Red Snapper Projections VII

Prepared by the NOAA/NMFS Southeast Fisheries Science Center
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1 Description of projections

This report describes a suite of projections requested in a memorandum, dated 8 October 2009, from Dr. Crabtree to Dr. Ponwith. In addition to projections, the memorandum requested a table of status indicators and related quantities associated with very high 2006 recruitment, similar to Table 4.1 in the document titled Red Snapper Projections V (dated March 19, 2009). However, because such quantities are based on longterm equilibrium values, they would not be affected by any one year of high, or low, recruitment. Thus, values of that previous table would not change. The table is repeated here for ease of reference (Table 4.1).

The projections assume that recruitment in 2006 was equal to the maximum level predicted by the stock assessment during the years 1974–2006. This maximum occurred in 1984 and was about 753,000 age-1 fish.

Several levels of fishing mortality rate were projected:

- Scenario P1: $F = F_{\text{rebuild}}$, the maximum fishing rate that allows rebuilding by the start of 2045
- Scenario P2: $F = 0.65F_{40\%}$
- Scenario P3: $F = 0.75F_{40\%}$
- Scenario P4: $F = 0.85F_{40\%}$
- Scenario P5: $F = F_{40\%}$

Projected fishing mortality rates in 2007–2009, prior to new management, assumed the regression levels used in the report titled, Red Snapper Projections V. These rates do not reflect any increase in fishing effort that may be associated with the very high landings reported by MRFSS in 2008.

2 Results

Results of the five projection scenarios are tabulated in Tables 4.2–4.6, and are shown graphically in Figures 5.1–5.5. The longterm equilibrium yield associated with F_{rebuild} is 2,287,000 lb.

3 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:

- These projections reflect a belief that the 2006 year-class was strong. However, for now, the actual strength can only be guessed, and thus the scientific merit of these projections is questionable. The real value of these projections may be more qualitative than quantitative.
- The projections used a spawner-recruit relationship with steepness of $h = 0.95$, the value estimated in the assessment but with considerable uncertainty. On this topic, the SEDAR-15 Review Workshop Report stated, "One of the principal difficulties with the SCA model estimate of stock recruitment parameters is that the steepness estimate appears unrealistically high." 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 2008 recreational landings reported by MRFSS indicate very high levels of landings, which could be due to a very strong 2006 year-class, as explored in these projections. The high landings could also be due, at least in part, to increased fishing effort, which is not accounted for here. If effort has actually increased along with the high landings, these projections could be considered overly optimistic in terms of spawning biomass, recruitment, and landing in subsequent years.
- The rebuilding time frame was computed without high 2006 recuitment. If it were recomputed using the high recruitment of these current projections, the rebuilding time frame may be shorter, which would lead to lower estimates of F_{rebuild}. Nonetheless, longterm stock projections, on which F_{rebuild} depends, are highly uncertain. (See last paragraph of this report.)
- Initial abundance at age of the projections, other than 2006 age-1 recruits, were based on estimates from the last year of the assessment. If those estimates are inaccurate, rebuilding will likely be affected.
- Fleets 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.

On the topic of uncertainty in projections, the SEDAR-15 Review Workshop Report stated in January of 2008, "The panel discussed the value of projections made beyond 5–10 years. Clearly the uncertainty increases rapidly with time as the currently measured stock is replaced by model values into the future. Realistically, the projections beyond the range of the predominant age groups in the stock are highly uncertain. In this assessment, the best that can be concluded is that rebuilding times will be very long." The assessment team concurs with that statement, and would add that uncertainty is even greater now because of the increased duration between the terminal year of the assessment (2006) and any new implementation of management (Shertzer and Prager. 2007. Delay in fishery management: diminished yield, longer rebuilding, and increased probability of stock collapse. ICES Journal of Marine Science 64:149–159.).

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* $M = 0.078$*. This table is repeated from the report titled Red Snapper Projections V of 19 March 2009.*

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 P1—fishing mortality rate $F = F_{\text{rebuild}}$, with very high 2006 recruitment. 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	262	286	541	541	144	292	177
2008	1.22	0	290	367	759	1300	174	297	165
2009	0.974	0	225	385	579	1878	124	176	125
2010	0.101	0	242	339	75	1954	16	26	16
2011	0.101	0	510	352	126	2079	25	34	19
2012	0.101	0	751	480	193	2272	34	36	21
2013	0.101	0	1041	537	272	2544	44	43	25
2014	0.101	0	1386	576	365	2909	55	52	29
2015	0.101	0	1775	605	472	3381	67	57	31
2016	0.101	0	2197	626	590	3972	78	61	33
2017	0.101	0	2638	642	714	4686	89	63	34
2018	0.101	0	3085	653	839	5525	99	65	35
2019	0.101	0	3528	661	963	6488	109	66	36
2020	0.101	0	3957	667	1084	7572	117	67	36
2021	0.101	0	4367	672	1198	8770	124	68	36
2022	0.101	0.01	4753	676	1306	10,076	131	68	37
2023	0.101	0.01	5112	679	1406	11,482	137	69	37
2024	0.101	0.03	5444	681	1499	12,981	142	69	37
2025	0.101	0.05	5747	683	1583	14,564	147	69	37
2026	0.101	0.07	6024	685	1660	16,224	151	70	37
2027	0.101	0.09	6274	686	1729	17,953	155	70	37
2028	0.101	0.11	6499	687	1792	19,745	158	70	38
2029	0.101	0.14	6702	688	1848	21,594	161	70	38
2030	0.101	0.18	6882	689	1899	23,492	164	70	38
2031	0.101	0.21	7044	689	1943	25,435	166	70	38
2032	0.101	0.24	7187	690	1983	27,419	168	70	38
2033	0.101	0.26	7315	690	2019	29,437	170	70	38
2034	0.101	0.29	7428	691	2050	31,487	171	70	38
2035	0.101	0.33	7528	691	2078	33,565	172	71	38
2036	0.101	0.35	7617	691	2102	35,668	174	71	38
2037	0.101	0.37	7695	692	2124	37,792	175	71	38
2038	0.101	0.39	7764	692	2143	39,935	176	71	38
2039	0.101	0.41	7826	692	2160	42,096	176	71	38
2040	0.101	0.44	7879	692	2175	44,271	177	71	38
2041	0.101	0.46	7927	692	2189	46,460	178	71	38
2042	0.101	0.47	7969	692	2200	48,660	178	71	38
2043	0.101	0.48	8006	693	2211	50,871	179	71	38
2044	0.101	0.5	8039	693	2220	53,090	179	71	38
2045	0.101	0.51	8068	693	2228	55,318	180	71	38
2046	0.101	0.51	8093	693	2235	57,553	180	71	38
2047	0.101	0.51	8115	693	2241	59,794	180	71	38
2048	0.101	0.51	8135	693	2246	62,040	181	71	38
2049	0.101	0.51	8152	693	2251	64,291	181	71	38
2050	0.101	0.52	8168	693	2255	66,547	181	71	38

*Table 4.3. Red snapper: Projection results under scenario P2—fishing mortality rate F = 65%$F_{40\%}$, with very high 2006 recruitment. 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	262	286	541	541	144	292	177
2008	1.22	0	290	367	759	1300	174	297	165
2009	0.974	0	225	385	579	1878	124	176	125
2010	0.068	0	242	339	51	1929	11	17	11
2011	0.068	0	525	352	87	2016	17	23	13
2012	0.068	0	787	485	135	2152	24	25	14
2013	0.068	0	1107	543	194	2346	31	30	17
2014	0.068	0	1492	583	264	2609	39	36	20
2015	0.068	0	1935	612	346	2955	48	40	22
2016	0.068	0	2421	633	437	3392	57	42	23
2017	0.068	0	2937	648	534	3926	65	44	24
2018	0.068	0	3467	658	633	4559	73	45	24
2019	0.068	0	3999	666	733	5292	80	46	25
2020	0.068	0.01	4524	672	831	6123	87	46	25
2021	0.068	0.01	5032	677	927	7050	93	47	25
2022	0.068	0.04	5518	680	1017	8067	99	47	25
2023	0.068	0.08	5977	683	1103	9170	104	48	25
2024	0.068	0.12	6408	686	1183	10,353	108	48	25
2025	0.068	0.18	6809	687	1258	11,611	112	48	26
2026	0.068	0.25	7179	689	1327	12,938	116	48	26
2027	0.068	0.33	7521	690	1390	14,328	119	48	26
2028	0.068	0.41	7833	691	1448	15,776	122	48	26
2029	0.068	0.49	8118	692	1501	17,278	125	48	26
2030	0.068	0.57	8377	693	1549	18,827	127	49	26
2031	0.068	0.64	8612	694	1593	20,420	129	49	26
2032	0.068	0.7	8824	694	1633	22,053	131	49	26
2033	0.068	0.75	9016	695	1668	23,721	133	49	26
2034	0.068	0.78	9189	695	1700	25,422	134	49	26
2035	0.068	0.81	9345	695	1729	27,151	136	49	26
2036	0.068	0.84	9486	696	1756	28,907	137	49	26
2037	0.068	0.86	9612	696	1779	30,686	138	49	26
2038	0.068	0.89	9726	696	1800	32,486	139	49	26
2039	0.068	0.91	9828	696	1819	34,305	140	49	26
2040	0.068	0.91	9919	697	1836	36,141	141	49	26
2041	0.068	0.91	10,002	697	1851	37,992	141	49	26
2042	0.068	0.93	10,075	697	1865	39,857	142	49	26
2043	0.068	0.94	10,142	697	1877	41,735	143	49	26
2044	0.068	0.94	10,201	697	1888	43,623	143	49	26
2045	0.068	0.94	10,254	697	1898	45,521	144	49	26
2046	0.068	0.95	10,302	697	1907	47,429	144	49	26
2047	0.068	0.96	10,345	697	1915	49,344	145	49	26
2048	0.068	0.95	10,384	697	1922	51,266	145	49	26
2049	0.068	0.96	10,418	697	1929	53,195	145	49	26
2050	0.068	0.97	10,449	697	1934	55,129	145	49	26

*Table 4.4. Red snapper: Projection results under scenario P3—fishing mortality rate F = 75%$F_{40\%}$, with very high 2006 recruitment. 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	262	286	541	541	144	292	177
2008	1.22	0	290	367	759	1300	174	297	165
2009	0.974	0	225	385	579	1878	124	176	125
2010	0.078	0	242	339	59	1937	13	20	12
2011	0.078	0	520	352	99	2036	19	26	14
2012	0.078	0	776	483	154	2190	27	29	17
2013	0.078	0	1086	541	219	2410	35	34	20
2014	0.078	0	1458	581	297	2706	44	41	23
2015	0.078	0	1884	610	388	3094	54	45	25
2016	0.078	0	2349	631	489	3583	64	48	26
2017	0.078	0	2840	646	595	4178	73	50	27
2018	0.078	0	3343	657	704	4882	82	51	28
2019	0.078	0	3845	665	812	5694	90	52	28
2020	0.078	0	4338	671	919	6613	97	53	28
2021	0.078	0.01	4813	675	1022	7635	104	54	29
2022	0.078	0.02	5265	679	1119	8754	110	54	29
2023	0.078	0.05	5690	682	1211	9965	115	54	29
2024	0.078	0.08	6087	684	1296	11,261	120	55	29
2025	0.078	0.12	6455	686	1375	12,636	124	55	29
2026	0.078	0.17	6793	688	1448	14,084	128	55	29
2027	0.078	0.22	7102	689	1514	15,598	131	55	29
2028	0.078	0.29	7384	690	1575	17,172	135	55	29
2029	0.078	0.35	7640	691	1629	18,802	137	55	29
2030	0.078	0.41	7871	692	1679	20,481	140	55	30
2031	0.078	0.47	8080	692	1724	22,204	142	55	30
2032	0.078	0.54	8268	693	1764	23,969	144	56	30
2033	0.078	0.59	8437	693	1800	25,769	146	56	30
2034	0.078	0.63	8588	694	1833	27,602	147	56	30
2035	0.078	0.68	8724	694	1862	29,464	149	56	30
2036	0.078	0.71	8845	694	1888	31,351	150	56	30
2037	0.078	0.74	8954	695	1911	33,263	151	56	30
2038	0.078	0.76	9051	695	1932	35,195	152	56	30
2039	0.078	0.79	9138	695	1951	37,145	153	56	30
2040	0.078	0.8	9216	695	1967	39,113	154	56	30
2041	0.078	0.81	9285	695	1982	41,095	154	56	30
2042	0.078	0.82	9347	696	1995	43,090	155	56	30
2043	0.078	0.83	9402	696	2007	45,097	156	56	30
2044	0.078	0.84	9451	696	2018	47,115	156	56	30
2045	0.078	0.85	9495	696	2027	49,142	157	56	30
2046	0.078	0.86	9534	696	2036	51,178	157	56	30
2047	0.078	0.88	9569	696	2043	53,221	157	56	30
2048	0.078	0.87	9600	696	2050	55,270	158	56	30
2049	0.078	0.87	9628	696	2056	57,326	158	56	30
2050	0.078	0.87	9652	696	2061	59,387	158	56	30

*Table 4.5. Red snapper: Projection results under scenario P4—fishing mortality rate F = 85%$F_{40\%}$, with very high 2006 recruitment. 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	262	286	541	541	144	292	177
2008	1.22	0	290	367	759	1300	174	297	165
2009	0.974	0	225	385	579	1878	124	176	125
2010	0.088	0	242	339	66	1945	14	23	14
2011	0.088	0	516	352	111	2056	22	30	16
2012	0.088	0	764	482	172	2228	30	32	19
2013	0.088	0	1066	539	244	2472	39	38	23
2014	0.088	0	1425	579	328	2800	49	46	26
2015	0.088	0	1834	608	428	3228	60	51	28
2016	0.088	0	2279	629	537	3764	71	54	29
2017	0.088	0	2747	644	651	4416	81	56	30
2018	0.088	0	3223	655	768	5184	90	58	31
2019	0.088	0	3698	663	885	6069	99	59	32
2020	0.088	0	4161	669	998	7067	106	60	32
2021	0.088	0.01	4605	674	1107	8174	114	60	32
2022	0.088	0.01	5026	678	1210	9384	120	61	32
2023	0.088	0.03	5420	680	1306	10,690	126	61	33
2024	0.088	0.05	5786	683	1395	12,085	131	61	33
2025	0.088	0.08	6123	685	1477	13,562	135	62	33
2026	0.088	0.11	6431	686	1552	15,115	139	62	33
2027	0.088	0.15	6712	688	1621	16,735	143	62	33
2028	0.088	0.19	6967	689	1683	18,418	146	62	33
2029	0.088	0.25	7197	690	1738	20,156	149	62	33
2030	0.088	0.29	7403	690	1789	21,945	151	62	33
2031	0.088	0.35	7589	691	1834	23,779	153	62	33
2032	0.088	0.38	7755	691	1874	25,654	155	62	33
2033	0.088	0.43	7904	692	1910	27,564	157	62	33
2034	0.088	0.48	8037	692	1943	29,507	159	62	33
2035	0.088	0.52	8155	693	1971	31,478	160	62	33
2036	0.088	0.55	8260	693	1997	33,475	161	63	33
2037	0.088	0.58	8354	693	2020	35,495	163	63	33
2038	0.088	0.6	8437	693	2040	37,535	164	63	33
2039	0.088	0.63	8511	694	2058	39,593	164	63	33
2040	0.088	0.65	8577	694	2074	41,667	165	63	33
2041	0.088	0.67	8635	694	2088	43,755	166	63	33
2042	0.088	0.68	8687	694	2101	45,856	166	63	33
2043	0.088	0.69	8733	694	2112	47,967	167	63	33
2044	0.088	0.7	8774	694	2122	50,089	167	63	33
2045	0.088	0.71	8810	694	2131	52,220	168	63	33
2046	0.088	0.72	8842	695	2138	54,358	168	63	33
2047	0.088	0.73	8871	695	2145	56,504	169	63	33
2048	0.088	0.73	8896	695	2151	58,655	169	63	33
2049	0.088	0.74	8918	695	2157	60,812	169	63	33
2050	0.088	0.74	8938	695	2162	62,974	169	63	33

*Table 4.6. Red snapper: Projection results under scenario P5—fishing mortality rate F = $F_{40\%}$, with very high 2006 recruitment. 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	262	286	541	541	144	292	177
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2009	0.974	0	225	385	579	1878	124	176	125
2010	0.104	0	242	339	78	1956	17	27	16
2011	0.104	0	509	352	129	2085	25	35	19
2012	0.104	0	748	480	198	2283	35	37	22
2013	0.104	0	1036	536	278	2561	45	44	26
2014	0.104	0	1376	576	373	2934	56	53	30
2015	0.104	0	1762	605	483	3417	68	59	32
2016	0.104	0	2178	626	603	4019	80	62	34
2017	0.104	0	2613	641	728	4747	91	65	35
2018	0.104	0	3053	652	855	5602	101	67	36
2019	0.104	0	3488	660	981	6583	111	68	37
2020	0.104	0	3910	667	1102	7685	119	69	37
2021	0.104	0	4312	671	1218	8903	127	70	37
2022	0.104	0.01	4690	675	1327	10,230	134	70	38
2023	0.104	0.01	5042	678	1428	11,658	140	71	38
2024	0.104	0.02	5366	681	1521	13,178	145	71	38
2025	0.104	0.04	5662	683	1606	14,784	150	71	38
2026	0.104	0.06	5931	684	1683	16,467	154	72	38
2027	0.104	0.08	6175	685	1752	18,219	158	72	38
2028	0.104	0.1	6394	686	1815	20,034	161	72	39
2029	0.104	0.12	6590	687	1871	21,905	164	72	39
2030	0.104	0.15	6765	688	1921	23,826	166	72	39
2031	0.104	0.18	6921	689	1966	25,792	169	72	39
2032	0.104	0.21	7060	689	2006	27,798	171	72	39
2033	0.104	0.23	7183	690	2041	29,839	172	72	39
2034	0.104	0.26	7292	690	2072	31,911	174	72	39
2035	0.104	0.28	7388	691	2099	34,010	175	72	39
2036	0.104	0.31	7473	691	2124	36,134	176	72	39
2037	0.104	0.33	7549	691	2145	38,279	177	72	39
2038	0.104	0.34	7615	691	2164	40,444	178	73	39
2039	0.104	0.36	7673	692	2181	42,625	179	73	39
2040	0.104	0.38	7725	692	2196	44,820	180	73	39
2041	0.104	0.41	7770	692	2209	47,029	180	73	39
2042	0.104	0.42	7810	692	2220	49,249	181	73	39
2043	0.104	0.43	7845	692	2230	51,479	181	73	39
2044	0.104	0.44	7876	692	2239	53,718	182	73	39
2045	0.104	0.45	7904	692	2247	55,965	182	73	39
2046	0.104	0.46	7928	692	2254	58,218	183	73	39
2047	0.104	0.46	7949	692	2260	60,478	183	73	39
2048	0.104	0.46	7967	692	2265	62,743	183	73	39
2049	0.104	0.45	7984	693	2270	65,013	183	73	39
2050	0.104	0.45	7998	693	2274	67,287	184	73	39

5 Figures

Figure 5.1. Projection results under scenarios with fishing mortality rate fixed at $F = F_{\text{rebuild}}$. For reference, the proxy reference point used to define stock recovery is $\text{SSB}_{\text{MSY}} = 8102.5$ mt, which corresponds to a yield of about 2.3 million lb.

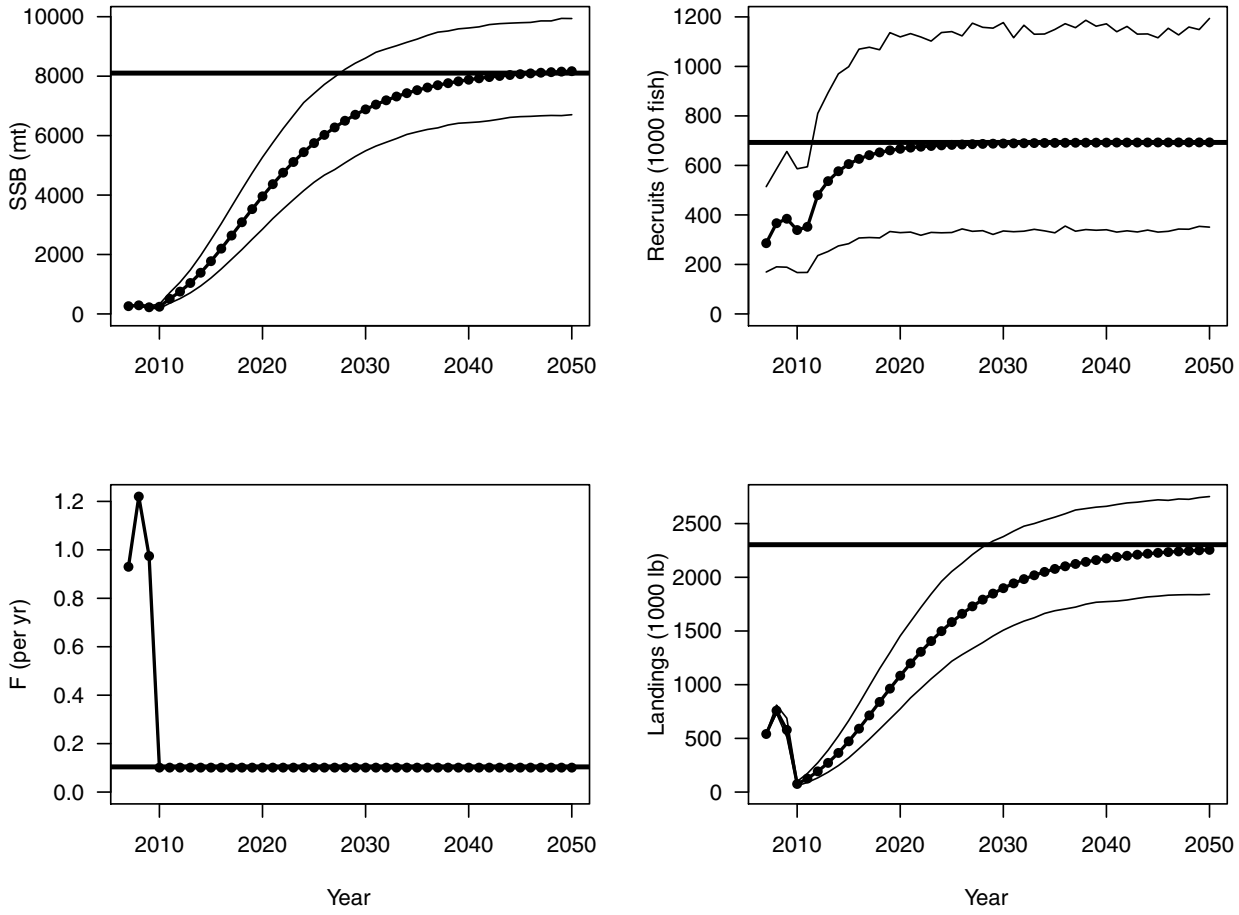

Figure 5.2. Projection results under scenarios with fishing mortality rate fixed at $F = 0.65F_{40\%}$. *For reference, the proxy reference point used to define stock recovery is* $\text{SSB}_{\text{MSY}} = 8102.5$ *mt, which corresponds to a yield of about 2.3 million lb.*

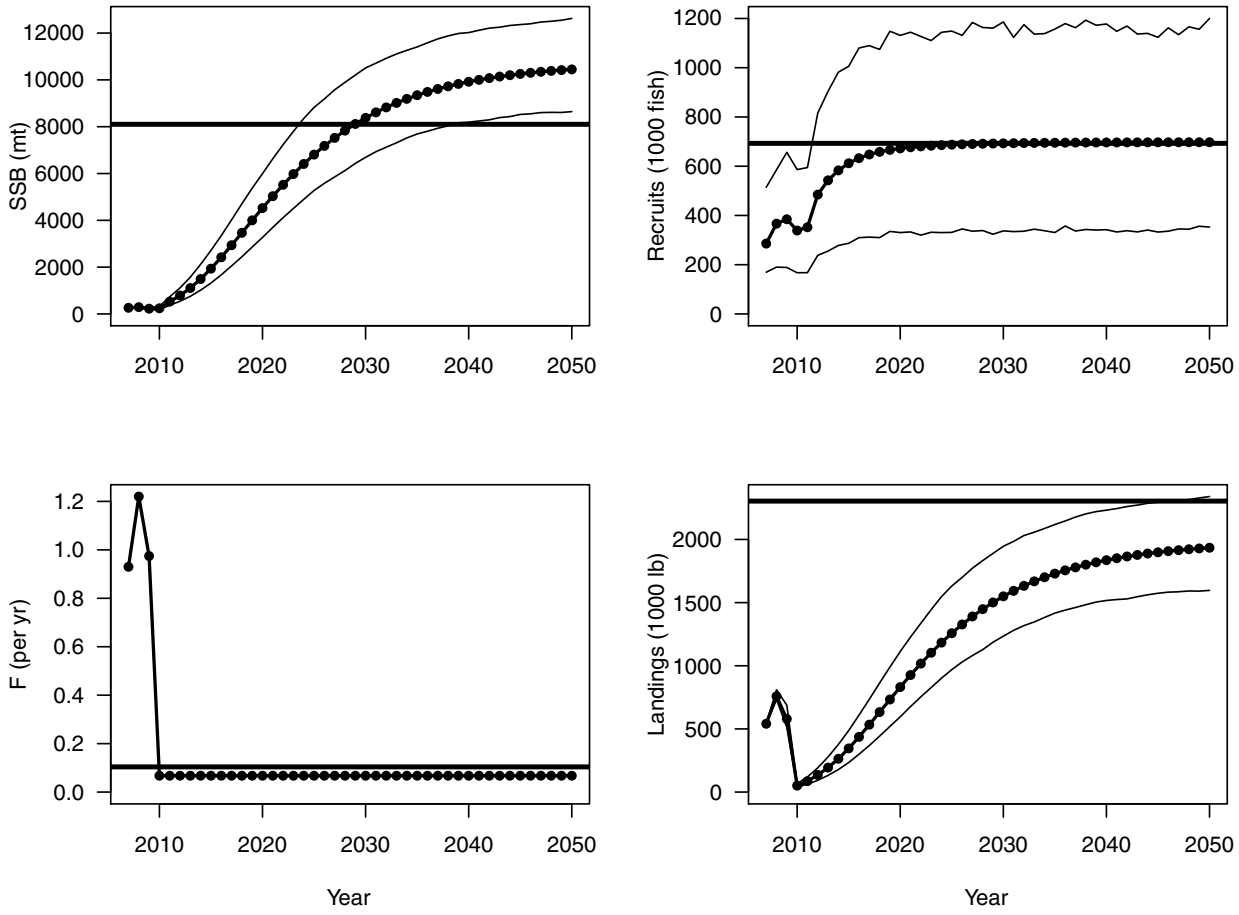

Figure 5.3. Projection results under scenarios with fishing mortality rate fixed at $F = 0.75F_{40\%}$. *For reference, the proxy reference point used to define stock recovery is* $\text{SSB}_{\text{MSY}} = 8102.5$ *mt, which corresponds to a yield of about 2.3 million lb.*

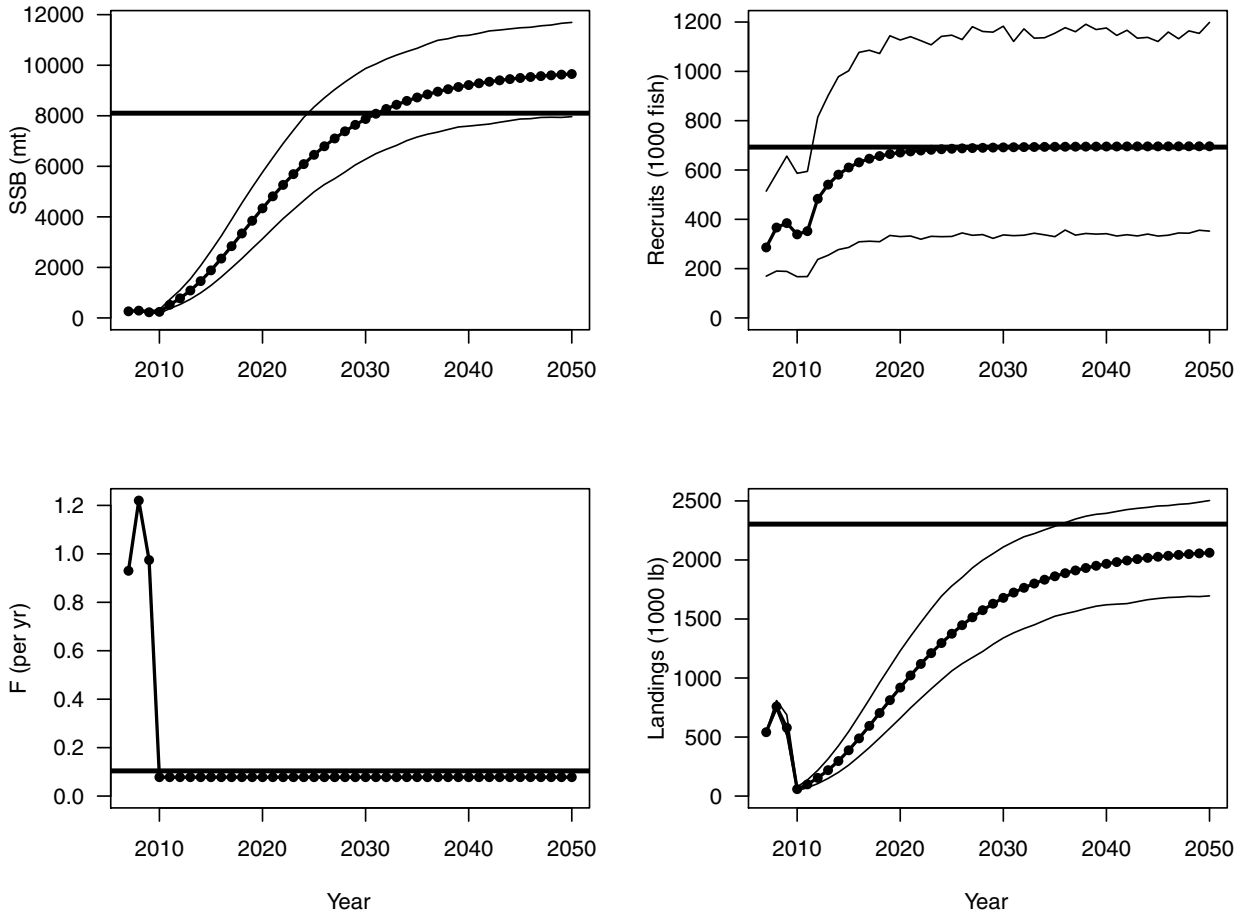

Figure 5.4. Projection results under scenarios with fishing mortality rate fixed at $F = 0.85F_{40\%}$. *For reference, the proxy reference point used to define stock recovery is* $\text{SSB}_{\text{MSY}} = 8102.5$ *mt, which corresponds to a yield of about 2.3 million lb.*

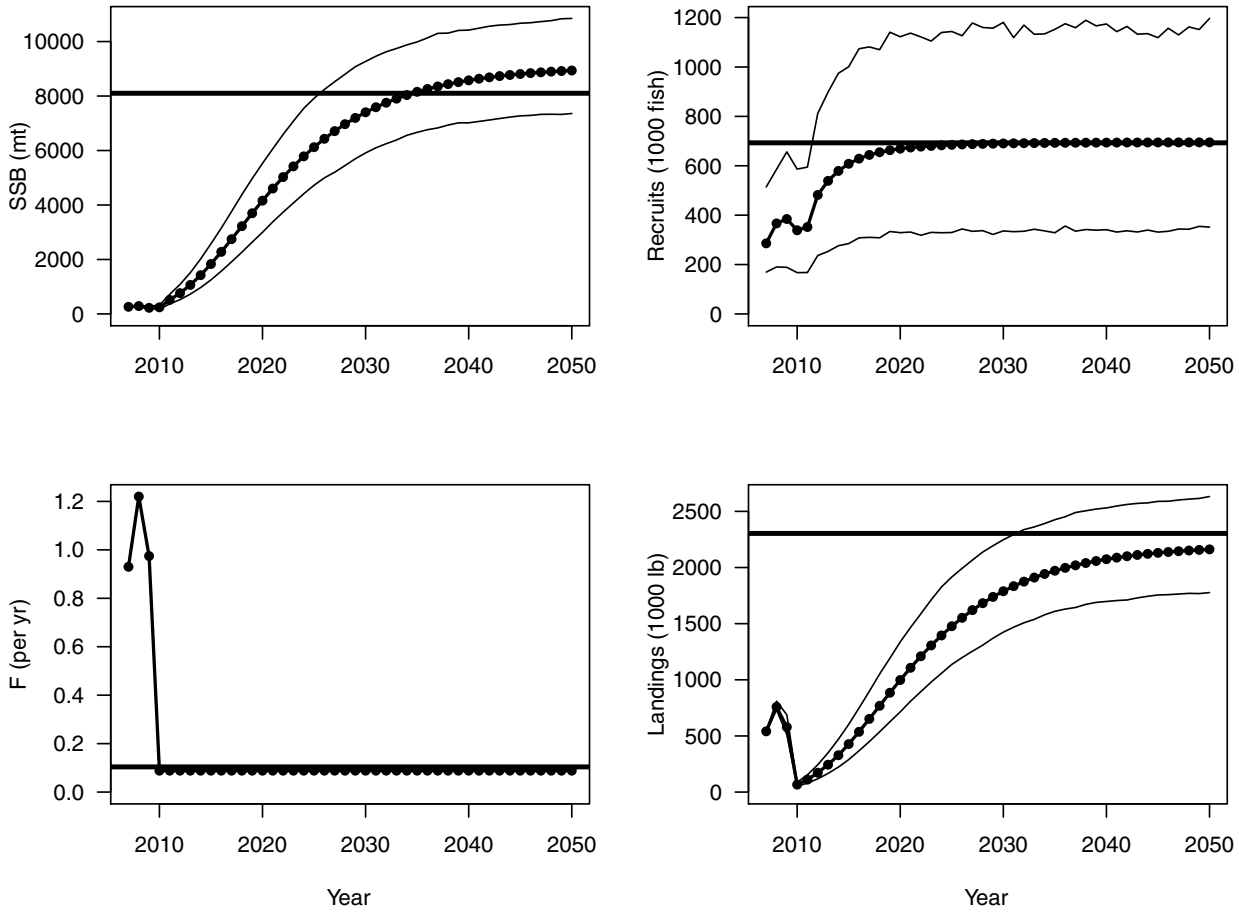

Figure 5.5. Projection results under scenarios with fishing mortality rate fixed at $F = F_{40\%}$. For reference, the proxy reference point used to define stock recovery is $SSB_{MSY} = 8102.5$ mt, which corresponds to a yield of about 2.3 million lb.