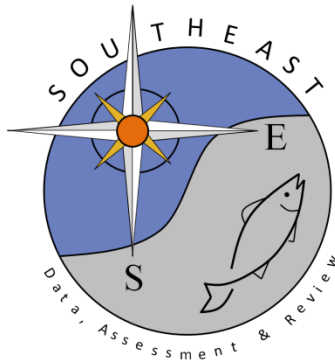


Standardized catch rates of undersized Red Snapper (*Lutjanus campechanus*) from headboat at-sea-observer data

Kevin Thompson^{1*}, Dominique Lazarre²

SEDAR90-DW-30

22 May 2025



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Introduction

Standardized catch rates were generated from the Southeast headboat at-sea-observer program for 2005-2023. 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 discarded by headboat vessels. Data filtering and subsetting steps were applied to the data to model trips that were likely to have fished over Red Snapper habitats. This index was used in the previous two Red Snapper assessments in the region (SEDAR 41, SEDAR 73)

Data Description

The data used for this index were all trips in the headboat at-sea observer database which discarded Red Snapper from 2005-2023. The at-sea-observer program occurred from 2004-2023 in North and South Carolina, but did not occur in Florida and Georgia in 2004. Data from Georgia, South Carolina, and North Carolina were provided as part of the NOAA-NMFS headboat observer program. Florida data were provided by the state observer program beginning in 2005. Data were available for this index up to 2023 in the states north of Florida, and up to 2024 for Florida's sampling program, as such the index is limited to a terminal year of 2023. The Florida Keys were not included in the at-sea observer program after 2007, and as such, the data excluded this region for this index.

Trip-level information included state, county, Florida region, 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 Red Snapper discarded, minimum depth of the fishing trip, 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. Refer to working paper SEDAR41-DW33 for more details regarding the headboat observer program.

Methods

Data Treatment

The South Atlantic Red Snapper season is primarily closed throughout the year starting in 2010, therefore to index population status the trips included in this analysis were during closed season so limited to discarded fish, rather than the brief open seasons where Red Snapper would have been recorded as landed. To create a representative dataset that included only headboat trips with observers that fished on potential Red Snapper habitat, a species association approach was used where species identified to be closely associated with Red Snapper were used to filter trips. Trips were retained for the index when one of the following species were observed: Bank Seabass, Black Seabass, Gag, Gray Triggerfish, Greater Amberjack, Knobbled Porgy, Red Porgy, Red Snapper, Scamp, Tomtate, Vermillion Snapper, White Grunt, Whitebone Porgy (Shertzer and Williams 2008).

Relevant Management History

A 20" TL minimum size regulation has been in place since 1992, therefore the index is representative of the population less than 20". Closures began in 2010 where all fish observed are discarded. In following years there were mini-seasons where Red Snapper were retained starting in 2012, however due to concerns of significantly different fishery behavior and effort patterns during these brief windows, trips during these time periods were removed from analysis. The discards remain limited to less than 20" to create a cohesive time series before closures going back to 2005.

Index Data Preparation

Trips were initially subset using the species and management regime as described above. Data were further subset to limit fish observed that were caught by anglers that were observed throughout the entire trip. Trips were also excluded if the party exceeded 120 anglers or the time fishing was greater than 10 hours as they were flagged as outliers and non-representative in previous uses of this index (SEDAR41-DW-14).

Response and Explanatory Variables

CPUE – DPUE (discards per unit effort) was calculated as the number of discarded fish under 20" divided by the number of interviewed anglers on that trip for a response metric of discards per angler at the trip level.

YEAR – A summary of the total number of trips with observed Red Snapper effort per year is provided in Table 1.

AREA –Area was defined as North Carolina, South Carolina, Georgia, North Florida (nFL), and South Florida, (excluding Monroe County/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 a 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 was modeled using the delta-GLM approach (Lo, Jacobson, and Squire 1992; Dick 2004; Maunder and Punt 2004). This approach combines two separate generalized linear models (GLMs), one to describe presence/absence of the focal species, and one to describe catch rates of successful trips (trips that caught the focal species). Estimates of variance were based on 1000 bootstrap runs where trips were chosen randomly with replacement (Efron and Tibshirani 1993). All analyses were programmed in R, with much of the code adapted from Dick (2004).

Bernoulli submodel

The Bernoulli component of the delta-GLM is a logistic regression model designed to predict the presence/absence (i.e., availability to be caught) of Red Snapper on any given trip. Initially, all explanatory variables were included in the model as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. In this case, the stepwise AIC procedure did not remove any explanatory variables.

Positive CPUE submodel

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. For both distributions, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. For both distributions, the best model fit included all explanatory variables. The two distributions were compared using AIC. Lognormal outperformed gamma, and was therefore applied in the final delta-GLM.

Results and Discussion

Initial data filtering for this run of the index showed higher numbers of retained trips than in previous runs for early years of the time series (Table 1, Fig. 1). After significant investigations into the limited available datasets, code, and with a limited amount of information in the working paper for SEDAR 41, these differences could not be elucidated. However, it was confirmed that the species-based filtering approach was appropriately applied to these data whereas that cannot be confirmed by the limited or conflicting datasets available for comparison from SEDAR 41 and 73. As such, we feel this is a representative dataset and can be reliably evaluated as representing the trends in the discarded, undersized Red Snapper as sampled by the headboat fishery in the region.

Sample sizes were adequate at the total level, but were low for some year and regional combinations (Table 1, Fig. 1). There were particularly low samples for 2020 due to the COVID-limited sampling, however there were potentially enough to evaluate it as being retained in the index especially in contrast to the lack of data for that year in the other index datasets available.

The final trends generally mirrored the nominal index with some divergence due to model estimation, as expected (Fig. 2). When compared to previous runs of this index, this model closely mirrored the values in SEDAR 41 and 73 through 2010 where they diverged with the current model estimating lower values of relative abundance through 2016 followed by higher estimates for the remainder of the years available to compare (through 2019; Fig.3). Later years of this index showed high relative abundance with a peak in 2021 and decline in the last few years from there (Fig.1, Fig. 3). CVs support that this is a well-fitted index with values in the range of 18-35% (Table 2). The model was successfully fit with residuals that didn't indicate any concerns with model structure or methodology (Appendix A,B).

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Table 1. Number of trips by area and year, and number of discarded Red Snapper in the South Atlantic headboat at-sea- observer data by area and year.

Year	N Trips					Total	N Discards					Total
	GA	SC	NC	N.FL	S.FL		GA	SC	NC	N.FL	S.FL	
2005	1	55	93	42	51	242	1	0	0	432	48	481
2006	4	44	78	35	44	205	7	0	0	662	0	669
2007	3	49	79	48	39	218	8	2	13	1435	34	1492
2008	3	34	73	49	49	208	37	1	23	1581	27	1669
2009	9	33	63	52	51	208	32	0	2	389	8	431
2010	3	25	72	46	45	191	3	0	5	168	13	189
2011	3	22	71	44	47	187	4	0	4	107	0	115
2012	10	29	65	48	48	200	21	0	23	260	3	307
2013	11	30	45	46	65	197	17	0	15	182	0	214
2014	12	29	53	52	72	218	9	0	2	365	0	376
2015	10	22	47	48	80	207	21	0	5	424	15	465
2016	9	25	61	45	62	202	32	0	18	473	20	543
2017	8	28	61	48	61	206	32	1	3	435	8	479
2018	5	24	42	46	65	182	209	3	10	455	10	687
2019	6	23	53	43	65	190	13	1	36	694	5	749
2020	0	2	10	10	14	36	0	0	0	190	1	191
2021	0	3	22	96	68	189	0	0	26	928	2	956
2022	0	17	38	86	110	251	0	13	9	680	1	703
2023	0	14	51	101	88	254	0	19	13	456	2	490

Table 2. The relative nominal CPUE, number of trips, standardized index, and CV for the Red Snapper headboat at-sea observer data in the South Atlantic from 2005-2023.

Year	N	Proportion Positive	Nominal CPUE	Relative Nominal	Standardized CPUE	CV
2005	242	0.1736	0.1060	0.4738	0.4390	0.3489
2006	205	0.1415	0.1611	0.7199	0.2607	0.3664
2007	218	0.2936	0.3398	1.5188	1.9998	0.1844
2008	208	0.2885	0.4383	1.9590	1.7218	0.2474
2009	208	0.2692	0.1434	0.6408	0.4971	0.2701
2010	191	0.2251	0.0559	0.2496	0.1705	0.3454
2011	187	0.1604	0.0550	0.2459	0.1169	0.3672
2012	200	0.2450	0.1282	0.5729	0.4966	0.3146
2013	197	0.2183	0.0882	0.3942	0.2383	0.3156
2014	218	0.1835	0.1240	0.5541	0.2496	0.3026
2015	207	0.2415	0.1760	0.7867	0.7318	0.2742
2016	202	0.2228	0.2096	0.9367	0.7322	0.3112
2017	206	0.2379	0.2044	0.9134	0.7546	0.2445
2018	182	0.3132	0.2906	1.2987	1.5915	0.2473
2019	190	0.2947	0.3237	1.4465	1.8385	0.2251
2020	36	0.3056	0.4250	1.8994	2.1222	0.3665
2021	189	0.5397	0.4602	2.0565	2.7513	0.2065
2022	251	0.3307	0.2890	1.2916	1.3065	0.2821
2023	254	0.3661	0.2330	1.0413	0.9809	0.2910

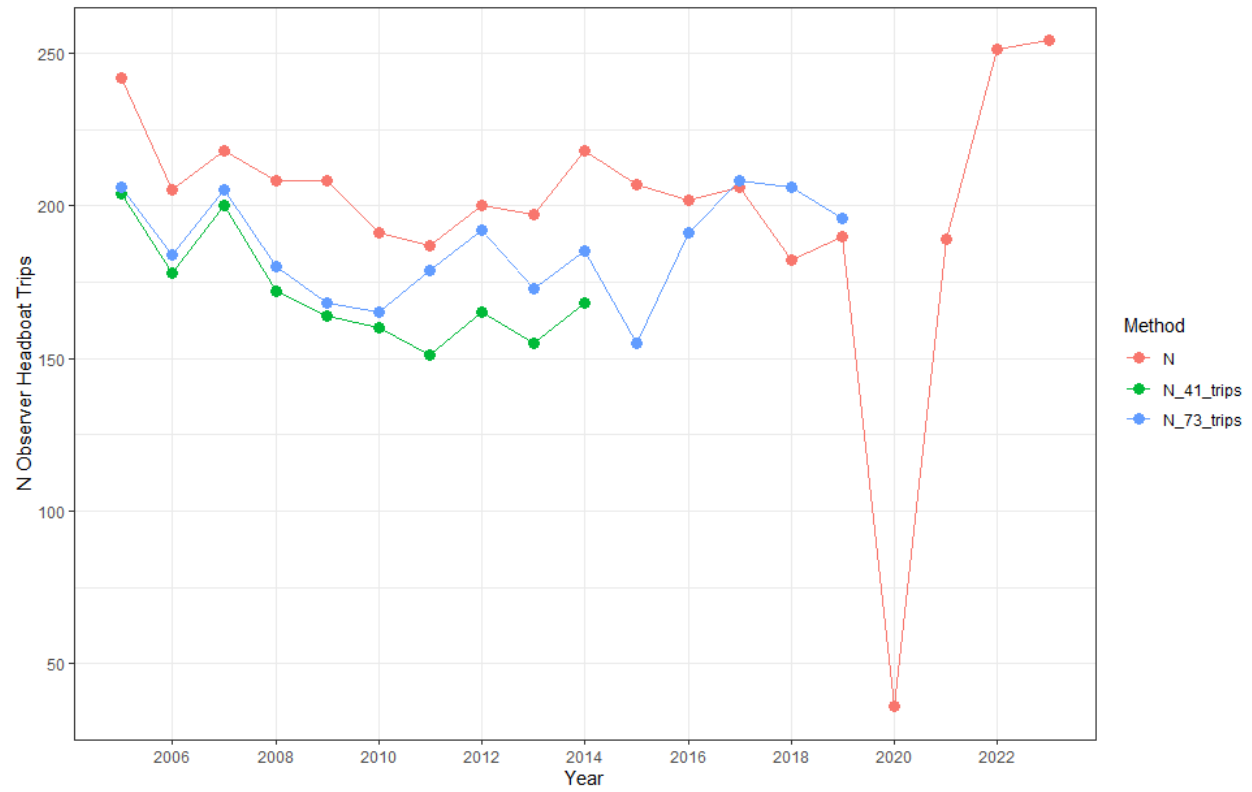


Figure 1. Comparison of the number of trips (N) between SEDAR 41, 73 and this analysis for S90.

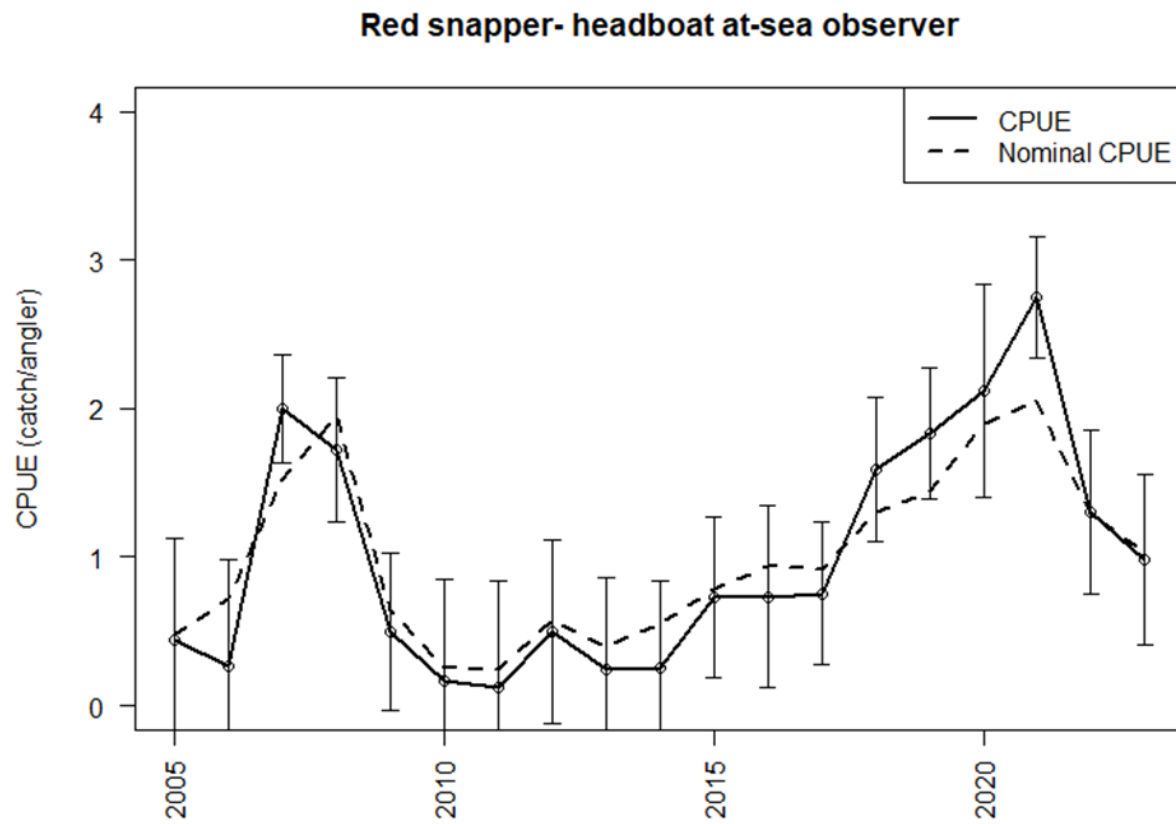


Figure 2. Nominal and estimated, standardized relative CPUE by year given by undersized discards per angler for 2005-2023.

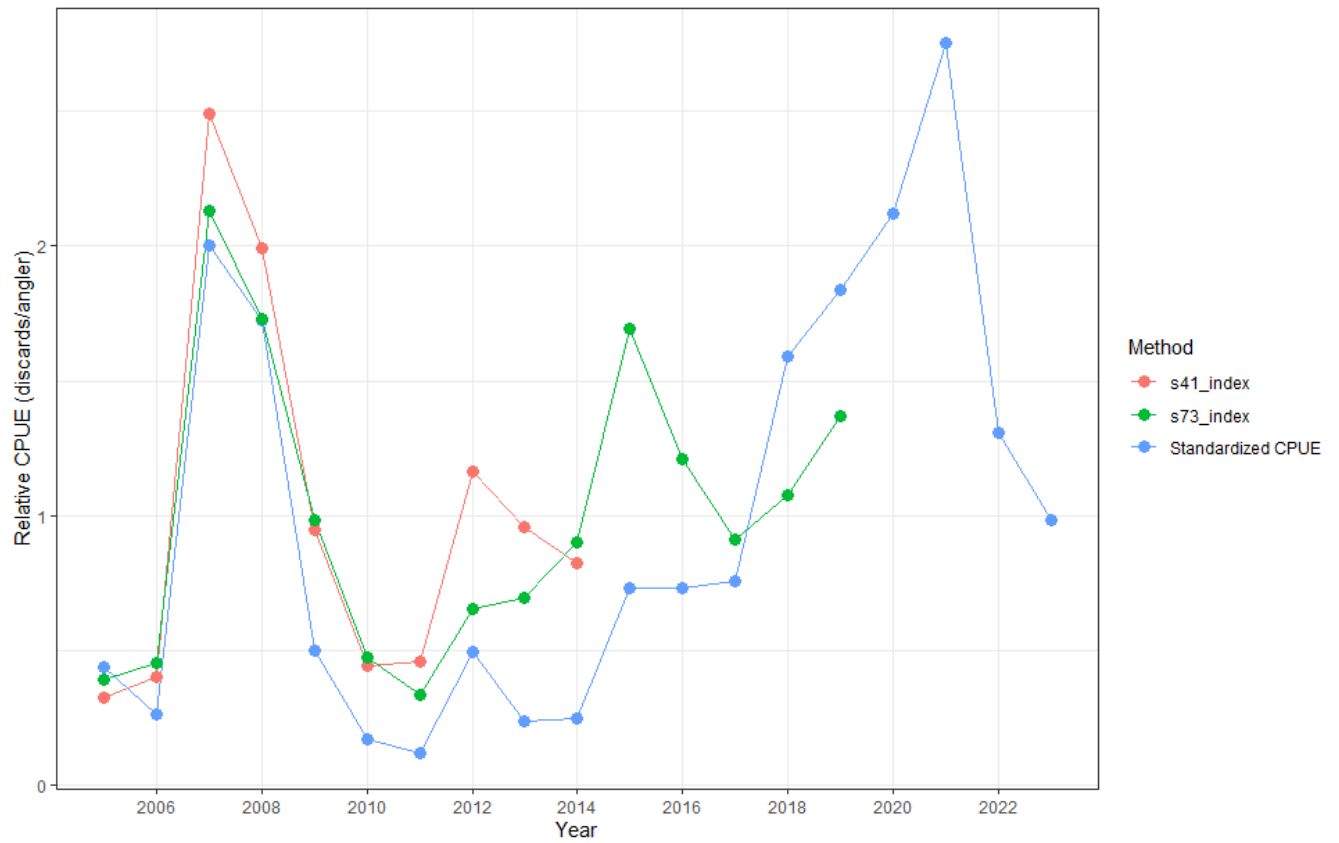
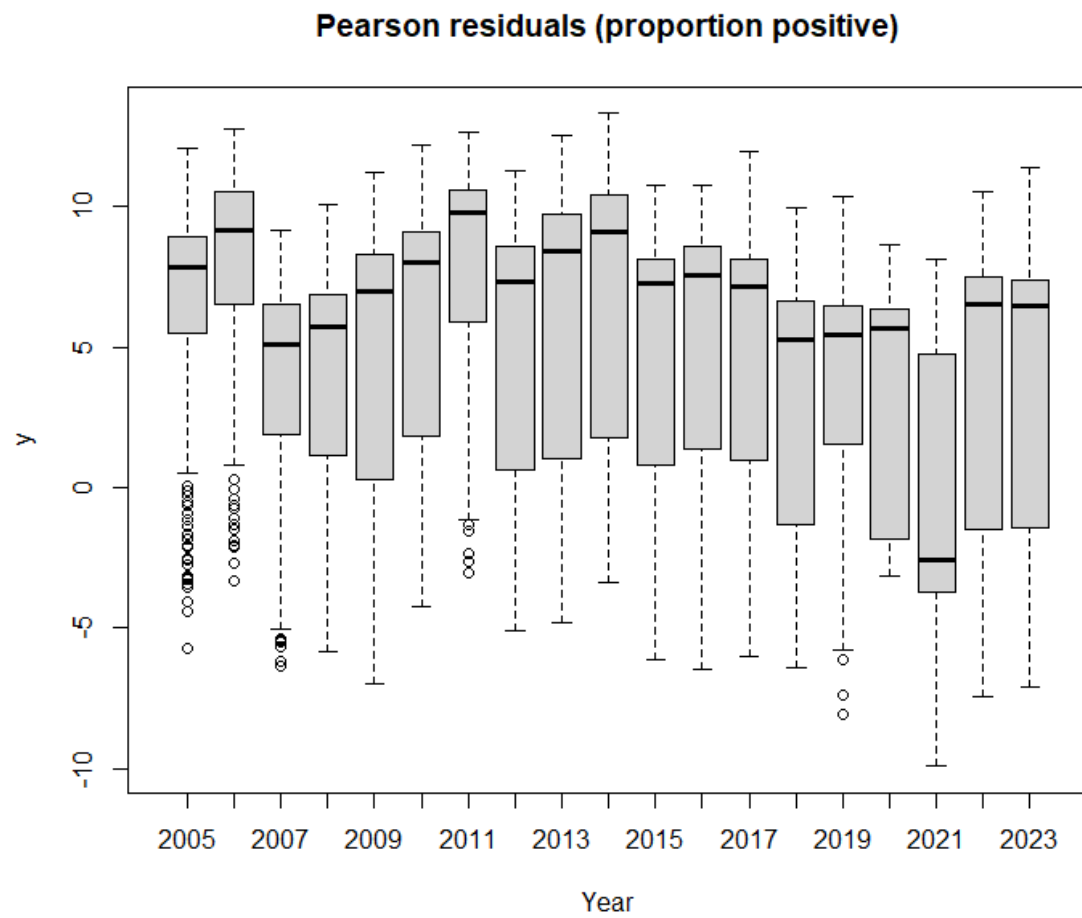
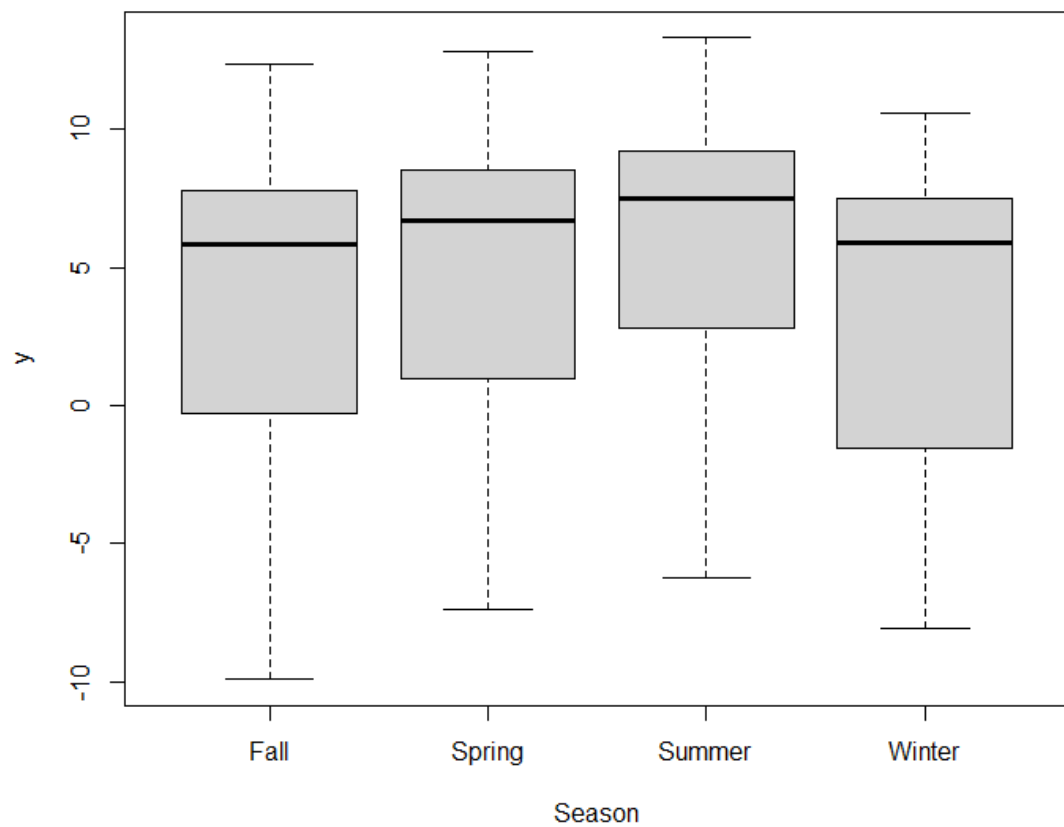


Figure 3. Comparison of standardized CPUE trends from the previous two SEDARs (S41 and S73) as well the final values from the analyses described here for S90.

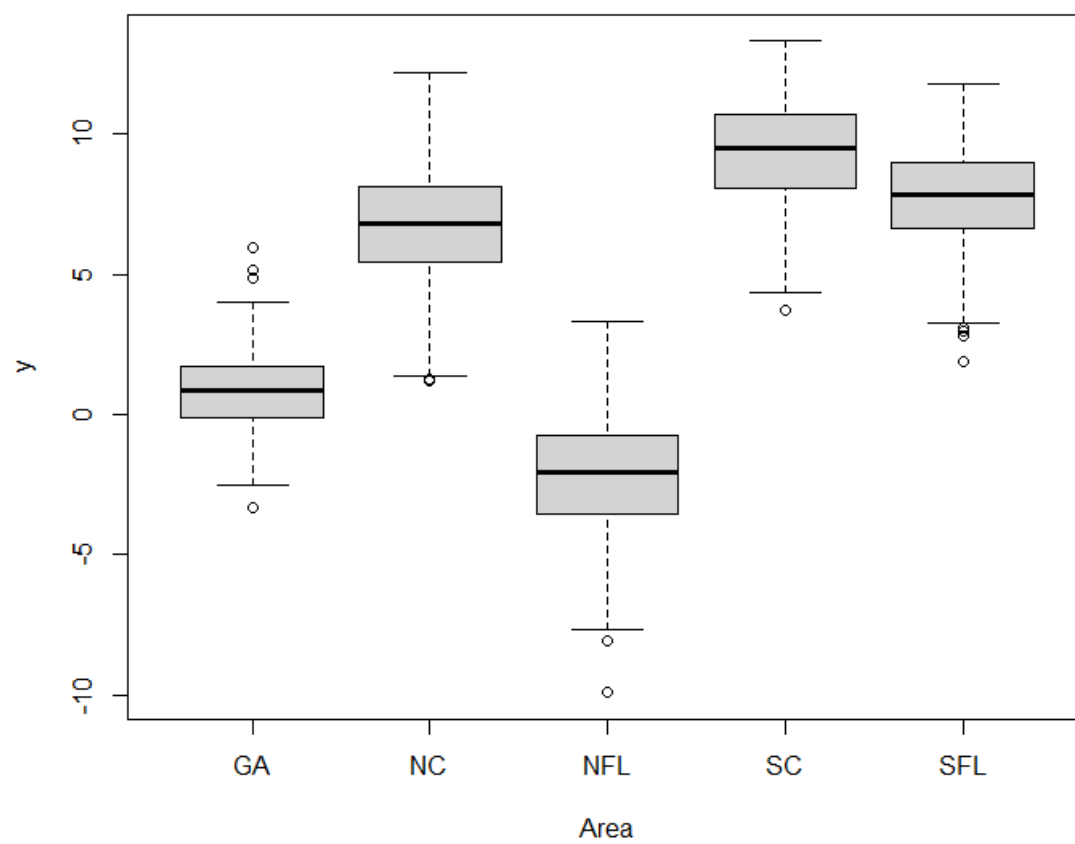
Appendix A. Figures 1- 4. Residuals for the factors included in the proportion positive model



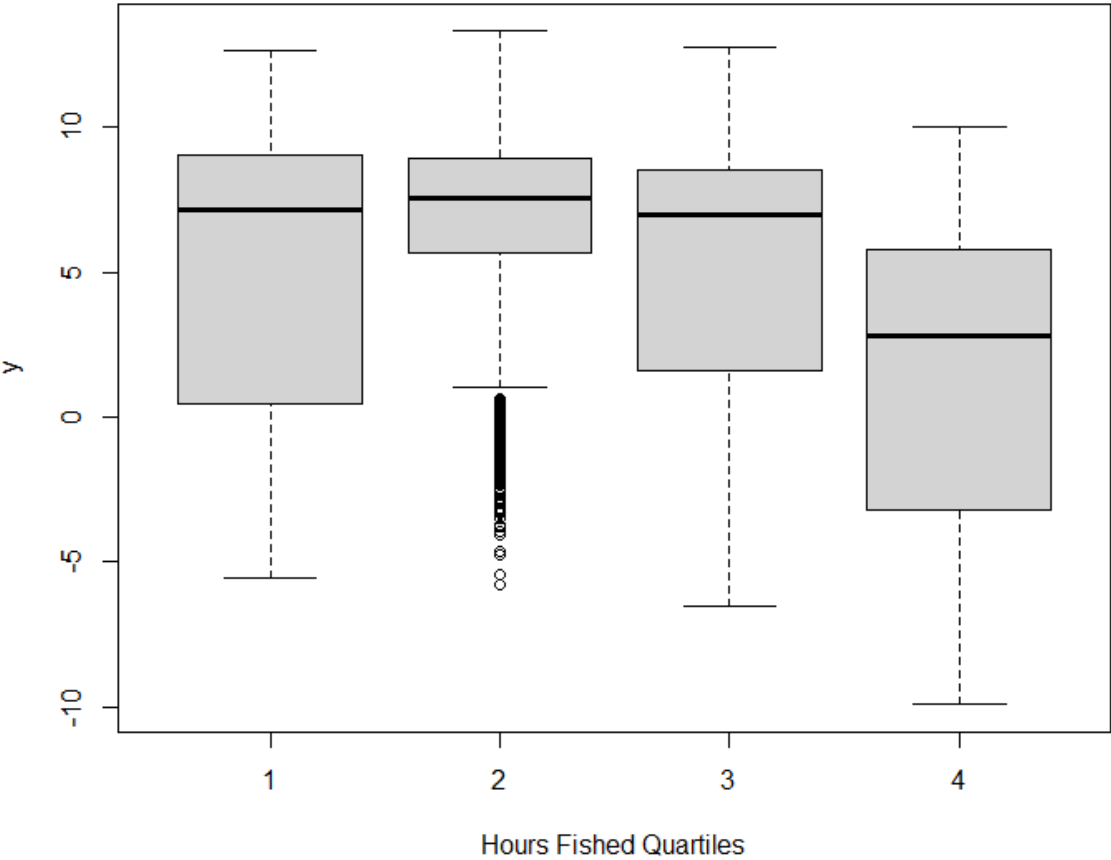
Pearson residuals (proportion positive)



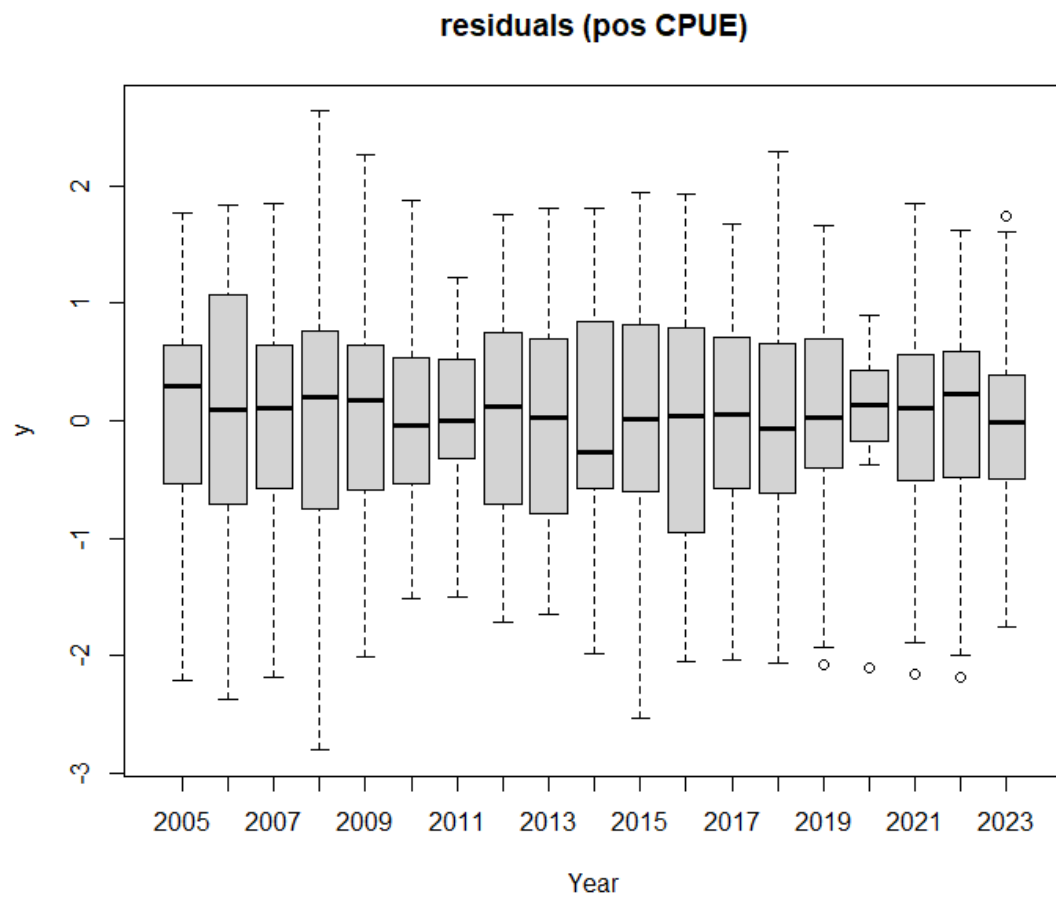
Pearson residuals (proportion positive)



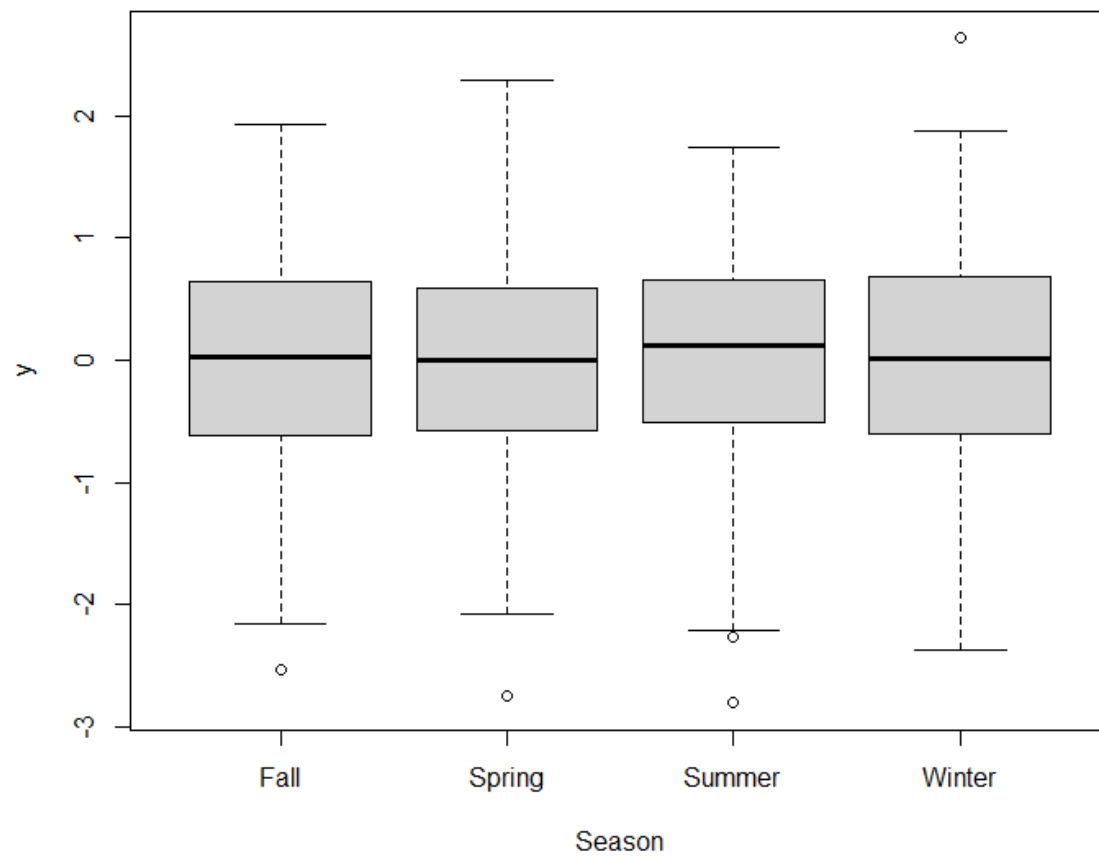
Pearson residuals (proportion positive)



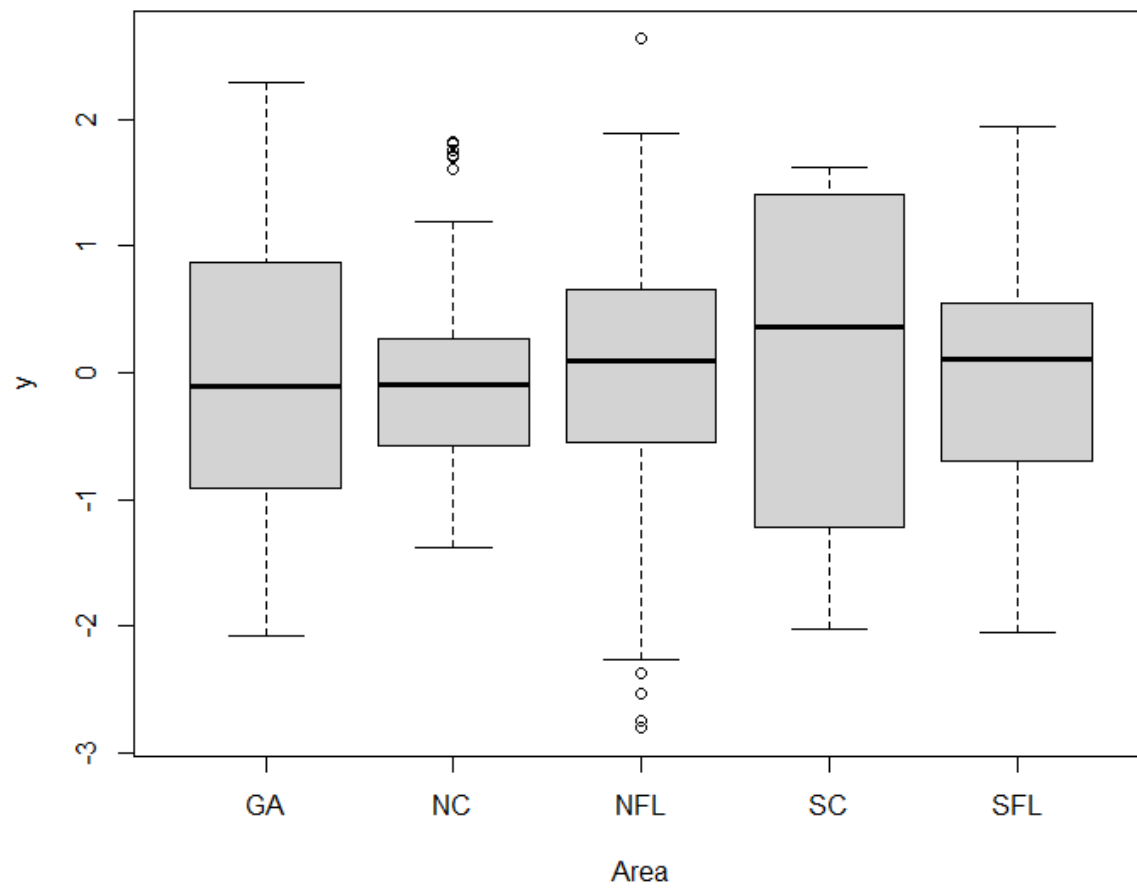
Appendix B. Figures 1-5, Residuals of the positive catch model for the factors included in the final model.



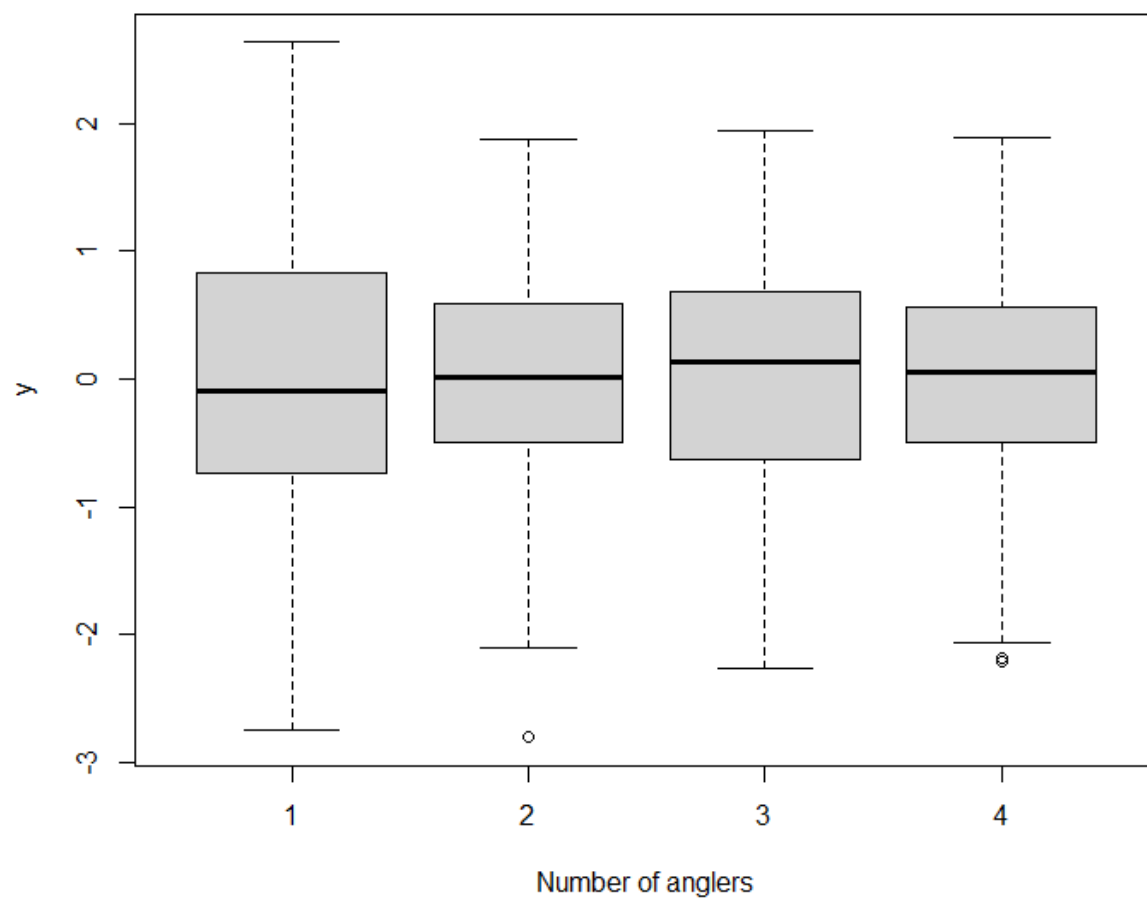
residuals (pos CPUE)



Raw residuals (pos CPUE)



Raw residuals (pos CPUE)



Raw residuals (pos CPUE)

