# Standardized catch rates of U.S. snowy grouper (Epinephelus niveatus) from commercial logbook longline data
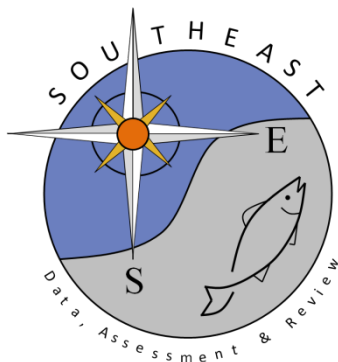
Sustainable Fisheries Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC (contact: Rob Cheshire)

## SEDAR36-WP-04

Submitted: 26 June 2013

Please cite this document as:

Sustainable Fisheries Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC. 2013. Standardized catch rates of U.S. snowy grouper (*Epinephelus niveatus*) from commercial logbook longline data. SEDAR36-WP04. SEDAR, North Charleston, SC. 14 pp.

# Notice on SEDAR Working Papers

# Standardized catch rates of U.S. snowy grouper (Epinephelus niveatus) from commercial logbook longline data

Sustainable Fisheries Branch, National Marine Fisheries Service,
Southeast Fisheries Science Center,
101 Pivers Island Rd, Beaufort, NC 28516

June 2013

## 1. Introduction

Landings and fishing effort of commercial vessels operating in the southeast U.S. Atlantic have been monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects information about each fishing trip from all vessels holding federal permits to fish in waters managed by the Gulf of Mexico and South Atlantic Fishery Management Councils.  Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal fisheries, and since then has maintained the objective of a complete census of federally permitted vessels in the southeast U.S.

Catch per unit effort (CPUE) from the logbooks was used to develop an index of abundance for snowy grouper landed with bottom longlines.  Thus, the size and age range of fish included in the index is the same as that of landings from this same fleet.  The time series used for construction of the index spanned 1993−2005, when all vessels with federal snapper-grouper permits were required to submit logbooks on each fishing trip. The trips from 2006-2011 were excluded due high percentage of trips that met the trip limit beginning in 2006 when the trip limit was reduced from 2500 pounds gutted weight to 275 pounds gutted weight (Figure 1).

## 2. Data and treatment

2.1 Available Data
For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings (reported fields described in Appendix 1). Fishing effort data available for longline gear included number of lines fished and number of hooks per line.  The number of hours fished is inconsistently reported for longline gear and not recommended for use in effort calculations.  For this southeast U.S. Atlantic stock, areas used in analysis were those between 24 and 37 degrees latitude, inclusive of the boundaries (Figure 2).

Data were restricted to include only those trips with landings and effort data reported within 45 days of the completion of the trip (some reporting delays were longer than one year). Reporting delays beyond 45 days likely resulted in less reliable effort data (landings data may be reliable even with lengthy reporting delays if trip ticket reports were referenced by the reporting fisher).  Also excluded were records reporting multiple areas or gears fished, which

prevents designating catch and effort to specific locations or gears. Therefore, only trips which reported one area and one gear fished were included in these analyses.

Clear outliers in the data, e.g. values falling outside the 99.5 percentile of the data, were also excluded from the analyses. These outliers were identified for commercial longline as records reporting more than 28 lines fished, 4000 hooks per line fished, 15 days at sea, or 8 crew members.

## 3. Standardization

The response variable, CPUE, was calculated for each trip as,

CPUE = pounds of snowy grouper/hook

where hook is the product of number of lines fished and the number of hooks per line. Explanatory variables, all categorical, are described below. Estimates of variance were based on 1000 bootstrap runs where trips were chosen randomly with replacement. The samples chosen for the bootstrap runs were equal to the number of trips each year (e.g. If the sample size for 1997 was 83 trips, 83 samples were drawn with replacement from the 1994 subset of the data). All analyses were programmed in R All analyses were programmed in R, with much of the code adapted from Dick (2004).

3.1 Explanatory variables considered
YEAR — Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993−2004. The total number of snowy grouper trips by year is provided in Table 1.

SEASON — Four seasons were considered in the model with the months pooled as Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Nov. The number of trips per year by season is provided in Table 2.

REGION — Two regions, NC-SC and GA-FL, were considered as an explanatory variable. The number of trips per year by season is provided in Table 3.

CREW SIZE — Crew size (crew) was pooled into two levels: one to two (1-2), and three or more (3plus). The number of trips per year by crew is shown in Table 4.

DAYS AT SEA — Days at sea (sea days) were pooled into four levels: one or three days (1-3), four to six days (4-6), seven to nine days (7-9), and ten or more days (10plus). The number of trips per year by sea days is shown in Table 5.

3.2 Positive CPUE model
Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. The gamma model did not converge. For the lognormal distribution, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables

and Ripley, 1997) with both  forward and backward algorithm was used to eliminate those variables that did not improve model fit.   The best model (lognormal) fit included all explanatory variables (Table 6).  Diagnostics suggested reasonable model fit (Figures 3 and 4).

## Results

There is significant uncertainty in the estimated index due to the small sample size.  (Figure 5, Table 1).  There is no evidence in a trend in CPUE over the 1993-2005 period.  The nominal index for each of the regions differ drastically (Figure 6).   Some of the factors considered are unbalanced in 2005 due to small sample size and likely shifts in effort.  The large change in the standardized from the nomial CPUE in 2005 is most likely a result of the unbalanced data.  For these reasons, the DW and AW panel recommended the commercial longline index was inadequate for use in the stock assessment of snowy grouper.

## Literature cited

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


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.

Tables

Table 1.  Standardized index of snowy grouper from commercial logbook longline data.

| Year | N | Relative nominal | Standardized CPUE | CV |
|------|-----|------|------|------|
| 1993 | 100 | 0.97 | 1.31 | 0.15 |
| 1994 | 119 | 0.43 | 0.51 | 0.14 |
| 1995 | 110 | 1.96 | 1.05 | 0.19 |
| 1996 | 78  | 0.42 | 0.50 | 0.20 |
| 1997 | 118 | 0.80 | 1.37 | 0.14 |
| 1998 | 68  | 1.67 | 0.95 | 0.24 |
| 1999 | 112 | 0.93 | 1.22 | 0.17 |
| 2000 | 157 | 1.93 | 0.78 | 0.17 |
| 2001 | 142 | 0.68 | 0.88 | 0.13 |
| 2002 | 100 | 0.79 | 0.90 | 0.15 |
| 2003 | 86  | 0.72 | 1.05 | 0.19 |
| 2004 | 59  | 0.86 | 0.62 | 0.22 |
| 2005 | 23  | 0.83 | 1.84 | 0.21 |

Table 2.  Number of positive snowy grouper commercial longline trips by year and season.

| Year | Jan-Mar | Apr-Jun | Jul-Sep | Oct-Dec |
|------|------|------|------|------|
| 1993 | 10 | 43 | 35 | 12 |
| 1994 | 35 | 39 | 29 | 16 |
| 1995 | 27 | 31 | 26 | 26 |
| 1996 | 14 | 25 | 24 | 15 |
| 1997 | 22 | 39 | 34 | 23 |
| 1998 | 16 | 36 | 10 | 6 |
| 1999 | 20 | 30 | 24 | 38 |
| 2000 | 24 | 55 | 50 | 28 |
| 2001 | 28 | 49 | 43 | 22 |
| 2002 | 23 | 36 | 25 | 16 |
| 2003 | 14 | 30 | 21 | 21 |
| 2004 | 17 | 19 | 9 | 14 |
| 2005 | 2 | 3 | 10 | 8 |

Table 3. Number of positive snowy grouper commercial longline trips by year and region.

| Year | NC-SC | GA-FL |
|------|-------|-------|
| 1993 | 26 | 74 |
| 1994 | 59 | 60 |
| 1995 | 58 | 52 |
| 1996 | 37 | 41 |
| 1997 | 79 | 39 |
| 1998 | 44 | 24 |
| 1999 | 41 | 71 |
| 2000 | 50 | 107 |
| 2001 | 51 | 91 |
| 2002 | 60 | 40 |
| 2003 | 49 | 37 |
| 2004 | 35 | 24 |
| 2005 | 21 | 2 |

Table 4. Number of positive snowy grouper trips by crew size and year.

| Year | 1-2 | 3-plus |
|------|-----|--------|
| 1993 | 64 | 36 |
| 1994 | 48 | 71 |
| 1995 | 33 | 77 |
| 1996 | 36 | 42 |
| 1997 | 51 | 67 |
| 1998 | 27 | 41 |
| 1999 | 67 | 45 |
| 2000 | 82 | 75 |
| 2001 | 81 | 61 |
| 2002 | 46 | 54 |
| 2003 | 39 | 47 |
| 2004 | 20 | 39 |
| 2005 | 5 | 18 |

Table 5.  Number of positive snowy grouper trips by days at sea and year.

| Year | 1-3 | 4-6 | 7-9 | 10-plus |
|------|-----|-----|-----|---------|
| 1993 | 37 | 41 | 19 | 3 |
| 1994 | 26 | 50 | 33 | 10 |
| 1995 | 26 | 54 | 23 | 7 |
| 1996 | 20 | 43 | 11 | 4 |
| 1997 | 25 | 37 | 42 | 14 |
| 1998 | 13 | 26 | 20 | 9 |
| 1999 | 22 | 44 | 39 | 7 |
| 2000 | 35 | 64 | 42 | 16 |
| 2001 | 30 | 55 | 43 | 14 |
| 2002 | 22 | 30 | 34 | 14 |
| 2003 | 15 | 26 | 25 | 20 |
| 2004 | 10 | 11 | 26 | 12 |
| 2005 | 4 | 4 | 7 | 8 |

Table 6. Model selection results from lognormal model.

| Removed | Df | Deviance | AIC |
|---------|-----|----------|-----|
| None | | 142.9 | 868.91 |
| Crew | 1 | 142.8 | 870.06 |
| Region | 1 | 142.9 | 870.84 |
| Days at sea | 3 | 143.8 | 870.97 |
| Season | 3 | 144.2 | 875.37 |
| Year | 12 | 146.5 | 876.66 |

Figures

Insert Figure 1.  Commercial longline snowy grouper trips per year (right axis), associated trip limits which dropped from 2500 to 275 gutted pounds in 2006 (right axis), and the proportion of the trips at or above 90% of the trip limit (left axis).
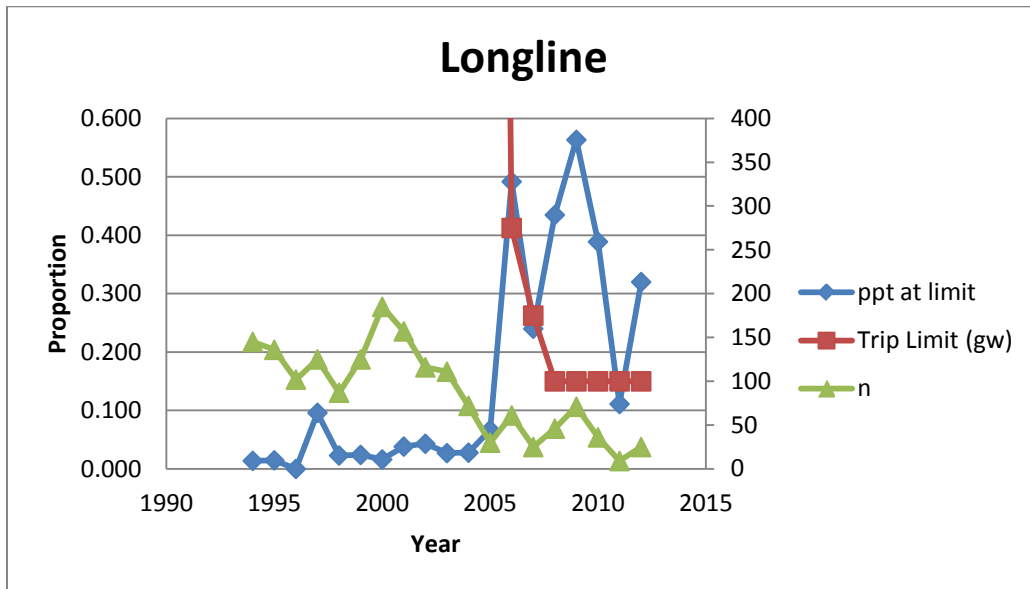
Figure 2. Commercial longline trips (left panel) and positive snowy grouper commercial longline trips (right panel). The red symbols represent the areas that combined signify fifty percent of the total trips, the red and green circles combined represent seventy-five percent of the total trips, the red, green, and yellow symbols combined represent ninety-nine percent of the total trips, and the gray symbols represent one percent of the trips. The area south of 37 degrees latitude were included in this analysis (solid horizontal red lines).
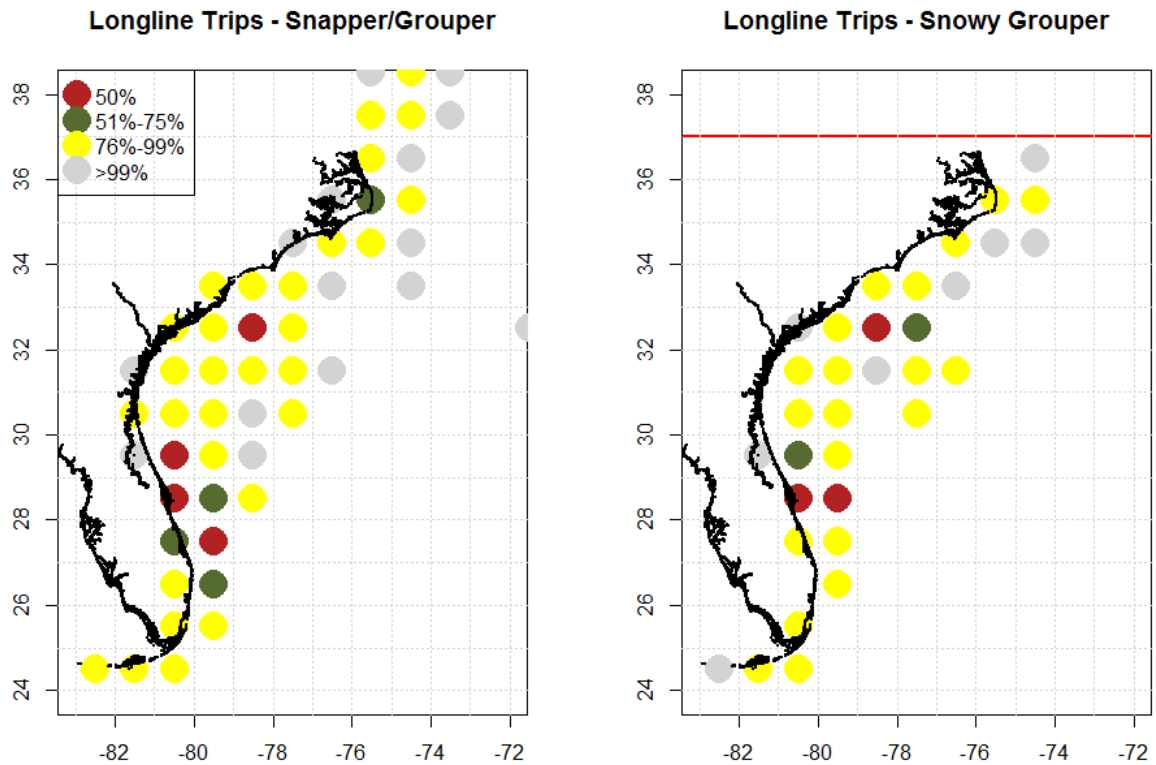
Figure 3. Diagnostics of lognormal model fits to positive CPUE data. Top panel shows the histogram of empirical log CPUE, with the normal distribution (empirical mean and variance) overlaid. Bottom panel shows the quantile-quantile plot of residuals from the fitted model.
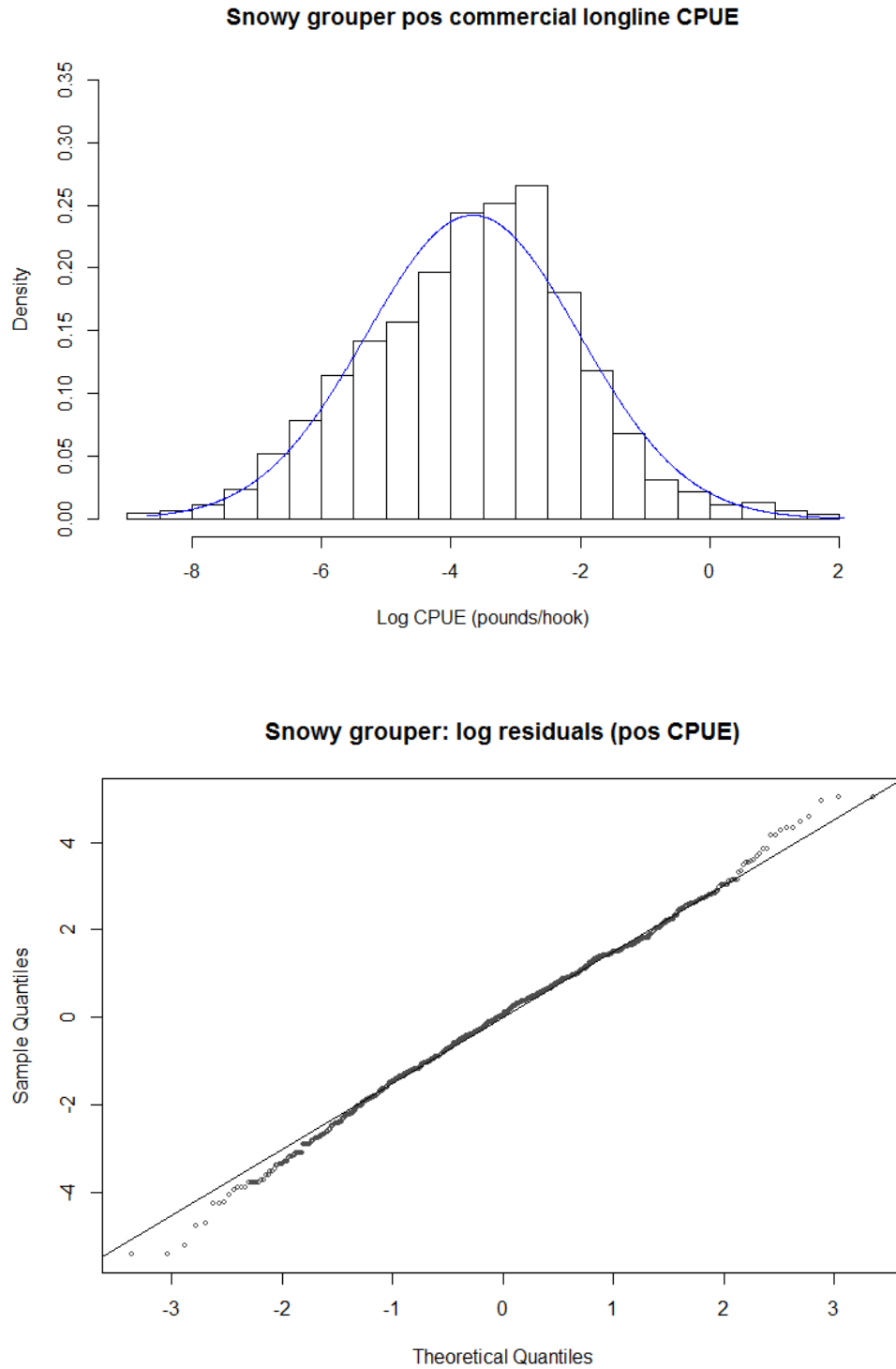


Snowy grouper pos commercial longline CPUE



Snowy grouper: log residuals (pos CPUE)

Figure 4. Diagnostics of lognormal model fits to positive CPUE data. Box-and-whisker plots give first, second (median), and third quartiles, as well as limbs that extend approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.
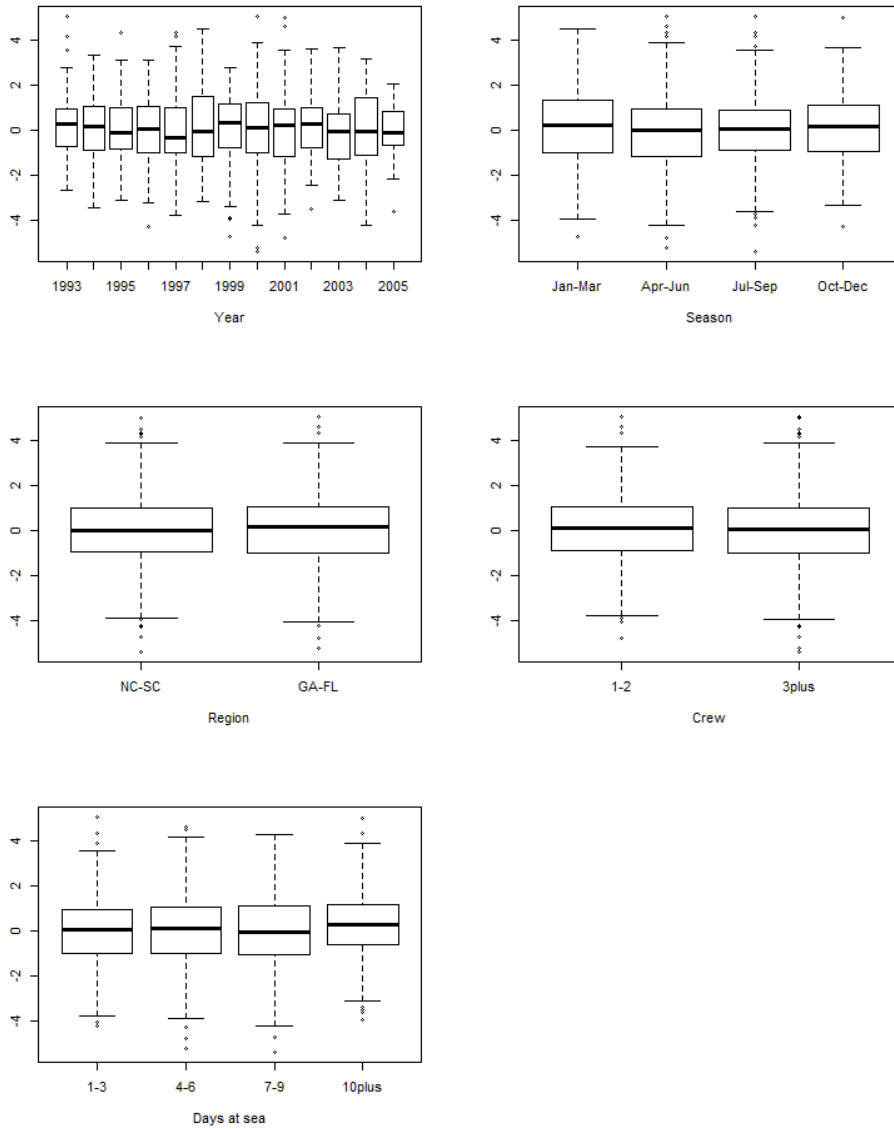
Figure 5.  Snowy grouper standardized CPUE and nominal CPUE from commercial longline logbooks.
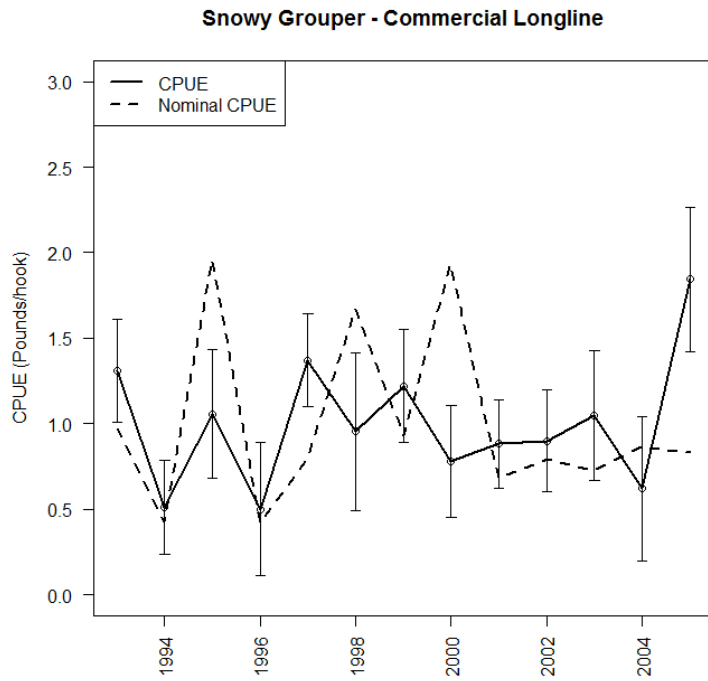


Figure 6.  Snowy grouper nominal CPUE by region from commercial longline logbooks.