SEDAR 10 Review Workshop

Assessment Advisory Report
South Atlantic Gag Grouper

Stock Distribution and identification

- The management unit for South Atlantic gag grouper includes gag grouper found in all waters within South Atlantic Fishery Management Council Boundaries.
- The SEDAR 10 Review Workshop (RW), using several sources of information, examined and accepted the current stock definitions for the South Atlantic and Gulf of Mexico gag.

Assessment Methods

- The South Atlantic gag grouper stock was assessed with two models: a statistical catch-at-age model, as the primary assessment model, and an age-aggregated production model to investigate results under a different set of model assumptions. Within each type of model various configurations and sensitivity runs were explored. Details of all models are available in the Stock Assessment Report and Addendum to the Stock Assessment Report.

- The assessment workshop (AW) developed two base runs: one assuming a time-varying catchability and one assuming constant catchability for the fishery dependent indices. Each base run of the catch-at-age model was the basis for estimation of benchmarks and stock status.

- The SEDAR 10 RW recommended the run with constant catchability as the preferred 'base run'.

Assessment Data

- Data sources include fishery-dependent abundance indices, recorded landings, and samples of annual length and age compositions from fishery-dependent sources.

- Three fishery–dependent abundance indices were developed by the SEDAR 10 data workshop: one from the NMFS headboat survey, one from the commercial logbook program, and one from the Marine Recreational Fishing Statistical Survey (MRFSS). Currently, there are no usable fishery–independent abundance data for this stock of gag grouper.

- Landings data were available from all recreational (headboat, charter boat, private boat, and shore sectors) and commercial fisheries (handline and diving gears). This benchmark assessment included data through 2004.

- Complete details are available in the SEDAR 10 Data and Assessment Reports, and the

SEDAR 10 workshop working papers. Additional information and discussion can be found in the companion SEDAR 10 Review Workshop Consensus Summary Report for South Atlantic Gag Grouper.

Catch Trends

- Landings are reported from the commercial and recreational sectors. The commercial landings are in gutted weight in pounds, while recreational landings are estimated in numbers. Commercial landings were converted to numbers for the assessment model (Table 1 and Figures 1-2).

- The commercial landings were dominated by handline gear peaking at over 1,000,000 pounds in 1984. Landings from the diving gear have been significant in recent years and are modeled separately. The contribution from other gears is small and included with the handline gear (Table 1 and Figure 1).

- The recreational sector catch peaked in 1984 at about 180,000 fish, and has two components: catch estimated from MRFSS which includes private and charter boats and a minor shore component, and catch estimated from a survey of headboats (larger for-hire vessels) (Table 1).

- When comparing across sectors, the largest landings in numbers are associated with the MRFSS (Table 1 and Figure 2).

- Coastwide landings of gag grouper in the South Atlantic had been increasing but have recently leveled off. The catch share among sectors has been changing over the last decade, with increased landings from the charter/private boat and shore mode recreational sectors relative to the commercial handline sector, which has been decreasing.

Fishing mortality trends

- Fishing mortality (fully selected F) increased from 0.03 in 1962 to 0.50 in 1983 (above $F_{MSY} = 0.295$; see discussion below). Fishing mortality has remained above F_{MSY} since then (Table 2 and Figure 3). Fishing mortality in 2004 was estimated as 0.40.

Stock abundance and biomass trends

- Total and spawning stock biomass (both sexes combined) declined from initial high values in the 1960s, went below levels corresponding to MSY in 1970s, remained relatively constant through the early 1980s, declined through the remainder of the 1980s and have apparently been on an increasing trend since (Table 2 and Figure 4). In particular, spawning stock biomass declined from 16.6 million pounds (gutted weight) in 1962 to 9.1 million pounds in 1979 (below the current value of $SSB_{MSY} = 9.4$ million pounds). Spawning stock biomass rose to 9.8 million pounds in 2003 (Table 2). The 2005 SSB value is estimated to be 11.0 million pounds.

Status determination criteria and Stock Status

- Status Determination Criteria: The SFA and management criteria recommendations and values are estimated from the preferred base model by the RW as follows:

Stock Status	Current Definition	Value from Previous Assessment	Value from Current Assessment
MSST	$(1-M)B_{MSY}$	NA	8062 klb
MFMT	F_{MSY} Proxy $= F_{30\%SPR}$	0.18	0.24
MSY	Yield at F_{MSY}	NA	1774 klb
F_{OY}	$F_{45\%SPR}$	NA	0.13
OY	Yield at F_{OY} ($F_{45\%SPR}$)	NA	1570 klb

Proposed Status Criteria	Definition	Value
MSST	$(1-M)SSB_{MSY}$ *(see special comment)	5000 klb
MFMT	F_{MSY}	0.295
MSY	Yield at F_{MSY}	1774 klb
OY	65%F_{MSY} (Alt. 1)	1714 klb
	75%F_{MSY} (Alt. 2)	1747 klb
	85%F_{MSY} (Alt. 3)	1765 klb
F_{OY}	65%F_{MSY} (Alt. 1)	0.192
	75%F_{MSY} (Alt. 2)	0.221
	85%F_{MSY} (Alt. 3)	0.251
M (Age-varying)	Constant Equivalent	0.14

Additional Benchmarks	Exploitation Rate	SSB	Yield
F_{MAX}	0.330	8592 klb	1770 klb
$F_{20\%SPR}$	0.420	7087 klb	1737 klb
$F_{30\%SPR}$	0.240	10929 klb	1760 klb
$F_{45\%SPR}$	0.130	16370 klb	1570 klb

Stock Status

- Current rates of exploitation indicate that overfishing is occurring for the South Atlantic gag grouper stock (Figure 5). Relative to the current value of the MSST specified by the FMP, South Atlantic gag is approaching an overfished condition and is projected to become overfished in 2007 (see projections, Figure 6). Relative to the MSST proposed by the RW, the stock is not overfished and is not projected to become overfished under any of the projection scenarios (Figure 6).
- The MSY-based benchmarks in this assessment are deemed useful for management.
- The current definition of MSST may be overly conservative. The RW recommends an operational definition of MSST of 5 million pounds (see Special Comments).

Projections

- Estimates of recruitment in 2002-2004 are below average and fishing mortality rates in 2002-2004 are above the MSY level. As a result, stock projections suggest that the stock will decline below the existing MSST in 2007. Projections for biomass, recruitment and fishing mortality at various levels of constant fishing mortality rates starting in 2008 are shown in Table 3 and Figures 6-10. The levels are based on current F (geometric mean of last three years of the base run, Figure 6), on F_{MSY} (Figure 7), and three levels of F_{OY} (65%, 75% and 85% of F_{MSY}, Figures 8-10).

Special Comments

- **Constant and time-varying catchability alternative**: The RW discussed the relationship of technology to catchability and the effects of catchability changes on fishery-dependent abundance indices. The RW recognized that technology improvements over time, particularly better electronics, have likely made fishermen more effective and efficient at catching fish. The RW, however, did not support an assessment that assumed a simple linear (2% annually) increase. Nevertheless, this is an important issue and the RW recommends further investigations of time-varying catchability.

- **Uncertainties**: The primary uncertainties in the assessment are from the model process errors and the data measurement errors. Because of the inherited high uncertainties from the assessment data and the estimated stock-recruitment relationship, the RW evaluated the uncertainties in this assessment with sensitivity runs to investigate the robustness of management benchmark parameter estimates to alternative choices about data usage.

- **Stock-recruitment relationship**: In both stock areas, the stock and recruitment scatter plot does not suggest that recruitment is strongly linked with SSB. In the South Atlantic, the Beverton-Holt stock-recruitment relationship indicates little change in recruitment for a wide range of SSB's and that B_{MSY} falls in the range of SSB's observed in the past. On the other hand, the Ricker stock-recruitment relationship indicates that maximum recruitment occurs at SSBs lower than those observed over the period of the assessment, which implies that B_{MSY} would also be lower than those observed in the period of the assessment. In the Gulf of Mexico, both the Beverton-Holt and Ricker relationships suggest that considerably higher recruitment would result from larger SSBs and SSB_{MSY} is estimated to be higher than SSB's observed in the past. The RW considers that the stock recruitment relationships in the two stock areas are equally uncertain. The derived benchmarks are considered useful for management in the South Atlantic, because they are within the range of past observed values. In the Gulf of Mexico, more stock and recruitment observations are necessary to confirm that the benchmarks estimated in the current assessment are indeed attainable.

- **Discussion of RW recommended MSST**: MSST, currently defined by the South Atlantic Council as $(1-M)B_{MSY}$, is very close to B_{MSY} because age-averaged natural mortality

rate, M, is estimated as 0.14. Given the uncertainties in the assessment, the biomass would be expected to fall below MSST with a relatively high frequency even if the true biomass were close to B_{MSY}. In addition, MSST, as currently defined, may be overly conservative. There are no indications of impaired recruitment at the lowest observed SSB (around 5 million lbs) and the RW suggests that MSST could be set at this level, operationally, to be re-examined at the next assessment.

- **Sensitivity investigations**: The RW requested sensitivity model runs for the constant catchability model. The Panel wished to better understand the behavior of the model when certain data were left out of the model. The base model run contains three fishery-dependent CPUE indices and three sets of age and length composition datasets (one for the commercial handline, commercial diving, and recreational headboat fisheries). The stock analysts completed nine additional model runs removing each index, each fishery age composition dataset, and each fishery length composition dataset, one at a time. The results from this analysis suggest that the selected model provides a balanced fit to all data sources, illustrated by the base run falling within the middle of this set of sensitivity runs (Figures 12-14). When examining the spawning stock biomass time series, the run with the headboat CPUE data omitted shows the population increasing rapidly in the most recent years, reaching the highest terminal value of all the runs. In contrast, the run with the commercial handline CPUE omitted produces the lowest estimate of SSB value in the terminal year (Figure 12).

Sources of Information:
- The report from the Data Workshop along with the associated workshop documents.
- The report from the Assessment workshop along with associated documents.
- The SEDAR10 Review workshop discussions and presentations
- The SEDAR10 Review Workshop Consensus Summary Assessment of South Atlantic Gag Grouper

Tables: Catch and Status

Table 1. Commercial landings by gear in weight (gutted), recreational landings in numbers, and discards in numbers for gag grouper from the U.S. South Atlantic, 1962-2004.

Year	Commercial (gutted klb) Handline	Diving	Recreational (1000s) Headboat	MRFSS	Discards (1000s) Handline	Headboat	MRFSS
1962	150.3		8.41	6.17			
1963	137.0		7.66	5.62			
1964	128.4		7.18	5.27			
1965	130.4		7.41	5.44			
1966	99.1		5.58	4.09			
1967	210.9		11.77	8.62			
1968	309.9		17.72	12.98			
1969	217.2		12.13	8.89			
1970	299.0		16.66	12.20			
1971	306.7		17.18	12.59			
1972	204.5		13.44	8.37			
1973	290.5		17.99	12.15			
1974	372.8		13.92	15.68			
1975	421.8		8.57	17.48			
1976	565.0	3.75	7.56	23.77			
1977	627.6	8.81	8.48	21.94			
1978	967.4	13.87	6.01	37.54			
1979	907.5	18.92	9.55	35.70			
1980	846.2	16.40	6.96	35.39			
1981	984.0	13.88	13.86	56.69		0.03	0.00
1982	1027.4	15.85	11.84	22.17		0.02	4.32
1983	1101.1	9.08	16.46	166.70		0.04	91.88
1984	1108.2	18.75	18.69	165.20		0.03	11.95
1985	865.7	11.62	16.13	55.31		3.76	3.09
1986	819.8	6.34	17.35	59.26		4.05	12.48
1987	857.8	21.93	24.09	97.68		5.63	10.30
1988	672.4	12.96	24.21	77.08		5.65	15.01
1989	967.0	22.26	22.42	118.69		5.23	43.41
1990	784.3	19.07	17.59	63.66		4.11	11.46
1991	656.4	85.01	13.55	60.90		3.16	24.19
1992	691.7	106.76	13.94	87.98		7.74	38.66
1993	756.6	78.15	11.80	83.03		6.54	31.23
1994	800.0	97.50	9.81	124.51		5.45	68.29
1995	840.4	83.77	10.54	114.50		5.85	73.97
1996	751.9	118.56	7.50	86.92		4.16	43.00
1997	608.2	98.71	6.85	114.74		3.81	82.41
1998	654.5	138.79	8.67	72.54		4.82	32.22
1999	538.1	113.49	5.34	109.31	7.37	4.80	58.86
2000	438.2	63.02	5.98	156.50	7.77	5.38	126.63
2001	450.1	82.30	5.12	90.15	13.71	4.60	47.41
2002	448.3	84.52	4.58	109.76	11.91	4.12	85.73
2003	443.9	117.41	3.27	183.73	5.10	2.95	137.62
2004	476.4	74.97	6.66	135.79	7.20	6.00	89.54

Table 2. Estimated time series and status indicators. Exploitation rate (E) is of ages 2+, F is the fully selected fishing mortality rate, and SPR is static spawning potential ratio. SSB is in thousands of gutted pounds.

Year	E	E/E_{MSY}	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SPR
1962	0.0191	0.233	0.0291	0.0987	16639	1.775	0.783
1963	0.0176	0.216	0.0273	0.0926	16402	1.750	0.795
1964	0.0177	0.217	0.0267	0.0907	16236	1.732	0.799
1965	0.0199	0.243	0.0285	0.0967	15958	1.702	0.785
1966	0.0166	0.203	0.0237	0.0803	15383	1.641	0.819
1967	0.0372	0.456	0.0483	0.1638	14698	1.568	0.662
1968	0.0601	0.735	0.0760	0.2577	13598	1.451	0.539
1969	0.0430	0.527	0.0569	0.1930	12180	1.299	0.620
1970	0.0575	0.704	0.0798	0.2707	11201	1.195	0.531
1971	0.0601	0.735	0.0872	0.2959	10310	1.100	0.509
1972	0.0446	0.546	0.0652	0.2213	9623	1.027	0.587
1973	0.0376	0.461	0.0648	0.2197	9220	0.984	0.598
1974	0.0460	0.563	0.0827	0.2805	8953	0.955	0.545
1975	0.0462	0.566	0.1090	0.3696	8839	0.943	0.490
1976	0.0601	0.736	0.1640	0.5564	9243	0.986	0.408
1977	0.0675	0.826	0.1798	0.6097	9788	1.044	0.402
1978	0.1131	1.384	0.2483	0.8421	9832	1.049	0.318
1979	0.0991	1.213	0.2295	0.7785	9112	0.972	0.325
1980	0.0861	1.054	0.2054	0.6966	8741	0.933	0.348
1981	0.1233	1.509	0.2780	0.9429	9022	0.962	0.258
1982	0.0987	1.208	0.2603	0.8830	8673	0.925	0.317
1983	0.1816	2.223	0.5038	1.7087	8535	0.910	0.161
1984	0.2768	3.388	0.5572	1.8901	7566	0.807	0.113
1985	0.1614	1.975	0.5650	1.9162	6068	0.647	0.213
1986	0.1746	2.137	0.3014	1.0224	5402	0.576	0.174
1987	0.1953	2.390	0.4991	1.6930	5097	0.544	0.149
1988	0.1439	1.761	0.5551	1.8827	4854	0.518	0.191
1989	0.2106	2.578	0.7721	2.6186	5138	0.548	0.124
1990	0.1530	1.873	0.5134	1.7413	4853	0.518	0.178
1991	0.1148	1.405	0.4493	1.5241	5214	0.556	0.204
1992	0.1239	1.516	0.4475	1.5178	6175	0.659	0.187
1993	0.1458	1.785	0.3979	1.3495	7395	0.789	0.202
1994	0.2091	2.559	0.4707	1.5964	7951	0.848	0.159
1995	0.1953	2.391	0.4814	1.6328	6894	0.735	0.153
1996	0.1412	1.728	0.4323	1.4664	6019	0.642	0.183
1997	0.1447	1.771	0.4271	1.4486	6298	0.672	0.177
1998	0.1249	1.528	0.4031	1.3671	6877	0.734	0.214
1999	0.1468	1.797	0.5283	1.7920	7475	0.797	0.188
2000	0.1503	1.839	0.5810	1.9707	7394	0.789	0.161
2001	0.0948	1.161	0.3911	1.3267	7235	0.772	0.230
2002	0.0946	1.158	0.3927	1.3320	8479	0.904	0.226
2003	0.1247	1.526	0.5233	1.7749	9823	1.048	0.178
2004	0.1260	1.542	0.4019	1.3633	10563	1.127	0.216
2005	.	.	.	.	11005	1.174	.

Table 3. Biomass, landings and discard projections under various fishing mortality (F) scenarios starting in 2008 (F fixed at the current value in 2005-2007). All results are in 1,000s of gutted pounds (klb). For reference, SSB_{MSY} = 9,374 klb, MSY = 1,774 klb, discards at MSY (D_{MSY}) = 88 klb

	Fcurrent	Fmsy	85% Fmsy	75% Fmsy	65% Fmsy
SSB (2005) (klb)	11005	11005	11005	11005	11005
SSB (2007) (klb)	7435	7435	7435	7435	7435
SSB (2010) (klb)	6265	7206	7545	7784	8034
SSB (2014) (klb)	6769	8689	9499	10112	10793
Landings (2005) (klb)	2720	2720	2720	2720	2720
Landings (2007) (klb)	2175	2175	2175	2175	2175
Landings (2010) (klb)	1523	1278	1166	1079	981
Landings (2014) (klb)	1698	1626	1560	1497	1415
Discards (2005) (klb)	138	138	138	138	138
Discards (2007) (klb)	75	75	75	75	75
Discards (2010) (klb)	117	84	73	65	58
Discards (2014) (klb)	118	87	76	68	60

Figure 1. Commercial gag grouper landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.
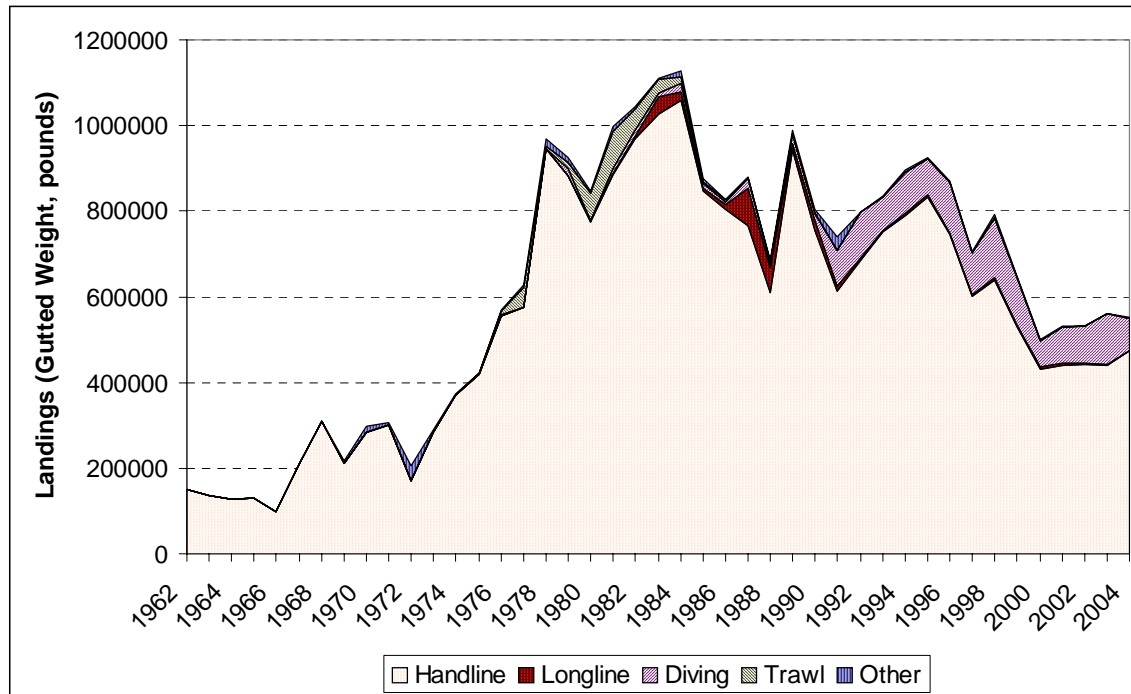
Figure 2. Total gag grouper catches (landings and discards) in numbers by sector from the U.S. South Atlantic, 1962-2004.
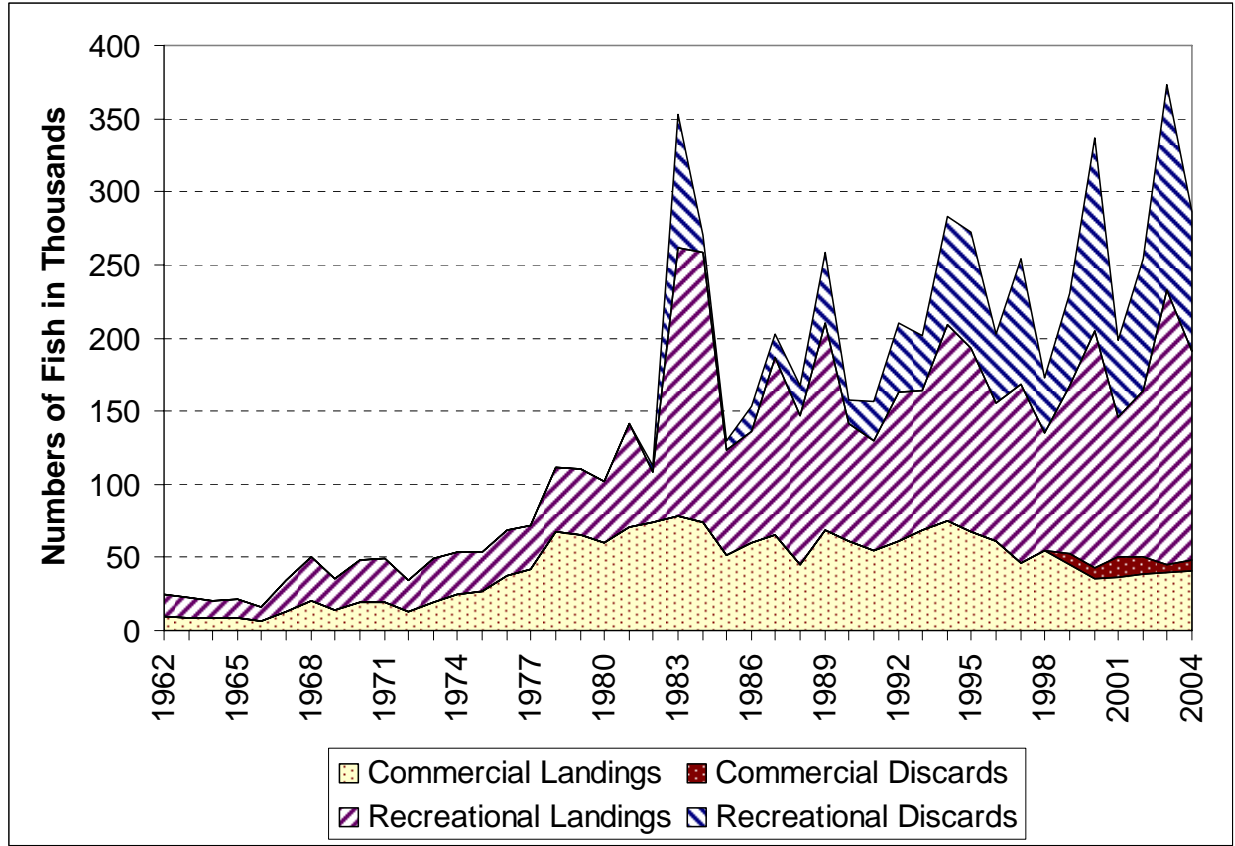
Figure 3. Estimated fully-selected fishing mortality rate. Solid horizontal line represents F_{MSY}.
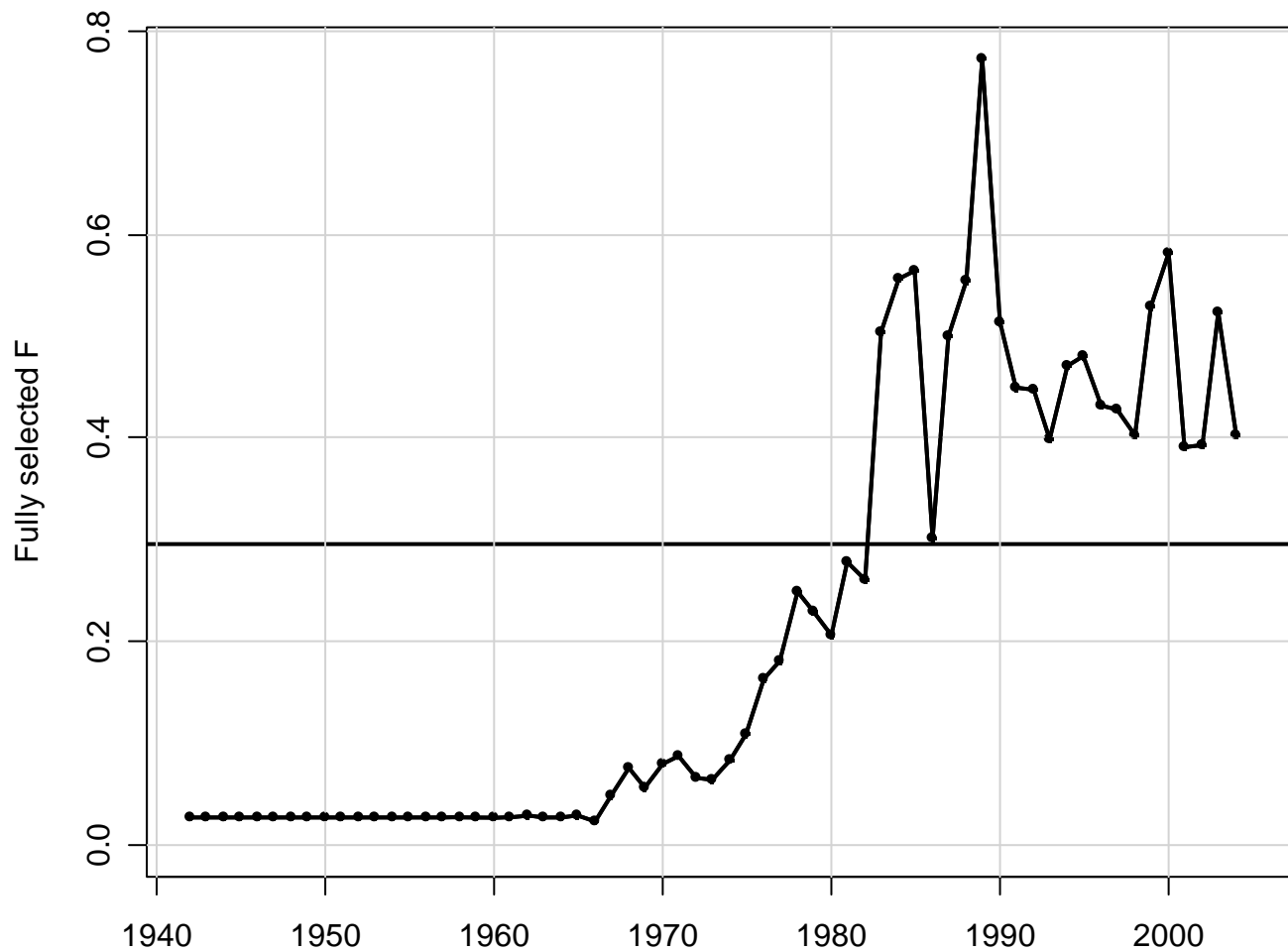
Figure 4. Estimated biomass time series (biomass in gutted weight). Total biomass (solid trend line) and spawning stock biomass (male mature biomass + female mature biomass, dashed trend line). The horizontal lines represents the level of biomass corresponding to MSY (B_{MSY} and SSB_{MSY}).
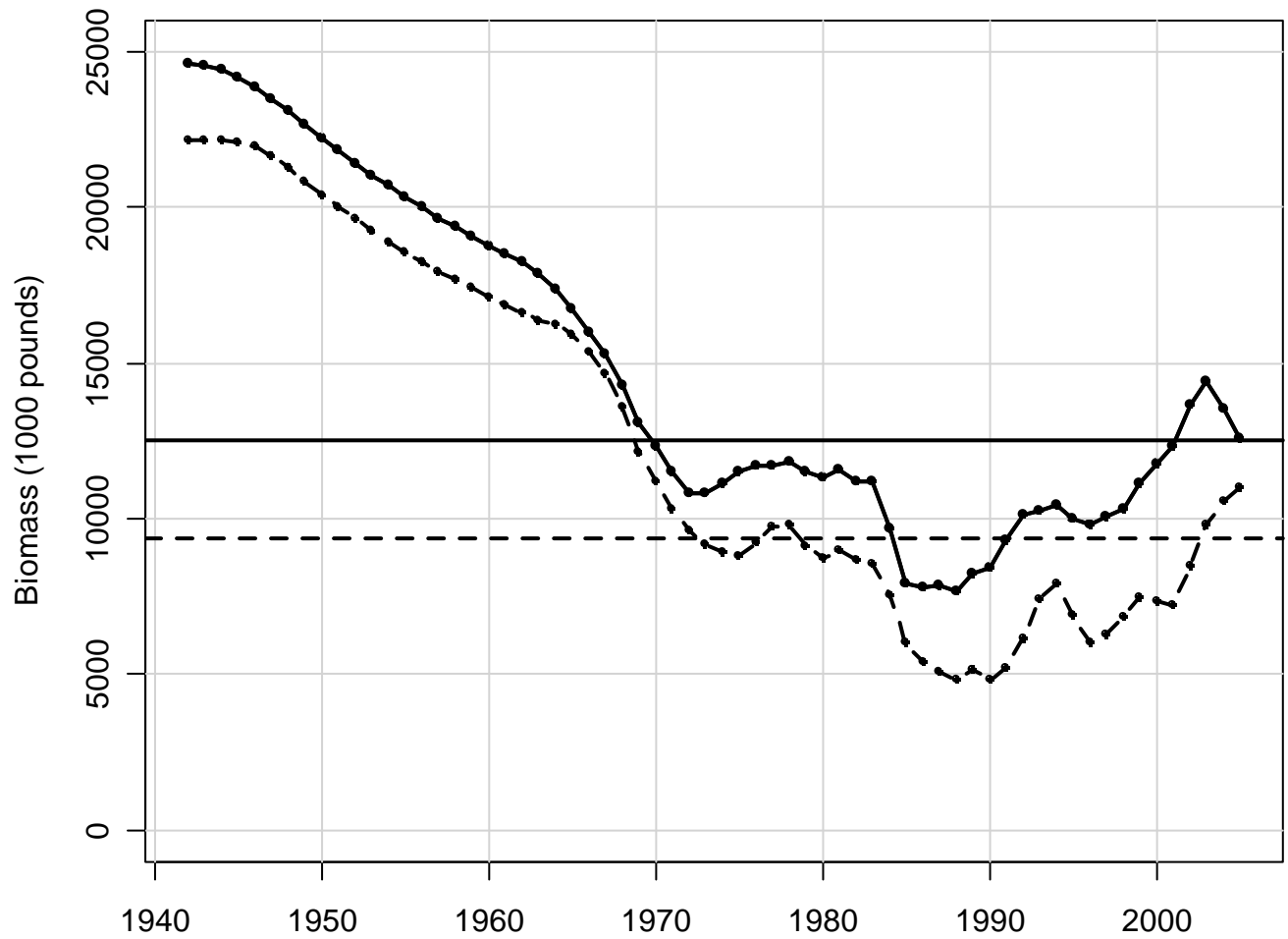
Figure 5. Phase plot of recent estimates of spawning stock biomass (klb, gutted weight) and fishing mortality rate. Solid lines correspond to MSY levels; vertical dashed line corresponds to MSST, defined as $(1-M)SSB_{MSY}$; and the vertical dotted line corresponds to the RW recommendation for an operational MSST.
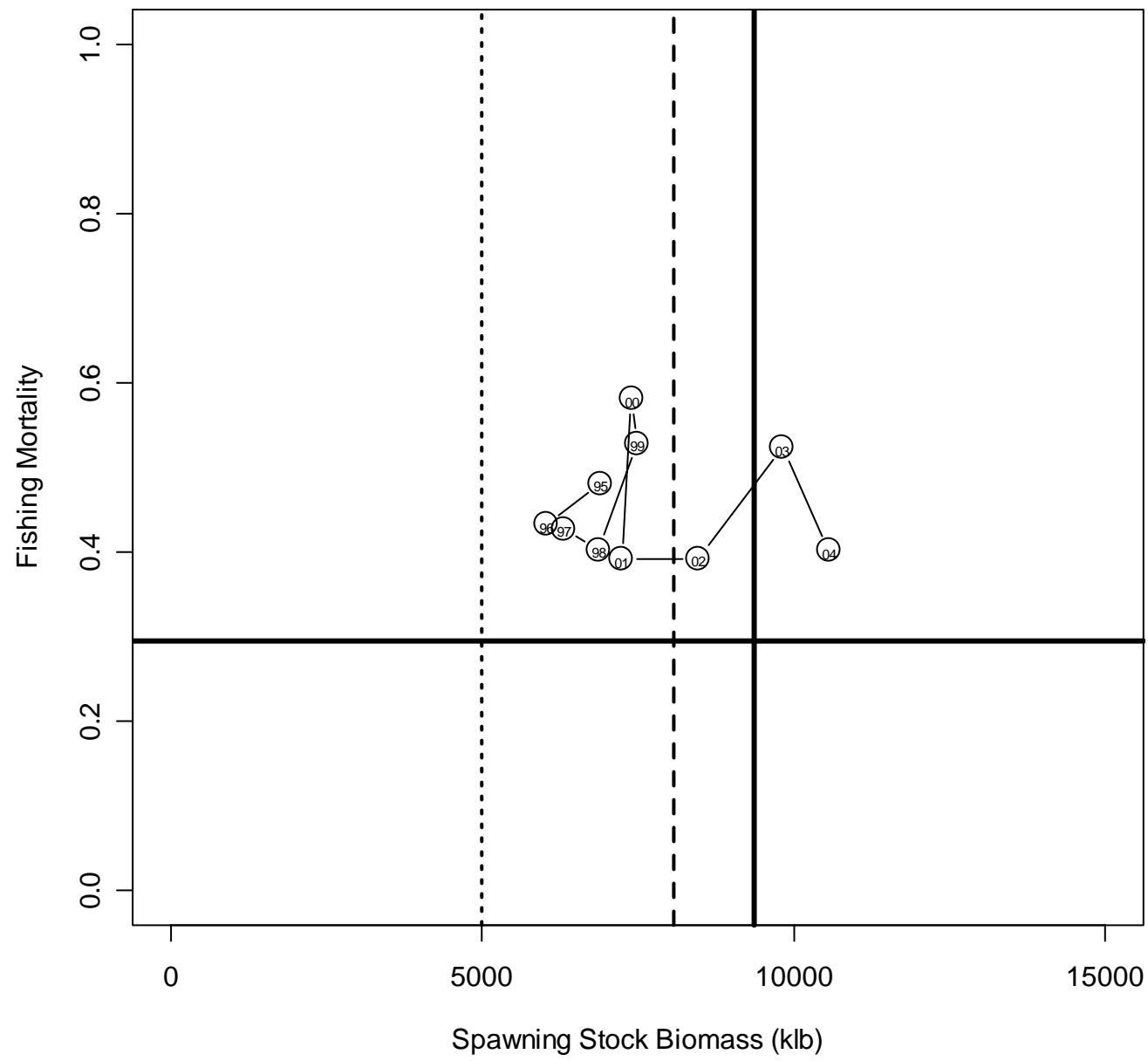
Figure 6. Projections under current fishing mortality rate for all years. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is SSB_{MSY} and dashed line is MSST (defined as $(1-M)SSB_{MSY}$); B) Recruits, horizontal line is R_{MSY}; C) Fishing mortality rate, horizontal line is F_{MSY}; and D) Landings, horizontal line is MSY.
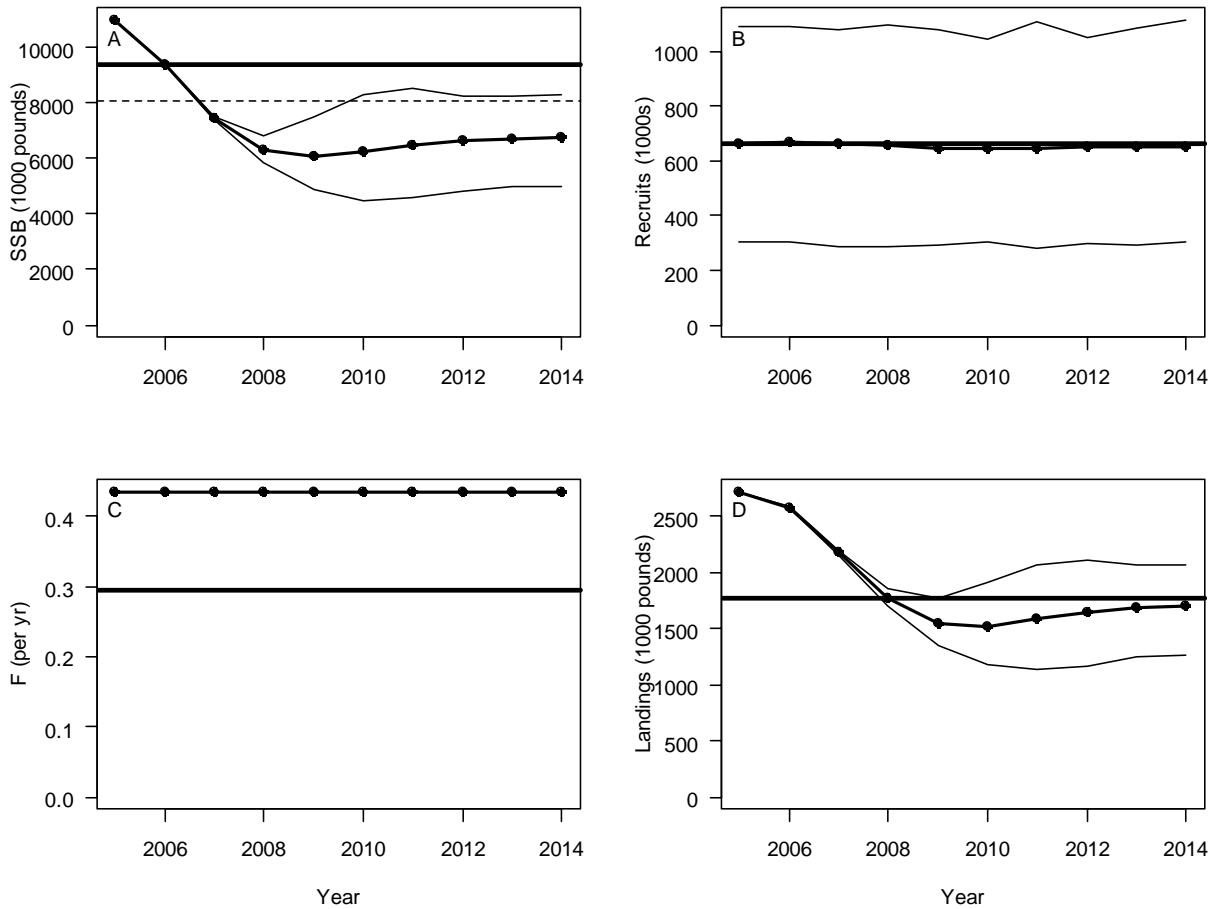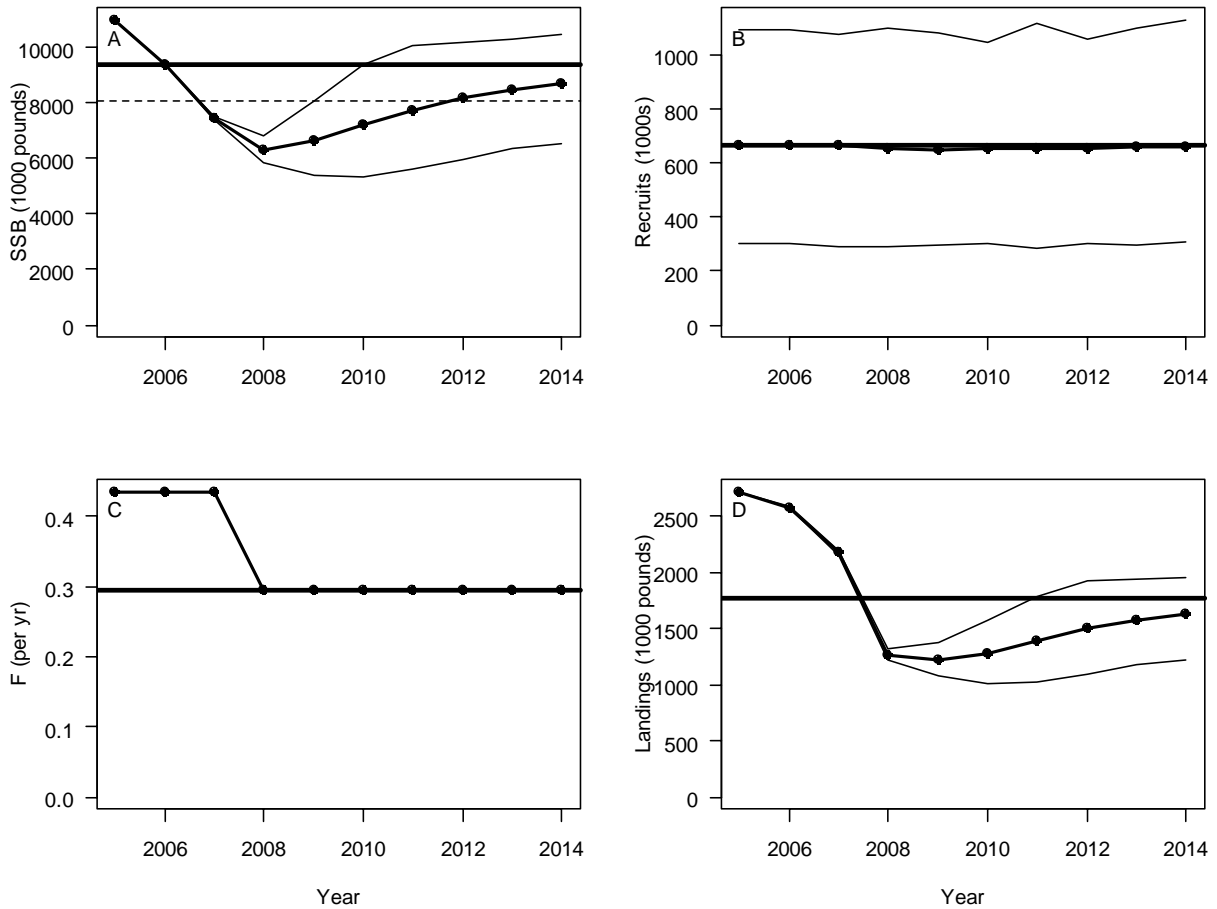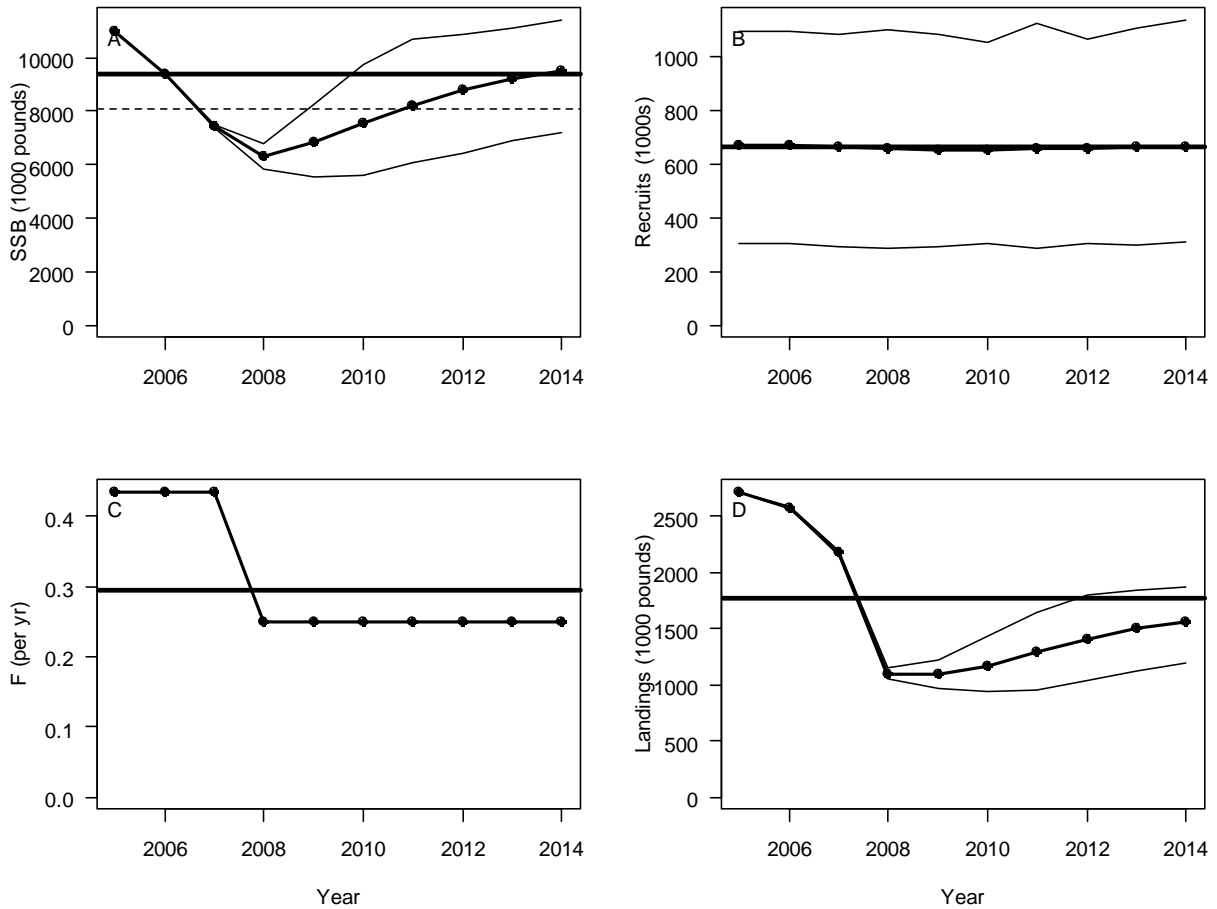
Figure 7. Projections under current fishing mortality rate in 2005-2007 and F_{MSY} in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is SSB_{MSY} and dashed line is MSST (defined as (1-M)SSB_{MSY}); B) Recruits, horizontal line is R_{MSY}; C) Fishing mortality rate, horizontal line is F_{MSY}; and D) Landings, horizontal line is MSY.
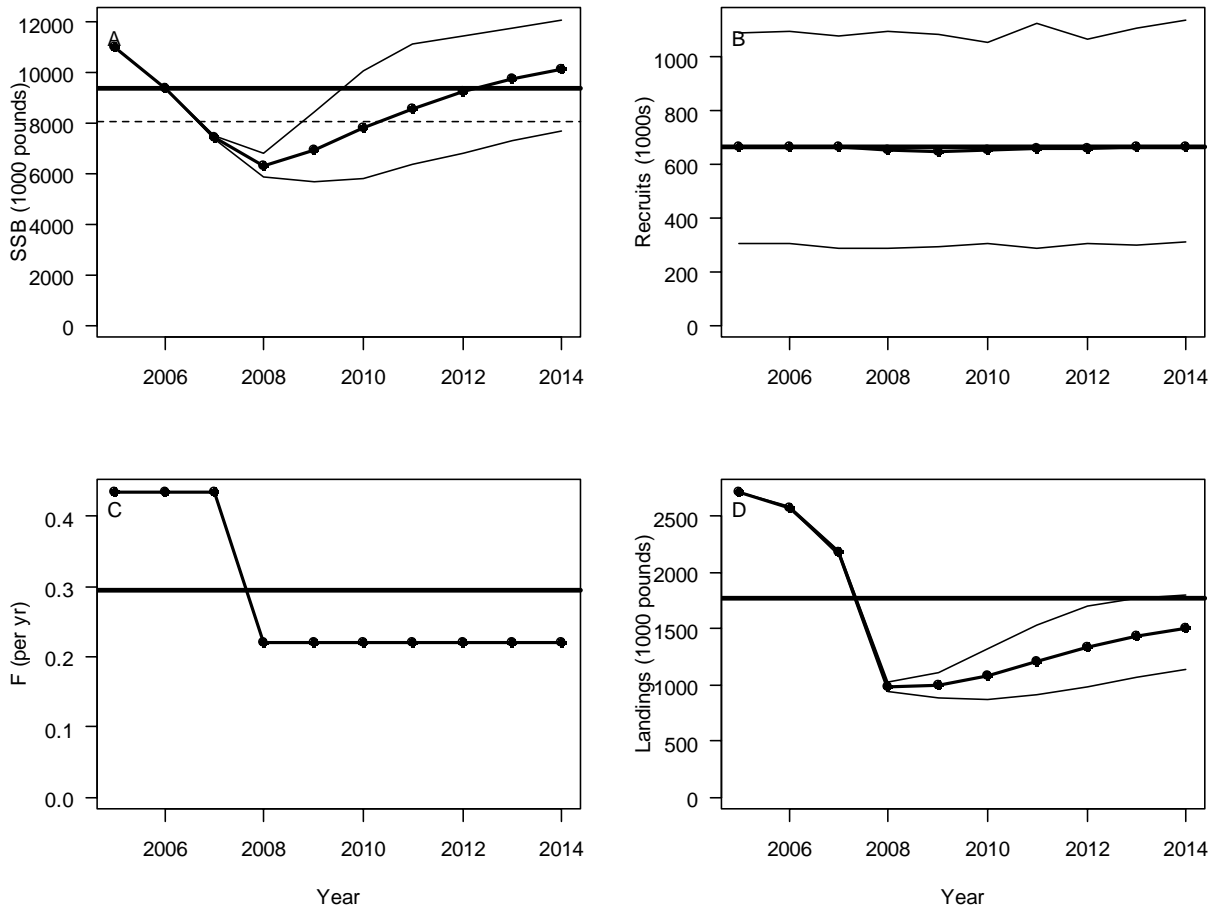
Figure 8. Projections under current fishing mortality rate in 2005-2007 and 85% of F_{MSY} in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is SSB_{MSY} and dashed line is MSST (defined as (1-M)SSB_{MSY}); B) Recruits, horizontal line is R_{MSY}; C) Fishing mortality rate, horizontal line is F_{MSY}; and D) Landings, horizontal line is MSY.

Figure 9. Projections under current fishing mortality rate in 2005-2007 and 75% of F_{MSY} in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is SSB_{MSY} and dashed line is MSST (defined as $(1-M)SSB_{MSY}$); B) Recruits, horizontal line is R_{MSY}; C) Fishing mortality rate, horizontal line is F_{MSY}; and D) Landings, horizontal line is MSY.

Figure 10. Projections under current fishing mortality rate in 2005-2007 and 65% of F_{MSY} in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is SSB_{MSY} and dashed line is MSST (defined as $(1-M)SSB_{MSY}$); B) Recruits, horizontal line is R_{MSY}; C) Fishing mortality rate, horizontal line is F_{MSY}; and D) Landings, horizontal line is MSY.
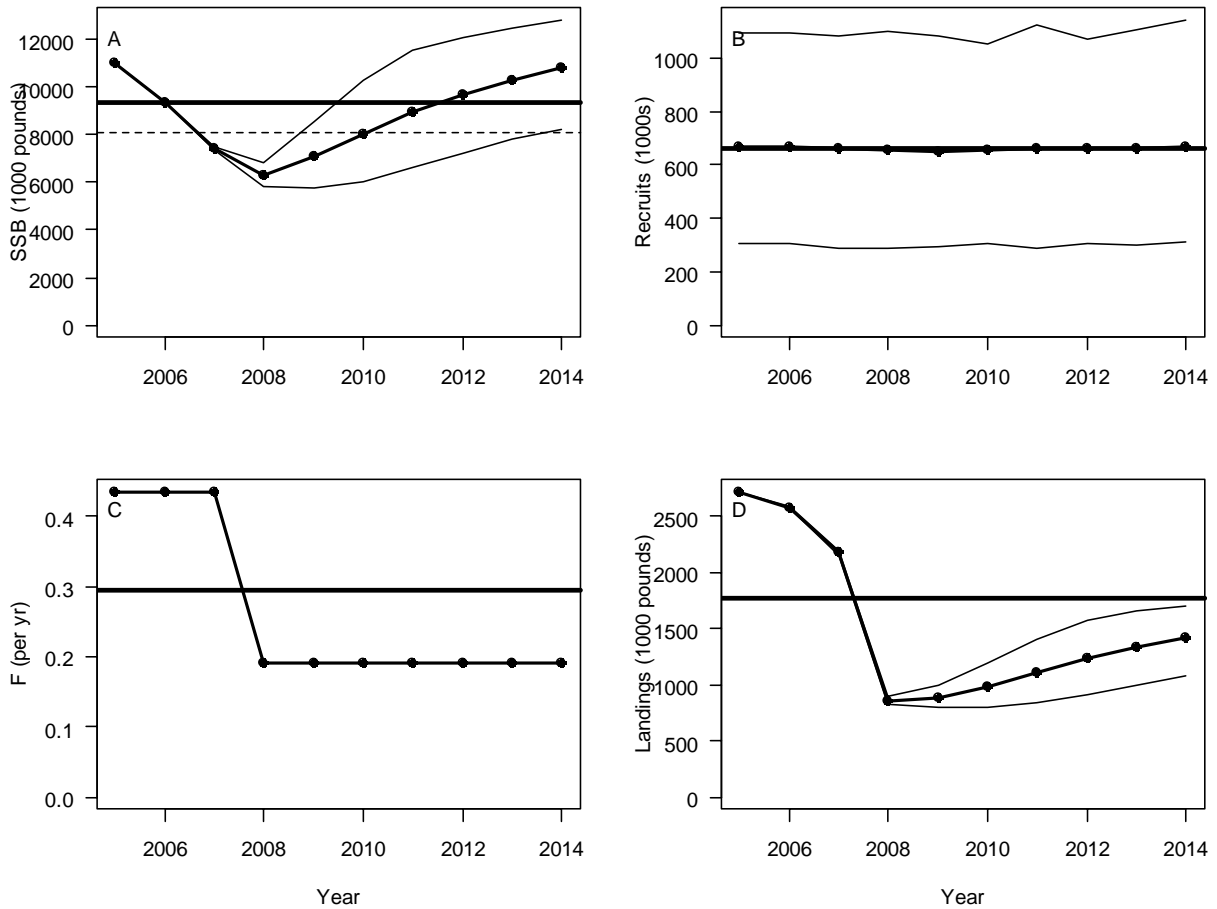
Figure 11. Estimated Beverton-Holt stock-recruitment relationship presented for South Atlantic gag grouper. Two digit year labels represent estimated recruitment values from 1972-2004; Dashed curve is estimated relationship; Solid curve is estimated relationship with lognormal bias correction, from which benchmarks are derived.
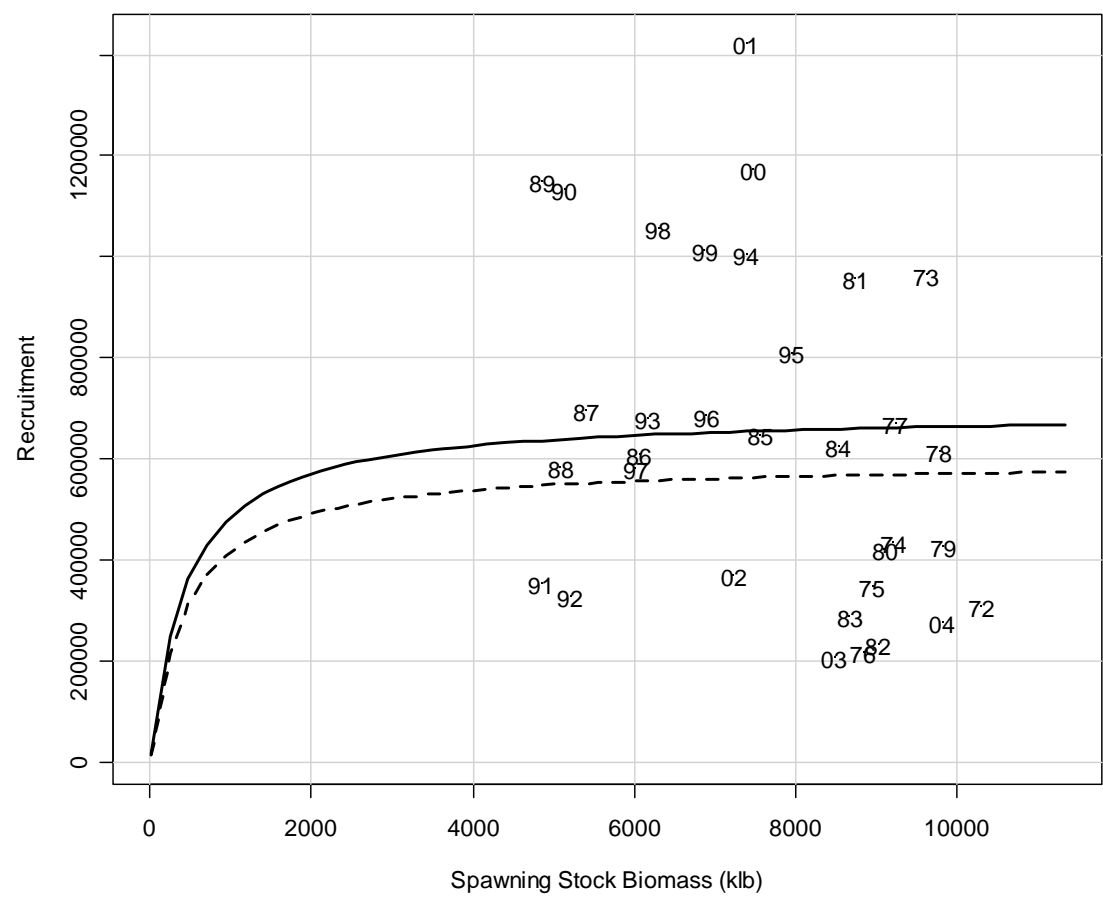
Figure 12. Estimated time series of spawning stock biomass (klb, gutted weight) from the base run model with constant catchability. The base run model with all data included is illustrated with a thick black line. Other runs with the labeled dataset left out of the model are shown in various colors and point markers.
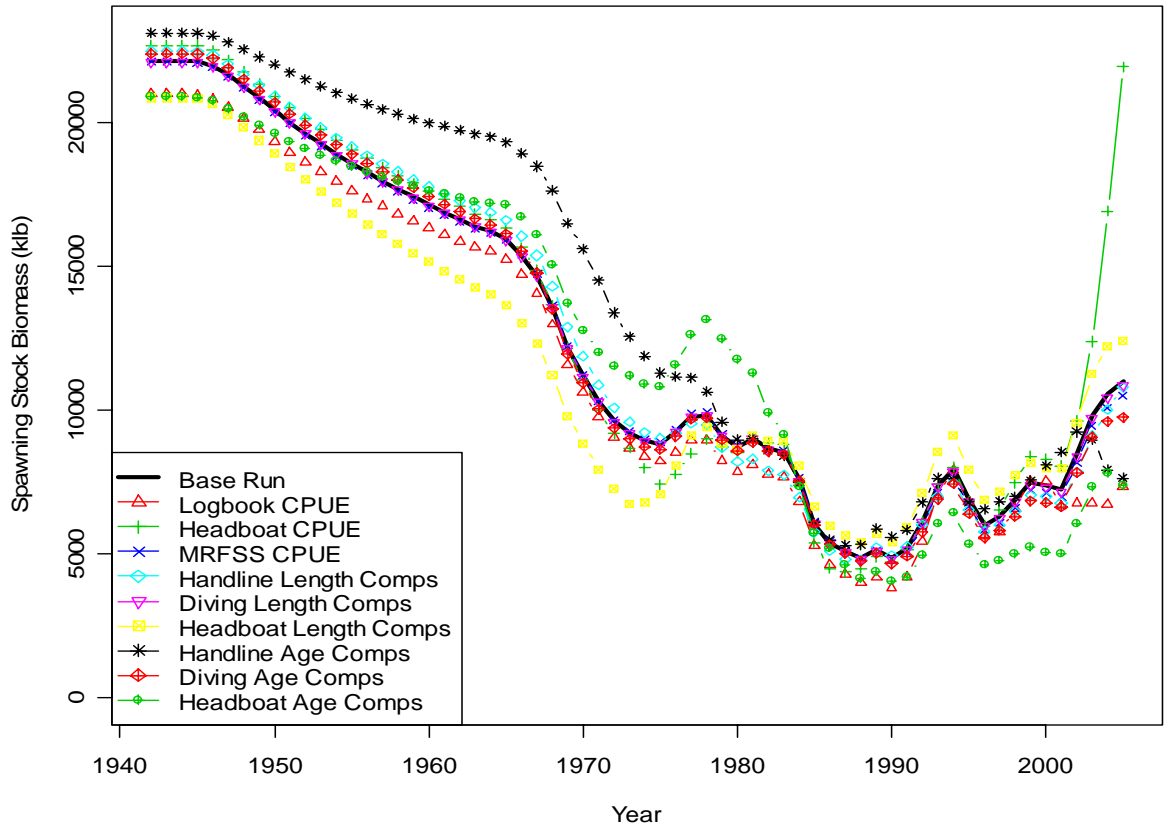
Figure 13. Estimated time series of fishing mortality rate from the base run model with constant catchability. The base run model with all data included is illustrated with a thick black line. Other runs with the labeled dataset left out of the model are shown in various colors
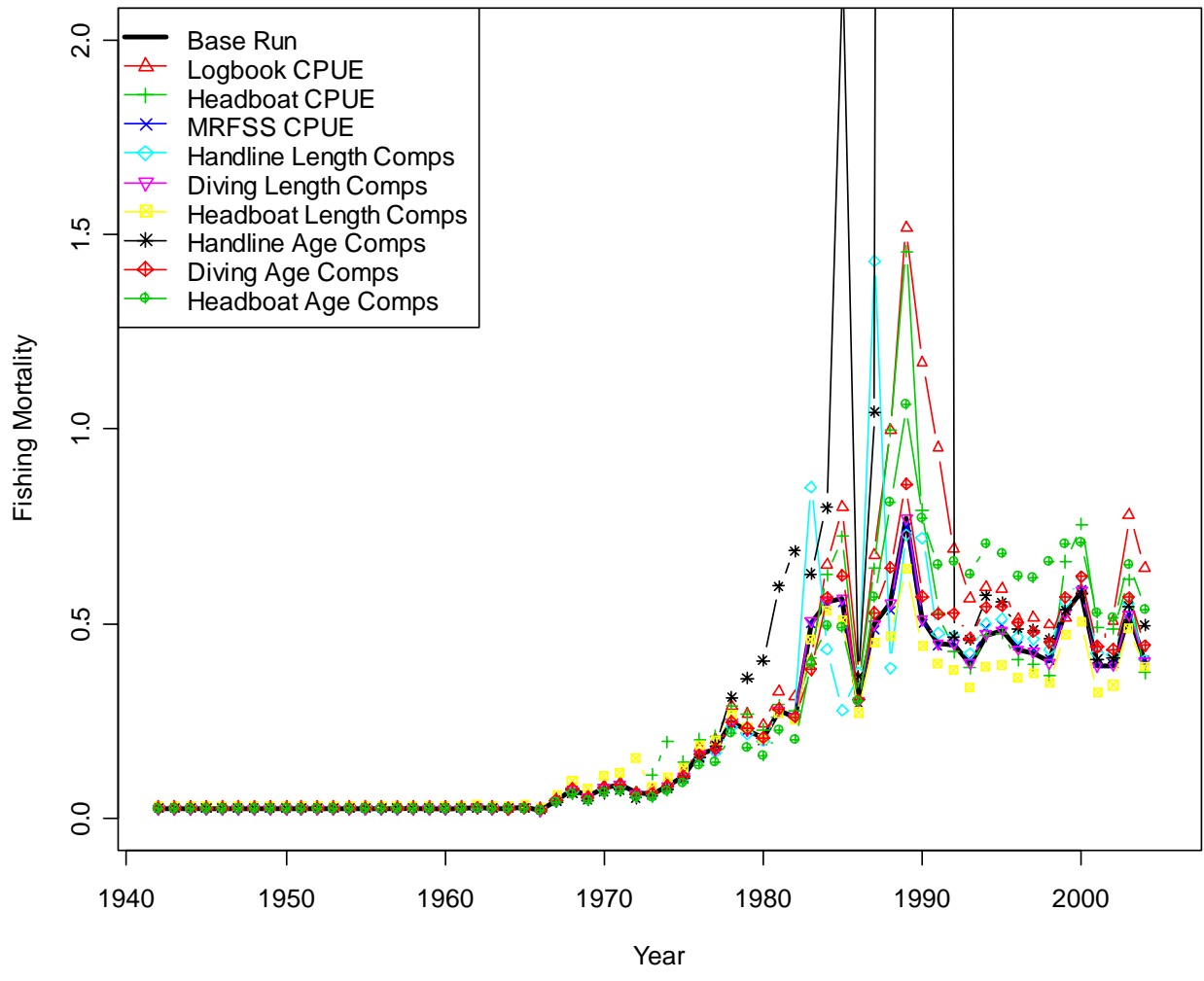
Figure 14.   Estimated time series of recruitment from the base run model with constant
catchability. The base run model with all data included is illustrated with a thick black
line. Other runs with the labeled dataset left out of the model are shown in various colors