SEDAR41-DW13: Preliminary standardized catch rates of Southeast US Atlantic gray triggerfish (Balistes capriscus) from headboat logbook data

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SEDAR82-RD49

Received: 5/26/2022

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SEDAR41-DW13

Submitted: 23 July 2014
Addendum: 20 August 2014
Updated Working Paper & Addendum: 17 August 2015

***Addendum added to reflect changes made during Data Workshop.**
Final index is found in the addendum.

Please cite this document as:

Sustainable Fisheries Branch – National Marine Fisheries Service. 2015. Preliminary standardized catch rates of Southeast US Atlantic gray triggerfish (*Balistes capriscus*) from headboat logbook data. SEDAR41-DW13. SEDAR, North Charleston, SC. 30 pp.

Notice on SEDAR Working Papers

Preliminary standardized catch rates of Southeast US Atlantic gray triggerfish (*Balistes capriscus*) from headboat logbook data

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July 21 2014

*__Addendum at end of document reflecting changes made at Data Workshop__

Abstract
Standardized catch rates were generated from the Southeast headboat survey trip records (logbooks) for 1995-~~2013~~2009. The analysis included areas from central North Carolina through south Florida. The index is meant to describe population trends of fish in the size/age range of fish landed by headboat vessels. Data filtering and subsetting steps were applied to the data to model trips that were likely to have directed gray triggerfish effort. The preliminary decisions made prior to the data workshop are presented here. The final results of the headboat index will be presented in the addendum of this working paper as well as the SEDAR 41 Data Workshop Report.

Background

The headboat fishery in the south Atlantic includes for-hire vessels. The fishery uses hook and line gear, generally targets hard bottom reefs as the fishing grounds, and generally targets multiple species in the snapper-grouper complex. One of the key characteristics defining a headboat from other recreational fishing such as charter boats is the number of anglers. Prior to 2000 headboats were defined as vessels carrying 15 or more recreational anglers. This criteria changed to 7 or more passengers in 2000 in the Atlantic (Ken Brennan, pers. comm. Dec. 2011).

Headboats in the south Atlantic are sampled from North Carolina to the Florida Keys.
Data have been collected since 1972, but logbook reporting did not start until 1973. In addition, only North Carolina and South Carolina were included in the earlier years of the data set. In 1976, data were collected from North Carolina, South Carolina, Georgia, and northern Florida, and starting in 1978, data were collected from southern Florida (Areas 1-17, Figure 1).

Variables reported in the data set include year, month, day, area, location, trip type, number of anglers, species, catch, and vessel id. Biological data and discard data were recorded for some trips in some years.

Until 1980, there was no category for gray triggerfish on the catch record form for all south Atlantic states. Until 1980, captains had to write in species in blanks provided on the form.

A 12" TL minimum size limit for gray triggerfish has been in place since 1995 in Florida.

Headboat records were examined to determine if sufficient data exists to develop a standardized index of abundance for south Atlantic gray triggerfish.

Data treatment

Data from area 1 (Figure 1) were excluded as this area was not recorded during most of the time series. The minimum number of anglers per vessel was set at 6, which excluded the lower 0.1% of trips. These trips were excluded because they were possibly misreported and likely don't reflect the behavior of headboats in general.

Although data were reported throughout the 1980s, the CPUE during that time period was considered unreliable as a measure of abundance. This was due to increases in desirability to keep gray triggerfish throughout the 1980s, and the fact that the headboat logbooks contained no information on discards during that period.

Many regulatory changes of snapper-grouper species were implemented in 1992, and they may have affected targeting of gray triggerfish. In addition, a 12-inch size limit was implemented in 1995 in state and federal waters off the east coast of Florida. For this reason, the index was computed starting in 1995.

Subsetting trips

Trips to be included in the computation of the index need to be determined based on effort directed at gray triggerfish. Effort can be determined directly for trips which had positive gray triggerfish catches, but some trips likely directed effort at gray triggerfish, but were unsuccessful at landing gray triggerfish. Given that information on directed effort for trips without gray triggerfish harvest is not available, another method must be used to compute total effort.
In order to determine effort that was likely directed at gray triggerfish and which trips should be used to compute an index, the method of Stephens and MacCall (2004) was applied. The Stephens and MacCall method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Species compositions differ across the south Atlantic; thus, the method was applied separately for two different regions: north (areas 2-10) and south (areas 11, 12, and 17; Shertzer *et al.* 2009). To avoid computation errors, the number of species in each analysis was limited to those species that occurred in 1% or more of trips. The most general model therefore included all species in the snapper-grouper complex which occurred in 1% or more of trips as main effects, excluding red porgy. Red porgy and Red snapper was removed because of regulation changes, which could erroneously remove trips likely to have caught gray triggerfish in recent years. A backwards stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of gray triggerfish in headboat trips to presence/absence of other species (Figure 2 – Figure 5).

Model Input

Response and explanatory variables

CPUE – catch per unit effort (CPUE) has units of fish/angler and was calculated as the number of gray triggerfish caught divided by the number of anglers.

Year – Because year is the explanatory variable of interest, it was necessarily included in the analysis. A summary of the total number of trips with gray triggerfish effort per year and area is provided in Table 1 & 2.

Area – Areas were pooled into regions of North Carolina (NC=2,3,9,10), South Carolina (SC=4,5), Georgia and North Florida (GNFL=6,7,8), and south Florida (sFL=11,12,17).

Season – The seasons were defined as winter (January, February, March), spring (April, May, June), summer (July, August, September) and fall (October, November, December).

Party – Five categories for the number of anglers on a boat were considered in the standardization process. The categories included: ≤20 anglers, 20-40 anglers, 40-60 anglers, 60-80 anglers, and >80 anglers. The minimum number of anglers per vessel was set at 6, which excluded the lower 0.5% of trips. These trips were excluded because they were possibly misreported and likely don't reflect the behavior of headboats in general.

Trip Type – Trip types of half and full day trips were included in the analysis. Three-quarter day trips were pooled with half-day trips (<10%). Multi-day trips were removed because most were in Florida and likely targeting deepwater species for some portion of the trip. The codes for first and second half-day trips designation for day and night trips were combined.

Standardization

CPUE was modeled using the delta-glm approach (Lo et al. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE. Also, the combination of predictor variables was examined to best explain CPUE patterns (both for positive CPUE and or positive CPUE). All analysis were performed in the R programming language, with much of the code adapted from Dick (2004).

BERNOULLI SUBMODEL
One component of the delta-GLM is a logistic regression model that attempts to explain the probability of either catching or not catching gray triggerfish on a particular trip. First, a model was fit with all main effects in order to determine which effects should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit.

POSITIVE CPUE SUBMODEL
Then, to determine predictor variables important for predicting positive CPUE, the positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm

was then used to eliminate those that did not improve model fit. All predictor variables were modeled as fixed effects (and as factors rather than continuous variables).

Both components of the model were then fit together (with the code adapted from Dick 2004) using the lognormal and gamma distributions and compared them using AIC. With CPUE as the dependent variable.

Preliminary model diagnostics are presented in Figures 6-10.

It should be noted that the Stephens and MacCall method is most appropriate for species which have strong species associations. In other words, if a species is ubiquitous in the catch, or does not have well-defined effort, Stephens and MacCall may not work well to identify directed effort.

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Shertzer, K.W., E.H. Williams, and J.C. Taylor. 2009. Spatial structure and temporal patterns in a large marine ecosystem: Exploited reef fishes of the southeast United States. Fish. Res. 100:126–133.

Venables, W. N. and B. D. Ripley. 1997. Modern Applied Statistics with S-Plus, 2nd Edition. Springer-Verlag, New York.

Table 1. Proportion positive trips of gray triggerfish in the south Atlantic Headboat fishery.

Year	pos.GTF.trips	HB.all.trips	% pos
1973	452	688	66%
1974	755	1182	64%
1975	957	1913	50%
1976	1338	3002	45%
1977	1392	3559	39%
1978	2064	4891	42%
1979	1881	8173	23%
1980	2148	11378	19%
1981	2369	11324	21%
1982	2828	12256	23%
1983	3194	12125	26%
1984	2604	11190	23%
1985	3143	11157	28%
1986	3449	13854	25%
1987	3626	13966	26%
1988	3602	11996	30%
1989	3545	10933	32%
1990	3589	11365	32%
1991	3428	10740	32%
1992	5216	15007	35%
1993	4593	13894	33%
1994	3683	12575	29%
1995	3155	12275	26%
1996	2327	9060	26%
1997	1815	6284	29%
1998	2924	9123	32%
1999	2568	7618	34%
2000	1963	7645	26%
2001	1970	6820	29%
2002	1931	5590	35%
2003	1856	5542	33%
2004	2882	6278	46%
2005	2174	5695	38%
2006	2023	5909	34%
2007	2245	6381	35%
2008	2704	9215	29%
2009	3654	10250	36%
2010	4012	10922	37%
2011	3690	10585	35%
2012	3766	11294	33%
2013	3817	13102	29%
Total	111332	366756	30%

Table 2. Number of gray triggerfish headboat trips by area, positive and zero trips following Stephens & MacCall (SM) method.

	NC			SC			GF			SF			Total.SM		
Year	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%
1995	332	457	73%	540	619	87%	704	1200	59%	337	1066	32%	1913	3342	57%
1996	373	466	80%	544	604	90%	408	775	53%	142	597	24%	1467	2442	60%
1997	229	273	84%	451	508	89%	440	652	67%	159	535	30%	1279	1968	65%
1998	357	430	83%	589	685	86%	928	1389	67%	190	606	31%	2064	3110	66%
1999	291	353	82%	502	615	82%	1012	1462	69%	75	320	23%	1880	2750	68%
2000	306	381	80%	482	672	72%	591	1180	50%	85	319	27%	1464	2552	57%
2001	214	320	67%	372	541	69%	626	1237	51%	191	455	42%	1403	2553	55%
2002	213	258	83%	396	546	73%	530	1115	48%	132	249	53%	1271	2168	59%
2003	220	276	80%	300	409	73%	527	896	59%	127	250	51%	1174	1831	64%
2004	307	348	88%	418	508	82%	812	1045	78%	241	454	53%	1778	2355	75%
2005	150	219	68%	245	347	71%	761	1014	75%	261	502	52%	1417	2082	68%
2006	173	241	72%	348	460	76%	805	1077	75%	100	426	23%	1426	2204	65%
2007	149	203	73%	420	554	76%	801	1104	73%	69	350	20%	1439	2211	65%
2008	158	206	77%	316	406	78%	762	1145	67%	497	1332	37%	1733	3089	56%
2009	152	206	74%	421	506	83%	1072	1328	81%	818	1836	45%	2463	3876	64%
2010	180	237	76%	424	515	82%	999	1164	86%	920	2056	45%	2523	3972	64%
2011	153	197	78%	342	424	81%	795	924	86%	949	1869	51%	2239	3414	66%
2012	166	213	78%	268	345	78%	755	870	87%	1257	2661	47%	2446	4089	60%
2013	134	182	74%	268	315	85%	683	822	83%	1104	2469	45%	2189	3788	58%
Grand Tot	4257	5466	78%	7646	9579	80%	14011	20399	69%	7654	18352	42%	33568	53796	62%

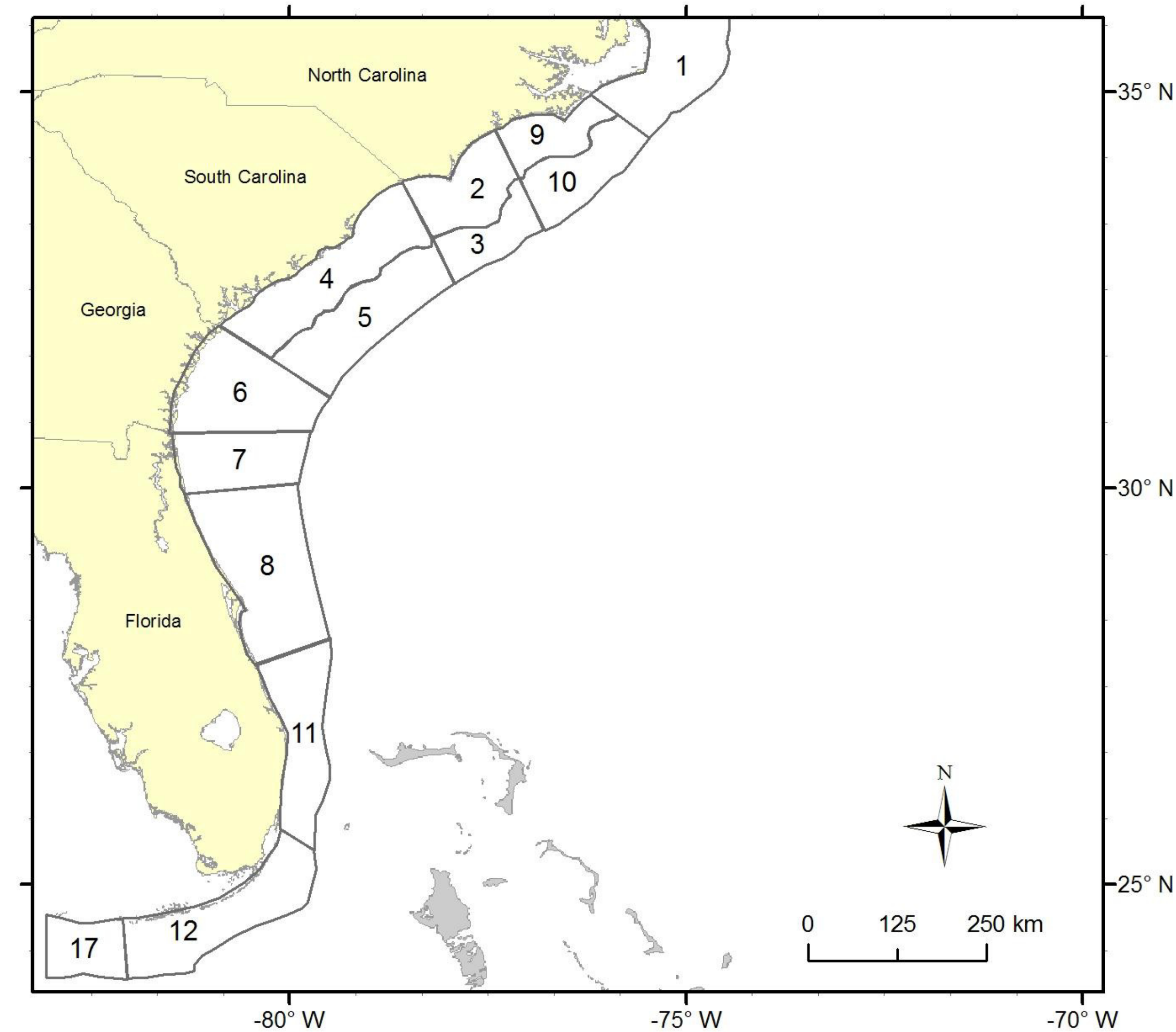


Figure 1. Map of headboat sampling area definition. These areas were pooled into regions of North Carolina (NC=2,3,9,10), South Carolina (SC=4,5), Georgia and North Florida (GNFL=6,7,8), and south Florida (sFL=11,12,17).

Figure 2. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the northern region (excludes areas 11, 12, and 17), as used to estimate each trip's probability of catching the focal species.

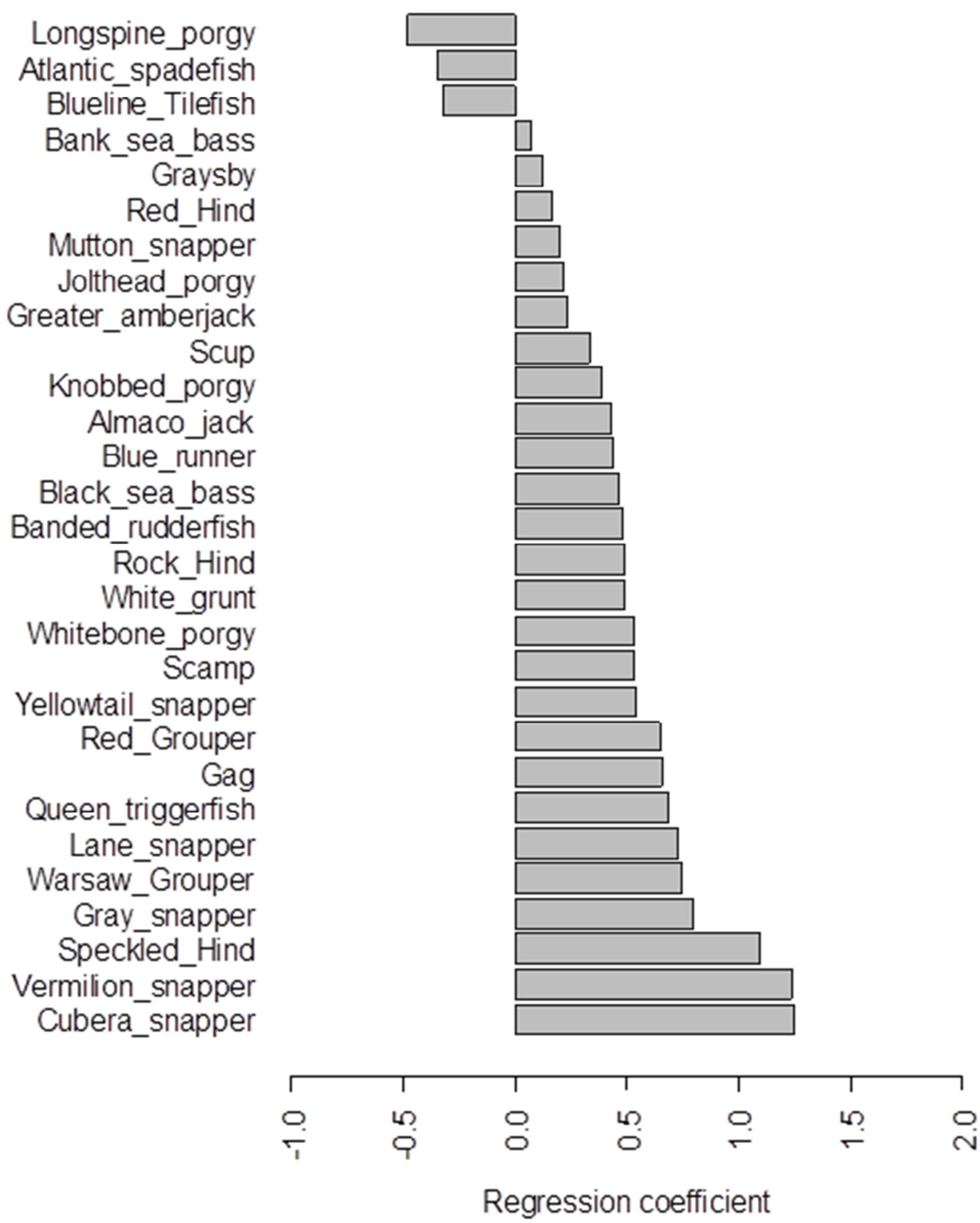


Figure 3. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the southern region (includes areas 11, 12, and 17), as used to estimate each trip's probability of catching the focal species.

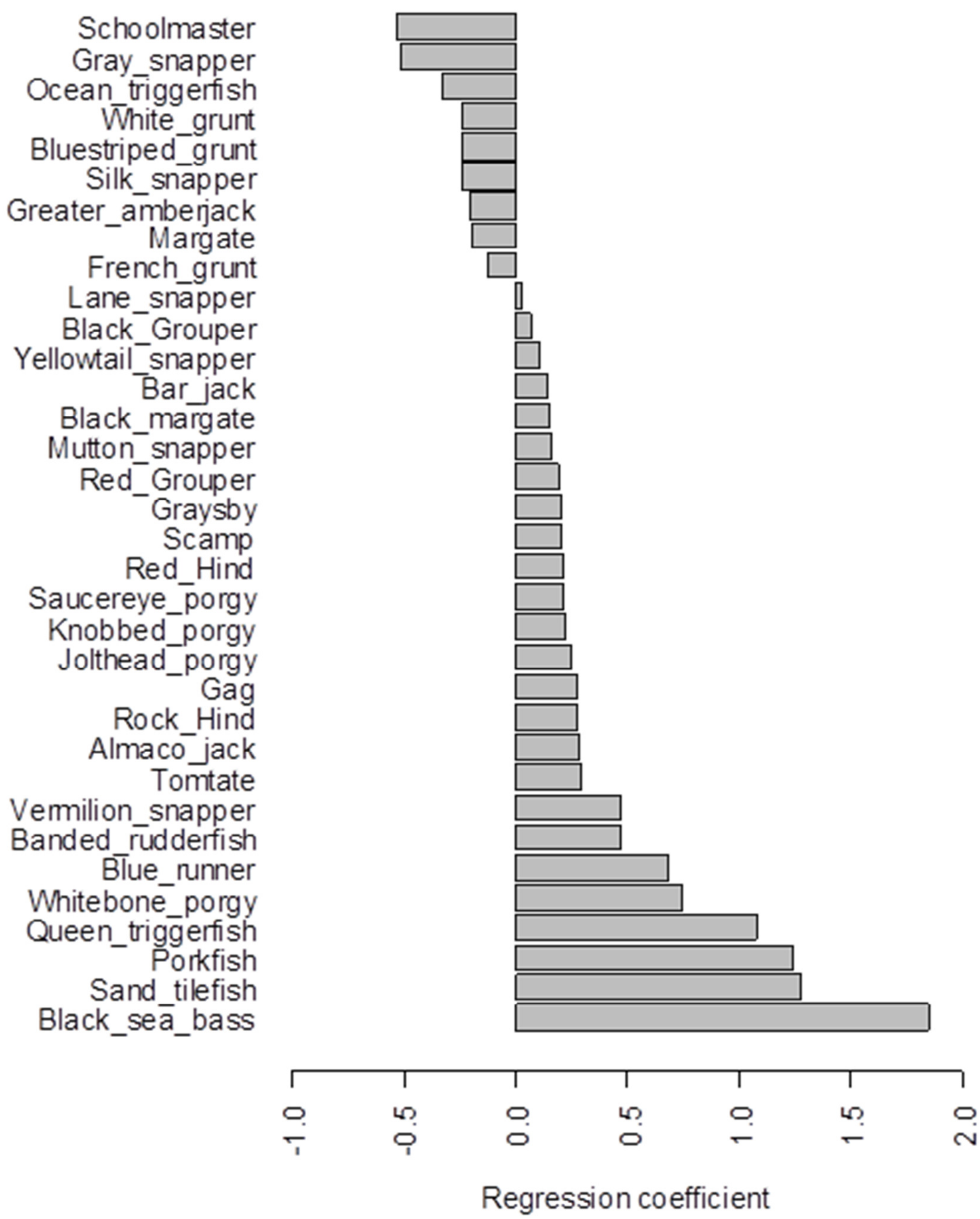


Figure 4. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the northern region (excludes areas 11, 12, and 17). Left and right panels differ only in the range of probabilities shown.

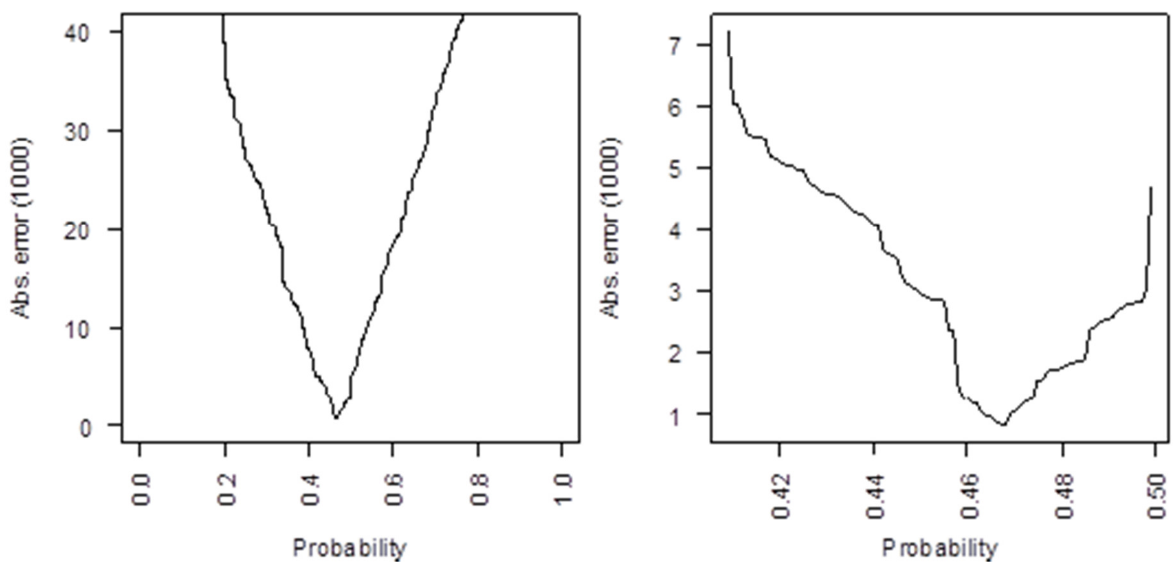


Figure 5. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the southern region (includes areas 11, 12, and 17). Left and right panels differ only in the range of probabilities shown.

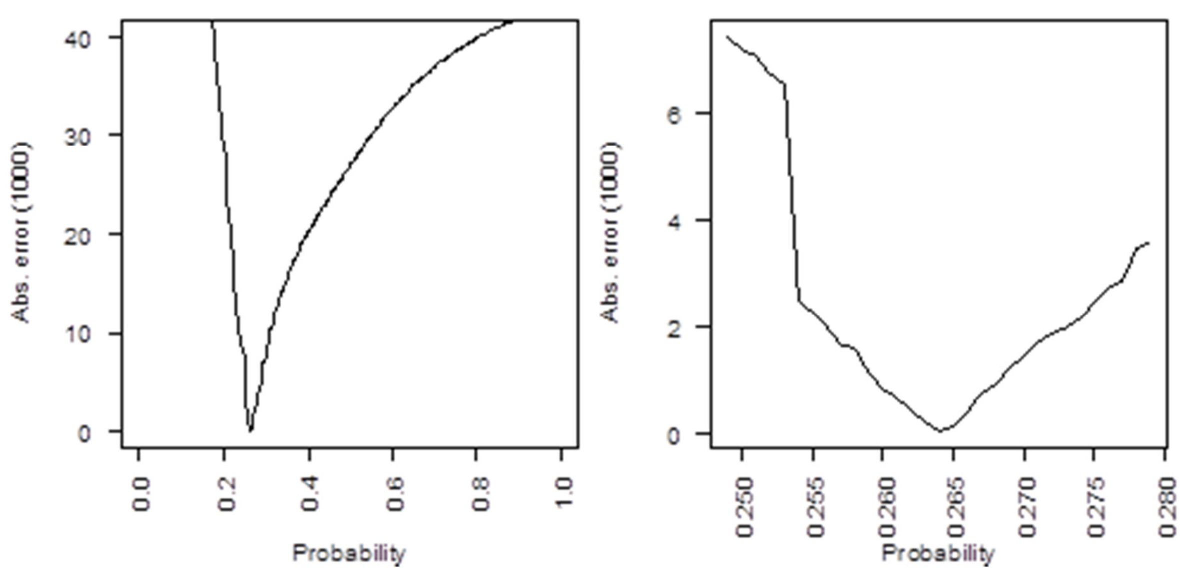


Figure 6 & 7. Total effort with gray triggerfish by area & season

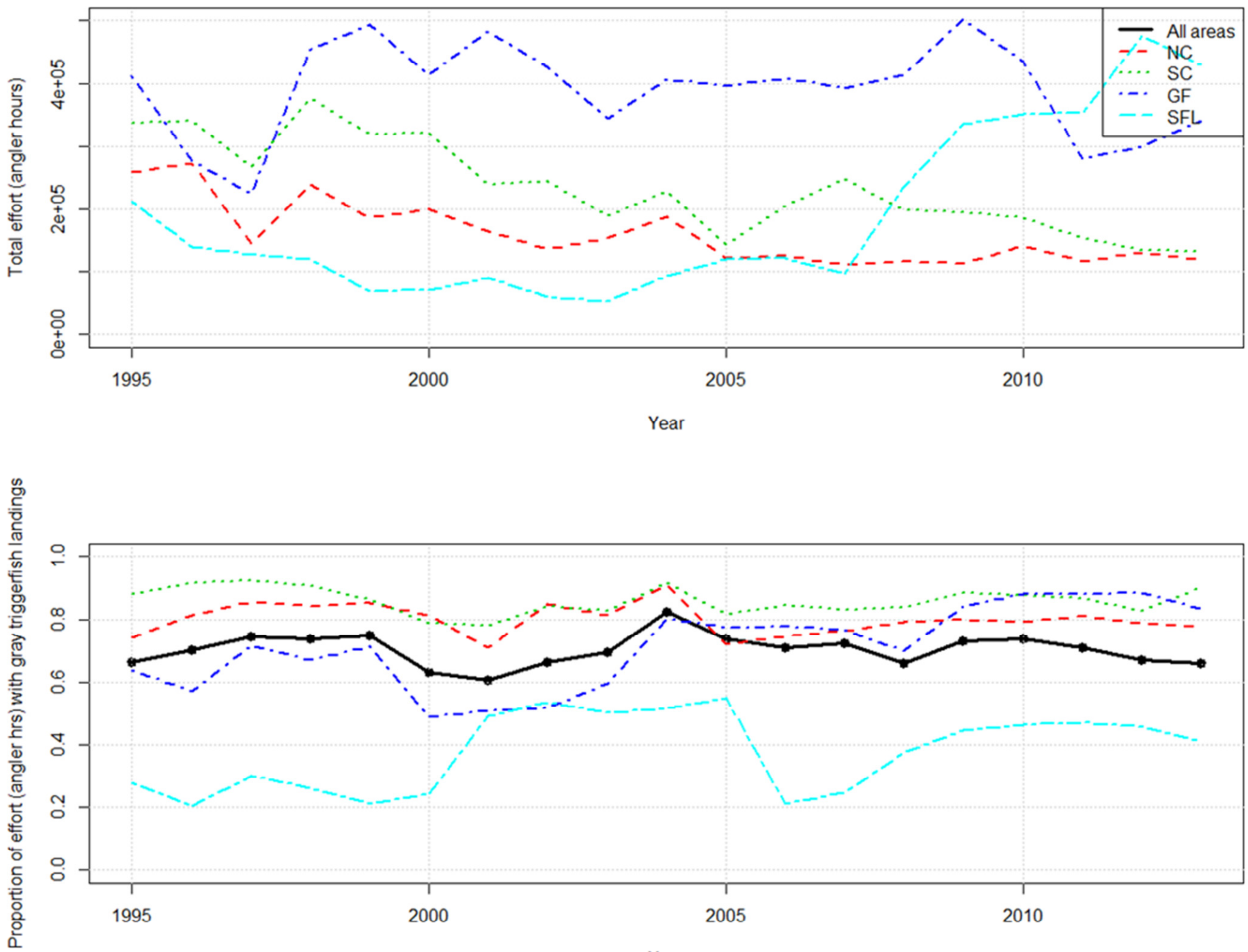
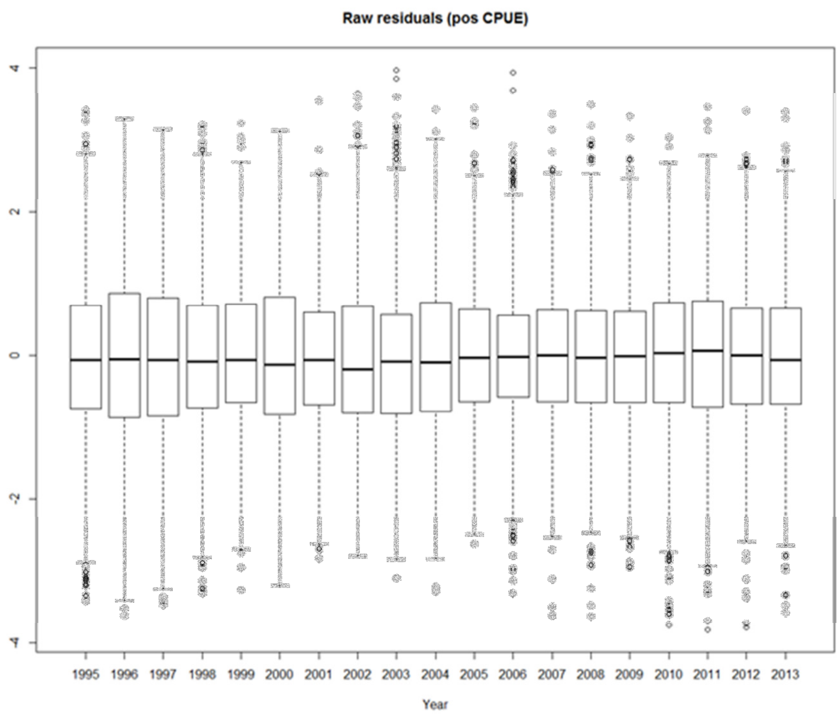
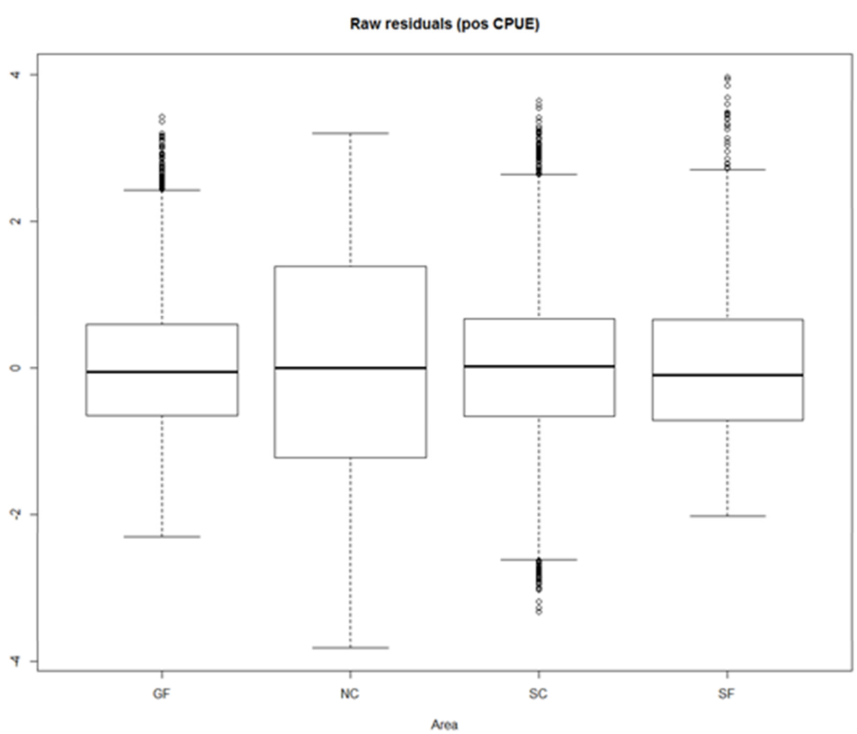
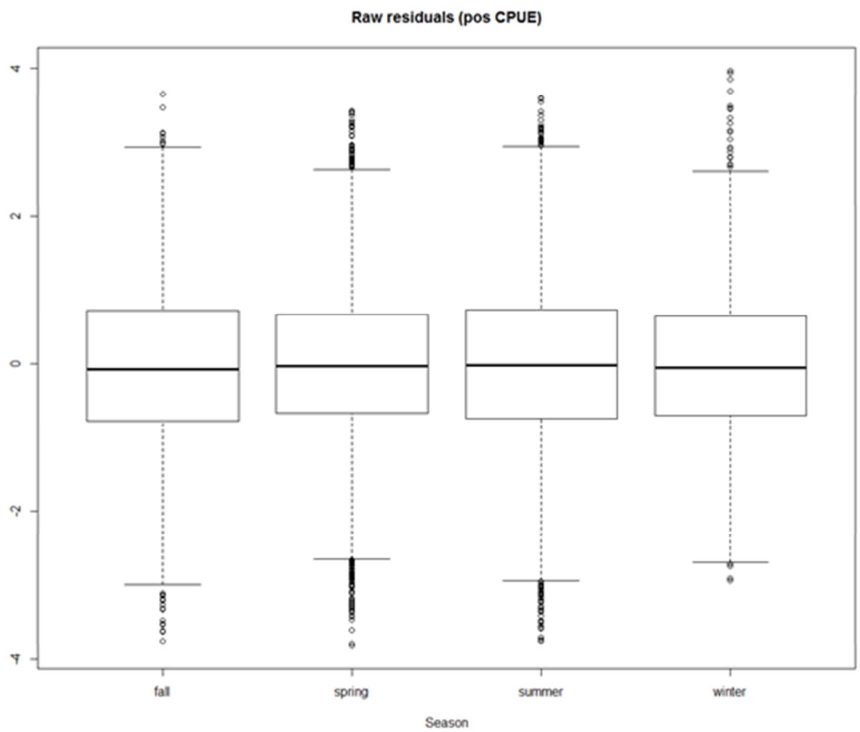


Figure 8. CPUE binomial residuals for year, area, season, trip type and party size.







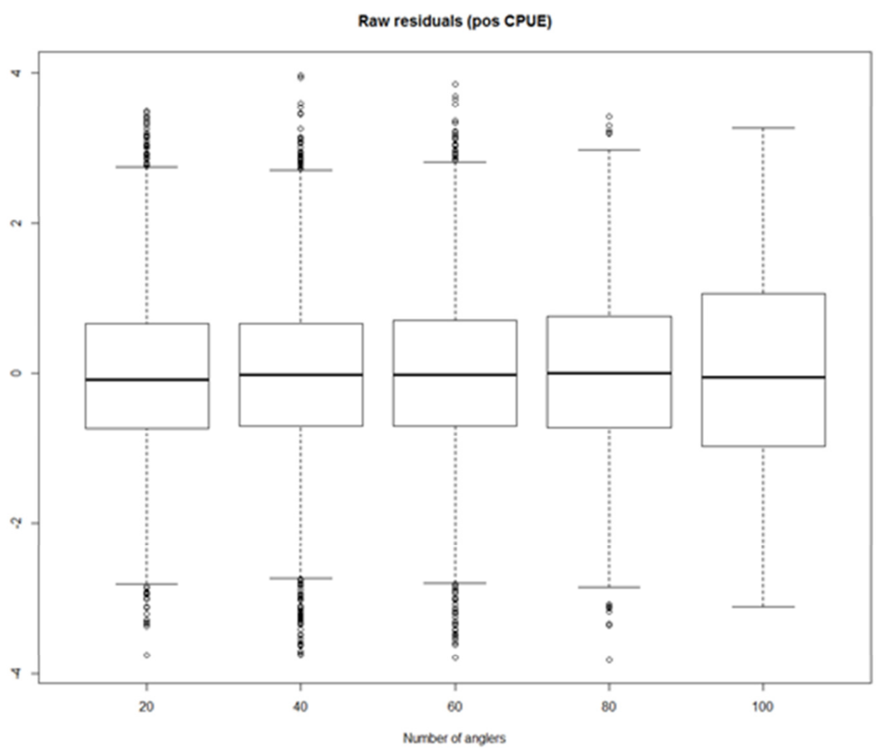


Figure 8. Continued.

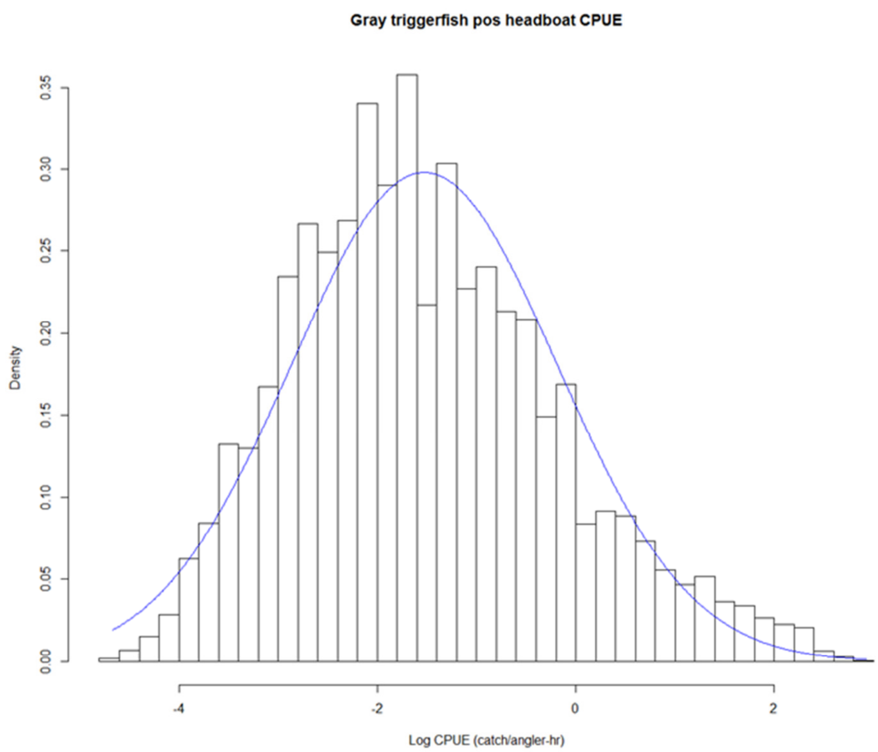


Figure 9. The lognormal distribution of catch for the south Atlantic gray triggerfish headboat logbook during 1995-2013.

ADDENDUM

Standardized catch rates of Southeast US Atlantic gray triggerfish (*Balistes capriscus*) from headboat logbook data

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Southeast Fisheries Science Center,
101 Pivers Island Rd, Beaufort, NC 28516
August 2015

Abstract
Standardized catch rates were generated from the Southeast headboat survey trip records (logbooks) for 1995-~~2013~~2009. The analysis included areas from central North Carolina through south Florida. The index is meant to describe population trends of fish in the size/age range of fish landed by headboat vessels. Data filtering and subsetting steps were applied to the data to model trips that were likely to have directed gray triggerfish effort.

SEDAR 41 Index Working Group Review

SEDAR 41 DW2 Scoping Calls recommended that the headboat index be reconsidered following the headboat data evaluation (SEDAR 41 DW46). As a result, several new data filters were applied (95% of these trips/vessels were filtered previously).

The SEDAR 41 index working group (IWG) reviewed the methods used to develop an index of abundance for gray triggerfish from headboat logbook data. Several decisions from SEDAR 41 index working group were also considered during the SEDAR 32 index working group. The following topics were discussed at the data workshop and include the final decisions.

Start year
For a fisheries dependent index like the headboat logbook index, identifying changes in angler behavior are important when developing an index. Beginning in the mid- to late 1980s, a potential shift in desirability of gray triggerfish was identified. Also, in 1995 a 12” minimum size limit began in Florida. Because of these changes in angler behavior prior to 1995, the IWG agreed with the recommendations from SEDAR 32 to begin the index in 1995.

End year
SEDAR 41 IWG participants along with fisherman present at the meeting discussed the red snapper closure in 2010 and its potential impact on the gray triggerfish headboat logbook index in 2010-2013. The overwhelming response was that targetting for gray triggerfish has increased due to this closure. Because of this shift in behavior, the IWG recommended to end the gray triggerfish headboat logbook index in 2009.

Subsetting technique- Stephens & MacCall
A run using a 5% cutoff was explored. Gray triggerfish in the southern region did not meet this upper cutoff so the 1% was used in the final model run. Stephens & MacCall subsetting was rerun with the final years recommended for use (1995-2009).

The following information represents the final model input and dGLM results for the gray triggerfish headboat logbook index.

Model Input

Response and explanatory variables

CPUE – catch per unit effort (CPUE) has units of fish/angler and was calculated as the number of gray triggerfish caught divided by the number of anglers.

Year – 1995-2009.

Area – Areas were pooled into regions of North Carolina (NC=2,3,9,10), South Carolina (SC=4,5), Georgia and North Florida (GNFL=6,7,8), and south Florida (sFL=11,12,17).

Season – The seasons were defined as winter (January, February, March), spring (April, May, June), summer (July, August, September) and fall (October, November, December).

Party – Five categories for the number of anglers on a boat were considered in the standardization process. The categories included: ≤20 anglers, 20-40 anglers, 40-60 anglers, 60-80 anglers, and >80 anglers. The minimum number of anglers per vessel was set at 6, which excluded the lower 0.5% of trips. These trips were excluded because they were possibly misreported and likely don't reflect the behavior of headboats in general.

Trip Type – Trip types of half and full day trips were included in the analysis. Three-quarter day trips were pooled with half-day trips (<10%). Multi-day trips were removed because most were in Florida and likely targeting deepwater species for some portion of the trip. The codes for first and second half-day trips designation for day and night trips were combined.

Standardization

CPUE was modeled using the delta-glm approach (Lo et al. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE. Also, the combination of predictor variables was examined to best explain CPUE patterns (both for positive CPUE and or positive CPUE). All analysis were performed in the R programming language, with much of the code adapted from Dick (2004).

BERNOULLI SUBMODEL

One component of the delta-GLM is a logistic regression model that attempts to explain the probability of either catching or not catching gray triggerfish on a particular trip. First, a model was fit with all main effects in order to determine which effects should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit.

POSITIVE CPUE SUBMODEL

Then, to determine predictor variables important for predicting positive CPUE, the positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. All predictor variables were modeled as fixed effects (and as factors rather than continuous variables).

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Preliminary model diagnostics are presented in Figures 6-10.

LITERATURE CITED

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2005	2174	5695	38%
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2007	2245	6381	35%
2008	2704	9215	29%
2009	3654	10250	36%
Total	111332	366756	30%

Table 2. Number of gray triggerfish headboat trips by area, positive and zero trips following Stephens & MacCall (SM) method.

	NC			SC			GF			SF			Total.SM		
Year	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%	Pos.SM	Total.SM	%
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2005	150	219	68%	245	347	71%	761	1014	75%	261	502	52%	1417	2082	68%
2006	173	241	72%	348	460	76%	805	1077	75%	100	426	23%	1426	2204	65%
2007	149	203	73%	420	554	76%	801	1104	73%	69	350	20%	1439	2211	65%
2008	158	206	77%	316	406	78%	762	1145	67%	497	1332	37%	1733	3089	56%
2009	152	206	74%	421	506	83%	1072	1328	81%	818	1836	45%	2463	3876	64%
2010	180	237	76%	424	515	82%	999	1164	86%	920	2056	45%	2523	3972	64%
2011	153	197	78%	342	424	81%	795	924	86%	949	1869	51%	2239	3414	66%
2012	166	213	78%	268	345	78%	755	870	87%	1257	2661	47%	2446	4089	60%
2013	134	182	74%	268	315	85%	683	822	83%	1104	2469	45%	2189	3788	58%
Grand Tot	4257	5466	78%	7646	9579	80%	14011	20399	69%	7654	18352	42%	33568	53796	62%

Table 3. The relative nominal CPUE, number of trips, standardized index, and CV for the gray triggerfish headboat logbook data in the south Atlantic.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1995	3275	0.3859	1.0827	0.8831	0.0354
1996	2431	0.5732	1.6081	0.9434	0.0424
1997	1925	0.5379	1.5090	1.2163	0.0391
1998	3033	0.4395	1.2331	0.9967	0.0326
1999	2648	0.3190	0.8949	0.8702	0.0344
2000	2602	0.2822	0.7916	0.5851	0.0406
2001	2591	0.2010	0.5639	0.6010	0.0378
2002	2183	0.3418	0.9588	0.7288	0.0424
2003	1806	0.4167	1.1690	0.9331	0.0439
2004	2306	0.4664	1.3085	1.5194	0.0326
2005	2100	0.2994	0.8401	1.1876	0.0359
2006	2137	0.2530	0.7098	0.9657	0.0366
2007	2243	0.3180	0.8922	1.1135	0.0349
2008	3215	0.2440	0.6846	1.0561	0.0327
2009	4049	0.2687	0.7538	1.3999	0.0272

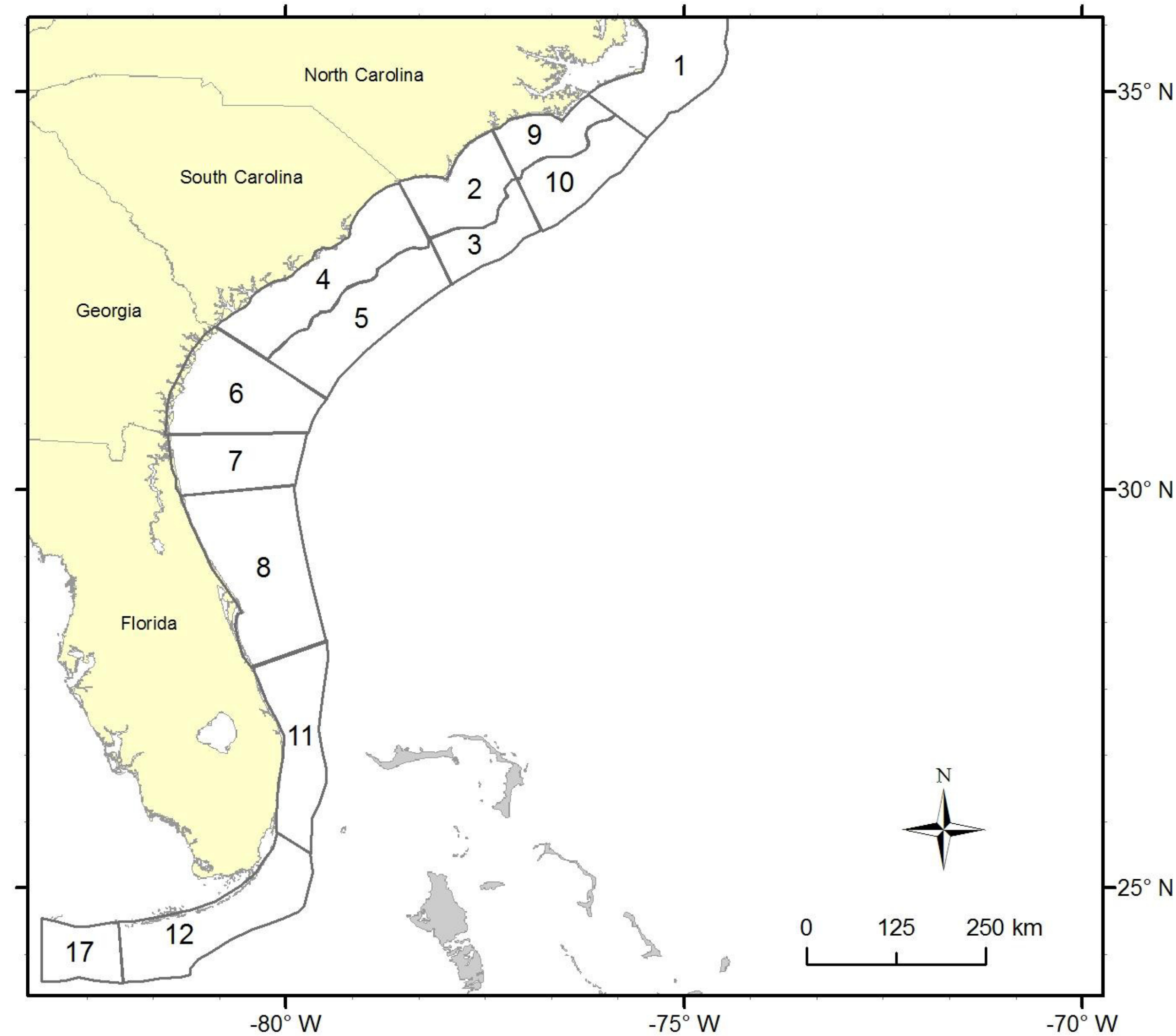


Figure 2. Map of headboat sampling area definition. These areas were pooled into regions of North Carolina (NC=2,3,9,10), South Carolina (SC=4,5), Georgia and North Florida (GNFL=6,7,8), and south Florida (sFL=11,12,17).

Figure 2. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the northern region (excludes areas 11, 12, and 17), as used to estimate each trip's probability of catching the focal species.

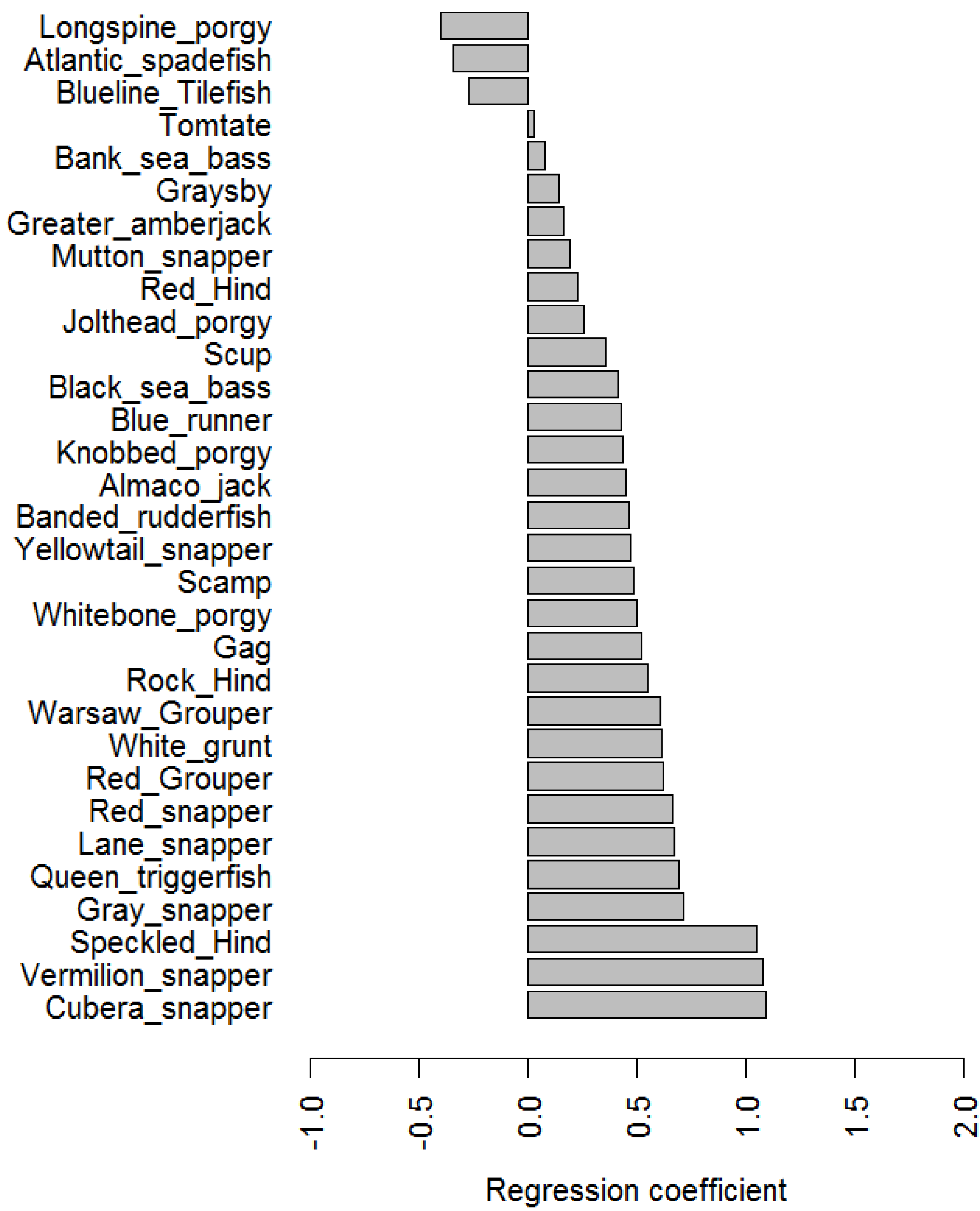


Figure 3. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to headboat data from areas in the southern region (includes areas 11, 12, and 17), as used to estimate each trip's probability of catching the focal species.

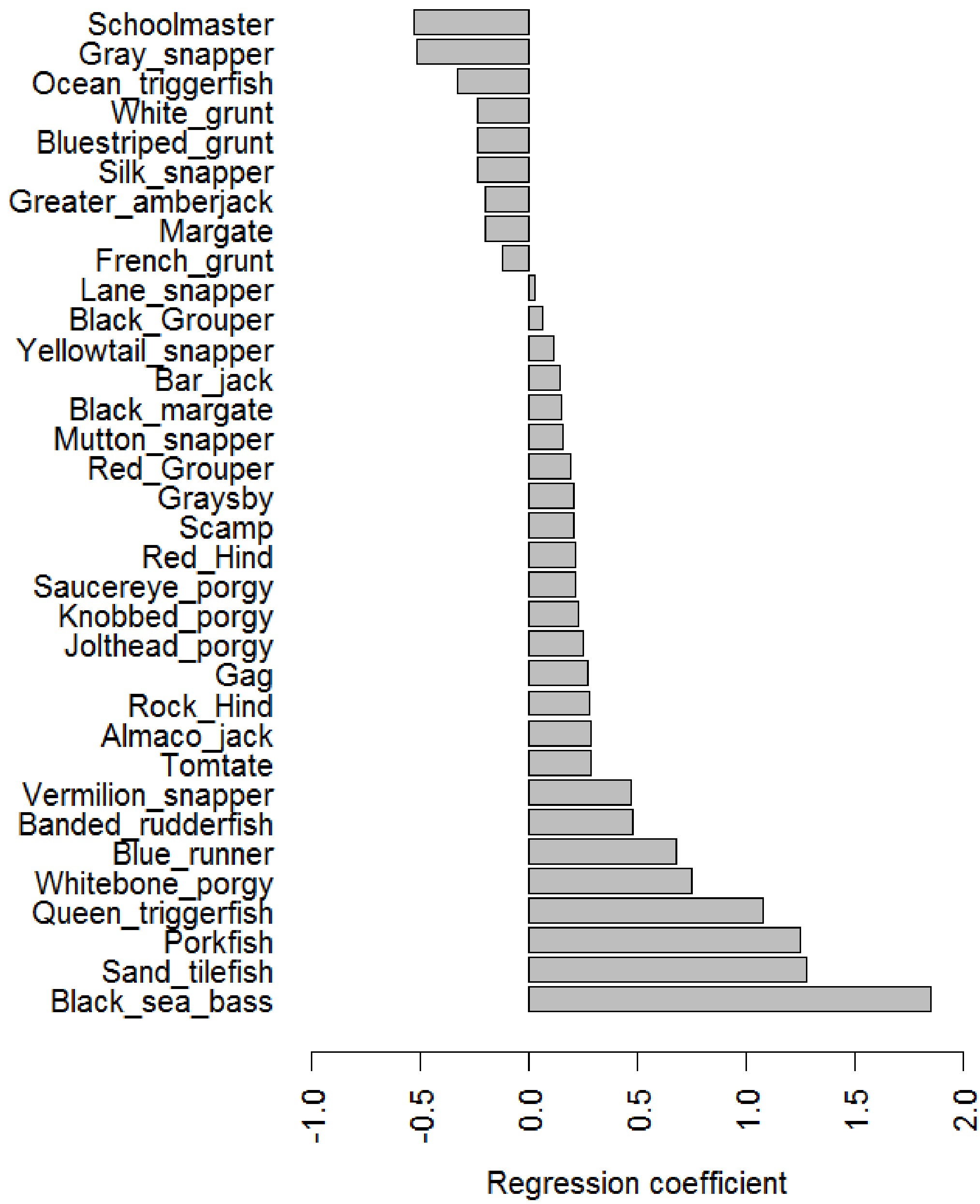


Figure 4. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the northern region (excludes areas 11, 12, and 17). Left and right panels differ only in the range of probabilities shown.

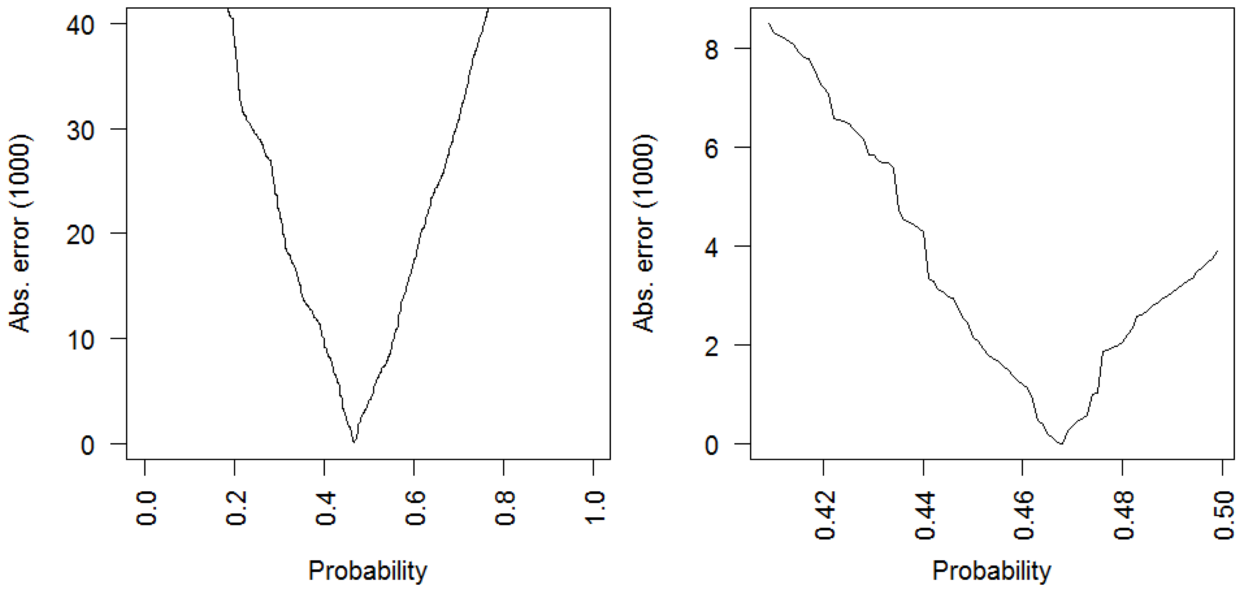


Figure 5. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to headboat data from the southern region (includes areas 11, 12, and 17). Left and right panels differ only in the range of probabilities shown.

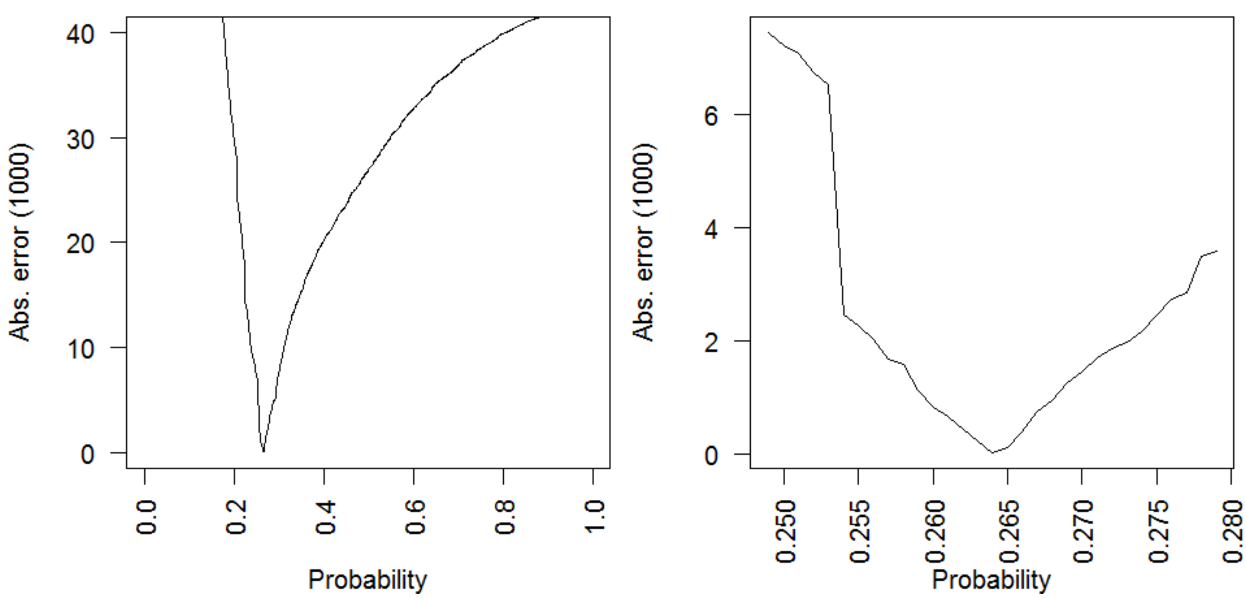
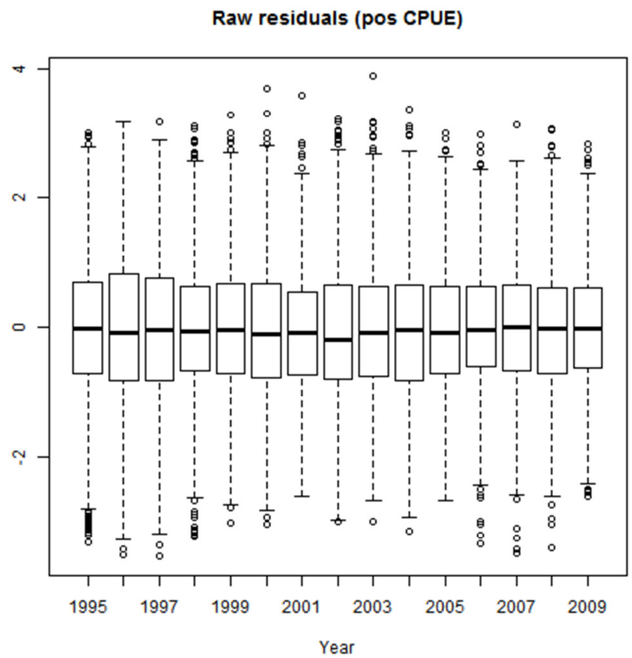


Figure 8. CPUE binomial residuals for year, area, season, trip type and party size.



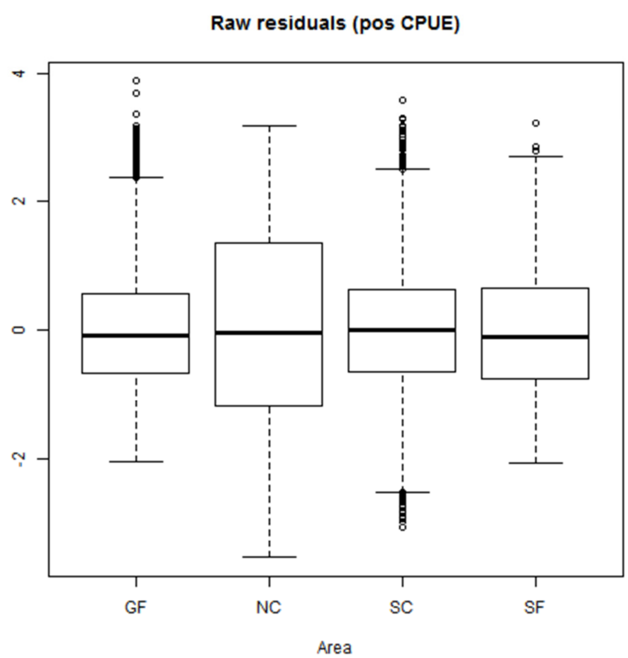
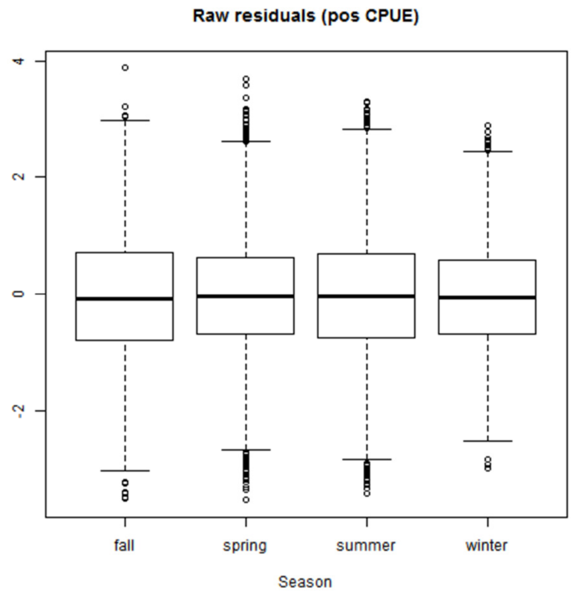
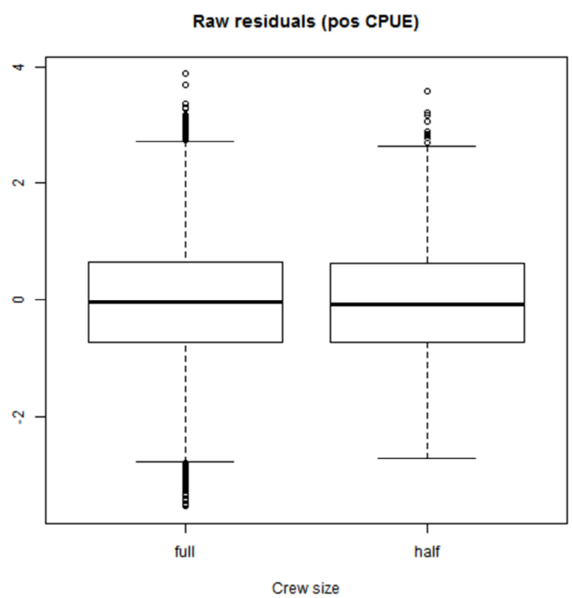


Figure 8. Continued.





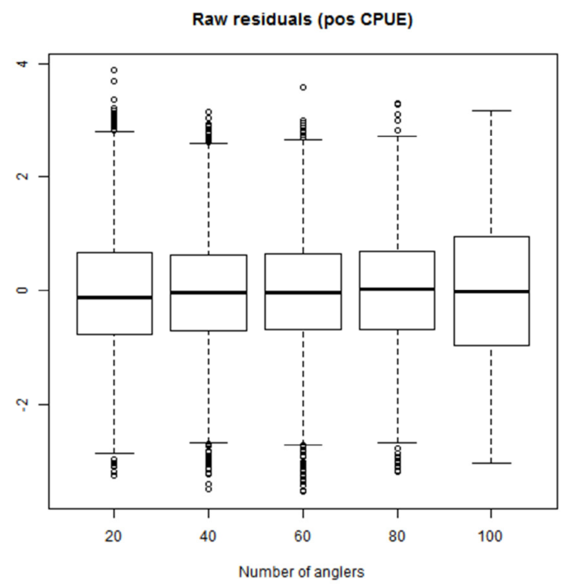
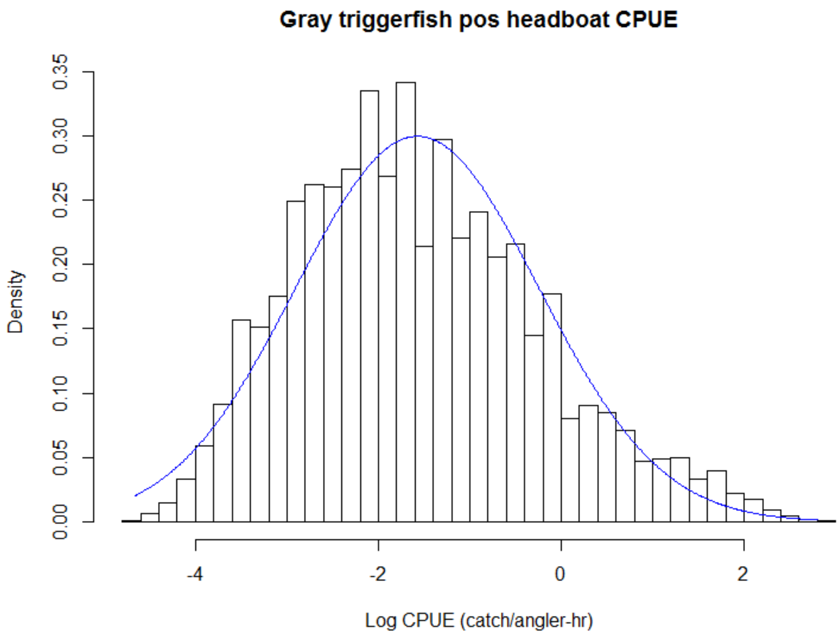

Raw residuals (pos CPUE)
4
2
0
-2
20
40
60
80
100
Number of anglers

Figure 9. The lognormal distribution of catch for the south Atlantic gray triggerfish headboat logbook during 1995-2009.



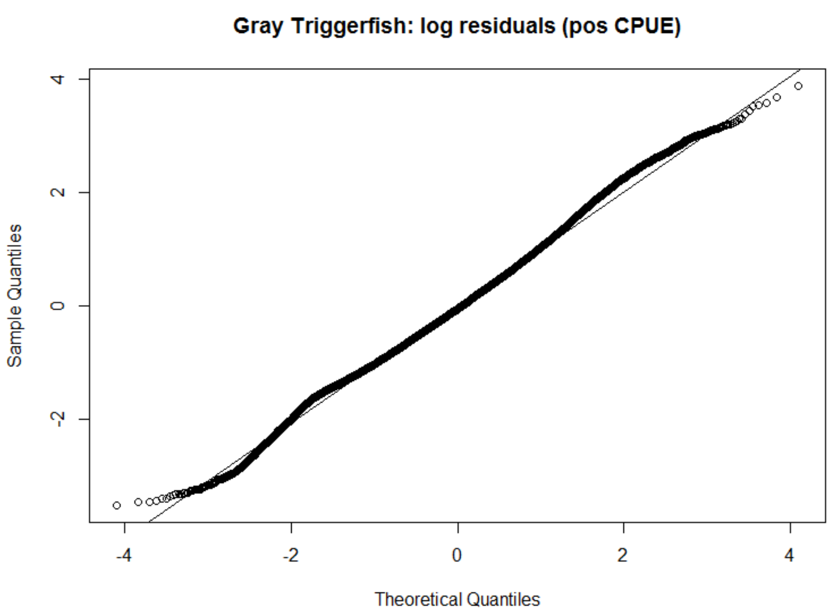


Figure 10. The standardized and nominal CPUE index with error bars at (+/-) 2 standard deviations (nominal by area below) computed for gray triggerfish in the south Atlantic using the headboat logbook data during 2005-2009.