

## **SEDAR 10 Review Workshop**

### **Assessment Advisory Report**

#### ***South Atlantic Gag Grouper***

*Reflecting recreational catch correction, February 2007*

#### **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 153,000 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 0.32 in 1983 (above  $F_{MSY} = 0.24$ ; see discussion below). Fishing mortality has remained above  $F_{MSY}$  since then (Table 2 and Figure 3). Fishing mortality in 2004 was estimated as 0.31.

## 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 1980s, continued in declined through the remainder of the 1980s and have apparently been on an increasing trend since the 1990s (Table 2 and Figure 4). In particular, spawning stock biomass declined from 14.6 million pounds (gutted weight) in 1962 to 4.0 million pounds in 1990 (below the current value of  $SSB_{MSY} = 7.9$  million pounds). Spawning stock biomass rose to 7.0 million pounds in 2004 (above the MSST of 6.8 million pounds; Table 2). The 2005 SSB value is estimated to be 7.4 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	6816 klb
MFMT	$F_{MSY}$ Proxy = $F_{30\%SPR}$	0.18	0.21
MSY	Yield at $F_{MSY}$	NA	1238 klb
$F_{OY}$	$F_{45\%SPR}$	NA	0.12
OY	Yield at $F_{OY}$ ( $F_{45\%SPR}$ )	NA	1570 klb
$SSB_{MSY}$	Biomass @ MSY	NA	7925 klb

Proposed Status Criteria	Definition	Value
MSST	$(1-M)SSB_{MSY}$ *(see special comment)	6816 klb
MFMT	$F_{MSY}$	0.24
MSY	Yield at $F_{MSY}$	1238 klb
OY	65% $F_{MSY}$ (Alt. 1) 75% $F_{MSY}$ (Alt. 2) 85% $F_{MSY}$ (Alt. 3)	1188 klb 1217 klb 1230 klb
$F_{OY}$	65% $F_{MSY}$ (Alt. 1) 75% $F_{MSY}$ (Alt. 2) 85% $F_{MSY}$ (Alt. 3)	0.16 0.18 0.20
M (Age-varying)	Constant Equivalent	0.14

## Stock Status

- Current rates of exploitation indicate that overfishing is occurring for the South Atlantic gag grouper stock (Figure 5). Based on the current MFMT, which is an  $F_{MSY}$  proxy of  $F_{30\%SPR}$ ,  $F_{2004}/MFMT = 1.5$ . Exploitation in 2004 relative to  $F_{MSY} = 1.3$ .
- Relative to the current MSST specified by the FMP  $\{(1-M)SSB_{MSY}\}$ , the South Atlantic stock of gag is approaching an overfishing condition (see projections, Figure 6). Relative to the MSST proposed by the RW, the stock is not overfished and is not projected to become overfished.
- 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<sup>1</sup>) and the RW suggests that MSST could be set at this level, operationally, to be re-examined at the next assessment.

<sup>1</sup>*Update Note: Based on the revised assessment including corrected recreational harvest values, the lowest observed SSB changed to 4.0 million pounds, rather than the 5 million pounds estimated originally.*

- **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

### **Report Revision History**

Tables and figures included in this report were revised in February 2007 to reflect updated model results. The South Atlantic gag assessment model was revised to correct an error discovered in the recreational landings component of the model input.

## 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)		Recreational (1000s)		Discards (1000s)		
	Handline	Diving	Headboat	MRFSS	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	17.85		0.02	4.32
1983	1101.1	9.08	16.46	74.82		0.04	91.88
1984	1108.2	18.75	18.69	153.25		0.03	11.95
1985	865.7	11.62	16.13	52.22		3.76	3.09
1986	819.8	6.34	17.35	46.78		4.05	12.48
1987	857.8	21.93	24.09	87.38		5.63	10.30
1988	672.4	12.96	24.21	62.07		5.65	15.01
1989	967.0	22.26	22.42	75.28		5.23	43.41
1990	784.3	19.07	17.59	52.20		4.11	11.46
1991	656.4	85.01	13.55	36.71		3.16	24.19
1992	691.7	106.76	13.94	49.32		7.74	38.66
1993	756.6	78.15	11.80	51.80		6.54	31.23
1994	800.0	97.50	9.81	56.22		5.45	68.29
1995	840.4	83.77	10.54	40.53		5.85	73.97
1996	751.9	118.56	7.50	43.92		4.16	43.00
1997	608.2	98.71	6.85	32.33		3.81	82.41
1998	654.5	138.79	8.67	40.32		4.82	32.22
1999	538.1	113.49	5.34	50.45	7.37	4.80	58.86
2000	438.2	63.02	5.98	29.87	7.77	5.38	126.63
2001	450.1	82.30	5.12	42.74	13.71	4.60	47.41
2002	448.3	84.52	4.58	24.03	11.91	4.12	85.73
2003	443.9	117.41	3.27	46.11	5.10	2.95	137.62
2004	476.4	74.97	6.66	46.25	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 <sub>msy</sub>	F	F/F <sub>msy</sub>	SSB	SSB/SSB <sub>msy</sub>	SPR
1962	0.0217	0.335	0.0346	0.1460	14577	1.839	0.747
1963	0.0200	0.308	0.0324	0.1365	14375	1.814	0.761
1964	0.0197	0.304	0.0313	0.1321	14257	1.799	0.768
1965	0.0219	0.337	0.0331	0.1395	14094	1.778	0.755
1966	0.0181	0.279	0.0272	0.1149	13714	1.730	0.794
1967	0.0405	0.624	0.0552	0.2326	13242	1.671	0.629
1968	0.0651	1.002	0.0861	0.3632	12342	1.557	0.504
1969	0.0462	0.711	0.0646	0.2723	11101	1.401	0.586
1970	0.0615	0.947	0.0910	0.3838	10279	1.297	0.493
1971	0.0643	0.990	0.0992	0.4184	9498	1.198	0.471
1972	0.0485	0.747	0.0749	0.3158	8872	1.120	0.549
1973	0.0413	0.636	0.0733	0.3090	8503	1.073	0.559
1974	0.0519	0.799	0.0953	0.4017	8254	1.042	0.502
1975	0.0513	0.790	0.1267	0.5344	8085	1.020	0.447
1976	0.0647	0.997	0.1934	0.8157	8292	1.046	0.368
1977	0.0695	1.069	0.2155	0.9086	8635	1.090	0.358
1978	0.1188	1.829	0.3251	1.3708	8739	1.103	0.281
1979	0.1078	1.661	0.2956	1.2464	8075	1.019	0.279
1980	0.0953	1.467	0.2636	1.1114	7670	0.968	0.299
1981	0.1352	2.082	0.3539	1.4924	7818	0.986	0.221
1982	0.1063	1.637	0.3282	1.3840	7396	0.933	0.280
1983	0.1506	2.318	0.3867	1.6308	7243	0.914	0.171
1984	0.2855	4.396	0.6640	2.7999	6792	0.857	0.106
1985	0.1746	2.689	0.7424	3.1303	5269	0.665	0.187
1986	0.1756	2.704	0.3566	1.5039	4601	0.581	0.157
1987	0.2021	3.111	0.6809	2.8711	4354	0.549	0.132
1988	0.1498	2.306	0.9333	3.9356	4100	0.517	0.169
1989	0.1996	3.074	1.2012	5.0650	4287	0.541	0.121
1990	0.1684	2.593	0.8273	3.4884	4015	0.507	0.149
1991	0.1183	1.822	0.6567	2.7689	4133	0.522	0.179
1992	0.1285	1.978	0.4836	2.0393	4742	0.598	0.172
1993	0.1597	2.459	0.4518	1.9050	5549	0.700	0.174
1994	0.1979	3.047	0.4905	2.0685	5777	0.729	0.153
1995	0.1746	2.689	0.4634	1.9539	5091	0.642	0.163
1996	0.1518	2.337	0.4592	1.9363	4581	0.578	0.172
1997	0.1158	1.784	0.4038	1.7028	4562	0.576	0.197
1998	0.1450	2.232	0.4704	1.9833	4979	0.628	0.182
1999	0.1529	2.355	0.4947	2.0862	5076	0.641	0.176
2000	0.0946	1.457	0.3560	1.5011	4862	0.614	0.220
2001	0.1030	1.586	0.3554	1.4985	5153	0.650	0.221
2002	0.0749	1.153	0.2899	1.2224	5597	0.706	0.271
2003	0.0841	1.295	0.3471	1.4635	6368	0.804	0.232
2004	0.0992	1.527	0.3105	1.3091	7058	0.891	0.244
2005	.	.	.	.	7468	0.942	.

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

	<b>Fcurrent</b>	<b>Fmsy</b>	<b>85% Fmsy</b>	<b>75% Fmsy</b>	<b>65% Fmsy</b>
SSB (2005) (klb)	7468	7468	7468	7468	7468
SSB (2007) (klb)	6062	6062	6062	6062	6062
SSB (2010) (klb)	5660	6206	6478	6667	6863
SSB (2014) (klb)	6008	7227	7908	8413	8965
Landings (2005) (klb)	1462	1462	1462	1462	1462
Landings (2007) (klb)	1299	1299	1299	1299	1299
Landings (2010) (klb)	1079	925	836	768	693
Landings (2014) (klb)	1183	1125	1070	1020	956
Discards (2005) (klb)	108	108	108	108	108
Discards (2007) (klb)	99	99	99	99	99
Discards (2010) (klb)	135	105	91	81	71
Discards (2014) (klb)	134	105	91	82	72

Figure 1. Commercial gag grouper landings (gutted weight in pounds) by gear from the U.S. South Atlantic, 1962-2004.

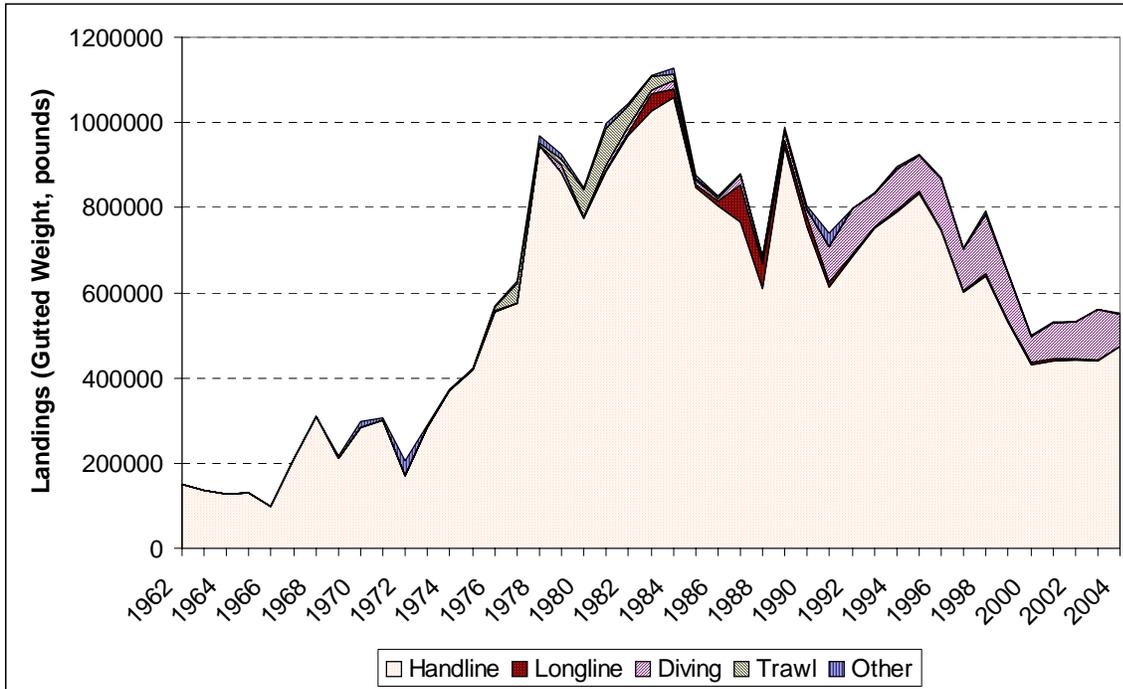


Figure 2. Total gag grouper catches (landings and discards) in numbers by sector from the U.S. South Atlantic, 1962-2004.

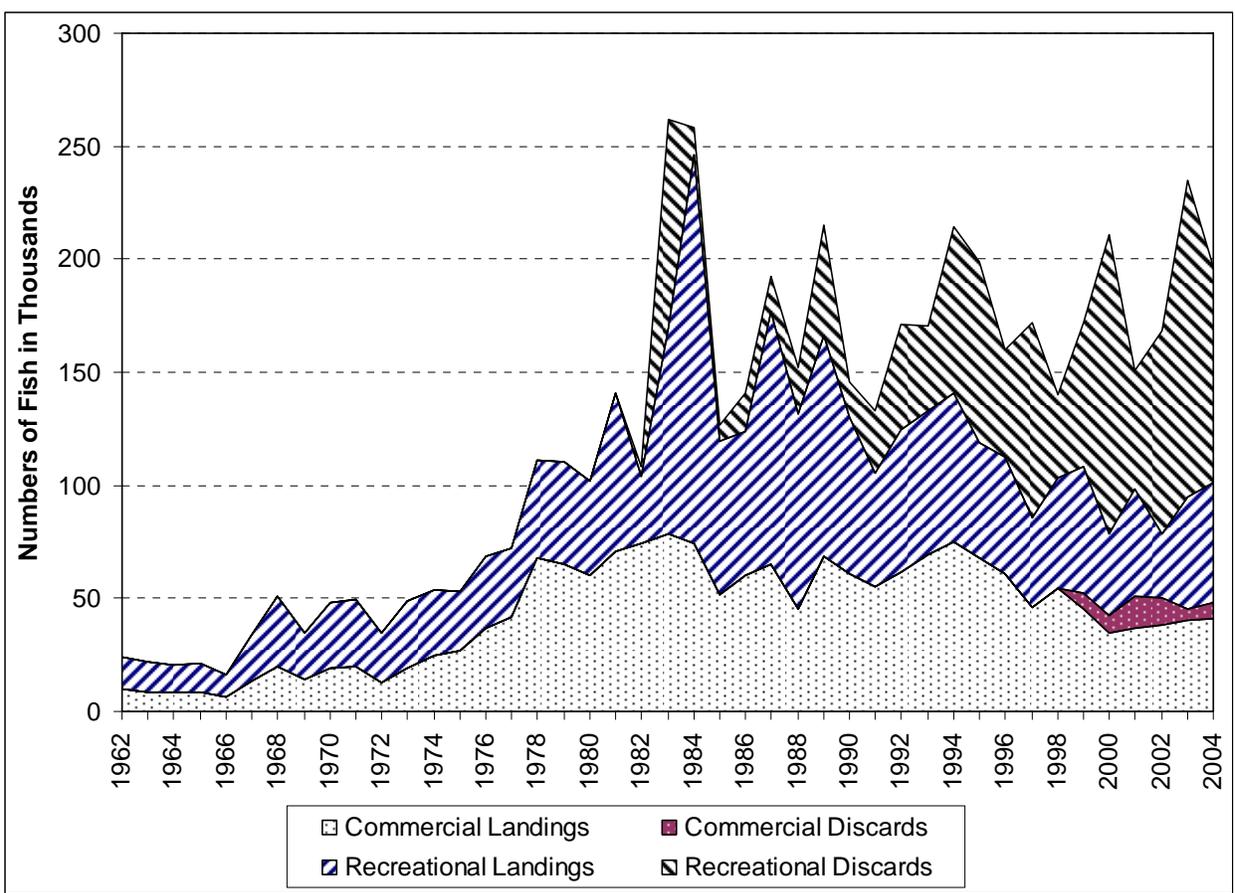


Figure 3. Estimated fully-selected fishing mortality rate. Solid horizontal line represents  $F_{MSY}$ .



Figure 4. Estimated biomass time series (biomass in gutted weight). Total biomass (TOP) and spawning stock biomass (male mature biomass + female mature biomass, Bottom). The horizontal lines represents the level of biomass corresponding to MSY ( $B_{MSY}$  and  $SSB_{MSY}$ ).

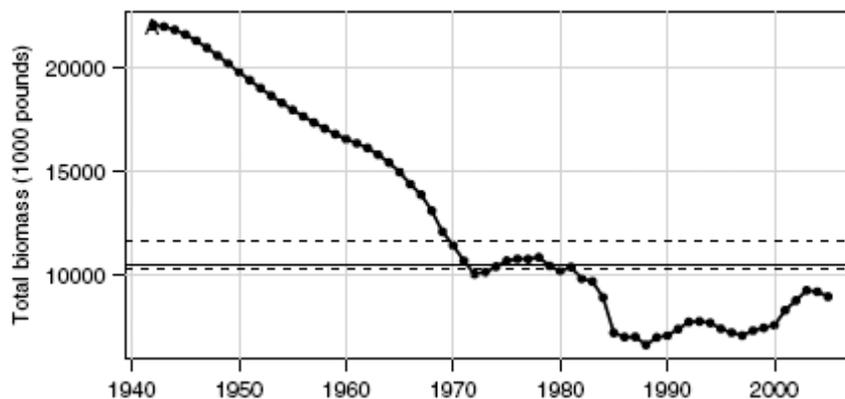


Figure 5. Phase plot of recent estimates of spawning stock biomass (klb, gutted weight) and fishing mortality rate. Solid lines correspond to MSY levels; vertical dashed line corresponds to MSST, defined as  $(1-M)SSB_{MSY}$ ; and the vertical dotted line corresponds to the RW recommendation for an operational MSST.

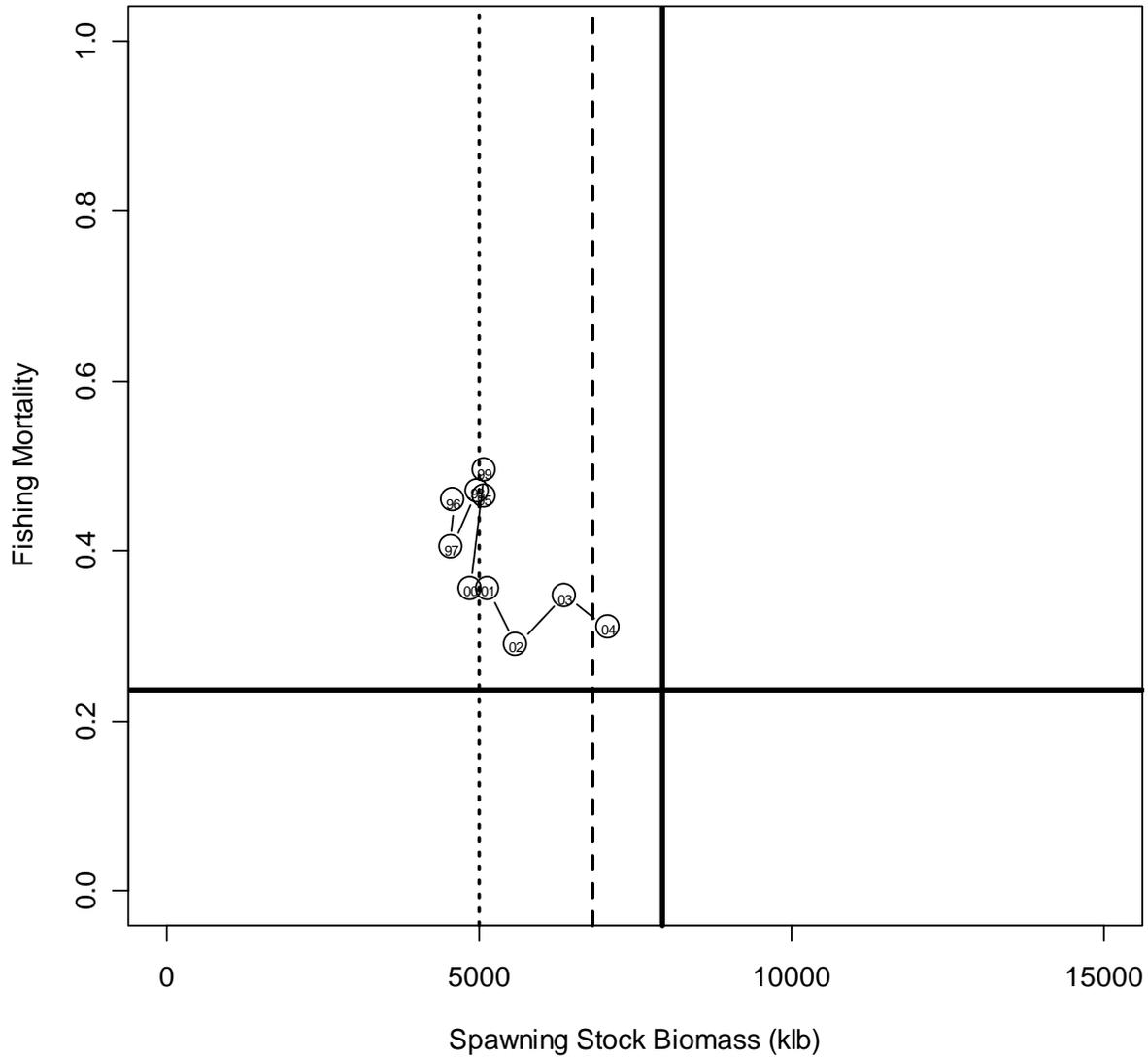


Figure 6. Projections under current fishing mortality rate for all years. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line is  $SSB_{MSY}$  and dashed 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.

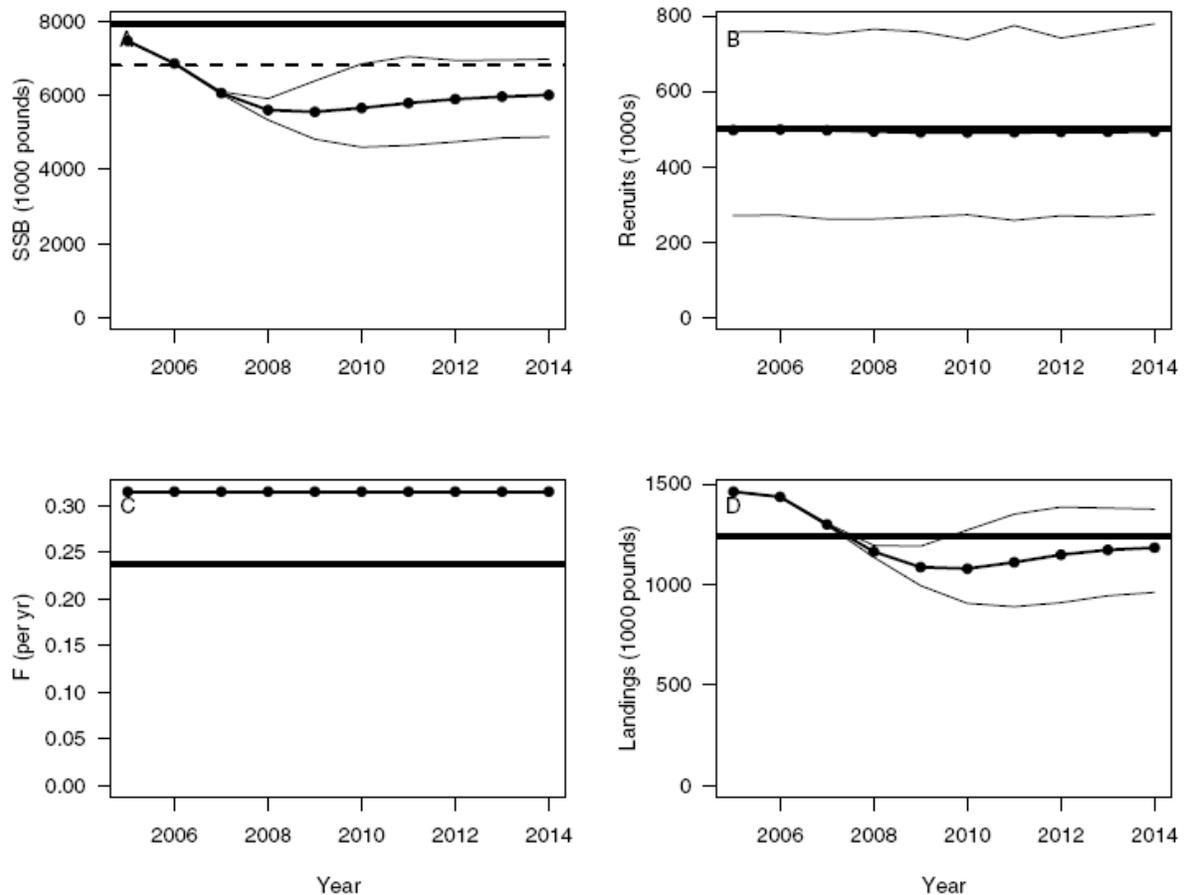


Figure 7. Projections under current fishing mortality rate in 2005-2007 and  $F_{MSY}$  in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid line 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.

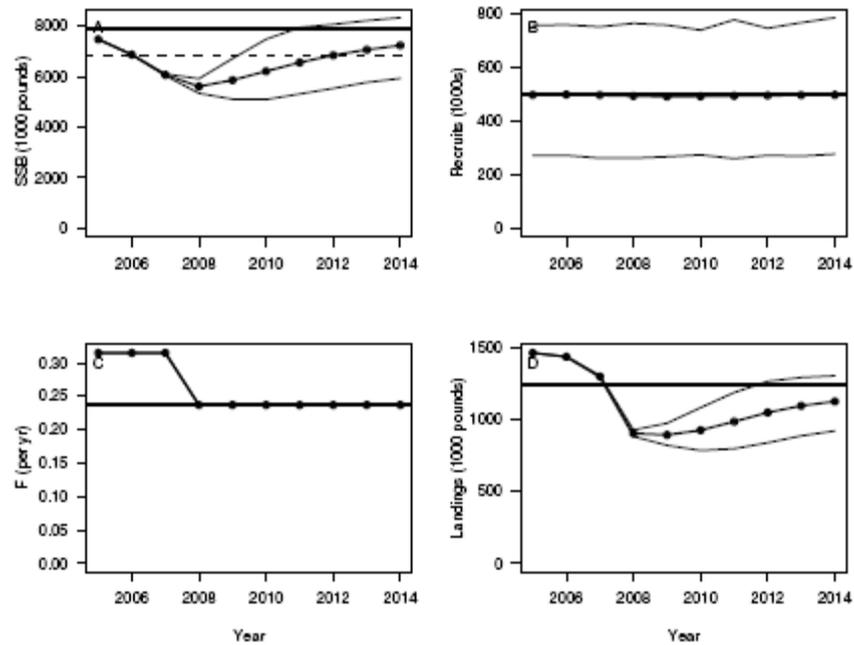


Figure 8. Projections under current fishing mortality rate in 2005-2007 and 85% of  $F_{MSY}$  in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid 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  $MSY$ .

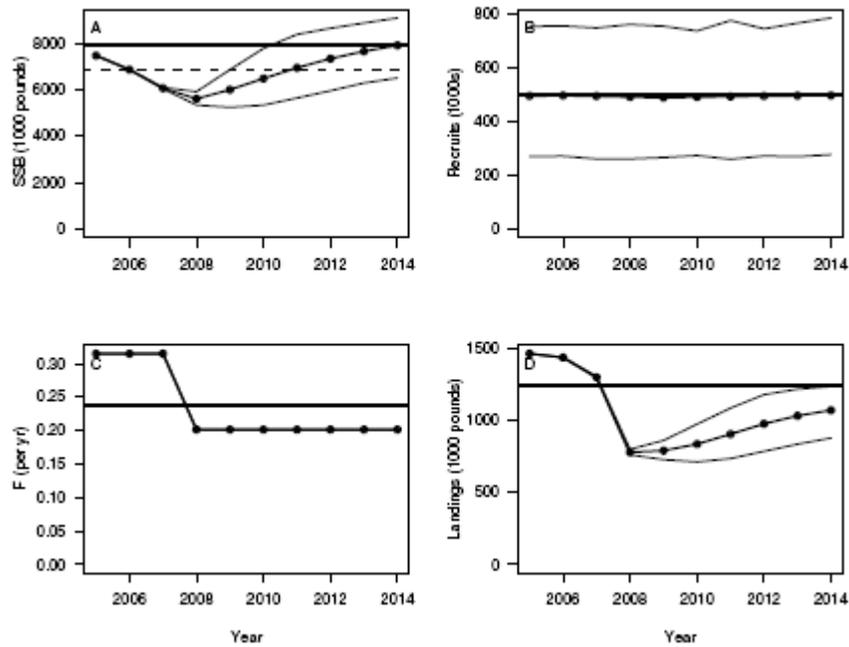


Figure 9. Projections under current fishing mortality rate in 2005-2007 and 75% of  $F_{MSY}$  in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal solid 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.

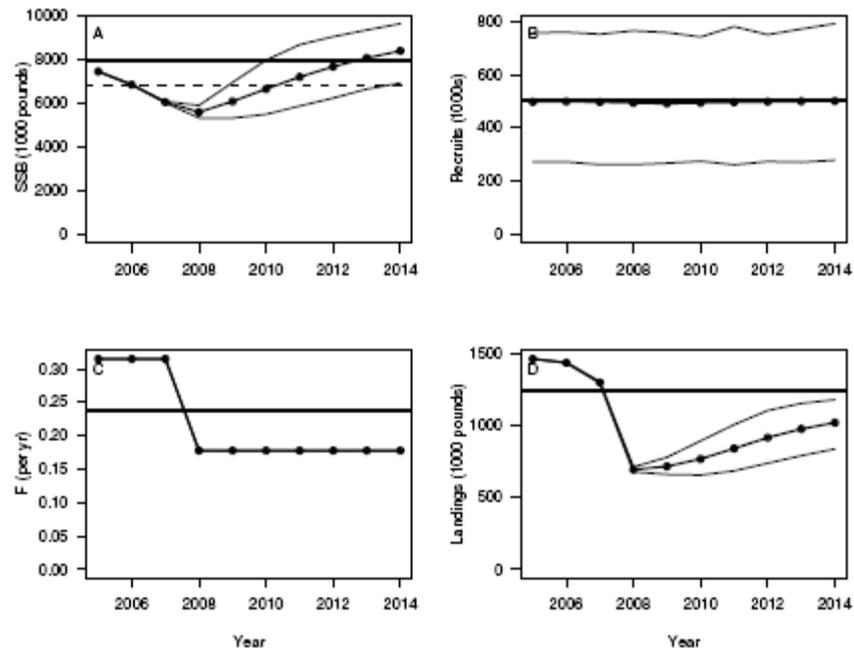


Figure 10. Projections under current fishing mortality rate in 2005-2007 and 65% of  $F_{MSY}$  in 2008-2014. Expected values represented by solid lines with circles, and uncertainty represented by thin lines corresponding to 10th and 90th percentiles of 1000 bootstrap replicates. A) SSB, horizontal 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.

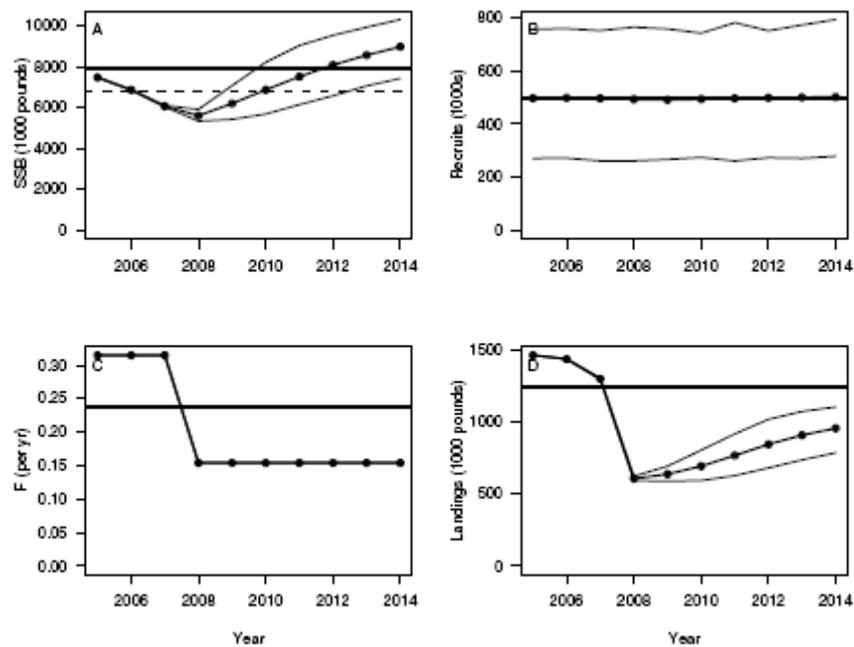


Figure 11. Estimated Beverton-Holt stock-recruitment relationship presented for South Atlantic gag grouper. Dashed curve is estimated relationship; Solid curve is estimated relationship with lognormal bias correction, from which benchmarks are derived.

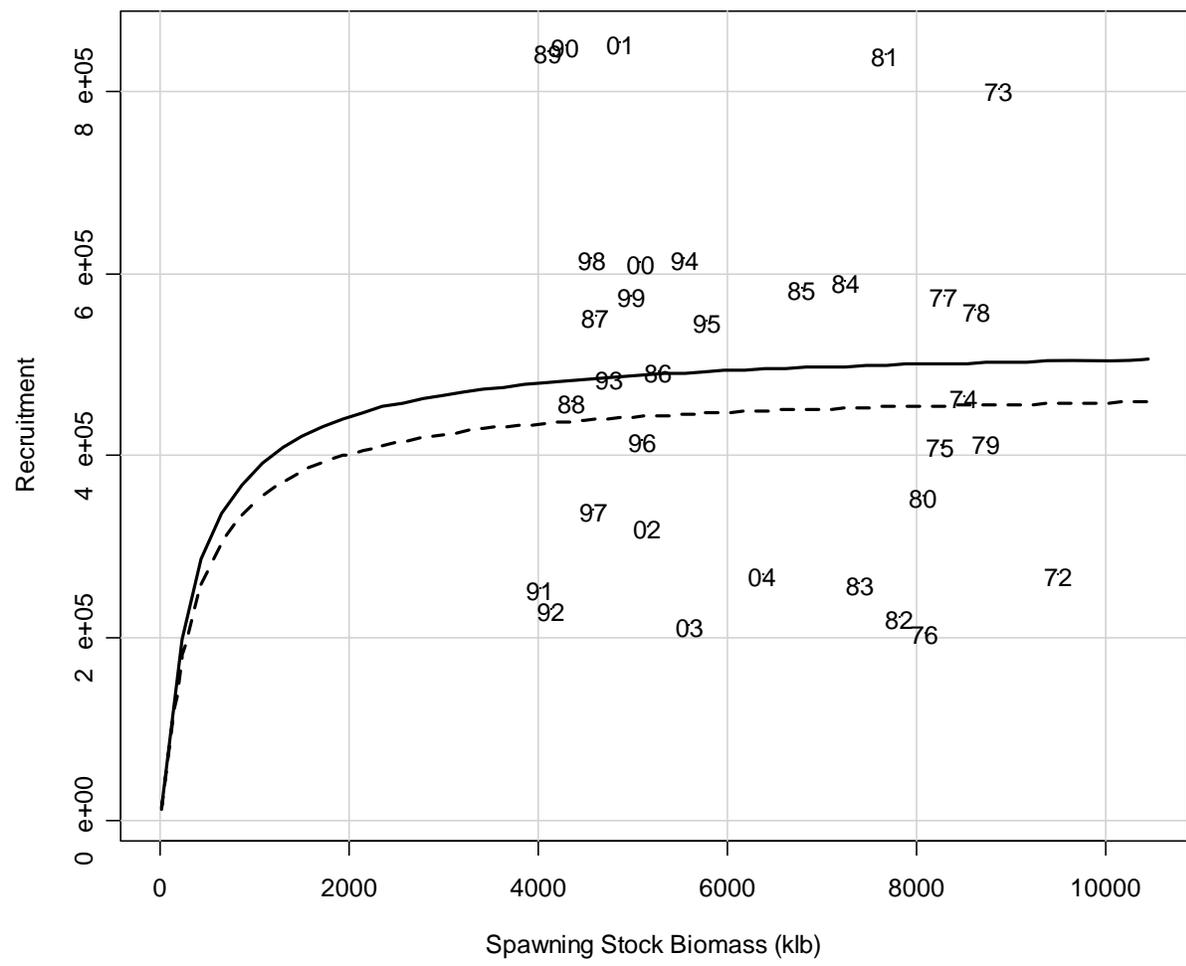




Figure 13. Estimated time series of fishing mortality rate from the base run model with constant catchability. The base run model with all data included is illustrated with a thick black line. Other runs with the labeled dataset left out of the model are shown in various colors and point markers.

*Note: The time series of estimates for several of these sensitivities, notably logbook CPUE, handline age comp, and diving age comp changed considerably following the recreational data correction. In the original analyses these data series were less divergent from the others during the mid 1970's and mid 1990's.*

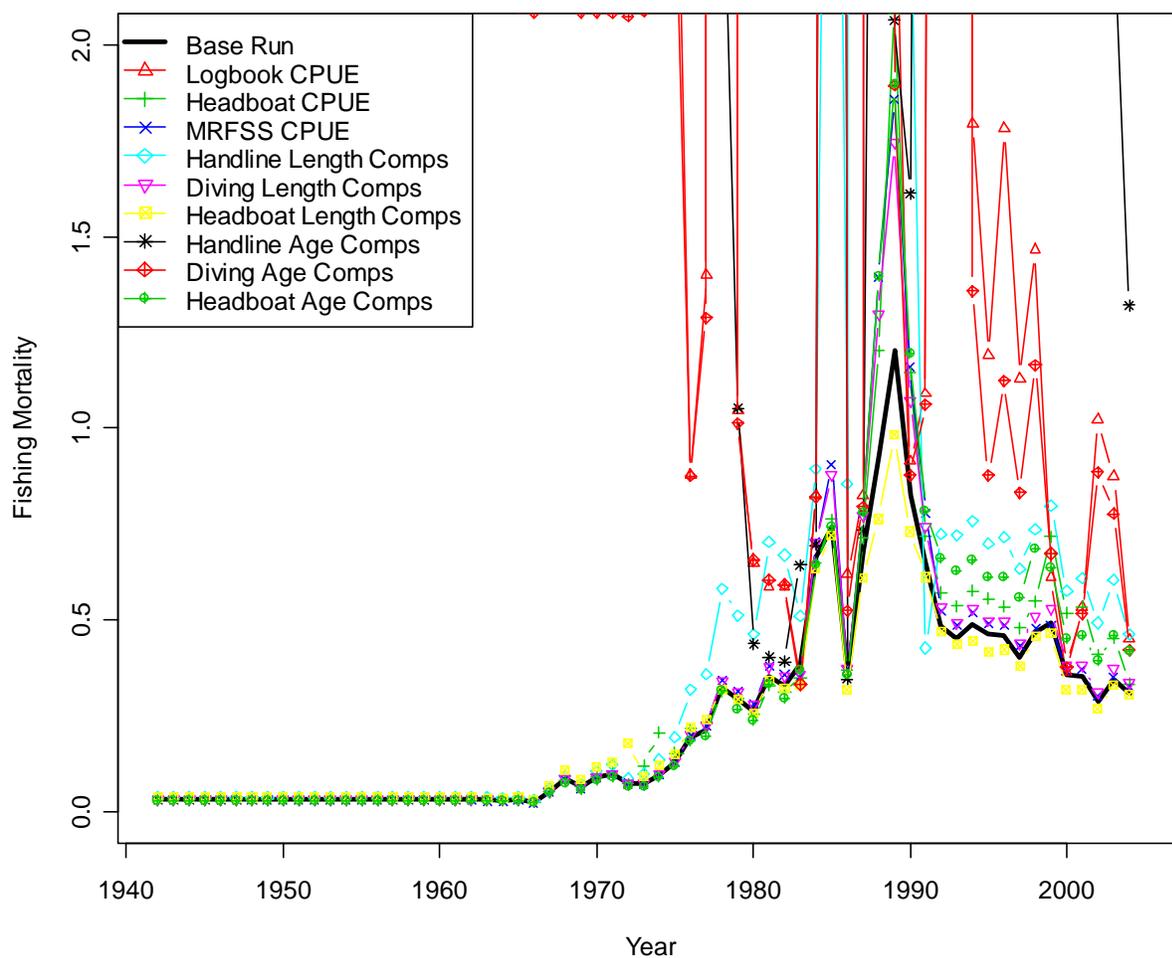


Figure 14. Estimated time series of recruitment from the base run model with constant catchability. The base run model with all data included is illustrated with a thick black line. Other runs with the labeled dataset left out of the model are shown in various colors and point markers.

*Note: The time series of estimates for several of these sensitivities, notably logbook CPUE, handline age comp, and diving age comp changed considerably following the recreational data correction. The large recruitment spikes in the mid-1960's did not appear in the original analyses.*

