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Abstract
Standardized catch rates were examined from the headboat at-sea observer data (not to be confused with the Southeast Regional Headboat Survey (SRHS)). Two indices, a discard index and a catch (harvested and discarded) index were developed from the same data source as alternative indices to discuss at the data workshop. 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 and discarded 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.

Background and Data Description

All sampled trips were included in the indices, since gray triggerfish may be caught during bottom fishing for reef fishes. The at-sea-observer program began in 2004 in North and South Carolina and 2005 in Florida and Georgia. The Atlantic coast of the Florida Keys are included in the time-series; however, headboats were not sampled in this area from 2008-2010 due to funding.

Trip-level information included state, county, Florida region (Brevard County north, or south of Brevard County), year, month, day, dock to dock hours (total trip hours), the number of hours fished (to the nearest half hour), the total number of anglers on the boat, the number of anglers observed on a trip, the number of gray triggerfish harvested and discarded, individual fish length (midline, in mm), and the minimum and maximum depth of the fishing trip. Depth information was not collected for South Carolina, North Carolina, and Georgia; therefore, it was not used in this analysis.

Methods

Data treatment
Data from 2004 were dropped from the analysis because Georgia and Florida were not sampled. Prior to 2015 there was a 12” TL minimum size in Florida only. During this period gray triggerfish discards were infrequent in North Carolina, South Carolina and Georgia where no size limit was in place. In 2015, Florida implemented a 14” FL minimum size while Georgia, South Carolina and North Carolina implemented a 12” FL minimum size. In April 2020, all states implemented a 12” FL minimum size. Coastwide sample coverage during 2020 and 2021 was

severely reduced due to the pandemic, and these years were dropped from the analysis. Two indices were explored: a discard index from 2005-2019 and a coastwide harvest + discard (catch) index from 2010-2019 (Table 1). The Southeast headboat survey provides a historic harvest-only index with a terminal year of 2009, thus starting this catch index prior to 2010 would duplicative.

Response and explanatory variables

CPUE/DPUE– Catch per unit effort (CPUE) or discard per unit effort (DPUE) is defined as units of fish/ angler observed during a sampled trip, and was calculated as the total number of gray triggerfish observed (harvested and/or discarded) divided by the number of anglers observed.

YEAR – A summary of the total number of trips with gray triggerfish effort per year is provided in Table 1.

AREA –Area was defined as North Carolina, South Carolina and Georgia (GA/SC/NC) north Florida (nFL), south Florida, (excluding the keys, flreg=3)

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

PARTY – Four categories (quantiles) for the number of anglers on the vessel were considered in the standardization process.

HRSF– Four categories (quantiles) for the number of hours fished were considered in the standardization process.

Standardization

CPUE were 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 models were compared using AIC. With CPUE/DPUE as the dependent variable.

Preliminary analysis focusing on the two alternative indices are provided in Tables 1-3 and Figures 1-12.

Topics to consider at the DW

- Potential shifts in desirability, particularly after the Red Snapper closure
- Management regulations (size regulations differences)
- Spatial and temporal sample sizes
- How do these indices compare to the fishery independent indices?

Objective for SEDAR 82 Data Workshop

- Discuss management regulations and their potential influence on index
- Run GLM based on DW decisions regarding data and factors
- Estimate uncertainty
- Provide updated text and figures for the SEDAR 82 DW IWG report

LITERATURE CITED

Dick, E.J. 2004. Beyond 'lognormal versus gamma': discrimination among error distributions for generalized linear models. Fish. Res. 70:351-366.

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

Maunder, M.N., Punt, A.E. 2004. Standardizing catch and effort data: a review of recent approaches. Fish. Res. 70:141-159.

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

Table 1. Total trips, positive trips and proportion positive from the headboat at-sea observer data.

				Discards						Harvest + Discards					
	Trips			Positive Trips			Proportion Positive			Positive Trips			Proportion Positive		
Year	GA-NC	nFL	sFL	GA-NC	nFL	sFL	GA-NC	nFL	sFL	GA-NC	nFL	sFL	GA-NC	nFL	sFL
2005	161	43	132	1	12	39	1%	28%	30%	39	14	43	24%	33%	33%
2006	140	38	128	1	9	43	1%	24%	34%	28	11	43	20%	29%	34%
2007	151	49	124	4	10	31	3%	20%	25%	36	14	32	24%	29%	26%
2008	120	50	76	2	4	24	2%	8%	32%	29	4	25	24%	8%	33%
2009	112	52	76	10	11	32	9%	21%	42%	28	12	34	25%	23%	45%
2010	112	46	72	4	7	29	4%	15%	40%	33	9	30	29%	20%	42%
2011	104	48	88	5	2	15	5%	4%	17%	39	25	25	38%	52%	28%
2012	125	51	97	6	4	23	5%	8%	24%	44	22	33	35%	43%	34%
2013	107	50	98	2	6	32	2%	12%	33%	36	27	40	34%	54%	41%
2014	123	56	82	1	7	27	1%	13%	33%	19	21	35	15%	38%	43%
2015	94	48	85	1	10	48	1%	21%	56%	13	19	50	14%	40%	59%
2016	113	48	112	9	16	62	8%	33%	55%	27	20	64	24%	42%	57%
2017	111	49	124	14	11	48	13%	22%	39%	37	18	51	33%	37%	41%
2018	95	50	149	9	11	57	9%	22%	38%	28	14	60	29%	28%	40%
2019	96	47	144	15	10	61	16%	21%	42%	34	13	64	35%	28%	44%
2020		10	22			10			45%			10			45%
2021		97	137		6	21		6%	15%		20	27		21%	20%

Table 2. The relative nominal DPUE, number of trips, standardized index, and CV for the gray triggerfish headboat at-sea observer data in the south Atlantic from **2005-2019**.

Year	N	Nominal DPUE	Relative nominal	Standardized DPUE	CV
2005	335	0.02	0.35	0.47	0.21
2006	300	0.03	0.38	0.48	0.19
2007	317	0.03	0.38	0.43	0.21
2008	246	0.02	0.25	0.33	0.24
2009	239	0.04	0.55	0.75	0.19
2010	230	0.03	0.46	0.54	0.22
2011	239	0.02	0.28	0.26	0.30
2012	265	0.03	0.41	0.43	0.26
2013	255	0.07	1.04	0.85	0.23
2014	261	0.06	0.87	0.77	0.24
2015	227	0.15	2.22	1.78	0.21
2016	265	0.15	2.24	2.62	0.16
2017	269	0.13	1.89	2.14	0.19
2018	283	0.12	1.84	1.43	0.20
2019	282	0.13	1.87	1.72	0.19

Table 3. The relative nominal CPUE, number of trips, standardized index, and CV for the gray triggerfish headboat at-sea observer data in the south Atlantic from **2010-2019**.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	CV
2010	230	0.29	0.49	0.60	0.19
2011	239	0.34	0.58	0.74	0.17
2012	265	0.72	1.20	0.73	0.17
2013	255	1.63	2.72	1.31	0.17
2014	261	0.82	1.38	0.93	0.21
2015	227	0.37	0.62	1.02	0.18
2016	265	0.37	0.62	1.36	0.15
2017	269	0.87	1.46	1.38	0.17
2018	283	0.24	0.41	0.97	0.16
2019	282	0.32	0.53	0.97	0.17

Figure 1. Positive trips by region for discards and harvested gray triggerfish trips in the headboat at-sea observer data.

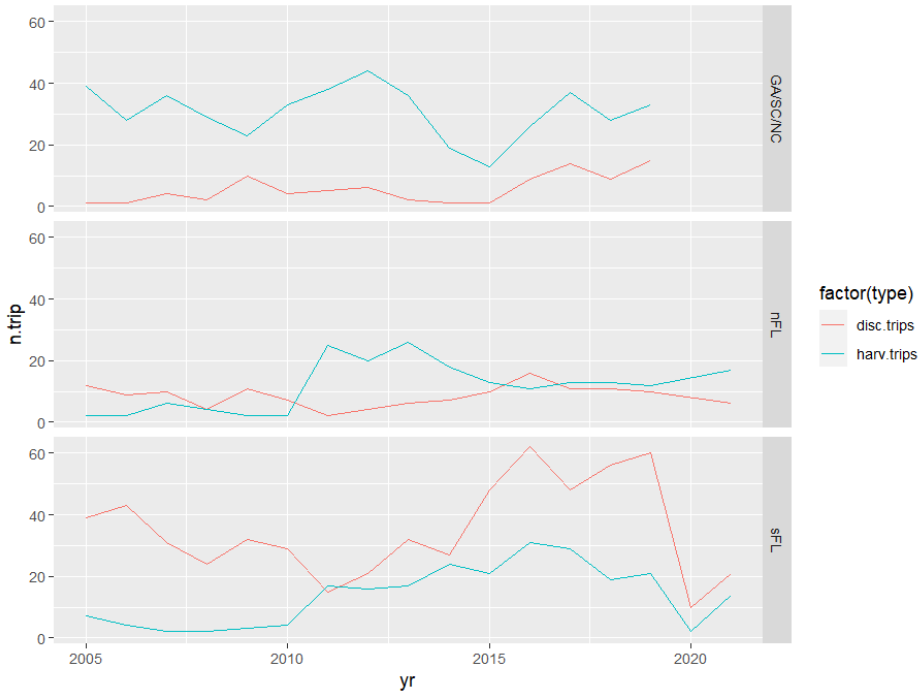


Figure 2. Proportion positive by region for the headboat at-sea discard index.

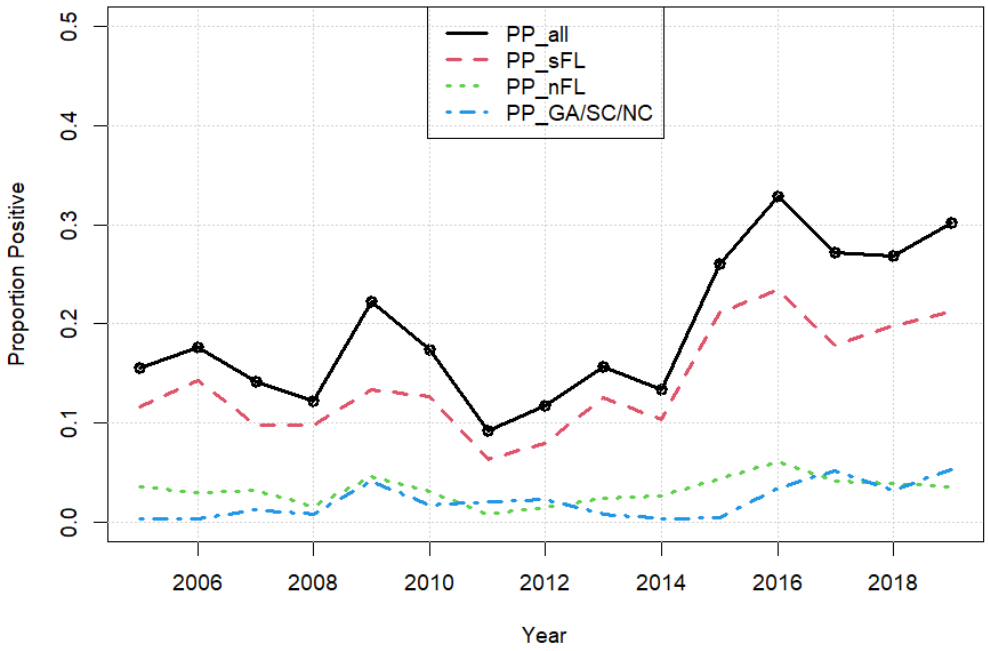


Figure 3. DPUE standardized residuals for by factors for the headboat at-sea observer discard index.

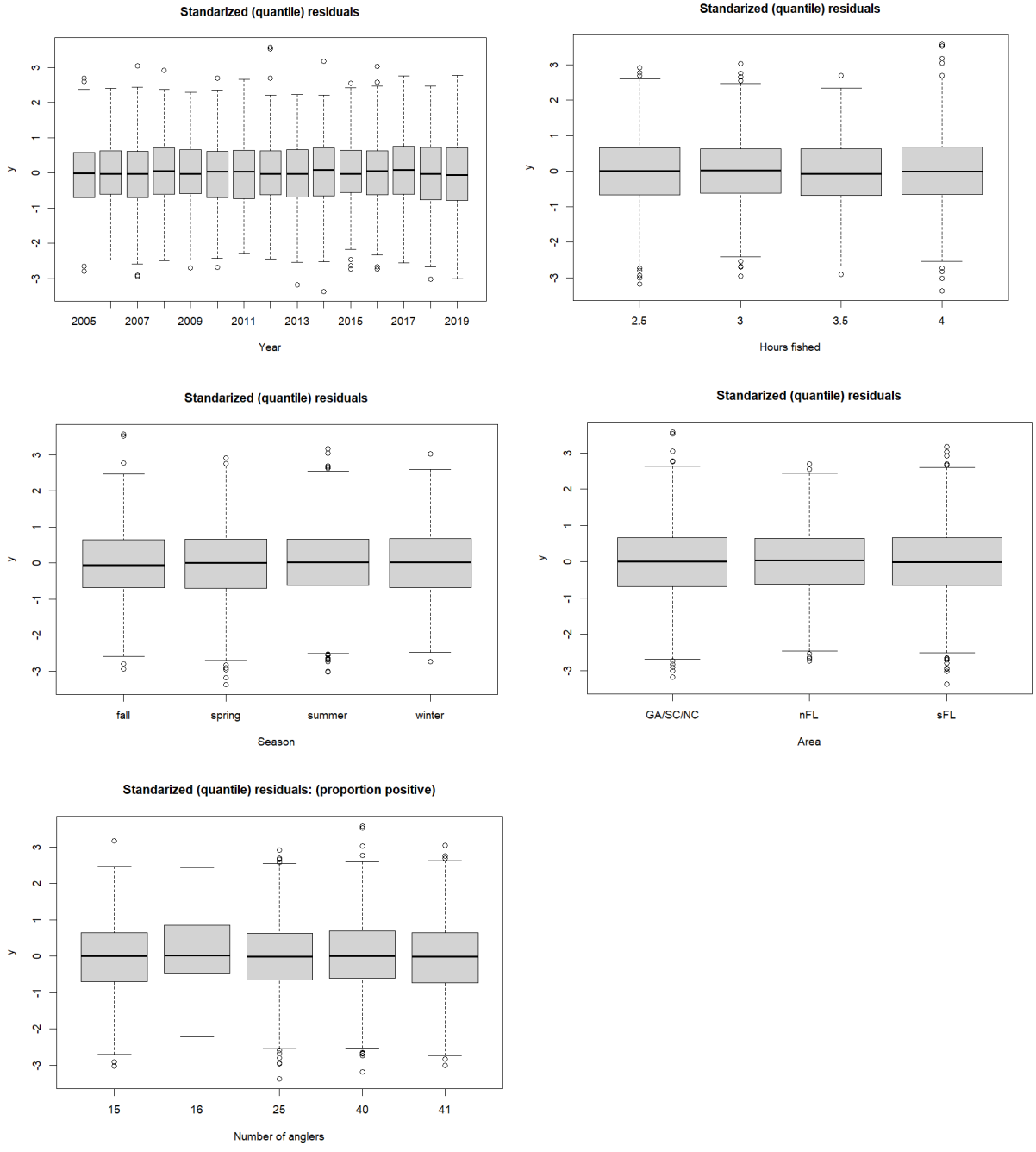
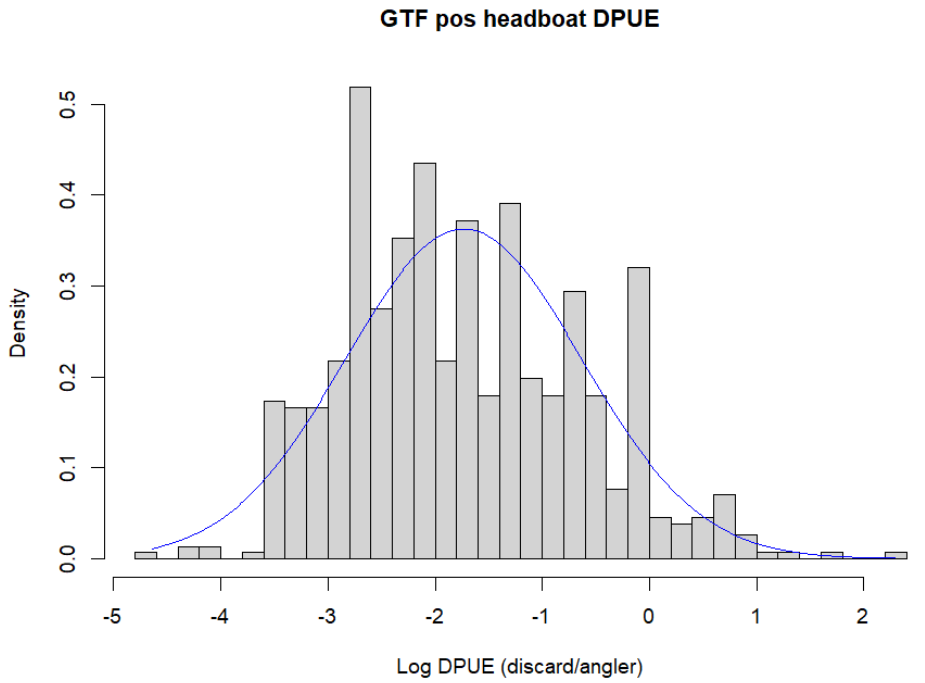


Figure 4. The lognormal distribution and qq plot of discard for the south Atlantic headboat at sea observer during **2005-2019**



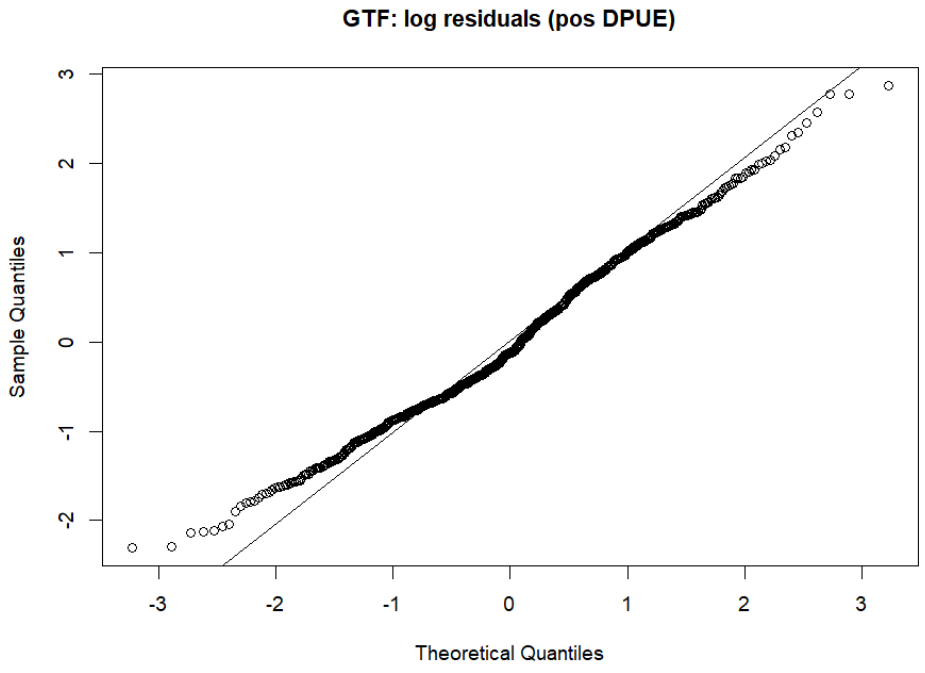


Figure 5. The standardized and nominal DPUE index with error bars at (+/-) 2 standard deviations (regional indices within the plot are nominal) computed for gray triggerfish in the south Atlantic using the headboat at-sea observer data during **2005-2019**. The colors time periods represent differences in size regulations by area.

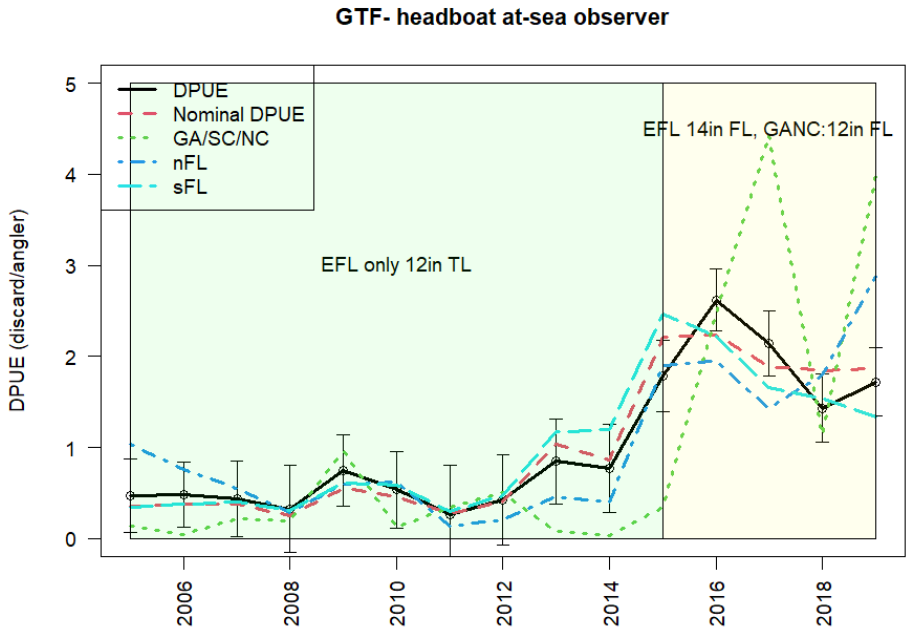


Figure 6. Annual discard length compositions from the headboat at-sea observer data. The colors time periods represent differences in size regulations by area.

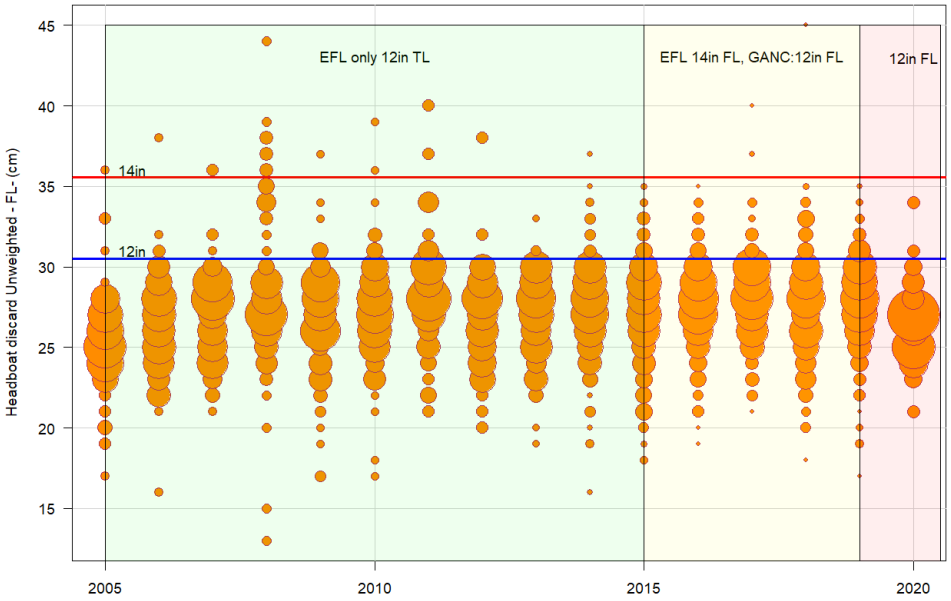


Figure 7. Proportion positive by region for the headboat at-sea harvest +discard (catch) index.

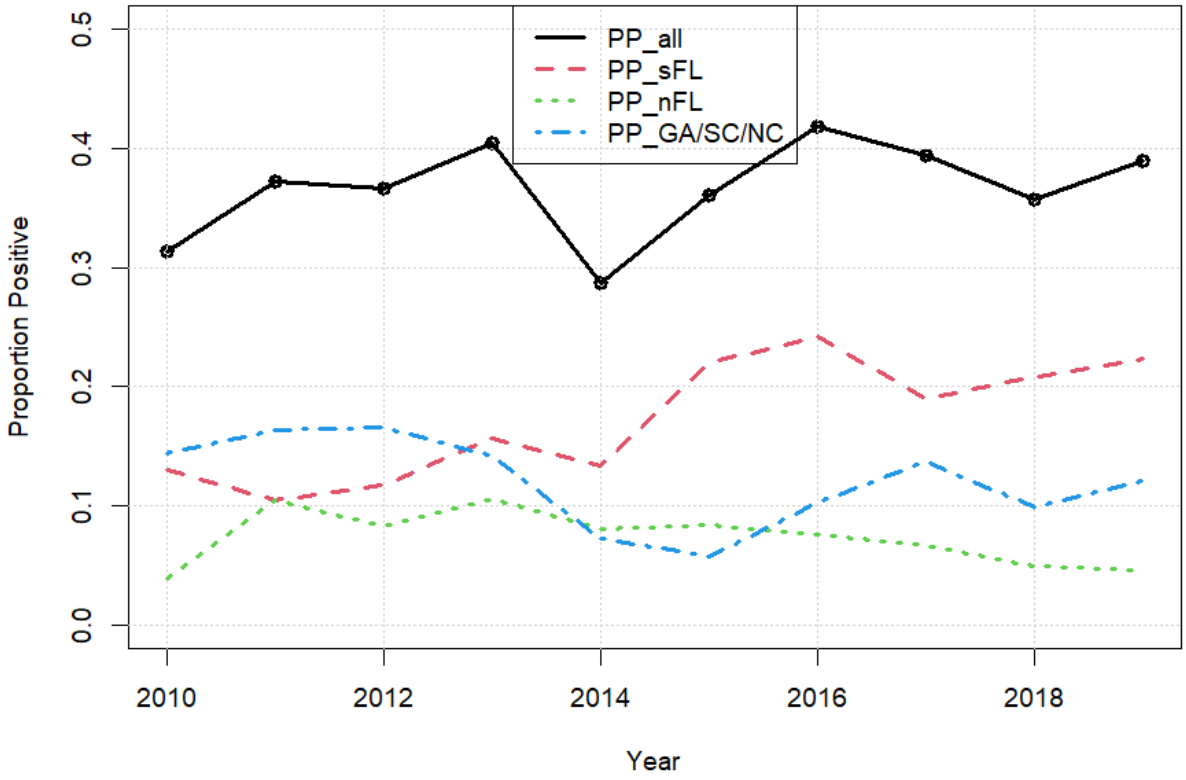


Figure 8. CPUE standardized residuals for by factors for the headboat at-sea observer catch index.

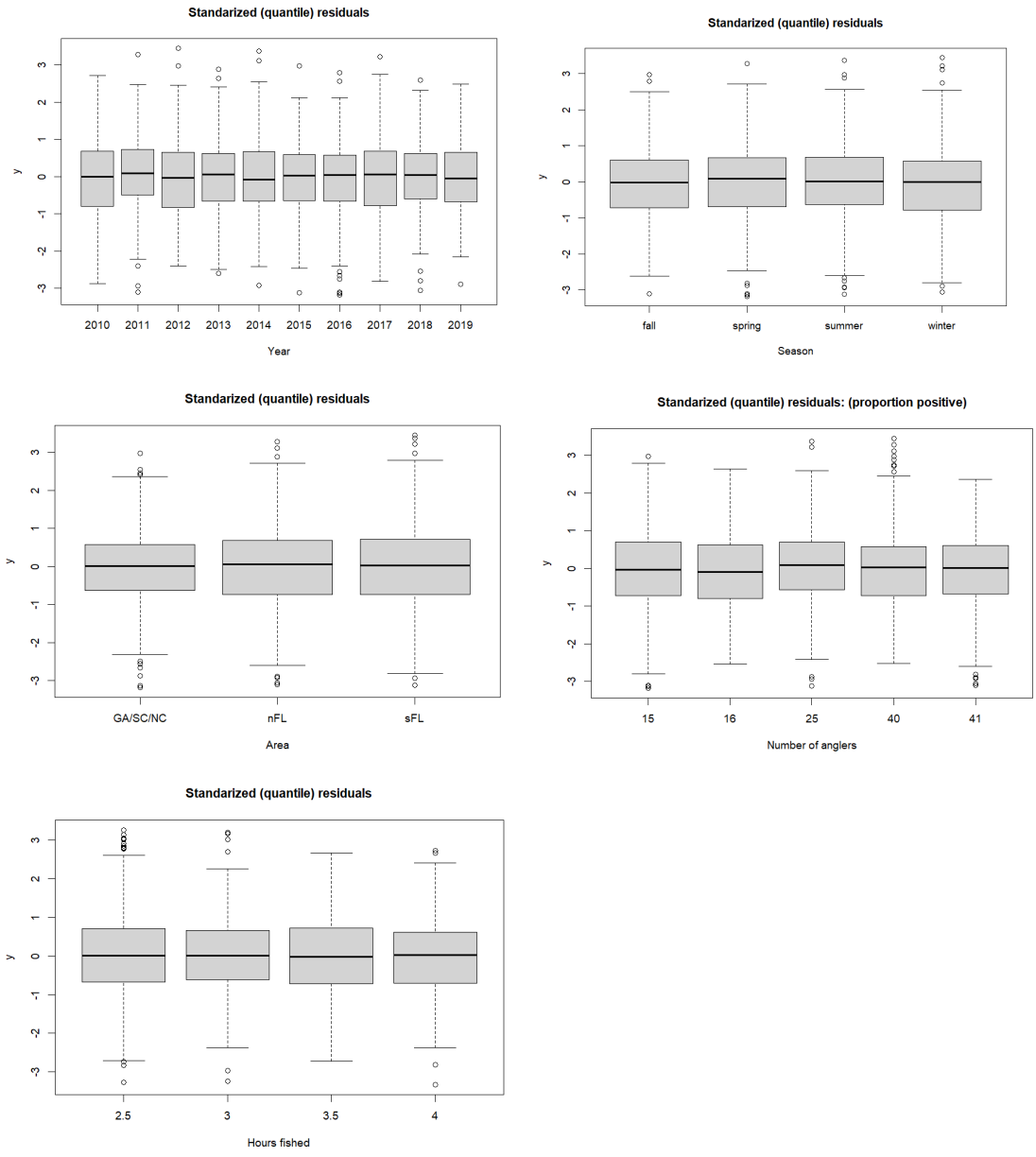


Figure 9. The lognormal distribution and qq plot of catch index for the south Atlantic headboat at sea observer during **2010-2019**

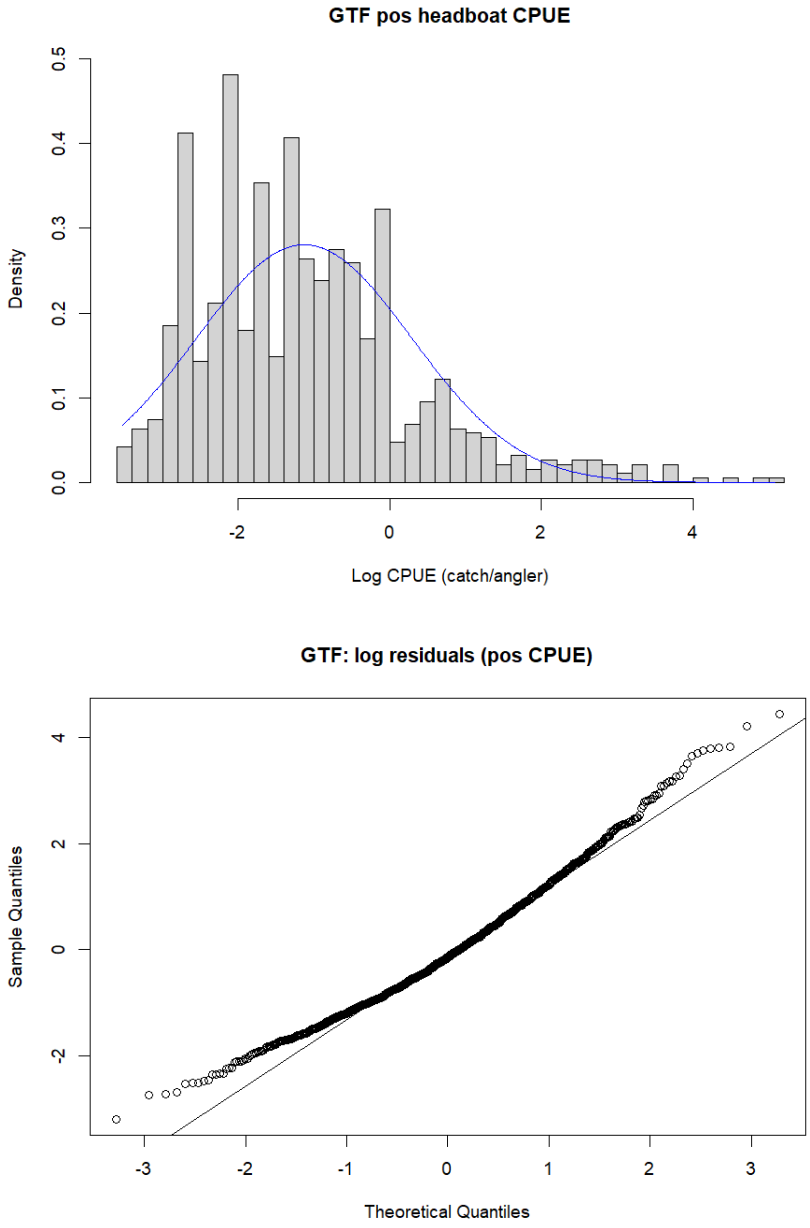


Figure 10. The standardized and nominal CPUE index with error bars at (+/-) 2 standard deviations (nominal by area below) computed for gray triggerfish in the south Atlantic using the headboat at-sea observer data during **2010-2019**.

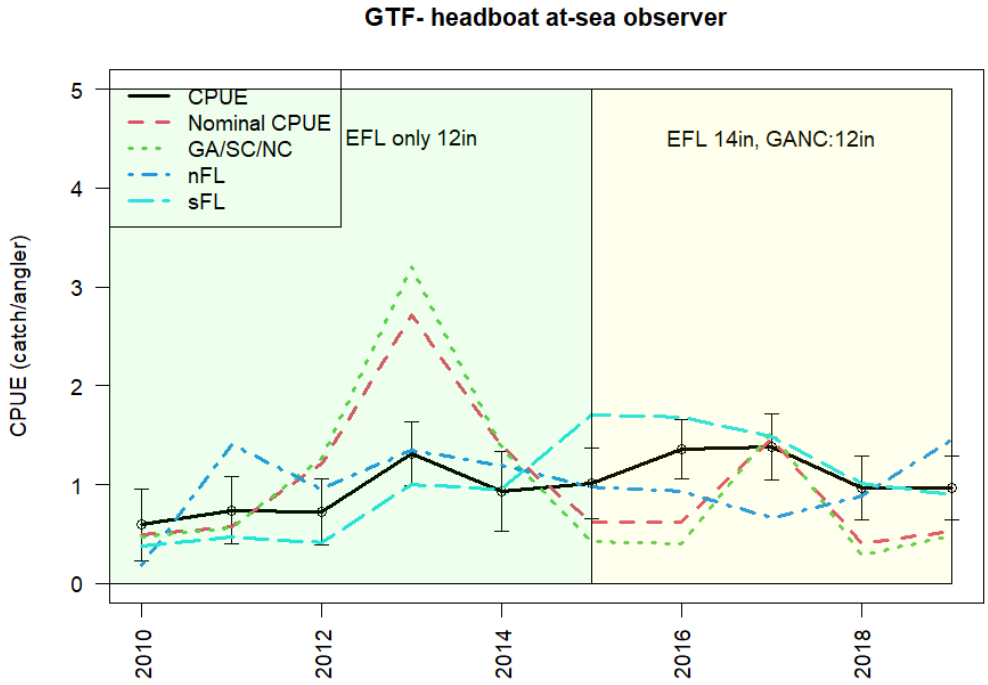


Figure 11. Annual length compositions from the headboat at-sea observer data (harvest and discards).

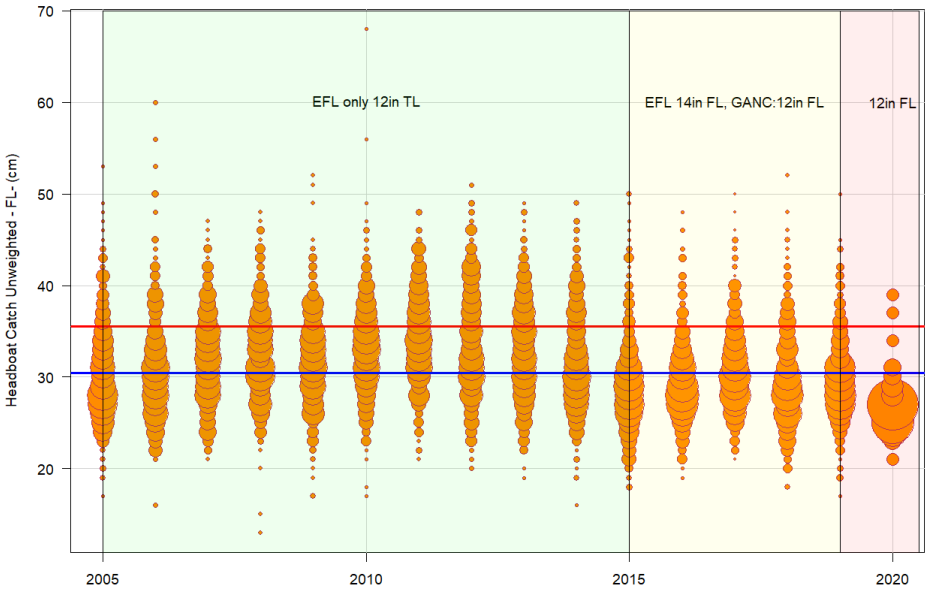


Figure 12. Plot of headboat at-sea observer indices along with the fishery dependent indices for SEDAR 82.

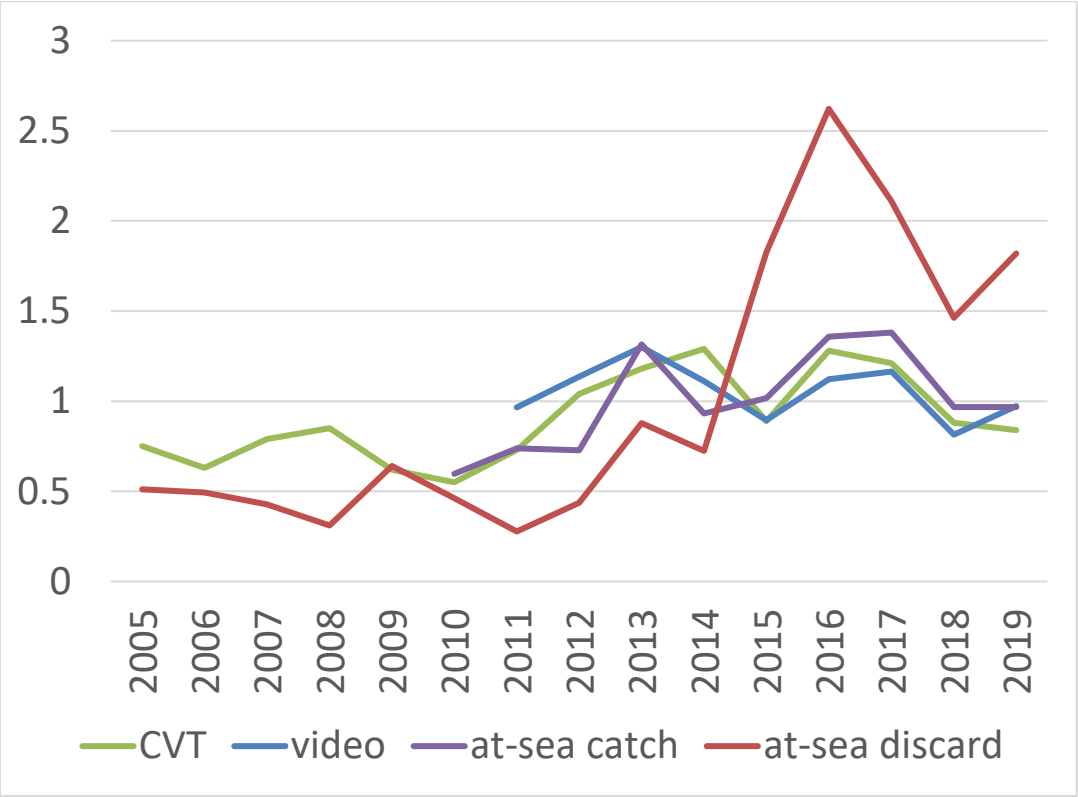


Table 4. Correlation matrix with the headboat at-sea observer indices with the fishery dependent indices.

	at-sea catch	CVT	Video	at-sea discard
at-sea catch	1			
CVT	0.75	1		
Video	0.48	0.74	1	
at-sea discard	0.75	0.53	-0.1	1