Standardized catch rates of Gulf of Mexico greater amberjack catch rates for the recreational fishery (MRFSS, Headboat) 1981-2004

by

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1.MATERIALS AND METHODS

Trip selection for both MRFSS and headboat data sets was based on the result of the analysis of species composition of the catch developed by Stephens and McCall (2004). This approach tends to eliminate trips where the only species caught was the target species (i.e., greater amberjack). The final set of trips used in the analysis were those selected by the species composition approach plus all trips were the only species caught was greater amberjack.

Relative indices of abundance were estimated by a GLM approach assuming a delta-lognormal model distribution. The delta model fits separately the proportion of positive trips (proportion of trips that reported greater amberjack catches) assuming a binomial error distribution and the catch rate estimated only from positive trips assuming a lognormal error distribution. The standardized index is the product of these model-estimated components.

A step-wise procedure was used to determine the set of systematic factors and interactions that significantly explained the observed variability in the proportion of positive sets and the catch rates. Factors were included in the final models if: 1) their inclusion in the model reduced the model deviance by at least 1% and 2) the factor was significant ($Pr<0.05$). The factor *Year* was always included in the final models. Statistical analysis for the selection of significant factors were performed using SAS GENMOD Procedure (SAS Institute 1997)

1.1 MRFSS

Catch rates were estimated for MRFSS catch and effort data for the charterboat and private boat fisheries (mode 3 and 4, respectively). Based on Cummings (2000), four areas were defined for the analysis of the data: 1) SW FL, 2) NW FL, 3) FL panhandle - AL, and 4) LA-MS.

Total catch by trip was estimated as the sum of landings (A+B1) and reported discards (B2). The number of B1 and B2 where adjusted for the number of participants of a given party that were not interviewed. Effort by trip was estimated as the number of anglers times hours fished. Thus, catch-per-unit-effort (CPUE) was the catch of a trip (A+B1+B2) divided by the effort. Because the MRFSS data set provides information on discards, the effect of changes in regulations (i.e., minimum size and bag limits) on catch rates was not investigated.

1.2 HEADBOAT

Following Turner (2000), 5 areas were defined for the analysis of headboat catch rates: 1) SW+CW FL, 2) NW FL-AL, 3) LA, 4) NE TX, and 5) CE+SE TX. CPUE for each trip was estimated as the number of fish caught divided the number of anglers in the trip. To investigate the potential effect of the bag limit regulations, the number of trip with CPUE in the range of 0, 0.001-1, 1.001-3 and >3 were plotted against year. It was assumed that if changes in bag limit affected the catch rates, the 3 fish bag that took effect in 1990 should have increased the proportion of trips with catch rates less than 3. Similarly, when the 1 fish bag limit when into regulation in 1997, an increase in the number of trips with CPUE in the range of 0-1 should be observed. Nominal and standardized catch rates were also estimated for the entire time series and separately for the period 1986-1997 and 1998-2003.

2. RESULTS

2.1 MRFSS

A total of 245,330 trips were used in the species composition trips selection process (total trips). The final number of headboat and private boat trips used in the catch rate analysis was 5,270 and 1,233, respectively (Table 1).

Table 2 shows the results of the stepwise factor selection process for the analysis of proportion of positive trips and catch rates. The factors tested for both models were *Year, Area, month,* and *Mode.* In both cases, only *Year, Area,* and *month* were significant. No interactions were selected because they were either non significant or the model did not converge when included.

Estimated nominal and standardized indexes of abundance are presented in Table 3 and Figure 1. Catch rates were very high at the beginning of the time series and showed a declining trend from 1986 to 1998 when they reached the lowest value of the analyzed period. The declining trend was reversed after 1998 and catch rates showed an increase during 1998-2002 to decrease again the last 2 years of the series (2003-2004).
Table 4 shows the species that were caught in at least 1% of all private boat and charteboat trips and their coefficient of association with greater amberjack.

2.2 HEADBOAT

For the headboat fishery, a total of 16,013 trips were used for the analysis of species composition. The results of such analysis reduced the number of trips to 12,518 (Table 1). Figure 2 shows the percentage of trips per year with no greater amberjack catches and with CPUE in the range of 0.001-1, 1.001-3, and >3. Although

the number of trips with CPUE >3 decreased after the implementation of the 3 fish bag limit regulation, no increase in the number of trips with CPUE in the range of 0.001-3 was observed. In addition, most of the trips on the 0.001-3 CPUE range had CPUE less than 1. The implementation of the 1 fish bag limit in 1997 reduced the percentage of trips with CPUE in the 1.001-3 range to practically 0. But, the proportion of those trip at that time was already so low that the effect of the regulation on the catch rates was probably negligible. A continuous increase of the number of trips with no greater amberjack catches was observed from 1986 to 1999 potentially indicating a decrease in population abundance during that period. The trend was reversed in 1999. In general, in most gears the majority of selected trips had 0.001-1 greater amberjack per angler. As a result, there appears to have been only limited effects of bag limit changes on the proportion of trips with greater amberjack and the observed changes in the percentage of trips with different catch rates seemed to be the result of changes in population abundance more than anything else.

To further investigate the potential impact of fish bag limits on the catch rates, standardized indexes of abundance were estimated for the periods 1986-2003, 1986-1996, and 1997-2003. The results of the stepwise factor selection process for the analysis of catch rates for those three periods are presented in Tables 5-7. The factors *Year* and *Area* were significant and included in the proportion of positive trips and catch rate models for the three periods. The only interaction that resulted significant was *Year*Area* for the catch rate model for the period 1986-1996. The estimated nominal and standardized catch rates and CV for the three periods are presented in Table 8 and figure 3. No significant differences were observed between the indexes for the three periods indicating that fish bag limits had not effect on greater amberjack catch rates for the headboat fishery. The general trend was a continuous decrease of the indexes from the beginning of the time series to 1993, followed by a period of relative stability during 1993-1999. The period 1999-2002 showed a noticeable increase.

Table 9 shows the species that were caught in at least 1% of all headboat trips and their coefficient of association with greater amberjack. Figure 4 shows the standardized indexes estimated for the headboat and MRFSS data sets. Both indexes followed the same trend at the beginning of the time series until 1993. The headboat index remains relatively stable afterwards while the MRFSS index continued to decrease until 1998. Both indexes then behaved almost identically from 1998 to 2003 showing a period of recovery until 2002 and a decline afterwards.

Figure 5 shows the standardized index of abundance for the headboat fishery estimated in the present document, the index estimated by Turner (2000) and used in the last greater amberjack stock assessment in 2000, and the index estimated by Diaz (2005) using all available trips. Although the absolute values between the indexes are different, the observed trends are similar.

REFERENCES

Diaz, G. A. 2005. Standardized catch rates of greater amberjack caught in the commercial and recreational fisheries in the Gulf of Mexico in 1981-2004. Miami Laboratory Document: SFD - 2004 - 064

Stephens, A. and A. McCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70:299-310.

Turner, S. C. 2000. Catch rates of greater amberjack caught in the headboat fisheries in the Gulf of Mexico in 1986-1998. Miami Laboratory Document SFD 99/00-107.

Table 1: Number of charterboat, private boat, charterboat+private boat (Total) and headboat trips that were selected by the species composition analysis and that were used in the analysis of catch rates.

Year	Charterboat	Private boat	Total	headboat
1981	220	29	249	
1982	142	81	233	
1983	98	35	133	
1984	92	46	138	
1985	45	12	57	
1986	220	29	249	1010
1987	142	81	233	834
1988	98	35	133	1002
1989	92	46	138	882
1990	45	12	57	624
1991	139	24	163	633
1992	233	72	305	681
1993	134	49	183	710
1994	112	38	150	536
1995	57	23	80	691
1996	73	36	109	539
1997	152	28	180	724
1998	247	31	278	599
1999	456	74	530	591
2000	529	67	596	613
2001	398	139	537	739
2002	600	144	744	588
2003	638	133	771	522
2004	802	125	927	
total	5,270	1,233	6,503	12,518

Table 2: Results of the step-wise procedure to select significant factors for the analysis of MRFSS catch rates, d.f. indicates degrees of freedom, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of a factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		8568.2				
Year	23	7838.8	8.18	8.18	729.4	0.0000
Year Area	3	7570.9	3.37	3.37	267.9	0.0000
Year Area Month	11	7427.2	1.73	1.73	143.7	0.0000
Year Area Month Mode	1	7403.2	0.31	0.31	24.0	0.0000

B)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		4810.1	1.122			
Year	23	4544.5	1.157	4.97	224.43	0.0000
Year Area	3	4471.8	1.140	1.52	63.69	0.0000
Year Area Month	11	4398.1	1.124			

Table 3: Estimated nominal and standardized catch rates and associated CV for the chaterboat and private boat fisheries combined.

Year	Nominal	Standardized	CV
1981	0.234	0.279	40.9%
1982	0.411	0.460	24.3%
1983	0.905	0.802	26.7%
1984	1.130	1.211	27.9%
1985	0.347	0.273	46.3%
1986	1.080	0.819	9.7%
1987	0.879	0.806	9.4%
1988	0.742	0.521	13.0%
1989	0.766	0.739	11.3%
1990	0.274	0.195	34.1%
1991	0.626	0.495	14.9%
1992	0.526	0.479	10.1%
1993	0.378	0.345	16.4%
1994	0.283	0.328	19.1%
1995	0.422	0.268	31.1%
1996	0.217	0.225	25.2%
1997	0.163	0.171	30.6%
1998	0.124	0.109	27.7%
1999	0.134	0.145	26.9%
2000	0.180	0.201	12.1%
2001	0.334	0.262	11.6%
2002	0.319	0.325	8.3%
2003	0.283	0.291	8.9%
2004	0.143	0.152	12.3%

Table 4: Coefficient of association of greater amberjack with species reported in at least 1% of all private and charterboat trips combined.

Species	Coefficient	Species	Coefficient
red snapper	2.640	southern flounder	-0.337
blue runner	0.939	black sea bass	-0.357
cobia	0.876	spanish mackerel	-0.377
vermilion snapper	0.709	gulf flounder	-0.527
little tunny	0.703	inshore lizardfish	-0.547
gag	0.451	black drum	-0.821
red grouper	0.392	red drum	-0.818
gray triggerfish	0.329	pigfish	-1.004
king mackerel	0.276	ladyfish	-1.104
gray snapper	0.275	hardhead catfish	-1.137
lane snapper	0.156	sheepshead	-1.171
pinfish	0.071	southern kingfish	-1.415
sand seatrout	-0.101	gafftopsail catfish	-1.891
white grunt	-0.110	spotted seatrout	-2.202
sand perch	-0.139	common snook	-2.686
crevalle jack	-0.139	stingray genus	-2.709
scaled sardine	-0.246		
atlantic croaker	-0.325		

Table 5: Results of the step-wise procedure to select significant factors for the analysis of headboat catch rates for year 1986-2003, d.f. indicates degrees of freedom, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of a factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		17131.2	1.368			
Year	17	16457.6	1.316	3.80	673.66	0.0000
Year Area	4	16158.3	1.291	1.79	299.34	0.0000
Year Area Season	2	16134.9	1.197	0.13	23.32	0.0000

B)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		2602.5	0.479			
Area	4	2497.2	0.461	3.98	224.21	0.0000
Area Year	17	2445.1	0.452	1.78	114.5	0.0000
Year Area Season	2	2443.9	0.452	0.01	2.51	0.2848

Table 6: Results of the step-wise procedure to select significant factors for the analysis of headboat catch rates for year 1986-1996, d.f. indicates degrees of freedom, Deviance/d.f. the model deviance per degrees of freedom of the model, and % reduction is the reduction of the model deviance obtained by the inclusion of a factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		11275.7	1.385			
Year	10	10870.2	1.336	3.48	405.5	0.0000
Year Area	4	10545.6	1.297	2.94	324.5	0.0000
Year Area Season	2	10537.2	1.296	0.06	8.48	0.0144

B)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		2304.6	0.588			
Area	4	2223.6	0.568	3.41	140.1	0.0000
Area Year	10	2175.8	0.557	1.90	85.23	0.0000
Year Area Season	2	2174.6	0.557	0.00	2.15	0.3405
Area Year Year*Area	40	2116.7	0.547	1.71	107.94	0.0000

Table 7: Results of the step-wise procedure to select significant factors for the analysis of headboat catch rates for year 1996-2003, d.f. indicates degrees of freedom, Deviance/d.f. the model deviance per degrees of freedom of the model, and % reduction is the reduction of the model deviance obtained by the inclusion of a factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		5636.7	1.288			
Area	4	5423.6	1.241	3.69	213.03	0.0000
Area Year	6	5368.0	1.229	0.89	55.64	0.0000
Area Year Season	2	5336.9	1.223	0.53	31.06	0.0000

B)

Factor	d.f. added factor	Model Deviance	Deviance/d.f.	% reduction	Chi-square	Probability
Base		287.4	0.191			
Area	4	255.5	0.170	10.87	177.5	0.0000
Area Year	6	230.7	0.154	9.33	153.7	0.0000
Area Year Season	2	229.1	0.153	0.56	10.46	0.0053

Table 8: Estimated nominal and standardized catch rates and associated CV for the Headboat fishery for periods 1986-2203, 1986-1996, and 1997-2003.

Year	Nominal	Stand.	CV	Nominal	Stand.	CV	Nominal	Stand.	CV
1986	0.42	0.40	13.4%	0.42	0.30	33.3%			
1987	0.23	0.21	18.2%	0.23	0.18	38.8%			
1988	0.25	0.22	16.9%	0.25	0.20	37.1%			
1989	0.28	0.29	13.7%	0.28	0.25	32.6%			
1990	0.18	0.15	23.4%	0.18	0.13	46.0%			
1991	0.12	0.11	33.2%	0.12	0.10	57.9%			
1992	0.18	0.12	28.6%	0.18	0.10	52.7%			
1993	0.09	0.08	32.2%	0.09	0.09	56.9%			
1994	0.10	0.09	34.7%	0.10	0.11	55.8%			
1995	0.11	0.13	29.5%	0.11	0.13	51.7%			
1996	0.10	0.09	41.9%	0.10	0.09	67.3%			
1997	0.09	0.09	35.2%				0.09	0.05	64.1%
1998	0.09	0.09	38.4%				0.09	0.05	68.9%
1999	0.09	0.09	43.3%				0.09	0.43	76.8%
2000	0.10	0.10	37.4%				0.10	0.06	64.9%
2001	0.14	0.14	28.8%				0.14	0.08	48.4%
2002	0.15	0.17	28.4%				0.15	0.12	43.8%
2003	0.12	0.15	31.5%				0.12	0.11	47.5%

Table 9: Coefficient of association of greater amberjack with species reported in at least 1% of all headboat trips.

Species	Coefficient	Species	Coefficient
vermilion snapper	1.001	white grunt	-0.078
great barracuda	0.958	knobbed porgy	-0.100
blackfin tuna	0.801	pigfish	-0.110
almaco jack	0.790	red snapper	-0.111
yellowtail snapper	0.737	bigeye	-0.111
littlehead porgy	0.700	gray triggerfish	-0.114
cobia	0.674	tomtate	-0.144
wahoo	0.660	bluefish	-0.164
scamp	0.390	whitebone porgy	-0.166
blue runner	0.276	jolthead porgy	-0.173
warsaw grouper	0.264	lane snapper	-0.222
gray snapper	0.221	squirrelfish	-0.223
rock hind	0.178	black sea bass	-0.238
atlantic croaker	0.174	sandbar shark	-0.259
king mackerel	0.123	dolphins	-0.291
red grouper	0.081	mutton snapper	-0.350
black grouper	0.079	banded rudderfish	-0.406
gag	0.074	bank sea bass	-0.453
little tunny	0.059	red porgy	-0.510
-0.588queen triggerfish	0.008	spanish mackerel	-0.588
uniden-0.673tified shark	0.001	black drum	-0.673
atlantic sharpnose shark	-0.019	lefteye flounder family	-0.746
sand perch	-0.038	sand seatrout	-0.816
atlantic spadefish	-0.076	crevalle jack	-0.866
blacktip shark	-0.077	red drum	-1.459

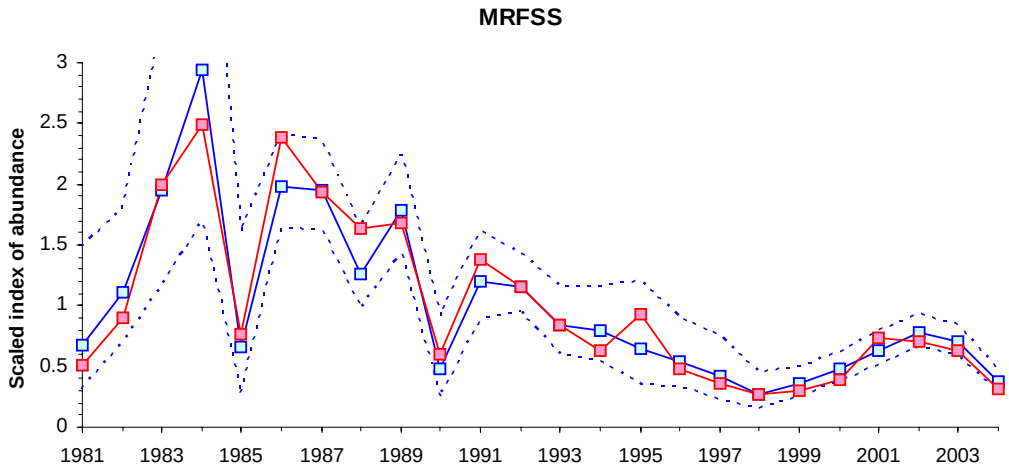

Figure 1: Estimated greater amberjack nominal (red line) and standardized (blue line) indexes of abundance for MRFSS (private+charterboat). Dashed blue line shows 95% confidence interval of the standardized index.

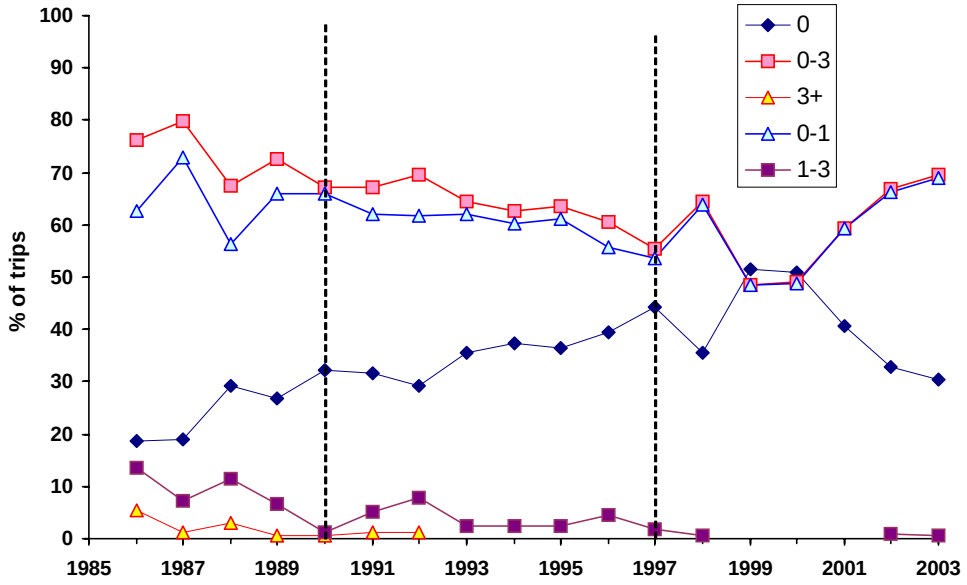

Figure 2: Percentage of headboat trips by year with CPUE=0 and CPUE in the range 0.001-1(0-1), 1.001-3 (1-3), 0.001-3 (1-3), and >3+ (3+). Vertical dashed lines show year of implementation of the 3 fish bag limit (1990) and 1 fish bag limit (1997).

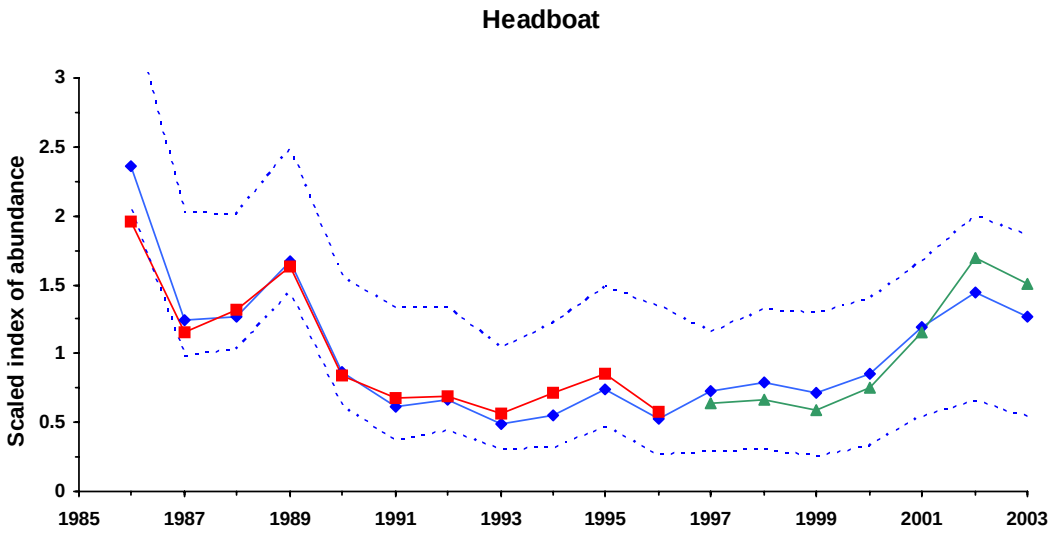

Figure 3: Estimated standardized indexes of abundance for the headboat fishery for the periods 1986-2003, 1986-1996, and 1997-2003. Dashed blue line shows 95% confidence interval of the standardized index for the entire period 1986-2003. For comparison purposes the indexes were scaled to their means of the corresponding overlapping time period.

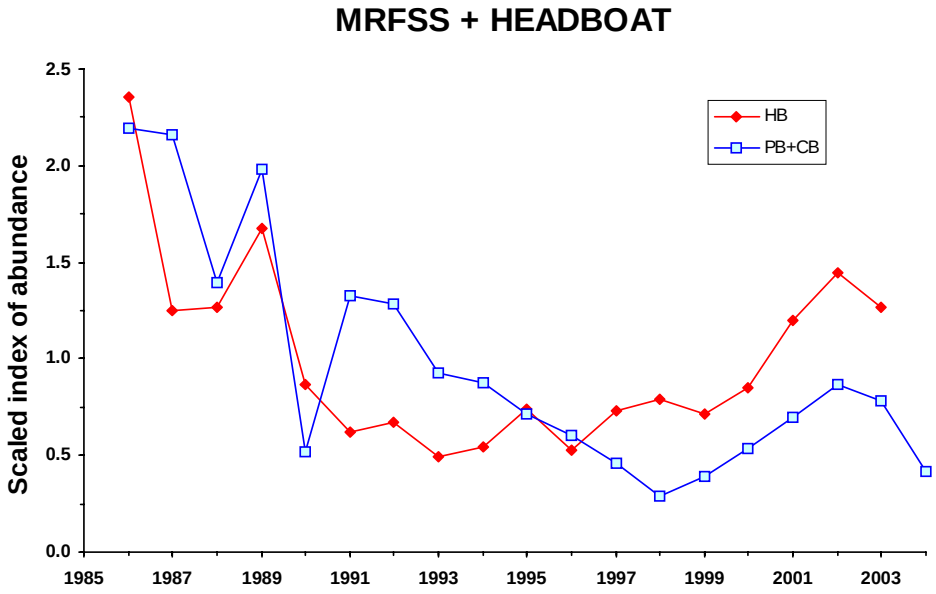

Figure 4: Standardized indexes of abundance for the headboat and the private+charterboat fisheries. For comparison purposes the indexes were scaled to their means of the corresponding overlapping time period.

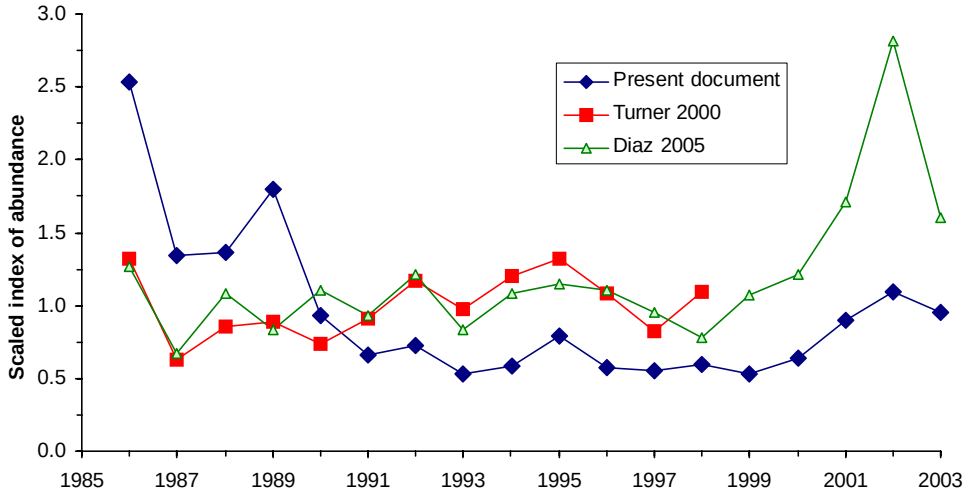

Figure 5: Estimated greater amberjack standardized index of abundance for the headboat fishery in the present document and by Turner (2000). For comparison purposes the indexes were scaled to their mean of the years where the series overlap.