STANDARDIZED CATCH RATES OF GAG, *MYCTEROPERCA MICROLEPIS*, FROM THE UNITED STATES HEADBOAT FISHERY IN THE GULF OF MEXICO DURING 1986-1999

by

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Introduction

Rod and reel catch and effort from party (head) boats in the Gulf of Mexico have been monitored by the National Marine Fisheries Service (NMFS) Southeast Zone Headboat Survey (conducted by the NMFS Beaufort Laboratory). The available catch per unit effort (CPUE) series, from 1986 - 1999, was used to develop abundance indices for gag.

Material and Methods

The NMFS Southeast Zone Headboat Survey collects data on the catch and effort for a vessel trip. This information on the landing date and location, vessel identification, the number of anglers, a single fishing location (10' x 10' rectangle of latitude and longitude) for the entire trip, the type/duration of the trip (half/three-quarter/full/multi-day, day/night, morning/afternoon), and catch by species in number and weight.

Catch rate was calculated in number of fish per angler-hour. For trips less than or equal to one day in duration, the number of hours fished was assigned as the midpoint of the range of fishing hours assigned to the trip duration type . For the multi-day trips, an assumption that 12 hours were fished per day was used (the length of the trip in days was recorded).

The geographic distribution of gag catches (1986-1999) is shown in Figure 1, with each symbol scaled to reflect the average catch rate at that location. Based upon this distribution, three zones having relatively high catch rates were defined. The analysis was restricted to data from these three zones, since the expectation of catching gag on a given trip was markedly higher from within those zones. This approach was intended to reduce variance and to minimize the potential biases of year-to-year fluctuations in the proportion of total effort occurring within these zones.

There was considerable variation in gag catch rates between vessels. It was clear that some vessels were more prone to catch gag than others, whether through differences in fishing methodology or location intended to direct effort at gag, or through unintentional differences in location, time, etc. which affected catch rates. Again, in order to reduce variance and to minimize the potential biases of year-to-year fluctuations in the proportion of vessels with tendencies to catch gag, a subset of higher catch rate vessels was defined. Vessels were ranked within each year and zone by average catch rate. To be included within the subset of higher catch rate vessels for a particular zone, a vessel needed to appear in the survey in more than half of the years and have an average CPUE rank above the median for the zone. By these criteria, 13 vessels were included in the analysis data set for the Zone 1, 16 vessels for Zone 2, and 18 vessels for the Zone 3.

The process of calculating the indices of abundance from this data involves the standardization of yearly changes in catch rate, accounting for the influence of those factors which have a significant influence. Factors which were considered as possible influences on catch rates included year, zone, vessel (nested within zone), month, season(WINTER=Dec.-Feb., SPRING=Mar.-May, etc.), trip category (TRIPCAT: half day/3qtr-full day/multi day), and whether the fishing occurred during the day or night (DAYNIGHT: day/night/unknown).

The Lo method (Lo et al. 1992) was used to develop standardized indices; with that method separate analyses are conducted of the positive catch rates and the proportions of the observed trips which were successful. This technique has been employed in calculating abundance indices for bluefin tuna, *Thunnus thynnus*, (Ortiz *et al.* 1999,Turner *et al.* 1999, Brown *et al.* 1999), wherein a delta-lognormal model approach was used; this used a delta distribution with an assumed binomial error distribution for the proportion of positive observations (trips), and assumed a lognormal error distribution for the catch rates on successful trips. The present analyses, the delta-Poisson model approach of Brown and Turner (2001) was used; differing from the delta-lognormal approach in that a Poisson error distribution is assumed for the catches on successful trips, with the natural log of the hours fished as an offset term.

Parameterization of the model was accomplished using a Generalized Linear Model (GLM) structure: The proportion of successful (i.e. positive observations) trips per stratum was assumed to follow a binomial distribution where the estimated probability was a linearized function of fixed factors, such as year, month, zone, vessel, month, season, trip category, and DAYNIGHT. The logit function linked the linear component and the assumed binomial distribution. Similarly, the estimated catch observed on positive trips was a function of similar fixed factors with the log function as a link. The number of angler-hours was used as the offset.

A stepwise approach was used to quantify the relative importance of the main factors explaining the variance in catch rates. That is, first the Null model was run, in which no factors were entered in the model. These results reflect the distribution of the nominal data. Each potential factor was then tested one at a time. The results were then ranked from greatest to least reduction in deviance per degree of freedom when compared to the Null model. The factor which resulted in the greatest reduction in deviance per degree of freedom was then incorporated into the model, provided two conditions were met: 1) the effect of the factor was determined to be significant at at least the 5% level based upon a χ^2 (Chi-Square) test, and 2) the deviance per degree of freedom was reduced by at least 1% from the less complex model. This process was repeated, adding factors (including factor interactions) one at a time at each step, until no factor met the criteria for incorporation into the final model.

Once the set of fixed effects was specified, possible random year interaction effects were evaluated. These random effects were tested for significance using the likelihood ratio taken as the difference of the –2*log likelihood estimator between the complete model (*i.e.* including the random variate) and the reduced model (*i.e.* dropping the random variate). The –2*log likelihood difference statistics follows a χ^2 distribution. Values greater than 3.84 (α=0.05, df=1) were considered significant. The final model then, included any significant fixed and random (year)*factors interactions.

The product of the standardized proportion positives and the standardized positive catch rates was used to calculate overall standardized catch rates. For comparative purposes, each relative index of abundance was obtained dividing the standardized catch rates by the mean value in each series.

Finally, the methods used by Schirripa (2000) to calculate gag abundance indices were applied to the current data in order to update the approach used for the last gag assessment; the model factors were maintained. These factors include PERIOD, which contains similar information as the factors TRIPCAT and DAYNIGHT of the present analysis, with a greater number of potential values. Also included in the model is LANDAREA, location information based upon the landing area.

Results and Discussion

The stepwise construction of the model is shown in Table 1 for the proportion positive analysis and in Table 2 for the positive catch rate analysis. The results of the model fits for the indices are shown in Tables 3 and 4. The index values are shown in Table 5 and in Figure 2.

The results of the updated Schirripa (2000) model fit for the indices are shown in Table 6. The index values for the updated Schirripa (2000) model are shown in Table 7 and in Figure 3. The various indices are compared in Figure 4.

Literature Cited

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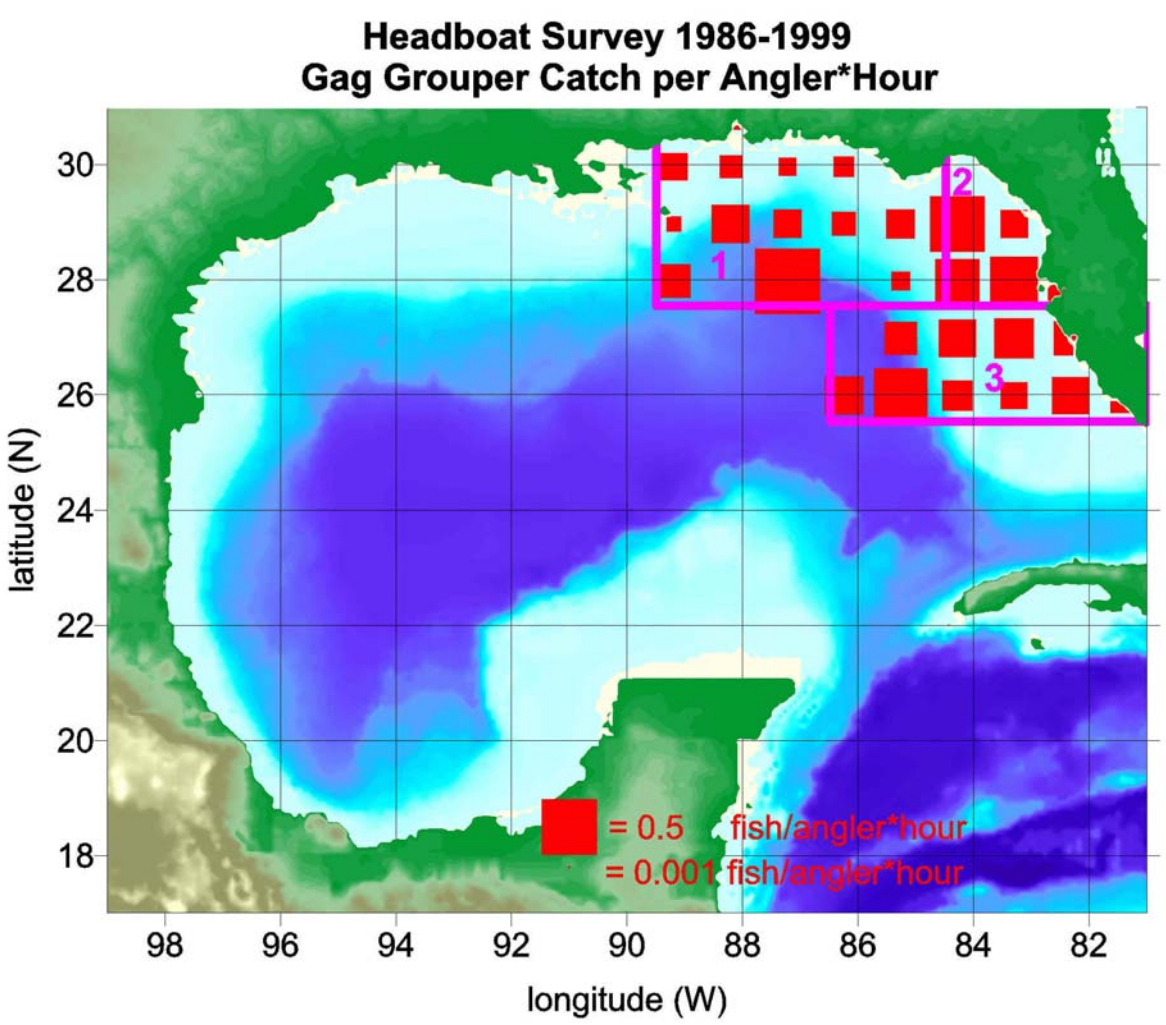

FIGURE 1: The geographic distribution of gag catches (1986-1999). Each symbol is scaled to reflect the average catch rate within that 1 by 1 square.

TABLE 1: Results of the stepwise procedure to develop the proportion positive catch rate model.

FACTOR	df	deviance	deviance/df	%diff.	delta%	L	ChiSquare	Pr>Chi
NULL	47133.0	65316.7	1.39			-32658.3	.	.
ZONE(VESSEL)	47087.0	59411.5	1.26	9.0	9.0	-29705.8	5905.1	0.0
TRIPCAT	47131.0	60649.5	1.29	7.1		-30324.8	4667.1	0.0
MONTH	47122.0	64230.6	1.36	1.6		-32115.3	1086.0	0.0
ZONE	47131.0	64543.2	1.37	1.2		-32271.6	773.4	0.0
YEAR	47120.0	64543.3	1.37	1.2		-32271.6	773.4	0.0
SEASON	47130.0	64607.5	1.37	1.1		-32303.8	709.1	0.0
ZONE(VESSEL)+								
TRIPCAT	47085.0	57297.5	1.22	12.2	3.2	-28648.7	2114.1	0.0
YEAR	47074.0	58356.3	1.24	10.5		-29178.1	1055.2	0.0
MONTH	47076.0	58447.3	1.24	10.4		-29223.7	964.2	0.0
SEASON	47084.0	58830.6	1.25	9.8		-29415.3	581.0	0.0
ZONE(VESSEL)+TRIPCAT+								
YEAR	47072.0	56299.6	1.20	13.7	1.5	-28149.8	997.9	0.0
MONTH	47074.0	56503.5	1.20	13.4		-28251.8	794.0	0.0
SEASON	47082.0	56877.8	1.21	12.8		-28438.9	419.7	0.0
ZONE(VESSEL)+TRIPCAT+YEAR								
MONTH	47061.0	55479.1	1.18	14.9	1.2	-27739.6	820.5	0.0
SEASON	47069.0	55850.8	1.19			-27925.4	448.7	0.0
FINAL MODEL: ZONE(VESSEL)+TRIPCAT+YEAR+MONTH								

% diff: percent difference in deviance/df between each factor and the null model**;** delta%: percent difference in deviance/df between the newly included factor and the previous factor entered into the model; L: log likelihood; ChiSquare: Pearson Chi-square statistic; Pr>Chi: significance level of the Chi-square statistic.

TABLE 2: Results of the stepwise procedure to develop the positive catch rate model.

FACTOR	df	deviance	deviance/df	%diff.	delta%	L	ChiSquare	Pr>Chi
NULL	23024.0	161504.0	7.01			107652.0	.	.
ZONE(VESSEL)	22978.0	122504.4	5.33	24.0	24.0	127151.7	38999.6	0.0
MONTH	23013.0	147063.4	6.39	8.9		114872.3	14440.6	0.0
ZONE	23022.0	147450.4	6.40	8.7		114678.8	14053.6	0.0
SEASON	23021.0	151642.0	6.59	6.1		112583.0	9862.0	0.0
TRIPCAT	23022.0	158509.0	6.89	1.8		109149.4	2995.0	0.0
YEAR	23011.0	158965.9	6.91	1.5		108921.0	2538.1	0.0
ZONE(VESSEL)+								
MONTH	22967.0	115053.0	5.01	28.6	4.6	130877.4	7451.4	0.0
SEASON	22975.0	117476.1	5.11	27.1		129665.9	5028.3	0.0
YEAR	22965.0	118662.0	5.17	26.3		129073.0	3842.4	0.0
TRIPCAT	22976.0	122313.0	5.32	24.1		127247.5	191.5	0.0
ZONE(VESSEL)+MONTH+								
YEAR	22954.0	111006.0	4.84	31.1	2.5	132901.0	4047.0	0.0
TRIPCAT	22965.0	114788.6	5.00	28.7		131009.6	264.4	0.0
ZONE(VESSEL)+MONTH+YEAR								
TRIPCAT	22952.0	110740.7	4.82	31.2	0.2	133033.6	265.3	0.0
BASE MODEL: ZONE(VESSEL)+MONTH+YEAR								

% diff: percent difference in deviance/df between each factor and the null model**;** delta%: percent difference in deviance/df between the newly included factor and the previous factor entered into the model; L: log likelihood; ChiSquare: Pearson Chi-square statistic; Pr>Chi: significance level of the Chi-square statistic.

TABLE 3: Results of the analysis (1986-1999). Lo method with binomial error assumption for proportion positives.

Class Level Information

Class	Levels	Values
zone	3	1 2 3
vessel	38	501 506 508 510 512 515 519 520 522 523 527 528 529 530 534 535 536 537 540 542 543 544 546 578 581 582 585 602 627 630 633 634 639 649 660 665 666 667
tripcat	3	3qtr-full day half day multi day
year	14	1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
month	12	1 2 3 4 5 6 7 8 9 10 11 12

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	47E3	55479.1162	1.1789
Scaled Deviance	47E3	55479.1162	1.1789
Pearson Chi-Square	47E3	48492.1783	1.0304
Scaled Pearson X2	47E3	48492.1783	1.0304
Log Likelihood		-27739.5581	

Algorithm converged.

Analysis Of Parameter Estimates

Parameter			DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept			1	1.9089	0.1597	1.5959	2.2219	142.87	<.0001
zone(vessel)	3	501	1	1.8237	0.1116	1.6050	2.0423	267.22	<.0001
zone(vessel)	3	506	1	0.4672	0.0969	0.2773	0.6571	23.26	<.0001
zone(vessel)	3	508	1	2.4666	0.1589	2.1551	2.7781	240.84	<.0001
zone(vessel)	2	510	1	0.8732	0.1541	0.5712	1.1752	32.11	<.0001
zone(vessel)	3	510	1	1.2506	0.0983	1.0579	1.4433	161.83	<.0001
zone(vessel)	3	512	1	1.0523	0.0882	0.8794	1.2251	142.35	<.0001
zone(vessel)	2	515	1	1.0416	0.0997	0.8463	1.2369	109.25	<.0001
zone(vessel)	3	515	1	0.5484	0.1089	0.3350	0.7618	25.36	<.0001
zone(vessel)	2	519	1	0.9794	0.1551	0.6754	1.2835	39.87	<.0001
zone(vessel)	3	519	1	0.7065	0.1028	0.5051	0.9079	47.27	<.0001
zone(vessel)	2	520	1	1.8305	0.1156	1.6040	2.0570	250.83	<.0001
zone(vessel)	3	520	1	1.8705	0.1116	1.6516	2.0893	280.67	<.0001
zone(vessel)	2	522	1	1.1939	0.1657	0.8691	1.5188	51.90	<.0001
zone(vessel)	3	522	1	2.0049	0.0911	1.8263	2.1834	484.22	<.0001
zone(vessel)	2	523	1	1.7220	0.1687	1.3914	2.0526	104.20	<.0001
zone(vessel)	3	523	1	1.2726	0.0897	1.0969	1.4483	201.49	<.0001
zone(vessel)	2	527	1	1.0466	0.1128	0.8256	1.2676	86.15	<.0001
zone(vessel)	2	528	1	3.1064	0.1398	2.8324	3.3803	493.96	<.0001
zone(vessel)	2	529	1	2.4910	0.1493	2.1984	2.7835	278.52	<.0001
zone(vessel)	2	530	1	0.9484	0.0967	0.7589	1.1379	96.20	<.0001
zone(vessel)	1	534	1	1.3385	0.0993	1.1439	1.5332	181.61	<.0001
zone(vessel)	1	535	1	1.0546	0.0997	0.8592	1.2501	111.84	<.0001
zone(vessel)	1	536	1	0.6563	0.0964	0.4673	0.8452	46.35	<.0001
zone(vessel)	1	537	1	0.8603	0.0954	0.6734	1.0472	81.40	<.0001
zone(vessel)	1	540	1	-0.2095	0.1051	-0.4156	-0.0035	3.97	0.0463
zone(vessel)	1	542	1	0.4335	0.1093	0.2192	0.6478	15.72	<.0001
zone(vessel)	1	543	1	0.9790	0.1003	0.7823	1.1757	95.17	<.0001
zone(vessel)	1	544	1	0.6623	0.1321	0.4033	0.9212	25.12	<.0001
zone(vessel)	1	546	1	0.8532	0.0968	0.6635	1.0428	77.71	<.0001
zone(vessel)	3	578	1	0.2793	0.1515	-0.0177	0.5762	3.40	0.0653
zone(vessel)	3	581	1	1.0859	0.1116	0.8672	1.3046	94.73	<.0001

TABLE 3(cont.): Results of the analysis (1986-1999). Lo method with binomial error assumption for proportion positives.

Parameter			DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
zone(vessel)	2	582	1	0.8952	0.1126	0.6746	1.1158	63.27	<.0001
zone(vessel)	3	585	1	0.4296	0.1053	0.2231	0.6361	16.63	<.0001
zone(vessel)	2	602	1	1.8542	0.2069	1.4488	2.2596	80.34	<.0001
zone(vessel)	3	602	1	1.1019	0.0897	0.9261	1.2776	150.94	<.0001
zone(vessel)	2	627	1	1.9595	0.1271	1.7103	2.2087	237.50	<.0001
zone(vessel)	3	627	1	-0.1209	0.1203	-0.3567	0.1149	1.01	0.3150
zone(vessel)	2	630	1	0.6181	0.2364	0.1548	1.0814	6.84	0.0089
zone(vessel)	3	630	1	0.7009	0.1602	0.3870	1.0148	19.15	<.0001
zone(vessel)	2	633	1	1.2482	0.1478	0.9584	1.5379	71.27	<.0001
zone(vessel)	2	634	1	2.3690	0.2601	1.8592	2.8789	82.93	<.0001
zone(vessel)	3	639	1	0.5174	0.0952	0.3308	0.7039	29.54	<.0001
zone(vessel)	3	649	1	1.7014	0.1553	1.3970	2.0058	120.00	<.0001
zone(vessel)	1	660	1	0.2301	0.1050	0.0243	0.4359	4.80	0.0284
zone(vessel)	1	665	1	0.8830	0.1295	0.6291	1.1368	46.48	<.0001
zone(vessel)	1	666	1	0.2469	0.1143	0.0228	0.4710	4.66	0.0308
zone(vessel)	1	667	0	0.0000	0.0000	0.0000	0.0000	.	.
tripcat	3qtr-full day		1	-1.2812	0.1306	-1.5372	-1.0252	96.25	<.0001
tripcat	half day		1	-2.5063	0.1332	-2.7674	-2.2452	353.99	<.0001
tripcat	multi day		0	0.0000	0.0000	0.0000	0.0000	.	.
year	1986		1	-0.3498	0.0742	-0.4952	-0.2043	22.21	<.0001
year	1987		1	0.2331	0.0735	0.0891	0.3772	10.07	0.0015
year	1988		1	-0.4795	0.0640	-0.6050	-0.3540	56.06	<.0001
year	1989		1	-0.7858	0.0607	-0.9047	-0.6669	167.81	<.0001
year	1990		1	-0.9707	0.0571	-1.0825	-0.8588	289.19	<.0001
year	1991		1	-1.1521	0.0585	-1.2667	-1.0375	388.12	<.0001
year	1992		1	-0.9894	0.0577	-1.1025	-0.8763	294.12	<.0001
year	1993		1	-0.7227	0.0575	-0.8353	-0.6100	158.15	<.0001
year	1994		1	-0.7838	0.0572	-0.8959	-0.6716	187.73	<.0001
year	1995		1	-0.7800	0.0592	-0.8961	-0.6639	173.43	<.0001
year	1996		1	-0.4505	0.0582	-0.5646	-0.3365	59.91	<.0001
year	1997		1	-0.3734	0.0589	-0.4888	-0.2580	40.22	<.0001
year	1998		1	-0.4028	0.0598	-0.5201	-0.2855	45.32	<.0001
year	1999		0	0.0000	0.0000	0.0000	0.0000	.	.
month	1		1	-0.2709	0.0627	-0.3939	-0.1480	18.65	<.0001
month	2		1	-0.5794	0.0602	-0.6974	-0.4613	92.58	<.0001
month	3		1	-0.4975	0.0567	-0.6087	-0.3863	76.91	<.0001
month	4		1	-0.5079	0.0560	-0.6175	-0.3982	82.37	<.0001
month	5		1	-0.4700	0.0563	-0.5804	-0.3595	69.57	<.0001
month	6		1	-0.7448	0.0555	-0.8536	-0.6359	179.99	<.0001
month	7		1	-0.9321	0.0546	-1.0392	-0.8250	291.09	<.0001
month	8		1	-0.9979	0.0562	-1.1081	-0.8878	315.11	<.0001
month	9		1	-0.9063	0.0608	-1.0253	-0.7872	222.47	<.0001
month	10		1	-0.2375	0.0604	-0.3558	-0.1192	15.48	<.0001
month	11		1	-0.0612	0.0623	-0.1833	0.0610	0.96	0.3262
month	12		0	0.0000	0.0000	0.0000	0.0000	.	.
Scale			0	1.0000	0.0000	1.0000	1.0000		

NOTE: The scale parameter was held fixed.

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
zone(vessel)	46	3308.06	<.0001
tripcat	2	1881.88	<.0001
year	13	1024.38	<.0001
month	11	820.46	<.0001

TABLE 4: Results of the analysis (1986-1999). Lo method with Poisson error assumption for positive trips.

Class Level Information

Class	Levels	Values
zone	3	1 2 3
vessel	38	501 506 508 510 512 515 519 520 522 523 527 528 529 530 534 535 536 537 540 542 543 544 546 578 581 582 585 602 627 630 633 634 639 649 660 665 666 667
month	12	1 2 3 4 5 6 7 8 9 10 11 12
year	14	1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	23E3	111005.9917	4.8360
Scaled Deviance	23E3	111005.9917	4.8360
Pearson Chi-Square	23E3	367380.1010	16.0051
Scaled Pearson X2	23E3	367380.1010	16.0051
Log Likelihood		132900.9489	

Algorithm converged.

Analysis Of Parameter Estimates

Parameter			DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept			1	-3.7261	0.0377	-3.8000	-3.6522	9761.08	<.0001
zone(vessel)	3	501	1	0.7894	0.0438	0.7035	0.8752	324.78	<.0001
zone(vessel)	3	506	1	-0.4871	0.0401	-0.5658	-0.4084	147.21	<.0001
zone(vessel)	3	508	1	0.9982	0.0399	0.9199	1.0764	624.96	<.0001
zone(vessel)	2	510	1	0.0590	0.0743	-0.0867	0.2047	0.63	0.4277
zone(vessel)	3	510	1	0.1961	0.0416	0.1146	0.2776	22.25	<.0001
zone(vessel)	3	512	1	-0.2023	0.0395	-0.2798	-0.1247	26.15	<.0001
zone(vessel)	2	515	1	0.5278	0.0406	0.4482	0.6074	168.87	<.0001
zone(vessel)	3	515	1	-0.0218	0.0530	-0.1257	0.0820	0.17	0.6802
zone(vessel)	2	519	1	0.5538	0.0451	0.4654	0.6422	150.75	<.0001
zone(vessel)	3	519	1	0.0796	0.0405	0.0003	0.1590	3.87	0.0491
zone(vessel)	2	520	1	1.0079	0.0379	0.9336	1.0823	705.55	<.0001
zone(vessel)	3	520	1	1.3710	0.0378	1.2969	1.4451	1314.83	<.0001
zone(vessel)	2	522	1	0.3760	0.0532	0.2717	0.4803	49.92	<.0001
zone(vessel)	3	522	1	0.2731	0.0366	0.2014	0.3449	55.68	<.0001
zone(vessel)	2	523	1	0.3419	0.0531	0.2378	0.4460	41.45	<.0001
zone(vessel)	3	523	1	-0.1213	0.0390	-0.1977	-0.0448	9.67	0.0019
zone(vessel)	2	527	1	0.4083	0.0416	0.3268	0.4899	96.32	<.0001
zone(vessel)	2	528	1	0.6678	0.0376	0.5941	0.7415	315.35	<.0001
zone(vessel)	2	529	1	0.3727	0.0402	0.2938	0.4515	85.79	<.0001
zone(vessel)	2	530	1	1.1355	0.0367	1.0636	1.2074	957.94	<.0001
zone(vessel)	1	534	1	-0.4051	0.0389	-0.4814	-0.3288	108.32	<.0001
zone(vessel)	1	535	1	-0.0085	0.0382	-0.0834	0.0664	0.05	0.8245
zone(vessel)	1	536	1	-0.2709	0.0401	-0.3496	-0.1923	45.54	<.0001
zone(vessel)	1	537	1	-0.3425	0.0405	-0.4218	-0.2632	71.64	<.0001
zone(vessel)	1	540	1	-0.1580	0.0531	-0.2620	-0.0540	8.86	0.0029
zone(vessel)	1	542	1	-0.2373	0.0467	-0.3289	-0.1457	25.80	<.0001
zone(vessel)	1	543	1	-0.2371	0.0415	-0.3184	-0.1558	32.68	<.0001
zone(vessel)	1	544	1	-0.8856	0.0593	-1.0018	-0.7694	223.15	<.0001
zone(vessel)	1	546	1	-0.2209	0.0428	-0.3047	-0.1370	26.66	<.0001

TABLE 4(cont.): Results of the analysis (1986-1999). Lo method with Poisson error assumption for positive trips.

Parameter			DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
zone(vessel)	3	578	1	0.5054	0.0559	0.3959	0.6149	81.78	<.0001
zone(vessel)	3	581	1	0.7859	0.0404	0.7068	0.8651	379.06	<.0001
zone(vessel)	2	582	1	0.2883	0.0402	0.2095	0.3670	51.49	<.0001
zone(vessel)	3	585	1	-0.1132	0.0423	-0.1960	-0.0304	7.17	0.0074
zone(vessel)	2	602	1	0.1931	0.0675	0.0609	0.3253	8.20	0.0042
zone(vessel)	3	602	1	-0.0233	0.0388	-0.0993	0.0528	0.36	0.5488
zone(vessel)	2	627	1	0.6718	0.0517	0.5705	0.7731	168.92	<.0001
zone(vessel)	3	627	1	0.1925	0.0610	0.0730	0.3121	9.96	0.0016
zone(vessel)	2	630	1	0.4209	0.0876	0.2491	0.5927	23.07	<.0001
zone(vessel)	3	630	1	0.0453	0.0681	-0.0882	0.1787	0.44	0.5060
zone(vessel)	2	633	1	0.9783	0.0422	0.8957	1.0610	537.78	<.0001
zone(vessel)	2	634	1	0.1477	0.0372	0.0748	0.2206	15.79	<.0001
zone(vessel)	3	639	1	-0.1455	0.0438	-0.2315	-0.0596	11.02	0.0009
zone(vessel)	3	649	1	0.7893	0.0450	0.7010	0.8776	307.08	<.0001
zone(vessel)	1	660	1	-0.1160	0.0506	-0.2151	-0.0169	5.26	0.0218
zone(vessel)	1	665	1	0.1956	0.0529	0.0920	0.2992	13.69	0.0002
zone(vessel)	1	666	1	0.2797	0.0502	0.1814	0.3781	31.06	<.0001
zone(vessel)	1	667	0	0.0000	0.0000	0.0000	0.0000	.	.
month	1		1	0.0062	0.0130	-0.0192	0.0316	0.23	0.6307
month	2		1	-0.3143	0.0136	-0.3410	-0.2876	531.74	<.0001
month	3		1	-0.3548	0.0128	-0.3800	-0.3297	765.33	<.0001
month	4		1	-0.2314	0.0122	-0.2553	-0.2076	361.44	<.0001
month	5		1	-0.3401	0.0128	-0.3652	-0.3149	703.19	<.0001
month	6		1	-0.4614	0.0132	-0.4874	-0.4355	1214.73	<.0001
month	7		1	-0.6959	0.0141	-0.7235	-0.6683	2445.13	<.0001
month	8		1	-0.5591	0.0151	-0.5887	-0.5294	1363.54	<.0001
month	9		1	-0.3572	0.0156	-0.3878	-0.3266	523.33	<.0001
month	10		1	-0.0048	0.0130	-0.0303	0.0207	0.14	0.7131
month	11		1	0.1997	0.0122	0.1757	0.2237	266.17	<.0001
month	12		0	0.0000	0.0000	0.0000	0.0000	.	.
year	1986		1	-0.0119	0.0173	-0.0458	0.0220	0.47	0.4920
year	1987		1	0.1874	0.0153	0.1574	0.2173	150.10	<.0001
year	1988		1	-0.1501	0.0158	-0.1811	-0.1191	90.18	<.0001
year	1989		1	-0.1371	0.0152	-0.1668	-0.1074	81.82	<.0001
year	1990		1	-0.3200	0.0141	-0.3476	-0.2923	513.83	<.0001
year	1991		1	-0.3727	0.0151	-0.4023	-0.3431	610.22	<.0001
year	1992		1	-0.2704	0.0142	-0.2982	-0.2426	363.65	<.0001
year	1993		1	-0.2295	0.0141	-0.2571	-0.2019	265.89	<.0001
year	1994		1	-0.1901	0.0140	-0.2176	-0.1627	184.24	<.0001
year	1995		1	-0.1475	0.0165	-0.1800	-0.1151	79.59	<.0001
year	1996		1	0.0644	0.0146	0.0358	0.0930	19.51	<.0001
year	1997		1	0.1449	0.0142	0.1171	0.1727	104.44	<.0001
year	1998		1	0.2145	0.0136	0.1878	0.2411	248.52	<.0001
year	1999		0	0.0000	0.0000	0.0000	0.0000	.	.
Scale			0	1.0000	0.0000	1.0000	1.0000		

NOTE: The scale parameter was held fixed.

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
zone(vessel)	46	32952.8	<.0001
month	11	7655.98	<.0001
year	13	4047.02	<.0001

TABLE 5: Relative Abundance Indices for Gag in the Gulf of Mexico (based upon Headboat fishery)				
YEAR	**INDEX**	**LCI**	**UCI**	**CV**
1986	1.08	0.477	1.684	0.285
1987	1.653	1.069	2.237	0.18
1988	0.931	0.462	1.399	0.257
1989	0.793	0.361	1.225	0.278
1990	0.635	0.305	0.965	0.265
1991	0.552	0.199	0.904	0.326
1992	0.671	0.312	1.03	0.273
1993	0.789	0.418	1.159	0.24
1994	0.804	0.419	1.189	0.244
1995	0.826	0.341	1.31	0.299
1996	1.174	0.701	1.647	0.206
1997	1.341	0.839	1.843	0.191
1998	1.44	0.92	1.96	0.184
1999	1.313	0.829	1.797	0.188

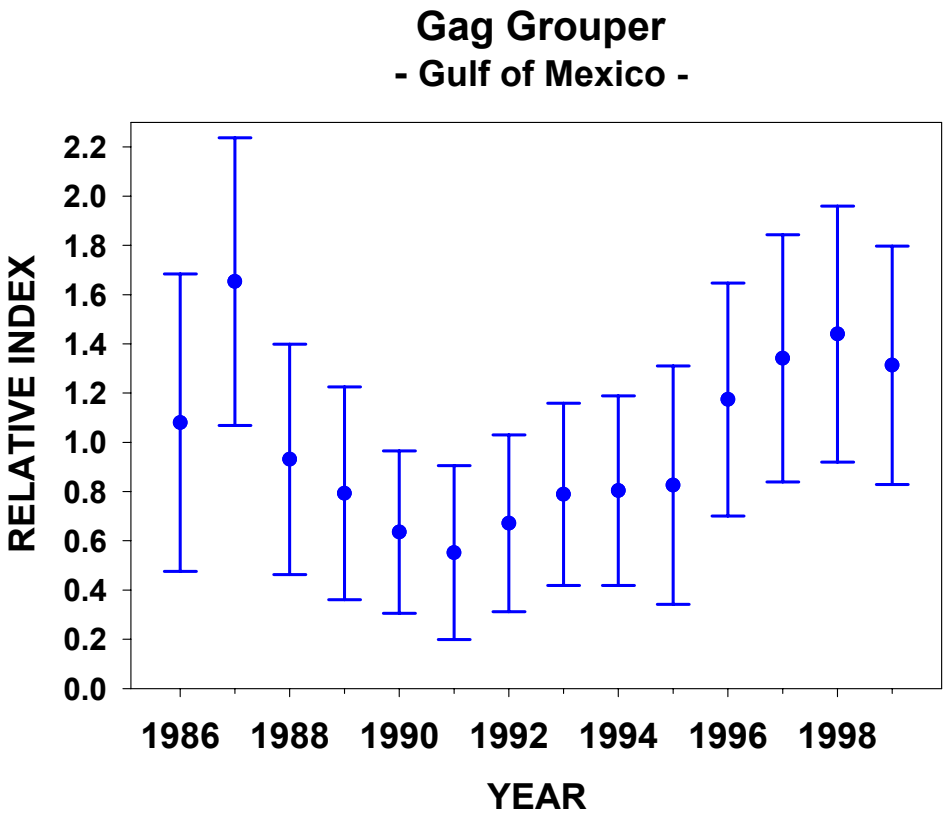

FIGURE 2. Relative abundance indices for gag in the Gulf of Mexico with approximate 95% confidence intervals.
Proportion Positive Model = ZONE(VESSEL)+TRIPCAT+YEAR+MONTH (success, error distribution: binomial)
Positive Trip Model= ZONE(VESSEL)+MONTH+YEAR (fish caught per trip, offset: natural log angler*hours, error distribution: Poisson)

TABLE 6: Results of the Schirripa (2000) model applied to current data (1986-1999). Lognormal error assumption for positive trips.

Class Level Information

Class	Levels	Values
year	14	1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
month	12	1 2 3 4 5 6 7 8 9 10 11 12
landarea	5	21 22 23 24 25

Number of observations 31149

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	10923.24911	364.10830	478.92	<.0001
Error	31118	23657.93890	0.76027		
Corrected Total	31148	34581.18801			

R-Square	Coeff Var	Root MSE	lcpue Mean
0.315873	32.06805	0.871932	2.719005

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	13	511.360240	39.335403	51.74	<.0001
month	11	816.024029	74.184003	97.58	<.0001
landarea	4	1487.010493	371.752623	488.98	<.0001
period	1	79.601328	79.601328	104.70	<.0001
anglers	1	5934.132758	5934.132758	7805.34	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		3.282477329	B	0.87291302	3.76	0.0002
year	1986	0.023449326	B	0.02859878	0.82	0.4123
year	1987	0.125650484	B	0.02804797	4.48	<.0001
year	1988	-0.167459230	B	0.02638888	-6.35	<.0001
year	1989	-0.164090839	B	0.02619784	-6.26	<.0001
year	1990	-0.216416900	B	0.02376134	-9.11	<.0001
year	1991	-0.440814433	B	0.02493567	-17.68	<.0001
year	1992	-0.223904790	B	0.02506094	-8.93	<.0001
year	1993	-0.166237953	B	0.02428188	-6.85	<.0001
year	1994	-0.173823037	B	0.02495190	-6.97	<.0001
year	1995	-0.245158688	B	0.02682727	-9.14	<.0001
year	1996	-0.090277663	B	0.02497465	-3.61	0.0003
year	1997	-0.141859798	B	0.02475142	-5.73	<.0001
year	1998	-0.010973847	B	0.02537706	-0.43	0.6654
year	1999	0.000000000	B	.	.	.
month	1	-0.091713681	B	0.02689757	-3.41	0.0007
month	2	-0.227823156	B	0.02688741	-8.47	<.0001
month	3	-0.267553609	B	0.02517914	-10.63	<.0001

TABLE 6(cont.): Results of the Schirripa (2000) model applied to current data (1986-1999). Lognormal error assumption for positive trips.

Parameter		Estimate		Standard Error	t Value	Pr > |t|
month	4	-0.246890450	B	0.02472618	-9.98	<.0001
month	5	-0.280869064	B	0.02468313	-11.38	<.0001
month	6	-0.398332020	B	0.02491926	-15.98	<.0001
month	7	-0.493883253	B	0.02488544	-19.85	<.0001
month	8	-0.494433186	B	0.02598052	-19.03	<.0001
month	9	-0.415231498	B	0.02784877	-14.91	<.0001
month	10	-0.116488896	B	0.02598398	-4.48	<.0001
month	11	0.053049127	B	0.02632078	2.02	0.0439
month	12	0.000000000	B	.	.	.
landarea	21	0.877226664	B	0.87240398	1.01	0.3147
landarea	22	1.295321495	B	0.87323508	1.48	0.1380
landarea	23	0.371813705	B	0.87242948	0.43	0.6700
landarea	24	0.053204995	B	0.87509012	0.06	0.9515
landarea	25	0.000000000	B	.	.	.
period		-0.009367648		0.00091549	-10.23	<.0001
anglers		-0.028291043		0.00032022	-88.35	<.0001

TABLE 7: Relative Abundance Indices for Gag in the Gulf of Mexico (based upon Headboat Fishery)- Schirripa (2000) model applied to current data

YEAR	INDEX	LCI	UCI	CV
1986	1.227	0.957	1.573	0.199
1987	1.292	1.025	1.629	0.185
1988	0.948	0.750	1.199	0.188
1989	0.949	0.751	1.201	0.188
1990	0.882	0.697	1.117	0.188
1991	0.701	0.552	0.890	0.192
1992	0.897	0.709	1.135	0.188
1993	0.943	0.746	1.193	0.188
1994	0.936	0.740	1.184	0.188
1995	0.944	0.747	1.194	0.188
1996	1.014	0.802	1.281	0.187
1997	1.014	0.803	1.281	0.187
1998	1.132	0.897	1.428	0.186
1999	1.120	0.888	1.413	0.186

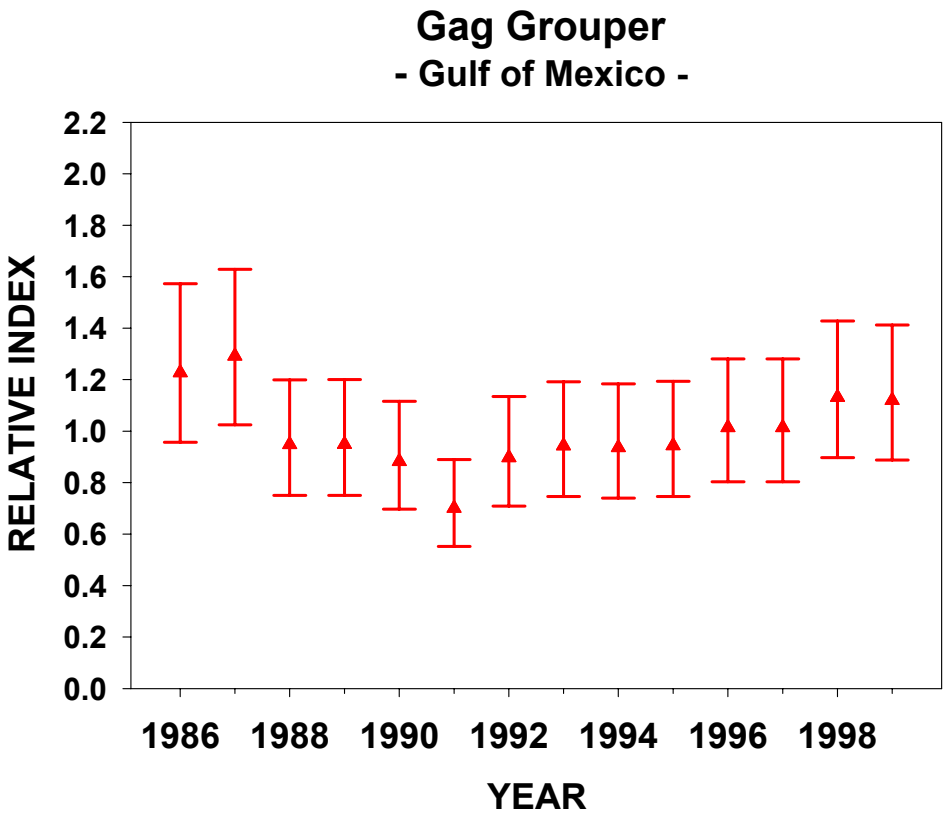

FIGURE 3. Relative abundance indices for gag in the Gulf of Mexico with approximate 95% confidence intervals; Schirripa (2000) model applied to current data.

Positive Trip Model= YEAR+MONTH+LANDAREA+PERIOD+ANGLERS (fish caught per angler*hours, error distribution: lognormal)

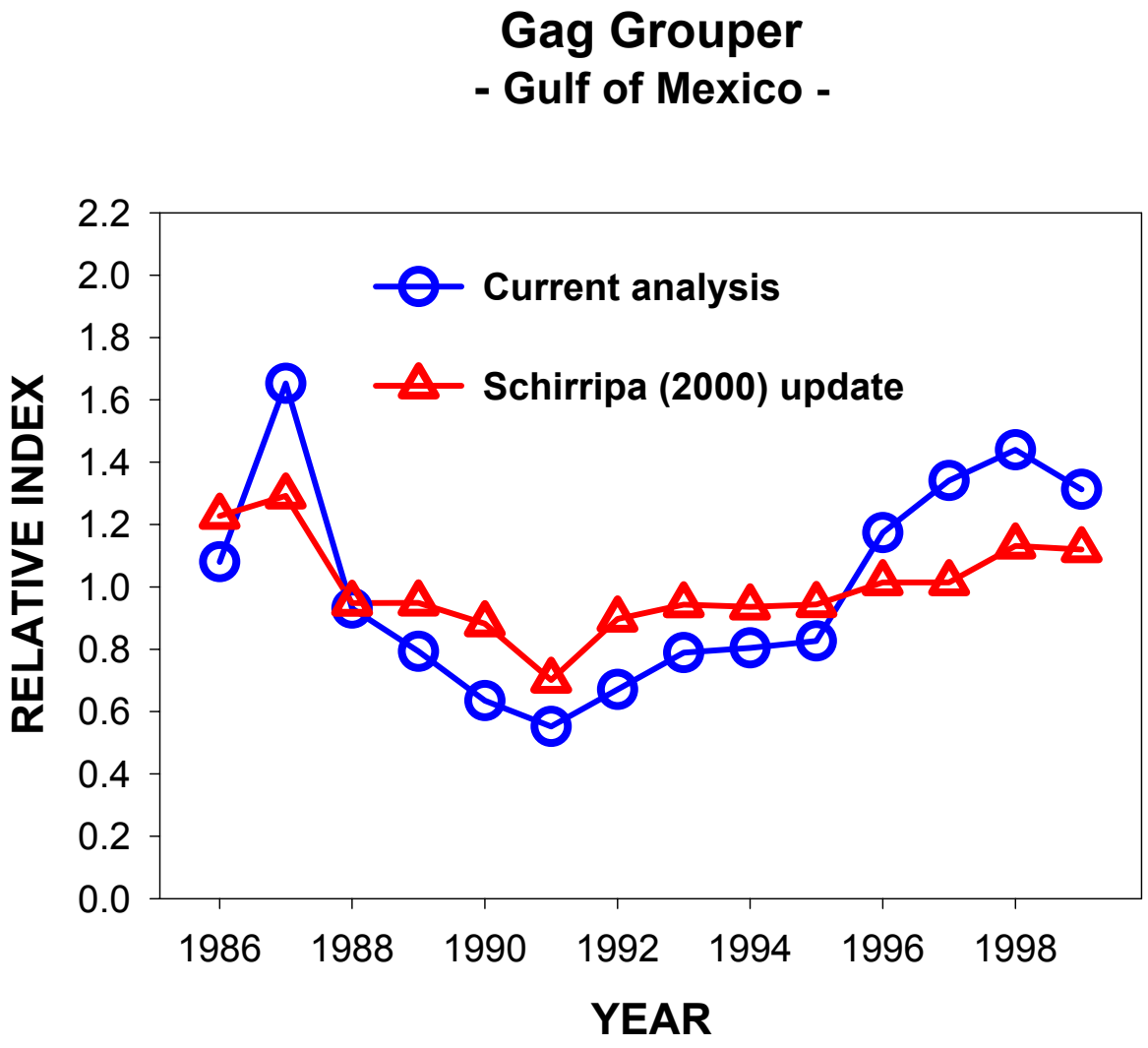

FIGURE 4. Comparison of relative abundance indices for gag in the Gulf of Mexico.