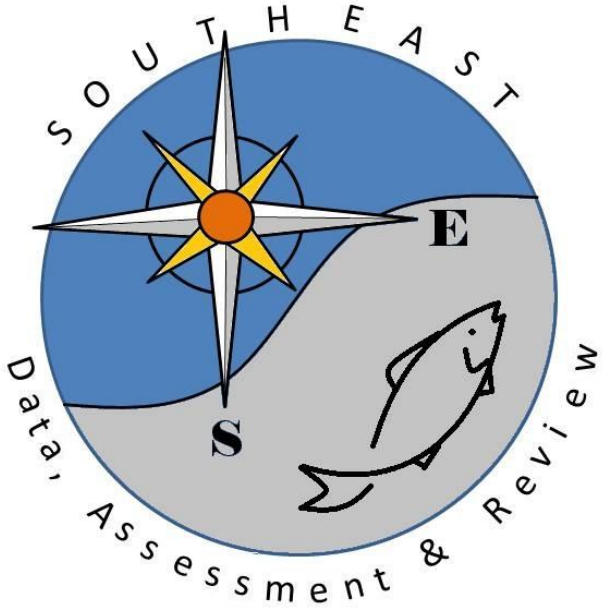
Standardized catch rates for gag grouper from the United States Gulf of Mexico commercial handline fishery during 1990-2009

Meaghan Bryan

SEDAR33-AW15

10 July 2013



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Please cite as:

Bryan, M. 2013. Standardized catch rates for gag grouper from the United States Gulf of Mexico commercial handline fishery during 1990-2009. SEDAR33-AW15. SEDAR, North Charleston, SC. 23 pp.

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Sustainable Fisheries Division Contribution SFD-2013-013

Introduction

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 fishing permits associated with 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 obtaining a complete census of reef fish fishery permitted vessel activity. The one exception was 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 and effort data from the commercial handline fishery were used to develop a standardized index of abundance for gag grouper.

Methods

Data exclusions and modifications

The logbook database includes a unique trip identifier for each fishing trip, the landing date, the fishing gear deployed, the areas fished (equivalent to NMFS shrimp statistical grids, Figure 1), the number of days at sea, the number of crew, the gear specific fishing effort (for handline: the number of lines fished, the number of hooks per line and the estimated total fishing time), the species caught and the whole weight of the landings. Vessels may fish in multiple areas using multiple gears during a single trip. Catch is reported by gear and area, however, effort is not. In such cases, apportioning effort to specific locations was not possible; therefore, trips reporting multiple fishing areas were not included in this analysis. Logbook data received 45 days after the trip completion date were not included in this analysis due to the lengthy gap in

the reporting time. 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 for this analysis.

Handline catch rate was calculated in weight of fish per hook-hour. Hook hours were calculated as product of the number of lines fished, the number of hooks per line, and the total hours fished. Catch per unit effort was then calculated as:

CPUE = Pounds of gag / hook hours.

The data were spatially restricted to areas 1 – 11 (Figure 1). These areas accounted for approximately 99% of the handline trips that caught gag grouper and 97% of the gag grouper landings during the years 1990-2009. These statistics support restricting the analyses to data reported from these areas.

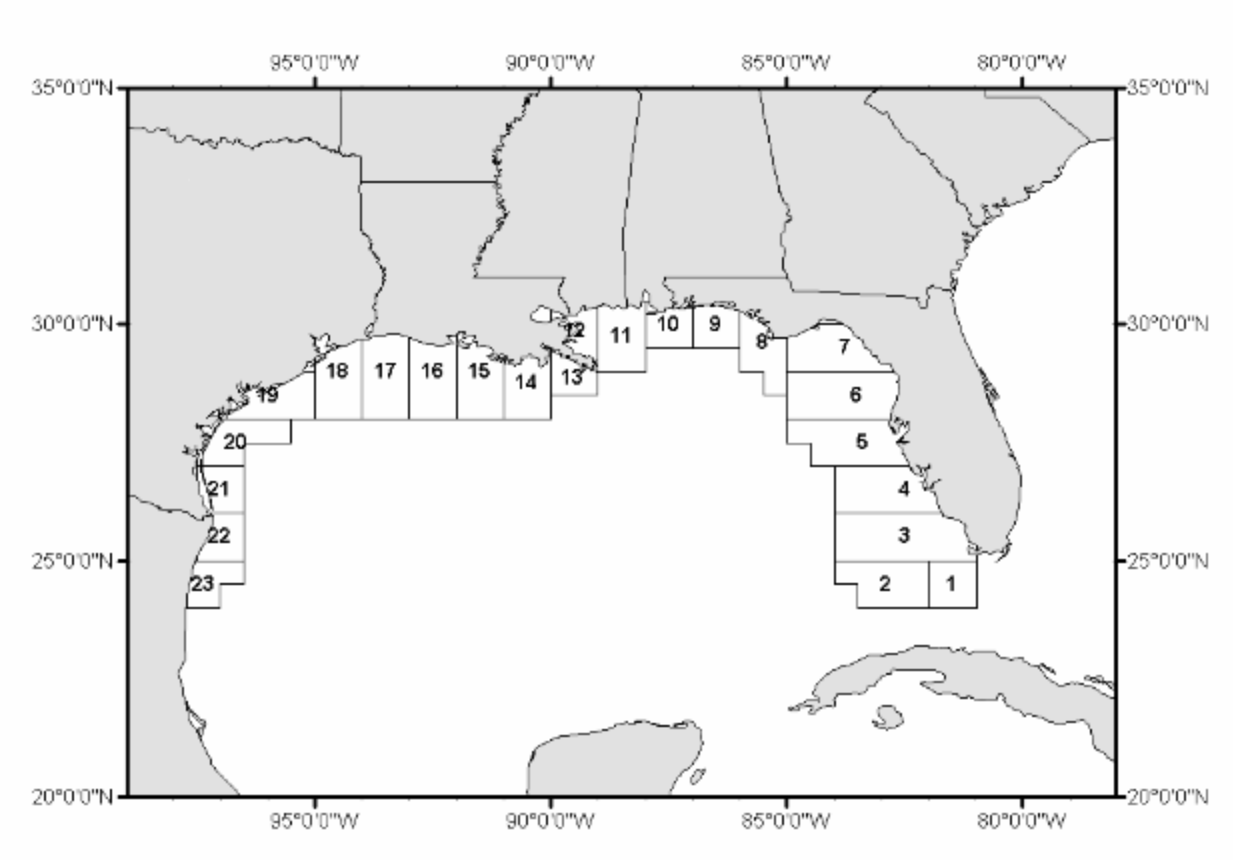

Figure 1. Gulf of Mexico defined commercial fishing areas.

The data were evaluated to identify trips that were atypical. The following factors were considered in this process: number of hooks per line, number of lines fished, number of days at sea, and the number of crew members. The cumulative percentage of trips for each factor was

determined. Trips that fell outside the 99th percentile were considered to represent mis-reported data or data entry errors and removed from the analysis for. Gag grouper handline trips included in this analysis were characterized by:

1. The number of hooks fished per line $\leq$ 35,
2. The number of lines fished $\leq$ 8,
3. The number of days at sea $\leq$ 12, and
4. The number of crew members $\leq$ 6.

Several strategies have been employed to manage the gag grouper commercial fisheries. These strategies include trip limits, seasonal closures, and quotas. Seasonal closures were implemented on the following dates:

1990: Closed 11/7 – 12/31
1999 - 2003: Closed 2/15 – 3/15
2004: Closed 2/15 – 3/15, Closed 11/15 – 12/31
2005: Closed 2/15 – 3/15. Closed 10/10 – 12/31
2006-2009: Closed 2/15 – 3/15.

The dataset was restricted to time periods for which fishing on gag grouper was allowed.

Quota management commenced in 2010 for the gag grouper fishery. This type of management strategy often leads to changes in fishing behavior (e.g., avoidance of capture) that can greatly influence CPUE. Catch and effort data from 2010-2012 were excluded from this analysis.

Proper species identification in the coastal logbook landings data was of concern during the development of the gag grouper indices of abundance. Specifically, the proportion of gag grouper to black grouper reported in the coastal logbook program differed considerably from that reported in the Trip Interview Program (TIP). Area specific percentages of gag to black grouper (Table 1), determined from the TIP, were used to estimate the total gag grouper landings by summing gag and black grouper landings reported from an area and multiplying those totals by the appropriate gag to black grouper percentage.

Table 1. The proportion of the total (gag grouper +black grouper) that were identified as gag grouper by area.

Area	Proportion of gag grouper
1	0.093
2	0.420
3	0.786
4	0.905
5	0.957
6	0.983
7 - 11	0.999

Index development

Table 2 summarizes the main factors considered as possible influences on the proportion of trips landing gag grouper and the resulting catch rates. A single index was developed for the entire time period considered unlike SEDAR 10 and the update assessment. During SEDAR 10 two indices were developed and corresponded to two time periods with different gag grouper size limits (20inch limit prior to 1999 and 24 inch limit after and including 1999). This was not a concern for this analysis as the assessment model can internally account for changing size regulations and its potential impacts on the index of abundance.

Table 2. Main factors considered as possible influences on the proportion of trips landing gag grouper and the catch rates of gag grouper.

Factor	Levels	Value
Year	20	1990-2009
Area	11	Gulf of Mexico shrimp grids 1-11
Days (days at sea)	12	1-12 days at sea
Crew (number of crew members)	4	1-4+ crew members
Hook hours	17	54-900+ (binning increments = 54 hours)

The delta lognormal model approach (Lo et al. 1992) was used to develop standardized indices of abundance. This method 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 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 the 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).

A stepwise approach was used to quantify the relative importance of the explanatory factors. Each potential explanatory 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 $\geq 1\%$. 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. All 2-way interactions among significant main effects were examined, however 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, the standardized index and the nominal CPUE series were scaled by dividing each value in the series by the mean value of the entire time-series.

Results and discussion

Various explanatory variables and one-way interactions were tested for significance using a stepwise approach and accordingly included or excluded from the model. The final models for the binomial on the proportion of positive trips (PPT) and the lognormal on CPUE of successful trips were:

$$PPT = \mu + \alpha_1(Area) + \alpha_2(Days) + \alpha_3(Year) + \varepsilon$$

$$\ln(CPUE) = \mu + \alpha_1(Area) + \alpha_2(Year) + \alpha_3(Crew) + \alpha_4(Area*Year) + \alpha_5(Area*Crew) + \varepsilon$$

The final deviance tables for the binomial and lognormal models are provided in Tables 3 and 4, respectively. The reader is referred to Appendix A for a summary of the total number of handline trips, the number of handline trips catching gag grouper, and the proportion of trips catching gag grouper by the main effects and year.

The standardized catch rates for gag grouper increased from 1990 until 2004 and then declined (Figure 1, Table 5). The standardized index closely follows the nominal index, except in 2007 and 2008. Figures 2 and 3 show the diagnostic plots for the lognormal and binomial models, respectively. The histogram of the catch rates shows that the data deviate from the normal distribution (Figure 2); however, the IWG determined that overall the diagnostics were adequate.

Figure 4 shows a comparison of the standardized index developed for SEDAR 33 and those developed for SEDAR10 and the 2009 update. During SEDAR 10 and the update, separate indices were developed for 1993-2000 and 2001-2004 because of differing size regulations. During the update assessment data from 1990 through 1992 were included, whereas, they were excluded during SEDAR 10. Although the objective of the logbook program was to obtain a census of the commercial catch and effort, in Florida between 1990 and 1992, logbook information of 20% of trips were obtained (100% reporting was required by all other Gulf States). After 1992, 100% reporting was required in Florida. Assuming that the samples from Florida in the early years were random and representative of the fishery the data from 1990 through 1992 can be used to develop a standardized index of abundance. Regardless of the years used in the development of the handline index, the index developed for SEDAR 33 is similar to the indices developed for SEDAR 10 and the update assessment (Figure 4).

Table 3. Linear regression statistics for the final GLM model on the proportion positive trips (PPT) for gag grouper in the Gulf of Mexico for vessels reporting handline landings.

Model	Factor	Factor df	Resid df	Resid dev	% red. var	AIC	Llike	delta AIC
Null	intercept	1	108055	146722.1	-	146724	-73361	43780.4
Null+area	area	10	108045	111757.3	23.82	111779	-55878.6	8835.6
Null+area+away	away	12	108034	104876	6.15	104920	-52438	1976.4
Null+area+away+year	year	19	108015	102861.6	1.9	102944	-51430.8	0

Table 4. Linear regression statistics for the final GLM model on log transformed CPUE for gag grouper in the Gulf of Mexico for vessels reporting handline landings.

Model	Factor	Factor df	Resid df	Resid dev	% red. var	AIC	Llike	delta AIC
Null	intercept	1	108055	277592.2	-	408603	-204300	26340.8
Null+area	area	10	108045	234392	15.55	390344	-195161	8082.4
Null+area+year	year	19	108026	229159.4	2.22	387943	-193941	5680.8
Null+area+year+crew	crew	3	108023	225993	1.38	386445	-193190	4183.2
Null+area+year+crew+area*year	area*year	190	107833	218962.1	2.94	383410	-191482	1148
Null+area+year+crew+area*year+area*crew	area*crew	30	107803	216527.7	1.32	382262	-190878	0

Table 5. Index values, coefficient of variation, upper confidence limit, and lower confidence limit for the commercial handline index for the Gulf of Mexico gag grouper. CPUE values were scaled to one by the mean of the index.

Year	Standardized Index	CV	Lower 95% CI	Upper 95% CI	Nominal Index
1990	0.314	0.316	0.170	0.582	0.391
1991	0.314	0.239	0.196	0.503	0.297
1992	0.562	0.232	0.355	0.889	0.727
1993	0.651	0.205	0.433	0.976	0.580
1994	0.589	0.204	0.393	0.881	0.604
1995	0.782	0.200	0.526	1.163	0.667
1996	0.930	0.198	0.629	1.377	0.709
1997	0.907	0.195	0.616	1.335	0.782
1998	1.546	0.194	1.053	2.271	1.591
1999	1.045	0.195	0.710	1.538	1.165
2000	1.109	0.196	0.753	1.634	1.257
2001	1.593	0.196	1.080	2.348	1.510
2002	1.590	0.197	1.077	2.347	1.470
2003	1.563	0.197	1.058	2.307	1.350
2004	1.991	0.197	1.349	2.939	1.841
2005	1.872	0.198	1.265	2.770	1.745
2006	1.006	0.202	0.674	1.502	0.870
2007	0.648	0.206	0.431	0.974	0.994
2008	0.640	0.209	0.424	0.967	0.980
2009	0.350	0.211	0.230	0.531	0.471

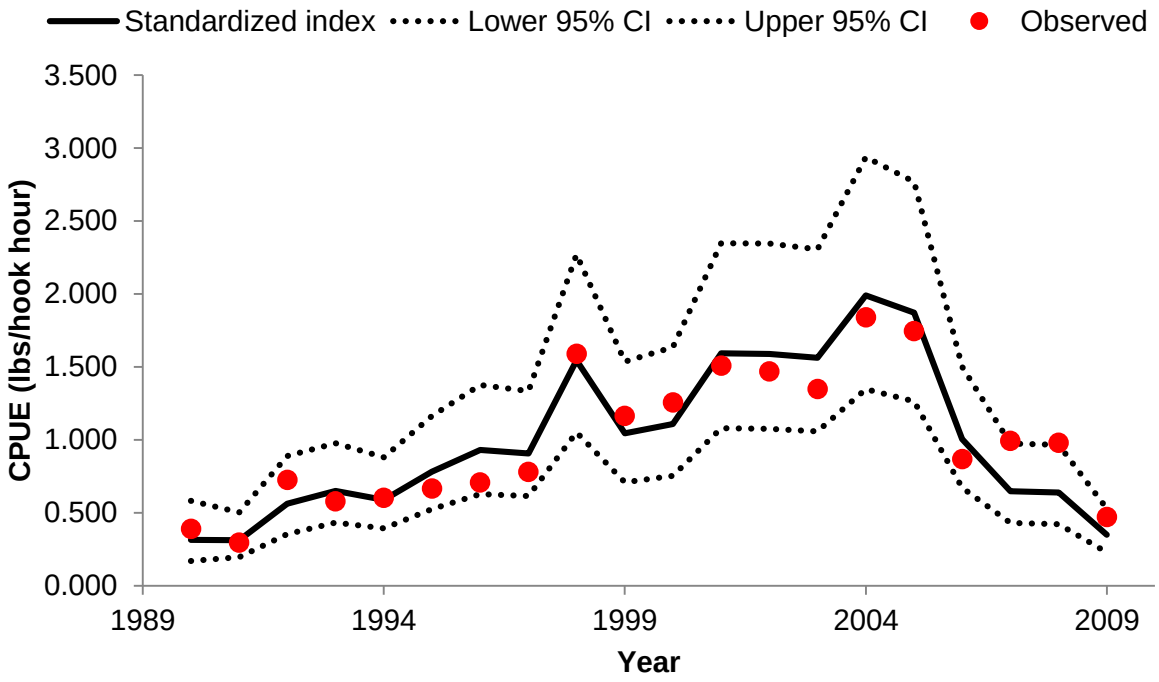

Figure 1. Nominal (observed) and standardized CPUE and the 95% confidence intervals for Gulf of Mexico gag grouper from the commercial handline fishery. CPUE values were scaled to one by the mean of the index.

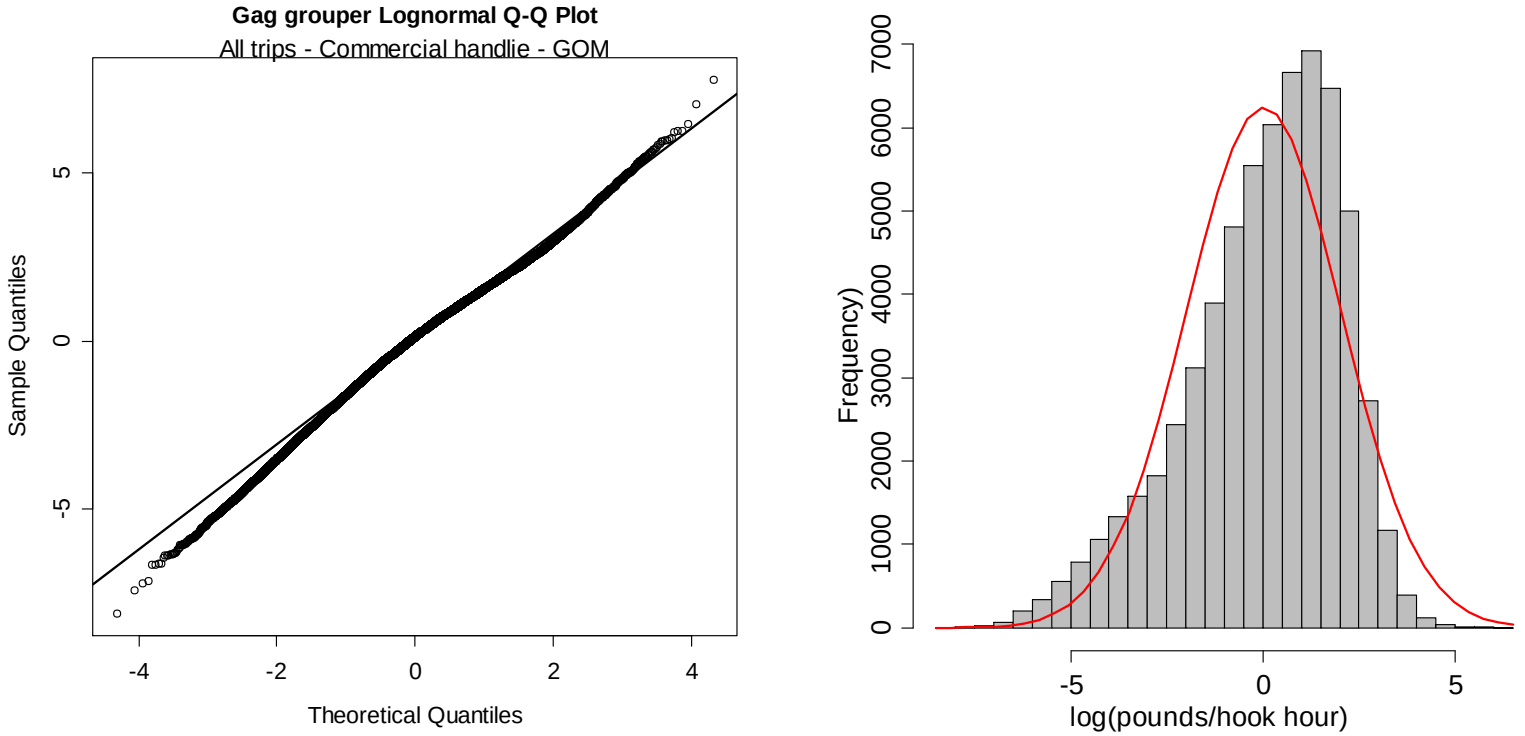

Figure 2. left panel : Lognormal Q-Q plot and right panel: the frequency distribution of the log transformed catch rates of the positive trips. The red line represents the expected normal distribution.

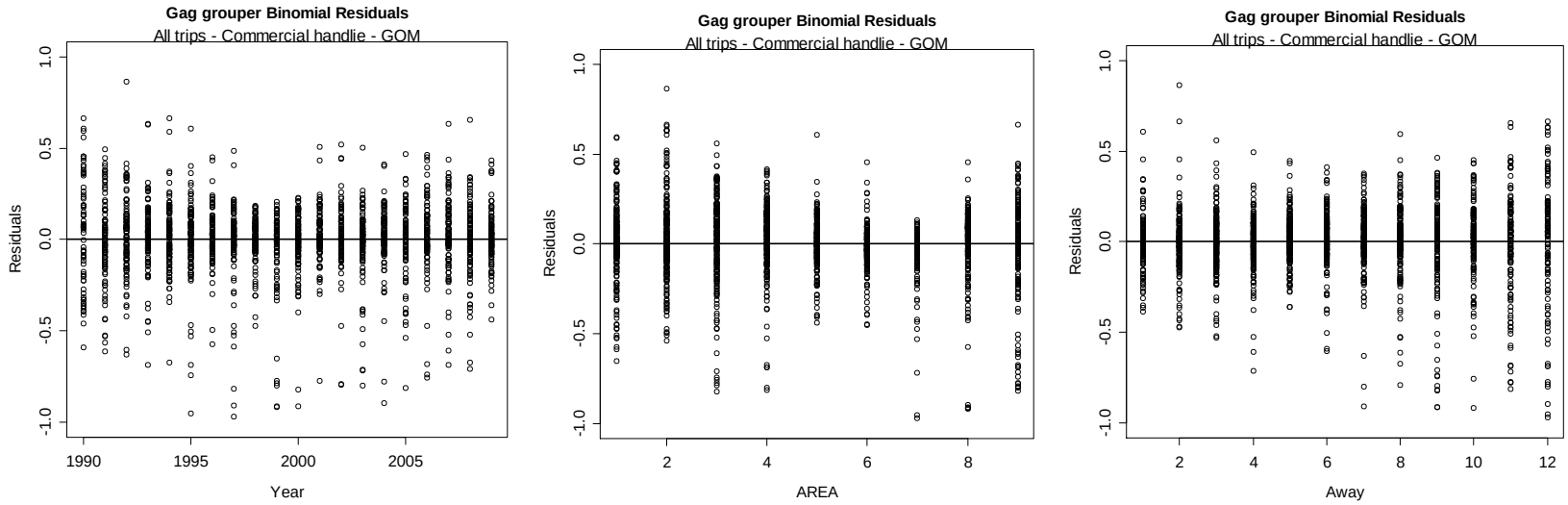

Figure 3. Residuals from the binomial model on the proportion of positive trips by factor.

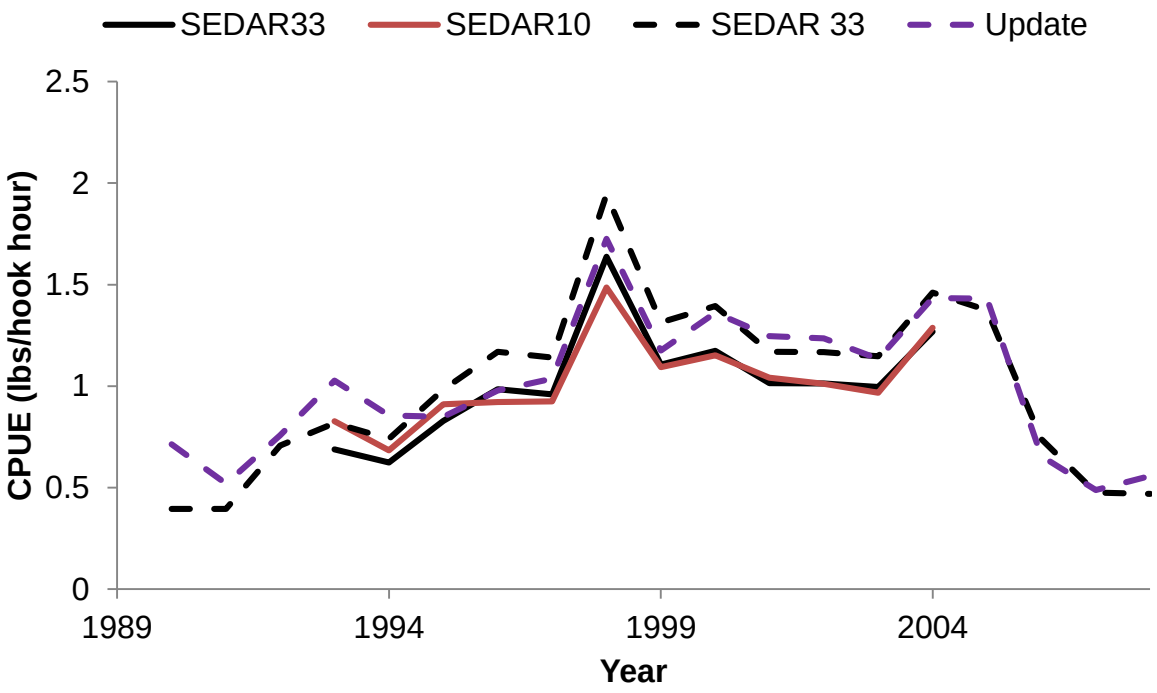

Figure 4. A comparison of the standardized index developed for SEDAR 33 and those developed for SEDAR 10 and the update assessment. All indices were scaled by the mean of the overlapping time period(s).

Appendix A.

Table A.1 The number of commercial handline trips catching gag grouper (Positive trips), the total number of trips, the proportion of trips catching gag grouper (proportion positives) by year. Shaded regions represent confidential data.

Year	Positive trips	Total Trips	Proportion positives
1990			0.55
1991	626	1316	0.48
1992	786	1629	0.48
1993	2138	4685	0.46
1994	2770	6391	0.43
1995	3138	6786	0.46
1996	2802	5004	0.56
1997	3987	6813	0.59
1998	4606	6996	0.66
1999	4578	7282	0.63
2000	4506	7213	0.62
2001	4788	7631	0.63
2002	4778	7720	0.62
2003	4603	7331	0.63
2004	4184	6380	0.66
2005	3425	4978	0.69
2006	3126	5286	0.59
2007	2771	4531	0.61
2008	2785	4713	0.59
2009	2572	5093	0.50

Table A.2 The total number of commercial handline trips by year and area. Shaded regions represent confidential data.

	Area										
Year	1	2	3	4	5	6	7	8	9	10	11
1990			14	35	31	63	25	12		51	
1991	65	45	36	150	160	240	86	46	140	288	60
1992	69	82	55	185	190	365	141	38	117	258	129
1993	1356	341	109	395	361	686	483	204	211	371	168
1994	1944	423	117	435	462	977	746	369	362	391	165
1995	2193	416	140	423	501	1090	635	416	398	423	151
1996	1176	284	154	327	524	809	462	338	359	374	197
1997	1318	579	215	520	717	1135	775	455	430	398	271
1998	1037	364	109	423	660	1398	1218	475	583	447	282
1999	997	559	124	462	680	1425	1273	535	427	476	324
2000	1071	373	134	489	721	1305	1354	568	427	391	380
2001	1098	451	142	473	682	1191	1748	618	340	356	532
2002	999	510	130	425	577	1234	1748	702	406	448	541
2003	958	373	87	434	620	1196	1589	707	372	434	561
2004	743	371	105	391	488	1122	1513	589	350	319	389
2005	609	332	84	280	386	970	1143	542	202	210	220
2006	555	442	107	231	390	968	1179	516	310	245	343
2007	431	289	96	214	318	698	1272	496	222	265	230
2008	526	213	95	223	310	738	1269	506	266	274	293
2009	557	312	94	283	385	781	972	569	346	426	368

Table A.3 The number of commercial handline trips catching gag grouper by year and area. Shaded regions represent confidential data.

	Area										
Year	1	2	3	4	5	6	7	8	9	10	11
1990			9	18	27	44	22	11		14	
1991	17	10	26	49	119	194	58	18	34	89	12
1992	4	16	32	71	142	321	116	23	24	25	12
1993	288	93	73	139	263	624	337	131	80	79	31
1994	375	126	63	136	290	786	514	240	146	76	18
1995	432	139	84	133	350	916	473	287	157	128	39
1996	236	95	109	149	407	674	401	247	166	214	104
1997	242	176	139	305	562	997	706	326	223	209	102
1998	168	129	84	282	569	1193	1147	370	299	234	131
1999	126	136	89	282	549	1240	1162	347	222	256	169
2000	149	110	84	296	517	1149	1219	407	207	201	167
2001	129	117	104	310	507	1041	1614	428	156	163	219
2002	149	116	93	272	430	1032	1608	494	176	201	207
2003	164	87	61	279	482	1064	1458	507	140	156	205
2004	112	107	68	261	379	986	1411	438	159	114	149
2005	126	92	54	199	279	847	1077	409	114	120	108
2006	95	152	64	153	277	774	997	314	91	97	112
2007	48	79	33	125	218	551	1143	326	92	92	64
2008	67	34	16	101	194	598	1125	359	105	101	85
2009	27	45	19	132	241	647	820	328	93	141	79

Table A.4 The proportion of commercial handline trips catching gag grouper by year and area. Shaded regions represent confidential data.

	Area										
Year	1	2	3	4	5	6	7	8	9	10	11
1990			0.64	0.51	0.87	0.7	0.88	0.92		0.27	
1991	0.26	0.22	0.72	0.33	0.74	0.81	0.67	0.39	0.24	0.31	0.2
1992	0.06	0.2	0.58	0.38	0.75	0.88	0.82	0.61	0.21	0.1	0.09
1993	0.21	0.27	0.67	0.35	0.73	0.91	0.7	0.64	0.38	0.21	0.18
1994	0.19	0.3	0.54	0.31	0.63	0.8	0.69	0.65	0.4	0.19	0.11
1995	0.2	0.33	0.6	0.31	0.7	0.84	0.74	0.69	0.39	0.3	0.26
1996	0.2	0.33	0.71	0.46	0.78	0.83	0.87	0.73	0.46	0.57	0.53
1997	0.18	0.3	0.65	0.59	0.78	0.88	0.91	0.72	0.52	0.53	0.38
1998	0.16	0.35	0.77	0.67	0.86	0.85	0.94	0.78	0.51	0.52	0.46
1999	0.13	0.24	0.72	0.61	0.81	0.87	0.91	0.65	0.52	0.54	0.52
2000	0.14	0.29	0.63	0.61	0.72	0.88	0.9	0.72	0.48	0.51	0.44
2001	0.12	0.26	0.73	0.66	0.74	0.87	0.92	0.69	0.46	0.46	0.41
2002	0.15	0.23	0.72	0.64	0.75	0.84	0.92	0.7	0.43	0.45	0.38
2003	0.17	0.23	0.7	0.64	0.78	0.89	0.92	0.72	0.38	0.36	0.37
2004	0.15	0.29	0.65	0.67	0.78	0.88	0.93	0.74	0.45	0.36	0.38
2005	0.21	0.28	0.64	0.71	0.72	0.87	0.94	0.75	0.56	0.57	0.49
2006	0.17	0.34	0.6	0.66	0.71	0.8	0.85	0.61	0.29	0.4	0.33
2007	0.11	0.27	0.34	0.58	0.69	0.79	0.9	0.66	0.41	0.35	0.28
2008	0.13	0.16	0.17	0.45	0.63	0.81	0.89	0.71	0.39	0.37	0.29
2009	0.05	0.14	0.2	0.47	0.63	0.83	0.84	0.58	0.27	0.33	0.21

Table A.5 The number of commercial handline trips by year and days-at-sea (days). Shaded regions represent confidential data.

	Days											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1990	54	27	33	22	36	28	22					
1991	428	112	101	88	122	134	99	92	58	40	33	9
1992	682	134	126	119	112	105	84	100	66	44	33	24
1993	2333	512	444	343	290	217	198	158	77	54	27	32
1994	3451	678	501	444	399	261	241	198	92	77	22	27
1995	3808	649	515	423	415	268	264	179	93	106	33	33
1996	2555	609	380	357	341	251	218	127	50	74	20	22
1997	3587	791	454	442	408	294	341	182	105	129	39	41
1998	3828	880	492	446	355	266	271	168	93	115	39	43
1999	3755	895	580	527	419	316	288	197	126	111	24	44
2000	3900	897	510	431	414	308	298	176	81	126	43	29
2001	3878	977	537	531	517	375	349	204	105	109	24	25
2002	3626	1074	664	585	510	408	331	251	103	111	29	28
2003	3526	1074	625	506	444	364	263	189	124	131	47	38
2004	3036	924	572	416	447	310	270	155	90	98	36	26
2005	2022	804	467	420	384	305	204	144	91	97	20	20
2006	2283	687	414	385	433	310	277	186	133	118	31	29
2007	1649	586	520	428	373	289	242	145	122	101	43	33
2008	1759	580	585	473	416	276	224	143	108	79	41	29
2009	1880	585	524	516	439	311	272	215	135	103	53	60

Table A.6 The number of commercial handline trips catching gag grouper by year and days-at-sea (days). Shaded regions represent confidential data.

	Days											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1990	11	11	14	16	27	15	16					
1991	93	42	33	50	72	86	73	72	41	34	25	5
1992	198	54	70	57	63	69	58	81	55	37	25	19
1993	582	265	235	232	199	162	169	130	68	48	21	27
1994	937	321	301	259	259	191	173	156	79	62	13	19
1995	1167	356	306	270	272	191	208	145	82	83	30	28
1996	958	389	279	263	270	199	185	113	45	67	15	19
1997	1568	517	329	317	315	236	285	155	89	105	34	37
1998	2084	640	382	355	286	225	225	145	86	105	33	40
1999	1894	642	425	394	324	251	242	161	102	93	17	33
2000	1905	665	408	320	329	248	261	139	68	106	36	21
2001	1803	663	430	435	419	327	312	178	86	96	19	20
2002	1537	790	506	448	430	342	285	210	85	99	24	22
2003	1495	805	496	430	382	315	233	159	107	114	37	30
2004	1375	758	478	364	372	257	234	135	77	87	26	21
2005	896	652	404	361	338	285	176	128	79	79	13	14
2006	781	487	300	301	356	251	232	156	111	103	26	22
2007	646	389	365	298	287	211	193	117	108	87	38	32
2008	608	398	399	365	302	203	177	121	92	62	33	25
2009	426	343	310	307	311	229	202	176	106	74	43	45

Table A.7 The proportion of commercial handline trips catching gag grouper by year and days-at-sea (days). Shaded regions represent confidential data.

	Days											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1990	0.2	0.41	0.42	0.73	0.75	0.54	0.73	0.7	0.78	0.5	0.86	1
1991	0.22	0.38	0.33	0.57	0.59	0.64	0.74	0.78	0.71	0.85	0.76	0.56
1992	0.29	0.4	0.56	0.48	0.56	0.66	0.69	0.81	0.83	0.84	0.76	0.79
1993	0.25	0.52	0.53	0.68	0.69	0.75	0.85	0.82	0.88	0.89	0.78	0.84
1994	0.27	0.47	0.6	0.58	0.65	0.73	0.72	0.79	0.86	0.81	0.59	0.7
1995	0.31	0.55	0.59	0.64	0.66	0.71	0.79	0.81	0.88	0.78	0.91	0.85
1996	0.38	0.64	0.73	0.74	0.79	0.79	0.85	0.89	0.9	0.91	0.75	0.86
1997	0.44	0.65	0.72	0.72	0.77	0.8	0.84	0.85	0.85	0.81	0.87	0.9
1998	0.54	0.73	0.78	0.8	0.81	0.85	0.83	0.86	0.92	0.91	0.85	0.93
1999	0.5	0.72	0.73	0.75	0.77	0.79	0.84	0.82	0.81	0.84	0.71	0.75
2000	0.49	0.74	0.8	0.74	0.79	0.81	0.88	0.79	0.84	0.84	0.84	0.72
2001	0.46	0.68	0.8	0.82	0.81	0.87	0.89	0.87	0.82	0.88	0.79	0.8
2002	0.42	0.74	0.76	0.77	0.84	0.84	0.86	0.84	0.83	0.89	0.83	0.79
2003	0.42	0.75	0.79	0.85	0.86	0.87	0.89	0.84	0.86	0.87	0.79	0.79
2004	0.45	0.82	0.84	0.88	0.83	0.83	0.87	0.87	0.86	0.89	0.72	0.81
2005	0.44	0.81	0.87	0.86	0.88	0.93	0.86	0.89	0.87	0.81	0.65	0.7
2006	0.34	0.71	0.72	0.78	0.82	0.81	0.84	0.84	0.83	0.87	0.84	0.76
2007	0.39	0.66	0.7	0.7	0.77	0.73	0.8	0.81	0.89	0.86	0.88	0.97
2008	0.35	0.69	0.68	0.77	0.73	0.74	0.79	0.85	0.85	0.78	0.8	0.86
2009	0.23	0.59	0.59	0.59	0.71	0.74	0.74	0.82	0.79	0.72	0.81	0.75

Table A.8 The number of commercial handline trips by year and the number of crew members on-board a fishing vessel (crew). Shaded regions represent confidential data.

	Crew			
Year	1	2	3	4+
1990				
1991	1316			
1992	1629			
1993	1576	2093	615	401
1994	1488	3272	1124	507
1995	1488	3344	1330	624
1996	1019	2528	1030	427
1997	1379	3629	1340	465
1998	1215	3884	1408	489
1999	1391	3865	1572	454
2000	1473	3641	1616	483
2001	1438	3796	1913	484
2002	1499	3849	1889	483
2003	1539	3562	1857	373
2004	1384	3143	1564	289
2005	1206	2476	1088	208
2006	1340	2673	1046	227
2007	981	2213	1024	313
2008	976	2302	1094	341
2009	854	2506	1303	430

Table A.9 The number of commercial handline trips catching gag grouper by year and the number of crew members on-board a fishing vessel (crew). Shaded regions represent confidential data.

	Crew			
Year	1	2	3	4+
1990				
1991	626			
1992	786			
1993	610	998	333	197
1994	546	1392	587	245
1995	632	1541	702	263
1996	502	1386	645	269
1997	702	2118	857	310
1998	708	2619	954	325
1999	788	2417	1070	303
2000	825	2297	1053	331
2001	840	2349	1268	331
2002	819	2394	1275	290
2003	873	2275	1214	241
2004	807	2108	1070	199
2005	704	1777	794	150
2006	650	1706	612	158
2007	482	1469	620	200
2008	430	1449	676	230
2009	329	1338	687	218

Table A.10 The proportion of commercial handline trips catching gag grouper by year and the number of crew members on-board a fishing vessel (crew). Shaded regions represent confidential data.

	Crew			
Year	1	2	3	4+
1990	0.55			
1991	0.48			
1992	0.48			
1993	0.39	0.48	0.54	0.49
1994	0.37	0.43	0.52	0.48
1995	0.42	0.46	0.53	0.42
1996	0.49	0.55	0.63	0.63
1997	0.51	0.58	0.64	0.67
1998	0.58	0.67	0.68	0.66
1999	0.57	0.63	0.68	0.67
2000	0.56	0.63	0.65	0.69
2001	0.58	0.62	0.66	0.68
2002	0.55	0.62	0.68	0.6
2003	0.57	0.64	0.65	0.65
2004	0.58	0.67	0.68	0.69
2005	0.58	0.72	0.73	0.72
2006	0.49	0.64	0.59	0.7
2007	0.49	0.66	0.61	0.64
2008	0.44	0.63	0.62	0.67
2009	0.39	0.53	0.53	0.51