Red Snapper Projections V

19 March 2009

1 Introduction

Projections of red snapper in the U.S. South Atlantic were completed as part of SEDAR-15 and were described in the SEDAR-15 assessment report. Following the SEDAR-15 Review Workshop, those projections were revised according to an SAFMC memorandum (dated August 12, 2008) from Bob Mahood to Dr. Bonnie Ponwith; the revised projections were described in the SEDAR-15 "Addenda and updates." Additional projections were computed for consideration of the SAFMC SSC at their December, 2008 meeting, as described in a report titled "Red snapper: Estimation of biomass benchmarks and projections." During that meeting, the SSC requested more projections, which were computed and described in a follow-up report to the SSC titled, "Red Snapper Projections: the SSC Alternative (1 December 2008)."

A SERO memorandum (dated February 13, 2009), from Dr. Roy Crabtree to Dr. Bonnie Ponwith, requested additional red snapper projections. This report describes those projections. A synopsis of the request follows:

1. Provide the time frame for rebuilding in the absence of fishing mortality (Tmin).

2. Provide the time frame for rebuilding in the absence of fishing mortality plus one mean generation time (Tmax).

3. Provide projections of spawning stock biomass, recruitment, landings, discards, and probability of stock recovery, from 2007 to Tmax for the fishing mortality rates F_{current}, $F_{40\%}$, 65%$F_{40\%}$, 75%$F_{40\%}$, and 85% $F_{40\%}$.

4. Provide similar projections as in #3 above, but assume no directed harvest and discards correspond to the yield associated with fishing mortality rates F_{current}, $F_{40\%}$, 65%$F_{40\%}$, 75%$F_{40\%}$, and 85% $F_{40\%}$.

It was requested that the above projections be based on the MFMT $F_{40\%} = 0.104$ and steepness $h = 0.95$. It was also requested that reductions in F begin in 2010 (rather than the previous beginning of 2009), and that available landings data for 2007 and 2008 be examined, if possible, to determine appropriate levels of F in 2007–2009.

To compute the time frame for rebuilding (i.e., item #1), a biomass benchmark is required. Here that value was taken as $\text{SSB}_{F_{40\%}}$, the equilibrium spawning biomass achieved when fishing at $F_{40\%}$ =0.104. The value of $\text{SSB}_{F_{40\%}}$(and other biomass benchmarks) was computed through long-term, deterministic projections with bias correction, providing consistency between benchmarks and harvest projections. For comparison to $F_{40\%}$ benchmarks, $F_{30\%}$ benchmarks were also computed in the same manner.

2 Projection scenarios

To accomplish item #1, projections were run with $F = 0$. This projection is labeled "Scenario P0." In this scenario, the minimum time frame for rebuilding (Tmin) was defined by when the probability of stock recovery achieved at least 0.5.

To accomplish item #3, several projection scenarios allowing harvest were considered:

- Scenario H1: $F = F_{\text{current}}$
- Scenario H2: $F = 65\%F_{40\%}$
- Scenario H3: $F = 75\%F_{40\%}$
- Scenario H4: $F = 85\%F_{40\%}$
- Scenario H5: $F = F_{40\%}$

To accomplish item #4, several discard-only projections were considered:

- Scenario D1: $F = F_{\text{current}}$
- Scenario D2: $F = 65\%F_{40\%}$
- Scenario D3: $F = 75\%F_{40\%}$
- Scenario D4: $F = 85\%F_{40\%}$
- Scenario D5: $F = F_{40\%}$

The discard-only projections differ from the harvest projections in two main ways: first, dive fishing was not included, and second, all fish caught were assumed released and were subjected to the release mortality rates used in the assessment (0.9 in the commercial sector and 0.4 in the headboat and recreational sectors). Thus, not all of the applied fishing rate contributes to mortality; tables of results report both the applied rate (e.g., F_{current}or $F_{40\%}$) and the rate that actually contributes to mortality (labeled as Fmort). When interpreting the discard-only projections, one should bear in mind that the distribution of full F among the various fisheries is different from that in the assessment, which leads to inconsistency between projections and benchmarks (e.g., fishing at $F_{40\%}$ leads to an equilibrium stock size other than $\text{SSB}_{F_{40\%}}$).

The period between the end of the assessment (2006) and the start of new management (2010) was projected using values of F_{2007}, F_{2008}, and F_{2009}. The 2007 and 2008 values of F were those that, in the deterministic projections, provided the 2007 and 2008 estimates of landings. The 2009 value of F was assumed to be F_{current}, defined as the geometric mean of F from 2004–2008.

2.1 Landings in 2007 and 2008

The 2007 and 2008 landings were examined by sector. The estimates of commercial landings were available in the Accumulated Landings System and were provided by D. Gloeckner (NMFS-Beaufort). Handline landings were 108,076 lb in 2007 and 160,101 lb in 2008; commercial dive landings were 7605 lb in 2007 and 4343 lb in 2008. The estimate of 2007 headboat landings—37,460 lb, a relatively low value—was available from the Headboat Survey and provided by K. Brennan (NMFS-Beaufort). Finalized headboat landings in 2008 were not available in the survey and were thus estimated by linear regression of 1999–2007 headboat landings on commercial handline landings, which yielded a value of 70,080 lb (Figure 5.1). The estimate of 2007 MRFSS landings was available from the MRFSS website (http://www.st.nmfs.noaa.gov/mrip/), which was queried on March 3, 2009 for South Atlantic A+B1 landings in numbers (total minus headboat) and multiplied by the 2007 mean weight. This query provided a 2007 estimate of MRFSS landings of 300,902 lb. Finalized MRFSS landings in 2008 were not available from the MRFSS website and were thus estimated by linear regression of 1999–2007 MRFSS landings on commercial handline landings, which yielded a value of 318,361 lb (Figure 5.1). Combined across sectors, 2007 landings were $\sim 454,000$ lb and 2008 landings were $\sim 553,000$ lb.

2.2 Alternative landings in 2008

Although the MRFSS website did not provide final landings data for 2008, it did provide preliminary estimates. Based on the same method described above to compute MRFSS landings in weight, preliminary 2008 MRFSS landings were 765,443 lb. This value, in combination with other sectors, resulted in 2008 landings of $\sim 1,000,000$ lb.

Sensitivity of projections to this alternative 2008 estimate of landings were examined in two cases. The first case was the $F = 0$ projection used to define the rebuilding time; it is labeled here as "Scenario P0-alt." The second case was the $F = 75\%F_{40\%}$ projection with harvest; it is labeled here as "Scenario H3-alt."

These sensitivity runs should be interpreted with caution for at least two reasons. First, the 2008 MRFSS estimate is preliminary, and its value is higher than any other since the sampling program began in 1981. Second, recruitment estimates near the end of the assessment period were necessarily constrained, and thus, projections can only match such a high level of 2008 landings by imposing very high F. If the high landings were included in the assessment model itself, they might alternatively be explained by higher than expected recruitment.

3 Results

3.1 Benchmarks

Benchmarks computed by projection using $F_{40\%} = 0.104$ were $\mathrm{SSB}_{F_{40\%}} = 8102.5$ mt, $\mathrm{Y}_{F_{40\%}} = 2,303,676$ lb, $\mathrm{D}_{F_{40\%}} = 72,717$ lb (38,966 fish), and $\mathrm{R}_{F_{40\%}} = 692,864$ fish (Table 4.1). Thus, the value of $\mathrm{SSB}_{F_{40\%}} = 8102.5$ was used when computing the probability of rebuilding, which in turn was used to compute the rebuilding time frame Tmin.

Analogous benchmarks based on $F_{30\%}$ were also computed. The value of $F_{30\%}$ was $F_{30\%} = 0.148$, and corresponding benchmarks were $\mathrm{SSB}_{F_{30\%}} = 6025.1$ mt, $\mathrm{Y}_{F_{30\%}} = 2,430,792$ lb, $\mathrm{D}_{F_{30\%}} = 99,092$ lb (53,666 fish), and $\mathrm{R}_{F_{30\%}} = 685,824$ fish. These $F_{30\%}$ benchmarks were not used in the projection scenarios, but are reported here simply for comparison with $F_{40\%}$ benchmarks.

3.2 Rebuilding time frame

In the projection with $F = 0$, the probability of stock recovery is expected to exceed 0.5 during the year 2024 (Table 4.2, Fig. 5.2). Thus, with stock recovery expected by the beginning of 2025, Tmin is 15 years (2010–2024). The mean generation time is 20 years (SEDAR-15), and thus Tmax is 35 years. This value would imply that stock recovery should occur by the beginning of 2045, at the latest.

3.3 Projection results

Results of projections with allowable harvest are tabulated in Tables 4.3–4.7, and are presented graphically in Figs. 5.3–5.7.

Results of projections with no allowable harvest (discards only) are tabulated in Tables 4.8–4.12, and are presented graphically in Figs. 5.8–5.12.

Sensitivity projections showed that results were sensitive to the preliminary estimates of 2008 MRFSS landings. In the $F = 0$ sensitivity projection (Scenario P0-alt), the probability of stock recovery is expected to exceed 0.5 during the year 2026 (Table 4.13, Fig. 5.13), two years after the prediction of Scenario P0. In the $F = 75\%F_{40\%}$ sensitivity projection (Scenario H3-alt), projected landings were lower than in Scenario H3 (Table 4.14, Fig. 5.14), because a very high 2008 F decimated the stock.

3.4 Comments on Projections

Projections should be interpreted in light of the model assumptions and key aspects of the data. Some major considerations are the following:

- Initial abundance at age of the projections were based on estimates from the last year of the assessment. If those estimates are inaccurate, rebuilding will likely be affected.
- Fisheries were assumed to continue fishing at their estimated current proportions of total effort, using the estimated current selectivity patterns. New management regulations that alter those proportions or selectivities would likely affect rebuilding.
- The projections assumed no change in the selectivity applied to discards. As recovery generally begins with the smallest size classes, management action may be needed to meet that assumption.
- The projections assumed that the estimated spawner-recruit relationship applies in the future and that past residuals represent future uncertainty in recruitment. If changes in environmental or ecological conditions affect recruitment or life-history characteristics, rebuilding may be affected.
- The projections used a spawner-recruit relationship with steepness of $h = 0.95$, the value estimated in the assessment but with considerable uncertainty. Such a high value implies that the stock, at its currently low abundance, spawns nearly as many recruits as it would at high abundance. That is, productivity is nearly independent of spawning biomass. If productivity depends on spawning biomass, stock recovery would take longer than projected.

- The preliminary estimates of 2008 MRFSS landings, as used in Scenarios P0-alt and H3-alt, were much higher than in recent years. These preliminary high values, if real, could reflect recruitment to the fishery of a strong year-class. The projection model, however, would be unaware of such a year-class, and instead interprets the high landings to be a consequence of high F. If a strong year-class is indeed pulsing through the population, and if it is protected by management regulations, stock recovery could occur more quickly than projected.
- Discard-only projections tacitly assumed that any individual fish would be caught only once per year. To the extent that this assumption is violated, discard-only projections may overestimate the velocity of recovery.
- Discard-only projections allocated sources of mortality in different proportions than those used in computing reference points. Thus discard-only projections are not consistent with reference points, in the sense that fishing at $F_{40\%}$ may lead to an equilibrium stock size other than $\mathrm{SSB}_{F_{40\%}}$.

4 Tables

Table 4.1. Estimated status indicators, benchmarks, and related quantities, conditional on estimated current selectivities averaged across fisheries. Values are MSY*-based proxies associated with $F_{40\%}$, the recommended proxy for F_{MSY}, and also $F_{30\%}$. Biomass-based and number-based quantities were computed as equilibrium values from projections with fishing rate $F_{30\%}$ or $F_{40\%}$ (or X% of those rates), as indicated. Estimates of yield (Y) do not include discard mortalities (D). The* MSST *is defined by* $\mathrm{MSST} = (1 - M)\mathrm{SSB}_{\mathrm{MSY}}$, *with constant* $M = 0.078$.

Quantity	Units	$F_{40\%}$ Proxy	$F_{30\%}$ Proxy
F_{MSY}	y^{-1}	0.104	0.148
$\mathrm{SSB}_{\mathrm{MSY}}$	mt	8102.5	6025.1
$\mathrm{D}_{\mathrm{MSY}}$	1000 fish	39	54
Recruits at F_{MSY}	1000 fish	693	686
Y at 65% F_{MSY}	1000 lb	1984	2257
Y at 75% F_{MSY}	1000 lb	2104	2338
Y at 85% F_{MSY}	1000 lb	2199	2391
Y at F_{MSY}	1000 lb	2304	2431
MSST	mt	7470.5	5555.1
$F_{2006}/F_{\mathrm{MSY}}$	–	7.67	5.39
$\mathrm{SSB}_{2006}/\mathrm{SSB}_{\mathrm{MSY}}$	–	0.02	0.03
$\mathrm{SSB}_{2006}/\mathrm{MSST}$	–	0.03	0.04

*Table 4.2. Red snapper: Projection results under scenario P0—fishing mortality rate F = 0. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish*).* For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $\text{SSB}_{F_{40\%}} = 8102.5$ mt, $\text{R}_{F_{40\%}} = 692,864$ fish, $\text{Y}_{F_{40\%}} = 2,303,676$ lb, and $\text{D}_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0	0	187	285	0	1414	0	0	0
2011	0	0	444	306	0	1414	0	0	0
2012	0	0	703	458	0	1414	0	0	0
2013	0	0	1041	527	0	1414	0	0	0
2014	0	0	1474	576	0	1414	0	0	0
2015	0	0	2001	611	0	1414	0	0	0
2016	0	0	2611	635	0	1414	0	0	0
2017	0	0	3290	652	0	1414	0	0	0
2018	0	0	4020	664	0	1414	0	0	0
2019	0	0.01	4786	673	0	1414	0	0	0
2020	0	0.05	5571	679	0	1414	0	0	0
2021	0	0.13	6364	684	0	1414	0	0	0
2022	0	0.28	7151	687	0	1414	0	0	0
2023	0	0.46	7926	690	0	1414	0	0	0
2024	0	0.62	8680	692	0	1414	0	0	0
2025	0	0.76	9409	694	0	1414	0	0	0
2026	0	0.86	10,108	696	0	1414	0	0	0

*Table 4.3. Red snapper: Projection results under scenario H1—fishing mortality rate $F = F_{\text{current}}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $\text{SSB}_{F_{40\%}} = 8102.5$ mt, $\text{R}_{F_{40\%}} = 692,864$ fish, $\text{Y}_{F_{40\%}} = 2,303,676$ lb, and $\text{D}_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0.974	0	187	285	425	1839	97	169	109
2011	0.974	0	192	306	443	2282	98	163	106
2012	0.974	0	195	311	453	2735	100	163	109
2013	0.974	0	199	314	459	3194	101	168	111
2014	0.974	0	202	317	467	3661	103	170	112
2015	0.974	0	205	320	474	4135	104	172	113
2016	0.974	0	207	322	481	4616	105	173	114
2017	0.974	0	210	325	486	5102	106	175	115
2018	0.974	0	212	327	491	5593	107	176	116
2019	0.974	0	213	328	495	6088	108	177	116
2020	0.974	0	215	330	499	6587	109	178	117
2021	0.974	0	216	331	502	7089	109	179	118
2022	0.974	0	217	332	505	7594	110	179	118
2023	0.974	0	218	333	507	8101	110	180	118
2024	0.974	0	219	334	510	8611	111	181	119
2025	0.974	0	220	335	511	9122	111	181	119
2026	0.974	0	221	335	513	9635	111	181	119
2027	0.974	0	221	336	515	10,150	112	182	119
2028	0.974	0	222	336	516	10,665	112	182	120
2029	0.974	0	222	337	517	11,182	112	182	120
2030	0.974	0	222	337	518	11,700	112	183	120
2031	0.974	0	223	337	519	12,219	112	183	120
2032	0.974	0	223	337	519	12,738	112	183	120
2033	0.974	0	223	338	520	13,258	113	183	120
2034	0.974	0	224	338	520	13,778	113	183	120
2035	0.974	0	224	338	521	14,299	113	183	120
2036	0.974	0	224	338	521	14,820	113	183	120
2037	0.974	0	224	338	522	15,341	113	183	120
2038	0.974	0	224	338	522	15,863	113	184	121
2039	0.974	0	224	339	522	16,385	113	184	121
2040	0.974	0	224	339	522	16,908	113	184	121
2041	0.974	0	224	339	522	17,430	113	184	121
2042	0.974	0	224	339	523	17,953	113	184	121
2043	0.974	0	225	339	523	18,475	113	184	121
2044	0.974	0	225	339	523	18,998	113	184	121
2045	0.974	0	225	339	523	19,521	113	184	121
2046	0.974	0	225	339	523	20,044	113	184	121
2047	0.974	0	225	339	523	20,568	113	184	121
2048	0.974	0	225	339	523	21,091	113	184	121
2049	0.974	0	225	339	523	21,614	113	184	121
2050	0.974	0	225	339	523	22,137	113	184	121

*Table 4.4. Red snapper: Projection results under scenario H2—fishing mortality rate $F = 65\%F_{40\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $SSB_{F_{40\%}} = 8102.5$ mt, $R_{F_{40\%}} = 692,864$ fish, $Y_{F_{40\%}} = 2,303,676$ lb, and $D_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0.068	0	187	285	39	1452	9	15	9
2011	0.068	0	418	306	68	1521	14	19	11
2012	0.068	0	640	448	109	1630	20	21	13
2013	0.068	0	920	514	160	1790	26	27	16
2014	0.068	0	1269	562	222	2012	34	34	19
2015	0.068	0	1681	597	299	2311	43	38	21
2016	0.068	0	2145	622	385	2696	52	41	22
2017	0.068	0	2647	640	479	3175	61	43	23
2018	0.068	0	3171	653	577	3753	69	44	24
2019	0.068	0	3703	662	677	4430	76	45	24
2020	0.068	0	4234	669	777	5207	83	46	25
2021	0.068	0.01	4752	675	874	6082	90	47	25
2022	0.068	0.02	5251	679	967	7049	96	47	25
2023	0.068	0.05	5725	682	1056	8105	101	47	25
2024	0.068	0.1	6172	684	1139	9244	106	48	25
2025	0.068	0.14	6590	686	1217	10,462	110	48	25
2026	0.068	0.21	6977	688	1289	11,751	114	48	26
2027	0.068	0.28	7335	690	1356	13,107	117	48	26
2028	0.068	0.37	7663	691	1417	14,523	120	48	26
2029	0.068	0.44	7963	692	1472	15,996	123	48	26
2030	0.068	0.53	8236	693	1523	17,519	126	48	26
2031	0.068	0.6	8484	693	1569	19,088	128	49	26
2032	0.068	0.66	8709	694	1611	20,700	130	49	26
2033	0.068	0.72	8912	694	1649	22,349	132	49	26
2034	0.068	0.76	9096	695	1683	24,032	133	49	26
2035	0.068	0.79	9261	695	1714	25,745	135	49	26
2036	0.068	0.83	9410	695	1741	27,487	136	49	26
2037	0.068	0.85	9544	696	1766	29,253	137	49	26
2038	0.068	0.88	9664	696	1789	31,042	139	49	26
2039	0.068	0.9	9772	696	1809	32,851	139	49	26
2040	0.068	0.91	9870	696	1827	34,677	140	49	26
2041	0.068	0.91	9957	697	1843	36,520	141	49	26
2042	0.068	0.92	10,035	697	1858	38,378	142	49	26
2043	0.068	0.93	10,106	697	1871	40,249	142	49	26
2044	0.068	0.94	10,169	697	1882	42,131	143	49	26
2045	0.068	0.94	10,226	697	1893	44,024	143	49	26
2046	0.068	0.95	10,276	697	1902	45,927	144	49	26
2047	0.068	0.95	10,322	697	1911	47,838	144	49	26
2048	0.068	0.95	10,363	697	1918	49,756	145	49	26
2049	0.068	0.96	10,399	697	1925	51,681	145	49	26
2050	0.068	0.97	10,432	697	1931	53,613	145	49	26

*Table 4.5. Red snapper: Projection results under scenario H3—fishing mortality rate $F = 75\%F_{40\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $SSB_{F_{40\%}} = 8102.5$ mt, $R_{F_{40\%}} = 692,864$ fish, $Y_{F_{40\%}} = 2,303,676$ lb, and $D_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0.078	0	187	285	44	1458	10	17	11
2011	0.078	0	414	306	78	1536	16	22	12
2012	0.078	0	631	446	124	1661	22	25	15
2013	0.078	0	903	512	181	1842	30	31	18
2014	0.078	0	1240	560	250	2092	39	39	22
2015	0.078	0	1637	595	335	2427	49	43	24
2016	0.078	0	2082	620	431	2858	58	46	25
2017	0.078	0	2561	638	534	3393	68	49	26
2018	0.078	0	3059	651	642	4035	77	51	27
2019	0.078	0	3563	660	751	4786	85	52	28
2020	0.078	0	4062	668	860	5646	93	53	28
2021	0.078	0.01	4548	673	965	6610	100	53	29
2022	0.078	0.02	5014	677	1065	7676	106	54	29
2023	0.078	0.03	5455	680	1160	8836	112	54	29
2024	0.078	0.06	5868	683	1249	10,085	117	55	29
2025	0.078	0.1	6252	685	1331	11,416	122	55	29
2026	0.078	0.14	6607	687	1408	12,824	126	55	29
2027	0.078	0.19	6932	688	1478	14,301	130	55	29
2028	0.078	0.25	7229	689	1541	15,843	133	55	29
2029	0.078	0.32	7499	690	1599	17,442	136	55	29
2030	0.078	0.38	7744	691	1652	19,094	138	55	30
2031	0.078	0.44	7966	692	1699	20,793	141	55	30
2032	0.078	0.5	8165	693	1742	22,535	143	56	30
2033	0.078	0.56	8344	693	1780	24,315	145	56	30
2034	0.078	0.61	8505	693	1815	26,130	146	56	30
2035	0.078	0.65	8650	694	1846	27,976	148	56	30
2036	0.078	0.69	8779	694	1874	29,850	149	56	30
2037	0.078	0.73	8895	694	1898	31,748	150	56	30
2038	0.078	0.75	8998	695	1921	33,669	151	56	30
2039	0.078	0.78	9091	695	1940	35,610	152	56	30
2040	0.078	0.79	9173	695	1958	37,568	153	56	30
2041	0.078	0.8	9247	695	1974	39,542	154	56	30
2042	0.078	0.82	9313	695	1988	41,530	155	56	30
2043	0.078	0.83	9372	696	2001	43,531	155	56	30
2044	0.078	0.84	9424	696	2012	45,543	156	56	30
2045	0.078	0.84	9471	696	2022	47,565	156	56	30
2046	0.078	0.86	9513	696	2031	49,596	157	56	30
2047	0.078	0.87	9550	696	2039	51,634	157	56	30
2048	0.078	0.87	9583	696	2046	53,681	157	56	30
2049	0.078	0.87	9613	696	2052	55,733	158	56	30
2050	0.078	0.87	9639	696	2058	57,791	158	56	30

*Table 4.6. Red snapper: Projection results under scenario H4—fishing mortality rate $F = 85\%F_{40\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $SSB_{F_{40\%}} = 8102.5$ mt, $R_{F_{40\%}} = 692,864$ fish, $Y_{F_{40\%}} = 2,303,676$ lb, and $D_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0.088	0	187	285	50	1464	11	19	12
2011	0.088	0	411	306	88	1552	18	25	14
2012	0.088	0	622	445	139	1691	25	28	16
2013	0.088	0	886	510	201	1892	33	35	21
2014	0.088	0	1212	558	277	2169	43	43	24
2015	0.088	0	1595	593	369	2538	54	48	27
2016	0.088	0	2021	618	474	3012	65	52	28
2017	0.088	0	2478	636	586	3597	75	55	30
2018	0.088	0	2951	649	702	4299	85	57	31
2019	0.088	0	3429	659	819	5118	94	58	31
2020	0.088	0	3899	666	934	6052	102	59	32
2021	0.088	0	4355	671	1046	7098	110	60	32
2022	0.088	0.01	4790	676	1152	8250	116	60	32
2023	0.088	0.02	5199	679	1252	9502	122	61	33
2024	0.088	0.04	5581	682	1345	10,848	128	61	33
2025	0.088	0.07	5935	684	1431	12,279	133	61	33
2026	0.088	0.09	6259	685	1511	13,790	137	62	33
2027	0.088	0.13	6556	687	1583	15,372	141	62	33
2028	0.088	0.17	6825	688	1648	17,020	144	62	33
2029	0.088	0.21	7069	689	1707	18,728	147	62	33
2030	0.088	0.27	7289	690	1761	20,489	150	62	33
2031	0.088	0.32	7486	691	1809	22,298	152	62	33
2032	0.088	0.37	7663	691	1852	24,150	154	62	33
2033	0.088	0.41	7822	692	1890	26,040	156	62	33
2034	0.088	0.46	7963	692	1925	27,965	158	62	33
2035	0.088	0.51	8089	693	1956	29,921	159	62	33
2036	0.088	0.53	8202	693	1983	31,903	161	62	33
2037	0.088	0.56	8302	693	2007	33,911	162	63	33
2038	0.088	0.59	8391	693	2029	35,939	163	63	33
2039	0.088	0.62	8470	694	2048	37,987	164	63	33
2040	0.088	0.64	8540	694	2065	40,052	165	63	33
2041	0.088	0.66	8603	694	2080	42,133	165	63	33
2042	0.088	0.67	8658	694	2094	44,226	166	63	33
2043	0.088	0.68	8707	694	2106	46,332	167	63	33
2044	0.088	0.69	8751	694	2116	48,448	167	63	33
2045	0.088	0.71	8790	694	2126	50,574	168	63	33
2046	0.088	0.71	8824	694	2134	52,708	168	63	33
2047	0.088	0.72	8855	695	2141	54,850	168	63	33
2048	0.088	0.73	8882	695	2148	56,998	169	63	33
2049	0.088	0.74	8906	695	2154	59,152	169	63	33
2050	0.088	0.74	8927	695	2159	61,311	169	63	33

*Table 4.7. Red snapper: Projection results under scenario H5—fishing mortality rate $F = F_{40\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $SSB_{F_{40\%}} = 8102.5$ mt, $R_{F_{40\%}} = 692,864$ fish, $Y_{F_{40\%}} = 2,303,676$ lb, and $D_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	1.22	0	205	321	553	1007	117	190	129
2009	0.974	0	165	322	407	1414	91	157	109
2010	0.104	0	187	285	59	1473	13	23	14
2011	0.104	0	405	306	102	1574	21	29	16
2012	0.104	0	609	442	160	1734	29	32	19
2013	0.104	0	861	507	230	1964	38	40	24
2014	0.104	0	1172	554	315	2278	49	50	28
2015	0.104	0	1533	589	417	2696	61	56	31
2016	0.104	0	1933	614	532	3228	73	60	33
2017	0.104	0	2359	633	655	3882	85	63	35
2018	0.104	0	2798	646	781	4664	96	66	36
2019	0.104	0	3238	656	908	5572	106	67	36
2020	0.104	0	3668	663	1033	6604	115	68	37
2021	0.104	0	4082	669	1152	7757	123	69	37
2022	0.104	0	4475	673	1265	9021	130	70	38
2023	0.104	0.01	4842	677	1370	10,392	136	70	38
2024	0.104	0.02	5182	679	1468	11,860	142	71	38
2025	0.104	0.03	5494	681	1557	13,417	147	71	38
2026	0.104	0.05	5779	683	1639	15,056	152	71	38
2027	0.104	0.07	6037	685	1713	16,769	156	72	38
2028	0.104	0.09	6270	686	1780	18,549	159	72	39
2029	0.104	0.11	6479	687	1839	20,388	162	72	39
2030	0.104	0.14	6666	688	1893	22,281	165	72	39
2031	0.104	0.17	6833	688	1941	24,222	167	72	39
2032	0.104	0.19	6982	689	1983	26,206	169	72	39
2033	0.104	0.21	7114	690	2021	28,227	171	72	39
2034	0.104	0.24	7231	690	2054	30,281	173	72	39
2035	0.104	0.27	7334	690	2084	32,365	174	72	39
2036	0.104	0.3	7426	691	2110	34,475	176	72	39
2037	0.104	0.32	7506	691	2133	36,608	177	72	39
2038	0.104	0.33	7578	691	2154	38,762	178	73	39
2039	0.104	0.35	7640	691	2172	40,933	179	73	39
2040	0.104	0.37	7696	692	2187	43,121	179	73	39
2041	0.104	0.4	7745	692	2201	45,322	180	73	39
2042	0.104	0.42	7788	692	2214	47,536	181	73	39
2043	0.104	0.43	7826	692	2224	49,760	181	73	39
2044	0.104	0.44	7859	692	2234	51,994	182	73	39
2045	0.104	0.44	7888	692	2242	54,237	182	73	39
2046	0.104	0.45	7914	692	2250	56,487	182	73	39
2047	0.104	0.45	7937	692	2256	58,743	183	73	39
2048	0.104	0.45	7957	692	2262	61,005	183	73	39
2049	0.104	0.45	7974	692	2267	63,272	183	73	39
2050	0.104	0.45	7990	693	2271	65,543	183	73	39

*Table 4.8. Red snapper: Projection results under scenario D1—fishing mortality rate $F = F_{\text{current}}$ (minus F associated with commercial diving). F = fishing rate (per year), Fmort = fishing rate (per year) as the portion of F that leads to (discard) mortality, Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $\text{SSB}_{F_{40\%}} = 8102.5$ mt, $\text{R}_{F_{40\%}} = 692,864$ fish, $\text{Y}_{F_{40\%}} = 2,303,676$ lb, and $\text{D}_{F_{40\%}} = 72,717$ lb.

Year	F	Fmort	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.930	0.930	0	203	286	454	454	95	153	99
2008	1.220	1.220	0	205	321	553	1007	117	190	129
2009	0.974	0.974	0	165	322	407	1414	91	157	109
2010	0.958	0.691	0	187	285	0	1414	0	421	163
2011	0.958	0.691	0	258	306	0	1414	0	495	174
2012	0.958	0.691	0	302	364	0	1414	0	563	191
2013	0.958	0.691	0	345	391	0	1414	0	643	214
2014	0.958	0.691	0	388	415	0	1414	0	722	234
2015	0.958	0.691	0	431	435	0	1414	0	796	251
2016	0.958	0.691	0	473	453	0	1414	0	865	266
2017	0.958	0.691	0	511	468	0	1414	0	929	279
2018	0.958	0.691	0	546	480	0	1414	0	988	291
2019	0.958	0.691	0	578	491	0	1414	0	1040	301
2020	0.958	0.691	0	605	499	0	1414	0	1086	309
2021	0.958	0.691	0	630	506	0	1414	0	1126	316
2022	0.958	0.691	0	651	512	0	1414	0	1161	322
2023	0.958	0.691	0	669	517	0	1414	0	1191	327
2024	0.958	0.691	0	685	521	0	1414	0	1216	331
2025	0.958	0.691	0	698	524	0	1414	0	1237	334
2026	0.958	0.691	0	709	527	0	1414	0	1255	337
2027	0.958	0.691	0	719	529	0	1414	0	1270	340
2028	0.958	0.691	0	726	531	0	1414	0	1283	341
2029	0.958	0.691	0	733	532	0	1414	0	1293	343
2030	0.958	0.691	0	738	533	0	1414	0	1302	344
2031	0.958	0.691	0	743	534	0	1414	0	1309	345
2032	0.958	0.691	0	746	535	0	1414	0	1315	346
2033	0.958	0.691	0	749	536	0	1414	0	1320	347
2034	0.958	0.691	0	752	536	0	1414	0	1324	348
2035	0.958	0.691	0	754	537	0	1414	0	1327	348
2036	0.958	0.691	0	756	537	0	1414	0	1330	348
2037	0.958	0.691	0	757	537	0	1414	0	1332	349
2038	0.958	0.691	0	758	538	0	1414	0	1334	349
2039	0.958	0.691	0	759	538	0	1414	0	1335	349
2040	0.958	0.691	0	760	538	0	1414	0	1337	349
2041	0.958	0.691	0	760	538	0	1414	0	1338	350
2042	0.958	0.691	0	761	538	0	1414	0	1338	350
2043	0.958	0.691	0	761	538	0	1414	0	1339	350
2044	0.958	0.691	0	762	538	0	1414	0	1340	350
2045	0.958	0.691	0	762	538	0	1414	0	1340	350
2046	0.958	0.691	0	762	538	0	1414	0	1341	350
2047	0.958	0.691	0	762	538	0	1414	0	1341	350
2048	0.958	0.691	0	763	539	0	1414	0	1341	350
2049	0.958	0.691	0	763	539	0	1414	0	1341	350
2050	0.958	0.691	0	763	539	0	1414	0	1341	350

*Table 4.9. Red snapper: Projection results under scenario D2—fishing mortality rate F = 65%$F_{40\%}$. F = fishing rate (per year), Fmort = fishing rate (per year) as the portion of F that leads to (discard) mortality, Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%}$ = 0.104, $SSB_{F_{40\%}}$ = 8102.5 mt, $R_{F_{40\%}}$ = 692,864 fish, $Y_{F_{40\%}}$ = 2,303,676 lb, and $D_{F_{40\%}}$ = 72,717 lb.

Year	F	Fmort	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.930	0.930	0.00	203	286	454	454	95	153	99
2008	1.220	1.220	0.00	205	321	553	1007	117	190	129
2009	0.974	0.974	0.00	165	322	407	1414	91	157	109
2010	0.068	0.049	0.00	187	285	0	1414	0	35	13
2011	0.068	0.049	0.00	427	306	0	1414	0	56	18
2012	0.068	0.049	0.00	661	451	0	1414	0	82	23
2013	0.068	0.049	0.00	961	519	0	1414	0	118	30
2014	0.068	0.049	0.00	1338	567	0	1414	0	161	38
2015	0.068	0.049	0.00	1789	602	0	1414	0	211	45
2016	0.068	0.049	0.00	2302	627	0	1414	0	267	51
2017	0.068	0.049	0.00	2864	645	0	1414	0	328	57
2018	0.068	0.049	0.00	3458	657	0	1414	0	391	63
2019	0.068	0.049	0.00	4070	666	0	1414	0	457	68
2020	0.068	0.049	0.01	4688	673	0	1414	0	522	73
2021	0.068	0.049	0.03	5299	678	0	1414	0	587	78
2022	0.068	0.049	0.07	5896	682	0	1414	0	651	82
2023	0.068	0.049	0.14	6473	685	0	1414	0	712	85
2024	0.068	0.049	0.22	7023	688	0	1414	0	770	89
2025	0.068	0.049	0.34	7545	690	0	1414	0	825	92
2026	0.068	0.049	0.46	8036	691	0	1414	0	877	94
2027	0.068	0.049	0.58	8496	693	0	1414	0	926	97
2028	0.068	0.049	0.69	8924	694	0	1414	0	971	99
2029	0.068	0.049	0.77	9322	695	0	1414	0	1013	101
2030	0.068	0.049	0.85	9690	696	0	1414	0	1052	103
2031	0.068	0.049	0.89	10,029	696	0	1414	0	1088	105
2032	0.068	0.049	0.93	10,341	697	0	1414	0	1121	107
2033	0.068	0.049	0.95	10,627	697	0	1414	0	1151	108
2034	0.068	0.049	0.97	10,890	698	0	1414	0	1179	110
2035	0.068	0.049	0.98	11,131	698	0	1414	0	1205	111
2036	0.068	0.049	0.99	11,350	699	0	1414	0	1228	112
2037	0.068	0.049	0.99	11,552	699	0	1414	0	1249	113
2038	0.068	0.049	0.99	11,735	699	0	1414	0	1268	114
2039	0.068	0.049	1.00	11,903	699	0	1414	0	1286	115
2040	0.068	0.049	1.00	12,056	700	0	1414	0	1302	115
2041	0.068	0.049	1.00	12,196	700	0	1414	0	1317	116
2042	0.068	0.049	1.00	12,323	700	0	1414	0	1331	117
2043	0.068	0.049	1.00	12,440	700	0	1414	0	1343	117
2044	0.068	0.049	1.00	12,545	700	0	1414	0	1354	118
2045	0.068	0.049	1.00	12,642	700	0	1414	0	1364	118
2046	0.068	0.049	1.00	12,730	700	0	1414	0	1374	119
2047	0.068	0.049	1.00	12,811	700	0	1414	0	1382	119
2048	0.068	0.049	1.00	12,884	701	0	1414	0	1390	120
2049	0.068	0.049	1.00	12,950	701	0	1414	0	1397	120
2050	0.068	0.049	1.00	13,011	701	0	1414	0	1403	120

*Table 4.10. Red snapper: Projection results under scenario D3—fishing mortality rate F = 75%$F_{40\%}$. F = fishing rate (per year), Fmort = fishing rate (per year) as the portion of F that leads to (discard) mortality, Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%}$ = 0.104, $SSB_{F_{40\%}}$ = 8102.5 mt, $R_{F_{40\%}}$ = 692,864 fish, $Y_{F_{40\%}}$ = 2,303,676 lb, and $D_{F_{40\%}}$ = 72,717 lb.

Year	F	Fmort	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.930	0.930	0.00	203	286	454	454	95	153	99
2008	1.220	1.220	0.00	205	321	553	1007	117	190	129
2009	0.974	0.974	0.00	165	322	407	1414	91	157	109
2010	0.078	0.056	0.00	187	285	0	1414	0	40	16
2011	0.078	0.056	0.00	424	306	0	1414	0	65	20
2012	0.078	0.056	0.00	655	450	0	1414	0	94	27
2013	0.078	0.056	0.00	949	518	0	1414	0	134	35
2014	0.078	0.056	0.00	1318	566	0	1414	0	183	43
2015	0.078	0.056	0.00	1759	601	0	1414	0	240	51
2016	0.078	0.056	0.00	2258	626	0	1414	0	303	59
2017	0.078	0.056	0.00	2804	643	0	1414	0	371	65
2018	0.078	0.056	0.00	3379	656	0	1414	0	442	72
2019	0.078	0.056	0.00	3971	665	0	1414	0	515	78
2020	0.078	0.056	0.01	4566	672	0	1414	0	588	83
2021	0.078	0.056	0.02	5154	677	0	1414	0	660	88
2022	0.078	0.056	0.06	5726	681	0	1414	0	730	92
2023	0.078	0.056	0.11	6277	684	0	1414	0	797	97
2024	0.078	0.056	0.18	6802	687	0	1414	0	861	100
2025	0.078	0.056	0.28	7298	689	0	1414	0	922	104
2026	0.078	0.056	0.39	7763	691	0	1414	0	979	107
2027	0.078	0.056	0.51	8198	692	0	1414	0	1032	109
2028	0.078	0.056	0.61	8601	693	0	1414	0	1081	112
2029	0.078	0.056	0.70	8975	694	0	1414	0	1127	114
2030	0.078	0.056	0.79	9319	695	0	1414	0	1169	116
2031	0.078	0.056	0.85	9636	696	0	1414	0	1207	118
2032	0.078	0.056	0.89	9926	696	0	1414	0	1243	120
2033	0.078	0.056	0.92	10,192	697	0	1414	0	1275	122
2034	0.078	0.056	0.94	10,435	697	0	1414	0	1305	123
2035	0.078	0.056	0.96	10,656	698	0	1414	0	1332	124
2036	0.078	0.056	0.97	10,858	698	0	1414	0	1356	126
2037	0.078	0.056	0.98	11,043	698	0	1414	0	1379	127
2038	0.078	0.056	0.98	11,210	698	0	1414	0	1399	128
2039	0.078	0.056	0.99	11,363	699	0	1414	0	1418	128
2040	0.078	0.056	0.99	11,502	699	0	1414	0	1435	129
2041	0.078	0.056	0.99	11,628	699	0	1414	0	1450	130
2042	0.078	0.056	1.00	11,743	699	0	1414	0	1464	131
2043	0.078	0.056	1.00	11,847	699	0	1414	0	1477	131
2044	0.078	0.056	1.00	11,942	699	0	1414	0	1489	132
2045	0.078	0.056	1.00	12,028	700	0	1414	0	1499	132
2046	0.078	0.056	1.00	12,107	700	0	1414	0	1509	133
2047	0.078	0.056	1.00	12,178	700	0	1414	0	1517	133
2048	0.078	0.056	1.00	12,243	700	0	1414	0	1525	134
2049	0.078	0.056	1.00	12,301	700	0	1414	0	1533	134
2050	0.078	0.056	1.00	12,355	700	0	1414	0	1539	134

*Table 4.11. Red snapper: Projection results under scenario D4—fishing mortality rate F = 85%$F_{40\%}$. F = fishing rate (per year), Fmort = fishing rate (per year) as the portion of F that leads to (discard) mortality, Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%}$ = 0.104, $SSB_{F_{40\%}}$ = 8102.5 mt, $R_{F_{40\%}}$ = 692,864 fish, $Y_{F_{40\%}}$ = 2,303,676 lb, and $D_{F_{40\%}}$ = 72,717 lb.

Year	F	Fmort	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.930	0.930	0.00	203	286	454	454	95	153	99
2008	1.220	1.220	0.00	205	321	553	1007	117	190	129
2009	0.974	0.974	0.00	165	322	407	1414	91	157	109
2010	0.088	0.064	0.00	187	285	0	1414	0	46	18
2011	0.088	0.064	0.00	422	306	0	1414	0	73	23
2012	0.088	0.064	0.00	649	449	0	1414	0	106	30
2013	0.088	0.064	0.00	938	516	0	1414	0	150	39
2014	0.088	0.064	0.00	1299	564	0	1414	0	205	48
2015	0.088	0.064	0.00	1729	599	0	1414	0	267	57
2016	0.088	0.064	0.00	2215	624	0	1414	0	337	66
2017	0.088	0.064	0.00	2745	642	0	1414	0	412	73
2018	0.088	0.064	0.00	3302	655	0	1414	0	490	80
2019	0.088	0.064	0.00	3874	664	0	1414	0	570	87
2020	0.088	0.064	0.01	4448	671	0	1414	0	649	93
2021	0.088	0.064	0.02	5013	676	0	1414	0	728	98
2022	0.088	0.064	0.05	5562	680	0	1414	0	804	103
2023	0.088	0.064	0.09	6088	684	0	1414	0	877	107
2024	0.088	0.064	0.15	6588	686	0	1414	0	946	111
2025	0.088	0.064	0.23	7060	688	0	1414	0	1012	115
2026	0.088	0.064	0.32	7501	690	0	1414	0	1073	118
2027	0.088	0.064	0.43	7912	691	0	1414	0	1130	121
2028	0.088	0.064	0.54	8292	692	0	1414	0	1182	124
2029	0.088	0.064	0.63	8643	693	0	1414	0	1231	127
2030	0.088	0.064	0.71	8965	694	0	1414	0	1275	129
2031	0.088	0.064	0.78	9261	695	0	1414	0	1316	131
2032	0.088	0.064	0.84	9531	695	0	1414	0	1354	133
2033	0.088	0.064	0.87	9778	696	0	1414	0	1388	134
2034	0.088	0.064	0.91	10,002	696	0	1414	0	1419	136
2035	0.088	0.064	0.93	10,207	697	0	1414	0	1447	137
2036	0.088	0.064	0.94	10,393	697	0	1414	0	1473	138
2037	0.088	0.064	0.96	10,561	697	0	1414	0	1496	140
2038	0.088	0.064	0.97	10,714	698	0	1414	0	1517	141
2039	0.088	0.064	0.98	10,853	698	0	1414	0	1537	141
2040	0.088	0.064	0.98	10,979	698	0	1414	0	1554	142
2041	0.088	0.064	0.98	11,094	698	0	1414	0	1570	143
2042	0.088	0.064	0.99	11,197	698	0	1414	0	1584	144
2043	0.088	0.064	0.99	11,291	699	0	1414	0	1597	144
2044	0.088	0.064	0.99	11,376	699	0	1414	0	1609	145
2045	0.088	0.064	0.99	11,453	699	0	1414	0	1619	145
2046	0.088	0.064	0.99	11,523	699	0	1414	0	1629	146
2047	0.088	0.064	0.99	11,586	699	0	1414	0	1638	146
2048	0.088	0.064	1.00	11,643	699	0	1414	0	1646	147
2049	0.088	0.064	1.00	11,695	699	0	1414	0	1653	147
2050	0.088	0.064	1.00	11,742	699	0	1414	0	1659	147

*Table 4.12. Red snapper: Projection results under scenario D5—fishing mortality rate F = $F_{40\%}$. F = fishing rate (per year), Fmort = fishing rate (per year) as the portion of F that leads to (discard) mortality, Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%}$ = 0.104, $SSB_{F_{40\%}}$ = 8102.5 mt, $R_{F_{40\%}}$ = 692,864 fish, $Y_{F_{40\%}}$ = 2,303,676 lb, and $D_{F_{40\%}}$ = 72,717 lb.

Year	F	Fmort	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.930	0.930	0.00	203	286	454	454	95	153	99
2008	1.220	1.220	0.00	205	321	553	1007	117	190	129
2009	0.974	0.974	0.00	165	322	407	1414	91	157	109
2010	0.104	0.075	0.00	187	285	0	1414	0	54	21
2011	0.104	0.075	0.00	418	306	0	1414	0	85	27
2012	0.104	0.075	0.00	640	448	0	1414	0	123	35
2013	0.104	0.075	0.00	921	514	0	1414	0	174	45
2014	0.104	0.075	0.00	1270	562	0	1414	0	236	56
2015	0.104	0.075	0.00	1685	597	0	1414	0	307	66
2016	0.104	0.075	0.00	2152	622	0	1414	0	386	76
2017	0.104	0.075	0.00	2659	640	0	1414	0	470	84
2018	0.104	0.075	0.00	3191	653	0	1414	0	558	92
2019	0.104	0.075	0.00	3734	663	0	1414	0	647	100
2020	0.104	0.075	0.00	4277	670	0	1414	0	736	106
2021	0.104	0.075	0.01	4809	675	0	1414	0	823	112
2022	0.104	0.075	0.03	5325	679	0	1414	0	907	118
2023	0.104	0.075	0.06	5817	682	0	1414	0	987	123
2024	0.104	0.075	0.11	6283	685	0	1414	0	1063	127
2025	0.104	0.075	0.16	6720	687	0	1414	0	1134	131
2026	0.104	0.075	0.24	7127	689	0	1414	0	1201	135
2027	0.104	0.075	0.32	7504	690	0	1414	0	1262	138
2028	0.104	0.075	0.42	7852	691	0	1414	0	1319	141
2029	0.104	0.075	0.50	8172	692	0	1414	0	1371	144
2030	0.104	0.075	0.59	8464	693	0	1414	0	1419	146
2031	0.104	0.075	0.66	8731	694	0	1414	0	1462	148
2032	0.104	0.075	0.73	8974	694	0	1414	0	1502	150
2033	0.104	0.075	0.78	9195	695	0	1414	0	1537	152
2034	0.104	0.075	0.83	9395	695	0	1414	0	1570	154
2035	0.104	0.075	0.86	9576	696	0	1414	0	1600	155
2036	0.104	0.075	0.88	9740	696	0	1414	0	1626	156
2037	0.104	0.075	0.90	9888	696	0	1414	0	1650	158
2038	0.104	0.075	0.92	10,022	697	0	1414	0	1672	159
2039	0.104	0.075	0.93	10,143	697	0	1414	0	1692	160
2040	0.104	0.075	0.94	10,252	697	0	1414	0	1709	160
2041	0.104	0.075	0.95	10,350	697	0	1414	0	1725	161
2042	0.104	0.075	0.96	10,439	697	0	1414	0	1740	162
2043	0.104	0.075	0.96	10,519	698	0	1414	0	1753	162
2044	0.104	0.075	0.97	10,591	698	0	1414	0	1765	163
2045	0.104	0.075	0.97	10,656	698	0	1414	0	1775	163
2046	0.104	0.075	0.98	10,715	698	0	1414	0	1785	164
2047	0.104	0.075	0.98	10,767	698	0	1414	0	1793	164
2048	0.104	0.075	0.98	10,815	698	0	1414	0	1801	165
2049	0.104	0.075	0.98	10,858	698	0	1414	0	1808	165
2050	0.104	0.075	0.98	10,896	698	0	1414	0	1814	165

*Table 4.13. Red snapper: Projection results under scenario P0-alt—fishing mortality rate F = 0. This scenario differs from P0 by using preliminary estimates of 2008 recreational landings from MRFSS. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $\text{SSB}_{F_{40\%}} = 8102.5$ mt, $\text{R}_{F_{40\%}} = 692,864$ fish, $\text{Y}_{F_{40\%}} = 2,303,676$ lb, and $\text{D}_{F_{40\%}} = 72,717$ lb.

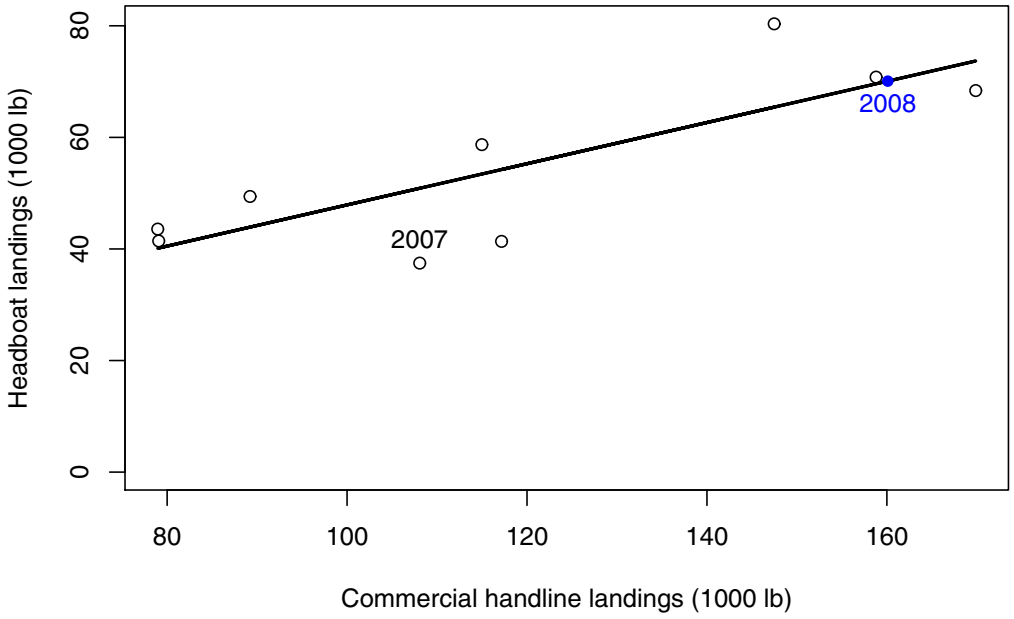
Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	4.98	0	205	321	1000	1454	218	383	304
2009	1.291	0	14	322	75	1529	29	89	91
2010	0	0	58	37	0	1529	0	0	0
2011	0	0	187	136	0	1529	0	0	0
2012	0	0	307	307	0	1529	0	0	0
2013	0	0	478	395	0	1529	0	0	0
2014	0	0	732	470	0	1529	0	0	0
2015	0	0	1082	533	0	1529	0	0	0
2016	0	0	1530	581	0	1529	0	0	0
2017	0	0	2070	614	0	1529	0	0	0
2018	0	0	2691	638	0	1529	0	0	0
2019	0	0	3379	654	0	1529	0	0	0
2020	0	0	4116	665	0	1529	0	0	0
2021	0	0.02	4886	673	0	1529	0	0	0
2022	0	0.06	5674	680	0	1529	0	0	0
2023	0	0.15	6467	684	0	1529	0	0	0
2024	0	0.29	7254	688	0	1529	0	0	0
2025	0	0.46	8026	690	0	1529	0	0	0
2026	0	0.63	8778	693	0	1529	0	0	0

*Table 4.14. Red snapper: Projection results under scenario H3-alt—fishing mortality rate $F = 75\%F_{40\%}$. This scenario differs from H3 by using preliminary estimates of 2008 recreational landings from MRFSS. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{40\%}}$, SSB = mid-year spawning biomass (*mt*), R = recruits (1000 fish), L = landings (1000* lb *whole weight or fish), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000* lb or fish). For reference, estimated proxy reference points are $F_{40\%} = 0.104$, $\text{SSB}_{F_{40\%}} = 8102.5$ mt, $\text{R}_{F_{40\%}} = 692,864$ fish, $\text{Y}_{F_{40\%}} = 2,303,676$ lb, and $\text{D}_{F_{40\%}} = 72,717$ lb.

Year	F	Pr(recover)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	L(1000)	D(1000 lb)	D(1000)
2007	0.93	0	203	286	454	454	95	153	99
2008	4.98	0	205	321	1000	1454	218	383	304
2009	1.291	0	14	322	75	1529	29	89	91
2010	0.078	0	58	37	12	1541	5	12	6
2011	0.078	0	174	136	31	1572	7	12	5
2012	0.078	0	275	294	56	1628	10	8	7
2013	0.078	0	414	375	81	1709	14	18	12
2014	0.078	0	616	446	120	1828	21	27	16
2015	0.078	0	888	509	176	2005	29	33	19
2016	0.078	0	1227	558	248	2252	39	39	22
2017	0.078	0	1625	594	333	2585	48	43	24
2018	0.078	0	2071	619	428	3013	58	46	25
2019	0.078	0	2550	638	532	3545	68	49	26
2020	0.078	0	3048	651	640	4185	77	51	27
2021	0.078	0	3553	660	750	4934	85	52	28
2022	0.078	0	4053	667	858	5792	93	53	28
2023	0.078	0.01	4540	673	963	6755	100	53	29
2024	0.078	0.02	5006	677	1063	7818	106	54	29
2025	0.078	0.03	5447	680	1158	8977	112	54	29
2026	0.078	0.06	5861	683	1247	10,224	117	55	29
2027	0.078	0.09	6246	685	1330	11,554	122	55	29
2028	0.078	0.13	6601	687	1406	12,961	126	55	29
2029	0.078	0.19	6927	688	1476	14,437	129	55	29
2030	0.078	0.25	7224	689	1540	15,977	133	55	29
2031	0.078	0.32	7495	690	1598	17,576	136	55	29
2032	0.078	0.38	7740	691	1651	19,227	138	55	30
2033	0.078	0.44	7962	692	1699	20,925	141	55	30
2034	0.078	0.51	8162	693	1741	22,666	143	56	30
2035	0.078	0.56	8342	693	1780	24,446	145	56	30
2036	0.078	0.6	8503	693	1814	26,261	146	56	30
2037	0.078	0.66	8647	694	1845	28,106	148	56	30
2038	0.078	0.69	8777	694	1873	29,980	149	56	30
2039	0.078	0.73	8893	694	1898	31,878	150	56	30
2040	0.078	0.75	8996	695	1920	33,798	151	56	30
2041	0.078	0.77	9089	695	1940	35,738	152	56	30
2042	0.078	0.79	9172	695	1958	37,696	153	56	30
2043	0.078	0.8	9246	695	1974	39,670	154	56	30
2044	0.078	0.82	9312	695	1988	41,658	155	56	30
2045	0.078	0.82	9371	696	2001	43,658	155	56	30
2046	0.078	0.83	9423	696	2012	45,670	156	56	30
2047	0.078	0.85	9470	696	2022	47,692	156	56	30
2048	0.078	0.86	9512	696	2031	49,723	157	56	30
2049	0.078	0.86	9549	696	2039	51,761	157	56	30
2050	0.078	0.86	9582	696	2046	53,807	157	56	30

5 Figures

Figure 5.1. Regressions used to estimate 2008 headboat (top panel) and general recreational (bottom panel) landings, as used in the projections. The 2007 data (indicated) were not available in the assessment but were used in this regression. Predicted landings for 2008 are shown as filled circles.



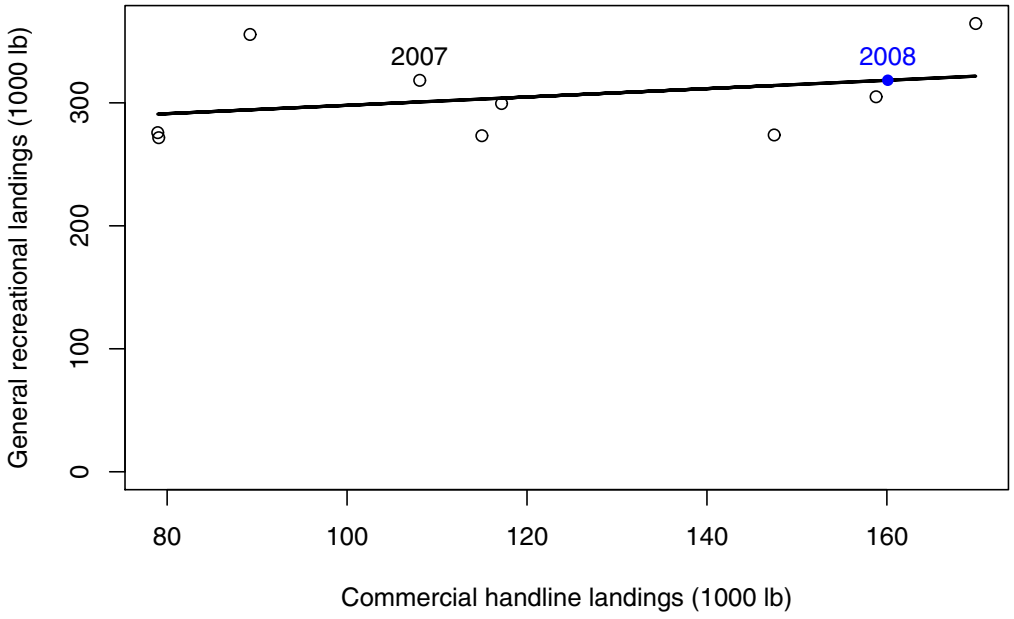


Figure 5.2. Projection results under scenario P0—fishing mortality rate fixed at $F = 0$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

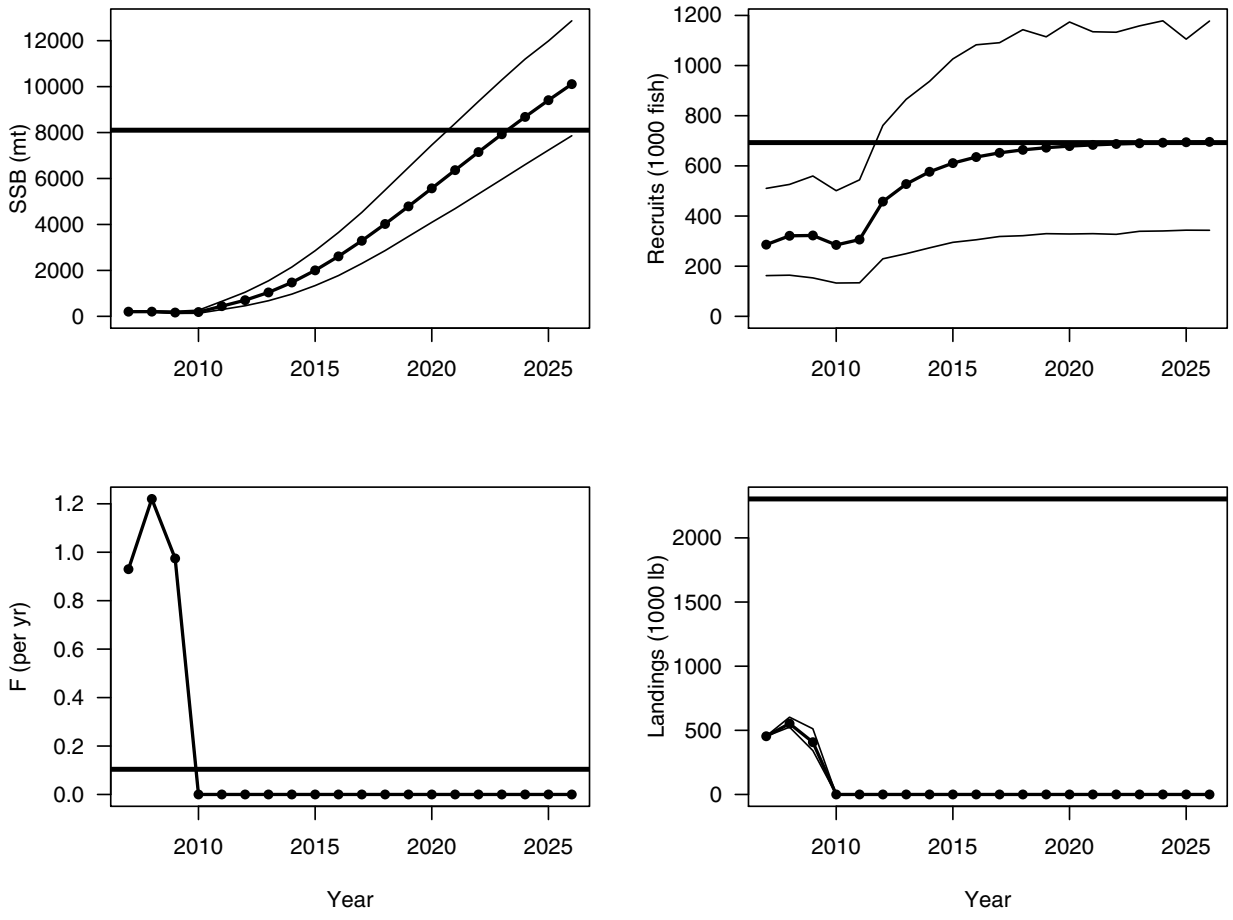


Figure 5.3. Projection results under scenario H1—fishing mortality rate fixed at $F = F_{\text{current}}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

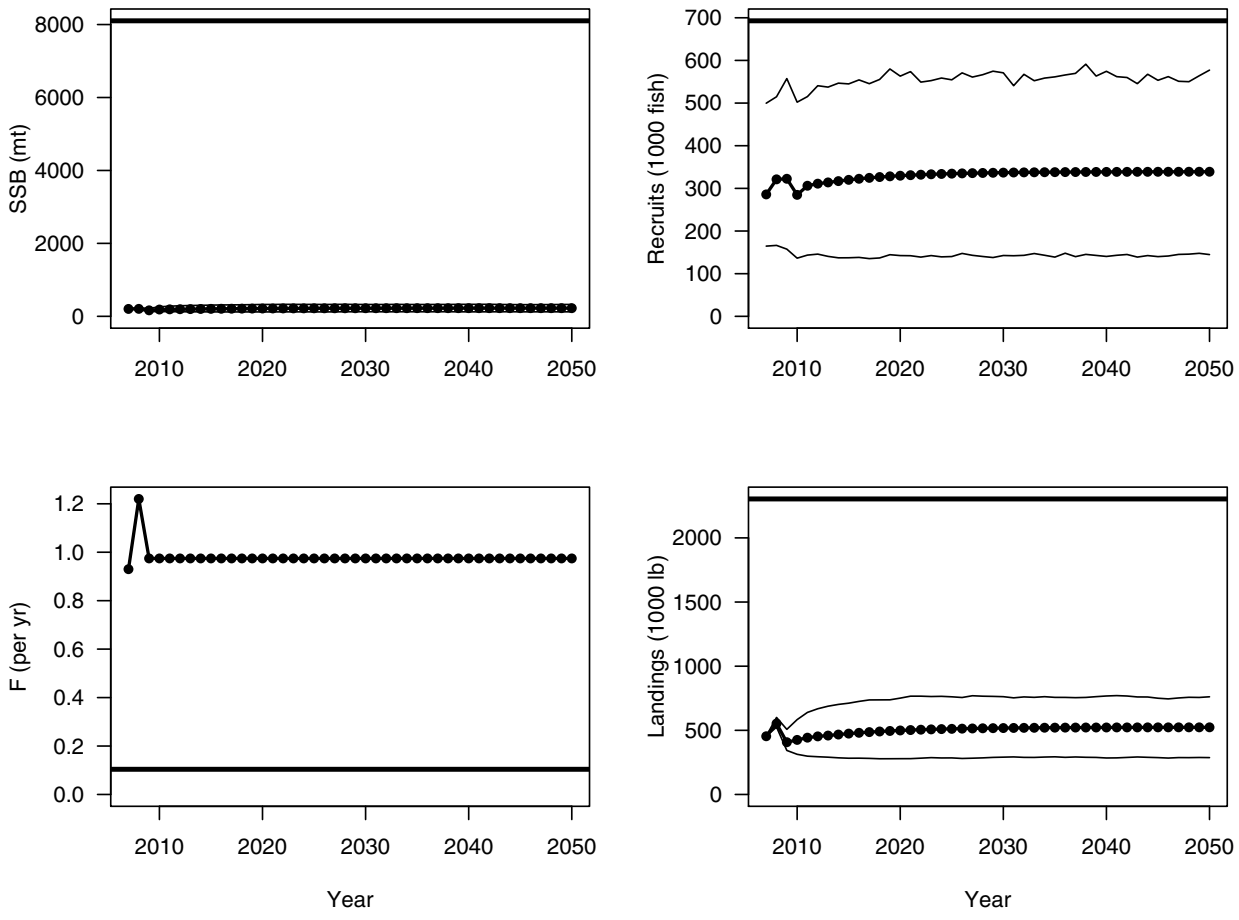


Figure 5.4. Projection results under scenario H2—fishing mortality rate fixed at $F = 65\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

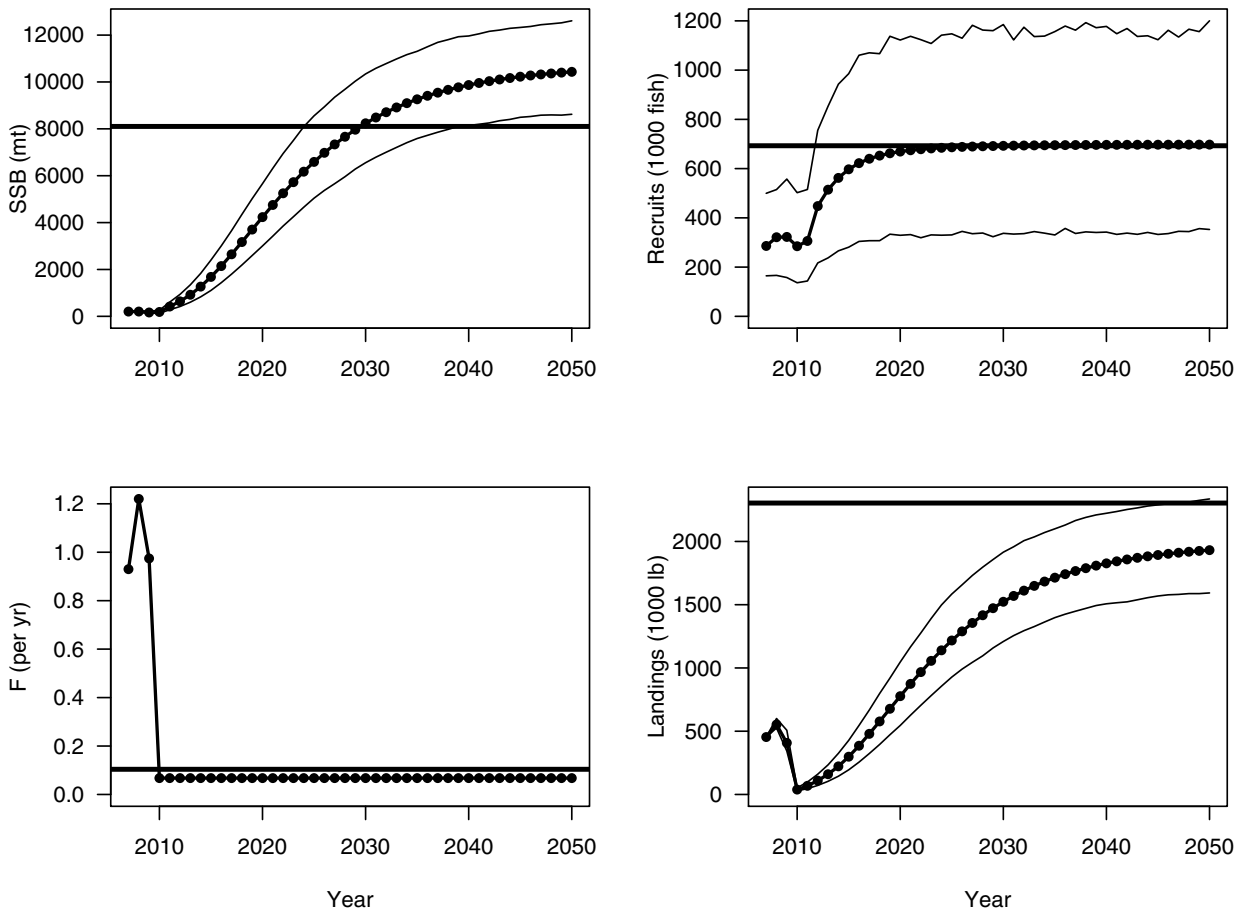


Figure 5.5. Projection results under scenario H3—fishing mortality rate fixed at $F = 75\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

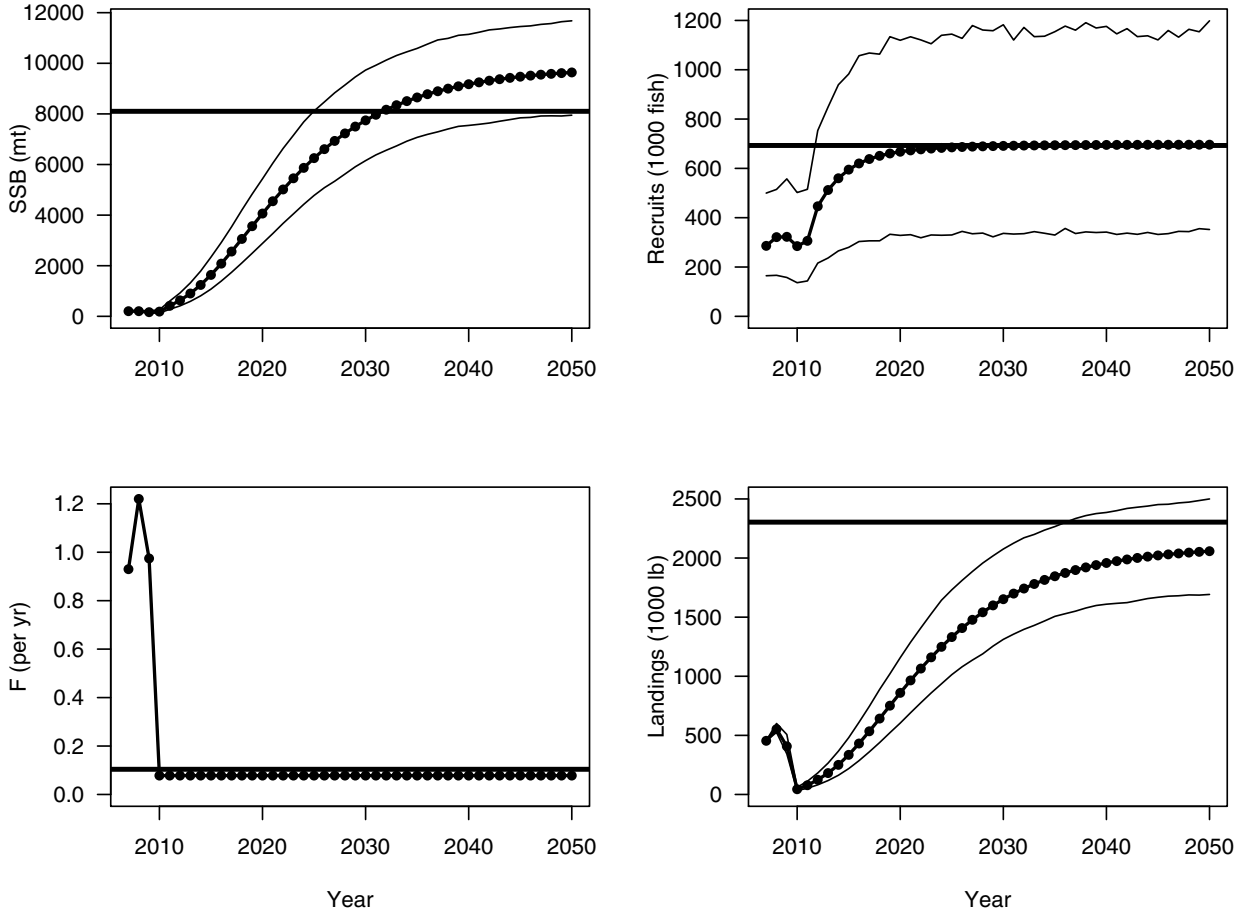


Figure 5.6. Projection results under scenario H4—fishing mortality rate fixed at $F = 85\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

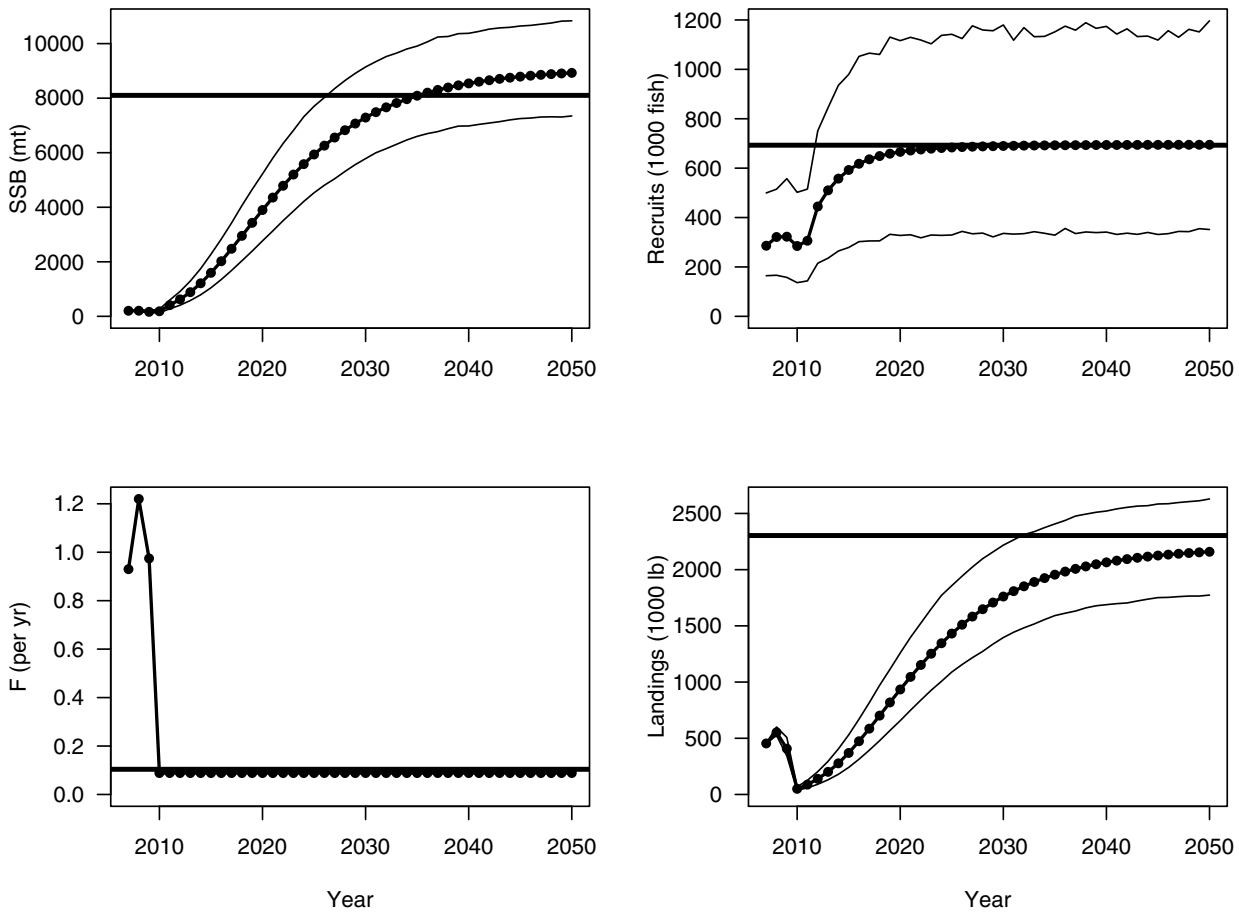


Figure 5.7. Projection results under scenario H5—fishing mortality rate fixed at $F = F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

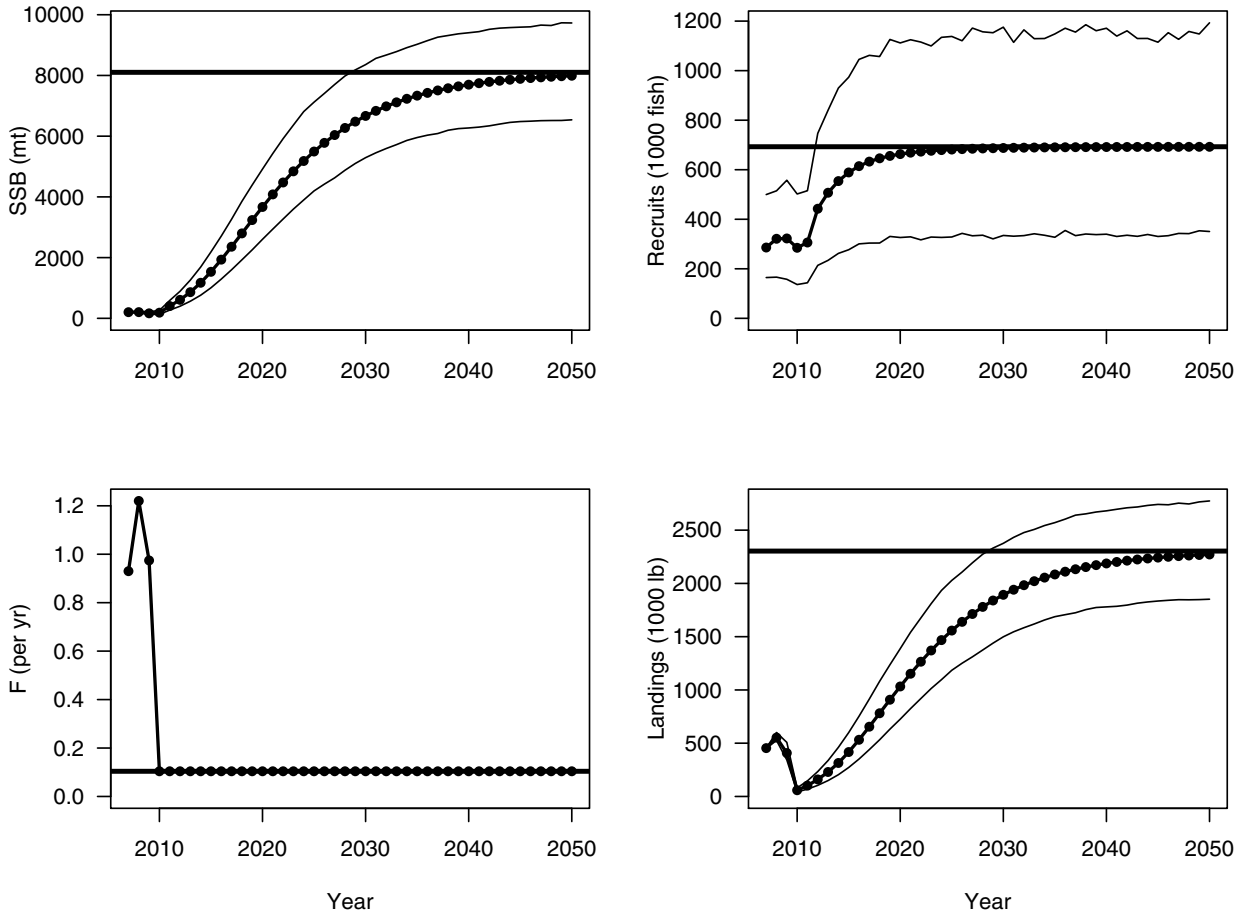


Figure 5.8. Projection results under scenario D1—Discard-only projection with fishing mortality rate fixed at $F = F_{\text{current}}$ (minus current F associated with commercial diving). Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks. In the F panel, the dashed horizontal line represents the fishing rate applied, of which only a portion, represented by the dotted solid line, contributes to (discard) mortality.

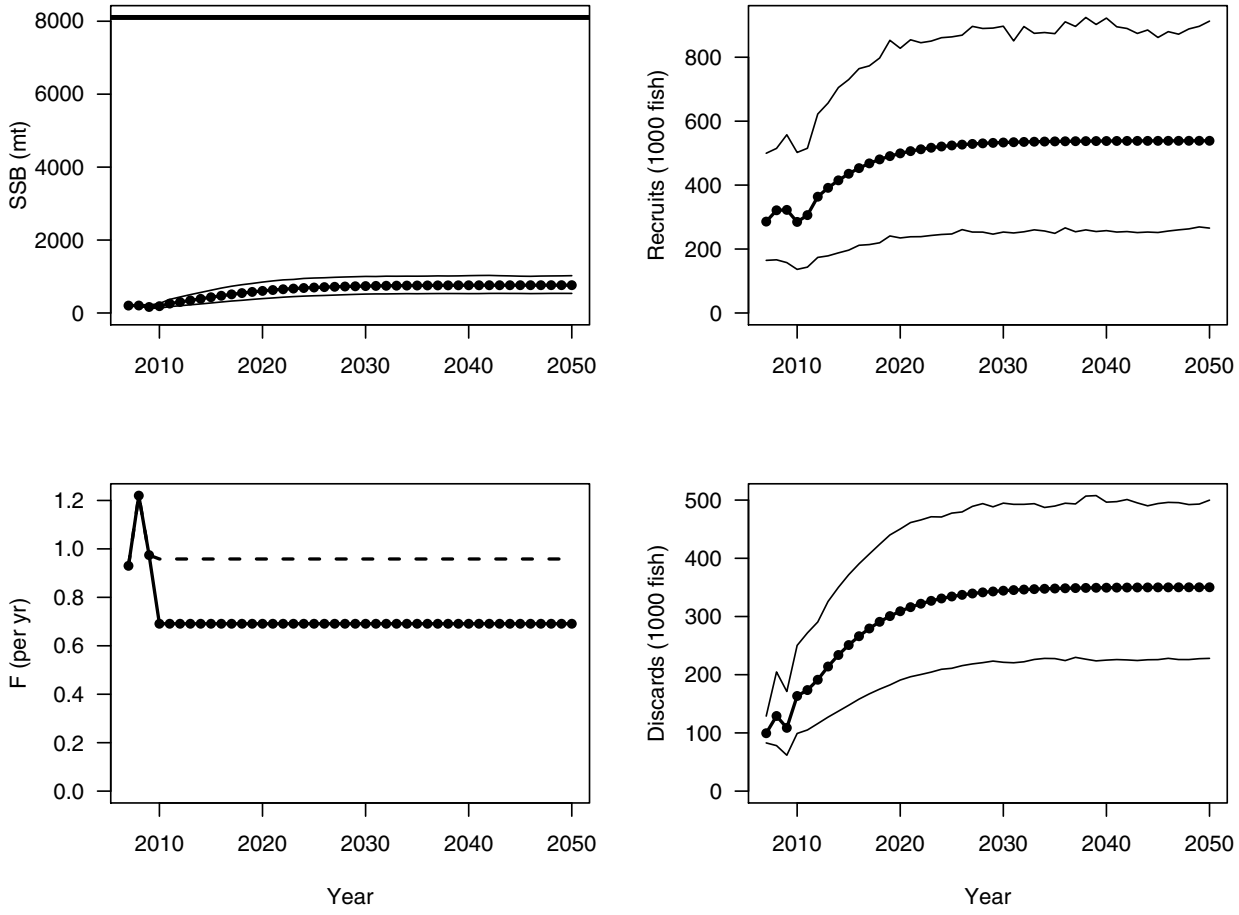


Figure 5.9. Projection results under scenario D2—Discard-only projection with fishing mortality rate fixed at $F = 65\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks. In the F panel, the dashed horizontal line represents the fishing rate applied, of which only a portion, represented by the dotted solid line, contributes to (discard) mortality.

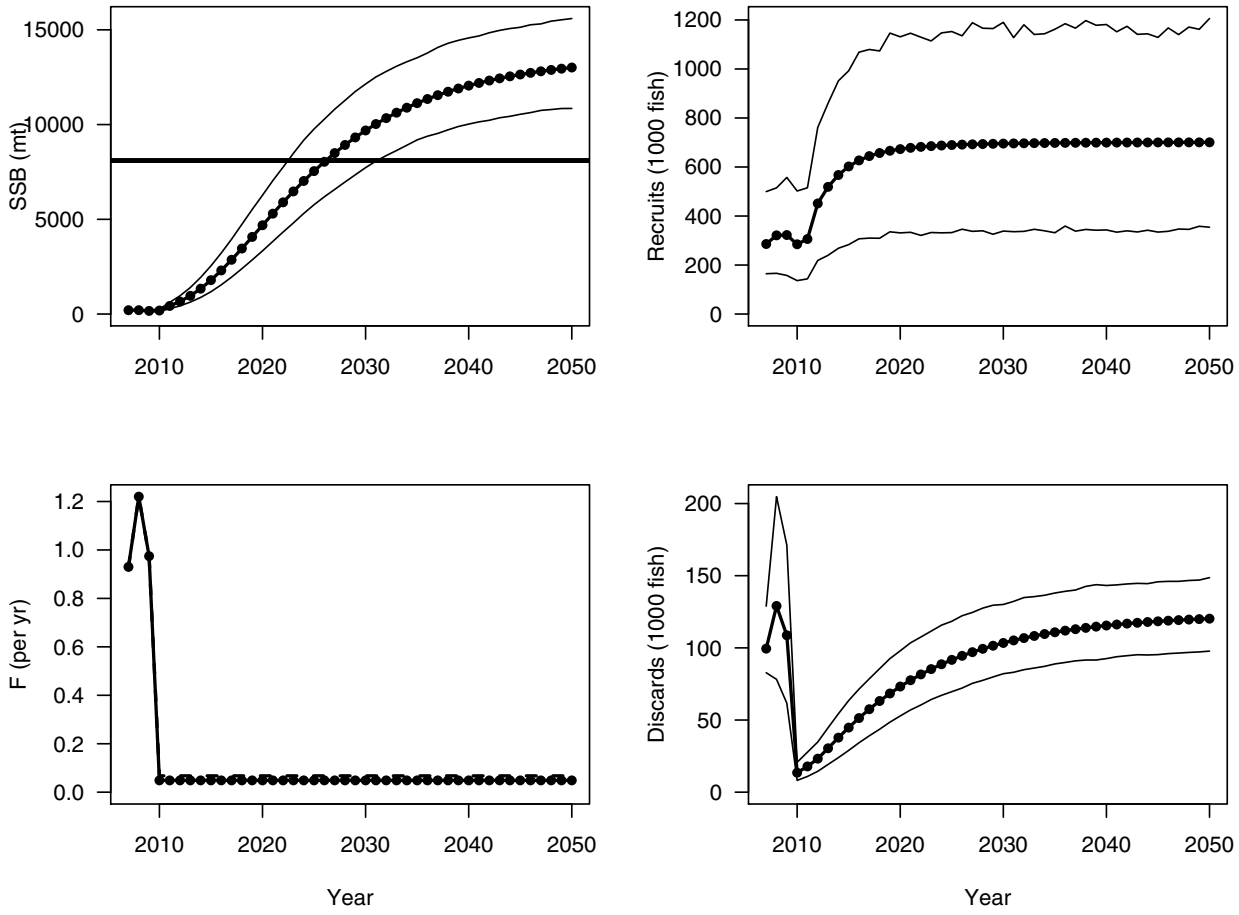


Figure 5.10. Projection results under scenario D3—Discard-only projection with fishing mortality rate fixed at $F = 75\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks. In the F panel, the dashed horizontal line represents the fishing rate applied, of which only a portion, represented by the dotted solid line, contributes to (discard) mortality.

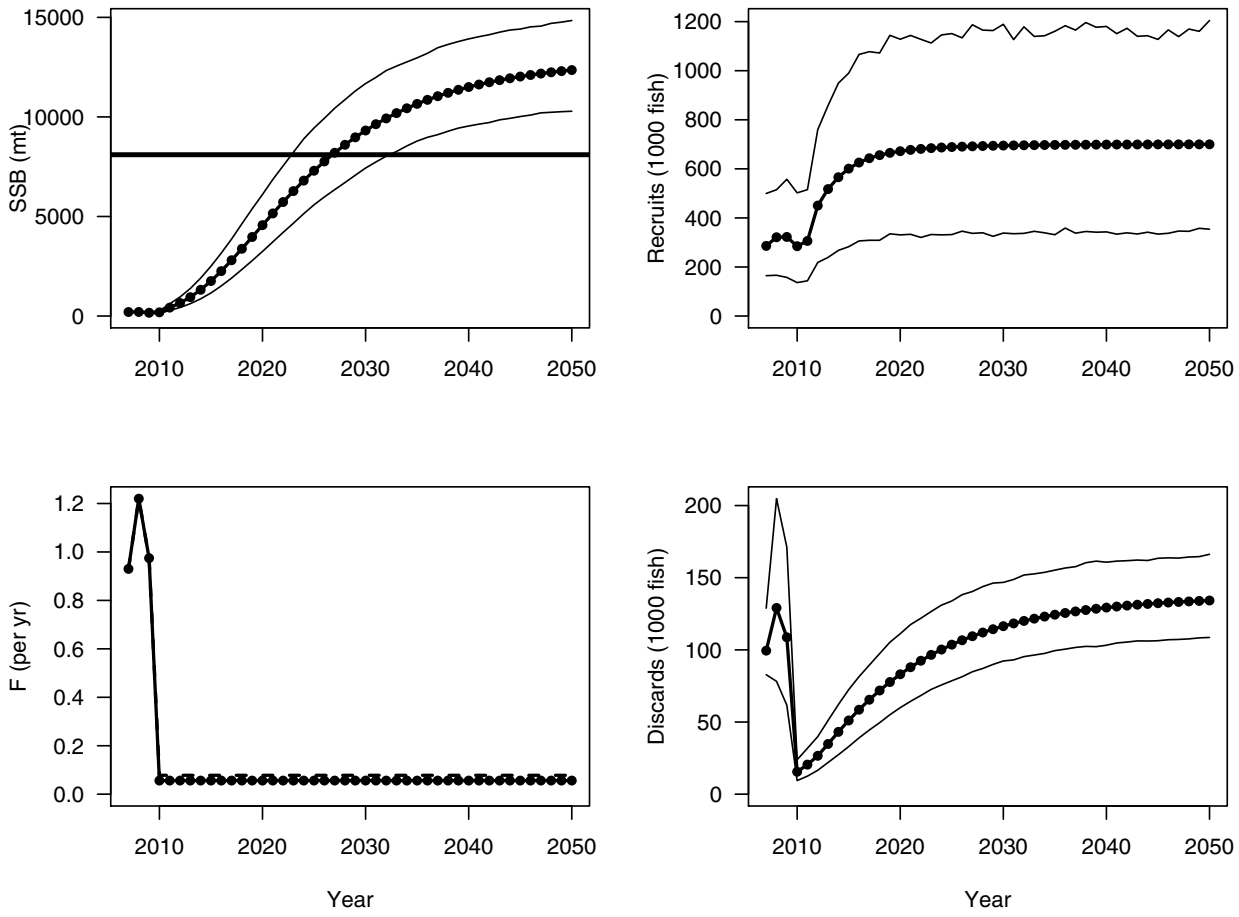


Figure 5.11. Projection results under scenario D4—Discard-only projection with fishing mortality rate fixed at $F = 85\%F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks. In the F panel, the dashed horizontal line represents the fishing rate applied, of which only a portion, represented by the dotted solid line, contributes to (discard) mortality.

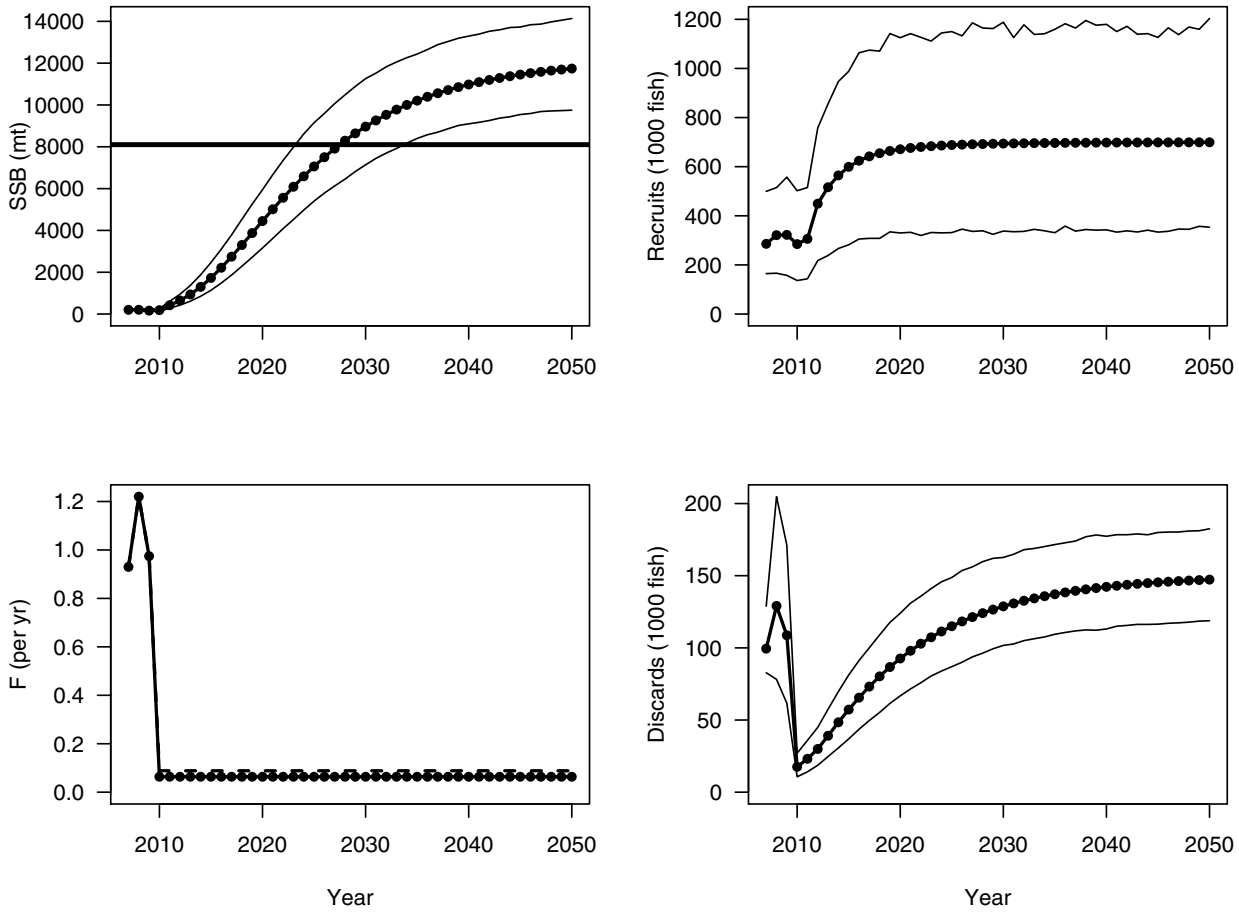


Figure 5.12. Projection results under scenario D5—Discard-only projection with fishing mortality rate fixed at $F = F_{40\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks. In the F panel, the dashed horizontal line represents the fishing rate applied, of which only a portion, represented by the dotted solid line, contributes to (discard) mortality.

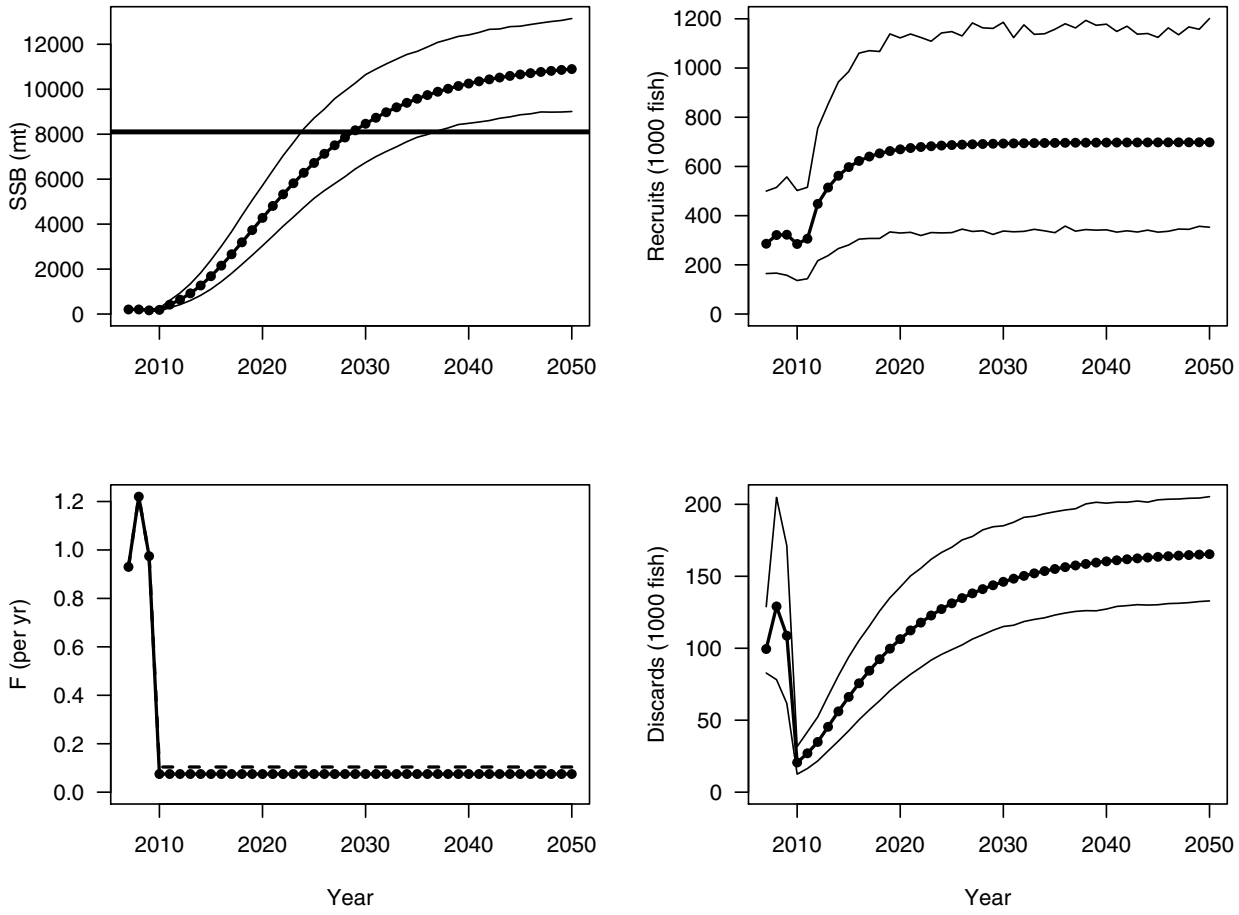


Figure 5.13. Projection results under scenario P0-alt—fishing mortality rate fixed at $F = 0$. This scenario differs from P0 by using preliminary estimates of 2008 recreational landings from MRFSS. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.

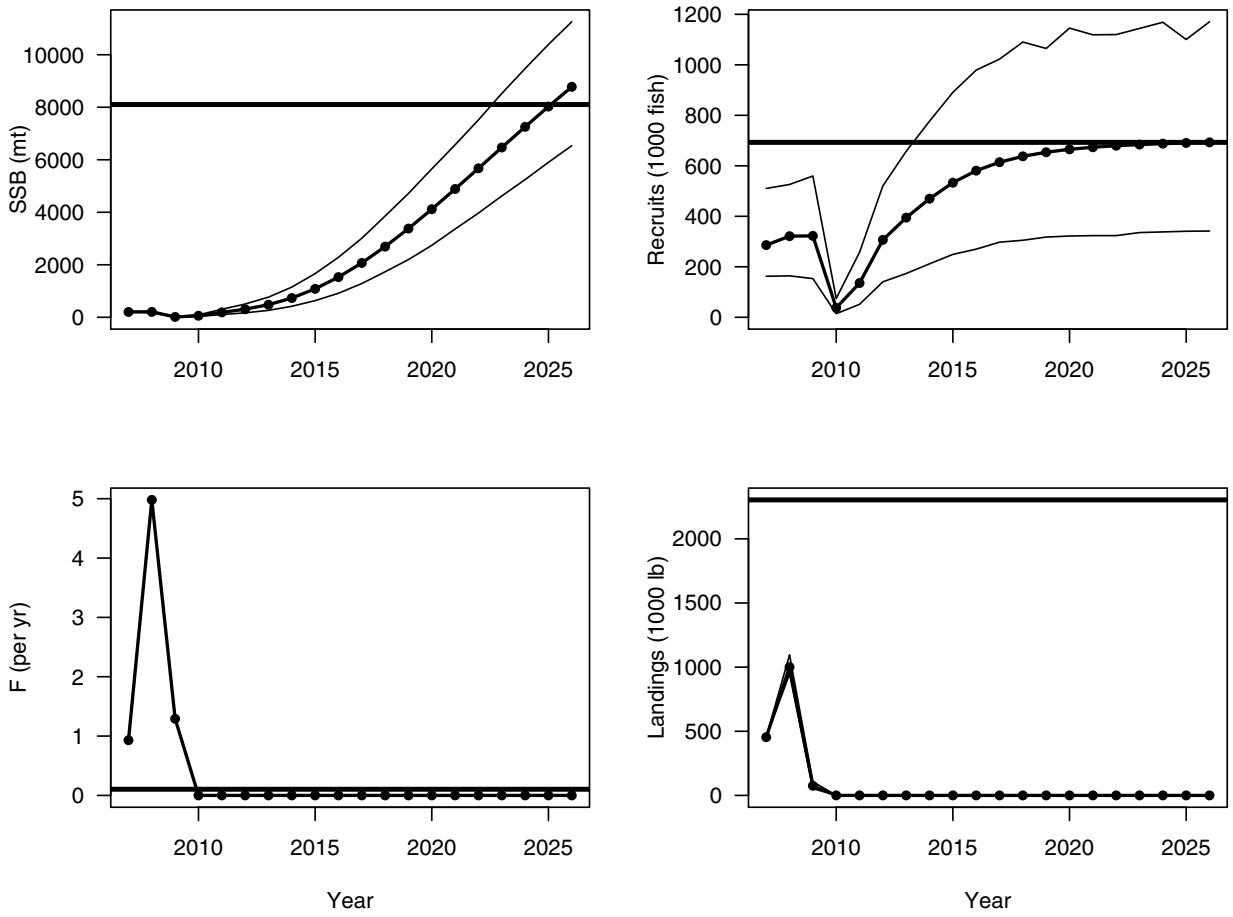


Figure 5.14. Projection results under scenario H3-alt—fishing mortality rate fixed at $F = 75\%F_{40\%}$. This scenario differs from H3 by using preliminary estimates of 2008 recreational landings from MRFSS. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent benchmarks.