Standardized catch rates for red grouper from the United States Gulf of Mexico handline, longline, and trap fisheries, 1990-2005

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Introduction

Handline, longline, and fish trap catch and fishing effort of commercial vessels operating in the Gulf of Mexico have been monitored by the National Marine Fisheries Service (NMFS) through the coastal logbook program (conducted by the NMFS Southeast Fisheries Science Center). The program collects data by fishing trip on catch and effort for vessels with permits to fish in a number of fisheries managed by the Gulf of Mexico Fishery Management Council. The Gulf of Mexico coastal logbook program began in 1990 with the objective of a complete census of reef fish fishery permitted vessel activity, with the exception of Florida, where a 20% sample of vessels was targeted. Beginning in 1993, the sampling in Florida was increased to require reports from all vessels permitted in the reef fish fishery.

The available catch per unit effort (CPUE) series, from 1990 - 2005, was used to develop six abundance indices for red grouper. Three indices; constructed using handline, longline, and trap data; were developed following methods used in the 2002 red grouper assessment. Handline, longline, and trap data were also used to construct additional indices using alternative methods for red grouper trip identification and index development.

Several regulatory controls on fishing effort and landings were considered in those analyses. Commercial harvest and sale of red, black, and gag grouper is prohibited each year from February 15 to March 15. This prohibition began in 2001. Additionally, in 2004 commercial harvest of shallow water grouper species, including red grouper, was closed beginning on November 15th because the shallow water grouper quota was met. Likewise, shallow water grouper harvest was closed beginning on October 10, 2005. Data from those periods of harvest moratorium were excluded while developing the indices.

Methods

Replication of 2002 indices

The following indices were constructed using the methods applied during the previous red grouper assessment (2002). They are intended to demonstrate the effect of updating the data without changing the standardization procedure.

Commercial HL

The dataset used to construct this index included all trips that fished with handlines and/or electric reels within shrimp statistical grids (areas) 1-9 (Figure 1), with the following exceptions: 1) trips that fished in multiple areas and 2) trips that fished with multiple gears were excluded from the analysis.

A lognormal model was fit to catch rates on positive trips. The model fit to the data was:

LOG(lbs/hook·hr) = YEAR + MONTH + SHRIMP GRID

Commercial LL

The dataset used to construct this index included all trips that fished with longlines within the U.S. Gulf of Mexico (shrimp statistical grids 1-21, Figure 1) with the following exceptions: 1) trips that fished in multiple areas and 2) trips that fished with multiple gears were excluded from the analysis.

A lognormal model was fit to catch rates on positive trips. The model fit to the data was:

LOG(lbs/days away) = YEAR + MONTH + SHRIMP GRID

Commercial Trap

The dataset used to construct this index included all trips that fished with longlines within the U.S. Gulf of Mexico (shrimp statistical grids 1-21, Figure 1) with the following exceptions: 1) trips that fished in multiple areas and 2) trips that fished with multiple gears were excluded from the analysis.

A lognormal model was fit to catch rates on positive trips. The model fit to the data was:

LOG(lbs/days away) = YEAR + MONTH + SHRIMP GRID

Alternate Indices

For each fishing trip, the logbook database includes a unique trip identifier, the landing date, fishing gear deployed, areas fished (equivalent to NMFS shrimp statistical grids, Figure 1), number of days at sea, number of crew, gear specific fishing effort (e.g. number of lines fished, number of hooks per line and estimated total fishing time), species caught and whole weight of the landings. Multiple areas fished may be recorded for a single fishing trip. In such cases, assigning catch and effort to specific locations was not possible; therefore, only trips in which one area fished was reported were included in these analyses. Prior to 2001, handline and electric reel (bandit rigs) gears were reported as a single gear type. Data from trips using those gear types were combined in these analyses.

Handline catch rate was calculated in weight of fish per hook-hour. For each trip, catch per unit effort was calculated as:

CPUE = landings of red grouper/(number of lines fished*hooks per line*total hours fished)

Longline catch rate was calculated in weight of fish per hook fished. For each trip, catch per unit effort was calculated as:

CPUE = total pounds of red grouper/(number of longline sets*number of hooks per set)

The data for number of hours fished while using longline gear is unreliable in the coastal logbook program due to misreporting. Calculating CPUE by hook-hour could not be done for the longline data.

Fish trap catch rate was calculated in weight of fish per trap fished. For each trip, catch per unit effort was calculated as:

CPUE = total pounds of red grouper/number of traps fished

For these trap data, the number of hours fished and the number of sets while using traps has clearly been misreported. This is probably due to confusion among fishers as to how those data should be reported. Calculating CPUE by soaktime (total trap-hours fished) was not possible with the trap data.

Data were restricted geographically to Areas 1 – 11 for handlines, Areas 1-10 for longlines, and Areas 1-8 for traps (Figure 1). Those areas accounted for greater than 99% of the red grouper landings reported to the coastal logbook program for each of those gear types during the years 1990 – 2005.

Red grouper trips were identified using the Stephens and MacCall (2004) approach, where trips are subset based upon the reported species composition of the landings. This method is intended to identify trips that fished in locations containing red grouper habitat and, therefore, had the potential of catching red grouper. Once red grouper trips were identified, restrictions were made by eliminating trips with reported data for days at sea, longline length, number of crew, number of lines fished (or longline sets or traps fished), number of hooks per line, or hours fished that fell beyond the 99.5 percentile of the data as a whole. For example, trips with handline vessels that reported more than 35 hooks per line were eliminated from the dataset.

Index Development

Handline

For the handline index, five factors were considered as possible influences on the proportion of trips that landed red grouper and are summarized below:

Factor	Levels	Value
YEAR	16	1990-2005
AREA	11	Gulf of Mexico shrimp grids 1-11
DAYS	4	1=1 day at sea, 2=2-3 days at sea, 4= 4-6 days at sea, 7=7-14 days at sea
MONTH	12	Month of the year
CREW	3	1, 2, 3 or more crew members

The delta lognormal model approach (Lo et al. 1992) was used to develop standardized indices of abundance for the handline data. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed red grouper) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM procedure of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was “normal”, and the response variable was ln(CPUE). The response variable was calculated as: ln(CPUE) = ln(pounds of red grouper/hook hours). All 2-way interactions among significant main effects were examined.

A stepwise approach was used to quantify the relative importance of the factors. First a GLM model was fit on year. These results reflect the distribution of the nominal data. Next, each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was

examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was ≥1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. Higher order interaction terms were not examined.

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

Longline

In developing the longline index, the same factors considered for the handline index were also examined. For the longline index only areas 1-10 were included. In addition, length of the longline was also examined where trips were grouped by: longline length <3, 3-3.9, 4-4.9, 5-5.9, 6-6.9, and 7 or more miles. The number of days at sea was categorized as: 1-2, 3-4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15-20. Of the trips identified as potential red grouper trips, the proportion of positive trips was greater than 90%. With such a high proportion of positive trips, a GLM assuming a binomial error distribution was inappropriate. A GLM assuming a lognormal error distribution was used to examine the above factors for effects on red grouper CPUE. In order to include all red grouper trips identified using the Stephens and MacCall (2004) method, including trips that did not report red grouper landings, a constant (10% of the mean red grouper CPUE) was added to the CPUE of each trip. Factors that significantly affected CPUE were then identified using the GLM assuming lognormal error distribution as described for handlines. The index was fit using the Proc Mixed procedure in SAS. Again all factors were modeled as fixed effects except two-way interaction terms containing YEAR that were modeled as random effects.

Trap

The red grouper trap index of abundance was developed similarly to the index developed from longline data. Factors considered as possible influences on red grouper CPUE included those listed for handline, but only areas 1-8 were considered. Trips were grouped in the following days at sea categories: 1, 2, 3, 4, 5, 6, 7, 8, or 9-16. As with the longline data, the proportion of positive trips was greater than 90%. Data from trips identified as potential red grouper trips were used, with a constant (10% of the mean CPUE) added to the CPUE of each trip. The index developed from trap data was constructed as described for the longline index.

Results and Discussion

Replication of 2002 indices

Commercial HL

The updated index is nearly identical to the 2002 commercial handline index (Figure 2). The index shows a general increase in the CPUE of red grouper from 1998 to 2005. The 2005 CPUE estimate is the highest observed. The index results, including CV and 80% confidence limits are summarized in Table 1 and Figure 3.

Commercial LL

The updated longline index is nearly identical to the 2002 index (Figure 4). Unlike the handline index described above, the longline index varies without obvious trend. However, the 2005 CPUE estimate is the highest observed. The index results, including CV and 80% confidence limits are summarized in Table 2 and Figure 5.

Commercial Trap

The updated trap index is very similar to the 2002 index during the period 1992-2001, however substantial departures are noted during 1990 and 1991 (Figure 6). These differences are likely due to changes in the raw data set, and are not due to differences in the methodologies. Early in the time series, the CPUE estimates are lower than average. After 1998, the CPUE estimates are typically higher than the series mean. The index results, including CV and 80% confidence limits are summarized in Table 3 and Figure 7.

Alternate Indices

Handline

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips were:

PPT = YEAR + DAYS + AREA

LN(CPUE) = YEAR + AREA + CREW + MONTH + YEAR*AREA + AREA*MONTH + YEAR*MONTH

The linear regression statistics of the final models are summarized in Table 4. Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Table 5 for the red grouper handline data. The delta-lognormal handline abundance indices, with 95% confidence intervals, are shown in Figure 8. The GLM on proportion positive trips that included the interaction Year*Area failed to converge. That interaction term was excluded from further analyses.

Standardized catch rates developed from red grouper handline data were relatively constant during all first six years of the time series. Catch rates decreased slightly over the three years ending in 1998. Over the last seven years of the time series examined, catch rates have been increasing, except for a decrease in 2003.

Longline

The final model for the lognormal on CPUE of successful trips was:

LN(CPUE) = YEAR + LENGTH + AREA + YEAR*AREA

The linear regression statistics of the final model are summarized in Table 6. Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Table 7 for the red grouper longline data. The delta-lognormal handline abundance indices developed, with 95% confidence intervals, are shown in Figure 9.

Standardized catch rates developed from red grouper longline data have increased only slightly over the time series examined. Somewhat higher catch rates were observed during the years 2001, 2004, and 2005. Lowest standardized CPUE was in 1992.

Trap

The final model for the lognormal on CPUE of successful trips was:

LN(CPUE) = YEAR + AREA + DAYS + MONTH + YEAR*AREA + YEAR*DAYS + AREA*DAYS + AREA*MONTH + YEAR*MONTH

The linear regression statistics of the final model are summarized in Table 8. Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Table 9 for the red

grouper trap data. The delta-lognormal handline abundance indices, with 95% confidence intervals, are shown in Figure 10.

Red grouper standardized catch rates developed from trap data have no consistent trend over the time series. A slight increase in catch rates during 1990-1994 was followed by four years of decreasing CPUE. The lowest catch rate in the series was observed in 1998 with the highest catch rate occurring in 1999. Catch rates steadily decreased during the period 2000-2003 then increased in 2005.

Of the three standardized indices developed using the Stephens and MacCall method for identifying red grouper trips, the handline index has the most noticeable trend in catch rate. During the second half of the time series (since 1998), catch rates of red grouper increased except during 2003. The other two indices have either catch rates that are consistent over time or have a slight increase over the complete time series.

Indices developed using the 2002 method and the alternate method are compared in Figure 11 (handline), Figure 12 (longline), and Figure 13 (trap). Trends in catch rates for indices developed from similar datasets (e.g. handline data) are generally similar between the two methods of index construction. There were, however, differences in magnitude of CPUE between the two methods used to construct these indices, particularly in the indices developed using trap data.

Literature Cited

Lo, N.C., L.D. Jackson, J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299-310.

Table 1. Standardized CPUE, coefficients of variation and 80% confidence intervals for the commercial handline index (2002 methods).

Year	Index	CV	Lower 80% CI	Upper 80% CI
1990	0.8126	0.3373	0.5374	1.2289
1991	0.8493	0.0490	0.7985	0.9033
1992	0.9160	0.0426	0.8681	0.9665
1993	0.7078	0.0278	0.6834	0.7330
1994	0.8038	0.0258	0.7781	0.8303
1995	0.8383	0.0261	0.8112	0.8664
1996	0.6412	0.0256	0.6209	0.6622
1997	0.7053	0.0251	0.6834	0.7279
1998	0.6474	0.0245	0.6277	0.6677
1999	0.8743	0.0230	0.8493	0.9000
2000	1.1144	0.0222	1.0838	1.1460
2001	1.2866	0.0222	1.2511	1.3232
2002	1.5266	0.0231	1.4828	1.5718
2003	1.1230	0.0236	1.0901	1.1569
2004	1.4673	0.0241	1.4235	1.5124
2005	1.6861	0.0263	1.6311	1.7428

Table 2. Standardized CPUE, coefficients of variation and 80% confidence intervals for the commercial longline index (2002 methods).

Year	Index	CV	Lower 80% CI	Upper 80% CI
1990	0.9658	0.2301	0.7254	1.2859
1991	0.7763	0.1292	0.6601	0.9129
1992	0.5908	0.1302	0.5017	0.6957
1993	1.2746	0.1148	1.1034	1.4723
1994	0.8217	0.1140	0.7121	0.9483
1995	0.7804	0.1146	0.6757	0.9012
1996	0.9086	0.1136	0.7878	1.0480
1997	0.9702	0.1133	0.8416	1.1185
1998	1.0433	0.1133	0.9049	1.2029
1999	1.2215	0.1134	1.0594	1.4084
2000	0.8782	0.1137	0.7613	1.0130
2001	1.1382	0.1131	0.9874	1.3120
2002	1.0786	0.1134	0.9354	1.2437
2003	0.9060	0.1134	0.7857	1.0447
2004	1.1697	0.1136	1.0141	1.3491
2005	1.4762	0.1143	1.2787	1.7041

Table 3. Standardized CPUE, coefficients of variation and 80% confidence intervals for the commercial trap index (2002 methods).

Year	Index	CV	Lower 80% CI	Upper 80% CI
1990	0.5956	0.2047	0.4614	0.7688
1991	0.8100	0.1230	0.6941	0.9452
1992	0.8565	0.1174	0.7391	0.9927
1993	0.7694	0.1152	0.6658	0.8891
1994	0.7780	0.1164	0.6722	0.9004
1995	0.8636	0.1173	0.7453	1.0007
1996	0.6270	0.1175	0.5410	0.7267
1997	0.9098	0.1186	0.7839	1.0559
1998	0.6990	0.1238	0.5984	0.8165
1999	1.3677	0.1203	1.1759	1.5907
2000	1.6288	0.1198	1.4014	1.8930
2001	1.2858	0.1230	1.1018	1.5006
2002	1.2337	0.1205	1.0606	1.4352
2003	0.8788	0.1224	0.7537	1.0248
2004	1.3507	0.1271	1.1516	1.5842
2005	1.3457	0.1339	1.1377	1.5917

Table 4. Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for red grouper in the Gulf of Mexico for vessels reporting handline landings 1990-2005.

a.

source	df	% reduction dev/df	chi square	p>chi square
year	15		1547.97	<0.0001
days	3	8.98	5361.84	<0.0001
area	10	10.53	5990.90	<0.0001

b.

source	df	% reduction dev/df	chi square	p>chi square
year	15		418.05	<0.0001
area	10	19.78	1980.39	<0.0001
crew	2	4.34	1930.32	<0.0001
month	11	1.02	62.33	<0.0001
year*area	146	2.07	1023.23	<0.0001
area*month	110	1.26	619.74	<0.0001
year*month	161	1.02	599.26	<0.0001

Table 5. Handline relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for red grouper (1990-2005) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1990	0.879391	524	0.818702	0.695932	0.44369	1.091576	0.227943
1991	0.749711	877	0.769669	0.647542	0.425821	0.984711	0.211905
1992	1.028832	1,057	0.843898	0.747581	0.506926	1.102484	0.196086
1993	0.837698	2,712	0.738201	0.68321	0.482617	0.967175	0.175109
1994	0.91172	3,260	0.755828	0.882157	0.633854	1.227729	0.166411
1995	0.934912	3,273	0.726245	0.871166	0.628675	1.207189	0.1642
1996	0.541588	3,679	0.686056	0.607847	0.433369	0.852571	0.170384
1997	0.565377	4,076	0.65211	0.565731	0.399981	0.800165	0.174661
1998	0.508538	4,756	0.632464	0.536622	0.379504	0.758789	0.174522
1999	0.787851	5,130	0.670175	0.717472	0.518217	0.993342	0.163752
2000	1.09465	4,975	0.72603	0.986686	0.720294	1.3516	0.158325
2001	1.142668	4,921	0.792725	1.453401	1.067544	1.978723	0.155195
2002	1.49484	4,856	0.808896	1.521937	1.125402	2.05819	0.151785
2003	1.12771	4,701	0.81706	1.139973	0.844665	1.538526	0.150756
2004	1.729313	4,409	0.861193	1.773366	1.321979	2.378879	0.147671
2005	1.665202	3,519	0.88008	2.169379	1.611426	2.920522	0.149486

Table 6. Linear regression statistics for the final GLM models on catch rates on positive trips for red grouper in the Gulf of Mexico for vessels reporting longline landings 1990-2005.

source	df	% reduction dev/df	chi square	p>chi square
year	15		85.58	<0.0001
length	5	2.48	392.05	<0.0001
area	9	1.37	156.99	<0.0001
year*area	134	2.24	501.52	<0.0001

Table 7. Longline relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for red grouper (1990-2005) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1990	0.603125	195	0.773679	0.594024	1.007668	0.132697
1991	0.654069	308	0.778615	0.612473	0.989825	0.120439
1992	0.626344	259	0.68038	0.521757	0.887227	0.133311
1993	2.254388	906	0.97293	0.787608	1.201858	0.105952
1994	0.841239	1,097	0.83165	0.676318	1.022656	0.10365
1995	0.883739	910	0.976892	0.795768	1.199241	0.102804
1996	0.664732	1,240	0.843683	0.687067	1.036001	0.102944
1997	0.841699	1,343	1.011894	0.830521	1.232875	0.099004
1998	1.131293	1,230	0.982457	0.802774	1.202359	0.10125
1999	0.894449	1,262	1.002236	0.813295	1.23507	0.104733
2000	0.859172	1,180	0.994235	0.812335	1.216867	0.101289
2001	1.074477	1,229	1.318567	1.085836	1.601181	0.097327
2002	1.348123	1,187	1.024595	0.837513	1.253467	0.101065
2003	0.892976	1,307	0.977595	0.79926	1.195721	0.10096
2004	1.155544	1,302	1.277705	1.050376	1.554234	0.098194
2005	1.274633	1,133	1.552887	1.276	1.889858	0.09843

Table 8. Linear regression statistics for the final GLM models on catch rates on positive trips for red grouper in the Gulf of Mexico for vessels reporting trap landings 1990-2005.

source	df	% reduction dev/df	chi square	p>chi square
year	15		85.59	<0.0001
area	7	27.88	652.00	<0.0001
days	8	20.35	143.22	<0.0001
month	11	3.79	34.16	0.0003
year*area	93	6.62	583.43	<0.0001
year*days	120	3.09	321.94	<0.0001
area*days	56	2.20	236.24	<0.0001
area*month	77	1.27	181.98	<0.0001
year*month	161	1.06	259.35	<0.0001

Table 9. Trap relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for red grouper (1990-2005) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1990	0.780379	228	0.821169	0.577937	1.166769	0.176996
1991	1.037095	337	0.942662	0.676815	1.312931	0.166798
1992	0.830952	751	1.028647	0.741597	1.426804	0.164697
1993	0.518173	930	0.947719	0.68599	1.309306	0.162658
1994	0.933751	816	1.121327	0.810047	1.552224	0.163668
1995	1.171113	717	1.058625	0.758957	1.476615	0.167549
1996	0.592134	694	0.794164	0.558485	1.129298	0.177403
1997	0.823875	619	0.767825	0.534805	1.102374	0.182318
1998	0.531894	392	0.659565	0.450036	0.966649	0.192886
1999	1.177524	487	1.301736	0.920397	1.841073	0.174635
2000	1.370369	526	1.273276	0.914994	1.77185	0.166349
2001	0.978911	434	1.00898	0.70602	1.441941	0.179957
2002	1.064813	516	0.953348	0.669776	1.356979	0.177902
2003	1.652919	392	0.845506	0.585998	1.219937	0.18486
2004	1.18556	294	1.245677	0.874341	1.77472	0.178377
2005	1.350538	230	1.229775	0.858718	1.761166	0.18103

Figure 1. Gulf of Mexico Commercial Logbook defined fishing areas.

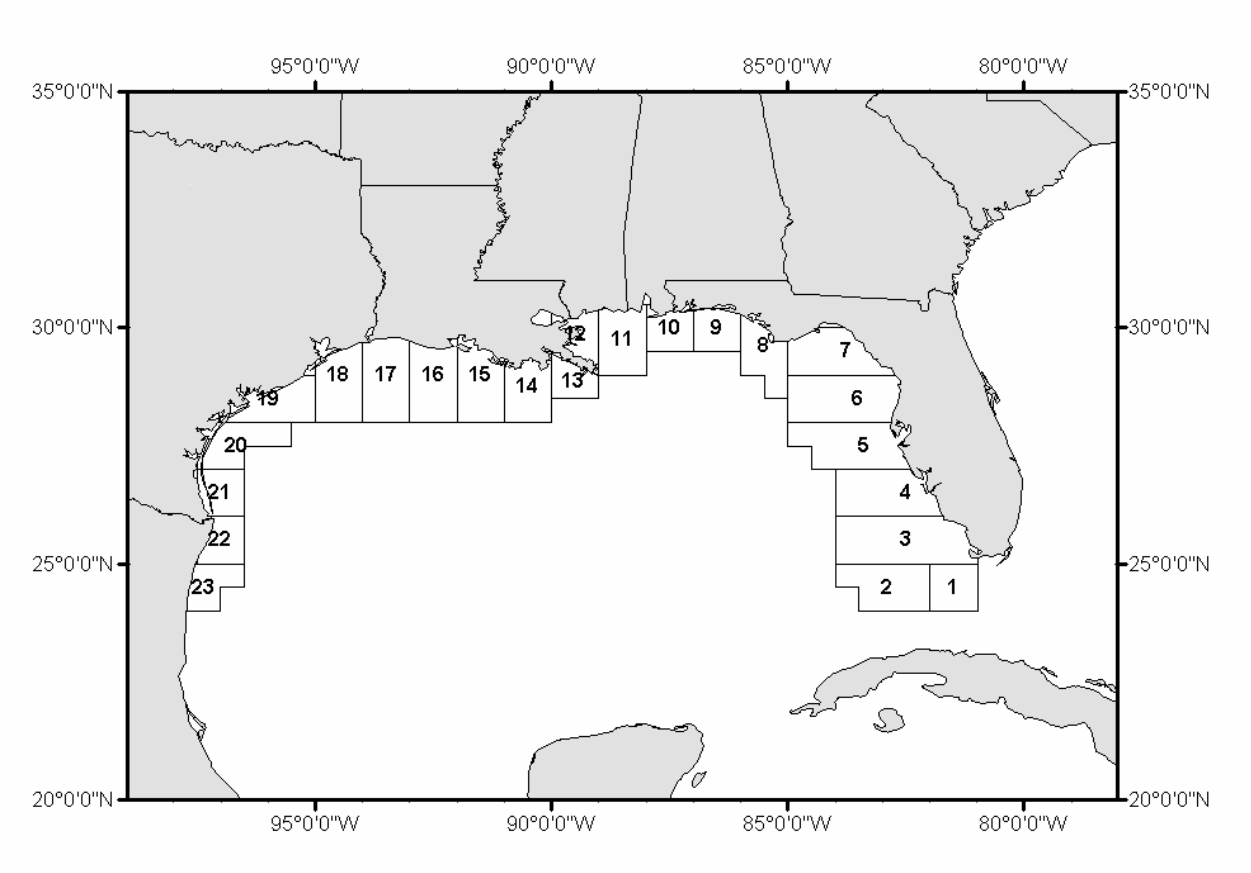

Figure 2. A comparison of the 2002 commercial handline index and the updated index that used the 2002 methods.

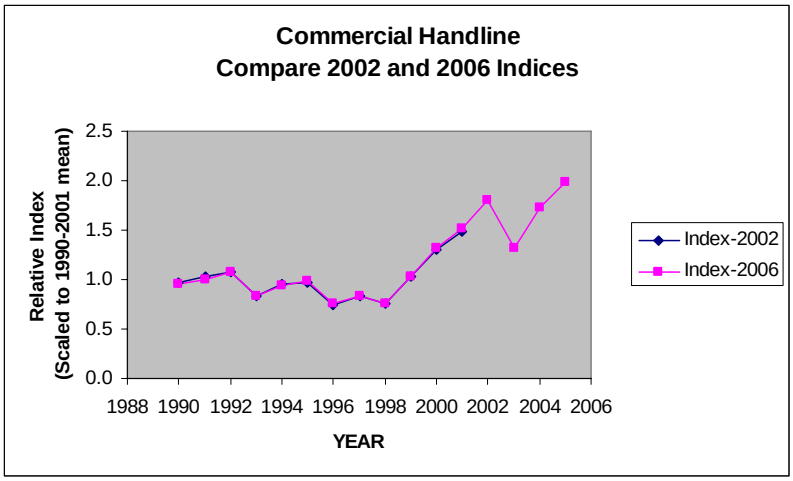

Figure 3. The updated commercial handline index (using 2002 methods) with 80% confidence limits.

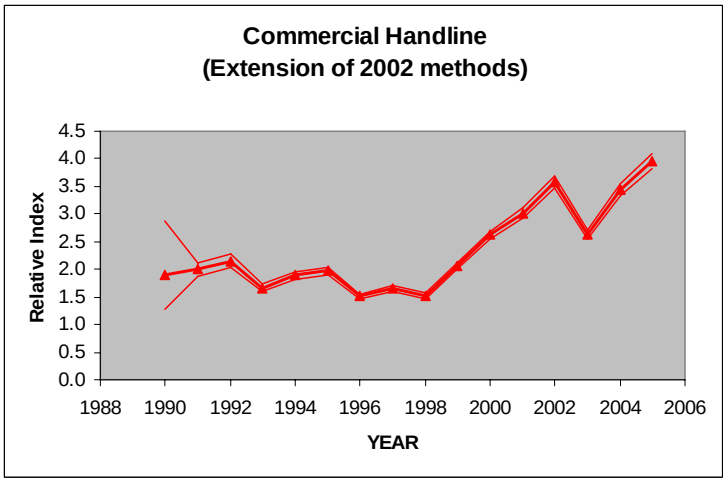

Figure 4. A comparison of the 2002 commercial longline index and the updated index that used the 2002 methods.

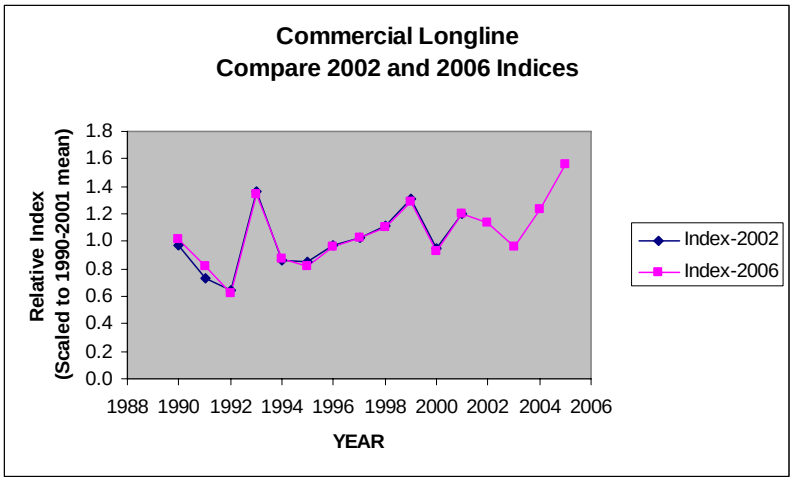

Figure 5. The updated commercial longline index (using 2002 methods) with 80% confidence limits.

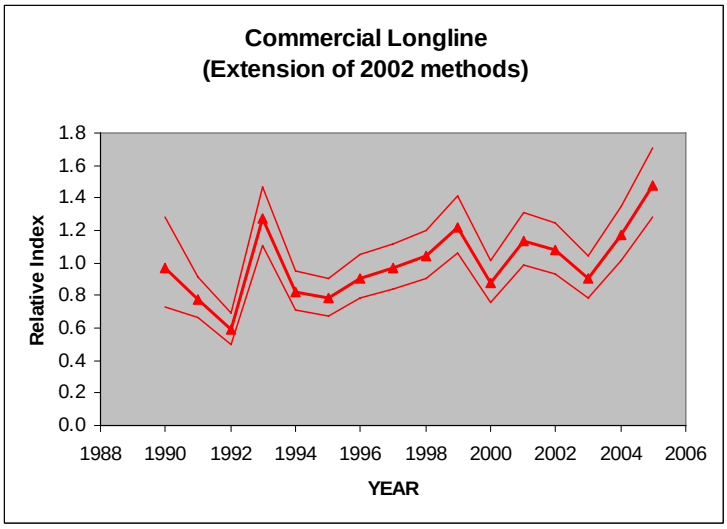

Figure 6. A comparison of the 2002 commercial trap index and the updated index that used the 2002 methods.

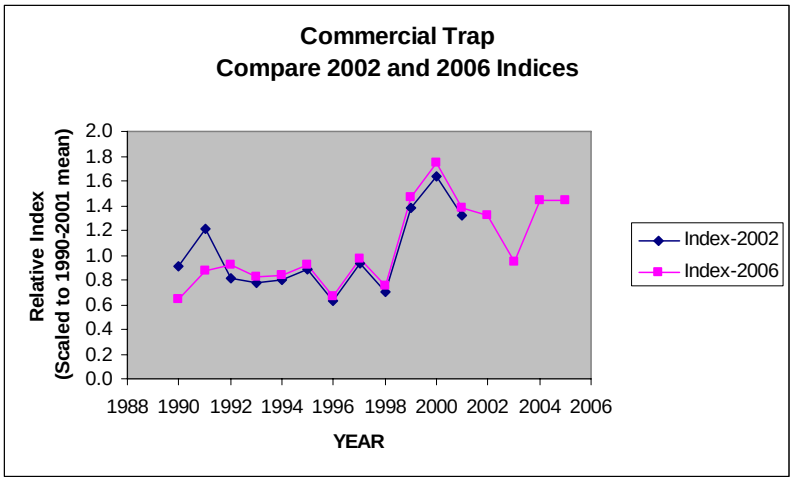

Figure 7. The updated commercial trap index (using 2002 methods) with 80% confidence limits.

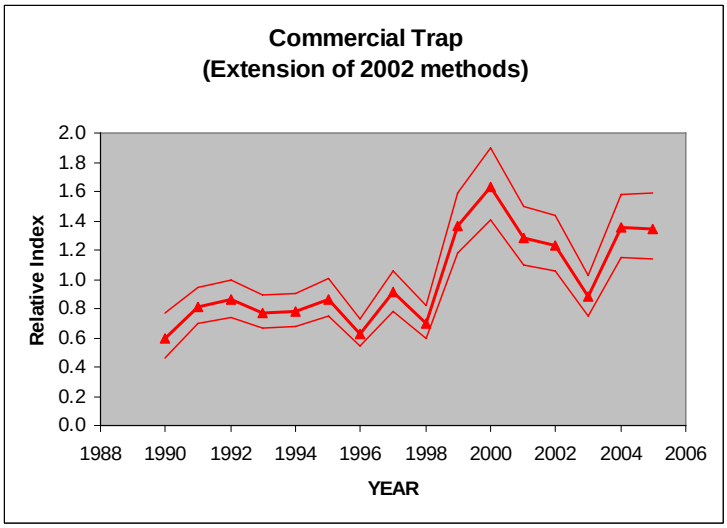

Figure 8. Red grouper (1990-2005) nominal CPUE (squares), standardized CPUE (diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dotted) for vessels fishing handlines in the Gulf of Mexico.

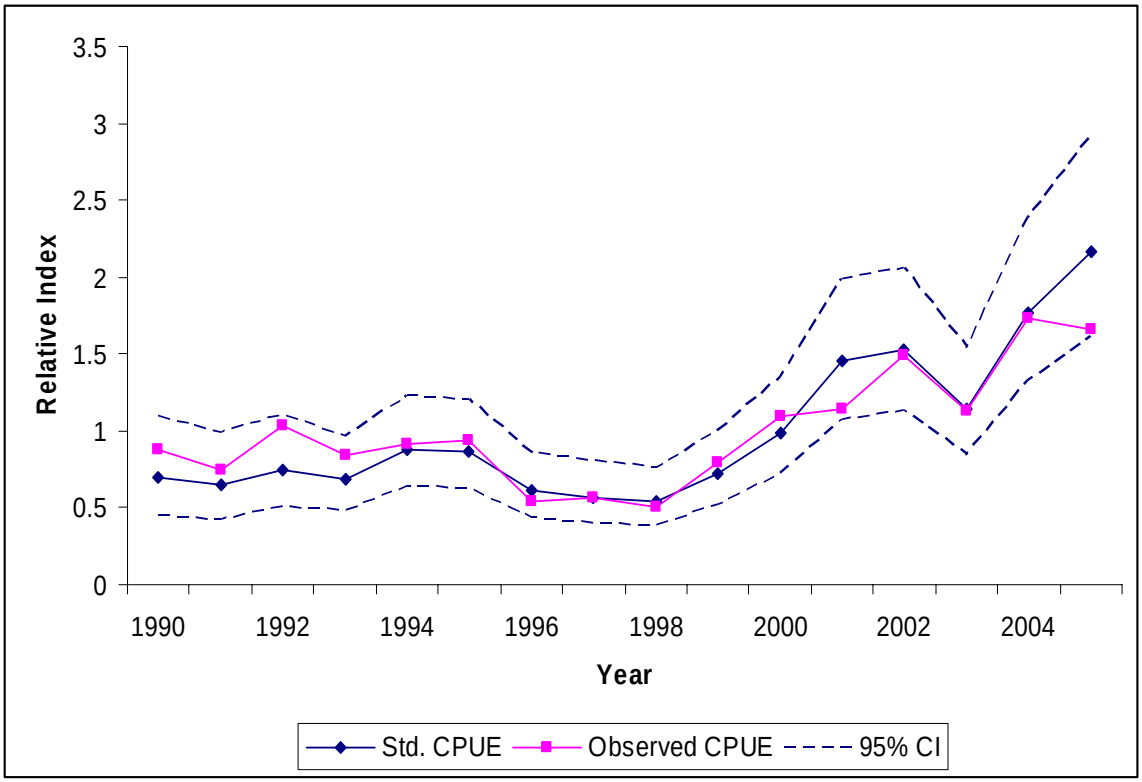

Figure 9. Red grouper (1990-2005) nominal CPUE (squares), standardized CPUE (diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dotted) for vessels fishing longlines in the Gulf of Mexico.

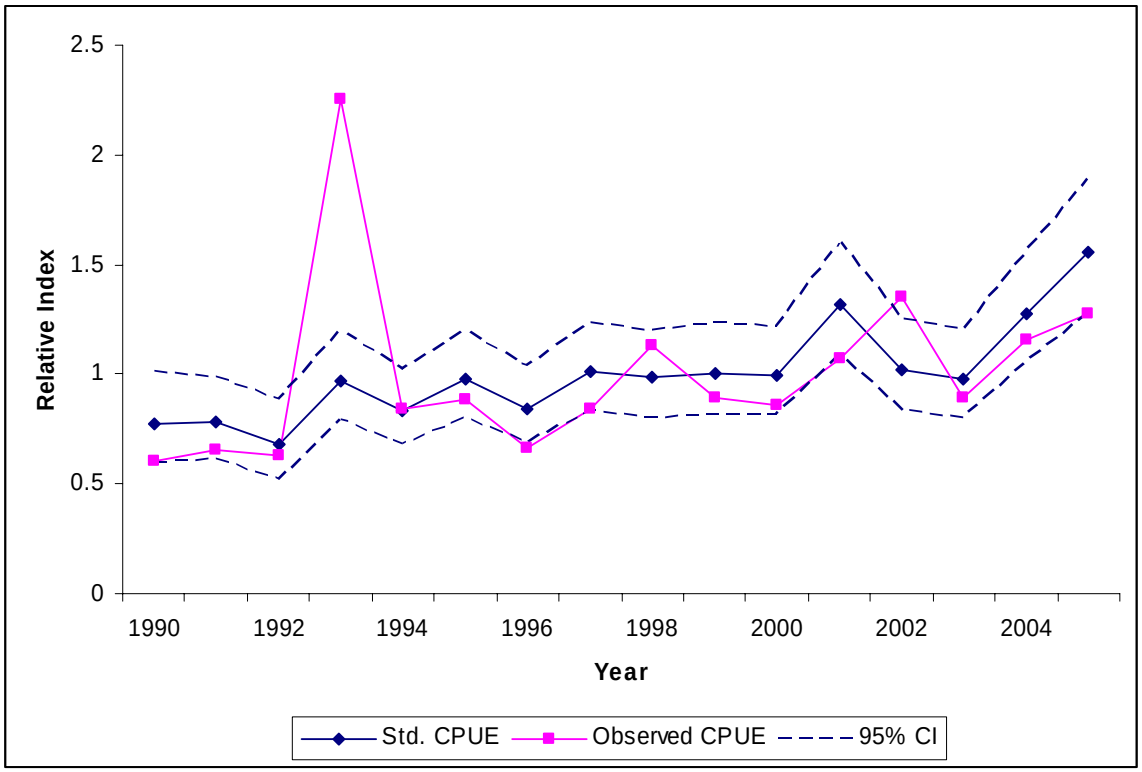

Figure 10. Red grouper (1990-2005) nominal CPUE (squares), standardized CPUE (diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dotted) for vessels fishing traps in the Gulf of Mexico.

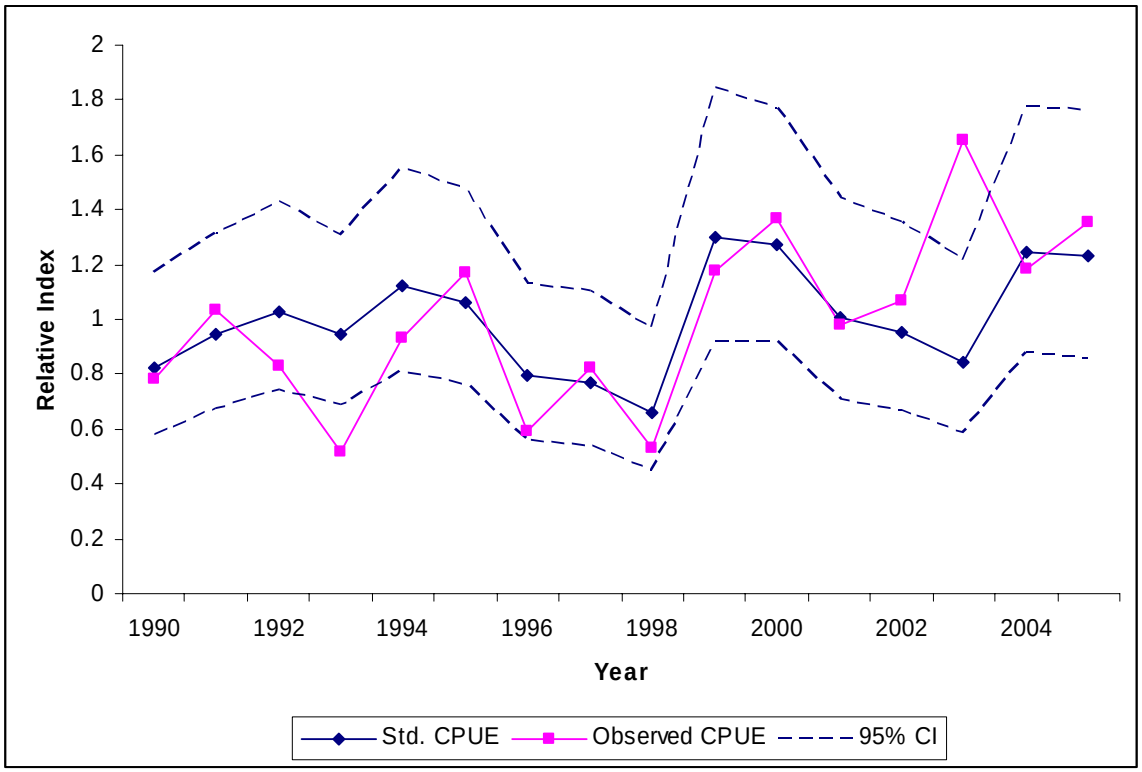

Figure 11. Red grouper (1990-2005) 2002 method standardized CPUE (diamonds) and alternate method standardized CPUE (squares) for vessels fishing handlines in the Gulf of Mexico.

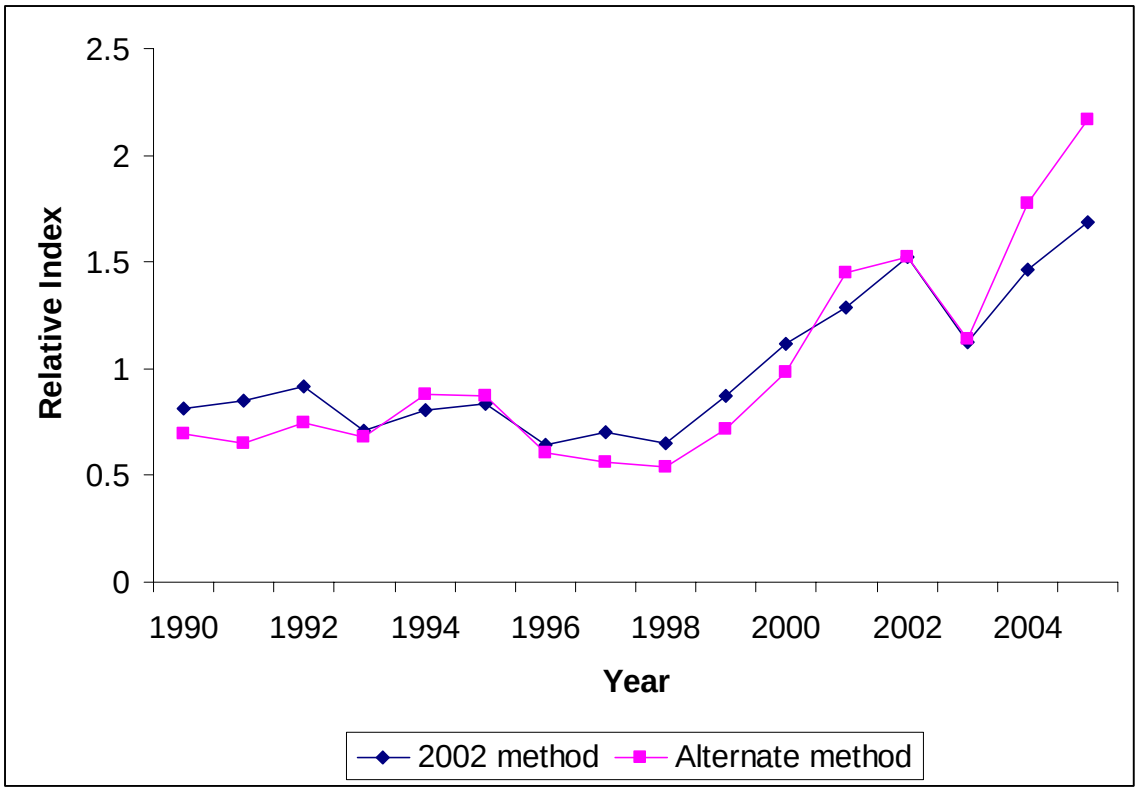

Figure 12. Red grouper (1990-2005) 2002 method standardized CPUE (diamonds) and alternate method standardized CPUE (squares) for vessels fishing longlines in the Gulf of Mexico.

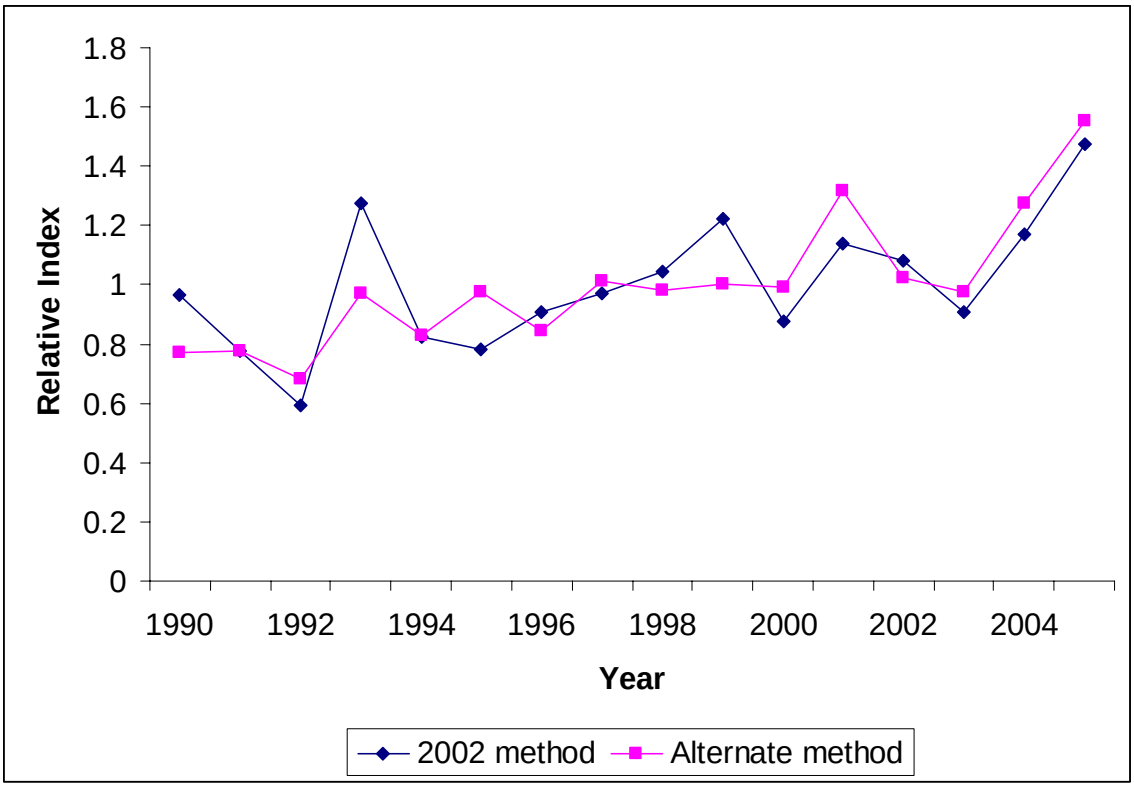

Figure 13. Red grouper (1990-2005) 2002 method standardized CPUE (diamonds) and alternate method standardized CPUE (squares) for vessels fishing traps in the Gulf of Mexico.