	4	1,061
20	106	5	1,060

Table S.29: Simulated red snapper indices of biomass and the CV values assumed for the handline and longline fleets.

Simulation Year	Typical Standardization				Extended Standardization				Perfect Information			
	Handline Index	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*
1	0.621	0.010	1.615	0.010	0.635	0.010	1.542	0.010	0.883	0.010	0.883	0.010
2	0.623	0.010	0.974	0.010	0.605	0.010	0.843	0.010	0.801	0.010	0.801	0.010
3	0.802	0.010	0.769	0.010	0.808	0.010	0.700	0.010	0.860	0.010	0.860	0.010
4	1.037	0.010	0.847	0.010	1.074	0.010	0.829	0.010	1.005	0.010	1.005	0.010
5	1.193	0.010	0.948	0.010	1.162	0.010	0.991	0.010	1.083	0.010	1.083	0.010
6	1.181	0.010	1.210	0.010	1.223	0.010	1.378	0.010	1.073	0.010	1.073	0.010
7	1.079	0.010	1.016	0.010	1.064	0.010	1.072	0.010	1.046	0.010	1.046	0.010
8	1.100	0.010	1.085	0.010	1.103	0.010	1.184	0.010	1.032	0.010	1.032	0.010
9	1.080	0.010	1.118	0.010	1.088	0.010	1.110	0.010	1.027	0.010	1.027	0.010
10	1.066	0.010	1.017	0.010	1.039	0.010	1.130	0.010	1.021	0.010	1.021	0.010
11	1.069	0.010	0.894	0.010	1.051	0.010	0.829	0.010	1.004	0.010	1.004	0.010
12	0.987	0.010	0.959	0.010	1.012	0.010	0.874	0.010	1.012	0.010	1.012	0.010
13	1.026	0.010	0.951	0.010	1.006	0.010	0.832	0.010	1.011	0.010	1.011	0.010
14	1.056	0.010	0.935	0.010	1.048	0.010	0.999	0.010	1.019	0.010	1.019	0.010
15	1.031	0.010	1.025	0.010	1.025	0.010	1.030	0.010	1.014	0.010	1.014	0.010
16	0.999	0.010	0.959	0.010	0.978	0.010	1.038	0.010	1.016	0.010	1.016	0.010
17	0.986	0.010	0.944	0.010	1.026	0.010	0.879	0.010	1.023	0.010	1.023	0.010
18	1.014	0.010	0.881	0.010	1.017	0.010	0.982	0.010	1.028	0.010	1.028	0.010
19	1.028	0.010	0.919	0.010	1.020	0.010	0.925	0.010	1.021	0.010	1.021	0.010
20	1.023	0.010	0.934	0.010	1.015	0.010	0.832	0.010	1.022	0.010	1.022	0.010

Table S.30: Simulated red snapper discards in metric tons for the handline and longline fleets and the assumed coefficients of variation.

Simulation Year	Handline	Handline CV	Longline	Longline CV
1	133	0.1	--	--
2	121	0.1	--	--
3	150	0.1	--	--
4	169	0.1	--	--
5	230	0.1	--	--
6	175	0.1	--	--
7	199	0.1	--	--
8	170	0.1	--	--
9	202	0.1	--	--
10	184	0.1	--	--
11	196	0.1	--	--
12	172	0.1	--	--
13	183	0.1	--	--
14	162	0.1	--	--
15	192	0.1	--	--
16	165	0.1	--	--
17	171	0.1	--	--
18	170	0.1	--	--
19	190	0.1	--	--
20	157	0.1	--	--

Table S.31: Red snapper effective sample sizes used for catch at length observations. Effective sample sizes were determined by dividing the actual sample sizes by 1,000.

Simulation Year	**Catch At Length Effective Sample Size**		
	Handline	*Longline*	*Recreational*
1	58	2	2,712
2	60	2	3,245
3	92	2	3,760
4	99	3	4,827
5	107	2	6,252
6	91	3	6,476
7	98	2	6,217
8	95	3	6,074
9	101	2	6,092
10	92	3	6,237
11	99	2	6,216
12	92	3	6,238
13	95	2	6,247
14	95	3	6,201
15	97	2	6,187
16	87	3	6,229
17	97	2	6,172
18	87	3	6,197
19	100	2	6,186
20	85	3	6,185

Mutton Snapper

Table S.32: Simulated mutton snapper landings (in metric tons) included in this study's implementation of Stock Synthesis for the simulated handline and longline fishing fleets, and the removals from applying the recreational fishing mortality rate.

Simulation Year	Handline	Longline	Recreational
1	3	14	179
2	3	10	200
3	4	16	227
4	4	11	254
5	4	21	276
6	4	22	295
7	5	24	310
8	5	26	326
9	5	20	340
10	6	20	351
11	5	22	359
12	6	33	369
13	5	23	376
14	7	25	382
15	7	27	389
16	7	22	390
17	5	29	394
18	7	28	401
19	6	30	402
20	7	32	403

Table S.33: Simulated mutton snapper indices of biomass and the CV values assumed for the handline and longline fleets.

Simulation Year	**Typical Standardization**				**Extended Standardization**				**Perfect Information**			
	Handline Index	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*	*Handline Index*	*Handline Index CV*	*Longline Index*	*Longline Index CV*
1	0.532	0.010	0.496	0.010	0.506	0.010	0.702	0.010	0.510	0.010	0.510	0.010
2	0.462	0.010	0.805	0.010	0.451	0.010	0.745	0.010	0.563	0.010	0.563	0.010
3	0.624	0.010	0.633	0.010	0.615	0.010	0.616	0.010	0.620	0.010	0.620	0.010
4	0.686	0.010	0.698	0.010	0.676	0.010	0.691	0.010	0.679	0.010	0.679	0.010
5	0.773	0.010	0.726	0.010	0.760	0.010	0.757	0.010	0.737	0.010	0.737	0.010
6	0.844	0.010	0.823	0.010	0.839	0.010	0.822	0.010	0.796	0.010	0.796	0.010
7	1.033	0.010	0.745	0.010	0.997	0.010	0.833	0.010	0.853	0.010	0.853	0.010
8	0.882	0.010	0.994	0.010	0.868	0.010	1.018	0.010	0.910	0.010	0.910	0.010
9	1.040	0.010	0.938	0.010	1.071	0.010	0.967	0.010	0.963	0.010	0.963	0.010
10	1.264	0.010	0.973	0.010	1.264	0.010	1.014	0.010	1.016	0.010	1.016	0.010
11	1.192	0.010	1.099	0.010	1.210	0.010	1.129	0.010	1.064	0.010	1.064	0.010
12	1.085	0.010	1.277	0.010	1.105	0.010	1.205	0.010	1.110	0.010	1.110	0.010
13	1.028	0.010	1.095	0.010	1.036	0.010	1.122	0.010	1.153	0.010	1.153	0.010
14	1.134	0.010	1.175	0.010	1.130	0.010	1.177	0.010	1.192	0.010	1.192	0.010
15	1.285	0.010	1.296	0.010	1.288	0.010	1.272	0.010	1.228	0.010	1.228	0.010
16	1.287	0.010	1.243	0.010	1.308	0.010	1.117	0.010	1.264	0.010	1.264	0.010
17	1.153	0.010	1.332	0.010	1.162	0.010	1.344	0.010	1.295	0.010	1.295	0.010
18	1.263	0.010	1.285	0.010	1.254	0.010	1.166	0.010	1.324	0.010	1.324	0.010
19	1.169	0.010	1.161	0.010	1.176	0.010	1.171	0.010	1.349	0.010	1.349	0.010
20	1.265	0.010	1.205	0.010	1.285	0.010	1.133	0.010	1.373	0.010	1.373	0.010

Table S.34: Simulated mutton snapper discards in metric tons for the handline and longline fleets and the assumed coefficients of variation.

Simulation Year	Handline	Handline CV	Longline	Longline CV
1	2	0.1	--	--
2	1	0.1	--	--
3	2	0.1	--	--
4	2	0.1	--	--
5	2	0.1	--	--
6	2	0.1	--	--
7	3	0.1	--	--
8	3	0.1	--	--
9	3	0.1	--	--
10	3	0.1	--	--
11	3	0.1	--	--
12	3	0.1	--	--
13	3	0.1	--	--
14	3	0.1	--	--
15	4	0.1	--	--
16	4	0.1	--	--
17	3	0.1	--	--
18	4	0.1	--	--
19	3	0.1	--	--
20	4	0.1	--	--

Table S.35: Mutton snapper effective sample sizes used for catch at length observations. Effective sample sizes were determined by dividing the actual sample sizes by 1,000.

Simulation Year	**Catch At Length Effective Sample Size**		
	Handline	*Longline*	*Recreational*
1	0.512	1.552	2,712
2	0.530	1.159	3,245
3	0.704	1.856	3,760
4	0.768	1.378	4,827
5	0.786	2.638	6,252
6	0.801	2.677	6,476
7	0.822	2.829	6,217
8	0.926	3.104	6,074
9	0.853	2.418	6,092
10	0.997	2.317	6,237
11	0.889	2.497	6,216
12	0.911	3.728	6,238
13	0.799	2.611	6,247
14	1.021	2.965	6,201
15	1.105	2.913	6,187
16	1.129	2.341	6,229
17	0.744	3.159	6,172
18	1.050	3.024	6,197
19	0.889	3.278	6,186
20	1.092	3.411	6,185

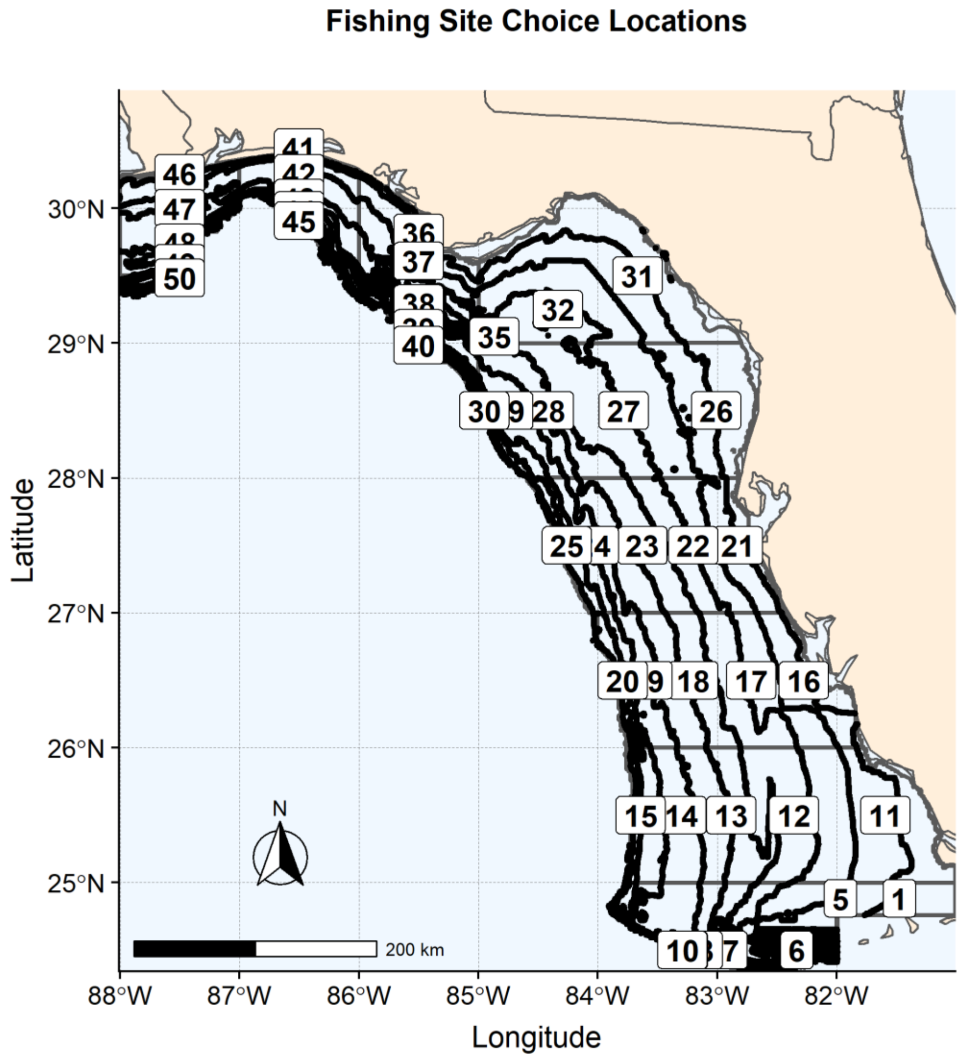

Figure S.1: Numbered polygons formed by the intersection of 20-meter depth contours with equal lines of integer latitude and longitude values, which were used to represent the domain of spatial locations that could be selected when modeling fishing site choice. The numbers in this figure correspond to the variables presented in tables S.13, S.14, and S.15.

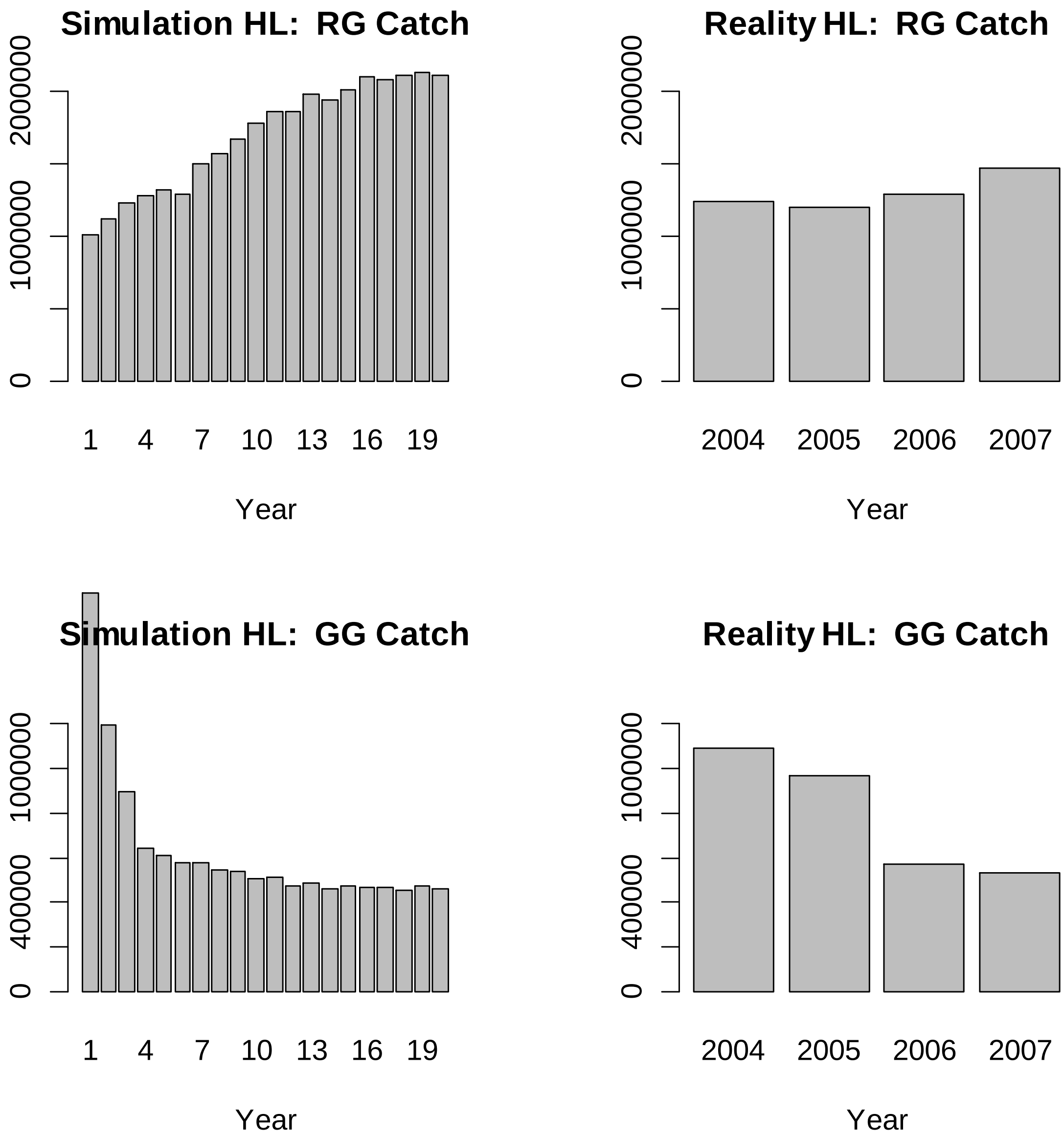

Figure S.2: Comparison of simulated to actual landings in pounds of gutted weight for red grouper (RG) and gag grouper (GG) caught by the handline (HL) fleet.

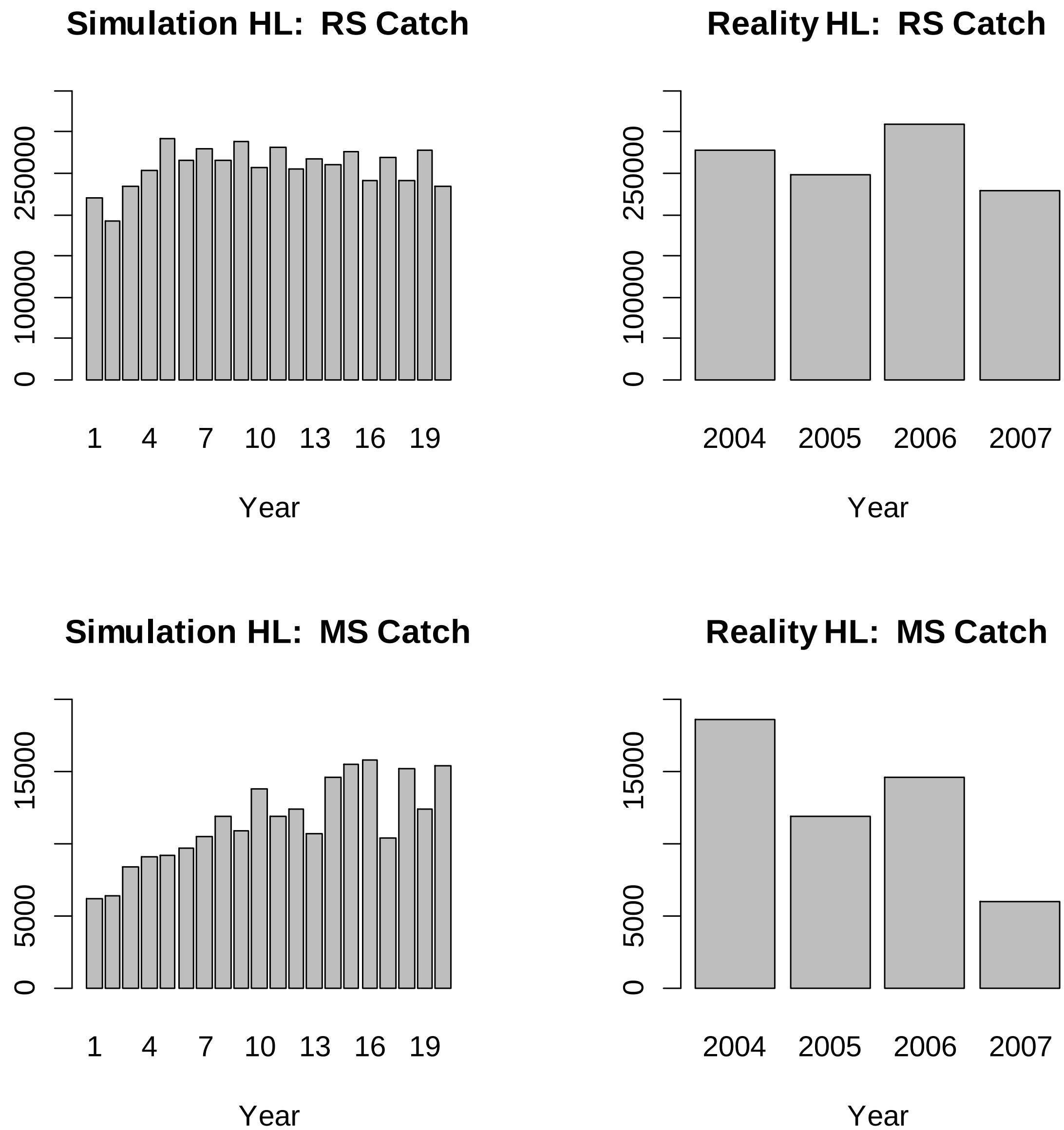

Figure S.3: Comparison of simulated to actual landings in pounds of gutted weight for red snapper (RS) and mutton snapper (MS) caught by the handline (HL) fleet.

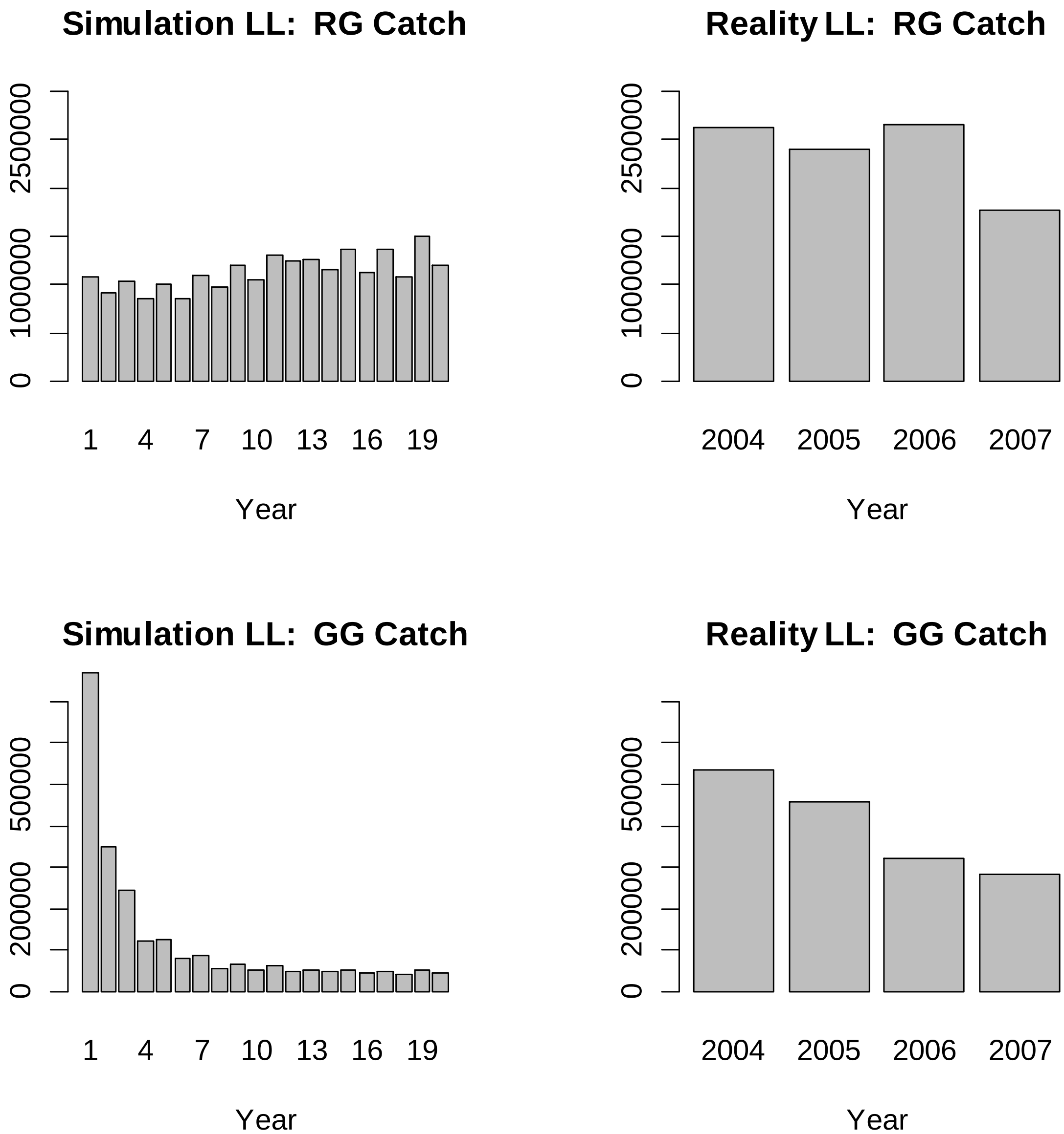

Figure S.4: Comparison of simulated to actual landings in pounds of gutted weight for red grouper (RG) and gag grouper (GG) caught by the longline (LL) fleet.

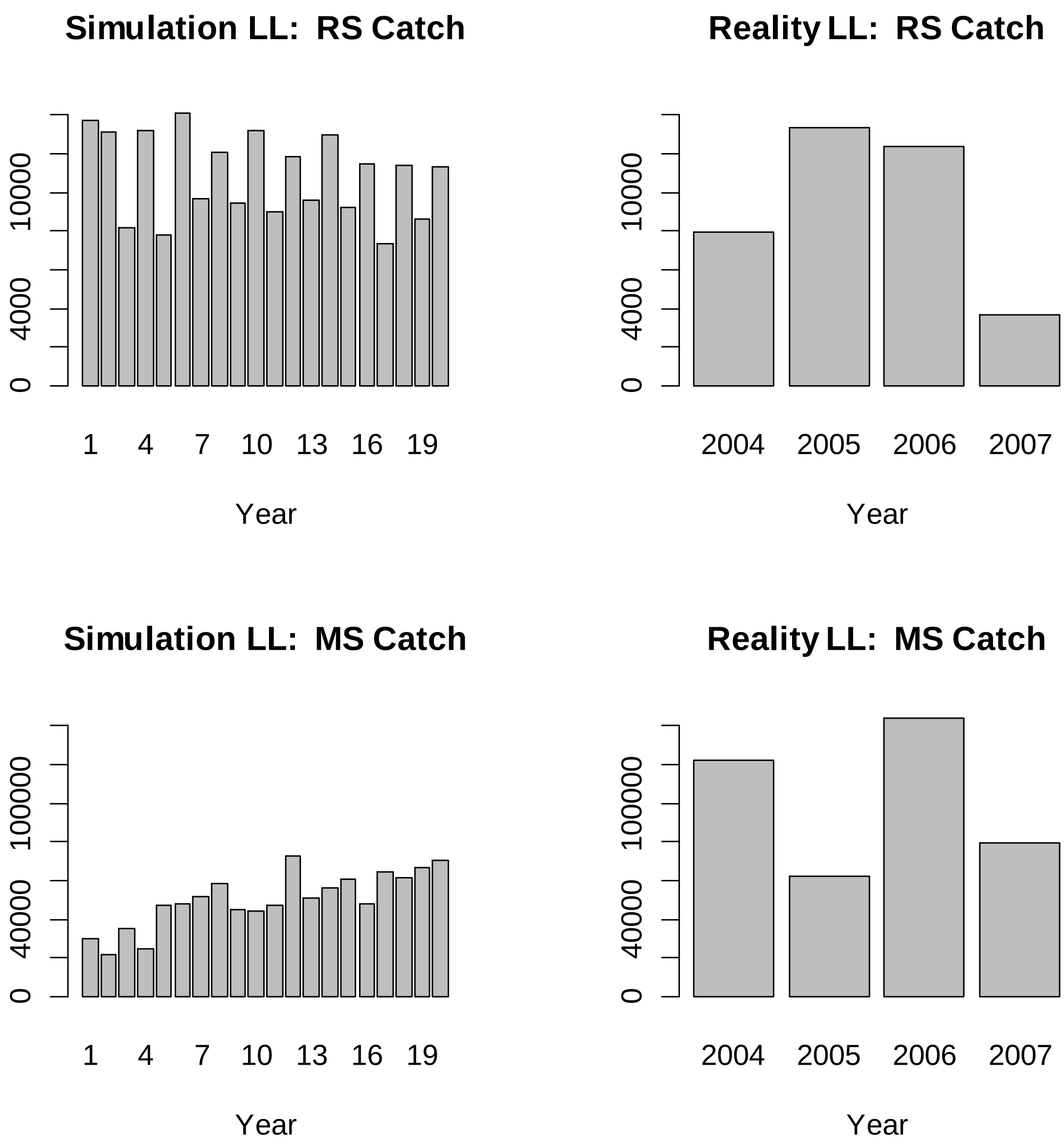

Figure S.5: Comparison of simulated to actual landings in pounds of gutted weight for red snapper (RS) and mutton snapper (MS) caught by the longline (LL) fleet.

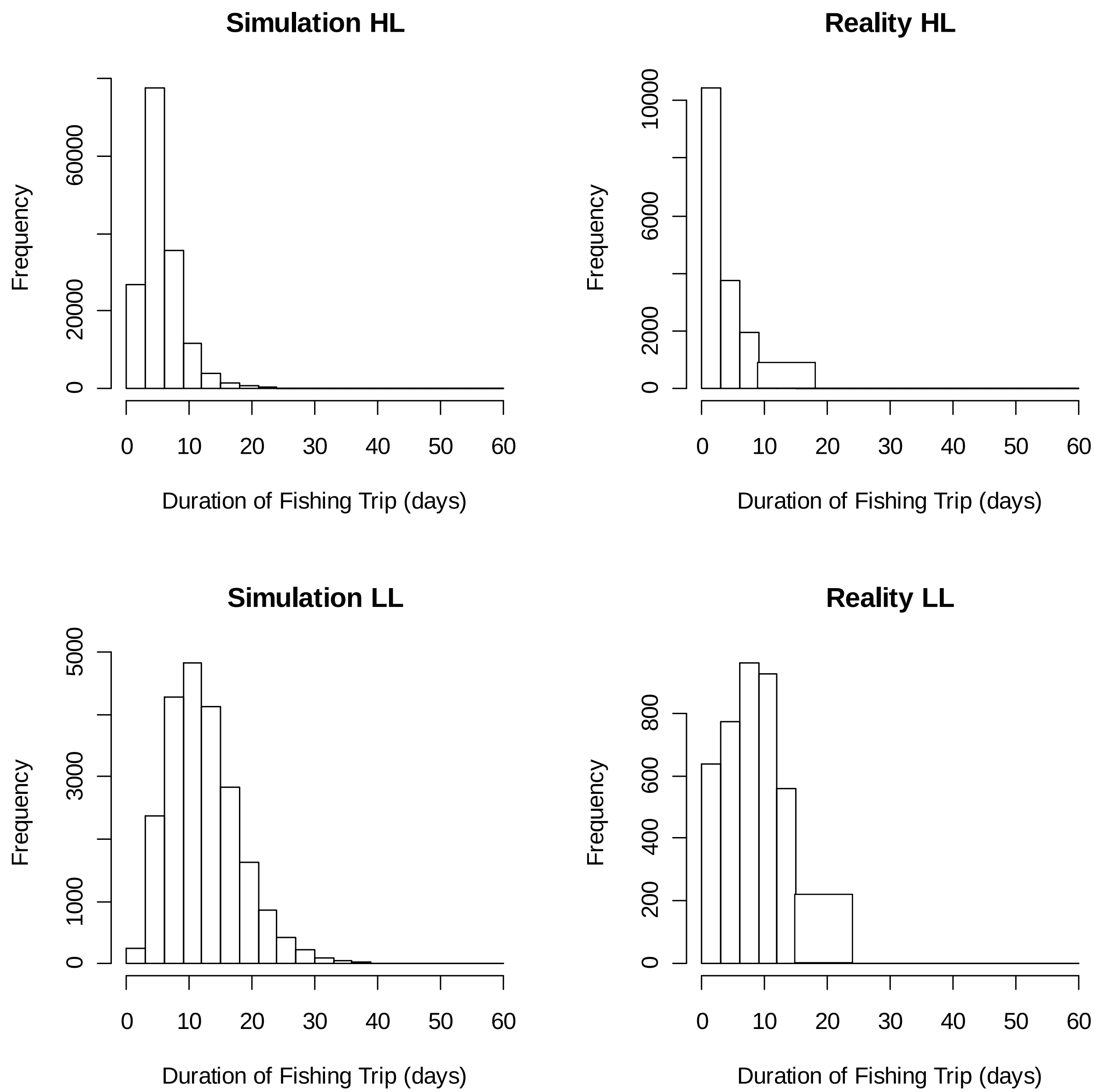

Figure S.6: Comparison of fishing trip duration between the simulated and actual handline (HL) and longline (LL) fleets. Histograms with the actual distributions of fishing trip length above were altered to group bars at the right most tail of each distribution in order to protect confidentiality.

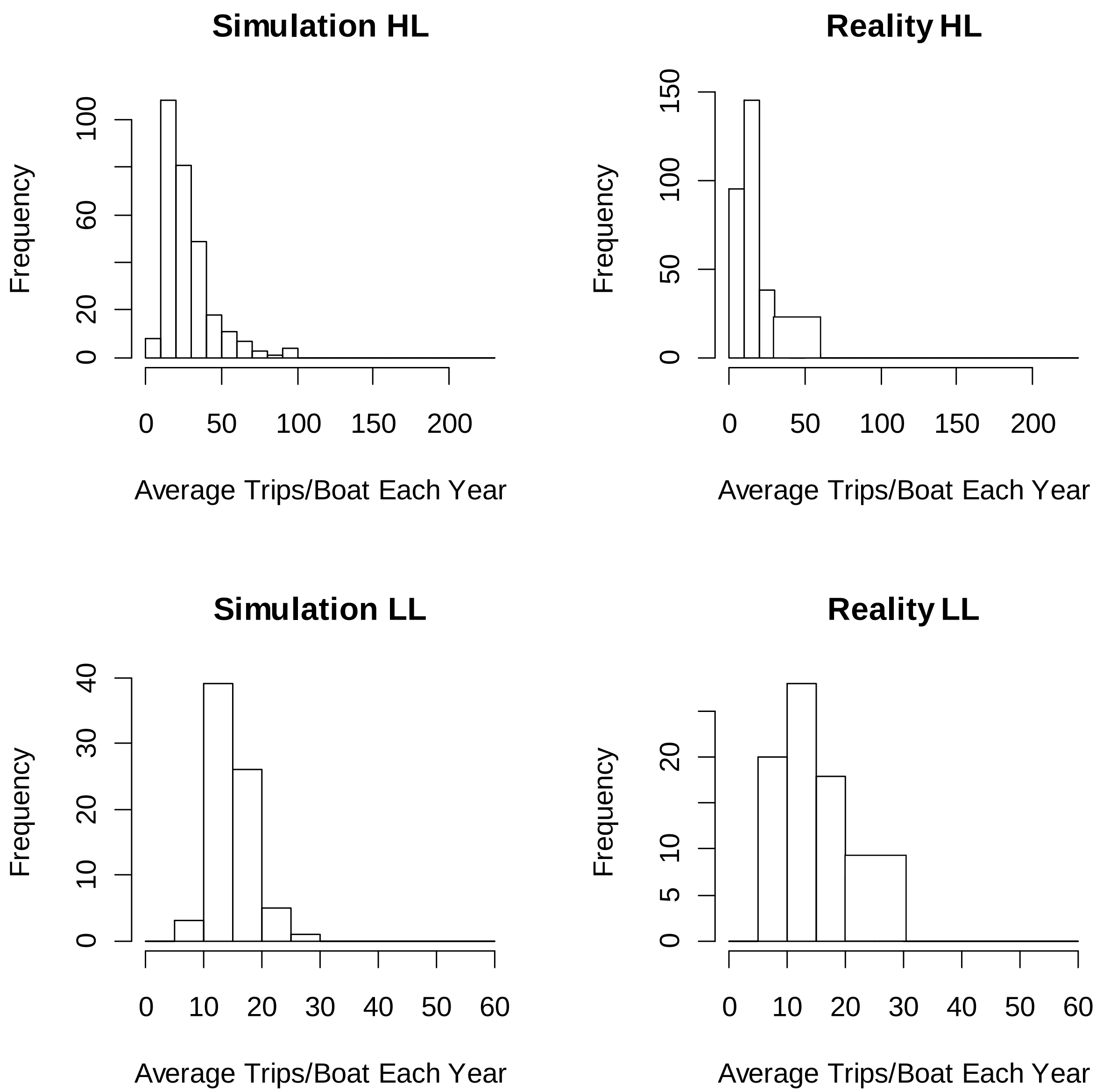

Figure S.7: Comparison of average trips per boat each year, between the simulated and actual handline (HL) and longline (LL) fleets. Histograms with the actual distributions of average trips per boat per year above were altered to group bars at the right most tail of each distribution in order to protect confidentiality.

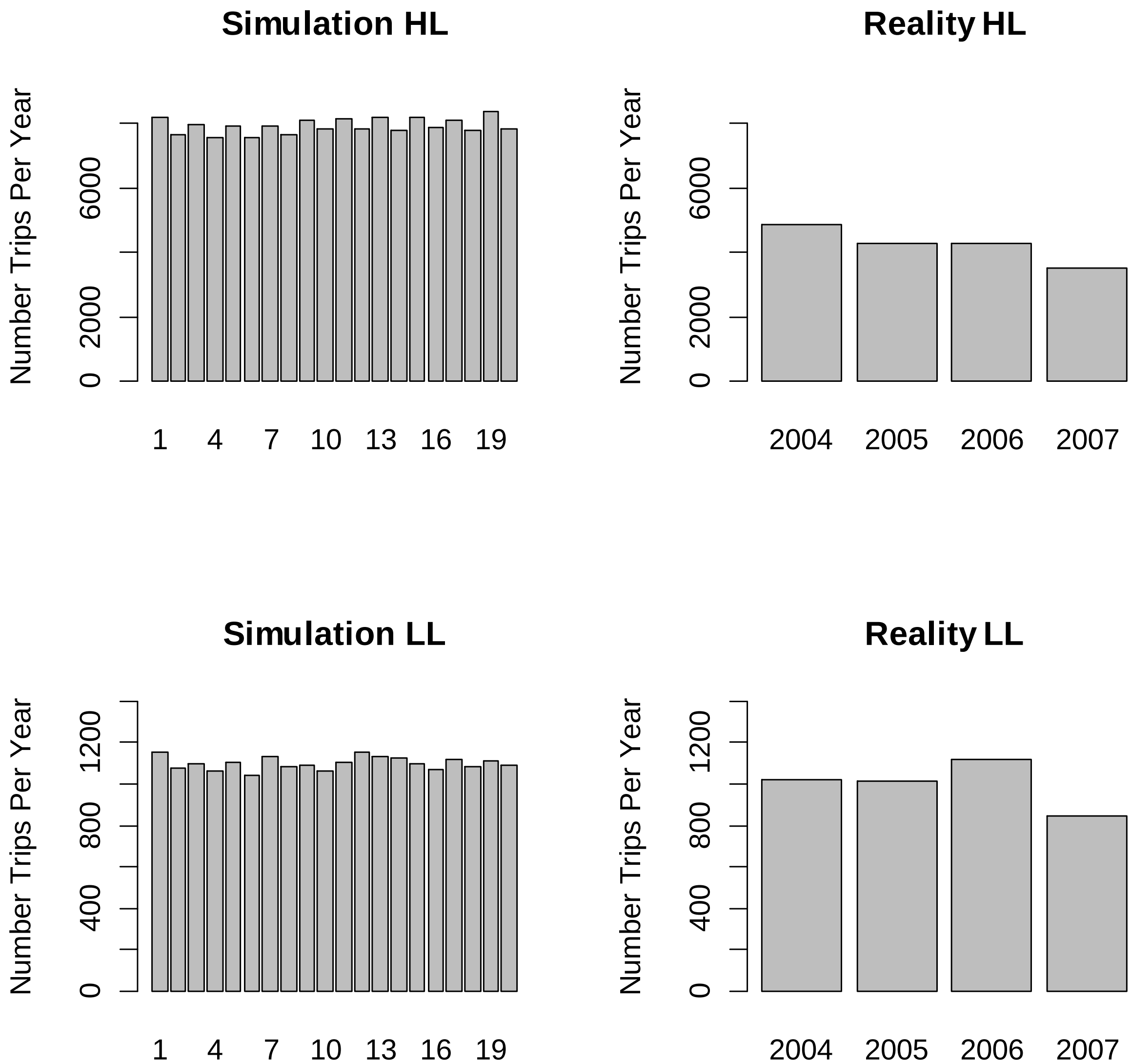

Figure S.8: Comparison of total number of trips per year, between the simulated and actual handline (HL) and longline (LL) fleets.

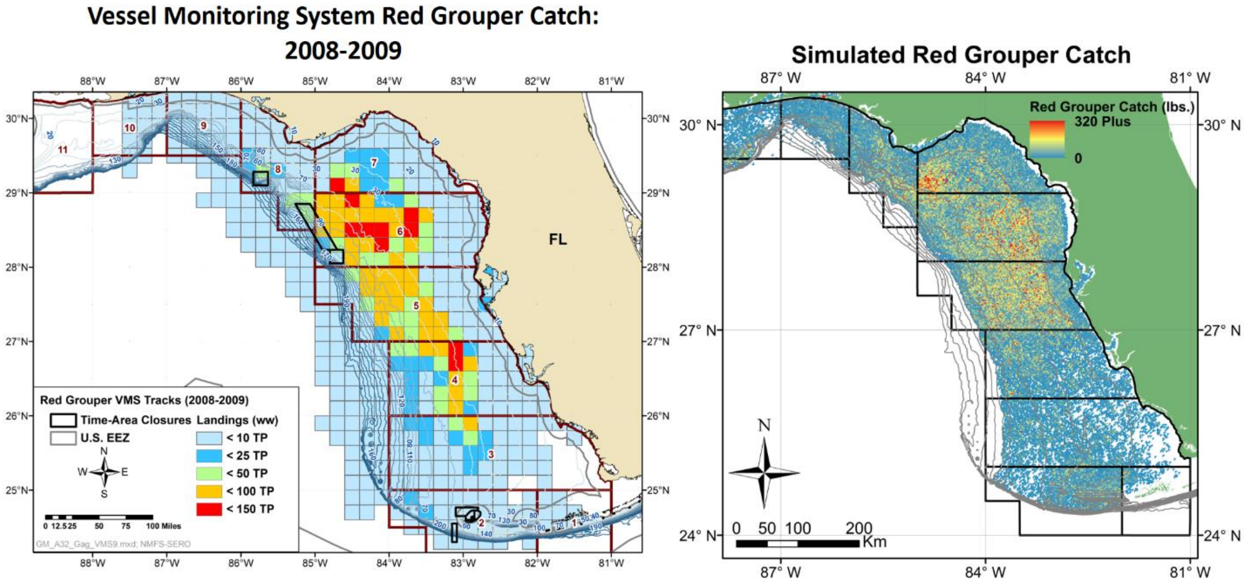

Figure S.9: Validation of spatial catch patterns for red grouper. The left panel presents the actual spatial catch of red grouper calculated by combining vessel monitoring system data and logbook observations, while the right panel presents the simulated spatial catch of red grouper in the terminal year of the simulation. Catch units in both plots are in total pounds (TP) of whole weight (ww). Values on the right most simulation panel are smaller because the spatial resolution is much finer compared with the figure on the right.

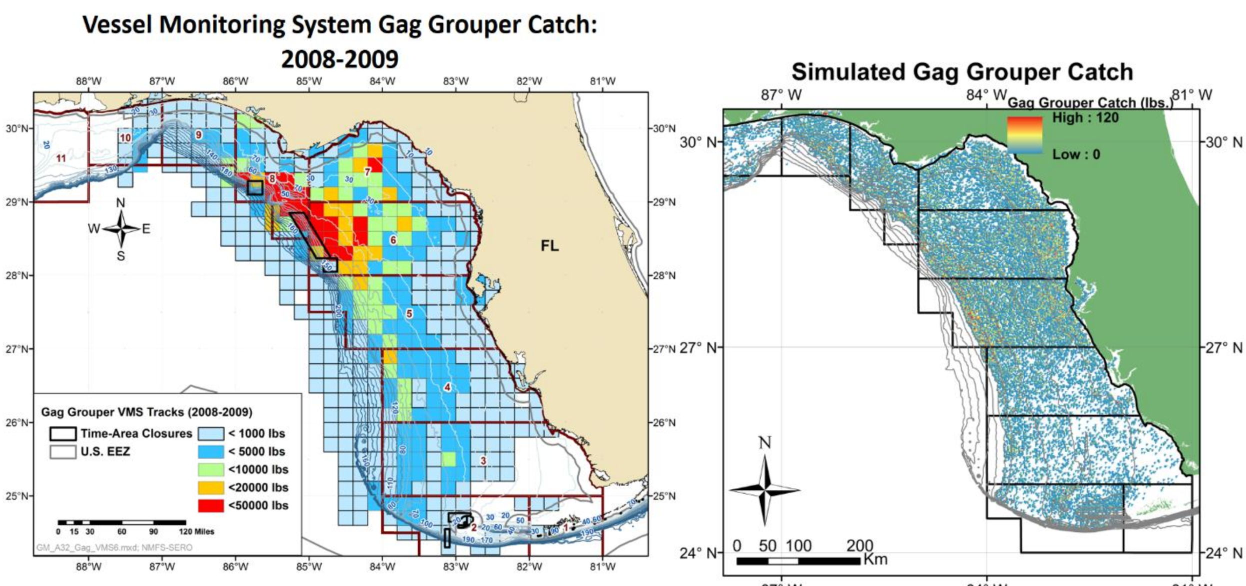

Figure S.10: Validation of spatial catch patterns for gag grouper. The left panel presents the actual spatial catch of gag grouper calculated by combining vessel monitoring system data and logbook observations, while the right panel presents the simulated spatial catch of gag grouper in the terminal year of the simulation. Catch units in both plots are in total pounds (TP) of whole weight (ww). Values on the right most simulation panel are smaller because the spatial resolution is much finer compared with the figure on the right.

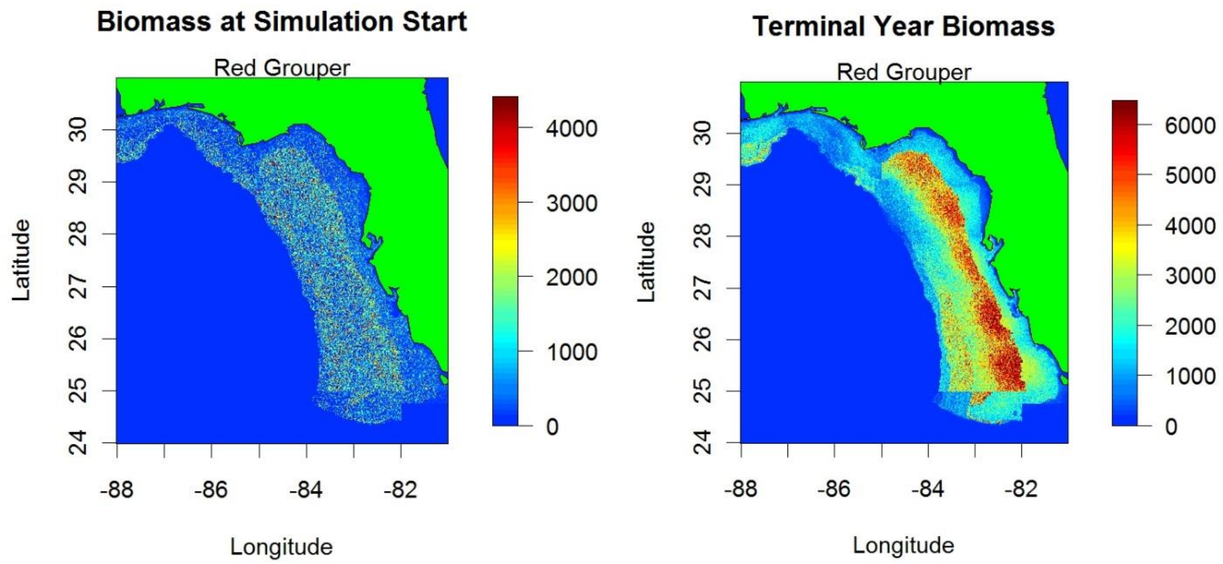

Figure S.11: Starting and ending year simulated population biomass (in pounds) for red grouper.

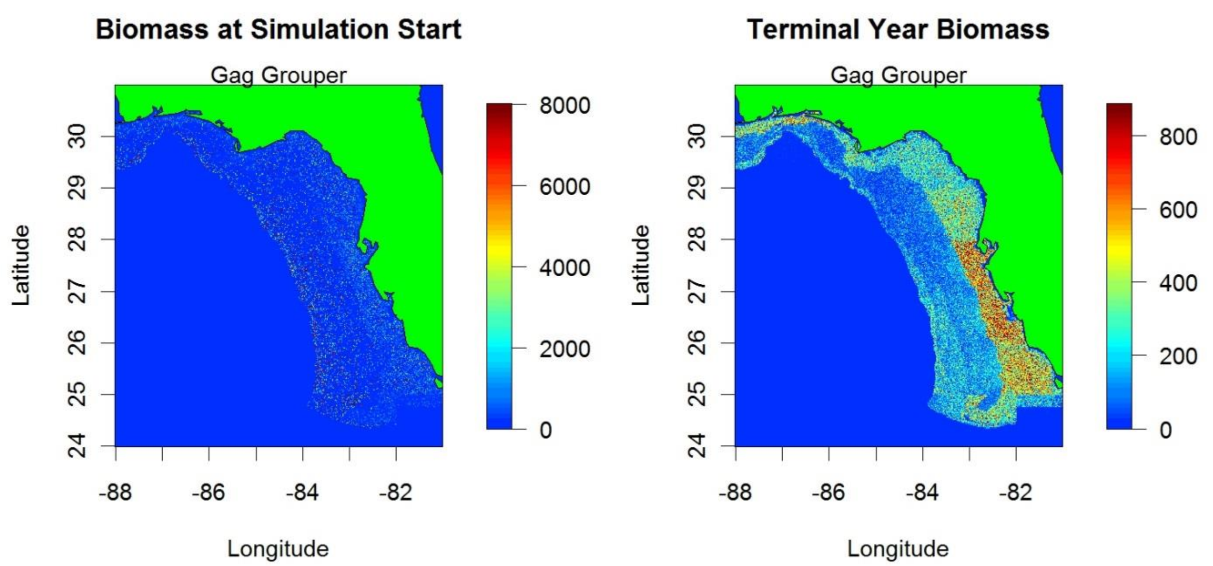

Figure S.12: Starting and ending year simulated population biomass (in pounds) for gag grouper.

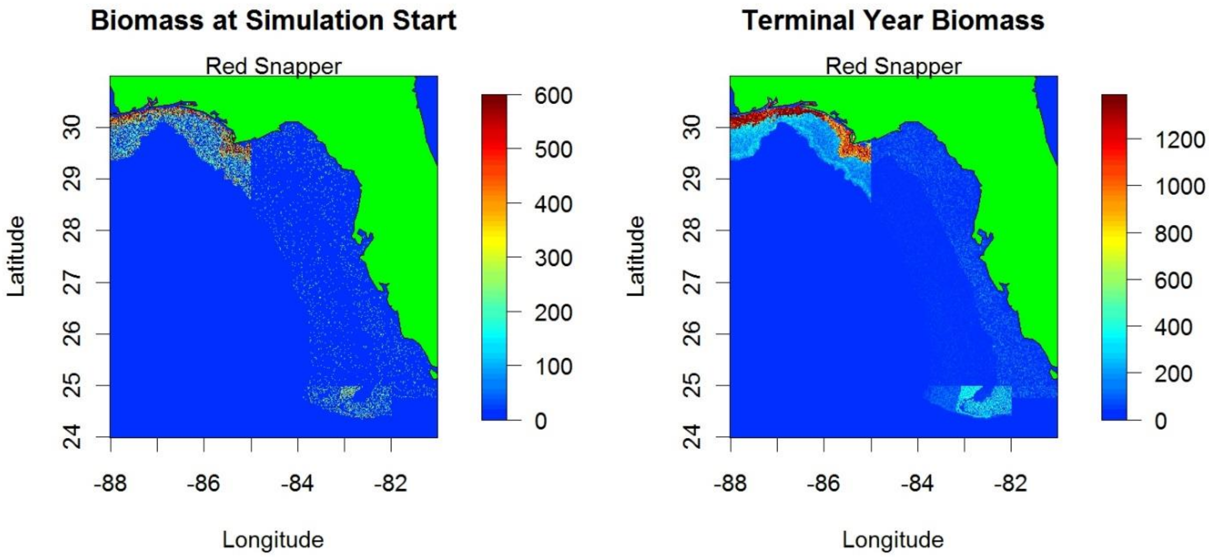

Figure S.13: Starting and ending year simulated population biomass (in pounds) for red snapper.

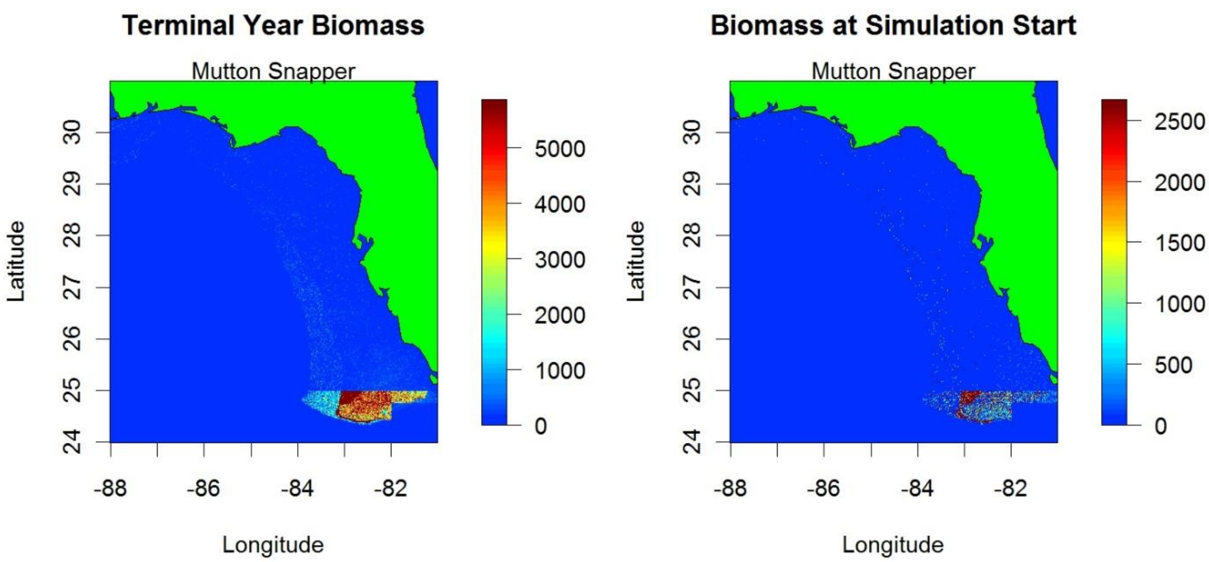

Figure S.14: Starting and ending year simulated population biomass (in pounds) for mutton snapper.