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Standardized catch rates of Southeast US Atlantic blueline tilefish (*Caulolatilus microps*) from headboat logbook data

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Abstract
Standardized catch rates were generated from the Southeast headboat survey trip records (logbooks) for 1980-1992. 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 blueline tilefish effort.

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 blueline tilefish on the catch record form for all south Altantic states. Prior to 1980, captains had to write in species in blanks provided on the form.

Exploratory Data Analysis

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

Blueline tilefish represent a small fraction of the overall catch in the south Atlantic headboat fishery (~1%). Data filtering steps were applied to the data to identify trips that likely had directed blueline tilefish effort. Table 1 summarizes all headboat trips and positive blueline

tilefish trips in the south Atlantic by year and area (North Carolina (NC), South Carolina (SC), Georgia-north Florida (GNFL), and south Florida(sFL).

Data Filtering Techniques

While exploring headboat data to develop a standardized index for blueline tilefish in the south Atlantic, multiple subsetting methods were investigated and discussed at the data workshop (Table 2).

Stephens & McCall
Applying methods described by Stephens & McCall (2004) to blueline tilefish resulted in a reduction in positive blueline tilefish trips. A large reduction in positive blueline tilefish trips and an inflation of zero blueline tilefish trips was anticipated due to the infrequency of blueline tilefish in the headboat fishery, therefore a more appropriate method was pursued.

Core Vessels
To identify headboat trips that best characterize the blueline tilefish fishery, vessels that consistently caught blueline tilefish were selected. A subset identifying data from <20 headboats representing 90% of blueline tilefish effort and landings was selected. This method proved problematic due to regional shifts in effort through time from South Carolina to south Florida. Another method was pursued.

Co-occurring species
In order to identify trips that fished in blueline tilefish habitat (deepwater) but did not catch blueline tilefish, an alternative method was investigated to identify these 'zero' trips. Trips that included a combination of either one, two or all of the following species (snowy grouper, yellowedge grouper and red porgy) but did not encounter a blueline tilefish were considered a blueline tilefish 'zero' trip. This method was problematic and was not pursued further.

Positive Trips
Headboat trips that caught blueline tilefish were investigated. This method underestimates the amount of effort directed at blueline tilefish in the headboat fishery by disregarding trips that were unsuccessful at catching blueline tilefish. This was the method recommended by the index working group.

Model Input

Response and explanatory variables

CPUE – catch per unit effort (CPUE) has units of fish/angler-hour and was calculated as the number of blueline tilefish caught divided by the number of anglers multiplied by the number of trip hours.

Year- A summary of the total number of trips with blueline tilefish effort per year and trips with positive blueline tilefish catch is provided in Table 1. Positive blueline tilefish trips after 1992

were very low and therefore removed from the analysis. Year included in the analysis were 1980-1992.

Trip Type- Trip types of half and full day trips were included in the analysis.

Area – These areas were pooled into two regions of North Carolina/South Carolina (NCSC=2,3,4,5,9,10) and Georgia/Florida (GNFL=6,7,8,11,12,17).
The total effort by year and area for blueline tilefish catch are provided in Figure 2.

Season – Due to low samples sizes by month the seasons were defined as season1 (January, February, March,April, May, June) and season2 (July, August, September, October, November, December).

Party – Two categories for the number of anglers on a boat were considered in the standardization process. The categories included: <=30 anglers and >30 anglers.

Standardization

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

POSITIVE CPUE SUBMODEL
To determine predictor variables important for predicting positive CPUE, 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).

With CPUE as the dependent variable, the lognormal distribution outperformed the gamma distribution with lower AIC values when all factors were included and when using only those factors that were selected in the previous step (Appendix 1).

Thus, the lognormal model with year, area and party was used for computing the index. Standard model diagnostics (Figures 3-5) appeared reasonable.

Index

The distribution of CPUE for the index appeared reasonable (Figure 4), as did the QQ plot of the residuals (Figure 5). The index is presented in Table 3 and visually in Figure 6.

LITERATURE CITED

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

Stephens, A., and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299-310.

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

Table 1. Positive blueline tilefish trips and blueline tilefish caught in the south Atlantic by year and zone (North Carolina (NC), South Carolina (SC), Georgia-north Florida (Ga/nFL) and south Florida (sFL).

	NC		SC		Ga/nFL		sFL		Total	
Year	N.trips	N.fish	N.trips	N.fish	N.trips	N.fish	N.trips	N.fish	N.trips	N.fish
1980	>10	>10	127	3083	7	82	46	459	192	3680
1981	13	131	32	441	10	188	22	125	77	885
1982	<10	>10	103	1375	<10	>10	8	16	120	1450
1983	<10	>10	107	1561	<10	>10	26	82	143	1716
1984	<10	>10	37	282			10	18	52	330
1985	<10	<10	61	478	<10	<10	10	17	73	498
1986	<10	<10	86	475			6	8	94	488
1987	<10	>10	58	340			16	54	77	411
1988	<10	<10	79	386	<10	<10	10	30	91	422
1989	<10	<10	47	231	<10	<10	22	139	71	377
1990	<10	<10	28	71	<10	<10	16	42	49	123
1991	<10	<10	>10	>10			22	108	42	181
1992			<10	>10			54	264	62	327
1993	<10	<10					11	94	>10	>10
1994			<10	>10			6	27	>10	>10
1995			<10	<10			8	54	<10	>10
1996			5	12			43	689	48	701
1997	<10	<10	<10	<10	<10	<10	7	48	12	55
1998	<10	<10	<10	<10			28	47	34	71
1999	<10	<10	<10	<10	<10	<10	6	14	11	20
2000			<10	<10			4	12	<10	>10
2001			<10	<10	<10	<10	8	39	>10	>10
2002			<10	<10	<10	<10	9	62	>10	>10
2003							<10	>10	<10	>10
2004	>10	>10					<10	>10	>10	>10
2005	<10	<10					5	21	<10	>10
2006	<10	>10					4	10	>10	>10
2007	>10	>10					<10	<10	>10	>10
2008	6	26	<10	<10			5	4	14	33
2009	>10	>10	<10	<10	<10	<10	5	7	19	23
2010	<10	<10					18	165	19	166
2011					<10	<10	75	2131	76	2132
Total	348	2957	1493	15649	>10	>10	522	4835	2398	23794

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

run	Progression leading to recommended index	Comments
1	1976-2011, Stephens & MacCall	no data from sFL until 1980 blueline tilefish was not listed on the logbook form until 1980 Stephens & MacCall method removed all positive trips for years 1992-2010 decided that sample sizes to small to include years 1992-2011
2	1980-1992, Stephens & MaCall	removed ~80% of positive trips
3	1980-1992, core vessel	problematic subsetting method due to shift in effort from SC to sFL in mid 1980s
4	1980-1992, positive trips + a priori zero trips	investigated alternative methods to identify unsuccessful blueline tilefish trips example: added zero trips that caught at least 5 snowy grouper problematic subsetting method
5	1980-1992, positive trips only	

Table 3. The relative nominal CPUE, number of trips, standardized index, and CV for the blueline tilefish headboat fishery in the south Atlantic.

Year	Relative nominal CPUE	N	Standardized index	CV (index)
1980	2.51	192	1.92	0.10
1981	1.82	77	1.79	0.16
1982	1.33	119	1.20	0.12
1983	1.43	143	1.39	0.11
1984	0.74	52	0.72	0.16
1985	0.80	73	0.67	0.14
1986	0.60	94	0.64	0.12
1987	0.47	77	0.92	0.13
1988	0.42	91	0.70	0.13
1989	0.68	71	0.75	0.14
1990	0.31	49	0.42	0.16
1991	0.58	42	0.67	0.16
1992	1.32	62	1.19	0.16

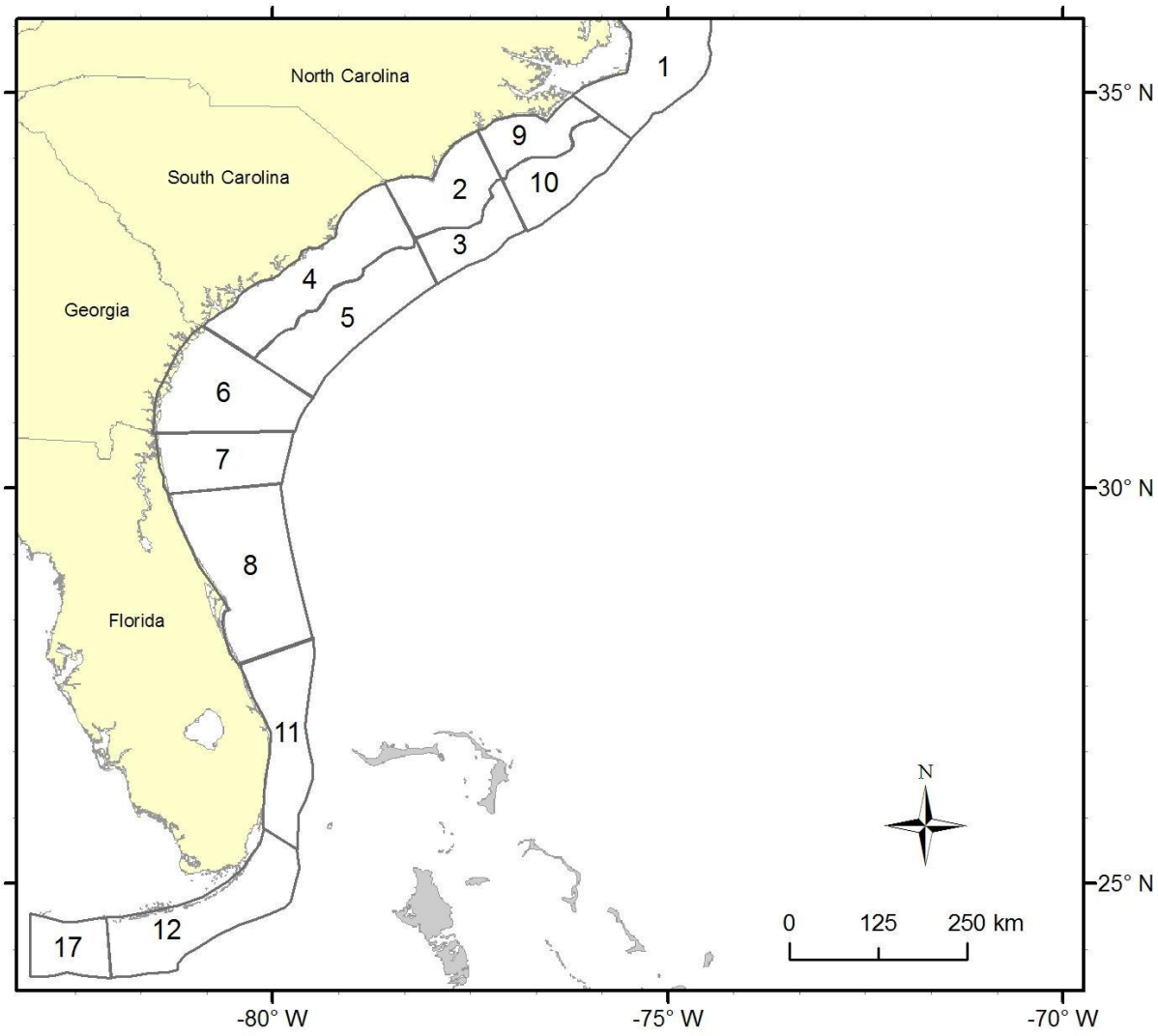


Figure 1. Map of headboat sampling area definition. These areas were pooled into regions of North Carolina, Georgia and South Carolina (NC/SC/GA=2,3,4,5,6,9,10), and Florida (FL=7,8,11,12,17).

Figure 2. Total effort with blueline tilefish by area.

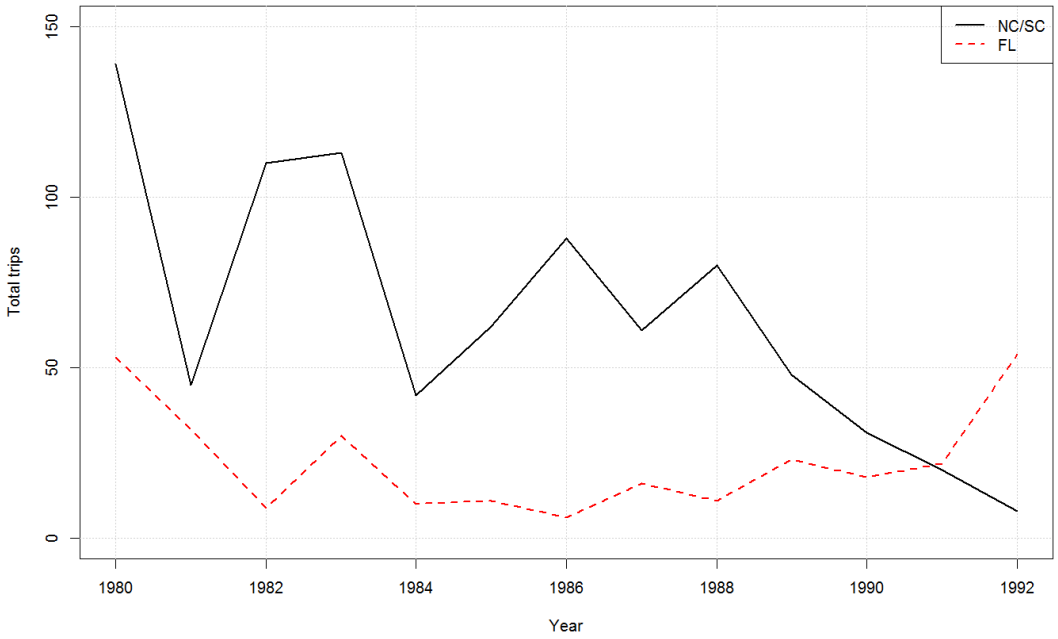
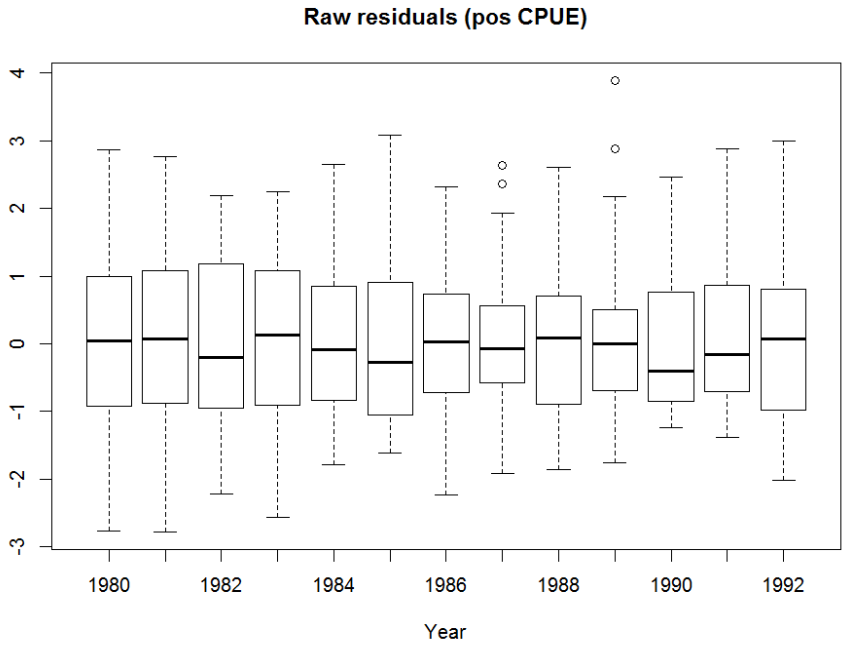


Figure 3. CPUE binomial residuals for year, area and party size.



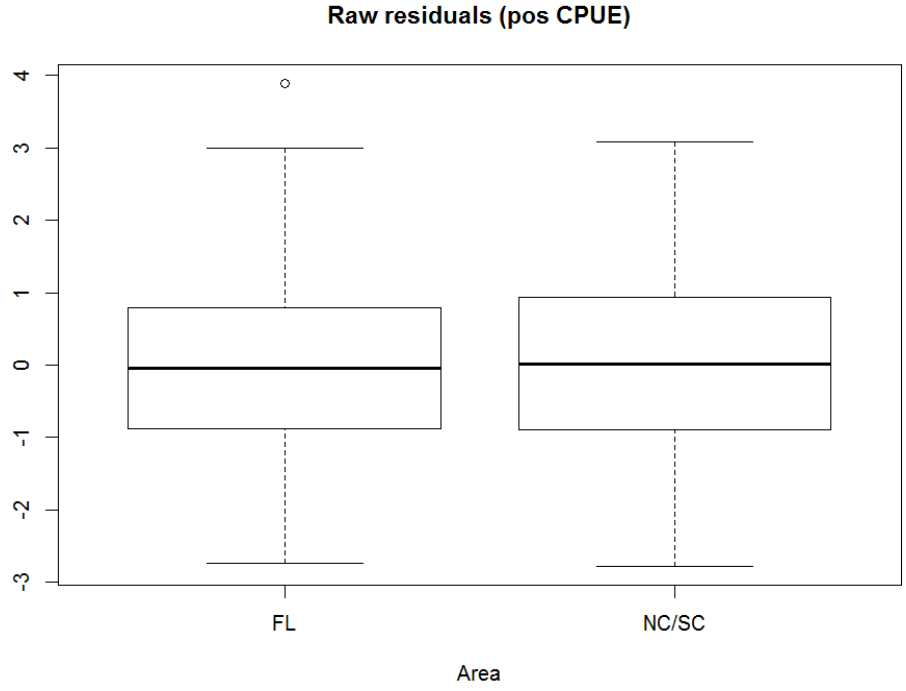


Figure 3. continued.

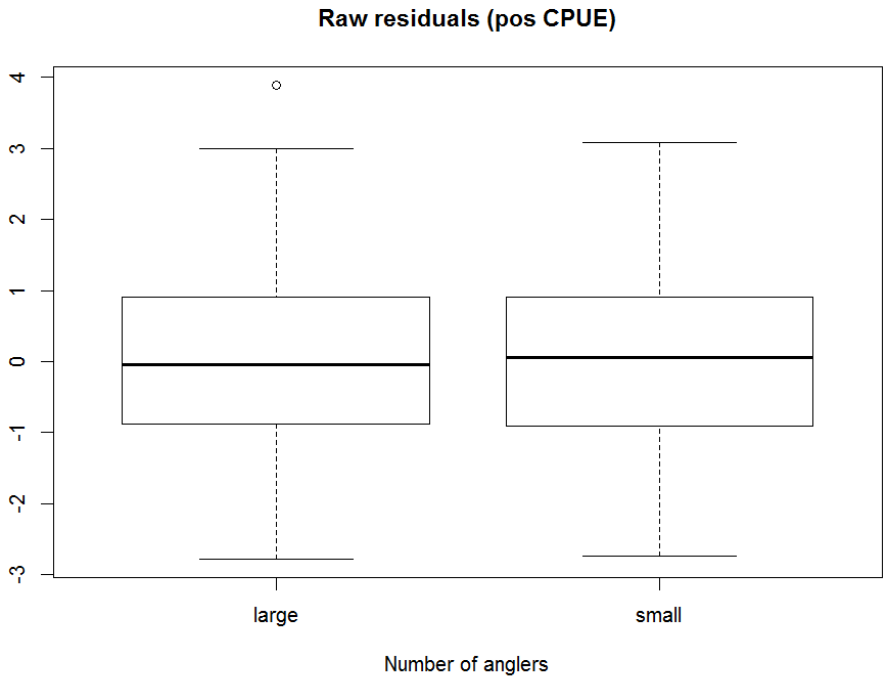


Figure 4. The distribution of catch for the south Atlantic blueline tilefish headboat logbook.

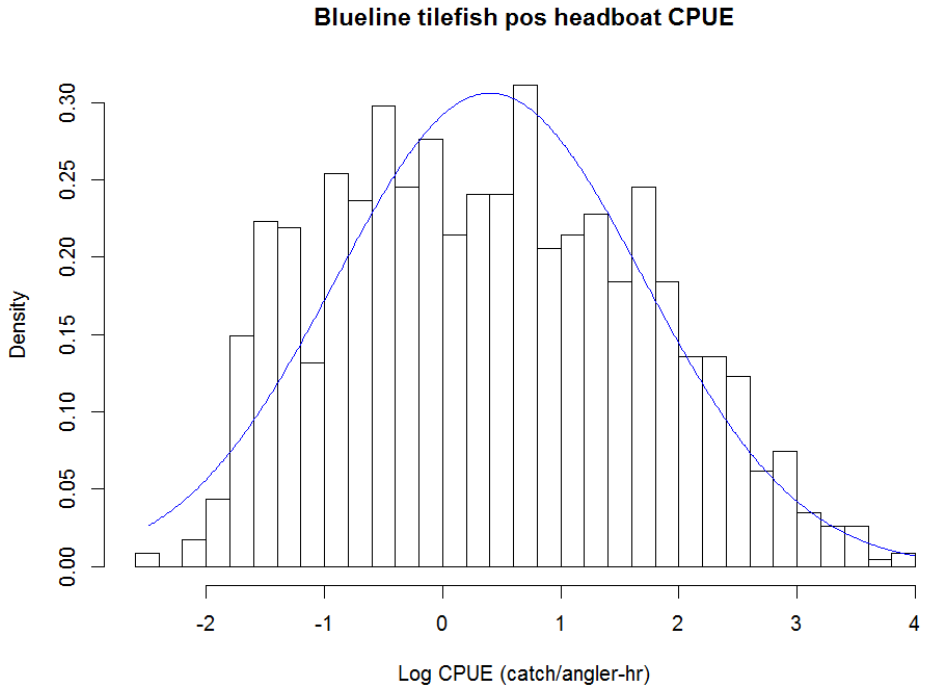


Figure 5. QQ plot residuals for CPUE.

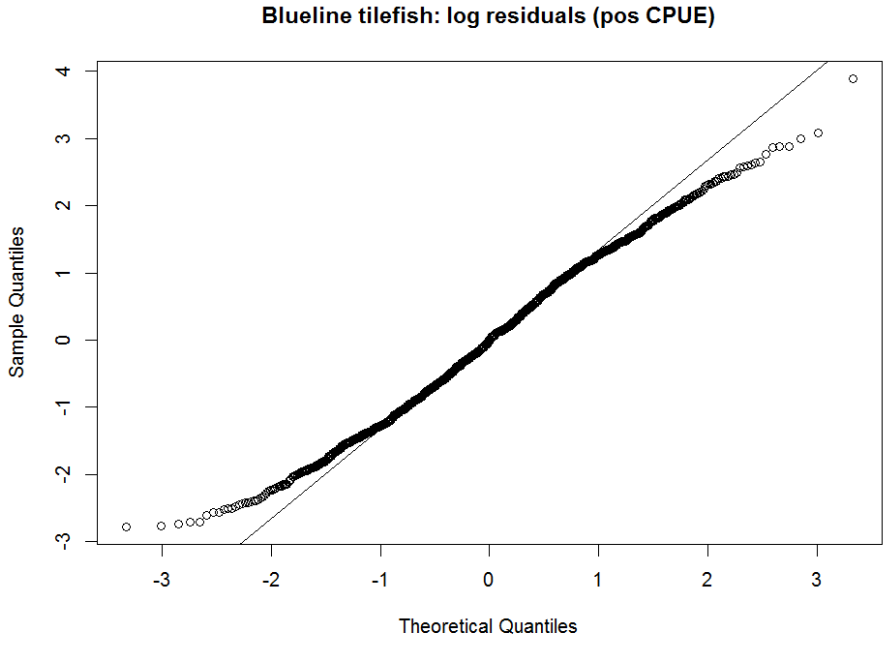
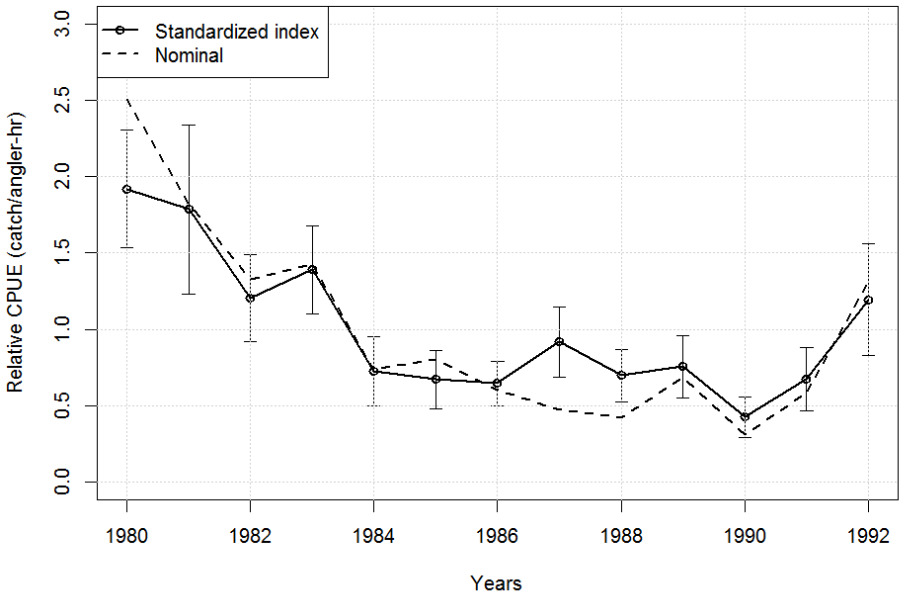
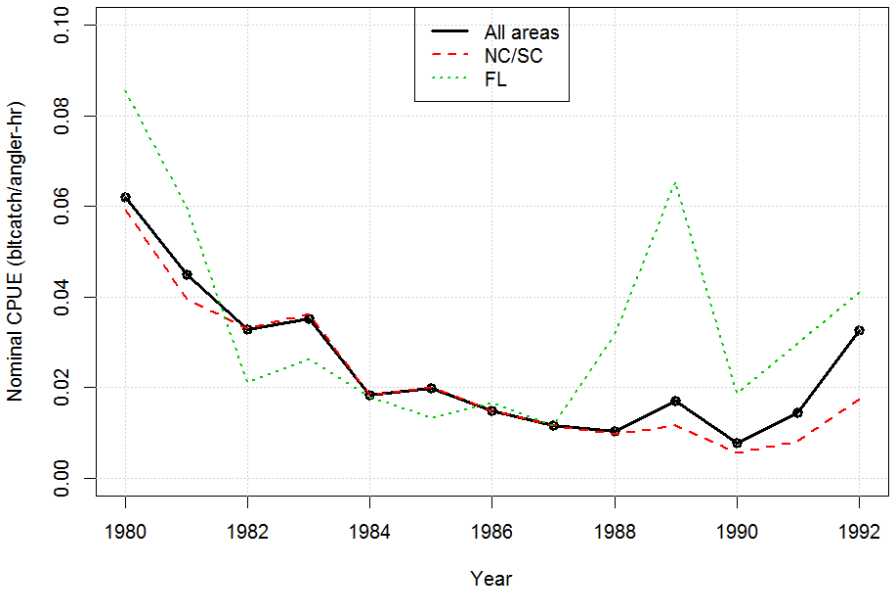


Figure 6. The standardized and nominal CPUE index with error bars at (+/-) 2 standard deviations (nominal by area below) computed for blueline tilefish in the south Atlantic using the headboat logbook data during 1980-1992.





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

a

```
Start:  AIC=3662.18
log(cpue) ~ year + area + season + anglers
        Df Deviance    AIC
- season   1   1603.4 3660.4
<none>         1603.1 3662.2
- area     1   1648.4 3692.0
- anglers  1   1683.1 3715.8
- year    12   1824.4 3785.8

Step:  AIC=3660.41
log(cpue) ~ year + area + anglers

        Df Deviance    AIC
<none>         1603.4 3660.4
- area     1   1648.6 3690.1
- anglers  1   1684.8 3714.9
- year    12   1824.5 3783.9
```

b

```
Start:  AIC=4768.13
cpue ~ year + area + season + anglers

        Df Deviance    AIC
- season   1   1529.4 4766.1
<none>         1529.4 4768.1
- area     1   1548.1 4775.9
- anglers  1   1602.3 4804.2
- year    12   1806.0 4888.5

Step:  AIC=4766.16
cpue ~ year + area + anglers

        Df Deviance    AIC
<none>         1529.4 4766.2
- area     1   1548.2 4773.9
- anglers  1   1602.5 4802.2
- year    12   1810.1 4888.5
>   pos.gamma.fit=glm.step
```

c)

```
blt.gam1$aic
                [,1]
AIC.binomial   30.0000000
AIC.gamma    4747.7150655
shape.mle       0.8759982
> blt.log1$aic
                [,1]
AIC.binomial    30.000000
AIC.lognormal 4576.412642
sigma.mle        1.184927
```