# **Standardized catch rates of gray triggerfish (*Balistes capriscus*) from headboat at-sea-observer data**

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# Standardized catch rates of gray triggerfish (*Balistes capriscus*) from headboat at-sea-observer data

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**Abstract**
Standardized catch rates were generated from the Southeast headboat at-sea-observer program for 2005-2011. 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.

## Background and Data Description

The data used for this index were all trips in the headboat at-sea observer database which harvested and discarded gray triggerfish from 2005-2011. The at-sea-observer program occurred from 2004-2009 in North and South Carolina, but did not occur in Florida and Georgia in 2004. In addition, after 2007 the Florida Keys were no longer included in the at-sea observer program. 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 gray triggerfish 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.

## Methods

*Data treatment*
Data from 2004 were dropped from the analysis because Georgia and Florida were not sampled. Preliminary analysis included discards only and was presented as a potential recruitment index. Due to the 12” minimum size in Florida only, triggerfish discards were infrequent in North Carolina, South Carolina and Georgia (Table 1).

A Florida only discard index was developed and presented to the DW index working group (IWG) and was not recommended for use due to limited spatial coverage and questionable relationship to the stock-wide gray triggerfish abundance. A headboat at-sea-observer catch index was developed at the data workshop including discards and harvested gray triggerfish from North Carolina to south Florida. Table 2 reports the models considered in this analysis and more details concerning this discussion.

*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 catch including discards. The resulting data set, given the methods described above, contained 520 trips containing gray triggerfish harvest and discards.

*Response and explanatory variables*

*CPUE* – Catch per unit effort (DPUE) is defined as units of fish/ angler-hour and was calculated as the number gray triggerfish caught including discards divided by the number of hours fished multiplied by the number of anglers on the vessel (angler-hours). CPUE relative to each explanatory variable is provided in Figure 5.

*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 Florida (excluding the keys, flreg=3) (FL), North Carolina, South Carolina and Georgia (NC/SC/GA). The total effort by year and area for gray triggerfish catch are provided in Figure 1.

*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 for the number of anglers on a boat were considered in the standardization process. The categories included: ≤16 anglers, 16-26 anglers, 27-40 anglers, and >40 anglers.

*DTD* – The number of dock to dock hours was included as a factor with ≤4 hours representing a shorter trip and >4 hours representing a longer trip. This factor indicates trip type.

*Standardization*

CPUE was modeled using the glm approach (Dick 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE, and examined which combination of predictor variables best explained CPUE patterns. Jackknife estimates of variance were computed using the ‘leave one out’ estimator (Dick 2004). All analyses were performed in the R programming language, with much of the code adapted from Dick (2004).

POSITIVE CPUE SUBMODEL

Then, to determine predictor variables important for predicting positive DPUE, 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 (Appendix 1). All predictor variables were modeled as fixed effects (and as factors rather than continuous variables). Backwards model selection eliminated no variables for the lognormal distribution but eliminated season and dock to dock (trip type) for the gamma distribution. Recognizable patterns were not apparent in the quantile residuals (Figure 2).

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, the lognormal distribution outperformed the gamma distribution and the lognormal model with all factors was used to compute the index (Appendix 1).

**Index**
The distribution of lognormal CPUE for the index are presented in Figure 3 and the Q-Q plot is in Figure 4. The index is presented in Table 3 and visually in Figure 5.

LITERATURE CITED

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

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

Table 1. The number of harvested and discarded gray triggerfish by region in the south Atlantic headboat at-sea-observer data. N.trips represents an observed trip with a positive triggerfish either harvested or discarded.

| | N.fish.harv | | | | N.fish.disc | | | | N.trips | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | FL keys | sFL | nFL | NC/SC/GA | FL keys | sFL | nFL | NC/SC/GA | FL keys | sFL | nFL | NC/SC/GA | N.fish.harv | N.fish.dis | Tot.trips |
| 2005 | 6 | 35 | 6 | 184 | 28 | 92 | 28 | 5 | 11 | 47 | 17 | 39 | 231 | 153 | 114 |
| 2006 | 4 | 15 | 4 | 72 | 39 | 78 | 14 | 1 | 18 | 28 | 12 | 28 | 95 | 132 | 86 |
| 2007 | | 8 | 12 | 121 | 15 | 85 | 18 | 8 | 7 | 26 | 17 | 36 | 141 | 126 | 86 |
| 2008 | | 9 | 6 | 214 | | 64 | 9 | 22 | | 25 | 10 | 29 | 229 | 95 | 64 |
| 2009 | | 13 | 4 | 233 | | 105 | 16 | 19 | | 36 | 13 | 28 | 250 | 140 | 77 |
| 2010 | 1 | 19 | 3 | 391 | 2 | 82 | 16 | 4 | 1 | 34 | 10 | 33 | 414 | 104 | 78 |
| 2011 | | 51 | 8 | 391 | | 28 | 2 | 30 | | 13 | 2 | 39 | 450 | 60 | 54 |
| Total | 11 | 150 | 43 | 1606 | 84 | 534 | 103 | 89 | 37 | 209 | 81 | 232 | 1810 | 810 | 559 |

Table 2. Progression of discussion of subsetting method leading to final index for the headboat logbook data.

| run | progression leading to recommended index | Comments |
|---|---|---|
| 1 | at-sea-observer discard only index | FL only index due to 12" minimum in FL |
| | | very few discards in NC/SC/GA |
| 2 | reran FL only discard index excluding FL keys | Due to lack of coverage in sampling in 2 years |
| | | identified circle hook regulation and potential effect between north and south FL |
| 3 | Index including harvest & discards provided | determined that including catch in index would extend spatial range of index |
| | | areas included sFL, nFL, and NC/SC/FL |
| 4 | reran index including harvest and discards | merged nFL and sFL, final area factor included 2 areas (NC/SC/GA & FL) excluding keys |
| 5 | index including harvest and discards | identified and corrected potential outliers (>100 triggerfish catch in one trip) |

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.

| Year | Relative nominal CPUE | N | Standardized index | CV (index) |
|---|---|---|---|---|
| 2005 | 0.67 | 101 | 0.84 | 0.11 |
| 2006 | 0.61 | 68 | 0.88 | 0.14 |
| 2007 | 0.67 | 79 | 0.92 | 0.12 |
| 2008 | 0.88 | 64 | 0.86 | 0.15 |
| 2009 | 0.93 | 73 | 0.80 | 0.13 |
| 2010 | 1.35 | 75 | 1.07 | 0.13 |
| 2011 | 1.90 | 54 | 1.63 | 0.20 |

Figure 1. Total effort with gray triggerfish harvest and discards by region.

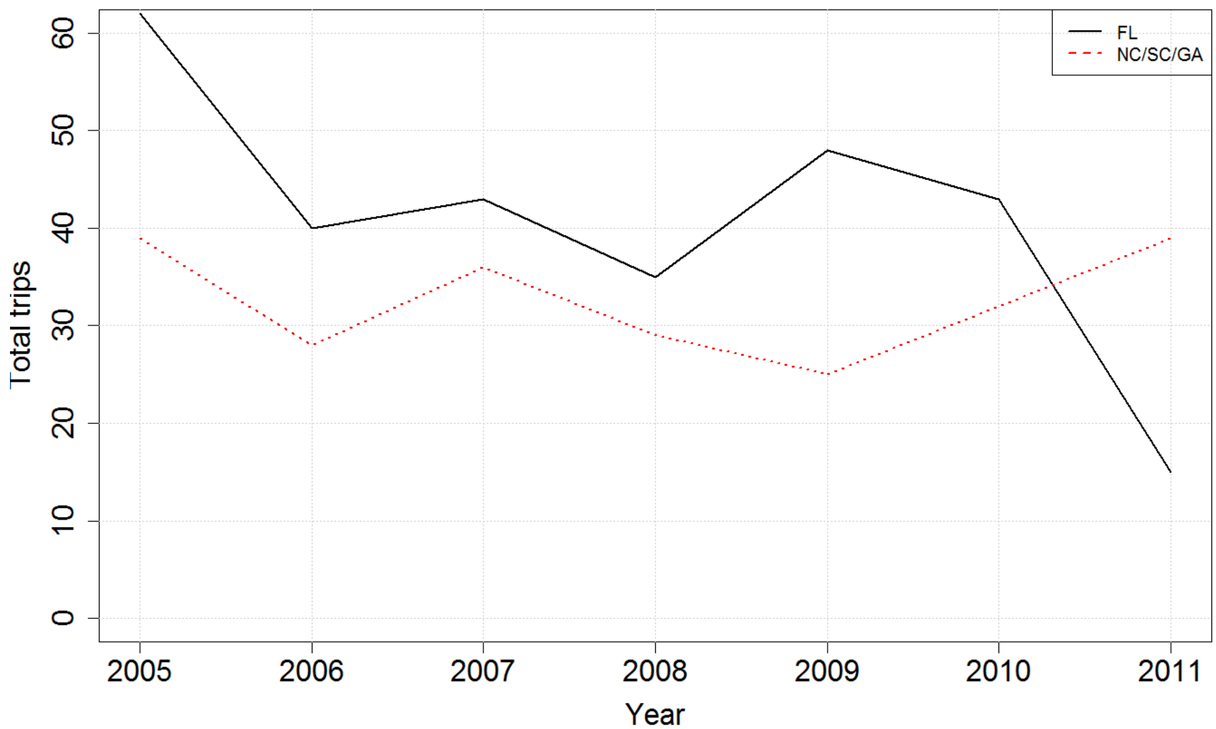
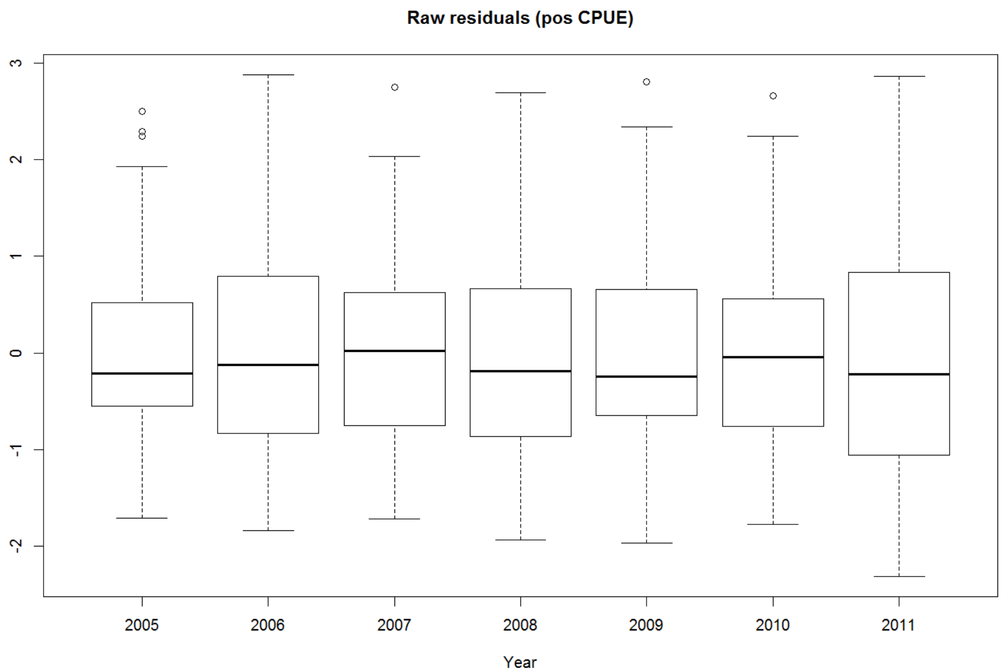


Figure 2. CPUE binomial residuals for year, party, season, area and dock to dock.



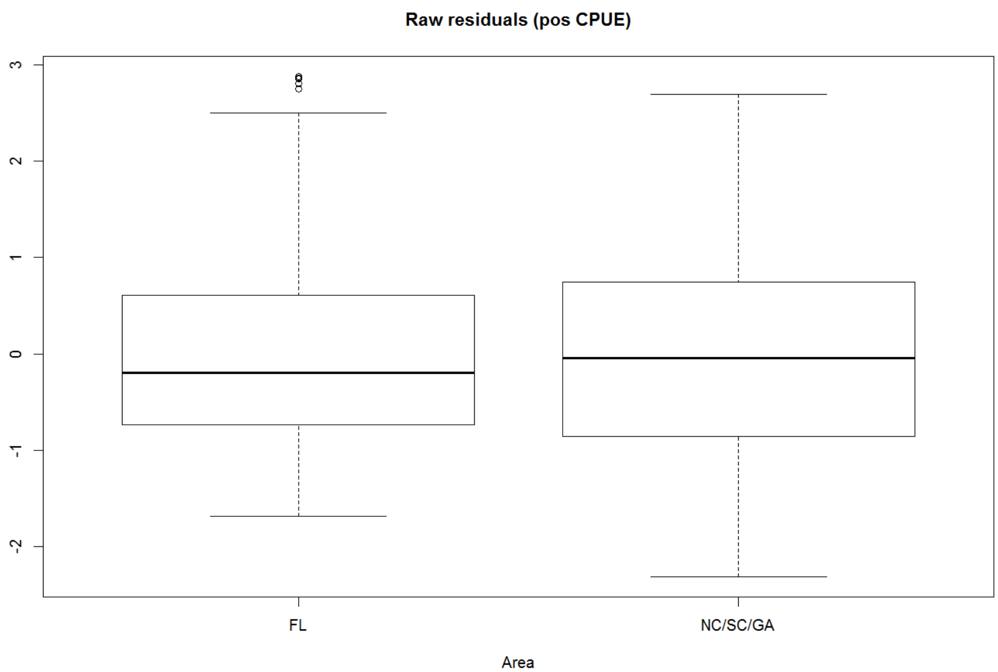



Figure 2. Continued.

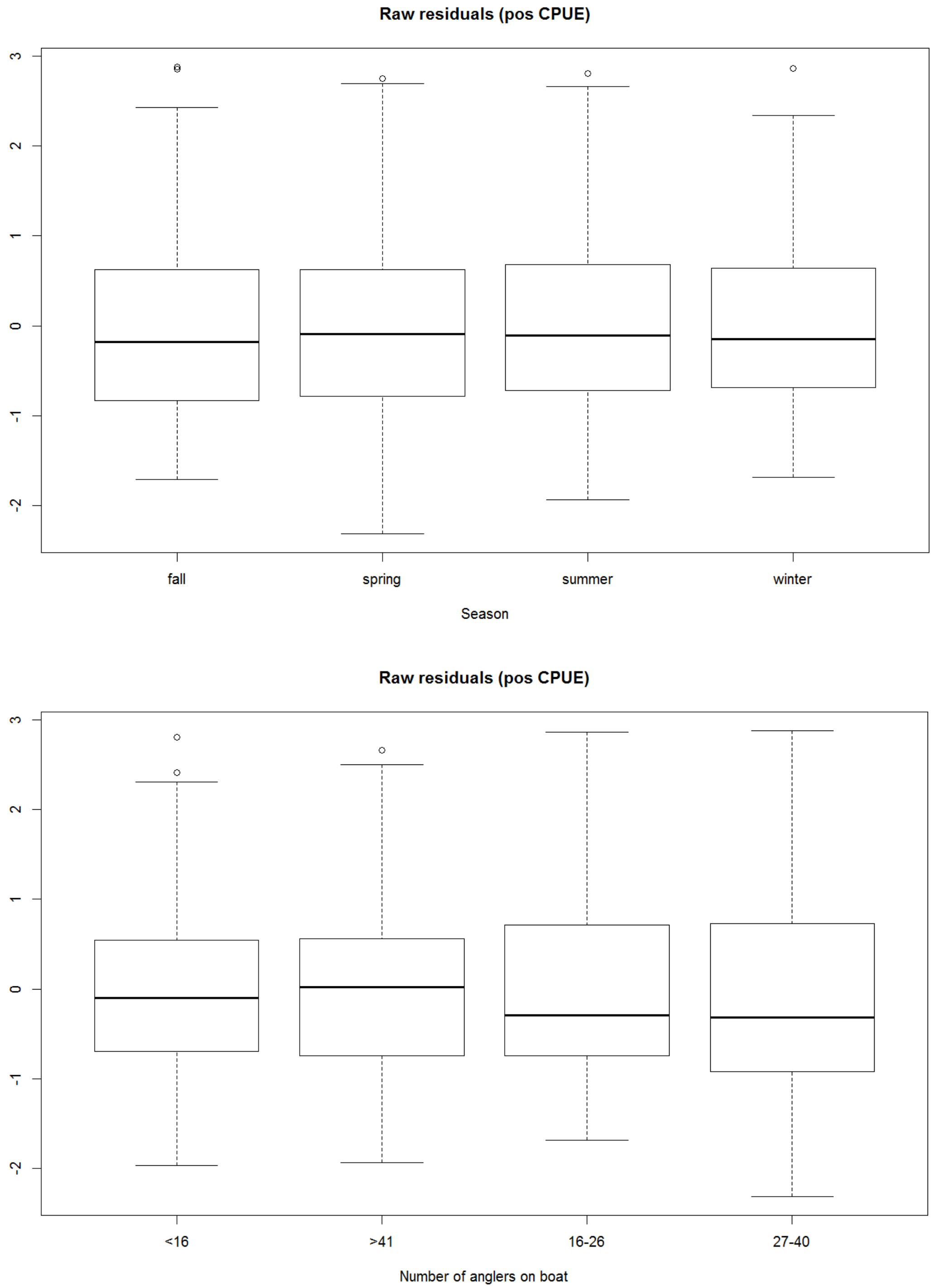


Figure 2. continued.

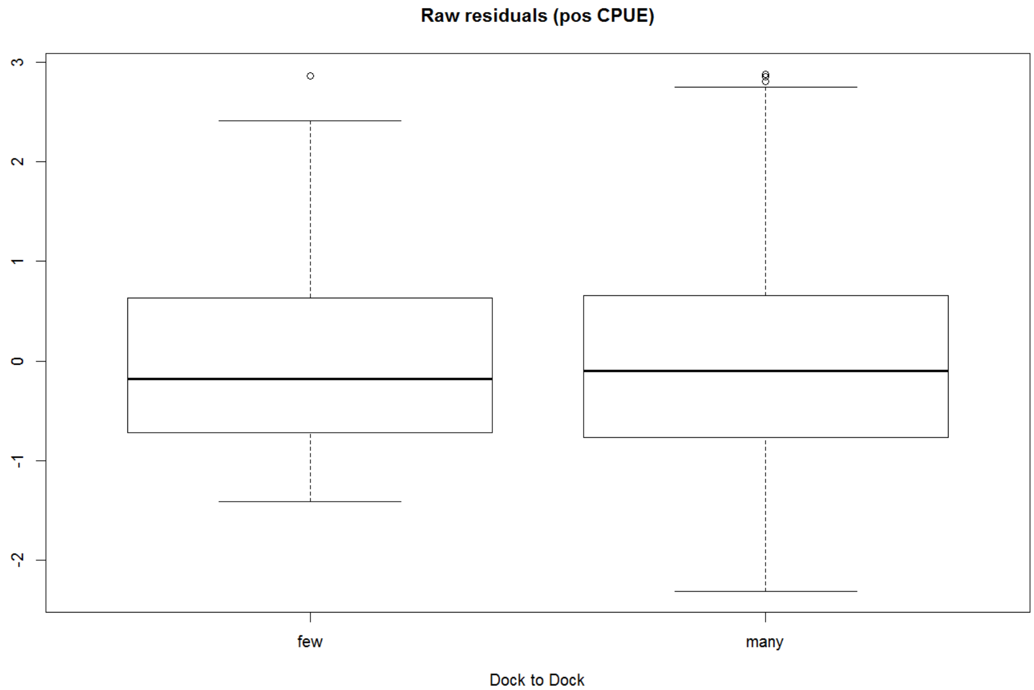


Figure 3. The distribution of log(catch) for the south Atlantic gray triggerfish headboat at-sea-observer program during 2005-2011.

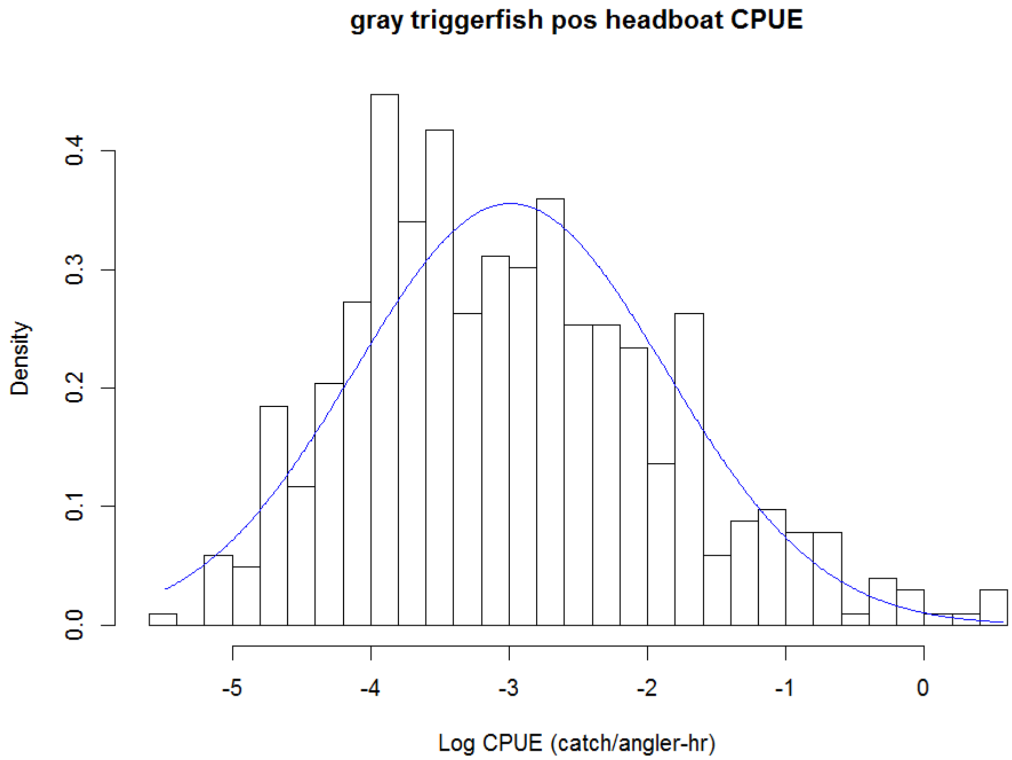



Figure 4.  QQ plot residuals for gray triggerfish CPUE.

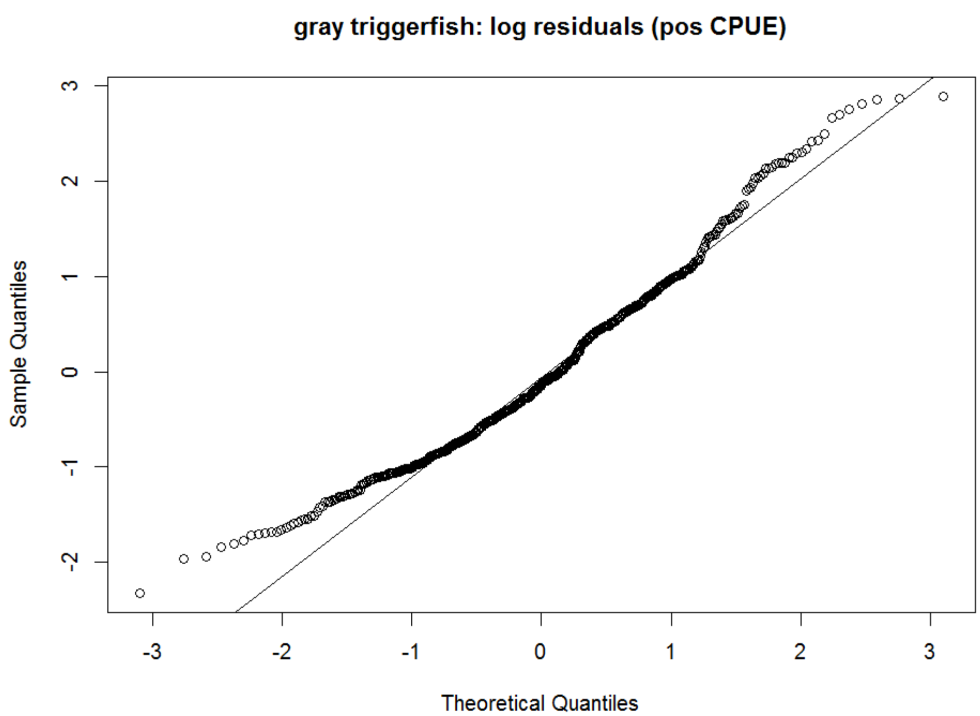
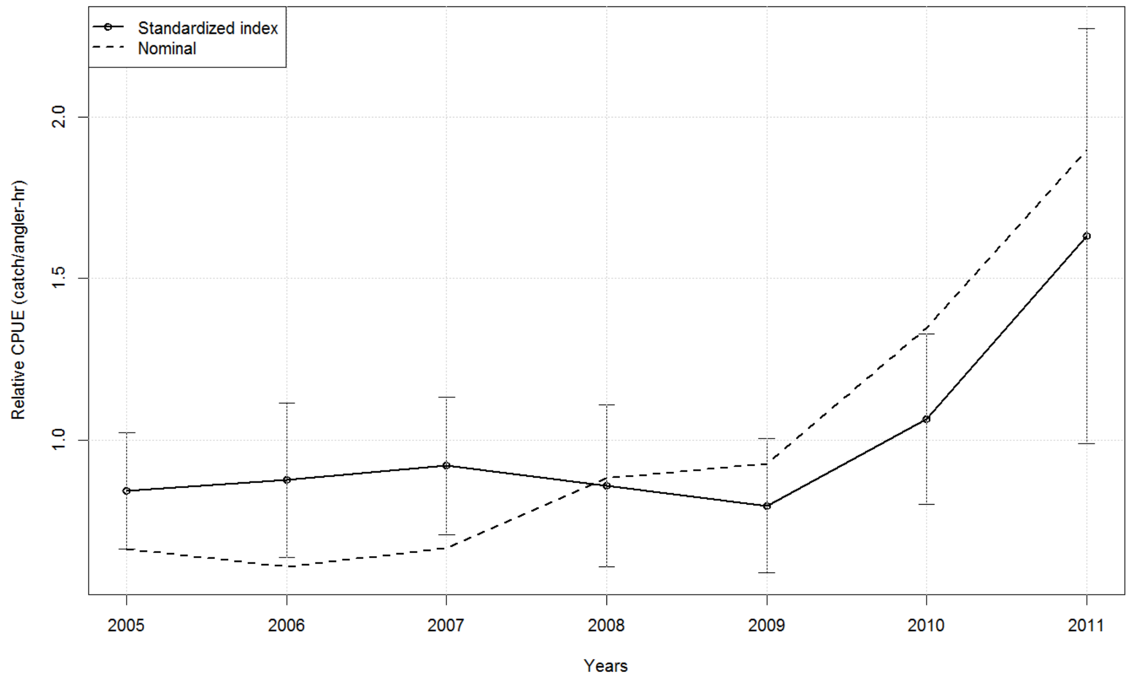
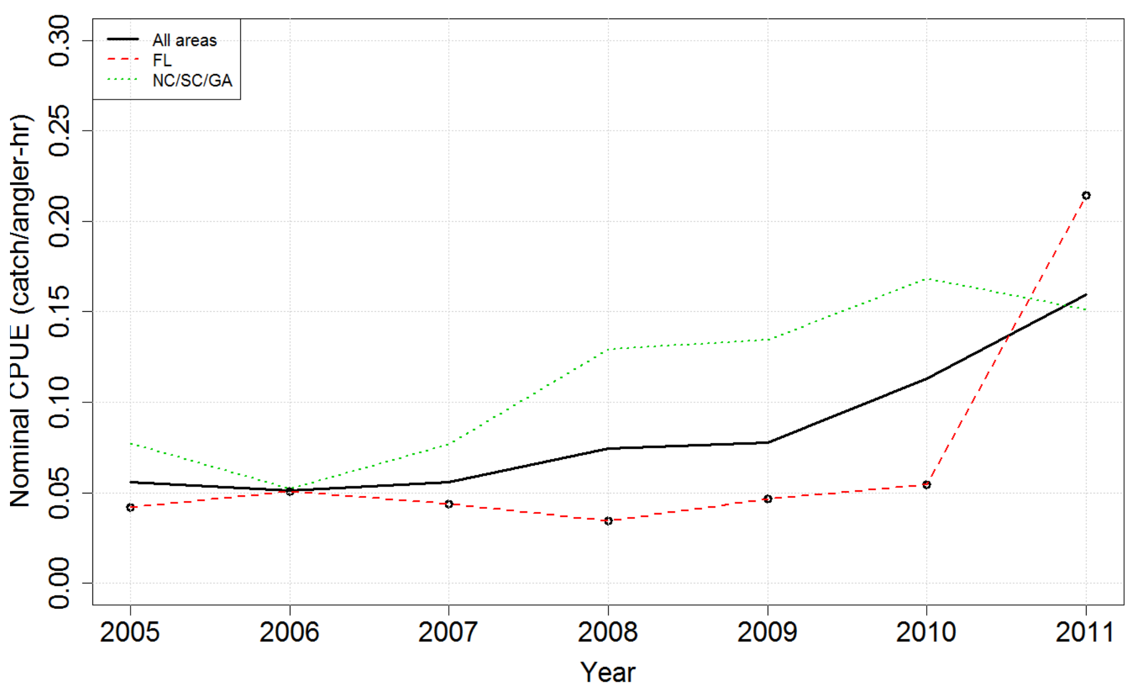


Figure 5. The standardized and nominal CPUE index with error bars at (+/-) 2 standard deviations (by area below) computed for gray triggerfish in the south Atlantic using the headboat at sea observer data during 2005-2011.



Appendix 1. The stepwise AIC output for the lognormal distribution (a), the gamma distribution (b) and AIC comparison (c).

a)

```
Start:  AIC=1488.49
log(cpue) ~ YEAR + flreg + season + party + dtd

        Df Deviance    AIC
<none>        511.83 1488.5
- season  3   520.19 1490.8
- dtd     1   516.57 1491.2
- YEAR    6   532.31 1496.7
- flreg   1   566.11 1538.3
- party   3   573.90 1541.3
```

b)

```
Start:  AIC=-1433.11
cpue ~ YEAR + flreg + season + party + dtd

        Df Deviance     AIC
- dtd     1   575.01 -1435.0
- season  3   584.93 -1433.8
<none>        574.84 -1433.1
- YEAR    6   631.77 -1415.3
- flreg   1   615.47 -1413.8
- party   3   633.07 -1408.6

Step:  AIC=-1434.94
cpue ~ YEAR + flreg + season + party
        Df Deviance     AIC
- season  3   585.20 -1435.5
<none>        575.01 -1434.9
- YEAR    6   636.08 -1414.5
- flreg   1   626.50 -1409.6
- party   3   635.05 -1409.1

Step:  AIC=-1430.36
cpue ~ YEAR + flreg + party
```

c)

```
gtf.gam1$aic
                [,1]
AIC.gamma -1439.365940
shape.mle     1.028841
> gtf.log1$aic
                   [,1]
AIC.lognormal -1580.858020
sigma.mle         1.010181
```