Red Snapper Projections VII

31 July 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. Those projections were described in the report titled, "Red Snapper Projections V". Following that report, the Council requested an additional projection, which was described in "Red Snapper Projections V – Addendum". In preparation for the June 2009 Council meeting, further projections were run to explore the potential effects of strong recruitment in 2006. Those projections were described in "Red Snapper Projections VI."

A SERO memorandum (dated July 10, 2009), from Dr. Roy Crabtree to Dr. Bonnie Ponwith, requested more red snapper projections. This report, along with the report titled, "Red Snapper Projections VI—Revised," documents these projections. A synopsis of the request follows:

1. New constant fishing mortality projections similar to those provided on March 9, 2009, which incorporates high recruitment that appears to have occurred in 2005 or 2006
2. An additional constant fishing mortality projection that would rebuild the stock in 35 years, which is the maximum allowable rebuilding time
3. A suite of projections using $F_{30\%}$
4. Provide the value of the yield at $F_{45\%}$

Item one regarding high recent recruitment is described in a companion report, titled "Red Snapper Projections VI—Revised." Items two through four are covered in this report.

To accomplish the fourth item, biomass benchmarks associated with $F_{45\%}$ were computed through long-term, deterministic projections with bias correction, as was done with $F_{30\%}$ and $F_{40\%}$. Similar long-term projections were run to compute the yield associated with 65%, 75%, and 85% of $F_{45\%}$. Benchmarks are shown in Table 5.1.

2 Projection scenarios

To accomplish the second and third items, several projection scenarios with constant F were considered:

- Scenario A: $F = F_{\text{rebuild}}$, defined as the maximum F that allows rebuilding by the start of 2045
- Scenario B: $F = 65\%F_{30\%}$
- Scenario C: $F = 75\%F_{30\%}$
- Scenario D: $F = 85\%F_{30\%}$
- Scenario E: $F = F_{30\%}$

Methods are described more fully in "Red Snapper Projections V."

3 Projection Results

Results of projections with $F = F_{\text{rebuild}}$ are tabulated in Table 5.2 and are presented graphically in Fig. 6.1. The maximum F that allowed rebuilding was $F_{\text{rebuild}} = 0.1$.

Results of the projections associated with $F_{30\%}$ are tabulated in Table 5.3–5.6, and are presented graphically in Figs. 6.2–6.5.

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.

5 Tables

Table 5.1. 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 $F_{35\%}$ and $F_{30\%}$. Biomass-based and number-based quantities were computed as equilibrium values from projections with fishing rate $F_{30\%}$, $F_{40\%}$, or $F_{45\%}$ (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	$F_{45\%}$ Proxy	$F_{40\%}$ Proxy	$F_{30\%}$ Proxy
F_{MSY}	y^{-1}	0.088	0.104	0.148
$\mathrm{SSB}_{\mathrm{MSY}}$	mt	9120.6	8102.5	6025.1
$\mathrm{D}_{\mathrm{MSY}}$	1000 fish	33	39	54
Recruits at F_{MSY}	1000 fish	695	693	686
Y at 65% F_{MSY}	1000 lb	1833	1984	2257
Y at 75% F_{MSY}	1000 lb	1963	2104	2338
Y at 85% F_{MSY}	1000 lb	2070	2199	2391
Y at F_{MSY}	1000 lb	2196	2304	2431
MSST	mt	8409.2	7470.5	5555.1
$F_{2006}/F_{\mathrm{MSY}}$	–	9.06	7.67	5.39
$\mathrm{SSB}_{2006}/\mathrm{SSB}_{\mathrm{MSY}}$	–	0.02	0.02	0.03
$\mathrm{SSB}_{2006}/\mathrm{MSST}$	–	0.02	0.03	0.04

*Table 5.2. Red snapper: Projection results under scenario A—fishing mortality rate $F = F_{\text{rebuild}}$. 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	0.1	0	187	285	56	1470	13	22	13
2011	0.1	0	406	306	98	1568	20	28	16
2012	0.1	0	612	443	155	1723	28	31	18
2013	0.1	0	868	508	223	1946	37	39	23
2014	0.1	0	1182	555	305	2251	48	48	27
2015	0.1	0	1548	590	405	2656	59	54	30
2016	0.1	0	1955	615	518	3174	71	58	32
2017	0.1	0	2389	634	638	3812	82	61	33
2018	0.1	0	2837	647	762	4574	93	63	34
2019	0.1	0	3285	657	886	5460	103	65	35
2020	0.1	0	3726	664	1009	6469	112	66	36
2021	0.1	0	4150	669	1127	7595	119	67	36
2022	0.1	0.01	4553	674	1238	8833	127	68	36
2023	0.1	0.01	4931	677	1342	10,176	133	68	37
2024	0.1	0.02	5281	680	1439	11,615	139	68	37
2025	0.1	0.04	5603	682	1528	13,142	144	69	37
2026	0.1	0.06	5898	684	1609	14,751	148	69	37
2027	0.1	0.08	6165	685	1682	16,434	152	69	37
2028	0.1	0.1	6407	686	1749	18,183	155	69	37
2029	0.1	0.13	6625	687	1809	19,991	159	69	37
2030	0.1	0.16	6819	688	1862	21,854	161	70	37
2031	0.1	0.2	6994	689	1910	23,764	164	70	37
2032	0.1	0.23	7149	690	1953	25,717	166	70	37
2033	0.1	0.26	7287	690	1991	27,708	168	70	37
2034	0.1	0.29	7410	691	2025	29,733	169	70	37
2035	0.1	0.32	7519	691	2055	31,788	171	70	37
2036	0.1	0.35	7615	691	2081	33,869	172	70	37
2037	0.1	0.37	7700	692	2105	35,974	173	70	37
2038	0.1	0.4	7776	692	2125	38,099	174	70	37
2039	0.1	0.42	7842	692	2144	40,243	175	70	37
2040	0.1	0.44	7901	692	2160	42,403	176	70	37
2041	0.1	0.47	7953	692	2174	44,577	177	70	38
2042	0.1	0.48	7999	692	2187	46,764	177	70	38
2043	0.1	0.5	8040	693	2198	48,962	178	70	38
2044	0.1	0.51	8075	693	2208	51,170	178	70	38
2045	0.1	0.52	8107	693	2216	53,386	179	70	38
2046	0.1	0.52	8135	693	2224	55,610	179	70	38
2047	0.1	0.53	8159	693	2231	57,841	179	70	38
2048	0.1	0.52	8181	693	2237	60,078	180	70	38
2049	0.1	0.53	8200	693	2242	62,320	180	70	38
2050	0.1	0.53	8217	693	2247	64,566	180	70	38

*Table 5.3. Red snapper: Projection results under scenario B—fishing mortality rate F = 65%$F_{30\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{30\%}}$, 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 $F_{30\%}$ = 0.148, $SSB_{F_{30\%}}$ = 6025.1 mt, $R_{F_{30\%}}$ = 685,824 fish, $Y_{F_{30\%}}$ = 2,430,792 lb, and $D_{F_{30\%}}$ = 99,092 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	0.096	0	187	285	54	1468	12	21	13
2011	0.096	0	408	306	95	1563	19	27	15
2012	0.096	0	615	444	150	1713	27	30	18
2013	0.096	0	874	509	216	1928	36	37	22
2014	0.096	0	1192	556	296	2224	46	47	26
2015	0.096	0	1563	591	394	2618	58	52	29
2016	0.096	0	1977	616	504	3122	69	56	31
2017	0.096	0	2418	634	621	3743	80	59	32
2018	0.096	0	2874	648	743	4486	90	61	33
2019	0.096	0.01	3332	657	865	5351	100	63	34
2020	0.096	0.03	3782	665	985	6336	109	64	34
2021	0.096	0.06	4216	670	1101	7438	116	65	35
2022	0.096	0.11	4629	674	1211	8649	123	65	35
2023	0.096	0.18	5017	678	1314	9963	130	66	35
2024	0.096	0.27	5377	680	1410	11,373	135	66	35
2025	0.096	0.37	5709	683	1498	12,870	140	66	36
2026	0.096	0.47	6013	684	1578	14,449	145	67	36
2027	0.096	0.58	6290	686	1652	16,101	148	67	36
2028	0.096	0.65	6541	687	1718	17,819	152	67	36
2029	0.096	0.72	6766	688	1778	19,596	155	67	36
2030	0.096	0.78	6969	689	1831	21,428	158	67	36
2031	0.096	0.84	7150	690	1879	23,307	160	67	36
2032	0.096	0.87	7313	690	1922	25,229	162	67	36
2033	0.096	0.9	7457	691	1961	27,190	164	67	36
2034	0.096	0.92	7586	691	1995	29,184	166	67	36
2035	0.096	0.93	7700	691	2025	31,209	167	67	36
2036	0.096	0.95	7801	692	2052	33,260	169	68	36
2037	0.096	0.96	7891	692	2075	35,336	170	68	36
2038	0.096	0.97	7971	692	2096	37,432	171	68	36
2039	0.096	0.97	8041	693	2115	39,547	172	68	36
2040	0.096	0.97	8103	693	2131	41,678	172	68	36
2041	0.096	0.98	8159	693	2146	43,824	173	68	36
2042	0.096	0.98	8207	693	2159	45,983	174	68	36
2043	0.096	0.98	8251	693	2170	48,154	174	68	36
2044	0.096	0.98	8289	693	2180	50,334	175	68	36
2045	0.096	0.99	8322	693	2189	52,524	175	68	36
2046	0.096	0.99	8352	693	2197	54,721	176	68	36
2047	0.096	0.99	8378	693	2204	56,925	176	68	36
2048	0.096	0.99	8402	694	2210	59,135	176	68	36
2049	0.096	0.99	8422	694	2216	61,351	176	68	36
2050	0.096	0.99	8440	694	2221	63,572	177	68	36

*Table 5.4. Red snapper: Projection results under scenario C—fishing mortality rate F = 75%$F_{30\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{30\%}}$, 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 $F_{30\%} = 0.148$, $SSB_{F_{30\%}} = 6025.1$ mt, $R_{F_{30\%}} = 685,824$ fish, $Y_{F_{30\%}} = 2,430,792$ lb, and $D_{F_{30\%}} = 99,092$ 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	0.111	0	187	285	62	1476	14	24	15
2011	0.111	0	402	306	108	1584	22	31	17
2012	0.111	0	603	441	169	1753	30	34	20
2013	0.111	0	851	506	242	1995	40	43	26
2014	0.111	0	1154	553	330	2325	52	53	30
2015	0.111	0	1506	588	437	2763	64	59	33
2016	0.111	0	1895	613	556	3319	77	64	35
2017	0.111	0	2308	631	683	4002	89	67	37
2018	0.111	0	2732	645	814	4816	100	69	38
2019	0.111	0.01	3156	655	944	5760	110	71	39
2020	0.111	0.01	3570	662	1072	6832	120	72	39
2021	0.111	0.03	3967	668	1194	8026	128	73	40
2022	0.111	0.07	4341	672	1309	9335	135	74	40
2023	0.111	0.12	4691	675	1416	10,751	142	75	40
2024	0.111	0.18	5014	678	1515	12,266	148	75	40
2025	0.111	0.24	5310	680	1606	13,872	153	75	41
2026	0.111	0.32	5578	682	1688	15,560	158	76	41
2027	0.111	0.41	5821	684	1762	17,322	162	76	41
2028	0.111	0.48	6039	685	1829	19,151	165	76	41
2029	0.111	0.56	6235	686	1888	21,039	168	76	41
2030	0.111	0.62	6409	687	1942	22,980	171	76	41
2031	0.111	0.68	6564	687	1989	24,969	173	76	41
2032	0.111	0.73	6701	688	2031	27,000	175	77	41
2033	0.111	0.76	6823	689	2068	29,068	177	77	41
2034	0.111	0.79	6930	689	2101	31,169	179	77	41
2035	0.111	0.82	7025	689	2130	33,298	180	77	41
2036	0.111	0.84	7108	690	2155	35,453	182	77	41
2037	0.111	0.86	7182	690	2177	37,631	183	77	41
2038	0.111	0.88	7246	690	2197	39,828	184	77	41
2039	0.111	0.89	7303	690	2215	42,043	184	77	41
2040	0.111	0.89	7353	691	2230	44,272	185	77	41
2041	0.111	0.9	7397	691	2243	46,515	186	77	41
2042	0.111	0.9	7435	691	2255	48,770	186	77	41
2043	0.111	0.91	7469	691	2265	51,035	187	77	41
2044	0.111	0.92	7499	691	2274	53,310	187	77	41
2045	0.111	0.93	7525	691	2282	55,592	188	77	41
2046	0.111	0.92	7547	691	2289	57,881	188	77	41
2047	0.111	0.93	7567	691	2295	60,176	188	77	41
2048	0.111	0.93	7585	691	2300	62,476	189	77	41
2049	0.111	0.93	7600	691	2305	64,781	189	77	41
2050	0.111	0.94	7614	692	2309	67,090	189	77	41

*Table 5.5. Red snapper: Projection results under scenario D—fishing mortality rate $F = 85\%F_{30\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{30\%}}$, 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 $F_{30\%} = 0.148$, $SSB_{F_{30\%}} = 6025.1$ mt, $R_{F_{30\%}} = 685,824$ fish, $Y_{F_{30\%}} = 2,430,792$ lb, and $D_{F_{30\%}} = 99,092$ 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	0.126	0	187	285	70	1484	16	27	17
2011	0.126	0	397	306	121	1605	25	35	19
2012	0.126	0	591	439	187	1792	34	38	23
2013	0.126	0	828	503	267	2059	45	48	29
2014	0.126	0	1117	549	362	2421	57	59	34
2015	0.126	0	1451	584	477	2898	71	66	37
2016	0.126	0	1817	610	604	3501	84	71	39
2017	0.126	0	2204	628	738	4240	97	75	41
2018	0.126	0	2599	642	876	5115	109	77	42
2019	0.126	0	2991	652	1013	6128	120	79	43
2020	0.126	0.01	3371	659	1146	7274	130	81	44
2021	0.126	0.02	3734	665	1272	8546	138	82	44
2022	0.126	0.04	4075	670	1391	9937	146	83	45
2023	0.126	0.07	4390	673	1500	11,437	153	83	45
2024	0.126	0.11	4680	676	1601	13,038	159	84	45
2025	0.126	0.15	4943	678	1692	14,730	164	84	45
2026	0.126	0.2	5181	680	1775	16,505	169	85	46
2027	0.126	0.26	5395	681	1849	18,354	173	85	46
2028	0.126	0.32	5585	683	1915	20,268	176	85	46
2029	0.126	0.38	5755	684	1973	22,242	180	85	46
2030	0.126	0.43	5905	685	2025	24,267	182	85	46
2031	0.126	0.48	6037	685	2071	26,338	185	85	46
2032	0.126	0.53	6154	686	2112	28,450	187	86	46
2033	0.126	0.58	6257	686	2147	30,597	188	86	46
2034	0.126	0.61	6346	687	2178	32,775	190	86	46
2035	0.126	0.64	6425	687	2205	34,980	191	86	46
2036	0.126	0.67	6494	688	2229	37,210	193	86	46
2037	0.126	0.69	6554	688	2250	39,460	194	86	46
2038	0.126	0.71	6607	688	2268	41,728	194	86	46
2039	0.126	0.73	6653	688	2284	44,012	195	86	46
2040	0.126	0.74	6693	688	2298	46,310	196	86	46
2041	0.126	0.75	6728	689	2310	48,620	197	86	46
2042	0.126	0.76	6758	689	2321	50,941	197	86	46
2043	0.126	0.76	6785	689	2330	53,271	197	86	46
2044	0.126	0.77	6808	689	2338	55,608	198	86	46
2045	0.126	0.78	6828	689	2345	57,953	198	86	46
2046	0.126	0.78	6845	689	2351	60,304	198	86	46
2047	0.126	0.78	6861	689	2356	62,660	199	86	46
2048	0.126	0.79	6874	689	2361	65,021	199	86	46
2049	0.126	0.79	6885	689	2365	67,385	199	86	46
2050	0.126	0.79	6895	689	2368	69,753	199	86	46

*Table 5.6. Red snapper: Projection results under scenario E—fishing mortality rate $F = F_{30\%}$. F = fishing mortality rate (per year), Pr(recover) = proportion of replicates reaching $SSB_{F_{30\%}}$, 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 $F_{30\%} = 0.148$, $SSB_{F_{30\%}} = 6025.1$ mt, $R_{F_{30\%}} = 685,824$ fish, $Y_{F_{30\%}} = 2,430,792$ lb, and $D_{F_{30\%}} = 99,092$ 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	0.148	0	187	285	82	1496	19	32	20
2011	0.148	0	390	306	139	1635	28	40	23
2012	0.148	0	573	436	214	1849	39	44	27
2013	0.148	0	796	498	301	2150	51	55	33
2014	0.148	0	1064	544	405	2555	64	68	39
2015	0.148	0	1372	579	529	3084	79	76	43
2016	0.148	0	1707	605	666	3749	94	81	45
2017	0.148	0	2058	623	809	4558	108	86	47
2018	0.148	0	2412	637	954	5513	121	89	49
2019	0.148	0	2761	647	1097	6610	132	91	50
2020	0.148	0	3097	655	1236	7846	143	93	51
2021	0.148	0.01	3415	661	1366	9212	152	94	51
2022	0.148	0.02	3710	666	1487	10,698	160	95	52
2023	0.148	0.03	3981	669	1598	12,296	167	96	52
2024	0.148	0.05	4227	672	1698	13,994	173	96	52
2025	0.148	0.07	4449	674	1789	15,783	179	97	53
2026	0.148	0.1	4648	676	1870	17,653	183	97	53
2027	0.148	0.12	4824	678	1942	19,595	187	98	53
2028	0.148	0.15	4980	679	2005	21,600	191	98	53
2029	0.148	0.18	5118	680	2061	23,662	194	98	53
2030	0.148	0.22	5238	681	2110	25,772	196	98	53
2031	0.148	0.25	5344	682	2153	27,925	198	98	53
2032	0.148	0.28	5436	682	2191	30,116	200	98	53
2033	0.148	0.3	5515	683	2223	32,339	202	99	53
2034	0.148	0.32	5585	683	2252	34,591	204	99	53
2035	0.148	0.35	5645	684	2276	36,867	205	99	53
2036	0.148	0.37	5697	684	2297	39,164	206	99	53
2037	0.148	0.38	5742	684	2316	41,480	207	99	54
2038	0.148	0.4	5781	684	2331	43,811	208	99	54
2039	0.148	0.41	5815	685	2345	46,157	208	99	54
2040	0.148	0.43	5844	685	2357	48,514	209	99	54
2041	0.148	0.45	5869	685	2367	50,881	209	99	54
2042	0.148	0.46	5890	685	2376	53,257	210	99	54
2043	0.148	0.46	5909	685	2384	55,640	210	99	54
2044	0.148	0.47	5925	685	2390	58,031	210	99	54
2045	0.148	0.48	5939	685	2396	60,426	211	99	54
2046	0.148	0.47	5951	685	2401	62,827	211	99	54
2047	0.148	0.47	5961	685	2405	65,232	211	99	54
2048	0.148	0.47	5970	686	2408	67,640	211	99	54
2049	0.148	0.47	5978	686	2412	70,052	212	99	54
2050	0.148	0.47	5984	686	2414	72,466	212	99	54

6 Figures

Figure 6.1. Projection results under scenario A—fishing mortality rate fixed at F_{rebuild}, the maximum F that allows rebuilding by the start of 2045. 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 $F_{40\%}$ benchmarks.

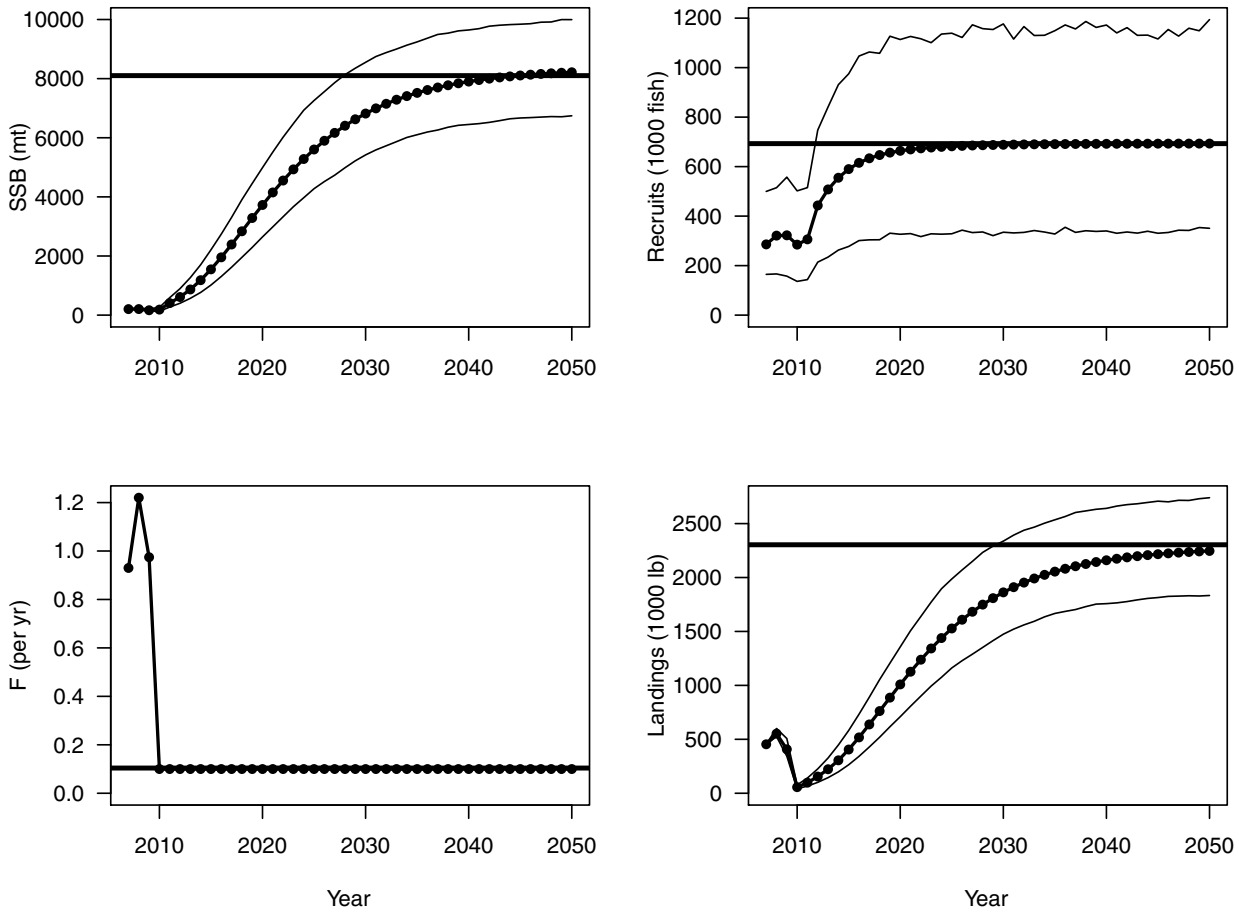

Figure 6.2. Projection results under scenario B—fishing mortality rate fixed at $F = 65\%F_{30\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent $F_{30\%}$ benchmarks.

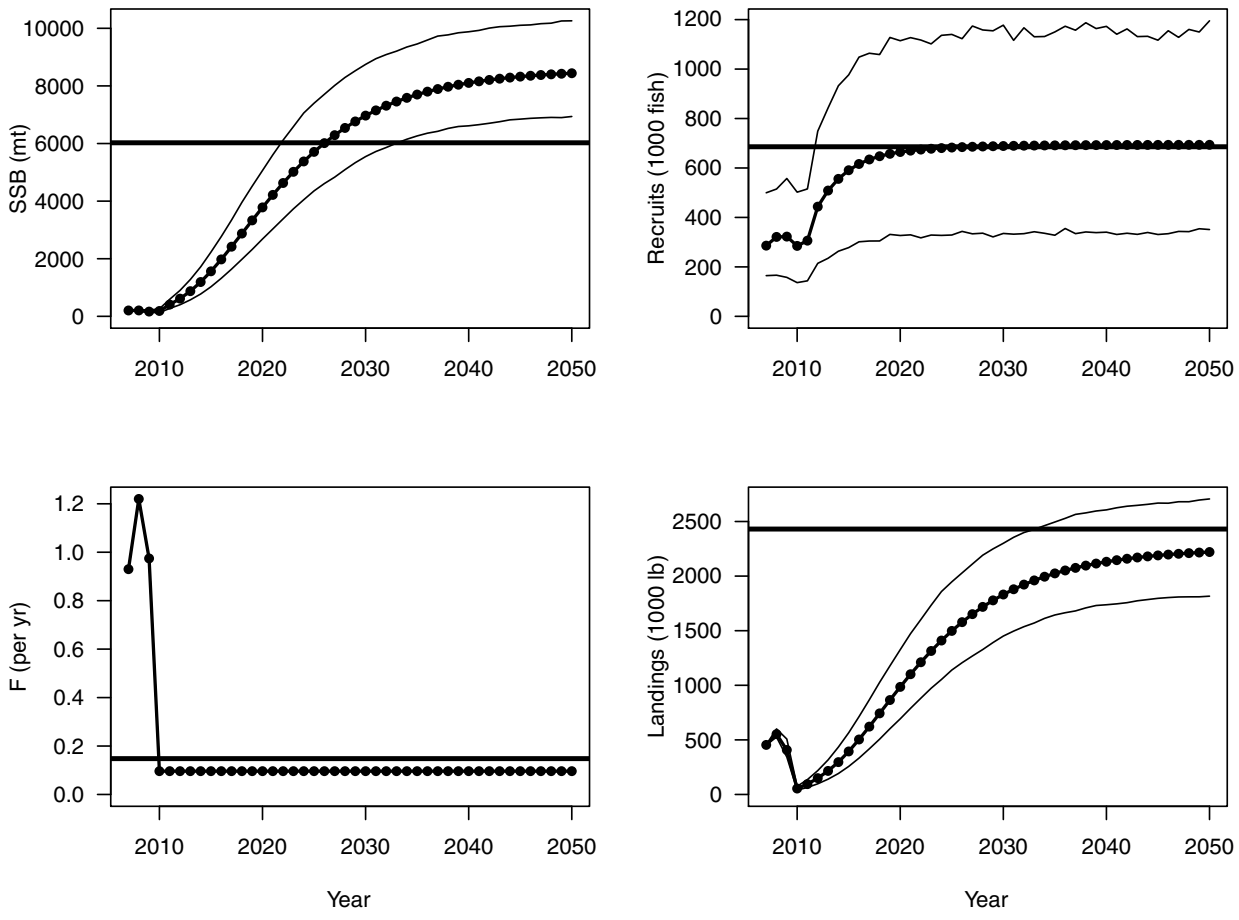

Figure 6.3. Projection results under scenario C—fishing mortality rate fixed at $F = 75\%F_{30\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent $F_{30\%}$ benchmarks.

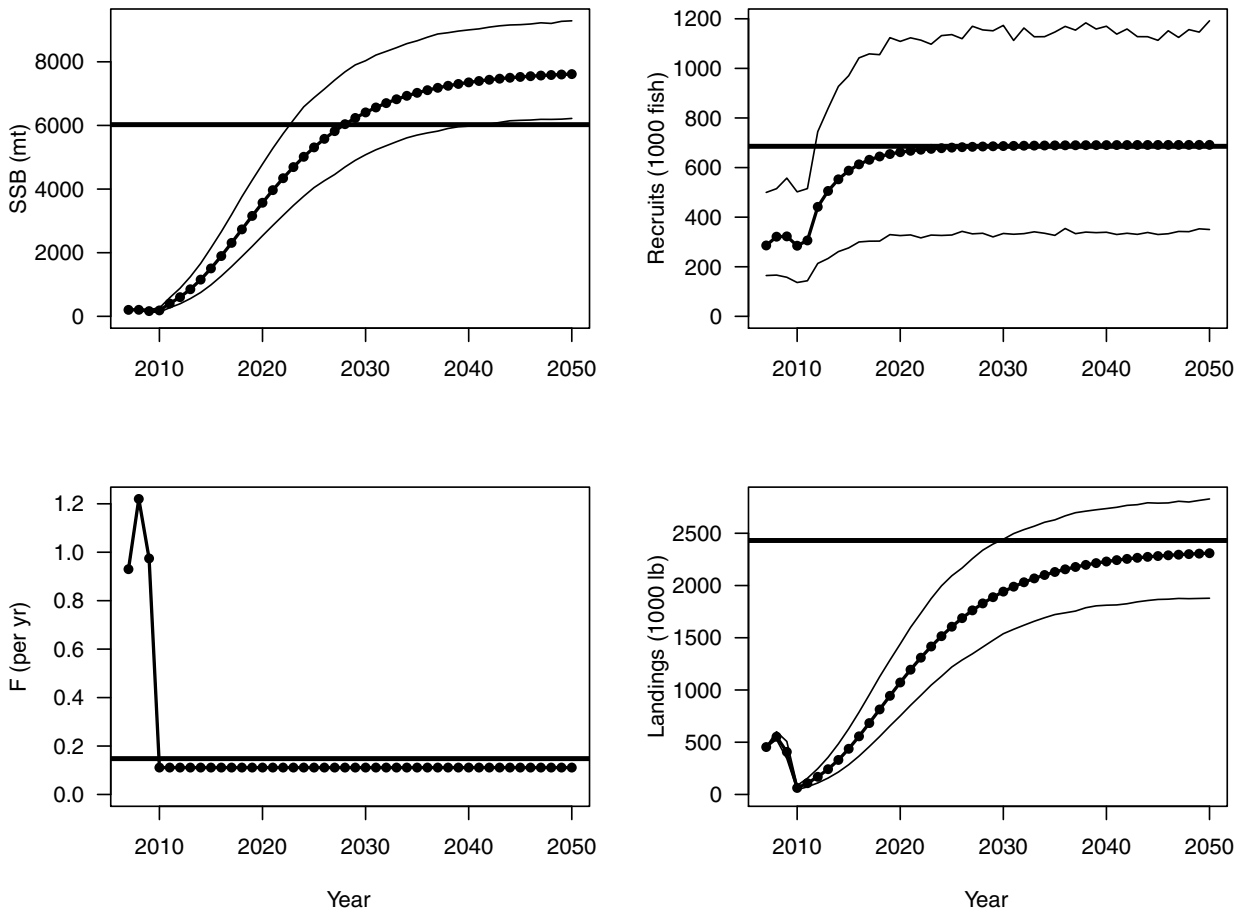

Figure 6.4. Projection results under scenario D—fishing mortality rate fixed at $F = 85\%F_{30\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent $F_{30\%}$ benchmarks.

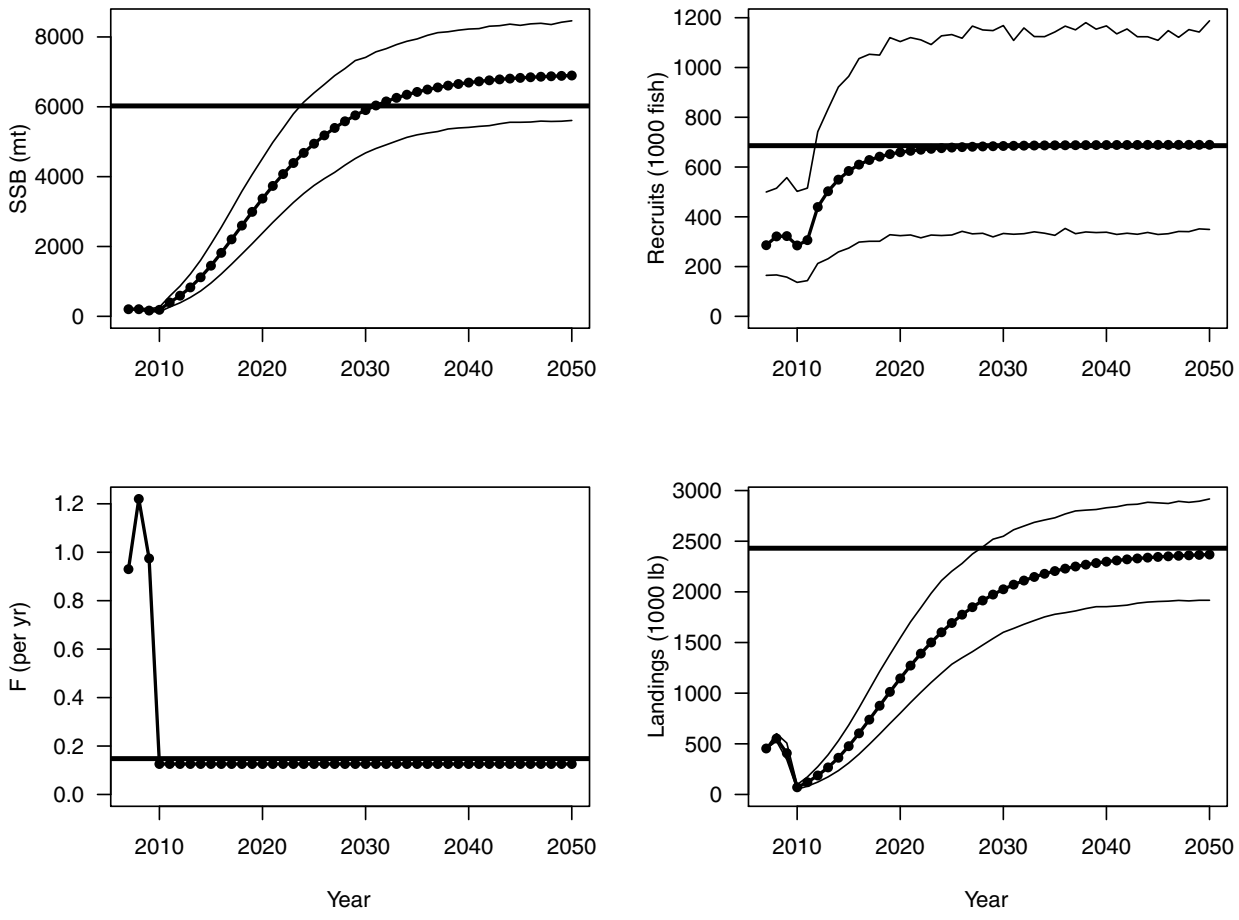

Figure 6.5. Projection results under scenario D—fishing mortality rate fixed at $F = F_{30\%}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 10^{th} and 90^{th} percentiles of 2000 replicate projections. Thick horizontal lines represent $F_{30\%}$ benchmarks.