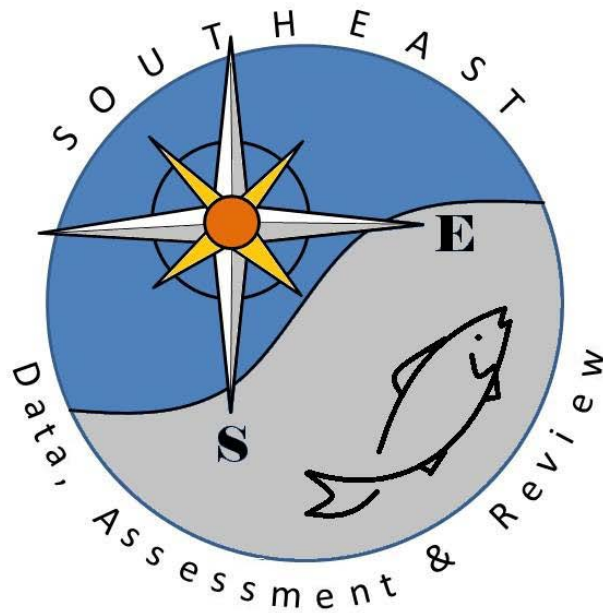


# Estimated Conversion Factors for Adjusting MRFSS Gulf of Mexico Red Snapper Catch Estimates and Variances in 1981-2003 to MRIP Estimates and Variances

Adyan Rios, Vivian M. Matter, John F. Walter, Nicholas Farmer, and Stephen C. Turner

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by

Adyan Rios<sup>1</sup>, Vivian M. Matter<sup>2</sup>, John F. Walter<sup>1</sup>, Nicholas Farmer<sup>3</sup>,  
and Stephen C. Turner<sup>2</sup>

National Marine Fisheries Service

Southeast Fisheries Science Center

<sup>1</sup>Sustainable Fisheries Division

<sup>2</sup>Fisheries Statistics Division

75 Virginia Beach Drive

Miami, FL 33149

<sup>3</sup>Southeast Regional Office

263 13th Avenue South

St Petersburg, FL 33701

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## **INTRODUCTION**

The Marine Recreational Information Program (MRIP) was implemented in 2004 to provide more detailed, timely, and reliable estimates of marine recreational fishing catch and effort. MRIP's independently peer reviewed methodology replaced the Marine Recreational Fisheries Statistics Survey (MRFSS) program that had operated since 1981 (Visit <http://www.st.nmfs.noaa.gov/st1/recreational/> for more information on MRIP and MRFSS). Official MRIP data for 2004 to 2011 represent the best available data for use in stock assessments. In order to maintain one consistent time series for the recreational data, it is necessary to re-estimate catch and adjust variances for years

prior to 2004. In March 2012, SEDAR hosted a workshop to discuss how to best to adjust catch estimates from the old MRFSS methodology with catch estimates from the new MRIP methodology. The recommendation from the Ad-Hoc Working Group that was created at the workshop is to apply ratio estimators, based on the ratios of the means, to hind-cast catch and variances (Salz et al. 2012). The methods recommended by the SEDAR 2012 Ad-Hoc Calibration Working Group report are employed here for red snapper in the Gulf of Mexico. In addition, recommendations from the Southeast Regional MRIP Recalibration Committee<sup>1</sup> have been applied.

### **DATA, METHODS, AND RESULTS**

Ratio estimators were developed using data for 2004-2011 from both the MRFSS program and the newly implemented MRIP for Gulf of Mexico red snapper. Data used to develop ratios are shown in Tables 1-3. Individual ratios were developed for estimates in number of A+B1 and B2 fish and for their associated variances. Type A fish are those fish landed and seen by the dockside interviewer. Type B1 fish are those fish reported by the angler as having died but not seen by the interviewer including fish landed (perhaps remaining in a cooler), discarded dead or used as bait. Type B2 fish are those fish reported by the angler as discarded alive.

The Ad-Hoc working group recommends that data used to calculate ratios be aggregated to the extent possible. However, when the Southeast Regional MRIP Recalibration Committee analyzed data for several southeast managed species they found substantial differences in ratios by mode. In order to adopt a calibration technique to apply to all southeast managed species, the committee recommended that separate ratios should be developed for each fishing mode (charter, private, and shore).

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<sup>1</sup> Participants: Lew Coggins, Nicholas Farmer, David Gloeckner, Michael Larkin, Vivian Matter, Clay Porch, Adyan Rios, Andy Strelcheck, Steve Turner, John F. Walter, and Erik Williams

In order to apply the charter mode ratio estimators back in time to 1981, the MRFSS combined charter/headboat mode in 1981-1985 had to be split. Effort estimates (angler trips) from the NMFS Southeast Headboat Survey were combined with charterboat effort estimates (angler trips) from the MRFSS from 1986 to 1988 to obtain an average charter to headboat ratio by state. This ratio was then used to split the combined charterboat/headboat mode estimates from 1981-1985.

Ratio estimators were applied to the For-Hire Survey (FHS) charterboat estimates when available (1998-2003). Prior to 1998, they were applied to the recalibrated charterboat estimates. See SEDAR31-DW-04 for more information on this charterboat mode calibration.

Ratio estimators were species, sub-region, and mode specific. Estimators for each fish type (AB1 and B2; numbers and variances) were calculated as ratios of their means using:

$$\hat{R} = \frac{\bar{C}_{MRIP}}{\bar{C}_{MRFSS}} = \frac{\frac{1}{n} * \sum_{y=1}^n C_{y,MRIP}}{\frac{1}{n} * \sum_{y=1}^n C_{y,MRFSS}} \quad (\text{eq. 1})$$

Respective ratios were then applied at each stratum (species, sub-region, year, wave, state, mode, and area) to the A, B1, and B2 estimates and variances using:

$$\hat{C}_{y,\hat{R}} = \hat{R} \hat{C}_{y,MRFSS} \quad (\text{eq. 2})$$

Resulting ratios estimators based on data from 2004-2011 are shown in Table 4. Original and adjusted catch estimates and variances for 1981-2003 are shown in Tables 5-7. Differences between original and adjusted catch and variance estimates for 1981-2003 are plotted in Figures 1 and 2.

In addition to applying ratio estimators to variances of catch estimates to account for the differences in MRFSS and MRIP methodologies, variances were further modified to account for the variance of the ratios used to adjust the catch estimates. The variance of each ratio was approximated using:

$$\hat{V}(\hat{R}) = R^2 \left[ \frac{\hat{V}(\bar{C}_{MRIP})}{\bar{C}_{MRIP}^2} + \frac{\hat{V}(\bar{C}_{MRFSS})}{\bar{C}_{MRFSS}^2} - 2 \frac{COV(\bar{C}_{MRFSS}, \bar{C}_{MRIP})}{\bar{C}_{MRFSS} \bar{C}_{MRIP}} \right] \quad (\text{eq. 3})$$

Where 
$$\hat{V}(\bar{C}) = \frac{1}{n} \frac{\sum_{y=1}^n (\hat{C}_y - \bar{C})^2}{n-1}$$

And 
$$COV(\bar{C}_{MRFSS}, \bar{C}_{MRIP}) = \frac{1}{n} \frac{\sum_{y=1}^n (\hat{C}_{MRFSS} - \bar{C}_{MRFSS})(\hat{C}_{MRIP} - \bar{C}_{MRIP})}{n-1}$$

Resulting variances of ratios are shown in Table 4. These variances of the ratios were then used to adjust the estimates of variance to account for uncertainty in the estimate of the conversion factor using:

$$\hat{V}(\hat{C}_{Y,\hat{R}}) = \hat{C}_{y,MRFSS}^2 \hat{V}(\hat{R}) + \hat{R}^2 \hat{V}(\hat{C}_{y,MRFSS}) - \hat{V}(\hat{R}) \hat{V}(\hat{C}_{y,MRFSS}) \quad (\text{eq. 4})$$

Where  $\hat{V}(\hat{C}_{y,MRFSS})$  = variances of catches after being adjusted

And  $\hat{V}(\hat{R})$  = Variance of the numbers ratio

Variances were adjusted at each stratum (species, sub-region, year, wave, state, mode, and area). These variances are summed across stratum and shown in Tables 5-7.

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[http://www.sefsc.noaa.gov/sedar/Sedar\\_Workshops.jsp?WorkshopNum=002](http://www.sefsc.noaa.gov/sedar/Sedar_Workshops.jsp?WorkshopNum=002)

Table 1. Gulf of Mexico red snapper MRFSS (white) and MRIP (gray) AB1 numbers and variances and B2 numbers and variances for 2004-2011 private fishing mode.

YEAR	MRFSS AB1 NUMBERS	MRIP AB1 NUMBERS	MRFSS AB1 Variance	MRIP AB1 Variance	MRFSS B2 NUMBERS	MRIP B2 NUMBERS	MRFSS B2 Variance	MRIP B2 Variance
2004	499,898	692,536	2,857,090,555	23,927,733,109	1,360,437	1,918,281	11,752,009,742	81,650,647,062
2005	379,671	393,843	2,260,807,557	4,563,320,520	1,189,041	1,448,331	9,095,151,702	52,146,715,220
2006	480,808	486,108	2,469,635,141	5,547,981,513	1,591,308	1,823,225	13,398,037,609	54,902,989,079
2007	615,093	699,481	3,327,235,587	8,289,166,046	1,929,297	2,457,097	19,892,941,855	91,840,925,623
2008	425,654	385,432	1,454,132,621	3,039,141,195	1,372,381	1,564,021	11,429,318,330	50,485,974,106
2009	512,399	563,967	2,364,767,485	8,776,754,956	1,683,063	1,618,482	29,148,418,402	54,106,843,251
2010	227,065	262,426	683,063,853	2,644,147,710	1,119,340	1,207,106	12,585,792,498	49,746,198,238
2011	430,209	371,381	1,868,251,214	3,672,483,377	1,215,499	1,156,030	12,844,104,737	37,515,438,505
Mean	446,350	481,897	2,160,623,001	7,557,591,053	1,432,546	1,649,071	15,018,221,859	59,049,466,386

Table 2. Gulf of Mexico red snapper MRFSS (white) and MRIP (gray) AB1 numbers and variances and B2 numbers and variances for 2004-2011 shore fishing mode.

YEAR	MRFSS AB1 NUMBERS	MRIP AB1 NUMBERS	MRFSS AB1 Variance	MRIP AB1 Variance	MRFSS B2 NUMBERS	MRIP B2 NUMBERS	MRFSS B2 Variance	MRIP B2 Variance
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	4,451	4,293	7,814,623	10,638,087
2006	0	0	0	0	4,953	8,641	14,484,500	71,375,892
2007	0	0	0	0	28,870	13,310	833,449,256	177,614,165
2008	1,542	2,271	2,379,441	5,085,063	4,208	4,225	10,776,235	9,944,824
2009	0	0	0	0	1,382	2,570	1,911,095	6,711,109
2010	0	0	0	0	3,253	2,431	4,271,697	3,560,025
2011	0	0	0	0	0	0	0	0
Mean	193	284	297,430	635,633	5,890	4,434	109,088,426	34,980,513

Table 3. Gulf of Mexico red snapper MRFSS (white) and MRIP (gray) AB1 numbers and variances and B2 numbers and variances for 2004-2011 charterboat fishing mode.

YEAR	MRFSS AB1 NUMBERS	MRIP AB1 NUMBERS	MRFSS AB1 Variance	MRIP AB1 Variance	MRFSS B2 NUMBERS	MRIP B2 NUMBERS	MRFSS B2 Variance	MRIP B2 Variance
2004	577,544	586,492	858,257,828	1,176,961,691	779,765	768,865	1,477,908,997	2,422,951,514
2005	449,216	441,323	579,622,530	894,398,917	710,046	741,077	1,393,488,448	3,573,618,355
2006	488,197	480,471	651,255,022	1,100,267,523	961,880	999,475	2,243,937,123	5,571,982,487
2007	502,275	524,337	576,221,280	1,131,400,893	796,724	787,409	1,601,364,628	2,477,031,135
2008	281,622	290,517	242,010,328	311,199,680	539,576	543,210	949,689,092	1,716,825,141
2009	209,403	231,618	192,116,407	406,420,182	504,090	524,812	967,706,647	2,086,266,454
2010	77,206	71,264	18,308,667	61,649,452	233,221	226,309	214,117,838	1,132,695,613
2011	134,307	148,888	110,361,131	246,855,858	362,829	365,214	502,042,288	1,008,027,907
Mean	339,971	346,864	403,519,149	666,144,275	611,016	619,546	1,168,781,883	2,498,674,826

Table 4. Gulf of Mexico red snapper ratio estimators for numbers, variances, and variances of the numbers ratio estimator.

	Private		Shore		Charter	
	AB1	B2	AB1	B2	AB1	B2
Numbers Ratio Estimator	1.080	1.151	1.473	0.753	1.020	1.014
Variance Ratio Estimator	3.498	3.932	2.137	0.321	1.651	2.138
Variance of Numbers Ratio Estimator	0.003635	0.003080	0.051214*	0.051214	0.000197	0.000107

\* The shore mode AB1 numbers ratio estimator was based on only one year. In order to avoid assuming that the variance of the ratio estimator is zero, the variance of the AB1 ratio estimator was borrowed from the variance of the B2 ratio estimator.



Table 5. Original (white) and adjusted (gray) numbers and variances for private fishing of red snapper in the Gulf of Mexico.

YEAR	MRFSS AB1 Numbers	AB1 Numbers with Ratio Adj.	MRFSS AB1 Variance	AB1 Variance with Ratio Adj.	Adj. A + Adj. B1 Variances with Ratio Estimator Variance Factor	MRFSS B2 Numbers	B2 Numbers with Ratio Adj.	MRFSS B2 Variance	B2 Variance with Ratio Adj.	Adj. B2 Variance with Ratio Estimator Variance Factor
1981	1,637,364	1,768,353	120,406,668,341	421,182,525,857	491,537,339,789	54,798	63,072	414,601,555	1,630,213,314	2,156,916,472
1982	725,623	783,673	59,988,264,668	209,838,949,809	244,303,890,334	10,629	12,234	33,281,649	130,863,445	173,080,549
1983	1,554,385	1,678,736	109,190,875,517	381,949,682,559	445,759,855,515	416	479	172,946	680,025	899,336
1984	232,110	250,678	3,953,364,358	13,828,868,524	16,119,304,913	20,880	24,033	281,520,705	1,106,939,414	1,463,932,153
1985	425,899	459,970	4,858,074,716	16,993,545,357	19,865,163,678	176,819	203,518	2,352,957,422	9,251,828,582	12,280,374,422
1986	247,436	267,230	1,508,225,081	5,275,771,332	6,172,053,140	14,989	17,252	57,642,367	226,649,787	299,777,869
1987	223,882	241,793	1,237,151,900	4,327,557,345	5,042,855,214	36,911	42,485	116,031,333	456,235,202	603,518,607
1988	344,246	371,786	2,257,615,706	7,897,139,740	9,255,659,845	166,096	191,177	2,923,858,845	11,496,612,979	15,225,960,943
1989	370,196	399,811	8,585,236,267	30,031,156,463	35,031,790,787	201,690	232,145	3,347,480,315	13,162,292,597	17,421,157,815
1990	202,792	219,015	1,421,655,040	4,972,949,329	5,793,424,246	361,311	415,868	11,286,744,325	44,379,478,687	58,795,130,621
1991	273,124	294,974	2,153,301,729	7,532,249,449	8,784,225,811	530,725	610,865	9,756,902,548	38,364,140,818	50,797,244,688
1992	663,219	716,277	3,823,166,798	13,373,437,461	15,642,518,328	663,027	763,144	4,712,253,263	18,528,579,829	24,568,083,569
1993	703,771	760,073	4,567,058,009	15,975,568,916	18,716,954,521	654,309	753,110	7,136,930,309	28,062,409,975	37,182,686,291
1994	496,134	535,825	2,127,667,660	7,442,581,473	8,715,580,940	494,226	568,854	4,877,066,940	19,176,627,210	25,418,398,043
1995	388,292	419,356	2,601,481,137	9,099,981,017	10,641,158,357	335,419	386,068	4,324,737,384	17,004,867,394	22,524,958,893
1996	281,009	303,490	1,387,105,705	4,852,095,756	5,661,646,275	345,581	397,764	2,263,722,729	8,900,957,772	11,793,928,017
1997	420,532	454,175	2,828,226,901	9,893,137,701	11,545,361,855	892,325	1,027,066	10,809,585,683	42,503,290,907	56,367,306,974
1998	243,597	263,085	1,027,397,985	3,593,838,153	4,193,652,846	409,356	471,169	1,661,851,660	6,534,400,729	8,666,803,639
1999	419,496	453,055	1,764,053,853	6,170,660,379	7,239,076,808	799,674	920,424	5,626,143,059	22,121,994,507	29,383,932,788
2000	340,077	367,283	1,695,235,332	5,929,933,191	6,934,198,610	882,954	1,016,280	9,121,922,317	35,867,398,551	47,587,542,273
2001	451,779	487,922	2,586,191,071	9,046,496,366	10,581,274,159	1,229,666	1,415,345	11,767,783,178	46,270,923,457	61,528,048,340
2002	509,841	550,629	2,272,079,775	7,947,735,053	9,346,989,088	1,507,645	1,735,300	17,970,613,084	70,660,450,648	93,963,372,017
2003	488,049	527,093	3,358,448,965	11,747,854,481	13,740,472,180	1,390,298	1,600,233	14,693,734,127	57,775,762,587	76,732,841,541

Table 6. Original (white) and adjusted (gray) numbers and variances for shore fishing of red snapper in the Gulf of Mexico.

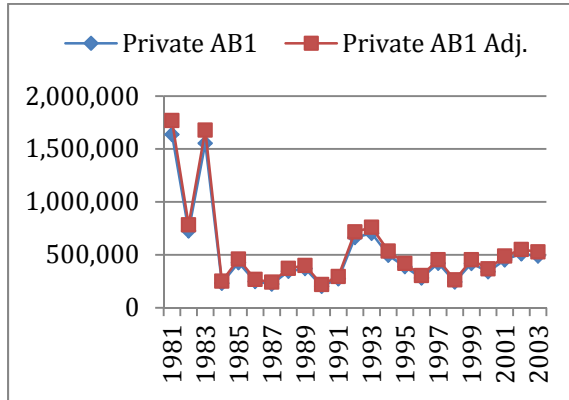
YEAR	MRFSS AB1 Numbers	AB1 Numbers with Ratio Adj.	MRFSS AB1 Variance	AB1 Variance with Ratio Adj.	Adj. A + Adj. B1 Variances with Ratio Estimator Variance Factor	MRFSS B2 Numbers	B2 Numbers with Ratio Adj.	MRFSS B2 Variance	B2 Variance with Ratio Adj.	Adj. B2 Variance with Ratio Estimator Variance Factor
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	11,327	16,685	25,758,480	55,045,872	118,833,411	0	0	0	0	0
1984	17,774	26,182	182,923,034	390,906,525	844,321,315	0	0	0	0	0
1985	6,218	9,160	38,669,580	82,636,893	177,047,921	0	0	0	0	0
1986	212	312	11,139	23,805	52,726	2,921	2,199	8,530,006	2,738,132	1,849,171
1987	1,990	2,931	3,960,384	8,463,340	18,132,540	7,600	5,723	24,934,347	8,003,925	5,405,372
1988	3,763	5,542	7,109,016	15,191,967	32,548,490	3,514	2,646	12,351,481	3,964,825	2,677,606
1989	33,923	49,969	325,828,120	696,294,693	1,534,046,812	14,583	10,981	73,027,683	23,441,886	22,983,232
1990	50,644	74,599	235,773,406	503,847,768	1,093,065,787	36,968	27,837	425,941,096	136,727,092	109,051,644
1991	9,462	13,938	26,100,268	55,776,273	120,236,954	53,506	40,290	918,665,545	294,891,640	199,152,171
1992	0	0	0	0	0	13,518	10,179	78,362,252	25,154,283	20,599,376
1993	4,255	6,268	3,997,170	8,541,952	18,883,556	2,607	1,963	2,272,545	729,487	492,652
1994	4,386	6,461	10,755,463	22,984,424	49,678,154	0	0	0	0	0
1995	0	0	0	0	0	3,235	2,436	10,465,075	3,359,289	2,268,663
1996	0	0	0	0	0	4,281	3,224	6,701,784	2,151,273	1,452,841
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	2,005	1,510	2,019,383	648,222	540,218
1999	0	0	0	0	0	9,808	7,385	38,245,918	12,276,940	8,380,086
2000	0	0	0	0	0	7,327	5,517	29,331,178	9,415,308	6,358,536
2001	0	0	0	0	0	11,185	8,422	24,210,995	7,771,729	6,863,657
2002	1,003	1,478	1,007,635	2,153,316	4,613,399	3,514	2,646	4,509,611	1,447,585	1,119,352
2003	0	0	0	0	0	914	688	834,682	267,933	180,946

Table 7. Original (white) and adjusted (gray) numbers and variances for charterboat fishing of red snapper in the Gulf of Mexico.

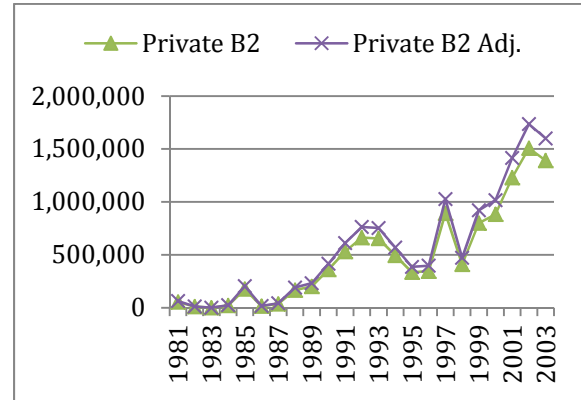
YEAR	MRFSS AB1 Numbers	AB1 Numbers with Ratio Adj.	MRFSS AB1 Variance	AB1 Variance with Ratio Adj.	Adj. A + Adj. B1 Variances with Ratio Estimator Variance Factor	MRFSS B2 Numbers	B2 Numbers with Ratio Adj.	MRFSS B2 Variance	B2 Variance with Ratio Adj.	Adj. B2 Variance with Ratio Estimator Variance Factor
1981	176,069	179,590	0	0	0	241	245	0	0	0
1982	912,203	930,447	0	0	0	14,818	15,026	0	0	0
1983	884,513	902,203	0	0	0	3,255	3,301	0	0	0
1984	498,383	508,350	0	0	0	687	697	0	0	0
1985	524,576	535,068	0	0	0	910	923	0	0	0
1986	549,735	560,729	11,547,847,590	19,065,496,371	19,837,768,465	27,005	27,383	78,955,646	168,807,171	173,562,437
1987	405,417	413,525	13,803,752,805	22,789,995,881	23,711,763,968	27,637	28,024	179,753,762	384,313,544	395,127,903
1988	378,246	385,811	9,004,203,320	14,865,939,681	15,466,585,578	19,797	20,075	95,856,908	204,942,069	210,725,975
1989	252,638	257,691	8,425,143,511	13,909,911,937	14,470,906,773	50,167	50,869	629,496,672	1,345,863,885	1,383,787,327
1990	185,881	189,598	4,141,923,170	6,838,315,153	7,114,215,029	179,271	181,781	9,495,243,069	20,300,829,680	20,872,168,979
1991	443,248	452,113	16,402,520,872	27,080,561,959	28,173,758,229	409,625	415,360	17,487,308,608	37,387,865,804	38,440,794,729
1992	390,721	398,535	7,968,222,546	13,155,535,424	13,687,782,859	295,046	299,177	5,131,749,514	10,971,680,461	11,280,939,122
1993	828,326	844,892	26,089,952,152	43,074,511,003	44,817,129,976	401,567	407,189	12,372,931,289	26,453,327,096	27,198,543,560
1994	452,438	461,487	7,756,702,687	12,806,316,135	13,323,571,946	416,844	422,680	11,601,258,773	24,803,491,256	25,502,109,423
1995	477,306	486,852	13,139,562,398	21,693,417,519	22,571,172,741	410,440	416,186	17,564,061,520	37,551,963,530	38,608,823,389
1996	415,190	423,494	10,405,409,504	17,179,331,091	17,872,591,767	572,942	580,963	26,177,848,644	55,968,240,401	57,543,392,875
1997	662,696	675,949	18,293,857,885	30,203,159,368	31,424,581,753	860,004	872,044	61,807,445,811	132,144,319,144	135,863,314,637
1998	594,159	606,042	1,018,872,145	1,682,157,912	1,756,924,035	559,544	567,378	1,138,165,765	2,433,398,405	2,504,702,634
1999	353,728	360,803	310,757,876	513,061,253	536,175,639	569,169	577,137	718,956,973	1,537,130,008	1,583,417,043
2000	427,034	435,575	579,057,758	956,024,359	998,189,168	537,025	544,544	923,838,097	1,975,165,851	2,033,385,117
2001	396,242	404,167	498,946,673	823,760,958	860,411,738	565,682	573,601	1,211,351,466	2,589,869,435	2,666,417,794
2002	594,958	606,857	897,818,679	1,482,298,639	1,549,980,876	579,892	588,010	902,589,477	1,929,736,302	1,987,362,579
2003	504,636	514,728	702,738,373	1,160,221,054	1,212,103,851	550,425	558,131	765,627,949	1,636,912,555	1,685,651,851

Figure 1. Original and adjusted numbers for AB1 and B2 by mode for red snapper in the Gulf of Mexico 1981-2011.

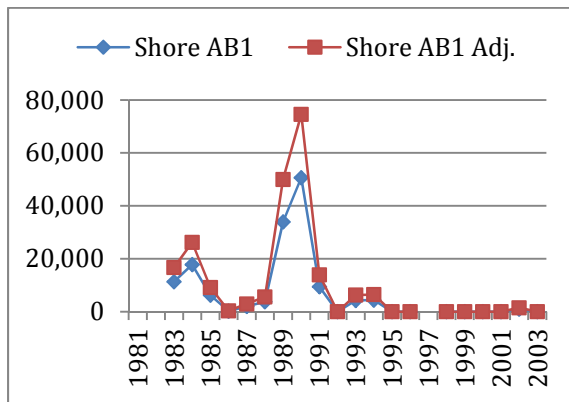
1a. Private AB1 (ratio = 1.080)



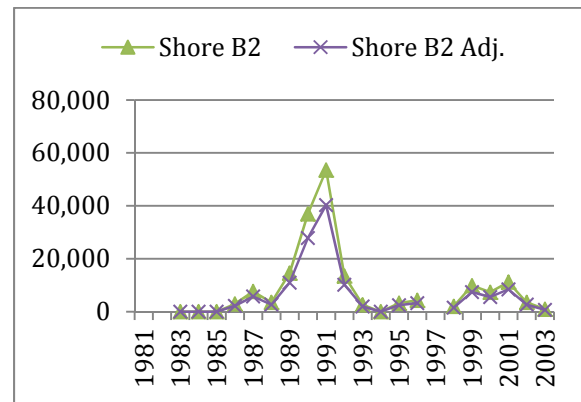
1b. Private B2 (ratio = 1.151)



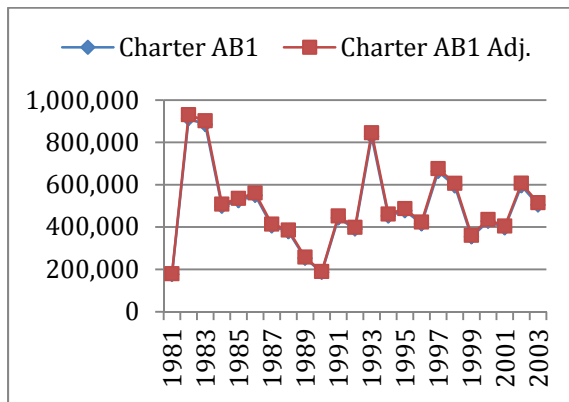
1c. Shore AB1 (ratio = 1.473)



1d. Shore B2 (ratio = 0.753)



1e. Charterboat AB1 (ratio = 1.020)



1f. Charterboat B2 (ratio = 1.014)

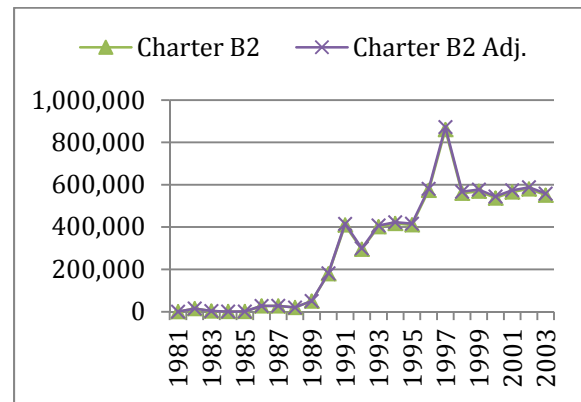
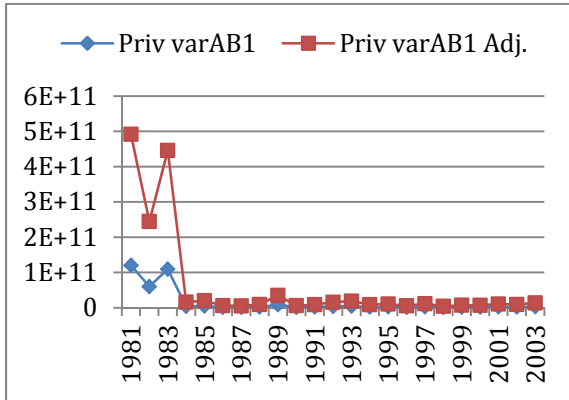
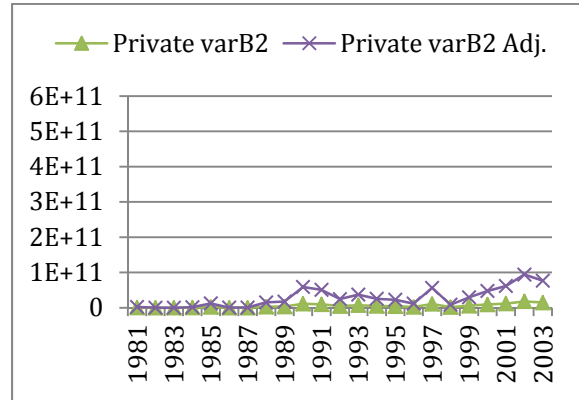


Figure 2. Original and adjusted variances for AB1 and B2 by mode for red snapper in the Gulf of Mexico 1981-2011.

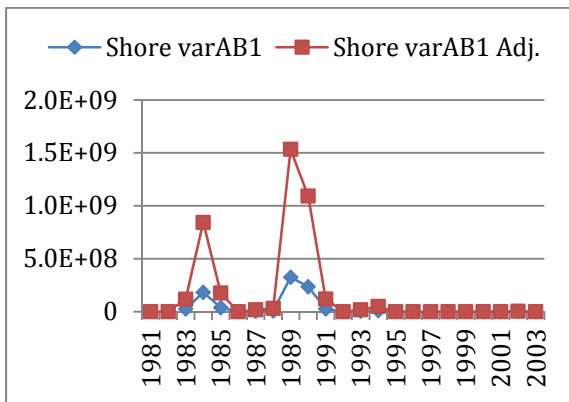
2a. Private AB1 Variance



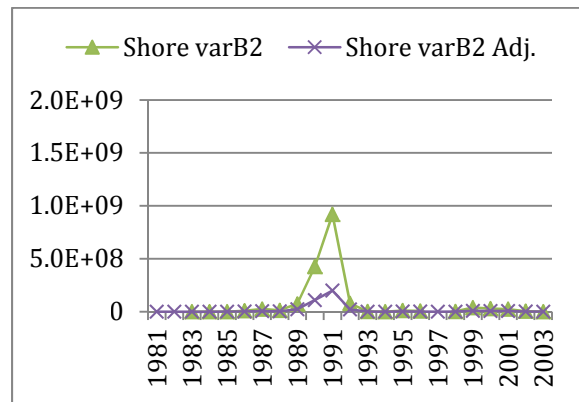
2b. Private B2 Variance



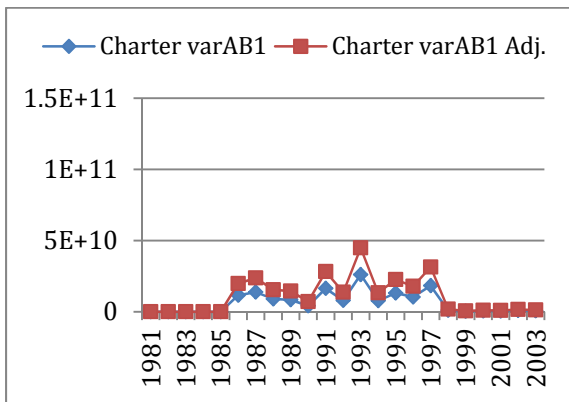
2c. Shore AB1 Variance



2d. Shore B2 Variance



2e. Charterboat AB1 Variance



2f. Charterboat B2 Variance

