Stock Assessment of Gag in the Gulf of Mexico: SEDAR Update Assessment Rerun

Southeast Fishery Science Center

SEDAR33-RD09

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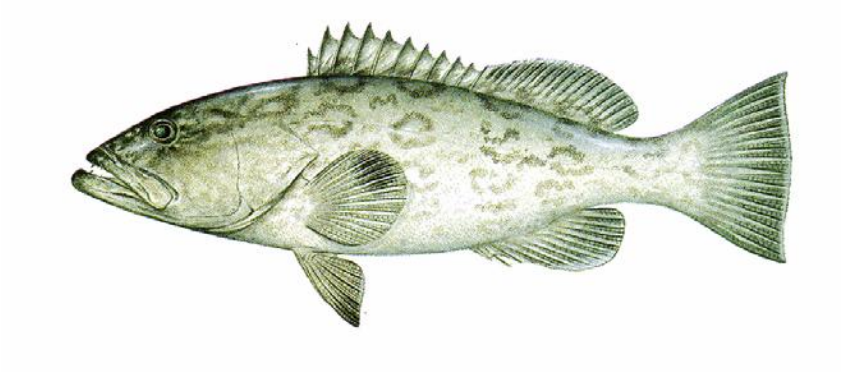
— SEDAR Update Assessment Rerun —



Report of Assessment Rerun Webinars

December 6-9, 2010

Introduction

A re-run of the 2009 SEDAR Assessment Update of gag (*Mycteroperca microlepis*) within US waters of the Gulf of Mexico was accomplished through webinars conducted during December 6-9, 2010 under the auspices of the Gulf of Mexico Fishery Management Council , the NMFS Southeast Fisheries Science Center, and the SEDAR process.

This update assessment rerun is intended to update only those population and status measures identified at the August 2010 Gulf Council meeting, i.e., size distribution of released fish in the recreational fishery, and discard rate and mortality of released fish in the commercial fishery based on observer data. It is not the intent of this update assessment rerun to resolve any critical issues identified in the initial SEDAR 10 assessment or the 2009 assessment update, other than those described in items 1 and 2 of the terms of reference.

Terms of Reference

1. Review the estimates of size distribution and abundance of released gag in the recreational private, charter boat, and headboat fisheries. Document any changes from the 2009 gag assessment update and the reason for such changes. Determine which estimates represent the best available scientific information to use in the reassessment.
2. Evaluate estimates of discards and discard mortality from commercial fisheries based on observer data, and compare with estimates from the SEDAR 10 2009 gag assessment update methodology. Determine which estimates represent the best available scientific information to use in the reassessment.
3. Rerun the 2009 gag assessment update model that was selected by the SSC to use for management decisions. This is the "red tide" model with increasing catchability, which is based on the approved SEDAR 10 gag model base configuration, forward projection catch-age model using CASAL. Use data through 2009.
4. Document any changes or corrections made to input datasets and tabulate complete updated input datasets. Provide tables of commercial and recreational landings and discard in pounds gutted weight. Clarify units of measurement in all tables.
5. Estimate and provide complete updated tables of stock parameters (Table 1).
6. Evaluate future stock status for 2010-2016 under the following conditions:
    a. $F_{current}$
    b. F_{max} (proxy for F_{MSY})
    c. $F_{rebuild}$ (rebuilding period 2011 – 2020)
    d. F_{OY} (75% of F_{max})
7. Develop a stock assessment workshop report to fully document changes to the input data, methods, and results of the stock update re-assessment.

Council requests reporting of both commercial and recreational landings in pounds gutted weight.

Update Assessment Workshop Participants

Assessment Panel

Luiz Barbieri, Chair ..... GMFMC SSC
Harry Blanchet ..... GMFMC SSC
Bill Lindberg..... GMFMC SSC
Russell Nelson ..... GMFMC Reef Fish AP

Analytical team

Brian Linton..... NMFS SEFSC Miami
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Appointed Observers

Kay Williams..... GMFMC member

Observers

Nick Farmer.....SERO
Dennis O'Hern..... GMFMC Reef Fish AP
Claudia Friess .....Ocean Conservancy
Chad Hanson .....Pew Environmental Group

Staff

Steven Atran ..... GMFMC
Julie Neer .....SEDAR
Clay Porch ..... NMFS SEFSC Miami
Steve Turner..... NMFS SEFSC Miami
Kevin McCarthy..... NMFS SEFSC Miami

Methods

The 2010 rerun of the Gulf of Mexico (GOM) gag assessment update used the red tide model with increasing catchability and associated data described in the Gag 2009 Assessment Update Report, except where otherwise noted in this report.

Data Inputs

Recreational Discard Size Composition

In the original 2009 assessment update, size data from the NMFS Beaufort Headboat Survey, MRFSS, TIP, and a Mote Marine Laboratory tagging study were used to generate the size composition of discarded fish from the recreational sector. In addition, the assessment panel (AP) decided to use discard size data from the Headboat Observer Program for headboat mode discards from the second half of 2000 through 2008 (i.e., the time period with the 22" minimum size limit). While the Mote tagging data include size data from discarded fish, the Headboat Survey, MRFSS, and TIP data only include size data from sublegal landed fish. The inclusion of sublegal landed fish led to peaks in the discard size distributions near the minimum size limit (Figures 1-3). These peaks were particularly noticeable in the charter and private modes from 2006 to 2008, after the last year of Mote data.

Since the 2009 assessment update, it was discovered that two additional years of Mote tagging data from 2006 and 2007 were available at the time of the update. Therefore, the AP decided to include these additional years of Mote data in the 2010 rerun of the assessment update, because these data should have been included in the original update.

For the 2010 rerun of the assessment update, the AP decided to exclude the Headboat Survey, MRFSS, and TIP data from 1990 (i.e., the year of the first minimum size limit) to 2008, because the size distribution of sublegal landed fish was concentrated near the minimum size limit, and was not representative of the full size range of discarded fish. This decision left only the Mote tagging data and headboat observer data from which to generate discard size distributions for 1990 to 2008. Mote tagging data sample sizes were small for the charter mode from 2000-2008. Therefore, the AP decided to use the headboat observer data for the charter mode discards from 2000-2008. This decision seemed reasonable based on a comparison of discard size distributions from headboat and charter observer data from 2009 and 2010, the only years where data were available for comparison (Figure 4). For charter mode discards, size samples were bootstrapped from the headboat observer data with a sample size of 1,160 fish (i.e., the average annual sample size from the headboat observer data) from the second half of 2000 to 2008. This approach is in keeping with how the headboat observer data were used in the 2009 assessment update for the headboat mode for years between 2000 and 2008, which did not have headboat observer data. The bootstrapping produces an "average" discard size distribution from the years in which observer data are available. For the private mode, Mote tagging data sample sizes were large enough to use only Mote data from 1990 to 2008. For years in which sample sizes were too small (i.e., less than 75 fish for a given year and mode), size data were pooled across adjacent years with small sample sizes, or data were substituted from adjacent years with adequate sample sizes. This approach to dealing with small sample

sizes is in keeping with what was done in SEDAR 10 and the 2009 assessment update. The recreational discard size compositions for the 2010 rerun are presented in Figures 5-7.

Commercial Discard Numbers

In the original 2009 assessment update, all commercial discards were assumed to be due to the minimum size limit. Commercial discard numbers were calculated using TIP commercial size data (Table 1, Figure 8). Data from 1984 to 1989 (i.e., the time period prior to the first minimum size limit) were used to calculate the ratio of fish less than 20" (i.e., the 1990 minimum size limit) to fish greater than 20", and the ratio of fish less than 24" (i.e., the 2000 minimum size limit) to fish greater than 24". These ratios were then applied to the landings above the size limits, for the time periods where the minimum size limits were in effect, to estimate the number of fish below the size limits. The sublegal landed fish were subtracted from the fish below the size limits to get the estimated number of discarded fish. This approach replicates the method used in SEDAR 10 to estimate commercial discard numbers. The underlying assumption of this approach is that, except for changes to the minimum size limit, the fishery has not changed substantially from 1984 to the present day. That assumption likely is not true given other changes over time in regulations and in the economic market.

In the 2010 rerun of the assessment update, GOM gag grouper yearly discards from commercial fishing vessels were calculated using a ratio estimator of discards per unit effort:total effort. GOM reef fish and shark bottom longline observer data were used to calculate gag grouper discard rates from commercial vertical line (handline and electric reel/bandit rig) and bottom longline vessels. The reef fish observer program data set included trips by vessels with reef fish and directed shark permits. The shark bottom longline observer data included only trips by bottom longline vessels with directed shark permits, although those vessels may also have had reef fish permits. Those trips by bottom longline vessels with directed shark permits in the reef fish observer data set were combined with the shark bottom longline data for discard rate calculation. Discard rates were calculated for each of the gear and permit categories: vertical line vessels with reef fish permits, bottom longline vessels with reef fish permits, and bottom longline vessels with directed shark permits.

Only two years of observer data were available from the reef fish observer program (2007-08); three years of shark bottom longline observer data (2006-08) were used in the calculations. Trip selection prior to 2006 in the shark bottom longline observer program differed from the selection procedure used from 2006 to present; therefore, data from the years prior to 2006 were excluded. The gag grouper assessment update included data through 2008; consequently, discards were not calculated for more recent years. In addition to limiting the available shark observer data to the years 2006-08, both observer data sets were filtered to remove a small

number of trips that had not been randomly selected, e.g., those trips specifically selected because the trip was targeting deep water species.

Total fishing effort of commercial vertical line and longline vessels in the GOM was available in the coastal logbook program data base for the years 1990-2008. Those data were filtered to remove trips with fishing reported in multiple regions (e.g., fishing in both the GOM and South Atlantic on a single trip) because effort reported from an individual trip cannot be apportioned among regions. Clearly erroneous data or trips with effort data outside the 99.5 percentile of the data set were also excluded from the calculations. Total filtered logbook effort was summed separately for each permit category: directed shark and reef fish. No permit data were available for the years prior to 1995 and a small percentage (<5%) of trips that reported to the logbook program each year did not have permit data.

Effort reported from bottom longline vessels with unknown permit status was assigned to a permit category based upon a ratio of reef fish permitted to shark permitted bottom longline effort during 1995-96 (for years prior to 1995) or during a specific year (1995-2008). All vertical line vessels were assumed to have had reef fish permits.

Discard rate was calculated as the number of discards per hook hour (vertical line) or hooks fished (longline). Preliminary calculations indicated that discard rates differed between the eastern and western GOM, therefore, two regions were defined in the GOM: east (statistical areas 1-8) and west (areas 9-21). Longline effort could not be defined as hook hours fished because of inconsistent reporting of hours fished on longline trips to the coastal logbook program. Discard rates were highly variable among years (e.g., vertical line vessel discard rates in the western GOM were 0.0015 discards/hook hour in 2007, but were 0.000013 discards/hook hour in 2008) resulting in large differences in yearly calculated discards. Such variability may have resulted from limited observer coverage (observers sample <1 to approximately 4% of total reef fish effort) rather than fluctuation in recruitment, as such variability may be interpreted by the assessment model. The decision was made to use mean discard rates across years for each gear, permit type (reef fish and directed shark), and region combination for calculating total discards.

Total discards were calculated as the mean discard rate within a gear/permit/region stratum x yearly total effort reported to the coastal logbook program within the corresponding gear/permit/region stratum. Yearly total discards were calculated as the sum of the discards across strata. A 20 percent sample of Florida commercial vessels with federal fishing permits were selected to report to the coastal logbook program during the years 1990-1992. All vessels in other states, and in Florida beginning in 1993, were required to report landings and effort data to the logbook program. To calculated discards prior to 1993, effort reported by vessels landing catch in Florida was expanded by a factor of five.

To account for the change in minimum size limit, which occurred in mid-2000, the TIP data were used to calculate the proportion of fish below 24" (i.e., the 2000 size limit) that were below 20" (i.e., the 1990 size limit). This proportion was applied to the commercial discard numbers for 1990 through 1999.

The revised commercial discard numbers used in the 2010 rerun of the assessment update are presented in Table 1 and Figure 8.

Assessment Models

The AP chose to explore two alternative model runs for the 2010 re-run of the GOM gag assessment update.

Run 1

Run 1 was identical to the red tide model with increasing catchability from the 2009 assessment update, except that the new recreational discard size compositions—i.e., no sublegal landed fish and headboat observer data used for charter mode, 2000 to 2008—were used.

Run 2

Run 2 was identical to Run 1, except that the new commercial discard numbers—i.e., based on commercial observer data—were used.

The AP selected Run 2 as their preferred assessment model run. Run 1 and Run 2 differ only in the commercial discard number estimates used. Though the AP recognizes that both approaches to estimating commercial discard numbers have their drawbacks, the AP felt that the commercial discard numbers for Run 2 were preferable to those used in Run 1, because the Run 2 numbers are based on actual at-sea measurements of discarded fish by trained observers. Therefore, all projection runs and benchmark calculations were made using Run 2.

Projections

Projections were run for the period 2009-2016 using Run 2 under several fixed F scenarios, which included: $F_{CURRENT}$ (i.e., geometric mean F from 2005 to 2007), F_{MAX} (i.e., proxy for F_{MSY}), F_{OY} (i.e., 75% of F_{MAX}), $F_{REBUILD}$ to SSB_{MAX}, and $F_{REBUILD}$ to SSB_{OY}. The methods employed were the same as those used in the March 2010 projection runs, except where stated otherwise in this report.

Commercial and recreational landings were incomplete for 2010, and had to be estimated using the best available data. For MRFSS landings, the average ratio of wave 1-4 landings to wave 1-6 landings from 2006-2009 was calculated. Landings data prior to 2006 were not used to calculate the average ratio, because of the fishery closures in 2005. This average ratio was

applied to the 2010 wave 1-4 landings from the ACL data set. For headboat and Texas landings, the ratio of MRFSS 2010 landings to MRFSS 2009 landings was calculated, and that ratio was applied to 2009 landings for headboat and Texas. Based on this approach, 2010 recreational landings of GOM gag were estimated to be 1.62 million pounds gutted weight.

For commercial landings, the average ratio of Jan-Nov landings to Jan-Dec landings from 2006-2009 was calculated. This average ratio was applied to SERO's estimate of 2010 landings from their IFQ monitoring program as of December 14, 2010. Based on this approach, 2010 commercial landings of GOM gag were estimated to be 0.48 million pounds gutted weight.

Summary Results

The AP reviewed the revised commercial discard size compositions. They noted that the commercial discard size data come entirely from TIP, and therefore only includes sublegal landed fish. As expected, the commercial discard size distributions were concentrated just below the minimum size limits. The AP recommends that this problem be explored at the next full assessment for Gulf of Mexico gag. In particular, discard size data from the commercial observer program should be evaluated for use in the next assessment.

Update re-run results (i.e., model fits, pattern of residuals, estimated biomass, fishing mortality, and recruitment trajectories) were very similar to the 2009 update assessment.

Trends in predicted SSB/MSST and F/MFMT (Fig. 15) were also similar to trends observed in the 2009 update assessment. Required SFA and MSRA evaluation metrics as well as rebuilding yield (i.e., annual yield at $F_{rebuild}$) for the period 2011-2016 are listed on Table 8.

Values of projected total biomass, spawning stock biomass, fishable biomass, and apical F for alternative model run 2 (the preferred model run selected by the AP) as well as projected yield streams are presented on Tables 6 and 7 and Figs. 16 and 17.

Tables

Table 1. Estimated commercial handline and longline discards in numbers for Gulf of Mexico gag. The 2009 assessment update values were calculated using TIP commercial size data. The 2010 rerun numbers were calculated using commercial observer data.

	2009 Update		2010 Rerun	
Year	Handline	Longline	Handline	Longline
1990	0	724	18,022	126
1991	0	586	28,872	229
1992	0	706	22,747	141
1993	0	583	20,959	119
1994	0	509	26,747	148
1995	0	542	24,701	126
1996	0	569	24,247	135
1997	0	598	22,857	157
1998	0	844	21,981	146
1999	0	707	23,895	171
2000	2,124	2,022	97,613	778
2001	5,351	5,710	84,731	785
2002	4,736	5,882	93,866	688
2003	3,356	6,857	96,811	748
2004	4,392	7,212	91,052	726
2005	3,096	6,842	105,446	550
2006	1,806	3,192	111,450	657
2007	1,769	2,926	120,881	595
2008	1,944	1,976	110,168	618

Table 2. Predicted total biomass, spawning stock biomass, total numbers, age-1 recruits, and fishing mortality rates from the Gulf of Mexico gag 2009 update assessment. Total biomass and spawning stock biomass are reported in thousand pounds gutted weight. Total numbers and age-1 recruits are reported in numbers.

Year	Total Biomass	Spawning Biomass	Total Numbers	Recruits	F
1986	20,933	15,890	3,238,070	1,651,780	0.34
1987	19,787	14,822	3,148,950	1,084,650	0.28
1988	19,140	14,444	2,788,410	1,348,230	0.35
1989	17,673	13,352	2,626,180	789,960	0.31
1990	16,454	12,441	2,230,620	3,245,790	0.26
1991	17,835	12,151	3,736,220	1,333,910	0.39
1992	17,342	10,976	3,231,690	1,715,640	0.35
1993	17,451	12,060	3,226,180	1,902,970	0.43
1994	16,904	11,758	3,266,620	4,260,460	0.34
1995	19,418	12,015	5,005,980	2,280,200	0.40
1996	20,715	12,482	4,687,830	2,111,630	0.32
1997	22,535	15,668	4,490,130	5,572,440	0.28
1998	27,136	18,052	6,777,520	3,007,660	0.38
1999	29,011	18,559	6,355,210	1,931,930	0.31
2000	30,449	22,360	5,437,330	4,529,830	0.36
2001	31,657	23,306	6,471,090	3,472,710	0.39
2002	32,030	22,198	6,426,640	2,652,490	0.41
2003	31,285	22,362	5,779,470	3,506,380	0.40
2004	30,878	22,321	5,927,670	1,980,670	0.54
2005	26,885	16,892	4,717,350	2,113,970	0.55
2006	18,037	12,991	3,352,810	2,716,920	0.47
2007	17,527	11,713	3,798,440	1,229,780	0.58
2008	15,346	10,067	2,936,700	2,582,540	1.02

Table 3. Predicted total biomass, spawning stock biomass, total numbers, age-1 recruits, and fishing mortality rates from alternative model run 2 for the 2010 rerun of the Gulf of Mexico gag update assessment. Total biomass and spawning stock biomass are reported in thousand pounds gutted weight. Total numbers and age-1 recruits are reported in numbers.

Year	Total Biomass	Spawning Biomass	Total Numbers	Recruits	F
1986	20,401	15,473	3,196,290	1,590,950	0.34
1987	19,172	14,369	3,050,400	1,089,610	0.28
1988	18,443	13,931	2,701,280	1,295,230	0.36
1989	16,834	12,704	2,498,070	882,177	0.32
1990	15,568	11,662	2,181,790	3,222,210	0.28
1991	16,915	11,290	3,665,280	1,354,900	0.40
1992	16,461	10,261	3,160,620	1,686,450	0.36
1993	16,580	11,378	3,135,520	1,848,770	0.44
1994	15,985	11,096	3,139,250	4,178,480	0.35
1995	18,379	11,311	4,831,890	2,191,740	0.39
1996	19,673	11,833	4,492,450	2,056,510	0.32
1997	21,456	14,939	4,309,930	5,270,050	0.29
1998	25,655	17,108	6,408,080	2,897,660	0.38
1999	27,379	17,580	6,010,680	1,852,980	0.31
2000	28,689	21,078	5,136,870	4,331,070	0.37
2001	29,570	21,691	6,088,100	3,317,060	0.40
2002	29,842	20,543	6,042,780	2,469,610	0.42
2003	28,955	20,586	5,374,290	3,637,650	0.39
2004	29,179	20,864	5,784,670	1,818,970	0.51
2005	25,860	15,449	4,549,400	2,208,530	0.60
2006	15,696	11,117	3,075,160	2,789,690	0.50
2007	15,646	10,004	3,677,470	1,949,940	0.55
2008	15,187	9,298	3,435,910	3,520,350	0.74

Table 4. Catch-at-age (landings + dead discards) in numbers from the 2010 rerun of the Gulf of Mexico gag assessment update Alternative Run 1.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Total
1986	31,630	88,164	113,153	88,552	104,448	65,027	34,375	16,459	8,511	5,330	2,436	10,503	568,587
1987	17,464	76,334	86,816	74,803	51,178	54,503	32,036	17,054	8,564	4,706	3,125	8,598	435,182
1988	28,613	75,201	134,396	100,987	72,489	41,831	38,673	20,926	10,716	5,294	2,889	7,611	539,625
1989	13,385	57,295	63,498	79,085	54,939	37,707	21,596	21,075	12,522	7,125	3,890	9,208	381,324
1990	31,184	25,244	46,918	38,969	45,957	29,917	19,954	11,779	12,276	7,857	4,787	9,852	284,693
1991	28,258	203,259	68,459	83,512	53,805	49,078	26,214	15,488	8,557	8,602	5,392	10,283	560,905
1992	28,212	63,357	192,356	45,663	49,787	29,194	25,475	13,925	8,787	5,253	5,689	11,792	479,489
1993	36,867	97,486	94,228	204,219	41,604	38,453	20,073	16,737	9,192	5,959	3,679	13,275	581,772
1994	64,961	83,364	94,707	65,462	120,488	20,663	17,243	8,818	7,589	4,386	2,993	9,494	500,167
1995	40,922	230,028	125,391	99,371	56,234	85,284	13,010	10,420	5,376	4,766	2,848	8,851	682,501
1996	29,257	88,266	212,686	83,901	57,919	28,517	40,125	6,116	5,131	2,818	2,655	7,311	564,701
1997	71,847	81,796	107,115	187,330	63,058	36,657	16,111	21,743	3,334	2,872	1,627	6,212	599,702
1998	46,386	249,333	126,177	123,333	190,757	55,749	29,463	12,562	17,206	2,730	2,441	7,264	863,402
1999	26,331	121,614	279,978	99,611	81,233	103,539	26,530	13,347	5,717	8,042	1,316	5,059	772,316
2000	78,987	97,504	189,508	307,925	94,537	64,667	71,554	16,811	8,022	3,285	4,411	3,511	940,721
2001	55,362	204,442	105,427	153,183	229,628	61,462	38,880	42,967	10,619	5,430	2,396	6,705	916,501
2002	46,933	178,712	276,669	104,132	129,350	154,485	35,451	21,099	23,424	5,982	3,199	6,240	985,676
2003	65,291	128,763	204,963	227,869	74,309	75,733	79,180	17,413	10,582	12,317	3,332	6,133	905,883
2004	44,315	257,294	211,212	236,279	225,576	60,343	53,020	51,779	11,282	6,971	8,342	7,199	1,173,612
2005	52,446	97,104	227,910	129,397	126,663	102,046	24,430	21,021	21,343	4,933	3,246	8,271	818,811
2006	65,873	126,774	93,284	145,326	67,135	51,582	35,570	8,168	7,255	7,803	1,922	5,356	616,047
2007	49,958	204,876	159,687	79,216	104,148	40,072	27,383	18,303	4,313	4,015	4,549	5,019	701,539
2008	123,387	190,544	311,146	158,914	65,435	71,015	24,122	15,879	10,800	2,635	2,545	6,867	983,288
Average	46,864	131,598	153,291	126,828	93,942	59,023	32,629	18,256	10,049	5,613	3,466	7,853	

Table 5. Catch-at-age (landings + dead discards) in numbers from the 2010 rerun of the Gulf of Mexico gag assessment update Alternative Run 2.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Total
1986	30,739	87,049	112,881	88,631	104,162	65,371	34,710	16,549	8,506	5,303	2,417	10,377	566,696
1987	17,385	74,412	87,180	74,738	50,871	54,361	32,343	17,295	8,636	4,711	3,111	8,491	433,534
1988	30,806	74,963	132,797	101,543	72,220	41,751	38,786	21,181	10,855	5,317	2,875	7,469	540,562
1989	13,947	61,850	64,530	78,501	54,798	37,338	21,482	21,085	12,642	7,196	3,894	9,027	386,293
1990	31,687	26,267	51,431	39,437	44,982	29,755	19,862	11,811	12,386	7,999	4,874	9,785	290,276
1991	29,554	204,006	71,217	90,247	53,650	47,905	26,065	15,367	8,526	8,610	5,444	10,202	570,795
1992	28,452	65,918	195,468	47,505	53,281	28,925	24,739	13,748	8,633	5,170	5,614	11,553	489,004
1993	36,818	97,744	99,196	207,123	42,841	40,912	19,748	16,049	8,910	5,723	3,529	12,648	591,242
1994	64,340	83,224	96,780	69,316	122,059	21,392	18,457	8,689	7,255	4,223	2,849	8,941	507,524
1995	41,283	227,906	127,313	101,657	59,080	86,059	13,400	11,035	5,211	4,461	2,676	8,115	688,196
1996	28,972	89,241	215,226	85,624	58,916	29,926	40,448	6,264	5,374	2,689	2,438	6,583	571,702
1997	71,585	80,897	109,990	189,274	63,773	37,275	16,938	21,881	3,394	2,978	1,533	5,528	605,046
1998	46,620	248,832	127,218	126,826	191,116	56,312	29,977	13,167	17,178	2,744	2,491	6,409	868,890
1999	26,849	122,026	283,456	100,079	82,697	103,844	26,903	13,580	5,961	7,955	1,307	4,563	779,220
2000	79,850	98,531	194,912	327,674	98,207	67,128	71,788	16,723	7,849	3,244	4,085	2,995	972,988
2001	55,495	207,259	111,578	167,174	239,504	61,931	39,570	42,751	10,507	5,310	2,371	6,012	949,461
2002	46,833	179,425	291,905	115,288	136,219	155,827	35,257	21,559	23,537	6,015	3,188	5,871	1,020,924
2003	66,292	128,509	213,233	250,828	79,533	76,769	78,186	17,230	10,836	12,502	3,400	6,005	943,323
2004	45,745	261,488	217,725	254,669	239,320	61,522	51,637	49,604	10,866	6,984	8,310	7,053	1,214,924
2005	54,799	100,933	242,333	142,244	136,380	106,746	24,758	20,560	20,597	4,807	3,296	8,306	865,759
2006	66,499	131,740	100,378	164,263	73,501	54,865	37,390	8,481	7,343	7,867	1,966	5,707	660,001
2007	50,956	206,846	172,787	91,544	117,782	42,491	28,182	18,799	4,406	4,036	4,587	5,367	747,783
2008	123,981	194,413	326,045	181,649	73,235	74,046	23,309	14,961	10,203	2,498	2,391	6,770	1,033,499
Average	47,369	132,760	158,503	134,602	97,745	60,107	32,780	18,190	9,983	5,580	3,420	7,556	

Table 6. Projected total biomass, spawning stock biomass, fishable biomass, and apical F for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment. Fishing mortality scenarios include $F_{CURRENT}$, F_{MAX}, F_{OY}, $F_{REBUILD}$ to SSB_{OY}, and $F_{REBUILD}$ to SSB_{MAX}. Biomass is reported in million pounds gutted weight.

Year	$F_{current}$	F_{max}	F_{oy}	$F_{rebuild}$ SSB_{oy}	$F_{rebuild}$ SSB_{max}
			Total Biomass		
2010	15.90	15.90	15.90	15.90	15.90
2011	16.62	18.20	18.49	18.59	18.27
2012	16.25	20.93	21.91	22.22	21.15
2013	15.93	23.35	25.09	25.66	23.72
2014	15.69	25.40	27.95	28.79	25.95
2015	15.53	27.14	30.47	31.61	27.87
2016	15.42	28.59	32.67	34.08	29.48
			Spawning Stock Biomass		
2010	8.25	8.25	8.25	8.25	8.25
2011	9.78	9.78	9.78	9.78	9.78
2012	9.72	12.35	12.88	13.04	12.47
2013	9.54	14.82	16.02	16.41	15.09
2014	9.33	16.89	18.81	19.46	17.31
2015	9.21	18.62	21.25	22.16	19.19
2016	9.11	19.87	23.10	24.25	20.56
			Fishable Biomass		
2010	9.28	9.28	9.28	9.28	9.28
2011	10.05	11.22	11.44	11.51	11.27
2012	9.91	13.61	14.40	14.65	13.78
2013	9.70	15.73	17.18	17.66	16.05
2014	9.51	17.45	19.56	20.28	17.91
2015	9.37	18.76	21.47	22.40	19.34
2016	9.29	19.71	22.93	24.05	20.40
			Apical F		
2010	0.35	0.35	0.35	0.35	0.35
2011+	0.55	0.22	0.17	0.15	0.21

Table 7. Projected yield streams for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment. Fishing mortality scenarios include $F_{CURRENT}$, F_{MAX}, F_{OY}, $F_{REBUILD}$ to SSB_{OY}, and $F_{REBUILD}$ to SSB_{MAX}. Yield is reported in million pounds gutted weight.

Year	$F_{current}$	F_{max}	F_{oy}	$F_{rebuild}$ SSB_{oy}	$F_{rebuild}$ SSB_{max}
2010	2.10	2.10	2.10	2.10	2.10
2011	3.64	1.67	1.28	1.16	1.58
2012	3.61	2.11	1.69	1.55	2.02
2013	3.55	2.54	2.11	1.95	2.45
2014	3.46	2.91	2.49	2.32	2.82
2015	3.39	3.19	2.80	2.64	3.12
2016	3.35	3.40	3.04	2.88	3.34

Table 8. Required SFA and MSRA evaluations for the 2010 rerun of the Gulf of Mexico gag update assessment. 2009 assessment update values come from the Gulf of Mexico gag 2009 update assessment report, except where otherwise noted. Assessment rerun values come from alternative model run 2 for the 2010 rerun of the Gulf of Mexico gag update assessment.

Criteria	Definition	2009 Assessment Update Value Table 9.3 except as noted	Assessment rerun revisions
Mortality Rate Criteria			
$F_{MSY\ or\ proxy}$	F_{MAX}	0.22	0.22
MFMT	F_{MAX}	0.22	0.22
F_{OY}	75% of F_{MAX}	0.16	0.17
$F_{CURRENT}$	Geometric mean 2005-2007	0.53	0.55
$F_{CURRENT}$/MFMT	Geometric mean 2005-2007	2.47	2.50
Base M		0.15	0.15
Biomass Criteria			
SSB_{MAX}	Equilibrium SSB @ F_{MAX}	24.02 mp gw	22.51 mp gw
MSST	(1-M)*SSB_{MAX} M=0.15	20.41 mp gw	19.14 mp gw
$SSB_{CURRENT}$	current = 2008	9.58 mp gw	9.30 mp gw
$SSB_{CURRENT}$/MSST	current = 2008	0.47	0.49
Equilibrium MSY	Equilibrium Yield @ F_{MSY}	4.28 mp gw	4.19 mp gw
Equilibrium OY	Equilibrium Yield @ F_{OY}	4.17 mp gw	4.08 mp gw
OFL	Annual Yield @ F_{MAX}		
(June 10, 2010 e-mail	2011	1.32 mp gw	1.67 mp gw
From Clay Porch & Brian Linton)	2012	1.81 mp gw	2.11 mp gw
	2013	2.30 mp gw	2.54 mp gw
	2014	2.74 mp gw	2.91 mp gw
	2015	3.08 mp gw	3.19 mp gw
	2016	3.34 mp gw	3.40 mp gw
10-yr rebuild yield (ABC)	Annual Yield @ $F_{Rebuild}$		
(March 22, 2010 revised	2011	1.17 mp gw	1.58 mp gw
assessment with 2009 landings)	2012	1.64 mp gw	2.02 mp gw
	2013	2.12 mp gw	2.45 mp gw
	2014	2.57 mp gw	2.82 mp gw
	2015	2.93 mp gw	3.12 mp gw
	2016	3.20 mp gw	3.34 mp gw
Annual OY (ACT)	Annual Yield @ F_{OY}		
(March 22, 2010 revised	2011	1.01 mp gw	1.28 mp gw
assessment with 2009 landings)	2012	1.44 mp gw	1.69 mp gw
	2013	1.90 mp gw	2.11 mp gw
	2014	2.34 mp gw	2.49 mp gw
	2015	2.70 mp gw	2.80 mp gw
	2016	2.98 mp gw	3.04 mp gw

Figures

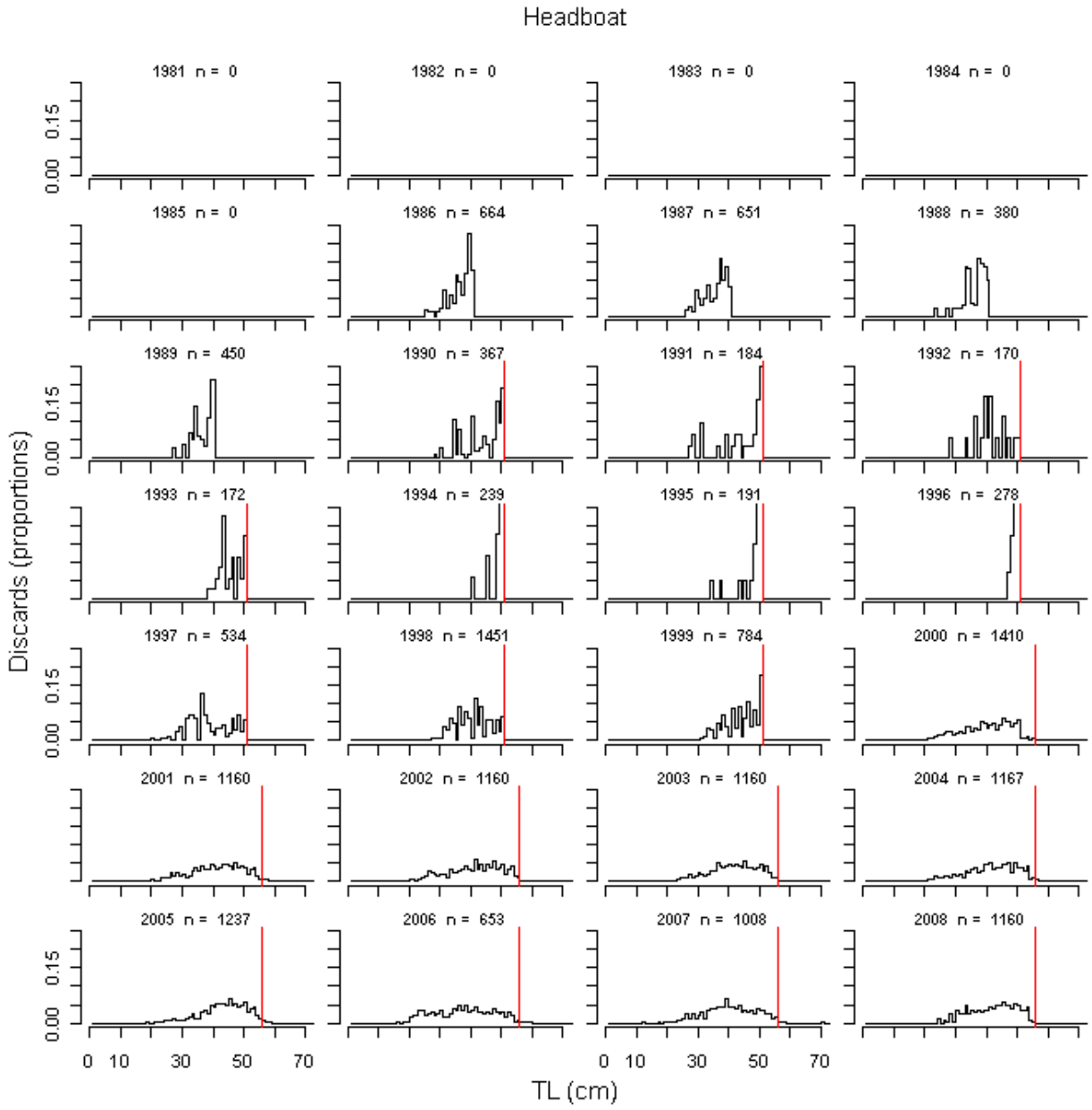

Figure 1. Recreational headboat discard size compositions used in the 2009 Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

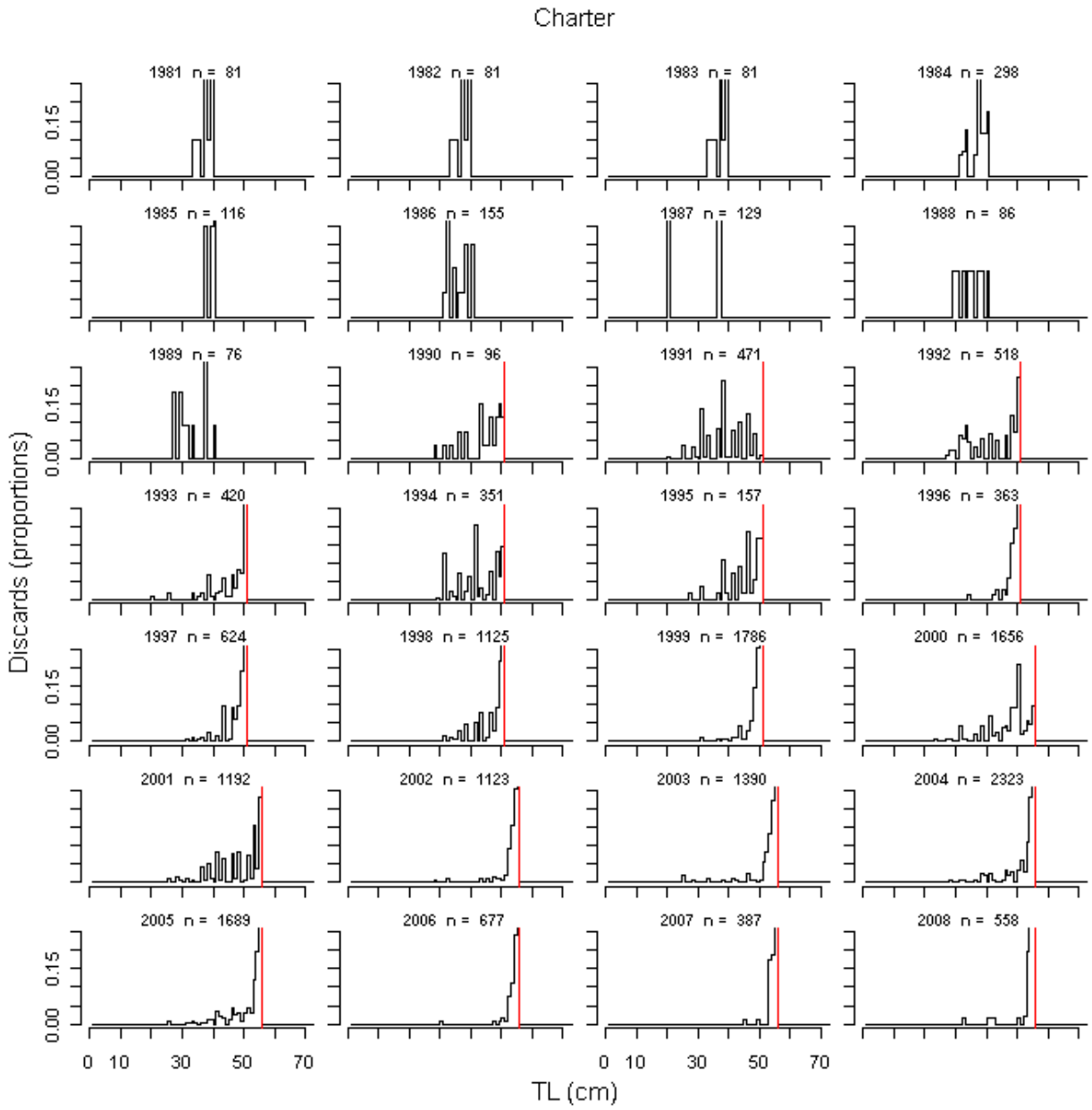

Figure 2. Recreational charter discard size compositions used in the 2009 Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

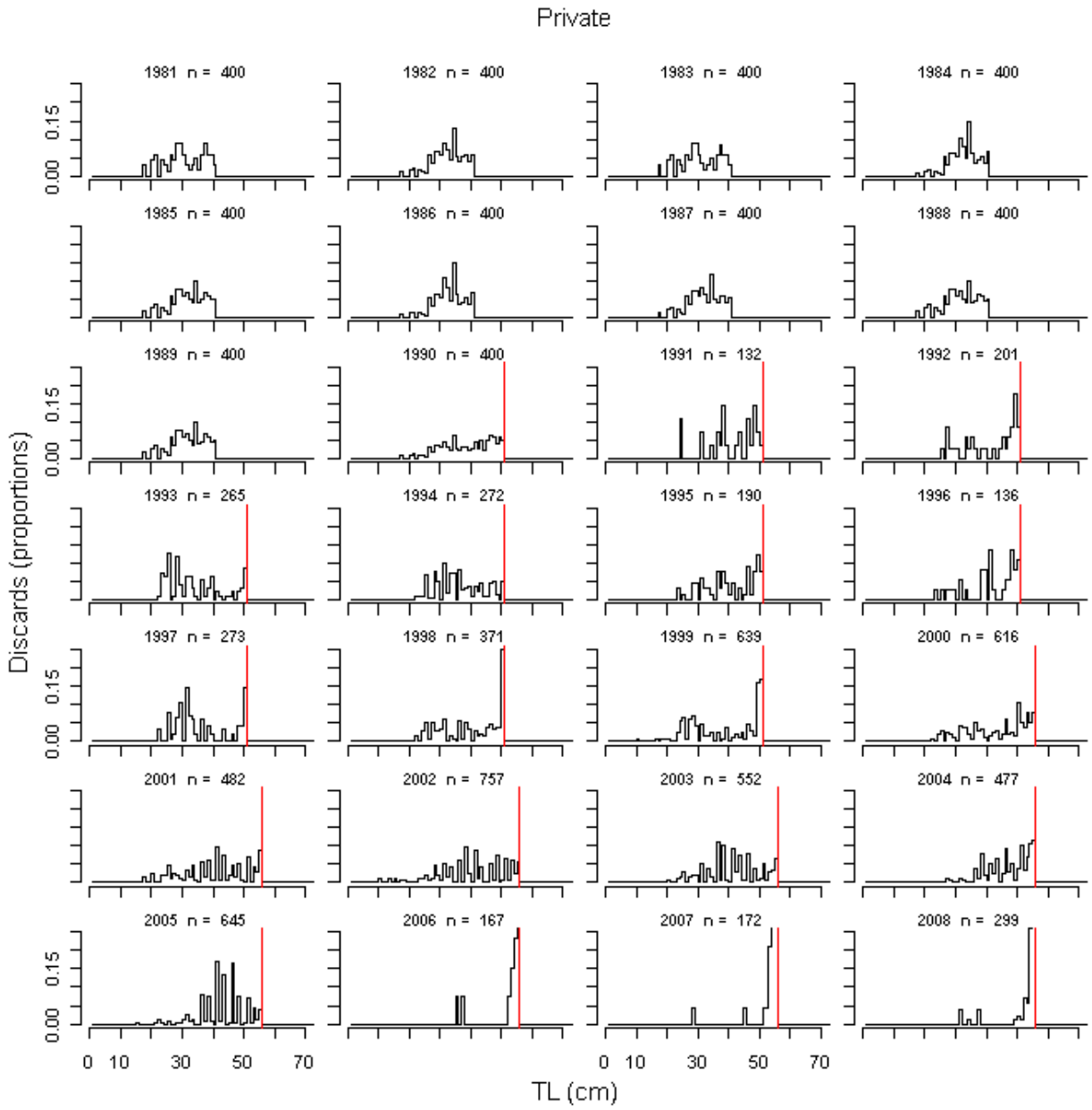

Figure 3. Recreational private discard size compositions used in the 2009 Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

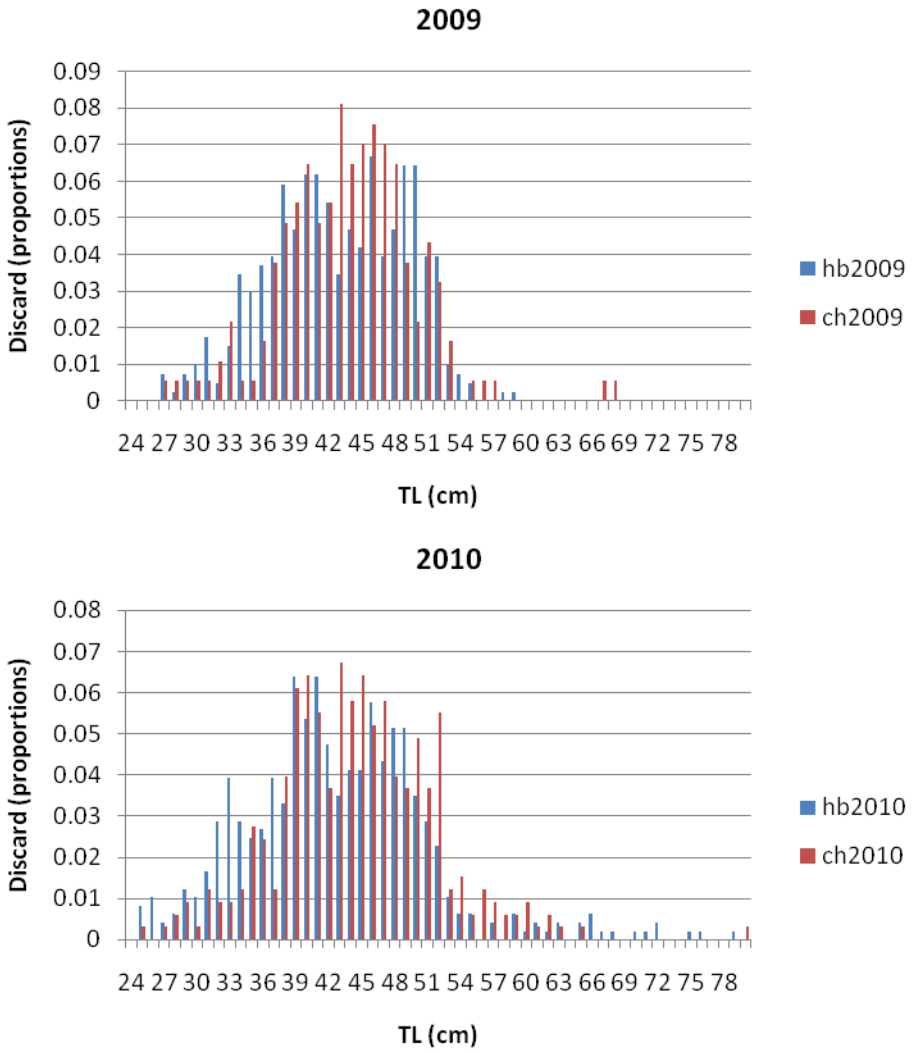

Figure 4. Comparison of discard size compositions for Gulf of Mexico gag from recreational headboat and charter observer data, 2009-2010.

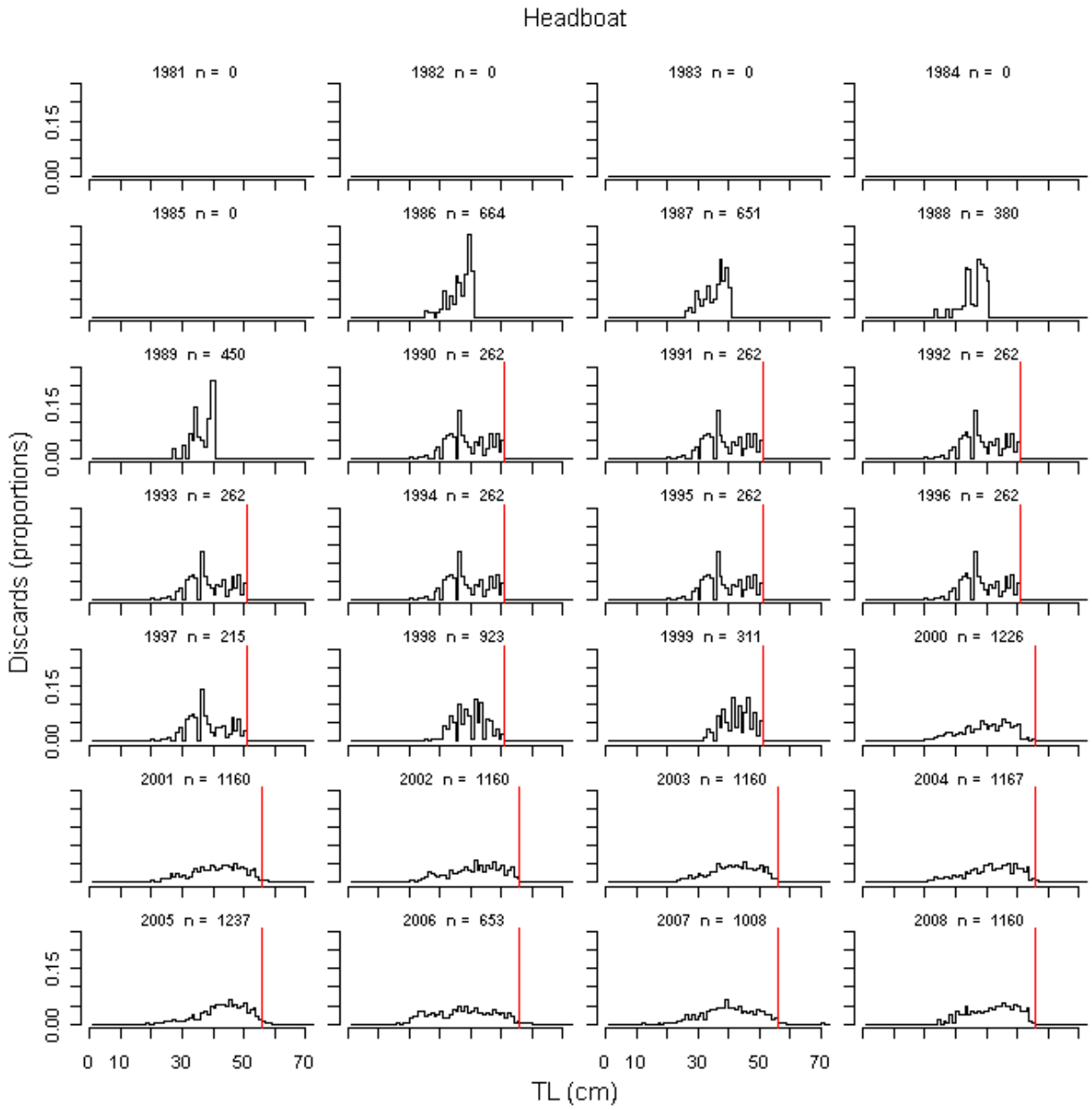

Figure 5. Recreational headboat discard size compositions used in the 2010 rerun of the Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

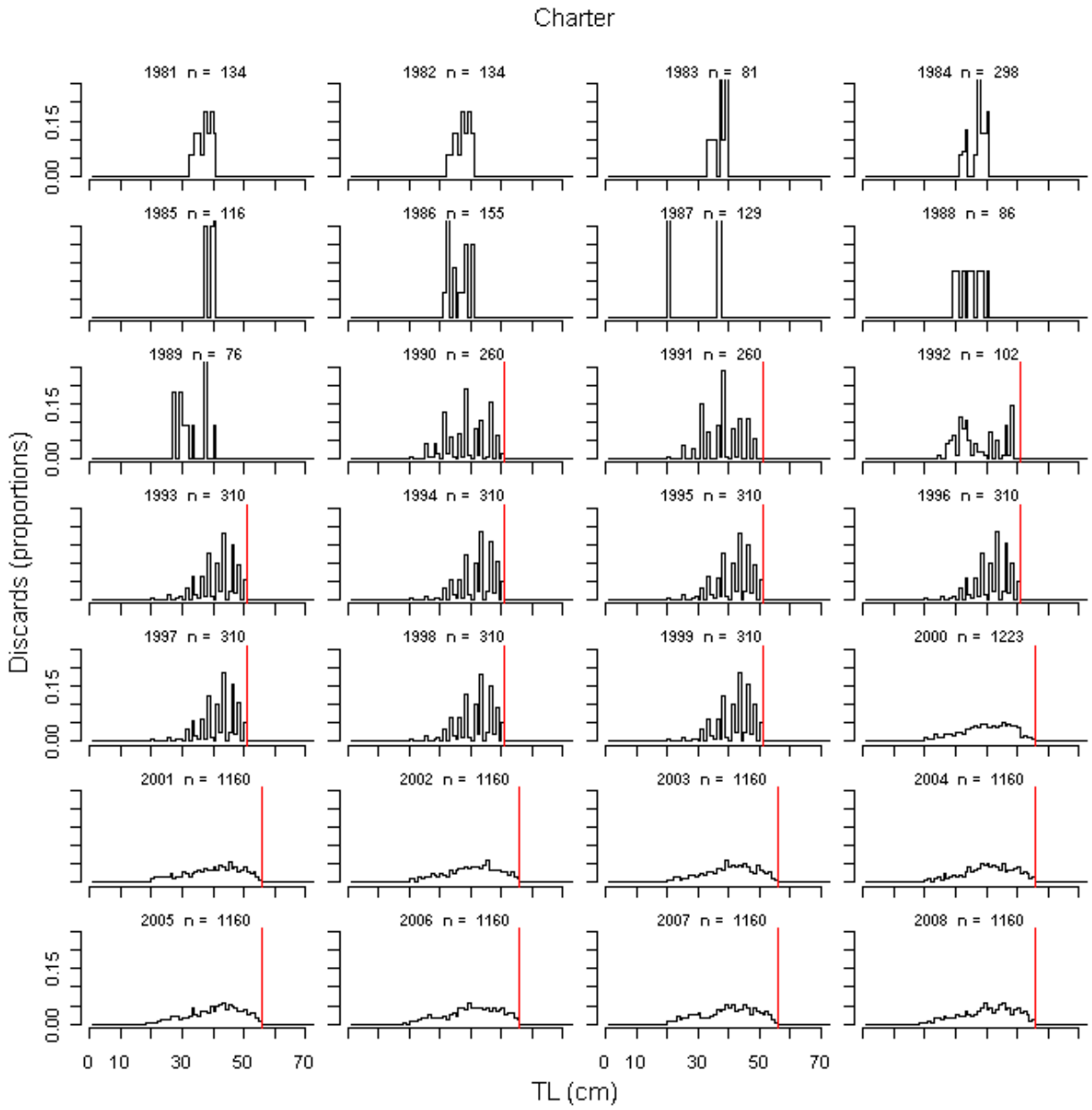

Figure 6. Recreational charter discard size compositions used in the 2010 rerun of the Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

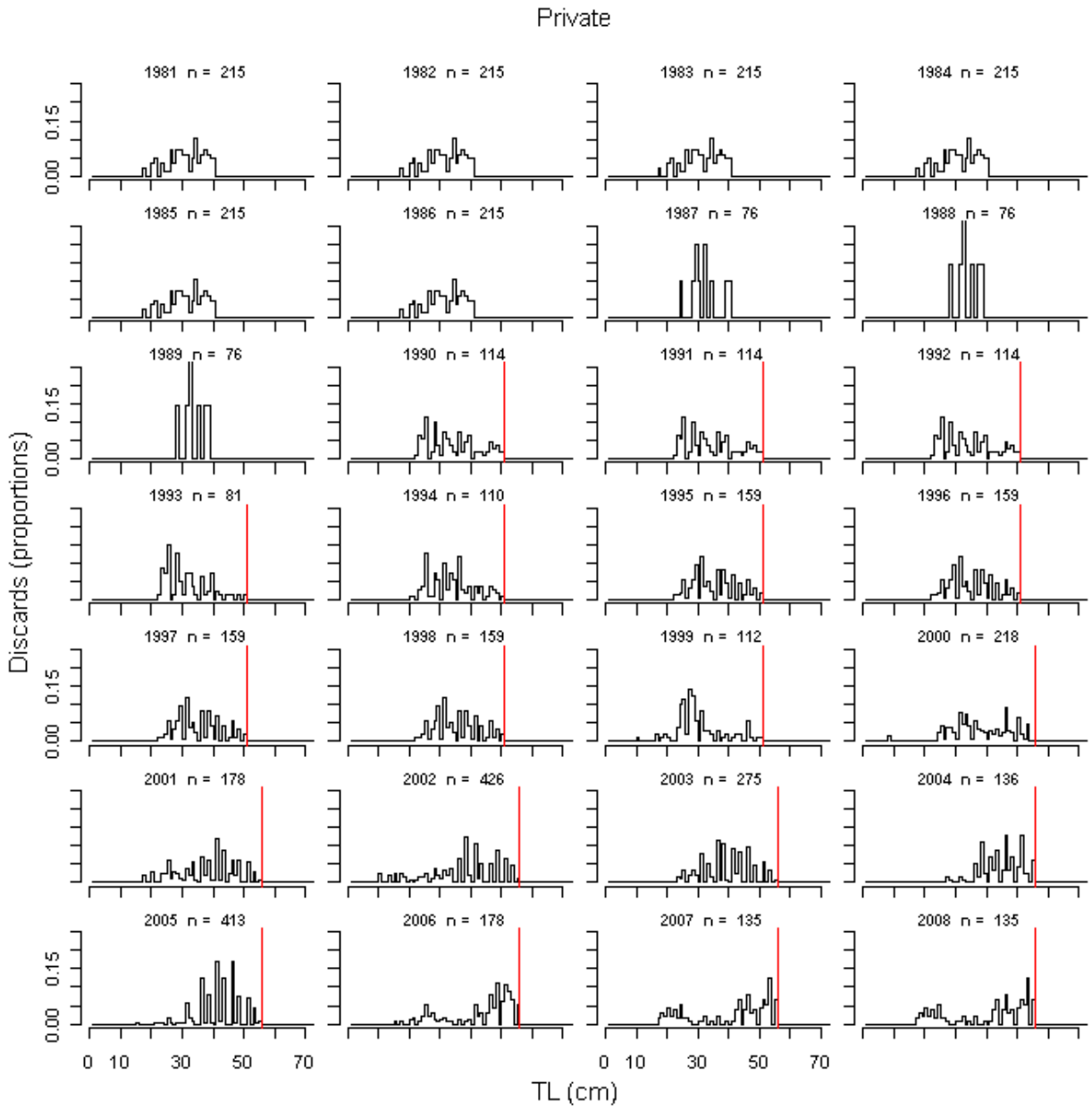

Figure 7. Recreational private discard size compositions used in the 2010 rerun of the Gulf of Mexico gag assessment update. Vertical red lines represent minimum size limits.

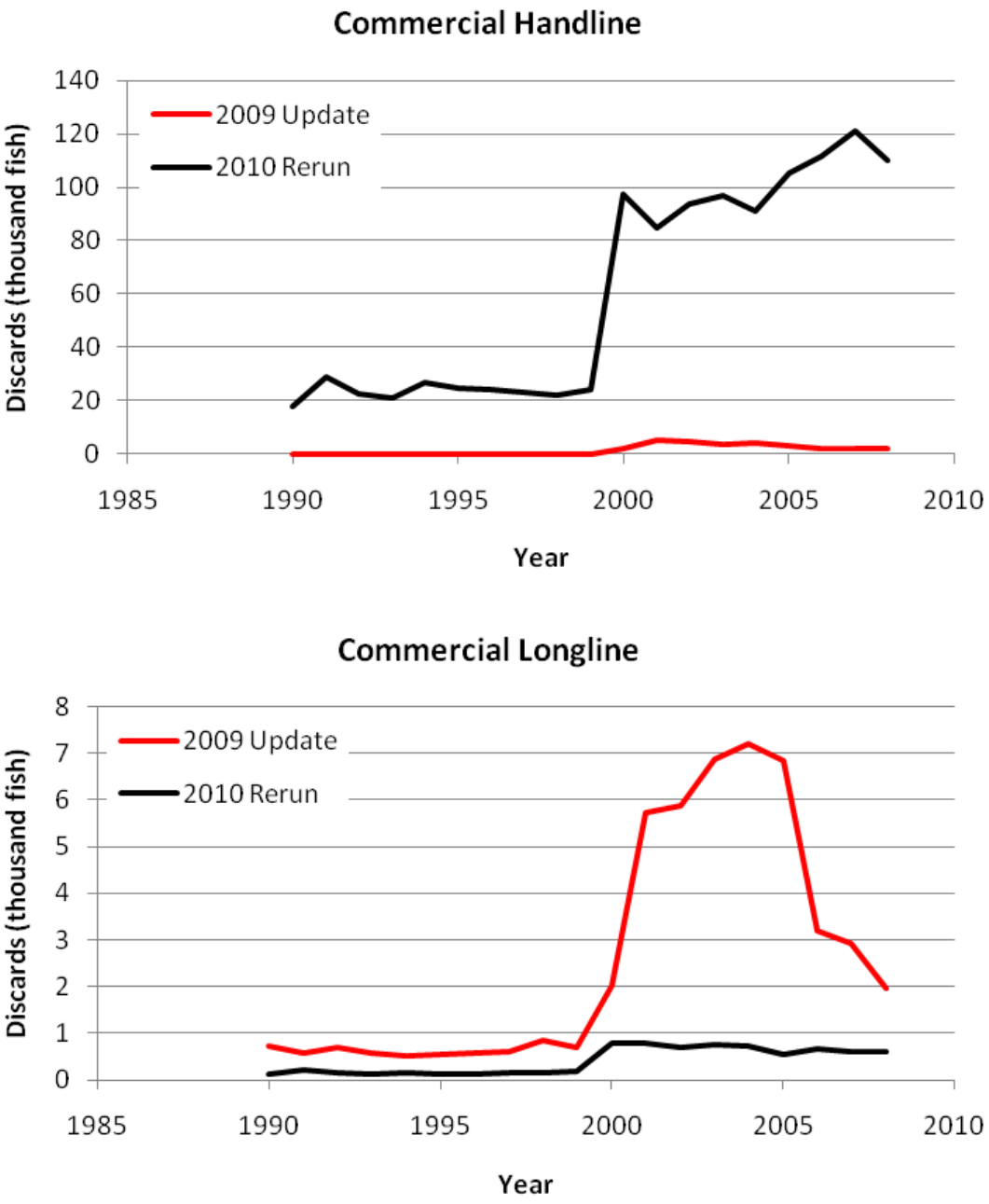

Figure 8. Commercial handline and longline discards in numbers (thousand fish) for Gulf of Mexico gag. The 2009 assessment update values were calculated using TIP commercial size data. The 2010 rerun numbers were calculated using commercial observer data.

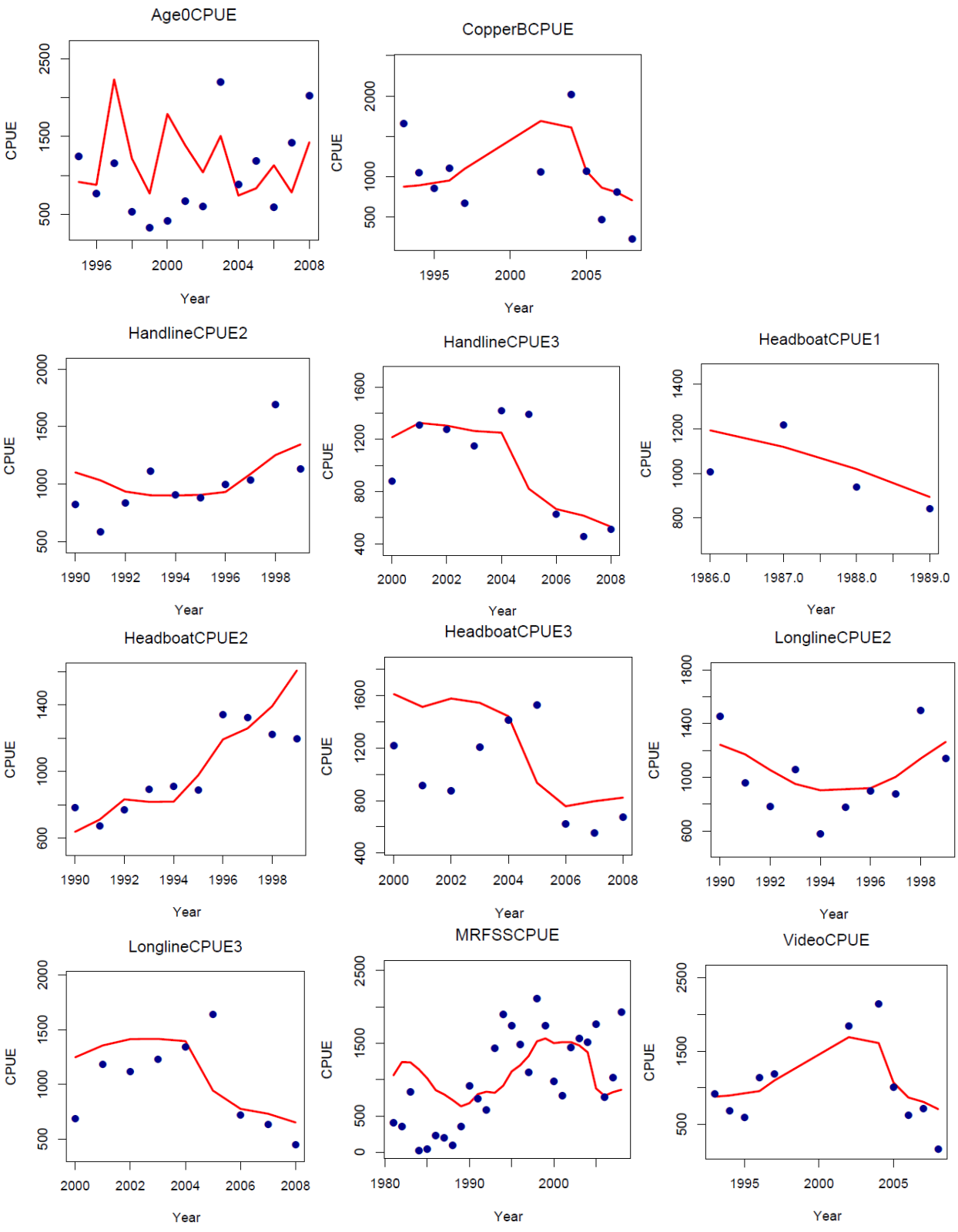

Fig 9. Fits to indices of abundance for alternative model run 1 from the 2010 rerun of the Gulf of Mexico gag update assessment.

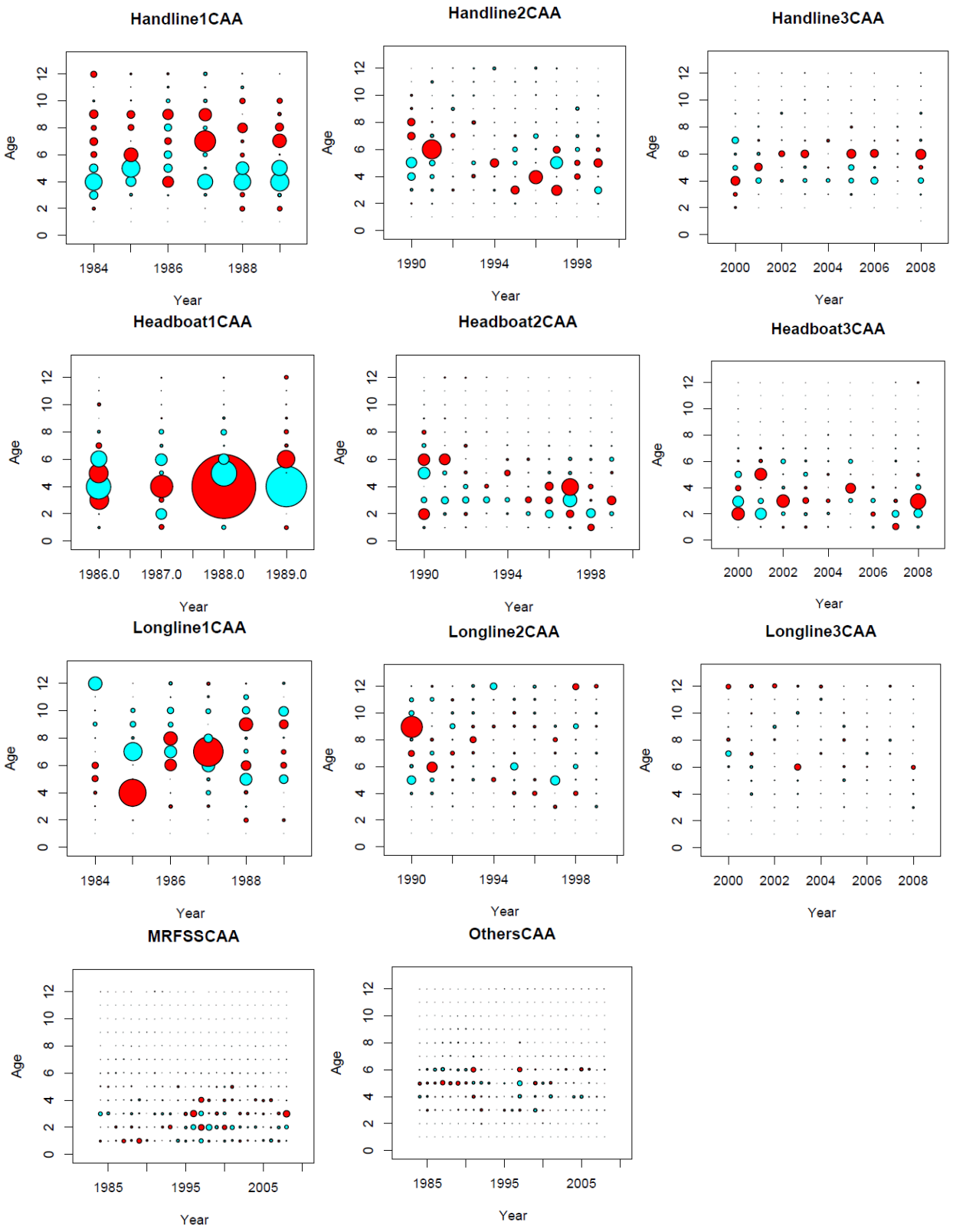

Fig. 10. Age composition residuals for alternative model run 1 from the 2010 rerun of the Gulf of Mexico gag update assessment. Positive residuals are red and negative residuals are blue.

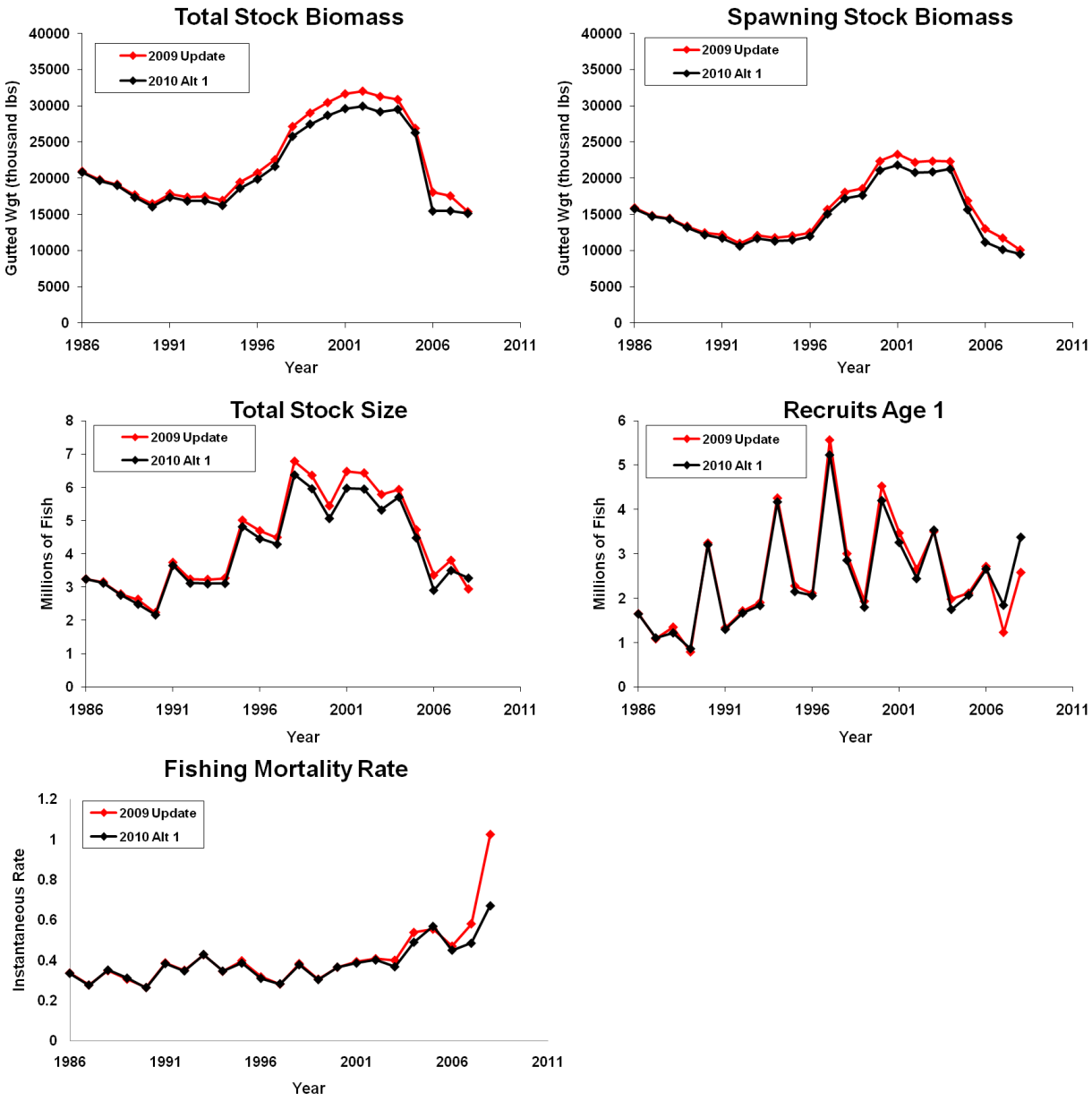

Fig. 11. Comparisons of predicted total stock biomass, spawning biomass, total stock size, age-1 recruits, and fishing mortality rates between the final 2009 Gulf of Mexico gag update assessment model and alternative model run 1 from the 2010 rerun of the Gulf of Mexico gag update assessment.

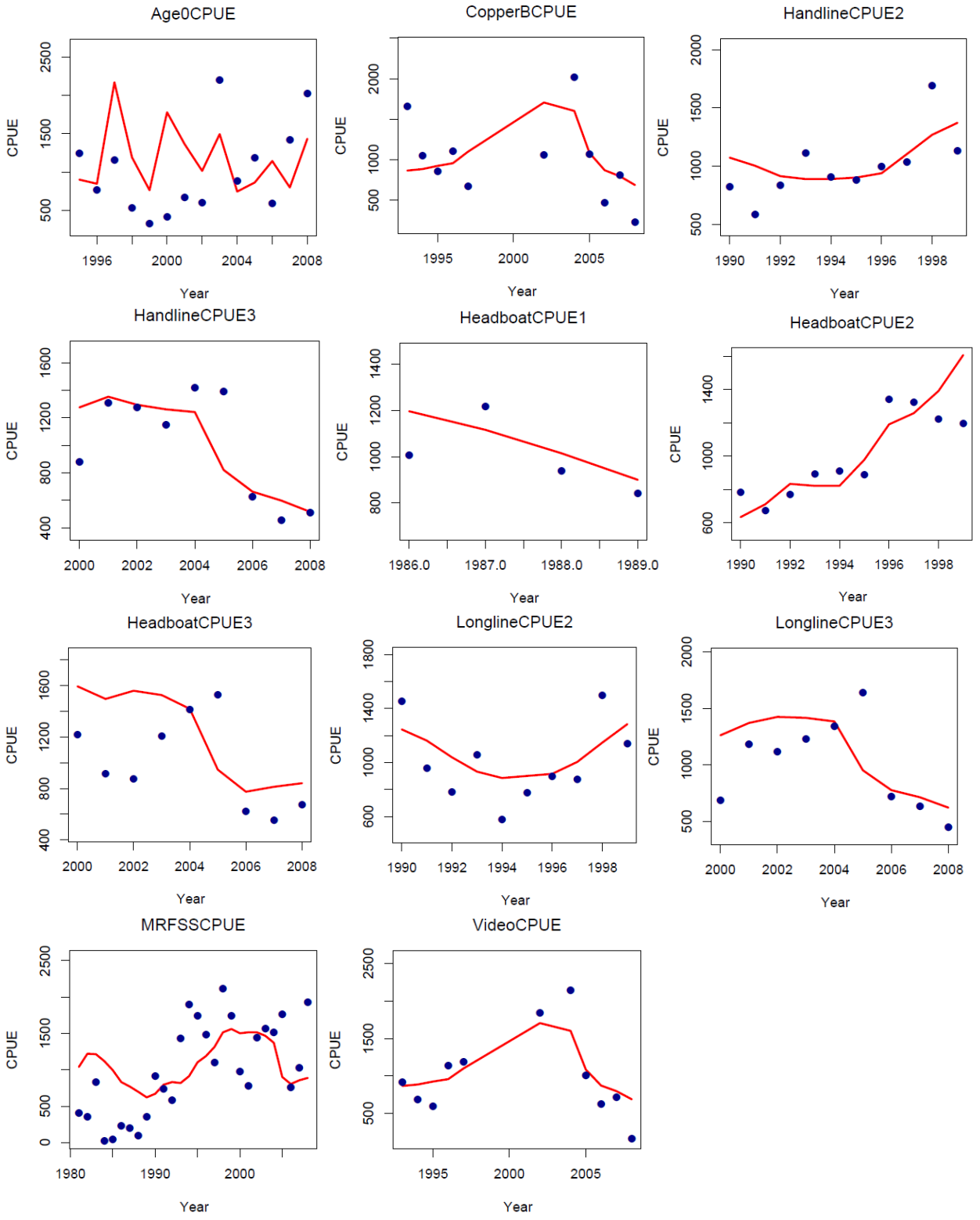

Fig. 12. Fits to indices of abundance for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment.

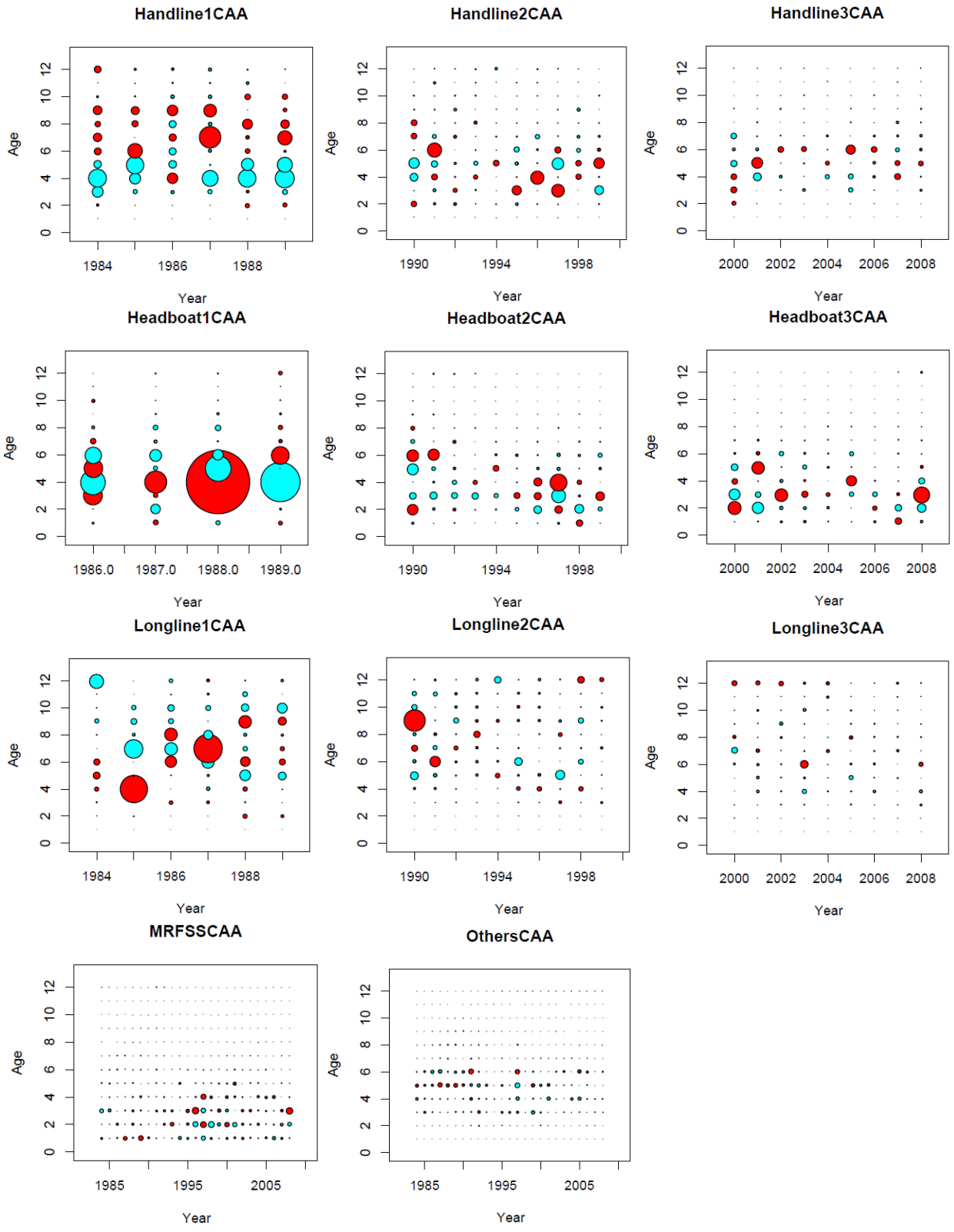

Fig. 13. Age composition residuals for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment. Positive residuals are red and negative residuals are blue.

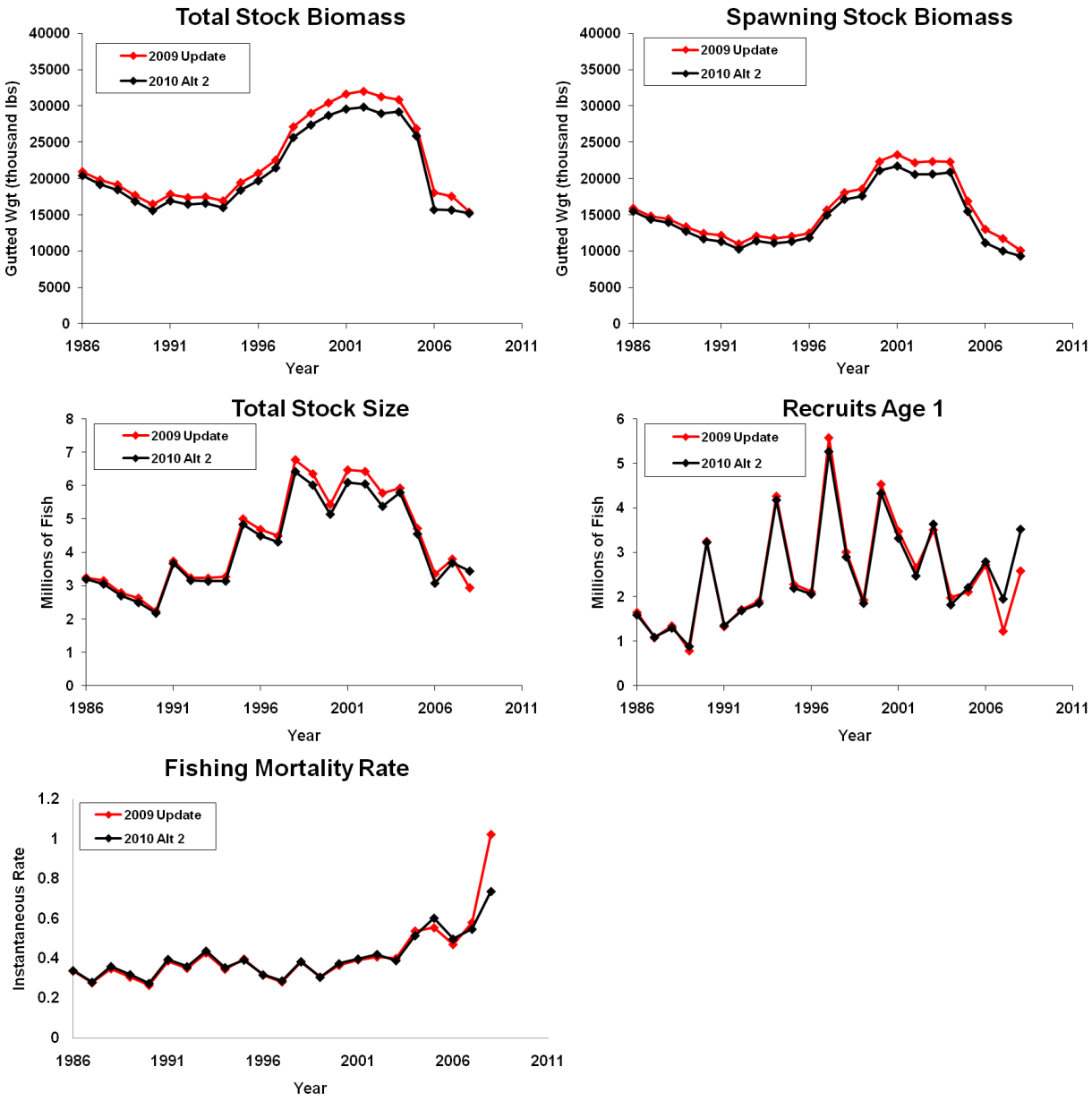

Fig. 14. Comparisons of predicted total stock biomass, spawning biomass, total stock size, age-1 recruits, and fishing mortality rates between the final 2009 Gulf of Mexico gag update assessment model and alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment.

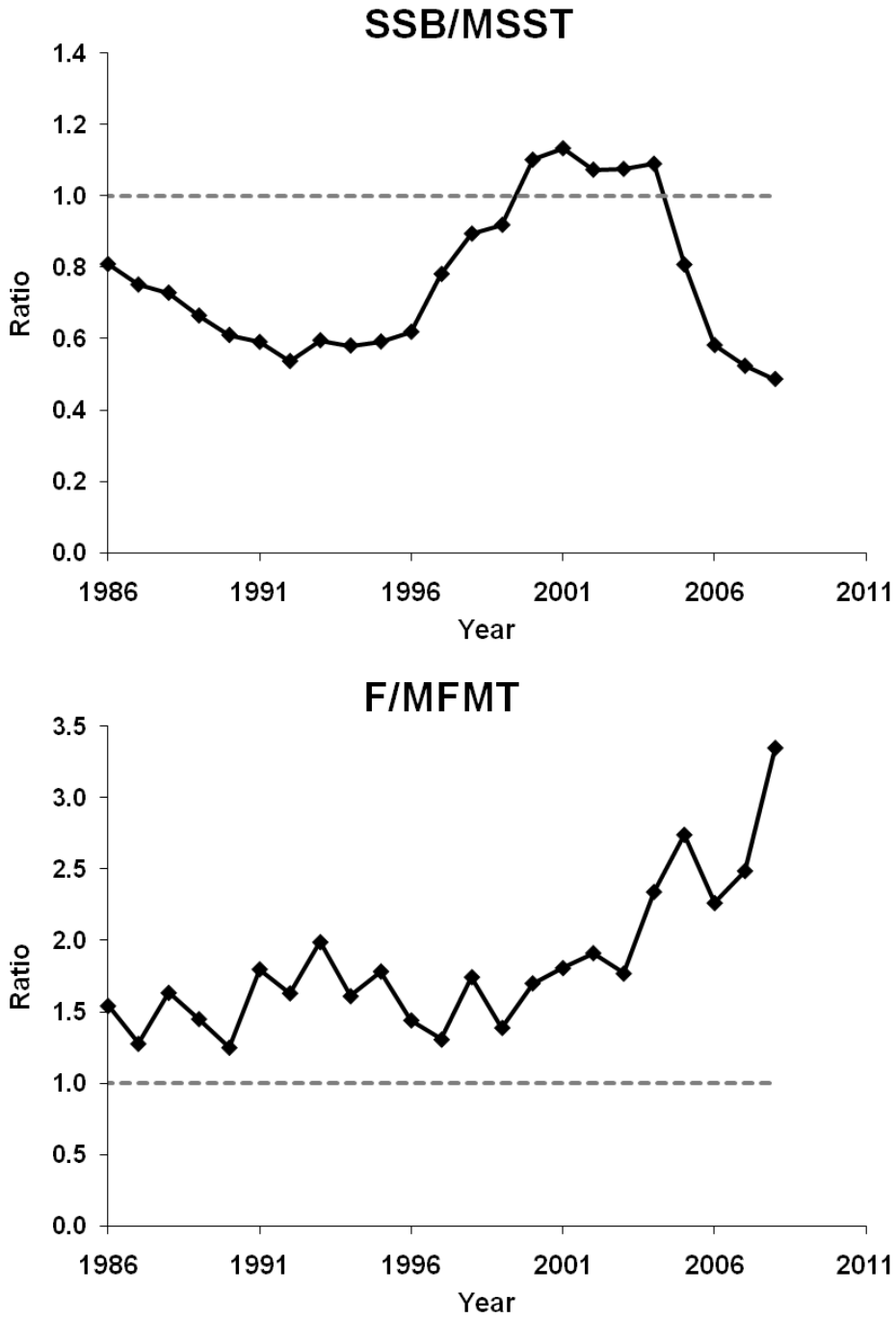

Fig. 15. Trends in predicted SSB/MSST and F/MFMT for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment.

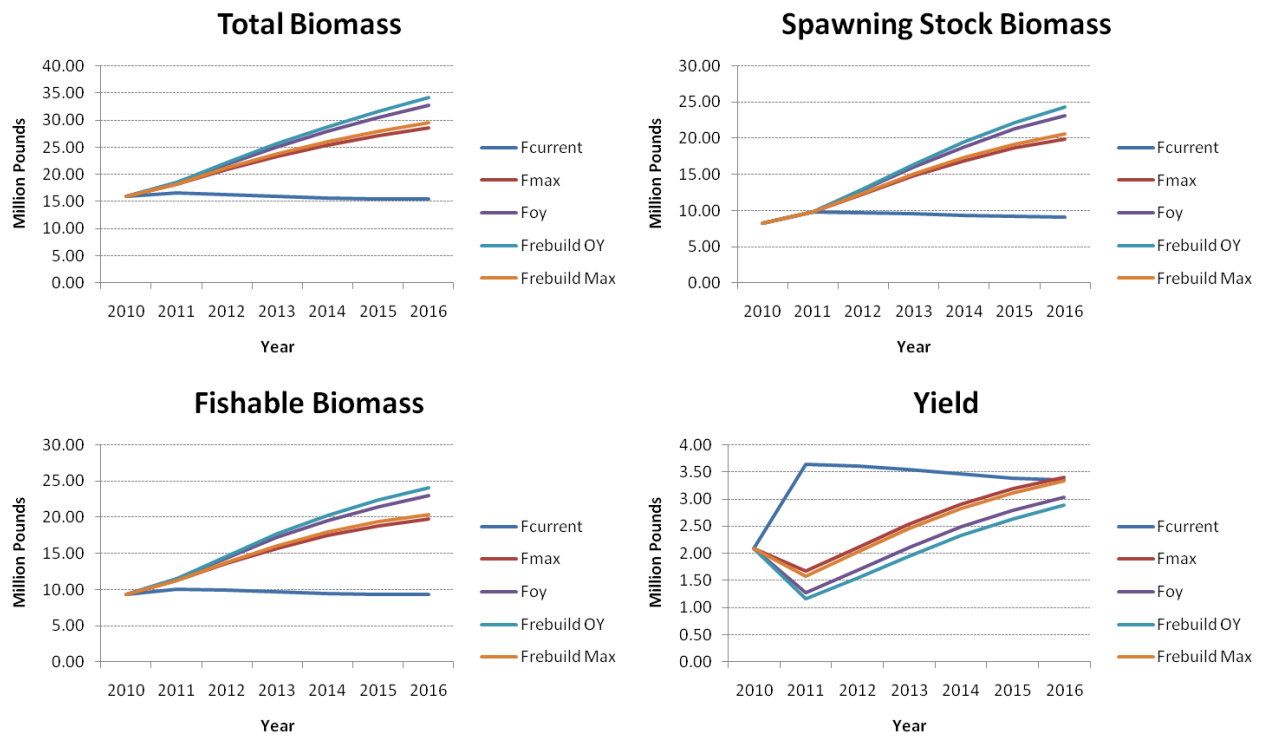

Fig. 16. Projected total biomass, spawning stock biomass, fishable biomass, and yield for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment. All weights are reported as gutted weight. Fishing mortality scenarios include $F_{CURRENT}$, F_{MAX}, F_{OY}, $F_{REBUILD}$ to SSB_{OY}, and $F_{REBUILD}$ to SSB_{MAX}.

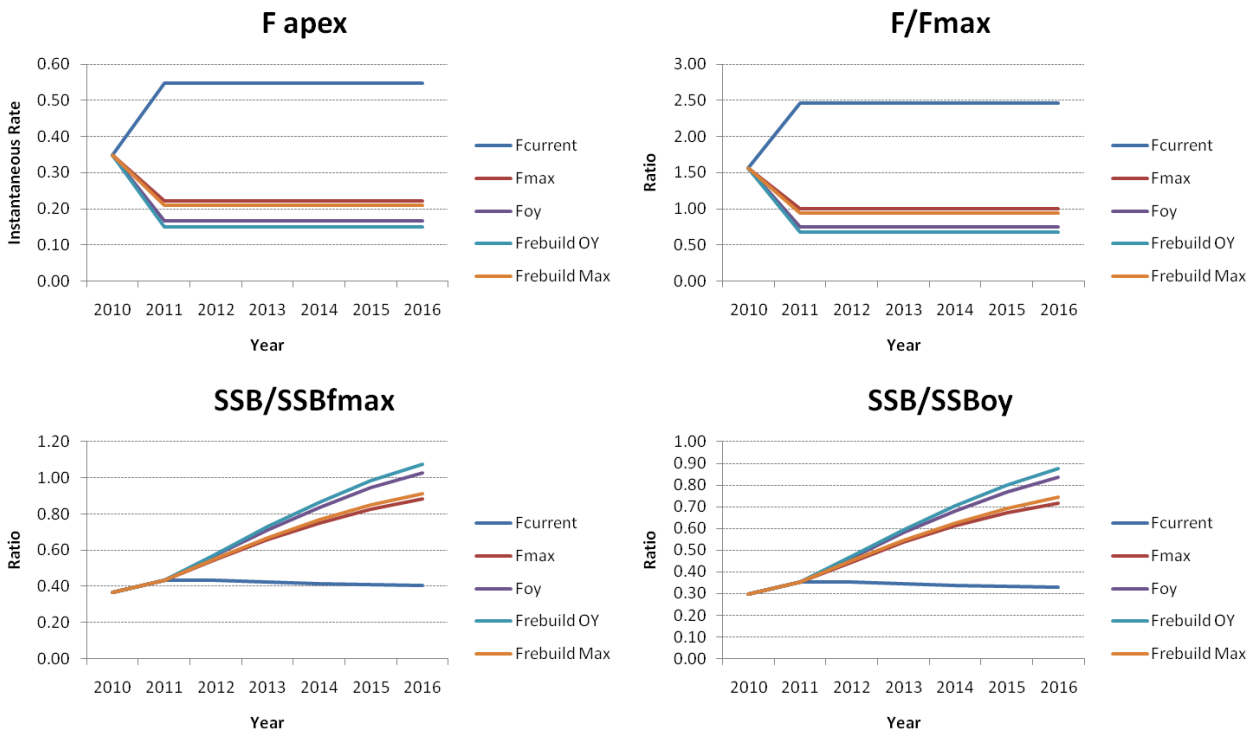

Fig. 17. Projected apical F, F/F_{MAX}, SSB/SSB_{MAX}, and SSB/SSB_{OY} for alternative model run 2 from the 2010 rerun of the Gulf of Mexico gag update assessment. Fishing mortality scenarios include $F_{CURRENT}$, F_{MAX}, F_{OY}, $F_{REBUILD}$ to SSB_{OY}, and $F_{REBUILD}$ to SSB_{MAX}.