

# Standardized catch rates of gray triggerfish (*Balistes capriscus*) in the southeast U.S. from commercial logbook data

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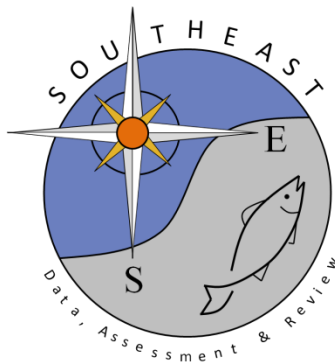
SEDAR41-DW20

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Addendum: 29 August 2014

**\*Addendum added to reflect changes made during 2014 Data Workshop.**

Updated to correct coding error: 30 July 2015



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## **Standardized catch rates of gray triggerfish (*Balistes caprisкус*) in the southeast U.S. from commercial logbook data**

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**Ammended July 2015**

(see Addendum, Tables 4–6, and Figures 16–24)

### **1.1 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 gray triggerfish landed with vertical lines (manual handline and electric reel), the dominant gear for this gray triggerfish stock (Tables 1 and 2). 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 started 1993 when all vessels with federal snapper-grouper permits were required to submit logbooks on each fishing trip. The terminal year of the index will be discussed at the SEDAR 41 DW. For this southeast U.S. Atlantic stock, areas used in analysis were those between 24 and 37 degrees latitude, inclusive of the boundaries (Figure 1).

### **1.2 Commercial Diving and Trap**

The CFLP diving and trap data were considered and rejected due to small sample sizes and limited spatial coverage (Tables 1 and 2, Figures 2 and 3).

### **1.3 Commercial Handline**

#### **1.3.1 Data filtering**

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). Fishing effort data available for vertical line gear included number of lines fished, hours fished, and number of hooks per line.

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). This restriction excluded approximately 24% of the full data set (i.e., the data set with all gears and all areas, including Gulf of Mexico). Also excluded were records reporting multiple gears fished, which prevents designating catch and effort to specific gears. Therefore, only trips which reported one gear fished were included in these analyses. For records where more than one area was reported, the first area reported was used to determine the latitude associated with the trip.

Clear outliers in the data used as factors in the model or to calculate cpue were excluded from the analyses. Outliers were defined as values falling outside the 99.5 percentile of the data. For trip-level data (crew, days at sea, hours fished, number of lines, and number of hooks per line) all snapper-grouper trips were evaluated instead of the positive gray triggerfish trips as in SEDAR 32 (Table 3). For hours fished, both upper and lower outliers were removed. Outliers related to CPUE for positive gray triggerfish trips were removed (Table 3).

The analysis of data from the Coastal Fisheries Logbook Program (CFLP) was completed through 2011 in SEDAR 32 for handline gear (electric and manual reels combined) using only positive trips.

### 1.3.2 Explanatory variables considered

**YEAR** - Year was necessarily included, as standardized catch rates by year are the desired outcome. The total number of gray triggerfish trips by year is provided in table 1 and catch per year is provided in table 2.

**SEASON** - Season included four levels: winter (January-March), spring (April-June), summer (July-September), and fall (October-December). The relative number of trips per month is shown in figure 4. The annual cpue associated with each season is given figure 5.

**AREA** - Area (latitude) is reported in the logbook on a one degree grid (Figure 1). For SEDAR 41, we propose keeping the data at the level it was collected with the exception of pooling the latitudes at the fringe of the range. Pooling latitudes 24 to 29 to 29 degrees and 34 to 38 to 34 degrees (Figure 4). This pooling gives 1000 to 2000 trips per latitude bin. Other methods for pooling areas were considered including quantiles. However, these methods require assigning latitude bins with large sample size to pooled bins when the geographical boundary (e.g. states) or quartile value falls in the middle of a latitude bin. The annual cpue associated with each latitude is given figure 6.

**DAYS AT SEA** - 'Days at sea' were pooled into three levels: one to two days, three to four days (twotofour), and five or more days (fiveplus). The relative number of trips per year by days at sea is shown in Figure 4. The annual cpue associated with days at sea is given figure 7.

**CREW SIZE** - Crew size (crew) could influence the total effort and could be a psuedo-factor for vessel size. The quantile split values (at 25, 50, and 75%) for gray triggerfish crew size fall at 2, 2, and 3 crew per trip. Therefore crew size was pooled more subjectively into three levels: one (one), two (two), and three or more days (threeplus). The relative number of trips in each level is given in figure 4. Trips with one crew member were not pooled even though the relative sample size is small because it is believed there would be a significant difference trip efficiency between a crew size of one and two. The annual cpue associated with crew size is given figure 8.

### 1.3.3 Response variable (CPUE) data considerations

The distribution of positive gray triggerfish trips generally showed a maximum off NC and SC declining further South (Figure 9). The trend in CPUE matches the trend in positive catch except for an increase in CPUE south of Cape Canaveral, FL (Figure 10). This may partially be explained by much shorter trips in South Florida on average. Fishermen are known to target other species at night on multi-day trips and this effort is counted towards the total effort for the trip.

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

CPUE = pounds of gray triggerfish/hook-hours

where hook-hours is the product of number of lines fished, number of hooks per line, and total hours fished. Spatio-temporal trends were examined for cpue and each of its components (Figures 11 – 10).

## 1.4 Objectives for SEDAR 41 Data Workshop

- Approve or modify proposed factors and factor definitions
- Discuss other possible factors (fuel price index, lunar phase) if time permits
- Approve or modify cpue definition
  - Discuss possible issue with correlation between cpue denominator component, hours fished, and days at sea factor (Figure 15)
- Discuss filtering (Stephens and MacCall method)
  - The Stephens and MacCall approach was not used SEDAR 32 because of the large number of positive trips dropped from the analysis. The Stephens and MacCall approach is problematic for habitats with many correlated species. Trips that have split effort among habitats or modified fishing behavior (hook size or bait size) within a trip exacerbate the problem because species assemblages become nonsense. For these reasons we propose running a GLM on positive gray triggerfish trips for SEDAR 41.
- Run GLM based on DW decisions regarding data and factors
- Estimate uncertainty
- Update working paper and provide text, figures, and research recommendations for the SEDAR 41 DW report

## Addendum

### 1.5 Workgroup decisions and justifications

- The proposed factors and definitions were accepted by the panel.
- The terminal year for the model was discussed with input from commercial and headboat fishermen. Commercial fishermen described a shift in effort away from red snapper habitat and towards black sea bass, vermilion, and gray triggerfish habitat in 2010 when red snapper closed. In addition, the shallow-water grouper spawning closure and other species closures since 2009 limit the use of the Stephens and MacCall (2004) approach for identifying effective effort. For these reasons the series was terminated in 2009.

- Lunar phase and a fuel price index were discussed briefly. Lunar phase can be calculated for each trip and might be of possible use after further investigation but was not recommended for inclusion in SEDAR 41. It was not clear how annual fuel price index would be incorporated and would be currently be absorbed in the year effect.
- The "days at sea" factor correlation with the hours fished which is a component of the CPUE denominator was discussed. The "days at sea" factor was binned into 3 categories. The workgroup did not have a concern that the correlation would influence the model.
- The use of the Stephens and MacCall approach was discussed and the panel felt, even though there are caveats with the method, it is still the best method to define effective effort. The Stephens and MacCall method of determining species association based on presence–absence of both target and predictor species was evaluated. In addition the species association was evaluated using presence-absence of the target species and the catch of the predictor species. The species and distribution of species associations were very similar. However, there was some concern that trip limits might influence the regression coefficients when using catch as a predictor. The group also evaluated a positive-only model with the notion that if it agreed well with the Stephens and MacCall approach, it could be extended through 2011 (last year without gray triggerfish closures). Overall the positive-only model dampened the peaks in the index and was not considered after the targeting issues were revealed starting in 2010. The Stephens and MacCall approach was recommended through 2009.

## 1.6 Subsetting

Effective effort was based on those trips from areas where gray triggerfish were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred, which was done here using the method of Stephens and MacCall (2004). The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Because a zoogeographic boundary is apparent near Cape Canaveral (Shertzer et al. 2009), the method was applied separately to data from regions north and south of 29 degrees latitude (near Cape Canaveral). To avoid undue influence of rare species on regression estimates, species included in each analysis were limited to those occurring in 1% or more of trips. Red porgy was also omitted because of strict harvest regulations since 1999 (including a temporary moratorium), which creates the potential for erroneously removing trips likely to have caught gray triggerfish during years of red porgy restrictions. A backwards stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables, where the most general model included all listed species as main effects. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of gray triggerfish in each trip to presence/absence of other species. For the northern sampling area (NC, SC, GA, north FL), stepwise AIC eliminated mutton snapper and sand tilefish; for the southern sampling area (south FL), it eliminated black grouper and almaco jack. Regression coefficients of included species for the northern sampling areas are shown in Figure 16, and for the southern areas in Figure 17. A trip was then included if its associated probability of catching gray triggerfish was higher than a threshold probability (Figures 18, 19). The threshold was defined to be that which resulted in the same number of predicted and observed positive trips, as suggested by Stephens and MacCall (2004). After applying the Stephens and MacCall method, and the constraints described above, the resulting data set contained 20,592 trips in the northern sampling areas, of which 79% were positive, and 2,158 trips from the southern sampling area, of which 17% were positive.

## 1.7 Standardization

CPUE was modeled using the delta-GLM approach (Lo et al. 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).

### **1.8 Bernoulli submodel**

The bernoulli 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 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 (Table 5). Diagnostics, based on randomized quantile residuals (Dunn and Smyth 1996), suggested reasonable fits of the Bernoulli submodel (Figure 20).

### **1.9 Explanatory variables considered**

All explanatory factors considered in the data evaluation were included in the model. Year, season (3-month intervals), latitude (29.5–34.5 degrees pooled at the tails), number of crew including captain (1,2 and 3-plus), and days at sea (1–2,3–4, and 5-plus).

### **1.10 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 the lognormal distribution, the best model fit included all explanatory variables (Table 5). The crew size was eliminated from the gamma model. The two distributions, each with their best set of explanatory variables, were compared using AIC lognormal(AIC=22,762) outperformed gamma (AIC=25,033), and was therefore applied in the final delta-GLM. Diagnostics suggested reasonable fits of the lognormal submodel (Figures 21, 22).

### **1.11 Results**

The Stephens and MacCall (2004) method had the effect of concentrating the higher CPUE values at the center of the population distribution (Figure 23). Overall, the SEDAR 41 index developed using the Stephens and MacCall (2004) approach is only slightly different than the alternative approach using the positive gray triggerfish trips (Figure 24).

## 1.12 References

### References

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## 1.13 Tables



*Table 1. Commercial logbook gray triggerfish trips by gear.*

Year	Diving	Handline	Other	Trap
1993	12	957	7	52
1994	25	1611	15	103
1995	14	1651	13	85
1996	19	1370	8	63
1997	64	1885	17	187
1998	59	1547	46	122
1999	64	1431	42	104
2000	41	1308	20	56
2001	37	1633	9	63
2002	39	1720	7	48
2003	15	1380	7	74
2004	25	1503	12	75
2005	16	1455	11	31
2006	21	1317	12	79
2007	46	1522	22	23
2008	28	1406	22	12
2009	30	1344	19	16
2010	108	1214	28	22
2011	110	1167	17	17
2012	95	967	21	10
2013	50	672	9	14

*Table 2. Commercial logbook gray triggerfish landings by gear (Thousand pounds).*

Year	Diving	Handline	Other	Trap
1993	0.14	100.47	2.81	1.76
1994	0.42	235.75	7.08	2.41
1995	0.27	253.29	3.20	2.32
1996	0.32	268.75	3.23	3.58
1997	1.80	409.67	0.45	10.19
1998	1.59	274.45	1.62	2.51
1999	1.50	223.10	3.37	2.30
2000	0.45	143.75	2.18	1.54
2001	0.78	172.80	0.49	1.85
2002	1.17	160.58	7.04	1.61
2003	0.24	149.08	0.17	1.62
2004	1.17	176.47	0.55	3.22
2005	0.89	215.23	0.65	1.00
2006	0.86	194.44	1.90	3.13
2007	1.53	252.25	1.24	0.56
2008	0.67	207.35	0.35	0.75
2009	0.67	223.30	1.30	0.57
2010	3.99	280.84	16.95	1.02
2011	5.19	303.01	4.92	1.05
2012	3.64	170.64	12.66	0.11
2013	2.41	209.23	0.23	0.53

*Table 3. CFLP Handline cutoff values for outliers (records reporting more (upper), or less (lower) were excluded).*

Year	s32manual	s32electric	s41manual	s41electric
lines fished (upper)	20	7	6	6
hooks per line (upper)	15	13	8	9
days at sea (upper)	16	16	10	12
crew (upper)	4	6	5	5
total pounds	2265	2265		
hours fished (lower)			4	4
hours fished (upper)			100	137
cpue (upper)			12	12

Table 4. Proportion positive by year and factor (*s*–season followed by months, *l*–latitude, *c*–crew size, *a*–days at sea)

Year	s1-3	s4-6	s7-9	s10-12	l29.5	l30.5	l31.5	l32.5	l33.5	l34.5	c1	c2	c3plus	a1-2	a3-4	a5plus
1993	0.50	0.72	0.73	0.54	0.49	0.80	0.62	0.57	0.71	0.80	0.53	0.71	0.69	0.53	0.73	0.76
1994	0.68	0.71	0.76	0.75	0.47	0.86	0.77	0.72	0.76	0.78	0.42	0.71	0.79	0.51	0.83	0.81
1995	0.70	0.69	0.75	0.77	0.46	0.85	0.79	0.70	0.75	0.81	0.34	0.71	0.81	0.57	0.83	0.76
1996	0.66	0.75	0.75	0.77	0.34	0.88	0.80	0.82	0.80	0.82	0.37	0.74	0.80	0.51	0.82	0.85
1997	0.65	0.79	0.83	0.74	0.25	0.92	0.87	0.88	0.88	0.88	0.28	0.74	0.88	0.49	0.88	0.90
1998	0.75	0.72	0.70	0.67	0.19	0.80	0.91	0.81	0.81	0.76	0.34	0.69	0.82	0.53	0.78	0.84
1999	0.73	0.65	0.74	0.70	0.27	0.78	0.84	0.78	0.81	0.65	0.31	0.66	0.81	0.51	0.80	0.83
2000	0.68	0.67	0.68	0.65	0.20	0.71	0.93	0.78	0.74	0.66	0.31	0.66	0.76	0.54	0.72	0.81
2001	0.69	0.73	0.75	0.72	0.38	0.63	0.86	0.78	0.79	0.73	0.40	0.71	0.79	0.57	0.80	0.82
2002	0.72	0.69	0.72	0.73	0.37	0.74	0.88	0.71	0.78	0.75	0.39	0.69	0.80	0.55	0.77	0.82
2003	0.70	0.68	0.63	0.78	0.37	0.86	0.81	0.72	0.74	0.78	0.32	0.71	0.80	0.53	0.76	0.79
2004	0.79	0.78	0.78	0.82	0.44	0.89	0.90	0.89	0.83	0.89	0.51	0.78	0.89	0.57	0.88	0.90
2005	0.82	0.78	0.78	0.73	0.34	0.87	0.98	0.87	0.78	0.88	0.36	0.74	0.90	0.53	0.86	0.89
2006	0.75	0.74	0.74	0.84	0.26	0.83	0.93	0.83	0.76	0.85	0.35	0.76	0.86	0.56	0.85	0.84
2007	0.72	0.69	0.79	0.76	0.34	0.88	0.96	0.85	0.70	0.80	0.51	0.68	0.85	0.53	0.81	0.89
2008	0.71	0.70	0.75	0.76	0.27	0.83	0.92	0.82	0.75	0.76	0.42	0.67	0.85	0.51	0.83	0.86
2009	0.69	0.73	0.77	0.88	0.47	0.86	0.89	0.83	0.71	0.78	0.43	0.67	0.86	0.54	0.83	0.84

Table 5. Model selection results from delta-lognormal model.

Factor	Df	Deviance	AIC
Bernouli submodel			
none		22646	22704
season	3	22670	22722
year	16	22769	22795
crew	2	22862	22916
away	2	23347	23401
lat	5	23616	23664
Lognormal submodel			
none		52212	66206
crew	2	52229	66207
away	2	52410	66265
season	3	52808	66388
year	16	53055	66440
lat	5	53062	66464

Table 6. Standardized index of gray triggerfish from commercial logbook data.).

Year	N	Proportion Positive	Relative nominal	Standardized CPUE	CV
1993	770	0.69	0.616	0.757	0.068
1994	1281	0.73	0.968	0.885	0.054
1995	1479	0.72	0.935	1.009	0.045
1996	1167	0.74	1.139	1.044	0.052
1997	1593	0.76	1.397	1.526	0.044
1998	1427	0.71	1.589	1.377	0.053
1999	1415	0.7	1.188	1.062	0.054
2000	1348	0.67	0.708	0.758	0.054
2001	1582	0.72	0.638	0.694	0.049
2002	1714	0.72	0.689	0.661	0.046
2003	1352	0.7	0.93	0.754	0.056
2004	1233	0.79	1.152	1.137	0.053
2005	1296	0.78	1.119	1.243	0.049
2006	1219	0.76	1.081	0.989	0.053
2007	1453	0.74	0.945	0.998	0.050
2008	1369	0.73	0.938	0.979	0.048
2009	1052	0.75	0.967	1.126	0.055

## **1.14 Figures**

Figure 1. CFLP Latitude Stratification (midpoint of each latitudinal grid is labeled with the floor for the bin).

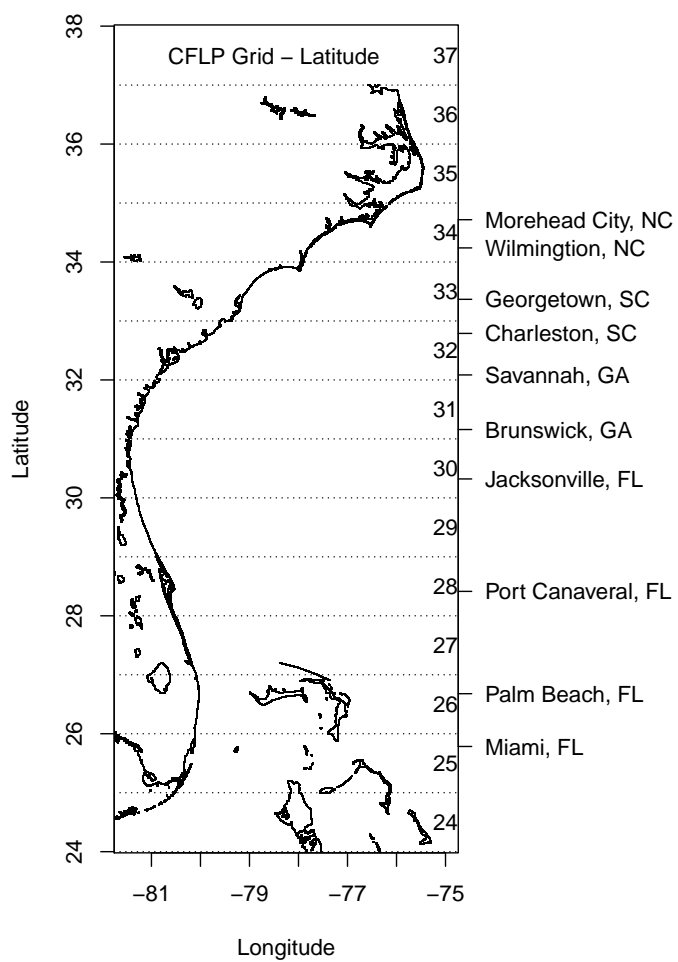


Figure 2. Gray triggerfish diving trips by year and latitude. Symbol size relative to number of trips, 'X' signifies confidential data and represents a small percentage of the total trips.

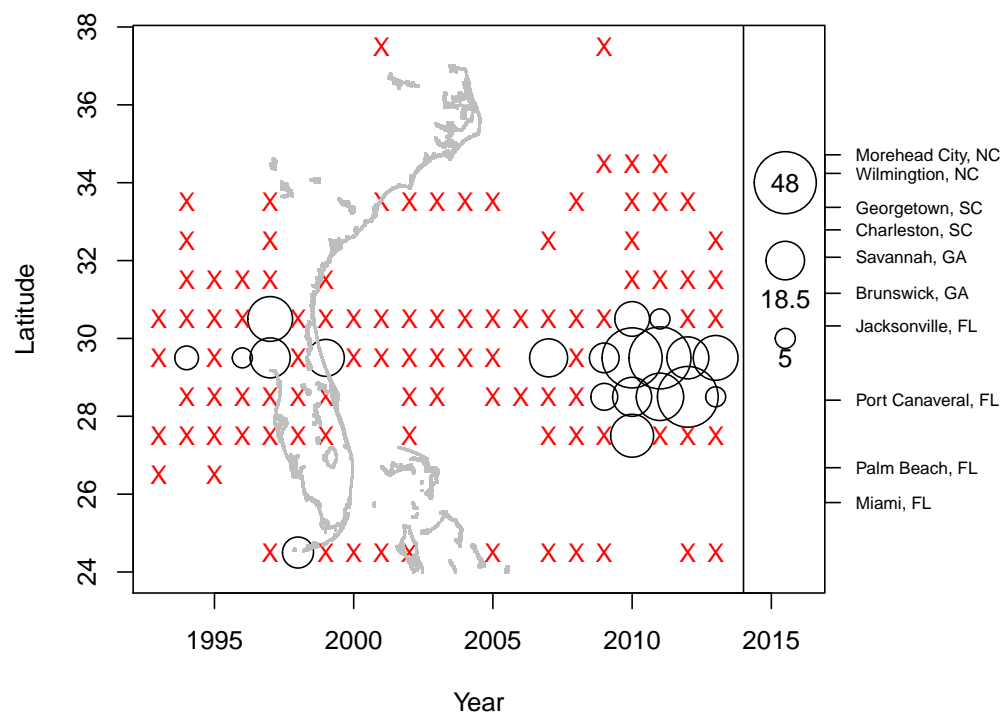


Figure 3. Gray triggerfish trap trips by year and latitude. Symbol size relative to number of trips, 'X' signifies confidential data and represents a small percentage of the total trips.

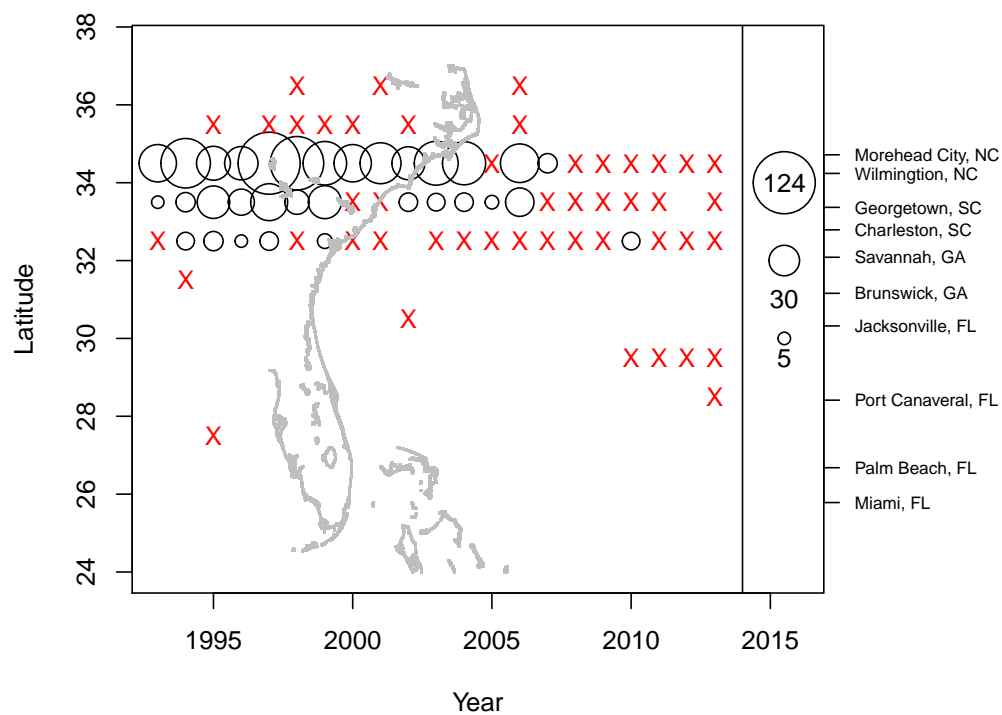




Figure 4. Gray triggerfish handline explanatory variable factor definition. Line represents the relative number of trips in each categorical variable. Vertical lines represent proposed breaks for factors).

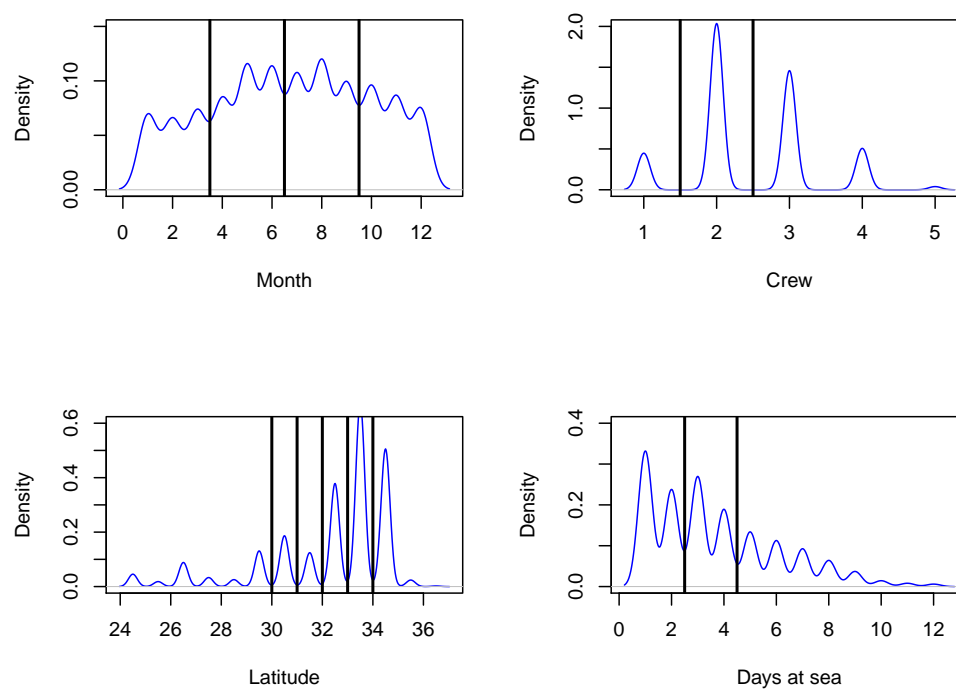


Figure 5. Gray triggerfish handline nominal cpue by year and season.

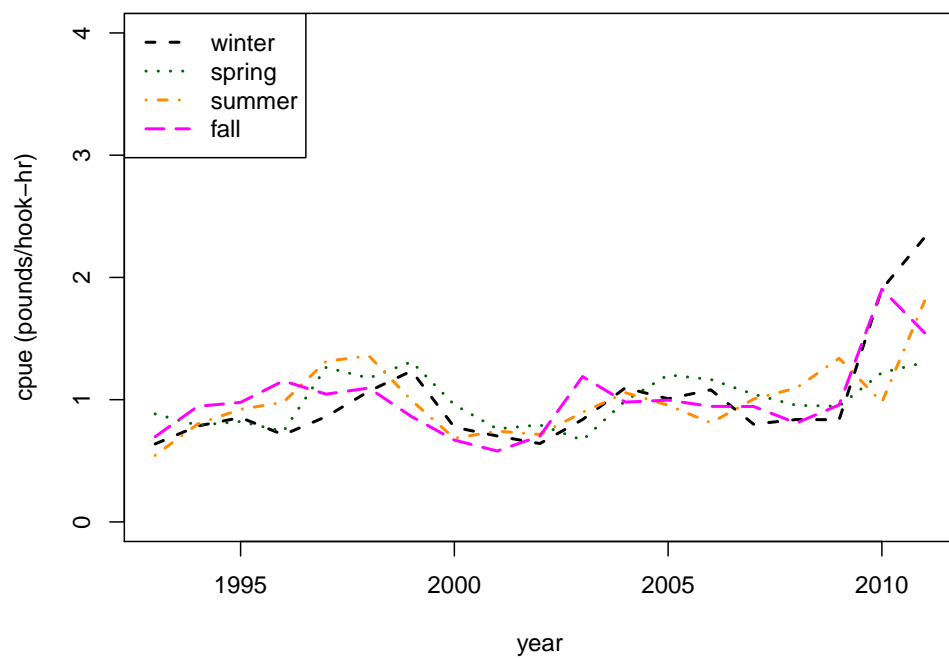


Figure 6. Gray triggerfish handline nominal cpue by year and latitude. Latitudes in the North are pooled at 34 degrees and latitudes in the South are pooled at 29 degrees.

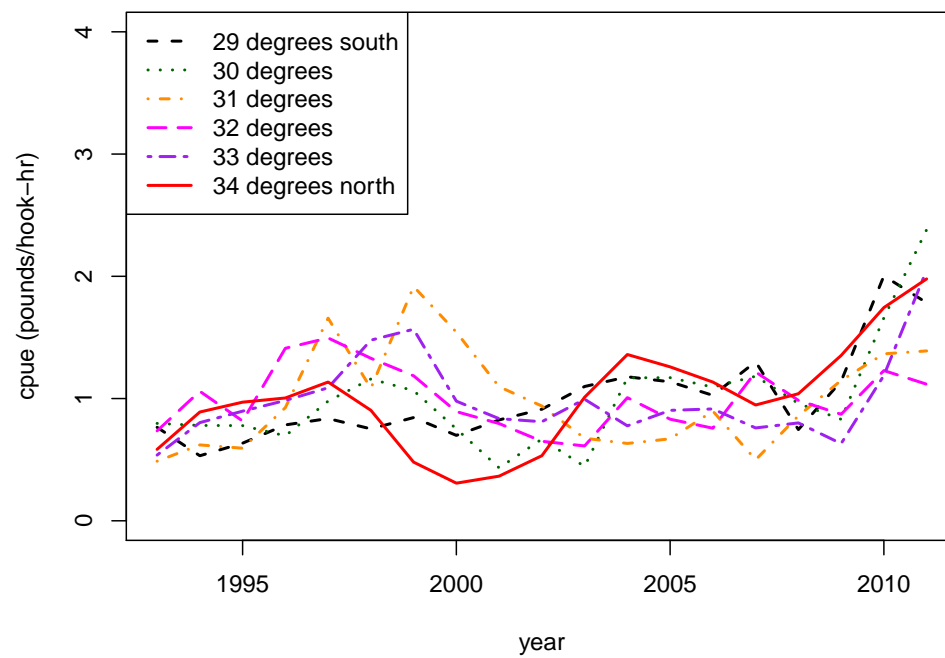


Figure 7. Gray triggerfish handline nominal cpue by year and days at sea.

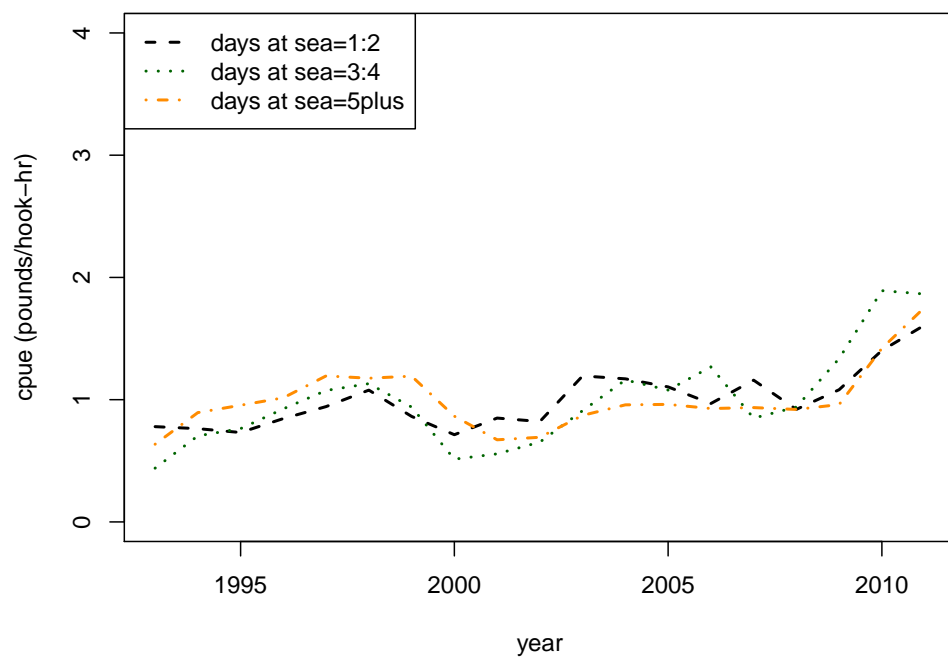


Figure 8. Gray triggerfish handline nominal cpue by year and crew.

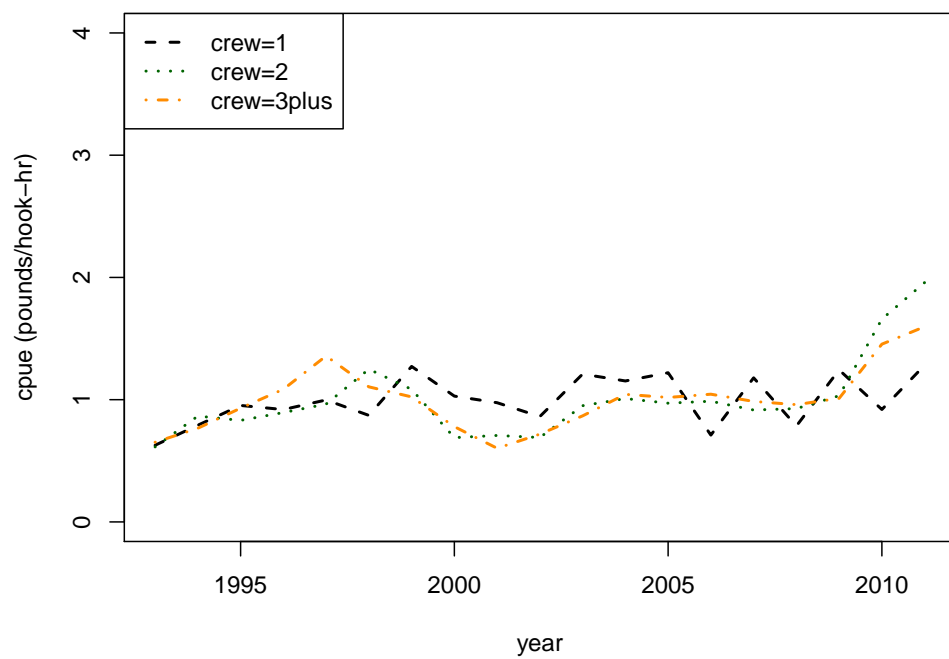


Figure 9. Gray triggerfish handline trips by year and latitude. Symbol size relative to number of trips, 'X' signifies confidential data and represents a small percentage of the total trips.

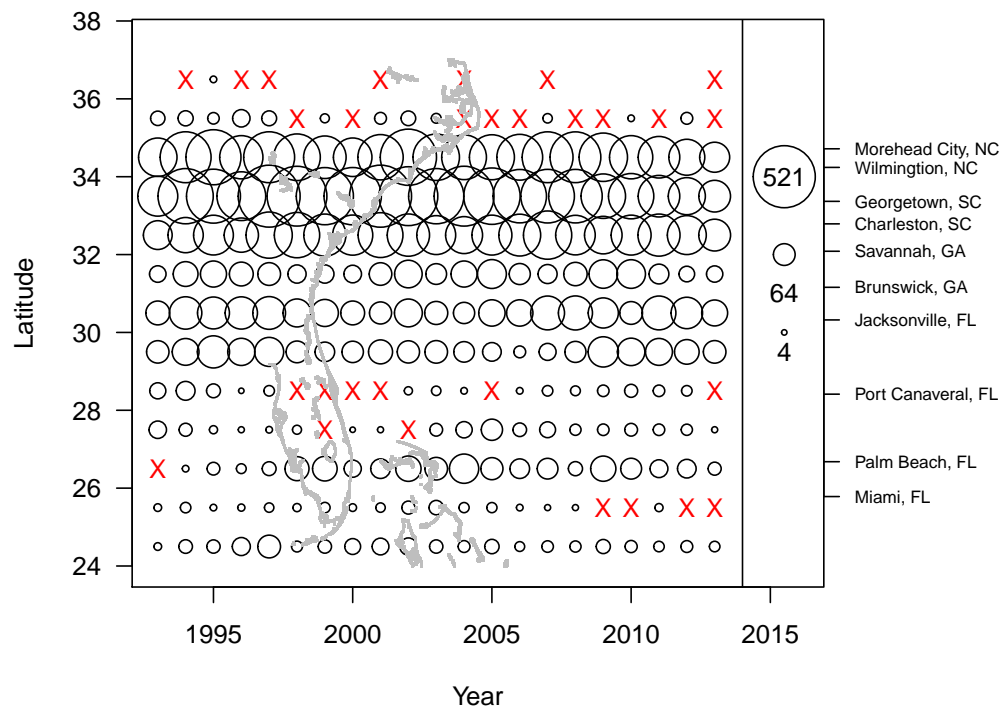


Figure 10. Gray triggerfish handline mean cpue (whole pounds/hook-hour) by year and latitude. Symbol size relative to cpue, X signifies confidential data and represents a small percentage of the total records.

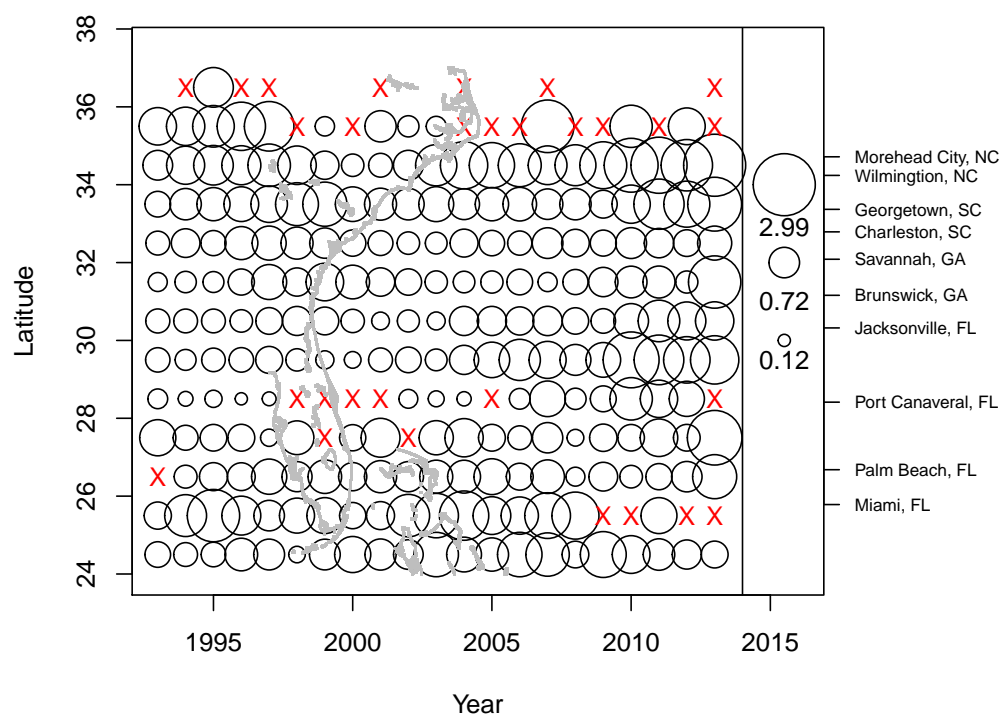


Figure 11. Gray triggerfish handline catch (whole pounds) by year and latitude. Symbol size relative to catch, X signifies confidential data and represents a small percentage of the total catch.

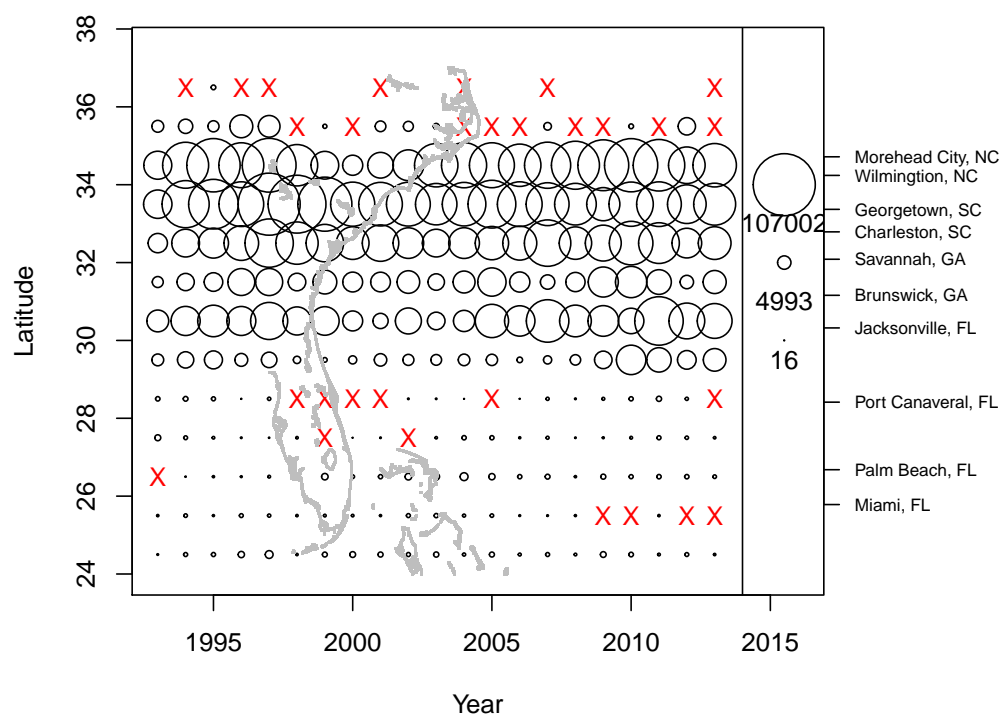




Figure 12. Gray triggerfish handline mean hours fished by year and latitude. Symbol size relative to hours fished, X signifies confidential data and represents a small percentage of the total hours fished.

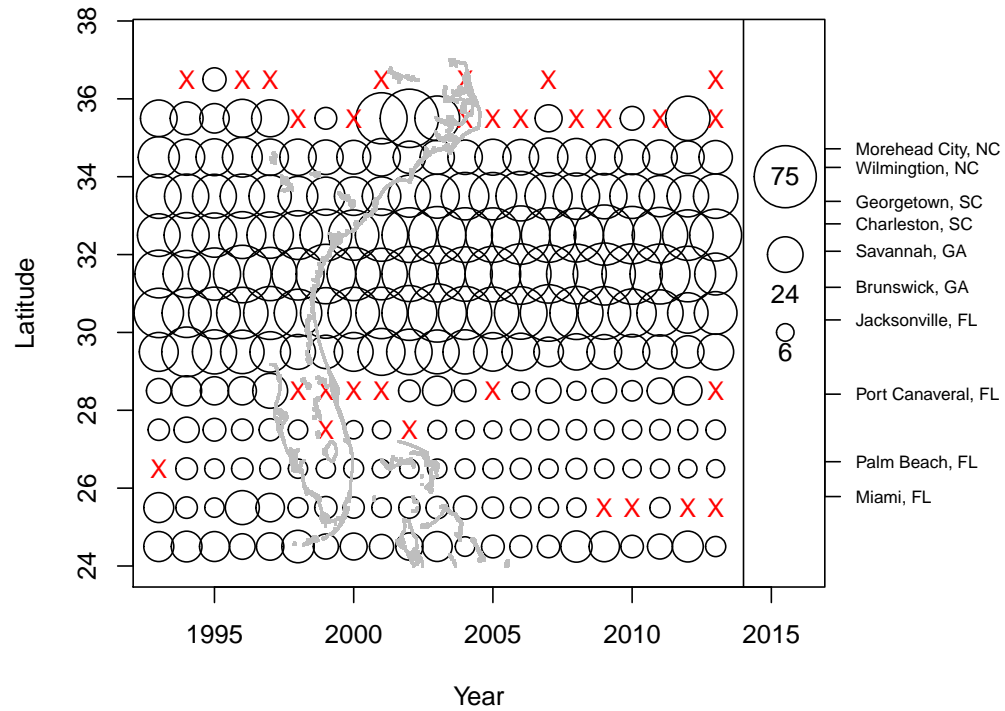


Figure 13. Gray triggerfish handline mean number hooks per line by year and latitude. Symbol size relative to number of hooks, X signifies confidential data and represents a small percentage of the total records.

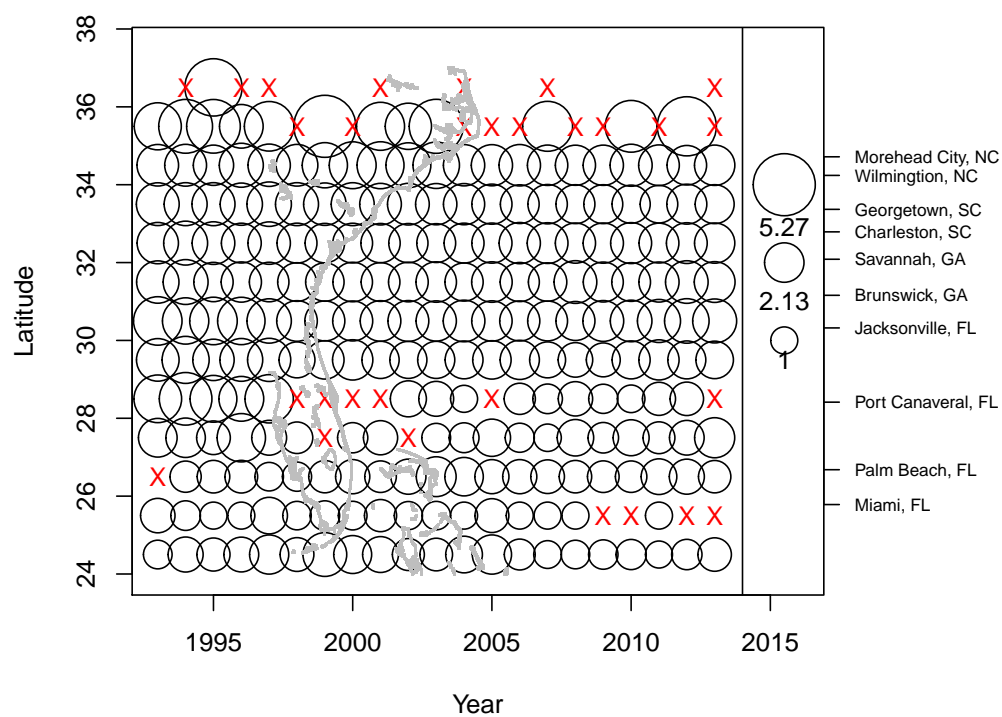


Figure 14. Gray triggerfish handline mean number of lines fished by year and latitude. Symbol size relative to number of lines, X signifies confidential data and represents a small percentage of the total records.

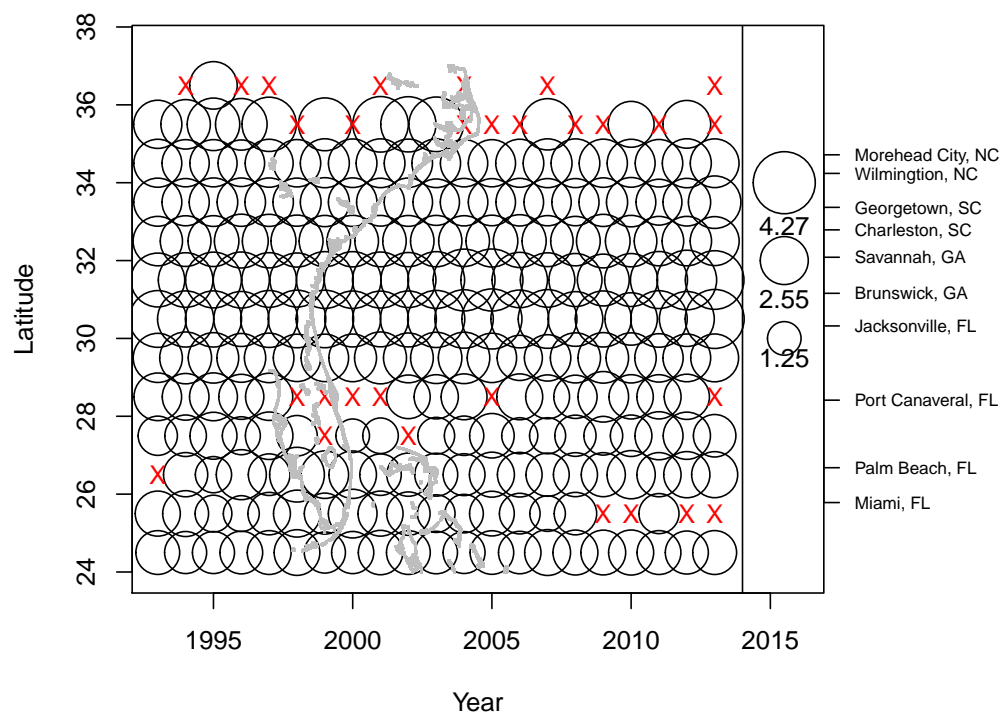


Figure 15. Gray triggerfish handline hours fished by days at sea with correlation coefficient. The mean of approximately 10 hours per day fished applies through approximately 9 days at sea with a pearson correlation coefficient of 0.85.

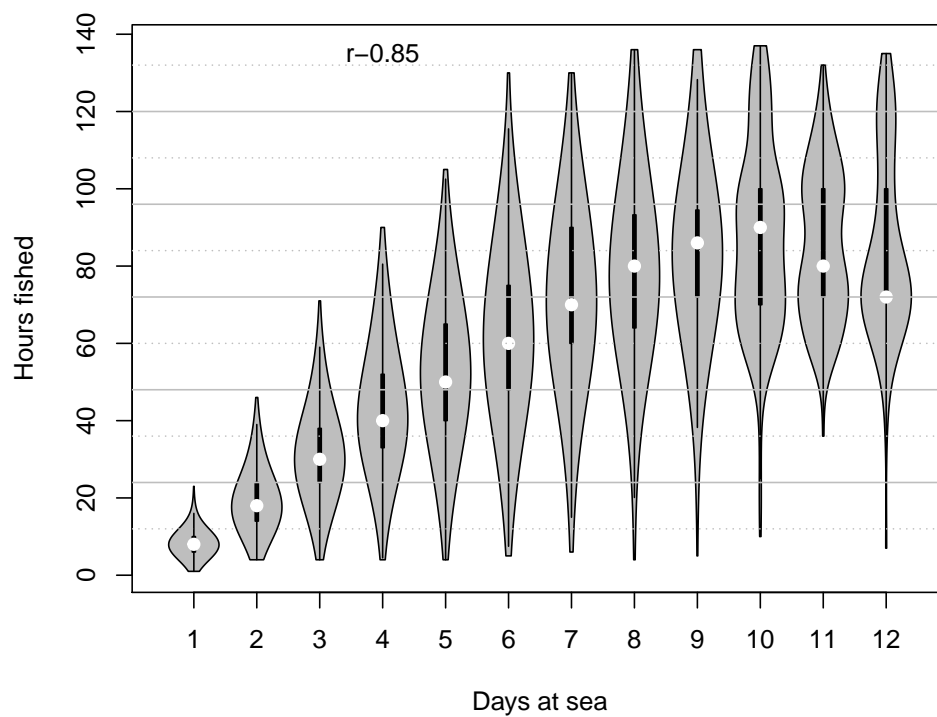


Figure 16. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to logbook data from areas in the northern region (NC, SC, GA, north FL), as used to estimate each trips probability of catching the focal species.

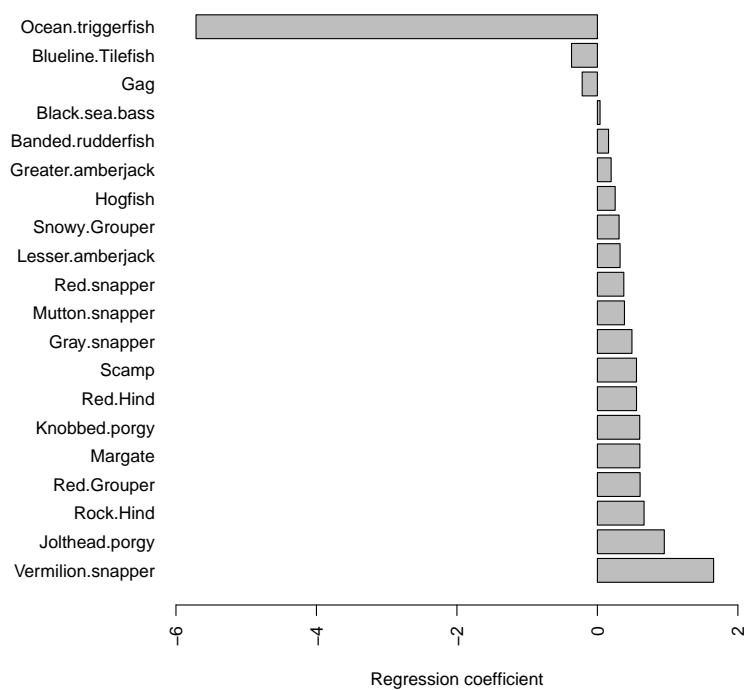


Figure 17. Estimates of species-specific regression coefficients from Stephens and MacCall method applied to logbook data from areas in the southern region (south FL), as used to estimate each trips probability of catching the focal species.

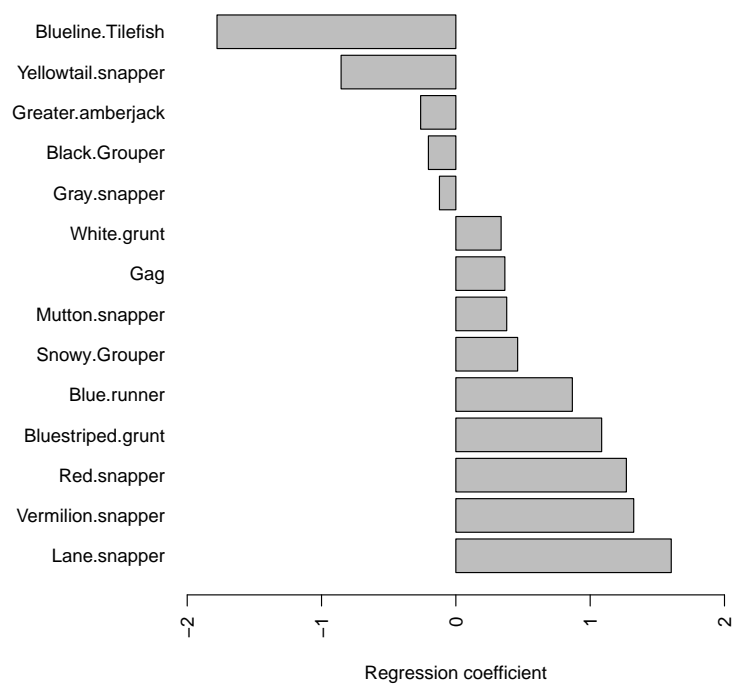


Figure 18. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to logbook data from the northern region (NC, SC, GA, north FL). Left and right panels differ only in the range of probabilities shown.

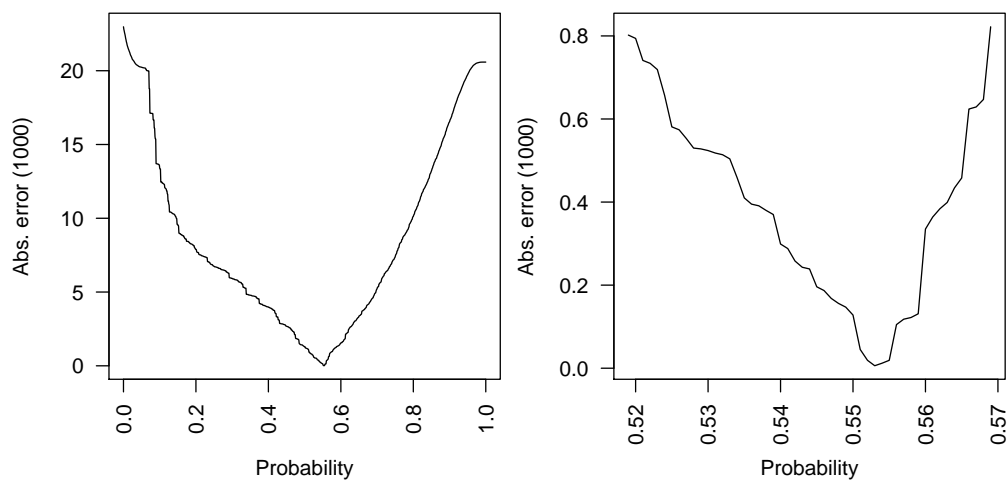


Figure 19. Absolute difference between observed and predicted number of positive trips from Stephens and MacCall method applied to logbook data from the southern region (south FL). Left and right panels differ only in the range of probabilities shown.

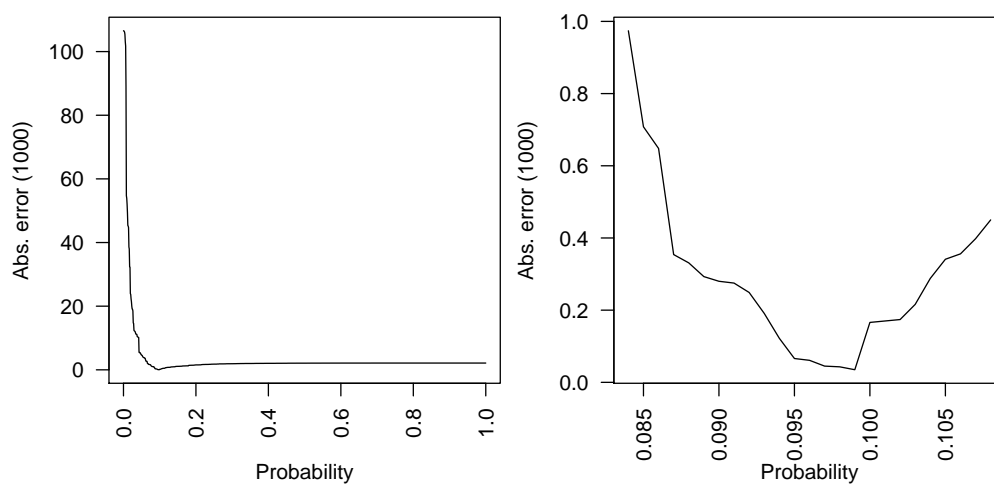




Figure 20. Diagnostics of Bernoulli submodel fits to positive versus zero CPUE data. Box-and-whisker plots give first, second (median), and third quartiles, as well as limbs that extend approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are randomized quantile residuals.

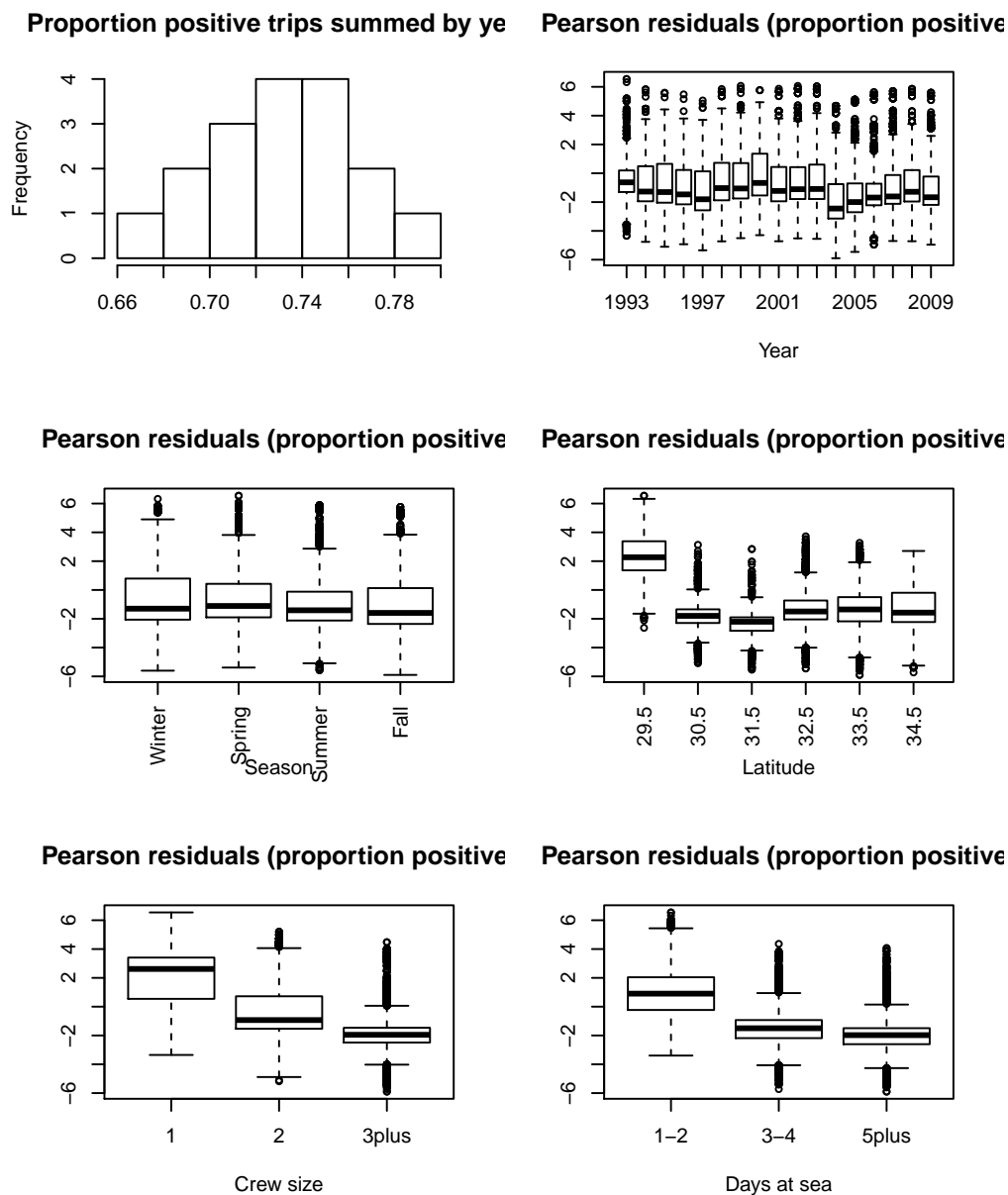


Figure 21. Diagnostics of lognormal submodel fits to positive CPUE data. Top left panel shows the histogram of empirical log CPUE, with the normal distribution (empirical mean and variance) overlaid. Box-and-whisker plots give first, second (median), and third quartiles, as well as limbs that extend approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

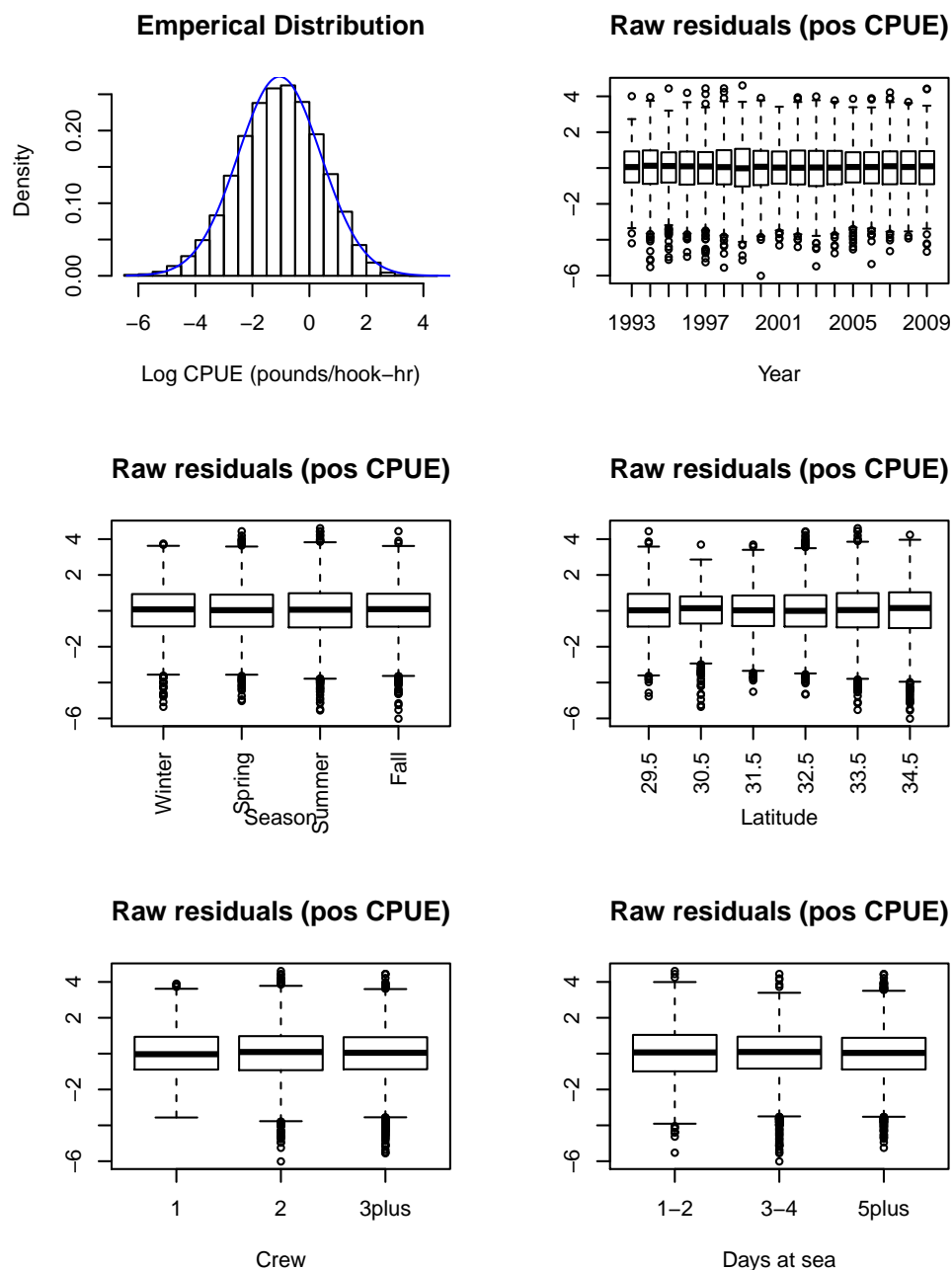


Figure 22. Quantile-quantile plot of residuals from the fitted lognormal submodel to the positive cpue data.

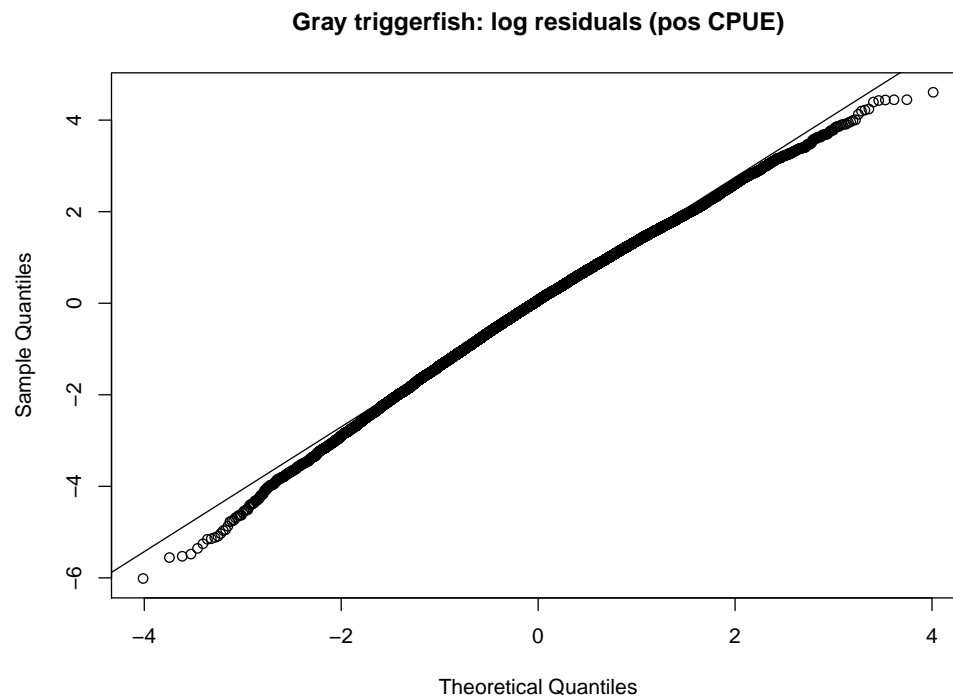


Figure 23. Gray triggerfish handline mean nominal cpue (whole pounds/hook-hour) by year and latitude after applying the Stephens and MacCall method. The symbol size is relative to cpue.

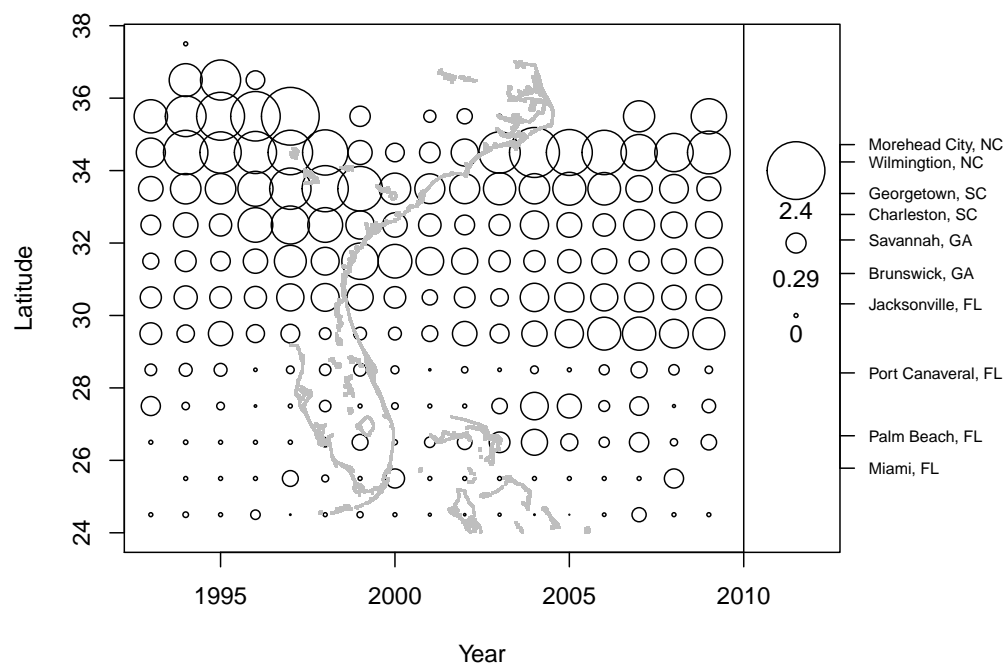
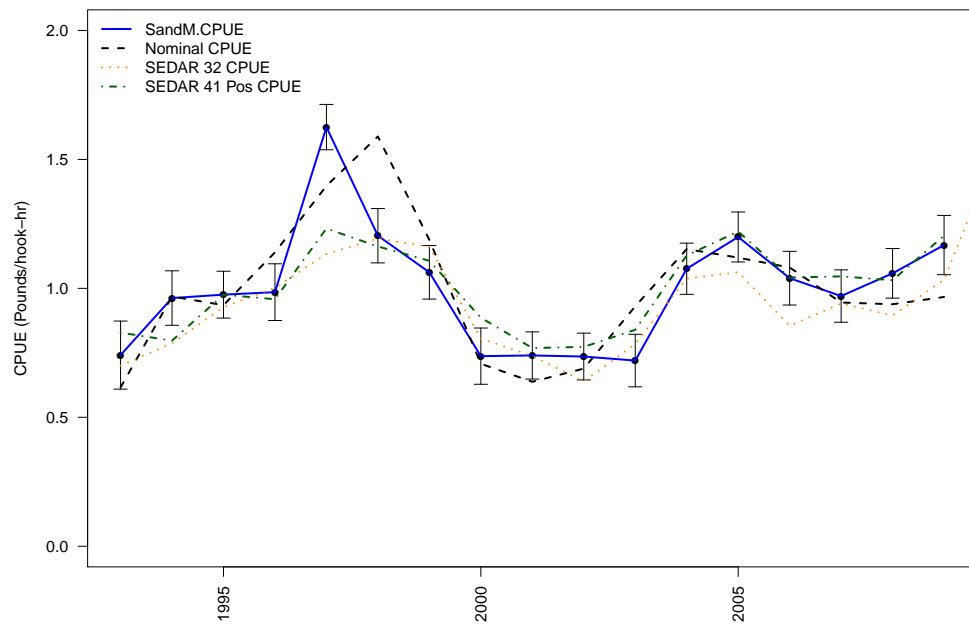


Figure 24. Relative standardized index (solid line, black circles, 95% error bars), relative nominal index (dashed), and alternative positive-only model (dash-dot).



## 2 Appendix A. The commercial logbook data set contains the following variables (all are numeric unless otherwise noted)

**schedule:** this is a unique identifier for each fishing trip and is a character variable

**species:** a character variable to identify species caught.

**gear:** a character variable, the gear type, multiple gear types may be used in a single trip, L = longline, H = handline, E = electric reels, B = buoy gear, GN = gill net, P = diver using power head gear, S = diver using spear gun, T = trap, TR = trolling

**area:** area fished, in the south Atlantic these codes have four digits- the first two are degrees of latitude and the second two are the degrees of longitude

**totlbs:** a derived variable that sums the gutted (with conversion factor) and whole weights, this is the total weight in pounds of the catch for a particular species, trip, gear, and area

**length:** length of longline (in miles) or gill net (in yards)

**numgear:** the amount of a gear used, number of lines (handlines, electric reels), number of sets (longlines), number of divers, number of traps, number of gill nets

**fished:** hours fished on a trip, this is problematic for longline data as discussed later

**effort:** like numgear, the data contained in this field depends upon gear type; number of hooks/line for handlines, electric reels, and trolling; number of hooks per longline for longlines; number of traps pulled for traps; depth of the net for gill nets, this field is blank for divers

**vesid:** a character variable, a unique identifier for each vessel

**landed:** numeric (mmddyy8) variable, date the vessel returned to port

**unload:** numeric (mmddyy8) variable, date the catch was unloaded

**received:** numeric (mmddyy8) variable, date the logbook form was received from the fisherman

**away:** number of days at sea, this value should equal (landed-started+1)

**crew:** number of crew members, including the captain

**state:** character variable, the state in which the catch was sold

**areal - area3:** areas fished, if the trip included catch from multiple areas, those areas will be listed here