Standardized Catch Rates of Gulf of Mexico Gag Grouper from Recreational Inshore, Charterboat, and Private Boat Fisheries (MRFSS) 1986 to 2010

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Standardized Catch Rates of Gulf of Mexico Gag Grouper from Recreational Inshore, Charterboat, and Private Boat Fisheries (MRFSS) 1986 to 2010

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Introduction

The Marine Recreational Fishery Statistics Survey (MRFSS), conducted by NOAA Fisheries (NMFS), collects information on shore based, charterboat and private/rental boat angler fishing. MRFSS provides information on participation, effort, and species-specific catch. Data are collected to provide catch and effort estimates in two-month periods ("waves") for each recreational fishing mode (shore fishing, private/rental boat, charterboat, or headboat/charterboat combined) and for each area of fishing (inshore, state Territorial Seas, U.S. Exclusive Economic Zone), in each Gulf of Mexico state (except Texas). Total catch information is collected by MRFSS on fish landed whole and observed by interviewers ("Type A"), fish reported as killed by the fishers ("Type B1") and fish reported as released alive by the fishers ("Type B2").

This work uses the catch and effort observations from MRFSS interviews to develop a standardized catch per unit effort (CPUE) index of abundance from inshore, charterboat, and private angler fishing for gag grouper (*Mycteroperca microlepis*) in the Gulf of Mexico. A delta lognormal modeling approach was used to develop these indices. The Species Association Approach (Stephens and MacCall 2004) was explored to identify fishing effort directed at gag grouper, while balancing these subsets of the data with sample size. Results for these data explorations are presented in this document.

Methods

The MRFSS data from 1981-2012 were available for analysis. Catch observations included the number of fish landed and observed by the interviewer (A), the number of fish caught but not available to the interviewer (B1), and the number of released fish (B2) also not observed by the interviewer. Information on effort included hours fished as reported to the interviewer. If there were anglers in a group that actively fished but were not interviewed, catch that was not observed by the interviewer (B1 and B2) was adjusted upwards by the ratio of non-interviewed to interviewed anglers in each group.

The following modifications and exclusions were made to the MRFSS dataset:

1. Data from TX were excluded (Texas parks and Wildlife conducts their own survey)
2. HB were excluded (not available in dataset after 1985 because there is a separate headboat survey)
3. Data prior to 1986 were excluded as there were very few positive trips prior to 1986
4. The index was limited to interviews that reported using hook and line gear.
5. Data from Monroe County were excluded.
6. Approximately, 98% of the interviews that reported the capture of gag grouper were conducted in Florida. Interviews from states other than Florida were removed from the database for this analysis.
7. Florida was defined by three sub-regions, southwest FL (counties: Collier - Pinellas), northwest FL (counties: Pasco - Franklin), and the Panhandle (counties: Gulf - Escambia).
8. Data from 2011 and 2012 were excluded given that the majority of these years was closed to fishing.
9. Months were aggregated in two-month pairs, which correspond to months with open or closed fishing seasons.
10. The Stephens and MacCall (2004) approach was not used to restrict the dataset to those interviews that targeted gag grouper.

Details about data exclusions:

The MRFSS dataset was looked at across different strata to assess the sample size of total interviews and successful interviews (interviews that reported having caught greater amberjack) within each of the strata. Data from Texas, present in the years 1981 through 1985, were removed from the MRFSS data because the State of Texas conducts its own survey. In addition, data from the headboat mode in MRFSS, also present in the years 1981 through 1985, were removed because this information is covered by the Headboat Survey program conducted by NMFS. Data were limited to interviews that reported using hook and line since these represented over 98% of all inshore, private, and charter interviews in the Gulf of Mexico. Data prior to 1986 were excluded due to an extremely low number of interviews resulting in missing data for multiple strata.

The dataset was further partitioned according to decisions that were made during the SEDAR 33 data workshop plenary sessions. During the data workshop the majority of charterboat and private boat fishing occurring in the Dry Tortugas and Florida Keys (Monroe County, Florida) were determined to occur in South Atlantic jurisdiction waters. As such, data from Monroe County were excluded.

Approximately, 98% of the interviews that were observed with gag catch or reported the capture of gag grouper were in FL. All states, except FL, were removed from the database for this analysis; therefore the MRFSS index developed for gag grouper is an FL-only index. Florida was separated into three regions: 1) SW FL (Collier – Pinellas), 2) NW FL (Pasco – Franklin), 3) FL Panhandle.

The Species Association Approach (Stephens and MacCall 2004) was explored to identify gag grouper directed trips. However, this approach did not work well for gag grouper because it eliminated many interviewed trips. As a result, an index was developed using a delta lognormal model on all interviewed trips after subsetting the data with the exclusions mentioned above.

Standardized index of abundance development

Delta lognormal approach

A delta-lognormal modeling approach was used to develop a standardized index using the MRFSS data from 1986 until 2010. The delta-lognormal modeling approach combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed gag grouper) and the catch rates on successful trips to construct a single standardized catch per unit effort, CPUE, index (Lo et al. 1992, Hinton and Maunder 2004, Maunder and Punt 2004). Parameterization of each model was accomplished using a stepwise approach and Akaike's information criteria (AIC). For each GLM procedure of proportion positive trips, a type-3 model assuming a binomial error distribution was assumed and the logit link was selected. The response variable was the proportion of successful trips across strata. For the analysis of the catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. A "normal" linking function was selected and the response variable was calculated as the natural log of CPUE. The CPUE was calculated on an individual group basis and was equal to the number of fish caught divided by the effort, where effort was the product of the number of anglers in the group that was interviewed and the total hours fished.

A stepwise approach was used to quantify the relative importance of the explanatory factors. First, a weighted GLM model was fit to the null model (only the intercept) and the AIC, deviance and degrees of freedom were calculated. Next, a suite of models was tested where each potential explanatory factor was added to the null model. Again, the AIC, deviance, and degrees of freedom were calculated. The model with the factor that had the lowest AIC became the new base model and the process was repeated by adding factors individually until either the AIC was no longer further reduced or the all the factors were added to the model. In addition to screening using AIC, factors were also screened and not added to the model if the reduction in deviance per degree of freedom was less than one percent. This screening was implemented in order to fit a more parsimonious model, given the fact that factors which reduce the deviance by so little exert little influence on the index trend. Two-way interactions among significant main effects were not examined because many of these interactions were confounded with one another (such as the interaction of year and month confounding with the regulatory season factor. The final delta lognormal model was fit using a weighted SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). The observed log-transformed CPUE and the proportion positive of successful trips were weighted by the sampling intensity in a given state. The sampling intensity was proportional to effort for all modes prior to 2000. In 2000, the sampling intensity of the charterboat fishery increased by twofold the base sampling in all states except Florida. The sampling intensity increased by six times in Florida in 2000. Therefore observations associated with the charterboat fishery in Florida were down-weighted by one-sixth starting in 2000.

Several factors were examined as possible influences on the proportion of positive interviews, and on the catch rates of interviewed anglers that observed gag grouper.

FACTOR	LEVELS	DESCRIPTION
Year	25	1986-2010
Mode	3	Inshore, Private, Charter
Region	3	SW FL NW FL Panhandle
Month	6	Dec-Jan Feb-Mar Apr-May Jun-Jul Aug-Sep Oct-Nov
gag_season	2	Open, Closed (see management history)
hrs	9	2 hour bins and a plus group (bins: 2, 4, 6, 8, 9+)

Notes:

(1) Since hours fish is a component of angler hours, and thereby of CPUE, this factor was only explored in the model for the proportion of positive interviews

(2) Months were binned to avoid missing data across months and years, and to match with the length and timing of closed seasons.

To facilitate visual comparison, the standardized index and the nominal CPUE series were adjusted by dividing the annual values by the mean value of the entire time-series.

Results

Efforts were made to apply the Species Association approach (Stephens and MacCall 2004) to the dataset. These efforts were met without success because the approach eliminated most of the interviews. Due to the inability to use this approach, a model for the proportion of successful interviews was constructed using of all interviews, and a model for the catch rates was constructed using only positive interviews.

Various factors and first level interactions were tested for significance using the stepwise approach and accordingly were included or excluded from the model. The following models resulted from the standardization procedures where PPT is a binomial indicating the proportion of interviews with observed gag grouper catch or reported the capture of gag grouper, α represents the parameter estimate of each factor, μ represents the mean, and ε represents the error term.

$$\text{Ln CPUE} = \mu + \alpha 1\text{Mode} + \alpha 2\text{ Year} + \varepsilon$$

$$\text{PPT} = \mu + \alpha 1\text{Mode} + \alpha 2\text{ Year} + \alpha 3\text{ Hours fished} + \varepsilon$$

Table 1 shows the final deviance table and the sequence of model building for the lognormal and binomial models. Mode was the only explanatory variable explaining more than one percent of the variance in the log normally transformed CPUE. Year was forced into the lognormal model. Mode, year, and hours fished all explained at least one percent of the variance in the binomial response variable. Tables summarizing the total number of trips, the number of trips catching gag grouper (positive trips), and the proportion of trips catching gag grouper (the proportion positive) can be found in Appendix A.

The standardized index is shown in Figure 1 and closely follows the nominal index. CPUE generally increased between 1986 and 1998 (Figure 1, Table 2). Between 1998 and 2000, CPUE declined to rates similar to 1995. This was followed by a 5-year period with increasing CPUE, which peaked in 2004 and then declined in 2005 and 2006 (Figure 1). CPUE increased to a similar level achieved in 2004 and declines in 2009 and 2010 (Figure 1). Figures 2-4 show the diagnostic plots for the lognormal and binomial models. All diagnostics indicated the model fit was adequate.

The standardized index that was developed for SEDAR 33 closely follows the previously developed indices even though model structure and data subsetting differed (Figure 5, see SEDAR 10 DW-09). The previous MRFSS index included interviews conducted in all Gulf states. This indicates previous indices were driven by the interviews conducted in the Eastern Gulf of Mexico as defined by the current analysis.

Tables

Table 1. Final deviance table for the regression of the Gulf of Mexico recreational fishery data. The table shows the sequential addition of explanatory variables to the model. The last line of the table section shows the final model.

Lognormal								
Model	factor	factor df	residual df	residual dev	% red var	AIC	Llike	Delta AIC
Null	intercept	1	313896	30051.3	-	154351.2	-77174.6	7859.6
Null + mode	mode	2	313894	29397.2	2.18	147446.6	-73720.3	955
Null + mode + year	year	24	313870	29303.4	0.31	146491.6	-73218.8	0

Binomial								
Model	factor	factor df	residual df	residual dev	% red var	AIC	Llike	Delta AIC
Null	intercept	1	313896	135108.2	-	135110.2	-67554.1	14066
Null + mode	mode	2	313894	126233	6.57	126239	-63116.5	5194.8
Null + mode + year	year	24	313870	123386.2	2.25	123440.2	-61693.1	2396
Null + mode + year + hrs	hrs	6	313866	120978.2	1.95	121044.2	-60489.1	0

Table 2. Index values, upper confidence limits, lower confidence limits, and coefficient of variation for the MRFSS index for Gulf of Mexico gag grouper.

Year	Standardized Index	CV	Lower 95% CI	Upper 95% CI	Nominal Index
1986	0.176	0.303	0.097	0.318	0.364
1987	0.144	0.236	0.091	0.230	0.177
1988	0.080	0.257	0.048	0.132	0.099
1989	0.248	0.243	0.154	0.401	0.227
1990	0.510	0.245	0.314	0.827	0.548
1991	0.656	0.205	0.438	0.984	0.690
1992	0.540	0.142	0.407	0.716	0.542
1993	0.915	0.121	0.719	1.164	0.770
1994	1.216	0.098	0.999	1.479	0.909
1995	1.426	0.101	1.165	1.746	1.067
1996	1.037	0.101	0.848	1.268	0.892
1997	1.176	0.092	0.980	1.412	1.133
1998	1.551	0.074	1.338	1.798	1.540
1999	1.232	0.066	1.080	1.406	1.228
2000	0.804	0.092	0.670	0.966	0.871
2001	0.913	0.085	0.770	1.083	0.979
2002	1.199	0.077	1.029	1.398	1.283
2003	1.487	0.072	1.287	1.718	1.662
2004	1.585	0.067	1.385	1.813	1.982
2005	1.226	0.077	1.051	1.430	1.645
2006	0.879	0.087	0.739	1.045	0.932
2007	1.393	0.076	1.197	1.622	1.298
2008	2.023	0.066	1.773	2.309	1.896
2009	1.353	0.072	1.173	1.562	1.213
2010	1.228	0.077	1.054	1.431	1.056

Figures

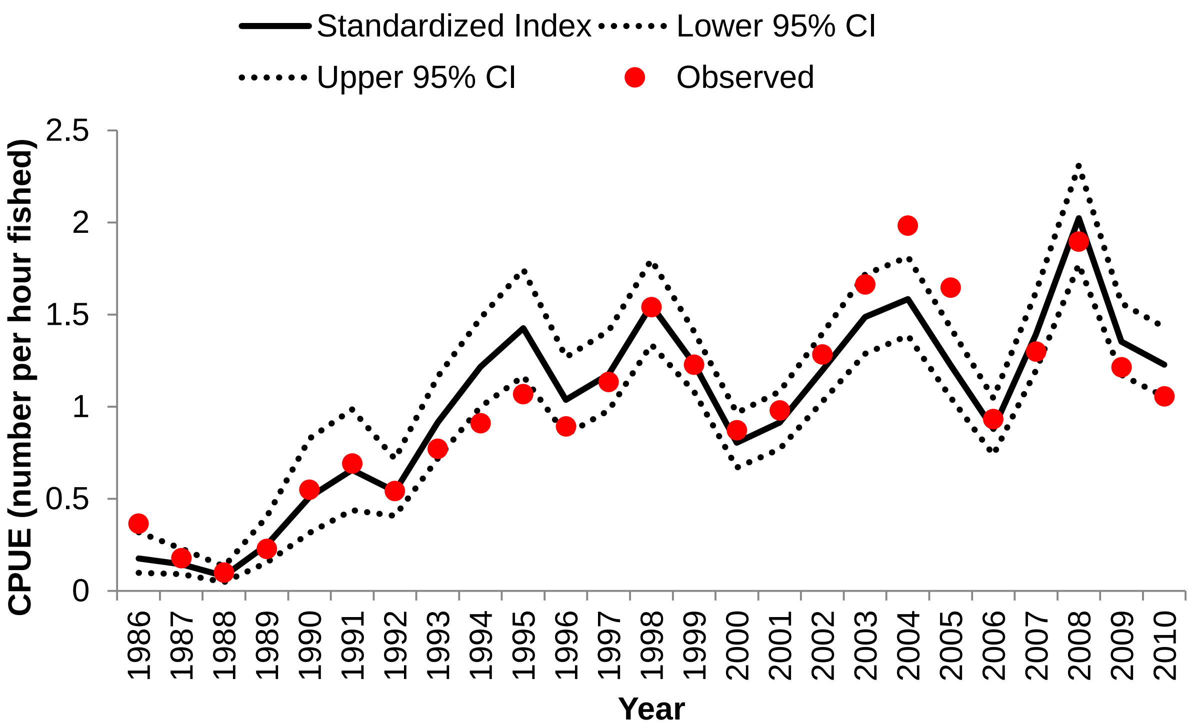

Figure 1. Nominal (observed) and standardized indices (CPUE) and the 95% confidence intervals for Gulf of Mexico gag grouper. CPUE values were scaled by the mean index.

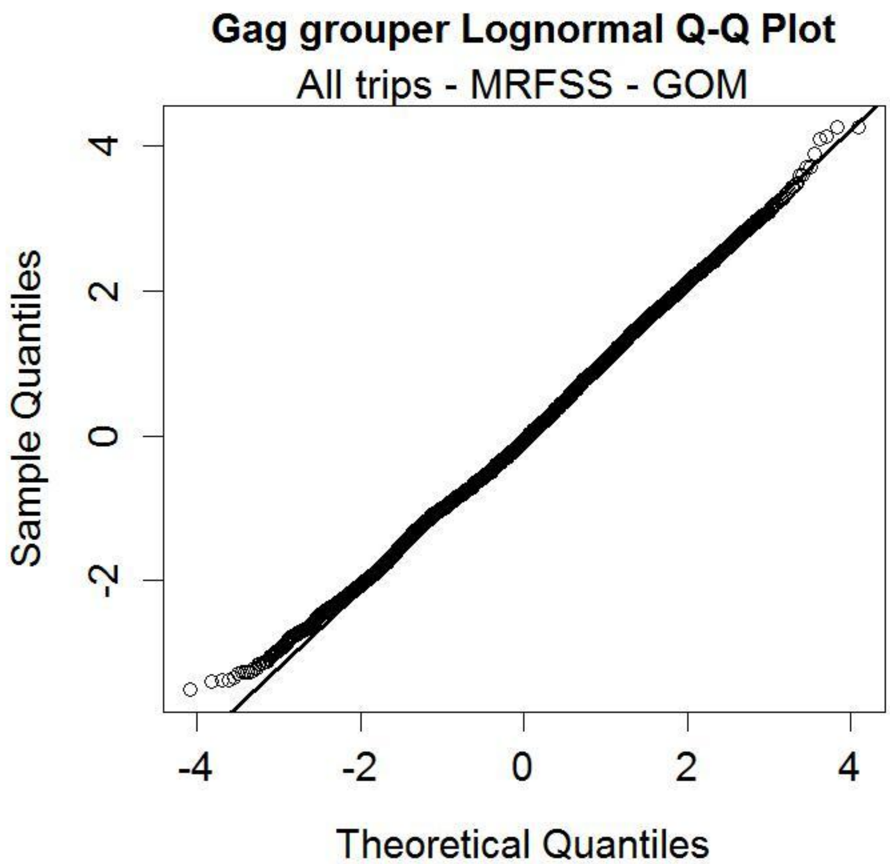

Figure 2. Lognormal Q-Q plot.

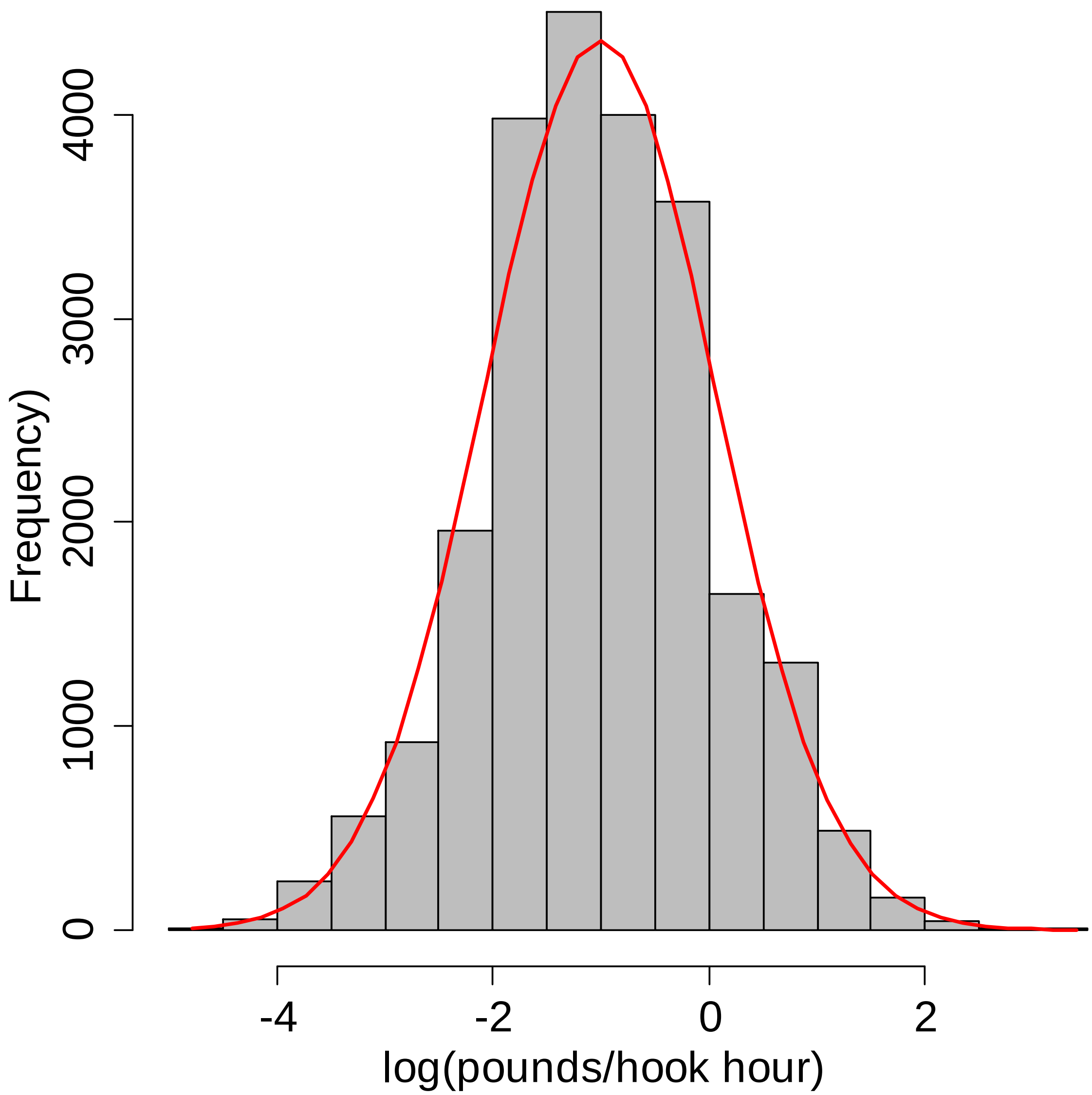

Figure 3. Frequency distribution of catch rates on positive interviews. The red line is the expected normal distribution.

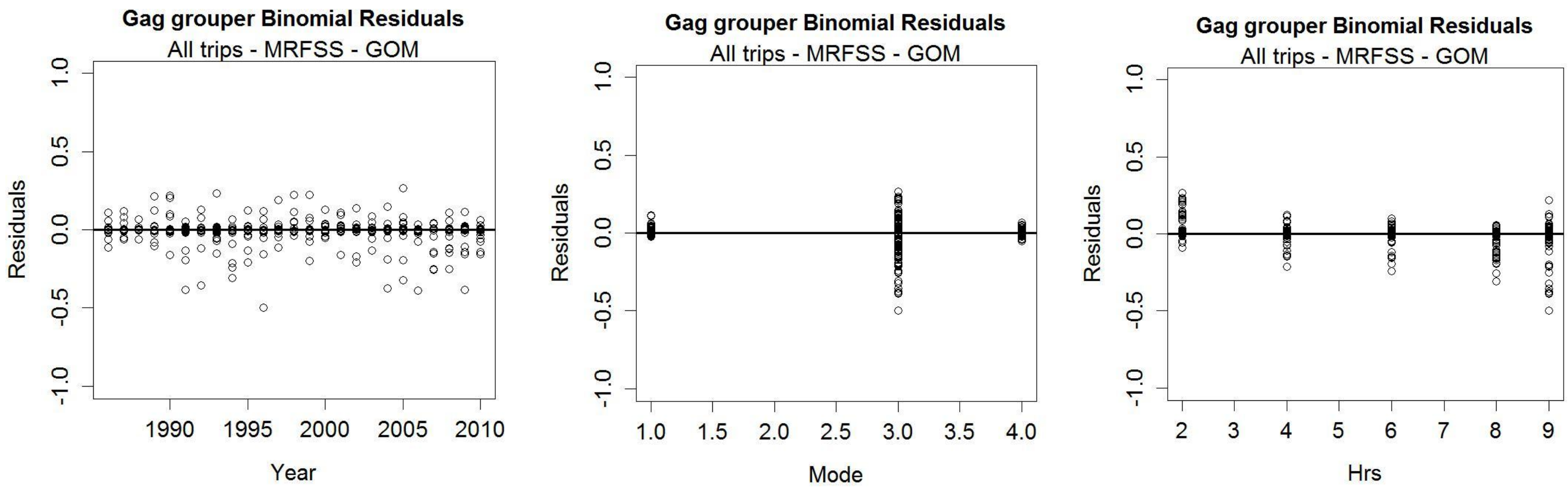

Figure 4. Residuals from the binomial model on proportion positive interviews, by factor. Mode was not treated as a continuous variable, but is plotted as such. Modes: Mode 1.0 – inshore, Mode 3.0 – charteboat, Mode 4.0 – private.

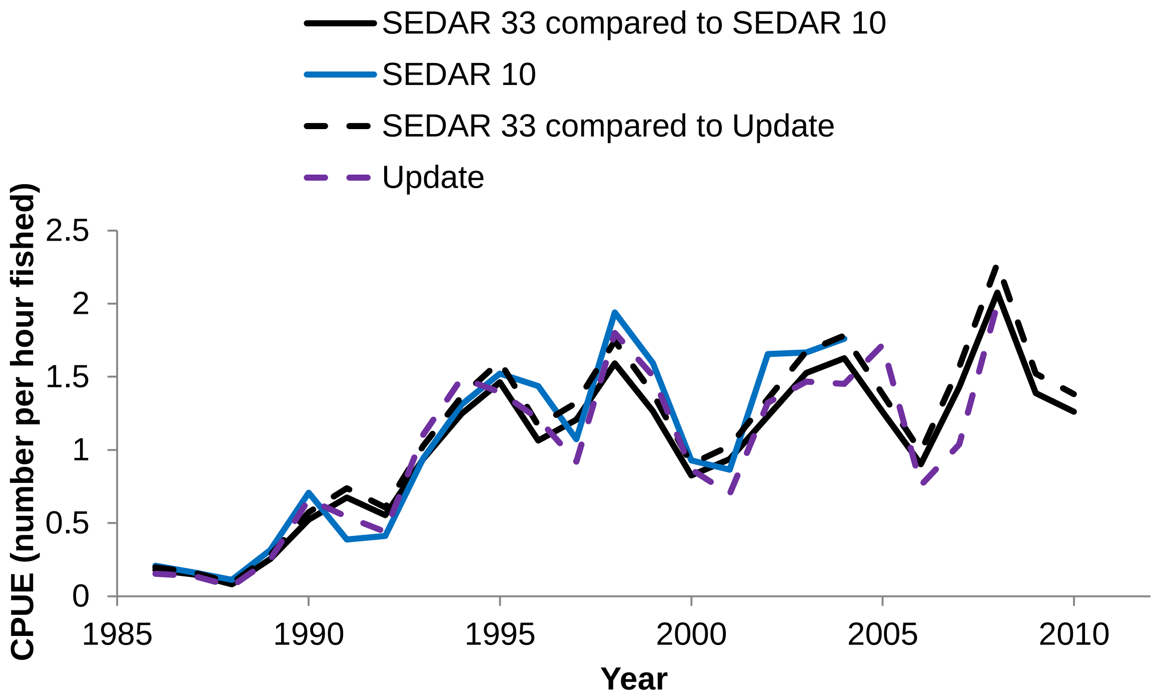

Figure 5. Comparison of the standardized indices from SEDAR 33 and SEDAR 10, which was also used for the update assessment of gag grouper. All indices were scaled by the mean of the overlapping period.

Appendix A.

Table A.1. The number of trips, the number of positive trips and the proportion of positive trips by year.

Year	Trips	Positive trips	Proportion of positive trips
1986	4552	65	1.43
1987	5934	107	1.80
1988	7450	89	1.19
1989	4936	100	2.03
1990	4123	97	2.35
1991	3944	139	3.52
1992	9700	293	3.02
1993	10630	404	3.80
1994	12451	617	4.96
1995	11526	567	4.92
1996	11384	591	5.19
1997	11671	730	6.25
1998	14223	1156	8.13
1999	18880	1516	8.03
2000	16013	1156	7.22
2001	17109	1206	7.05
2002	18704	1515	8.10
2003	19088	1867	9.78
2004	20475	2270	11.09
2005	18432	1786	9.69
2006	17561	1184	6.74
2007	18052	1356	7.51
2008	17489	1758	10.05
2009	19264	1508	7.83
2010	19319	1363	7.06

Table A.2. The total number of trips by mode.

Year	Inshore	Charterboat	Private
1986	960	711	2881
1987	1057	478	4399
1988	2184	461	4805
1989	1620	213	3103
1990	1248	135	2740
1991	1215	137	2592
1992	3012	199	6489
1993	4909	245	5476
1994	5758	327	6366
1995	5510	183	5833
1996	3674	230	7480
1997	3805	551	7315
1998	4548	905	8770
1999	6162	1491	11227
2000	5029	1947	9037
2001	5094	1350	10665
2002	5302	1556	11846
2003	5845	2149	11094
2004	5407	2777	12291
2005	5179	2228	11025
2006	4871	1595	11095
2007	4953	1575	11524
2008	4910	1148	11431
2009	5440	1271	12553
2010	5875	1417	12027

Table A.3. The number of trips catching gag grouper (positives) by mode.

Year	Inshore	Charterboat	Private
1986	0	51	14
1987	-	-	45
1988	0	38	51
1989	7	35	58
1990	0	27	70
1991	4	10	125
1992	20	43	230
1993	49	54	301
1994	55	35	527
1995	63	59	445
1996	32	57	502
1997	31	163	536
1998	59	411	686
1999	54	614	848
2000	33	516	607
2001	36	425	745
2002	94	531	890
2003	88	799	980
2004	74	1008	1188
2005	96	877	813
2006	57	436	691
2007	120	321	915
2008	135	358	1265
2009	116	316	1076
2010	111	342	910

Table A.4. The proportion of trips catching gag grouper by mode.

Year	Inshore	Charterboat	Private
1986	0.00	0.07	0.00
1987	-	-	0.01
1988	0.00	0.08	0.01
1989	0.00	0.16	0.02
1990	0.00	0.20	0.03
1991	0.00	0.07	0.05
1992	0.01	0.22	0.04
1993	0.01	0.22	0.05
1994	0.01	0.11	0.08
1995	0.01	0.32	0.08
1996	0.01	0.25	0.07
1997	0.01	0.30	0.07
1998	0.01	0.45	0.08
1999	0.01	0.41	0.08
2000	0.01	0.27	0.07
2001	0.01	0.31	0.07
2002	0.02	0.34	0.08
2003	0.02	0.37	0.09
2004	0.01	0.36	0.10
2005	0.02	0.39	0.07
2006	0.01	0.27	0.06
2007	0.02	0.20	0.08
2008	0.03	0.31	0.11
2009	0.02	0.25	0.09
2010	0.02	0.24	0.08

Table A.5. The total number of trips by hours fished.

Year	2	4	6	8	9
1986	1282	1799	981	356	134
1987	1647	2260	1358	501	168
1988	2167	2904	1585	580	214
1989	1422	1993	1076	350	95
1990	998	1660	1042	342	81
1991	957	1635	995	279	78
1992	2410	3751	2482	787	270
1993	3019	4081	2371	845	314
1994	3282	5140	2801	898	330
1995	3252	4449	2602	908	315
1996	2748	4490	2967	883	296
1997	2556	4920	3059	838	298
1998	3023	5708	4022	1127	343
1999	4054	7477	5188	1650	511
2000	3164	6471	4452	1551	375
2001	3447	6661	4948	1568	485
2002	3871	7310	5343	1690	490
2003	4455	7756	4935	1575	367
2004	4392	8004	5604	1981	494
2005	4243	7373	4841	1579	396
2006	3891	7088	4772	1403	407
2007	4464	7113	4782	1330	363
2008	4056	7058	4843	1247	285
2009	4068	8317	5132	1502	245
2010	4360	8431	4923	1288	317

Table A.6. The number of trips catching gag grouper by hours fished.

Year	2	4	6	8	9
1986	10	20	34	1	0
1987	9	37	41	13	7
1988	8	29	33	12	7
1989	7	44	34	9	6
1990	-	37	39	-	-
1991	10	49	50	26	4
1992	22	107	109	43	12
1993	40	148	131	61	24
1994	64	237	215	67	34
1995	45	210	204	85	23
1996	46	201	217	84	43
1997	69	267	264	94	36
1998	96	424	448	128	60
1999	142	588	550	180	56
2000	75	393	437	201	50
2001	60	448	498	148	52
2002	101	608	569	180	57
2003	127	731	726	215	68
2004	181	859	841	329	60
2005	139	801	611	188	47
2006	93	465	465	129	32
2007	154	504	495	140	63
2008	171	677	656	202	52
2009	121	644	538	160	45
2010	85	612	465	149	52

Table A.7. The proportion of trips catching gag grouper by hours fished.

Year	2	4	6	8	9
1986	0.01	0.01	0.03	0.00	0.00
1987	0.01	0.02	0.03	0.03	0.04
1988	0.00	0.01	0.02	0.02	0.03
1989	0.00	0.02	0.03	0.03	0.06
1990	-	0.02	0.04	-	-
1991	0.01	0.03	0.05	0.09	0.05
1992	0.01	0.03	0.04	0.05	0.04
1993	0.01	0.04	0.06	0.07	0.08
1994	0.02	0.05	0.08	0.07	0.10
1995	0.01	0.05	0.08	0.09	0.07
1996	0.02	0.04	0.07	0.10	0.15
1997	0.03	0.05	0.09	0.11	0.12
1998	0.03	0.07	0.11	0.11	0.17
1999	0.04	0.08	0.11	0.11	0.11
2000	0.02	0.06	0.10	0.13	0.13
2001	0.02	0.07	0.10	0.09	0.11
2002	0.03	0.08	0.11	0.11	0.12
2003	0.03	0.09	0.15	0.14	0.19
2004	0.04	0.11	0.15	0.17	0.12
2005	0.03	0.11	0.13	0.12	0.12
2006	0.02	0.07	0.10	0.09	0.08
2007	0.03	0.07	0.10	0.11	0.17
2008	0.04	0.10	0.14	0.16	0.18
2009	0.03	0.08	0.10	0.11	0.18
2010	0.02	0.07	0.09	0.12	0.16