SEDAR61-WP19: Model-estimated conversion factors for calibrating Coastal Household Telephone Survey (CHTS) charterboat catch and effort estimates with For-Hire Survey (FHS) estimates in the Atlantic and Gulf of Mexico with application to red grouper and greater amberjack

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2019

SEDAR59-RD09

25 February 2019

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21 February 2019

Please cite this document as:

Dettloff, K. and Vivian Matter. 2019. Model-estimated conversion factors for calibrating Coastal Household Telephone Survey (CHTS) charterboat catch and effort estimates with For Hire Survey (FHS) estimates in the Atlantic and Gulf of Mexico with application to red grouper and greater amberjack. SEDAR61-WP-19. SEDAR, North Charleston, SC. 17 pp.

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by

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October 2018

INTRODUCTION

The Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fishery Statistics Survey (MRFSS), was implemented in 1981 to provide regional based catch and effort estimates of marine finfish in United States recreational fisheries. Fishing pressure (effort) data are collected through a telephone survey of households in coastal counties (the Coastal Household Telephone Survey, CHTS) and by interviewing anglers at fishing access sites. NOAA Fisheries acknowledged that effort estimation in the charterboat sector is difficult due to the low occurrence of this fishing mode among households contacted in the telephone survey.

To improve charterboat effort estimation, NOAA Fisheries began testing a new survey protocol, the For Hire Survey (FHS), in 1995. To implement the new design, charterboat vessel directories were created by NMFS and participating state agencies which are maintained by the Gulf States Marine Fisheries Commission (GSMFC). Approximately 10% of the charterboat operators in the directory are randomly contacted by phone and asked relevant information regarding their fishing activities (e.g., number of trips and anglers, area of fishing, etc.). NOAA Fisheries concluded that the FHS produced significantly "more efficient, precise, and credible charter angler effort estimates than the traditional MRFSS method" (https://www.st.nmfs.noaa.gov/st1/recreational/queries/charter_method_test.html). Official FHS estimates are available for the Gulf of Mexico and East Florida beginning in 2000 and for the rest of the Atlantic coast beginning in 2004.

Previous Calibration Analyses

Conversion factors were previously calculated to calibrate the traditional CHTS charterboat estimates with FHS estimates in the Gulf of Mexico (Diaz and Phares, 2004) and South Atlantic (Sminkey, 2008). For years 1986 and later, the methods used in each region are consistent and are based on effort calibrations. Years 1981-1985 could not be calibrated with the same ratios developed for 1986+ because the survey estimated catch for charterboat and headboat modes as a single combined mode in both regions during that time period. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Headboat Survey (SRHS) must be included in the analysis. In the Gulf of Mexico, the calibration analysis for 1981-1985 was based on combined effort estimates from both surveys (SRHS and MRIP), and assumed that angler trips and angler days are equivalent (Diaz and Phares, 2004). In the South Atlantic, a different approach was used based on combined landings estimates by species (Sminkey, 2008), resulting in species-specific calibration factors. Calibrations were later calculated for 1981-1985 in the Gulf of Mexico and South Atlantic at the aggregate level of state, wave, and area based on equivalent effort units, for a consistent methodology across sub-regions (Matter et al., 2012).

In July 2018, NOAA Fisheries released new recreational catch estimates for all species and all modes, including charter mode estimates. As a result, the SEFSC conducted another analysis using the newly released data to correct for this change to the FHS. The present analysis uses a statistically sound, consistent methodology to provide improved calibrations for estimating FHS charterboat effort and landings with associated uncertainties from CHTS estimates. Estimates based on these calibrations are calculated for all sub-regions and years in which only CHTS estimates are available, producing a consistent time series of FHS estimates across all years of recreational data collection.

METHODS

Charterboat calibrations based on estimated effort were calculated for years 1981-1999 in the Gulf of Mexico and 1981-2003 in the South Atlantic, years prior to the implementation of the FHS. Due to the availability of only combined charter/headboat estimates from 1981-1985, calibrations for these years were modeled separately using combined estimates as described in Matter et al. 2012. Likewise, combined charter/headboat calibrations were calculated for years 1981-2003 in the North and Mid Atlantic. Effort estimates are available for each sub-region to the level of year, wave, state, and area fished. See table 1 below for a description of the years with overlapping FHS/CHTS estimates that were used to construct the calibration models for each sub-region.

As effort is a strictly-positive continuous variable, generalized linear models with a Gamma response structure and log-link were fit to non-missing FHS estimated trips, with CHTS estimated trips as a predictor in the regression. Outliers were handled by fitting linear models to FHS trips against CHTS trips and excluding observations with a Cook's distance greater than one. This resulted in the removal of four total points that would have otherwise had a high influence on the model coefficients. Wave, state, and fishing area plus interactions were used as other potential covariates, with area fished excluded from years 1981-1985 as it was unavailable in the headboat survey. Models were fit separately for each sub-region due to variation in the available years with overlapping data and to better capture spatial differences in the relationship between FHS and CHTS. In order to prevent erroneous predictions outside the range of the available data, CHTS trip estimates were left uncorrected (ratio set to 1) if they exceeded the maximum value of that available to be modeled for each sub-region. All combinations of covariates and interactions were considered for inclusion, with the final models selected according to lowest BIC values (see table 1).

	Calibrated Years	Overlap Years	Covariates Selected
Gulf of Mexico	1986-1999	2000-2004	*t, w, s, a, w:s, w:a, s:a*
	1981-1985*	1986-1990	*t, w, s, w:s*
South Atlantic	1986-2003**	2004-2007	*t, w, s, a, w:s, w:a, s:a*
	1981-1985*	1986-1990	*t, w, s, w:s*
Mid Atlantic	1981-2003	2004-2006	*t, w, s, s:a*
North Atlantic	1981-2003	2004-2006	*t, w, s, a, t:a, s:a*

*Table 1: Years in which CHTS units were adjusted to FHS units (calibrated years) and years of overlapping survey methods from which calibration models were constructed (overlap years). Terms selected for final models by minimizing BIC. t=CHTS trips, w=wave, s=state, a=area fished; colons represent interactions. *Combined charterboat/headboat effort (overlap years use estimated FHS effort). **Florida east coast calibrated 1986-1999 as official FHS estimates are available beginning in 2000 (overlap years include 2000-2003).*

FHS effort estimates for each sub-region were obtained by generating model predicted values using CHTS effort at each level of the stratification variables (year, wave, state, area fished):

$$\widehat{FHS_{eff}}_{hijk} = f\left(CHTS_{eff}{}_{hijk}\right)\ \{eq.1\}$$

$$where\ h = year, i = wave, j = state, k = area\ fished$$

Calibration ratios were calculated by dividing the model-predicted FHS effort values by estimated CHTS trips:

$$\hat{R}_{ijk} = \frac{\widehat{FHS_{eff}}_{hijk}}{CHTS_{eff}{}_{hijk}}\ \{\text{eq. 2}\}$$

These empirical ratios were then applied to catch estimates (claim, harvest, release, AB1-C, AB1-H) for each species (n=822) by multiplying the estimated CHTS catch by the calibration ratio at each stratification level:

$$\widehat{FHS_{cat}}_{hijkl} = \hat{R}_{ijk}\ CHTS_{cat}{}_{hijkl}\ \{\text{eq. 3}\}$$

$$where\ l = species$$

Approximate variances of the ratios were calculated using the delta-method:

$$v\left(\hat{R}_{hijk}\right) = \ (CHTS_{eff}{}_{hijk} e^{CHTS_{eff}{}_{hijk}\hat{\beta}_1})^2\ v\left(\hat{\beta}_1\right)\ \{\text{eq. 4}\}$$

$$where\ \hat{\beta}_1 = model\ estimated\ CHTS\ coefficient$$

As the variance of a Gamma random variable is proportional to the square of the mean, calibrated variances for new FHS estimates were calculated as follows:

$$v\left(\widehat{FHS}_{hijk(l)}\right) = \hat{R}^2{}_{ijk}\, v\left(CHTS_{hijk(l)}\right) \text{ \{eq. 5\}}$$

Adjusted calibrated variances incorporating the uncertainty from the model estimated ratios were calculated with the following equation:

$$v_{adj}\left(\widehat{FHS}_{hijk(l)}\right) = \widehat{FHS}^2{}_{hijk(l)}\, v\left(\hat{R}_{hijk}\right) + \hat{R}^2\, v\left(\widehat{FHS}_{hijk(l)}\right) - v\left(\hat{R}_{hijk}\right) v\left(\widehat{FHS}_{hijk(l)}\right) \text{ \{eq. 6\}}$$

To reduce the effect of corrections for extreme ratios on the total variance when summing within a stratum, as well as to eliminate the possibility of negative estimated variances, the median of the positive ratio adjusted standard errors to the calibrated standard errors was used as a constant correction factor within each sub-region:

$$adj_g = median\left(\left(\frac{v_{adj}\left(\widehat{FHS}_{hijk}\right) > 0}{v\left(\widehat{FHS}_{hijk}\right)}\right)^{-2}\right)_g \text{ \{eq. 7\}}$$

$$where\ g = subregion$$

Thus, each calibrated variance estimate was multiplied by this correction factor as an approximation of the magnitude by which the model estimated ratios contributed to the total FHS variance estimates:

$$v_{adj}\left(\widehat{FHS}_{ghijk(l)}\right) = adj_g * v\left(\widehat{FHS}_{ghijk(l)}\right) \text{ \{eq. 8\}}$$

Model outputs are provided in Appendix 2.

RESULTS AND DISCUSSION

The following table (2) provides mean estimated ratios and standard error correction factors to convert CHTS effort and standard errors to FHS units at each level of stratification:

REGION	WAVE	STATE	AREA	RATIO	SE ADJ
GOM	1	AL	Inshore	0.58	0.94
GOM	1	AL	Ocean<=3mi	1.96	4.89
GOM	1	AL	Ocean>3mi	1.41	3.28
GOM	1	FLW	Inshore	18.56	88.88
GOM	1	FLW	Ocean<=10mi	0.89	1.75
GOM	1	FLW	Ocean>10mi	1.08	1.94
GOM	1	LA	Inshore	1.27	3.1
GOM	1	LA	Ocean<=3mi	1.96	4.6
GOM	1	LA	Ocean>3mi	1.5	4.25
GOM	1	MS	Inshore	0.21	0.4
GOM	1	MS	Ocean<=3mi	1.07	2.03
GOM	1	MS	Ocean>3mi	0.22	0.4
GOM	2	AL	Inshore	1.24	2.34
GOM	2	AL	Ocean<=3mi	0.8	1.52
GOM	2	AL	Ocean>3mi	3.96	19.42
GOM	2	FLW	Inshore	9.13	42.4
GOM	2	FLW	Ocean<=10mi	1.79	3.52
GOM	2	FLW	Ocean>10mi	1.17	1.96
GOM	2	LA	Inshore	5.16	15.98
GOM	2	LA	Ocean<=3mi	2.41	6.32
GOM	2	LA	Ocean>3mi	14.41	67.96
GOM	2	MS	Inshore	1.96	5.58

REGION	WAVE	STATE	AREA	RATIO	SE ADJ
GOM	2	MS	Ocean<=3mi	1.51	5.1
GOM	2	MS	Ocean>3mi	2.3	7.61
GOM	3	AL	Inshore	1.02	1.8
GOM	3	AL	Ocean<=3mi	1.44	2.61
GOM	3	AL	Ocean>3mi	1.87	3.9
GOM	3	FLW	Inshore	5.66	20.35
GOM	3	FLW	Ocean<=10mi	1.55	2.59
GOM	3	FLW	Ocean>10mi	1.21	2.06
GOM	3	LA	Inshore	10.75	43.52
GOM	3	LA	Ocean<=3mi	3.16	7.78
GOM	3	LA	Ocean>3mi	2.85	6.54
GOM	3	MS	Inshore	2.56	7.46
GOM	3	MS	Ocean<=3mi	1.93	3.71
GOM	3	MS	Ocean>3mi	2.01	3.79
GOM	4	AL	Inshore	1.65	3.04
GOM	4	AL	Ocean<=3mi	1.25	2.24
GOM	4	AL	Ocean>3mi	1.39	2.4
GOM	4	FLW	Inshore	17.37	87.16
GOM	4	FLW	Ocean<=10mi	1.81	3.73
GOM	4	FLW	Ocean>10mi	1.12	1.93
GOM	4	LA	Inshore	6.26	15.04
GOM	4	LA	Ocean<=3mi	2.07	4.97

REGION	WAVE	STATE	AREA	RATIO	SE ADJ
GOM	4	LA	Ocean>3mi	2.89	6.13
GOM	4	MS	Inshore	1.47	2.63
GOM	4	MS	Ocean<=3mi	3.02	5.56
GOM	4	MS	Ocean>3mi	2.45	5.69
GOM	5	AL	Inshore	1.06	2.14
GOM	5	AL	Ocean<=3mi	0.44	0.9
GOM	5	AL	Ocean>3mi	0.66	1.16
GOM	5	FLW	Inshore	2.48	5.29
GOM	5	FLW	Ocean<=10mi	0.74	1.35
GOM	5	FLW	Ocean>10mi	0.85	1.4
GOM	5	LA	Inshore	5.99	16.92
GOM	5	LA	Ocean<=3mi	0.7	1.46
GOM	5	LA	Ocean>3mi	1.58	3.5
GOM	5	MS	Inshore	2.48	5.36
GOM	5	MS	Ocean<=3mi	1.5	3.6
GOM	5	MS	Ocean>3mi	1.16	3.08
GOM	6	AL	Inshore	0.49	0.93
GOM	6	AL	Ocean<=3mi	0.17	0.37
GOM	6	AL	Ocean>3mi	0.29	0.76
GOM	6	FLW	Inshore	1.51	2.81
GOM	6	FLW	Ocean<=10mi	0.81	1.38
GOM	6	FLW	Ocean>10mi	0.81	1.42
GOM	6	LA	Inshore	2.55	5.89
GOM	6	LA	Ocean<=3mi	1.28	3.35
GOM	6	LA	Ocean>3mi	1.27	4.74
GOM	6	MS	Inshore	0.72	1.62
GOM	6	MS	Ocean<=3mi	0.22	0.44
GOM	6	MS	Ocean>3mi	0.3	0.72
GOM	**Median**			**1.5**	**3.32**
MA	2	DE	Inshore	49.81	273.13
MA	2	DE	Ocean<=3mi	5.48	12.99
MA	2	DE	Ocean>3mi	0.53	1.34
MA	2	MD	Inshore	18	67.78
MA	2	MD	Ocean<=3mi	6.58	21.21
MA	2	MD	Ocean>3mi	0.23	0.46
MA	2	NJ	Inshore	0.21	0.42
MA	2	NJ	Ocean<=3mi	1.93	7.59
MA	2	NJ	Ocean>3mi	0.73	1.58
MA	2	NY	Inshore	0.24	0.53
MA	2	NY	Ocean<=3mi	2.95	9.16
MA	2	NY	Ocean>3mi	0.86	2.46
MA	2	VA	Inshore	2.46	6.4
MA	2	VA	Ocean<=3mi	0.2	0.56
MA	2	VA	Ocean>3mi	0.08	0.2
MA	3	DE	Inshore	2.81	15.28
MA	3	DE	Ocean<=3mi	9.93	22.36
MA	3	DE	Ocean>3mi	0.89	2.59
MA	3	MD	Inshore	3.28	7.22
MA	3	MD	Ocean<=3mi	54.83	225.18
MA	3	MD	Ocean>3mi	0.58	1.32
MA	3	NJ	Inshore	1.85	11.12
MA	3	NJ	Ocean<=3mi	1.34	3.4
MA	3	NJ	Ocean>3mi	1.14	1.99
MA	3	NY	Inshore	0.78	1.49
MA	3	NY	Ocean<=3mi	1.67	5.54
MA	3	NY	Ocean>3mi	3.75	9.31
MA	3	VA	Inshore	1.04	2.83
MA	3	VA	Ocean<=3mi	0.98	4.01
MA	3	VA	Ocean>3mi	0.3	1.01
MA	4	DE	Inshore	0.95	2.26
MA	4	DE	Ocean<=3mi	23.51	79.62
MA	4	DE	Ocean>3mi	0.77	1.74
MA	4	MD	Inshore	3.99	9.26
MA	4	MD	Ocean<=3mi	11.21	41.71
MA	4	MD	Ocean>3mi	0.36	0.69
MA	4	NJ	Inshore	1.72	5.01
MA	4	NJ	Ocean<=3mi	2.39	6.43
MA	4	NJ	Ocean>3mi	1.56	2.89
MA	4	NY	Inshore	1.38	2.6
MA	4	NY	Ocean<=3mi	1.17	2.47
MA	4	NY	Ocean>3mi	2.01	4.35
MA	4	VA	Inshore	1.04	2.26
MA	4	VA	Ocean<=3mi	91.41	544.32
MA	4	VA	Ocean>3mi	0.36	1.19
MA	5	DE	Inshore	0.9	2.07
MA	5	DE	Ocean<=3mi	4.43	11.01
MA	5	DE	Ocean>3mi	0.65	1.72
MA	5	MD	Inshore	1.48	3.49
MA	5	MD	Ocean<=3mi	16.99	93.93
MA	5	MD	Ocean>3mi	0.2	0.39
MA	5	NJ	Inshore	1.04	2.32
MA	5	NJ	Ocean<=3mi	0.65	1.27
MA	5	NJ	Ocean>3mi	0.77	1.39
MA	5	NY	Inshore	1.12	3.37
MA	5	NY	Ocean<=3mi	0.44	0.84
MA	5	NY	Ocean>3mi	1.25	3.19
MA	5	VA	Inshore	1.2	5.25
MA	5	VA	Ocean<=3mi	0.27	0.75
MA	5	VA	Ocean>3mi	0.23	0.66
MA	6	DE	Inshore	1.6	4.23
MA	6	DE	Ocean<=3mi	0.94	2.48
MA	6	DE	Ocean>3mi	2.12	9.12
MA	6	MD	Inshore	3.69	12.36
MA	6	MD	Ocean<=3mi	0.72	1.35
MA	6	MD	Ocean>3mi	0.49	1.11
MA	6	NJ	Inshore	2.04	9.28
MA	6	NJ	Ocean<=3mi	2.17	15.17
MA	6	NJ	Ocean>3mi	1.91	6.93
MA	6	NY	Inshore	0.88	1.91
MA	6	NY	Ocean<=3mi	0.67	1.7
MA	6	NY	Ocean>3mi	7.28	47.15
MA	6	VA	Inshore	1.02	2.38
MA	6	VA	Ocean<=3mi	0.37	0.9
MA	6	VA	Ocean>3mi	0.46	2.57
MA	**Median**			**1.14**	**2.83**
NA	2	CT	Inshore	0.54	2.06
NA	2	CT	Ocean<=3mi	0.02	0.07
NA	2	CT	Ocean>3mi	0.18	0.7
NA	2	MA	Inshore	1.24	4.77
NA	2	MA	Ocean<=3mi	13.19	87.76
NA	2	MA	Ocean>3mi	0.79	4.7
NA	2	ME	Ocean<=3mi	0.56	2.01
NA	2	ME	Ocean>3mi	0.39	1.31
NA	2	NH	Inshore	124.35	373.49
NA	2	NH	Ocean<=3mi	1.23	4.84
NA	2	NH	Ocean>3mi	1.79	5.57
NA	2	RI	Inshore	5.4	16.22
NA	2	RI	Ocean<=3mi	3.71	13.4
NA	2	RI	Ocean>3mi	0.35	1.56
NA	3	CT	Inshore	1.33	6.18
NA	3	CT	Ocean<=3mi	0.79	2.66
NA	3	CT	Ocean>3mi	2.75	16.1

REGION	WAVE	STATE	AREA	RATIO	SE ADJ
NA	3	MA	Inshore	1.01	2.98
NA	3	MA	Ocean<=3mi	2.35	8.28
NA	3	MA	Ocean>3mi	2.51	10.12
NA	3	ME	Inshore	4.45	18.32
NA	3	ME	Ocean<=3mi	2.58	14.63
NA	3	ME	Ocean>3mi	0.78	3.18
NA	3	NH	Inshore	31.39	103.66
NA	3	NH	Ocean<=3mi	4.13	24.17
NA	3	NH	Ocean>3mi	1.15	4.53
NA	3	RI	Inshore	39.96	268.61
NA	3	RI	Ocean<=3mi	2.78	9.53
NA	3	RI	Ocean>3mi	0.53	2.59
NA	4	CT	Inshore	1.58	5.75
NA	4	CT	Ocean<=3mi	0.74	2.69
NA	4	CT	Ocean>3mi	0.32	1.83
NA	4	MA	Inshore	1.65	4.96
NA	4	MA	Ocean<=3mi	3.72	17.85
NA	4	MA	Ocean>3mi	2.45	9.06
NA	4	ME	Inshore	4.6	18.58
NA	4	ME	Ocean<=3mi	1.78	5.99
NA	4	ME	Ocean>3mi	0.86	3.56
NA	4	NH	Inshore	111.95	550.67
NA	4	NH	Ocean<=3mi	9.7	74.71
NA	4	NH	Ocean>3mi	1.77	7.73
NA	4	RI	Inshore	64.59	311.43
NA	4	RI	Ocean<=3mi	4.75	17.54
NA	4	RI	Ocean>3mi	1.36	5.49
NA	5	CT	Inshore	0.56	1.6
NA	5	CT	Ocean<=3mi	0.06	0.21
NA	5	CT	Ocean>3mi	0.78	4.11
NA	5	MA	Inshore	1.51	8.03
NA	5	MA	Ocean<=3mi	4.33	37.87
NA	5	MA	Ocean>3mi	3.01	15.95
NA	5	ME	Inshore	3.43	14.34
NA	5	ME	Ocean<=3mi	1.28	5.26
NA	5	ME	Ocean>3mi	0.53	2.31
NA	5	NH	Inshore	43.84	131.68
NA	5	NH	Ocean<=3mi	2.3	8.43
NA	5	NH	Ocean>3mi	3.32	14.4
NA	5	RI	Inshore	90.29	426.86
NA	5	RI	Ocean<=3mi	4.78	21.08
NA	5	RI	Ocean>3mi	0.89	5.1
NA	6	CT	Inshore	0.51	1.7
NA	6	CT	Ocean<=3mi	1.14	3.42
NA	6	CT	Ocean>3mi	1.29	6.51
NA	6	MA	Inshore	1.4	4.87
NA	6	MA	Ocean<=3mi	3.94	21.35
NA	6	MA	Ocean>3mi	1.63	6.8
NA	6	RI	Inshore	6.12	29.14
NA	6	RI	Ocean<=3mi	3.46	24.32
NA	6	RI	Ocean>3mi	1.35	6.85
NA	**Median**			**1.71**	**6.83**
SA	1	FLE	Inshore	5.21	12.7
SA	1	FLE	Ocean<=3mi	1.92	5.69
SA	1	FLE	Ocean>10mi	1.24	2.24
SA	1	FLE	Ocean>3mi	0.71	2.17
SA	2	FLE	Inshore	16.4	44.3
SA	2	FLE	Ocean<=3mi	1.39	3.23
SA	2	FLE	Ocean>3mi	1.14	2.49
SA	2	GA	Inshore	1.02	2.14
SA	2	GA	Ocean<=3mi	1.32	3.17
SA	2	GA	Ocean>3mi	4.39	16.27
SA	2	NC	Inshore	0.72	1.6
SA	2	NC	Ocean<=3mi	1.38	2.98
SA	2	NC	Ocean>3mi	0.8	1.79
SA	2	SC	Inshore	0.64	1.47
SA	2	SC	Ocean<=3mi	0.45	0.97
SA	2	SC	Ocean>3mi	1.21	2.92
SA	3	FLE	Inshore	2.42	5.41
SA	3	FLE	Ocean<=3mi	6.86	44.3
SA	3	FLE	Ocean>3mi	0.58	1.16
SA	3	GA	Inshore	1.1	2.17
SA	3	GA	Ocean<=3mi	2.62	5.13
SA	3	GA	Ocean>3mi	3.45	7.14
SA	3	NC	Inshore	1.73	4.44
SA	3	NC	Ocean<=3mi	1.99	5.02
SA	3	NC	Ocean>3mi	1.75	3.51
SA	3	SC	Inshore	0.69	1.63
SA	3	SC	Ocean<=3mi	0.7	1.61
SA	3	SC	Ocean>3mi	1.13	2.31
SA	4	FLE	Inshore	3.35	7.4
SA	4	FLE	Ocean<=3mi	1.14	2.59
SA	4	FLE	Ocean>3mi	0.69	1.55
SA	4	GA	Inshore	3.6	8.49
SA	4	GA	Ocean<=3mi	4.74	12.12
SA	4	GA	Ocean>3mi	7.86	20.35
SA	4	NC	Inshore	3	7.03
SA	4	NC	Ocean<=3mi	2.53	6.53
SA	4	NC	Ocean>3mi	2.37	5.6
SA	4	SC	Inshore	1.31	4.04
SA	4	SC	Ocean<=3mi	1.48	4.26
SA	4	SC	Ocean>3mi	2.69	7.05
SA	5	FLE	Inshore	3.49	9.64
SA	5	FLE	Ocean<=3mi	1.3	4.43
SA	5	FLE	Ocean>3mi	0.97	2.84
SA	5	GA	Inshore	1.08	2.66
SA	5	GA	Ocean<=3mi	1.26	2.8
SA	5	GA	Ocean>3mi	2.25	6.06
SA	5	NC	Inshore	4.57	12.74
SA	5	NC	Ocean<=3mi	1.29	2.7
SA	5	NC	Ocean>3mi	1.34	2.7
SA	5	SC	Inshore	0.52	1.23
SA	5	SC	Ocean<=3mi	0.27	0.81
SA	5	SC	Ocean>3mi	1.5	5.54
SA	6	FLE	Inshore	8.88	20.8
SA	6	FLE	Ocean<=3mi	0.93	2.19
SA	6	FLE	Ocean>3mi	0.61	1.56
SA	6	GA	Inshore	1.26	3.11
SA	6	GA	Ocean<=3mi	2.68	5.88
SA	6	GA	Ocean>3mi	2.21	5.43
SA	6	NC	Inshore	1.83	3.6
SA	6	NC	Ocean<=3mi	4.16	13.83
SA	6	NC	Ocean>3mi	4.27	18.54
SA	6	SC	Inshore	0.68	2.41
SA	6	SC	Ocean<=3mi	0.18	0.44
SA	6	SC	Ocean>3mi	1.59	7.13
SA	**Median**			**1.39**	**3.56**
ALL	**Median**			**1.44**	**4.12**

Table 2: Estimated CHTS to FHS conversion factors.

Figure 1: Relationship between model-estimated FHS trips and CHTS trips, color coded by sub-region with a 1:1 reference line.

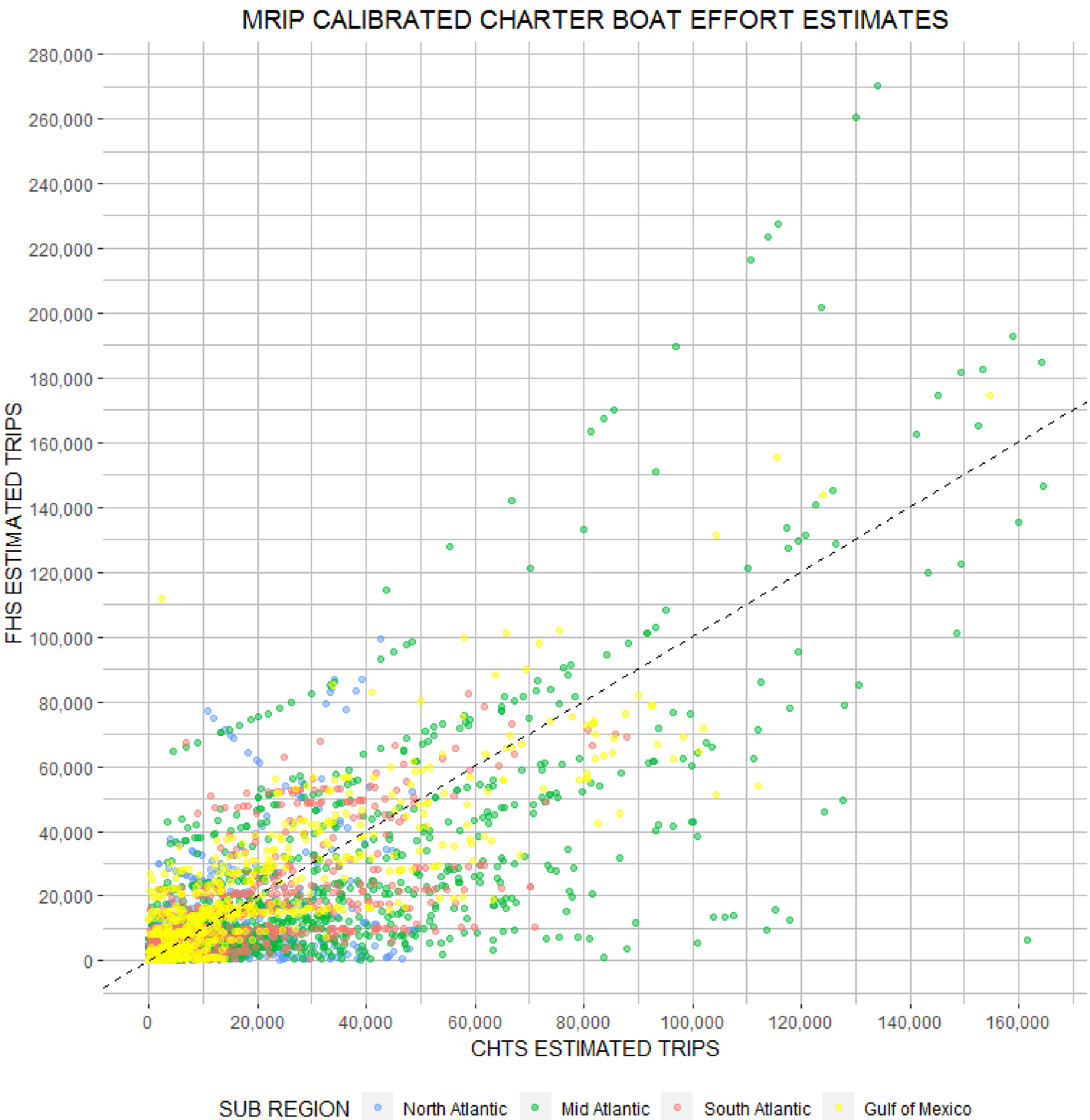
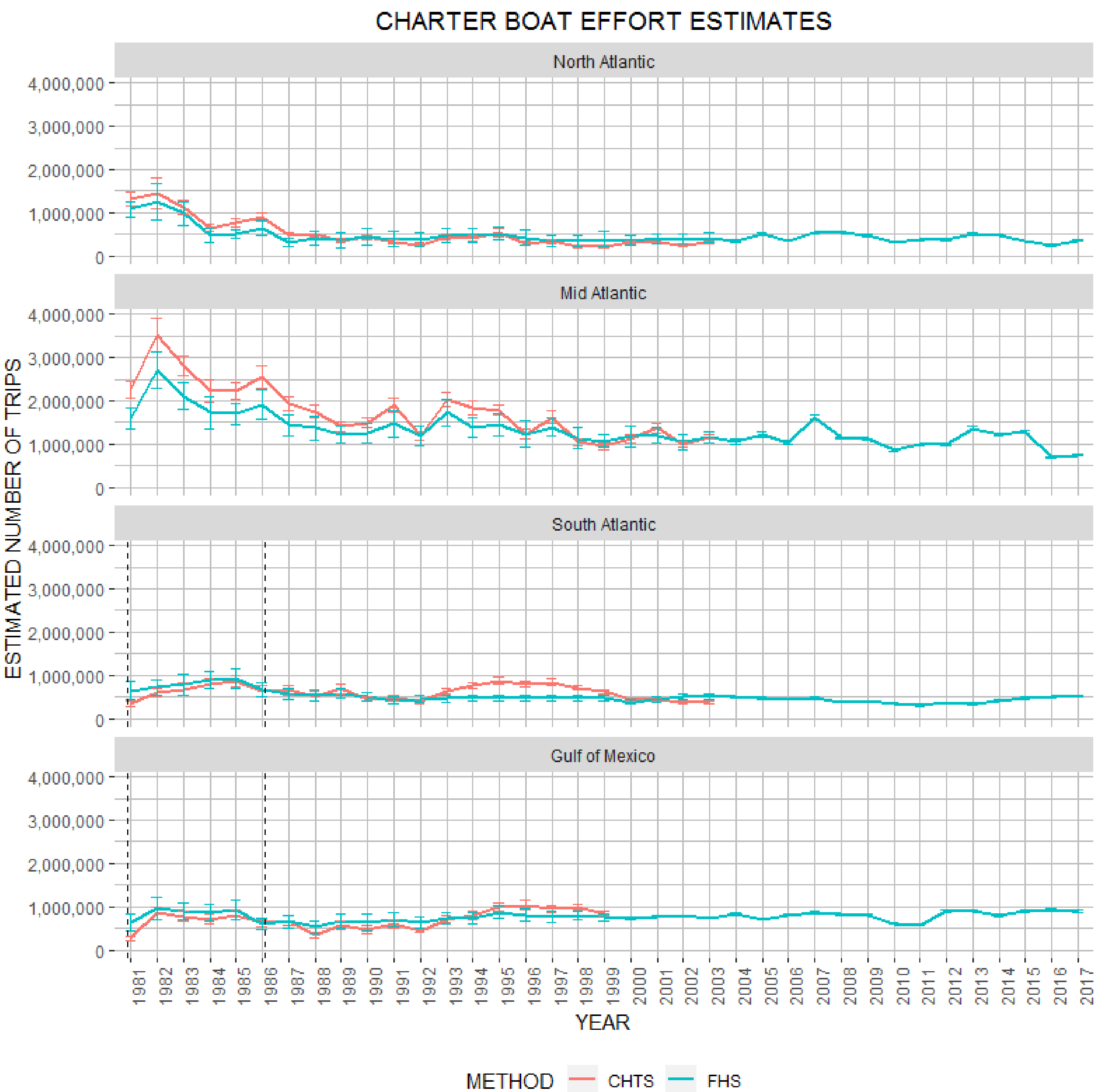


Figure 2: Annual time series of aggregated FHS and CHTS charterboat effort estimates (with standard errors) by sub-region. Values in years between dashed vertical lines represent combined charter/headboat effort (all values in North and Mid Atlantic represent combined effort).



Note that within a given stratum, overall FHS effort (and thus catch) estimates are estimated to be greater than CHTS estimates (median ratio > 1). However, as seen in figure 2, this varies from year to year and sub-region to sub-region when estimates are aggregated on an annual level. Estimates from each method in the North Atlantic are relatively similar across time, while CHTS seemed to overestimate effort in the Mid Atlantic in earlier years. In contrast, in the Gulf of Mexico and South Atlantic, CHTS effort appears to have been slightly underestimated in earlier years and slightly overestimated in later years. Some ratios may lack robustness on an individual level due to lack of data in given stratum, and those with large standard error adjustments should be applied cautiously. This approach is preferable to previous methods in which data were aggregated before the estimation of calibration factors, leading to the loss of spatial and temporal variability. Potential relationships across space and time are now preserved, and a unified methodology now allows for a fair comparison of estimates across years and sub-regions. It is also possible to apply these ratios to smaller spatial units (e.g., domains) under the assumption that the relationship between estimates is constant across the level at which the ratio was calculated.

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Sminkey, T. 2008. Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates from the Southeastern US (North Carolina to Florida-east coast) in 1981-2003 with For-Hire Survey estimates with application to King Mackerel landings. Silver Spring, MD. SEDAR 16-DW-15.

APPENDIX 1: GOM red grouper and SA greater amberjack

Table 3: FHS vs. CHTS total catch estimates and standard errors (lbs.) for Gulf of Mexico red grouper by year and state.

YEAR	ST	CHTS	FHS	SE CHTS	SE FHS
1981	FLW	363,673	510,314	242,969	511,851
1982	FLW	126,361	135,185	42,131	72,029
1983	FLW	104,388	110,497	27,963	42,565
1984	AL	91	65	105	116
1984	FLW	576,684	644,827	241,060	378,460
1985	FLW	740,949	796,397	412,123	702,280
1986	FLW	291,429	226,476	67,338	73,792
1987	FLW	139,396	121,858	38,337	45,728
1988	FLW	100,410	127,891	31,352	57,038
1989	FLW	318,997	240,474	100,911	113,438
1990	AL	270	116	270	181
1990	FLW	280,962	289,768	135,189	200,979
1991	FLW	349,796	261,127	299,924	329,672
1991	FLW	35	33	24	35
1992	FLW	227,020	281,258	58,949	114,065
1993	FLW	107,470	113,240	49,342	78,706
1994	FLW	222,611	189,067	97,615	135,512
1995	AL	147	5	166	9
1995	FLW	439,978	312,006	143,841	159,248
1996	AL	163	150	193	274
1996	FLW	233,841	152,131	100,623	100,764
1997	FLW	201,671	150,604	49,077	62,267
1998	FLW	367,184	230,890	67,375	65,076
1999	AL	164	74	112	78
1999	FLW	556,087	411,423	87,216	113,825
Total		**5,749,777**	**5,305,872**	**689,750**	**1,082,731**

Figure 4: Gulf of Mexico red grouper annual estimates for FHS calibrated years (error bars represent ±1 SE).

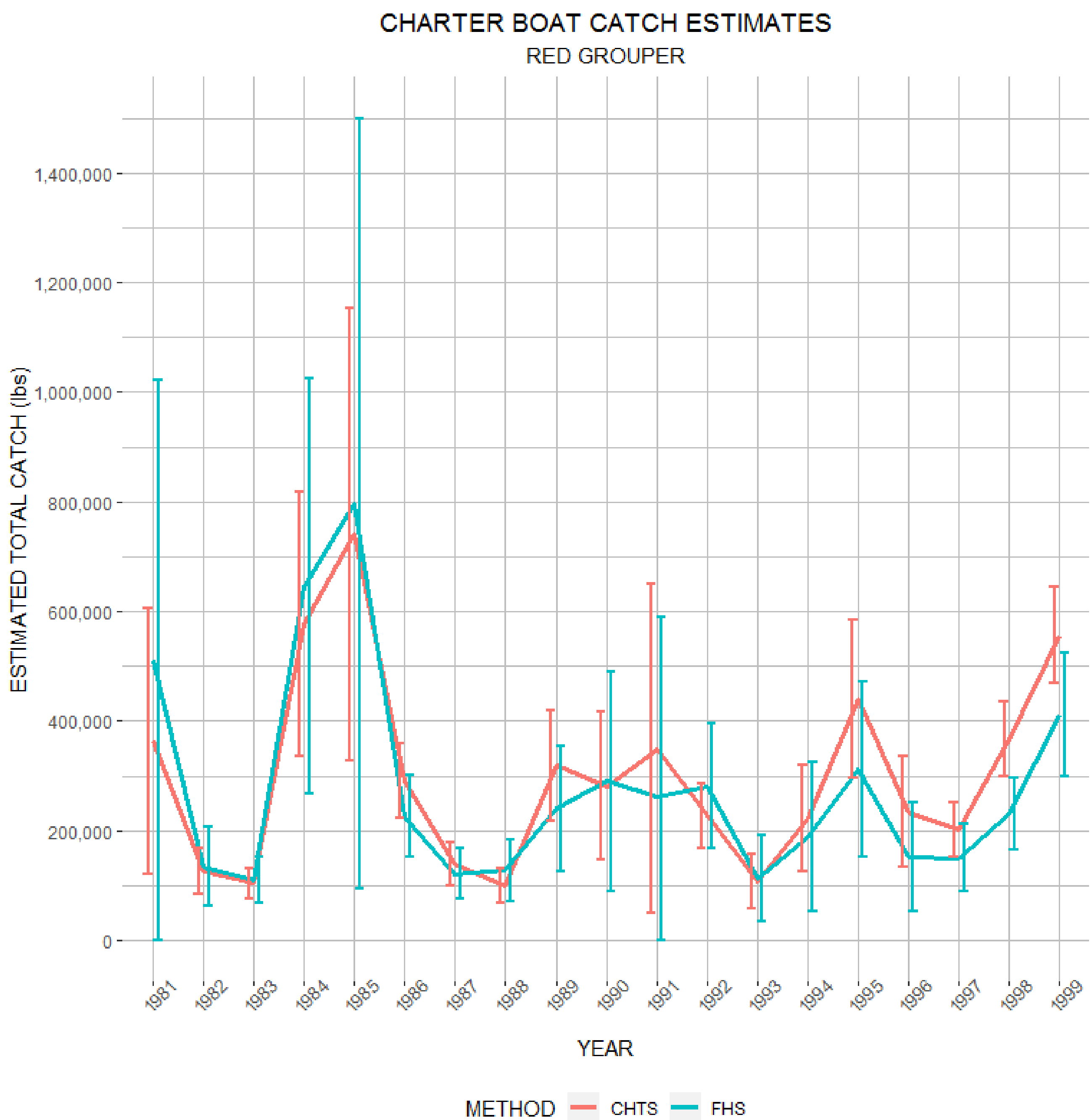
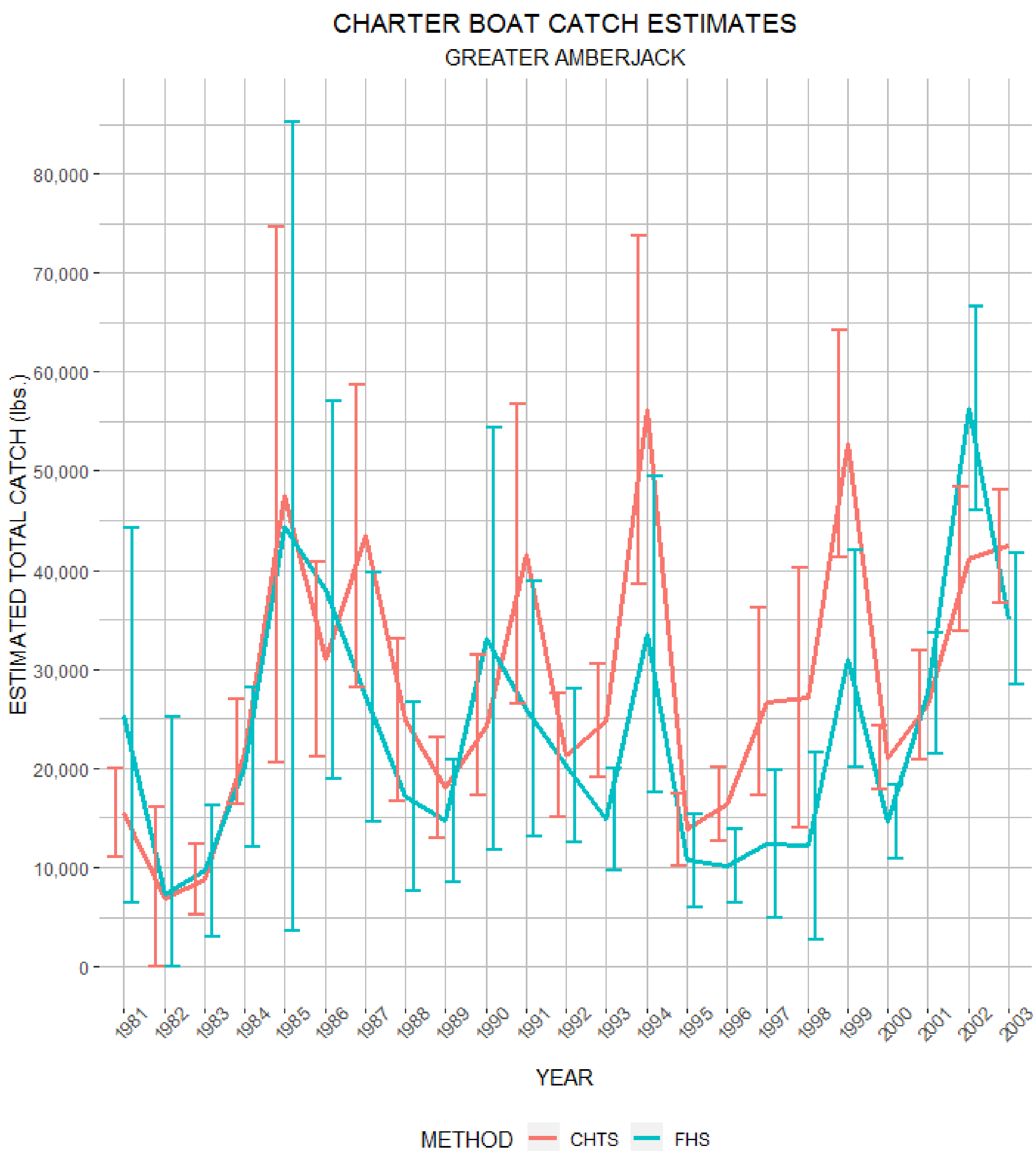


Table 4: FHS vs. CHTS total catch estimates and standard errors (lbs.) for South Atlantic greater amberjack by year and state.

YEAR	ST	CHTS	FHS	SE CHTS	SE FHS
1981	FLE	14,592	16,724	4,361	8,876
1981	NC	772	7,727	934	16,608
1981	SC	171	857	190	1,692
1982	FLE	6,830	7,352	9,312	17,822
1983	FLE	8,035	8,703	3,527	6,539
1983	NC	659	471	662	842
1983	SC	71	460	63	703
1984	FLE	15,206	15,917	4,309	7,465
1984	GA	517	673	319	722
1984	NC	754	593	764	1,068
1984	SC	5,180	2,903	2,895	2,722
1985	FLE	20,429	21,225	10,445	18,631
1985	GA	2,215	2,037	2,085	3,287
1985	SC	24,962	21,129	24,876	36,191
1986	FLE	18,754	19,660	9,083	16,746
1986	GA	465	4,299	291	5,259
1986	NC	6,302	10,650	2,326	6,849
1986	SC	5,460	3,406	3,017	3,326
1987	FLE	37,531	19,109	15,095	12,079
1987	GA	1,024	2,663	900	2,767
1987	NC	2,619	2,861	1,689	1,629
1987	SC	2,291	2,608	785	1,624
1988	FLE	21,663	12,828	7,971	8,972
1988	NC	886	3,406	451	3,164
1988	SC	2,328	912	1,938	1,044
1989	FLE	14,641	11,440	4,959	6,018
1989	NC	1,336	2,629	439	1,523
1989	SC	2,026	639	1,037	475
1990	FLE	16,632	15,094	5,853	10,370
1990	NC	7,175	17,273	3,953	18,617
1990	SC	548	668	301	622
1991	FLE	38,419	21,958	15,048	12,732
1991	GA	392	640	370	1,076
1991	NC	1,710	2,650	512	1,282
1991	SC	1,133	725	820	902
1992	FLE	18,731	14,829	6,189	7,210
1992	GA	1,238	2,957	579	2,493
1992	NC	1,208	2,344	435	1,489
1992	SC	143	150	134	241
1993	FLE	18,565	8,921	5,269	4,404
1993	NC	2,656	4,361	688	2,111
1993	SC	3,575	1,582	2,171	1,667

YEAR	ST	CHTS	FHS	SE CHTS	SE FHS
1994	FLE	49,473	24,655	17,421	15,307
1994	GA	1,406	2,533	959	3,078
1994	NC	3,538	5,344	897	2,773
1994	SC	1,768	1,031	1,770	1,774
1995	FLE	11,417	7,571	3,603	4,577
1995	GA	52	159	18	99
1995	NC	2,195	2,798	520	1,225
1995	SC	181	146	184	257
1996	FLE	10,424	4,179	3,353	2,397
1996	GA	575	457	473	574
1996	NC	4,246	4,826	1,193	2,728
1996	SC	1,178	681	796	912
1997	FLE	24,304	10,312	9,442	7,388
1997	GA	176	386	126	538
1997	NC	1,323	1,031	427	761
1997	SC	942	616	375	439
1998	FLE	24,915	9,628	13,107	9,333
1998	GA	101	109	95	184
1998	NC	1,984	2,400	728	1,642
1998	SC	75	39	74	66
1999	FLE	50,784	27,811	11,357	10,646
1999	GA	332	1,530	166	1,470
1999	NC	1,631	1,699	1,279	2,073
1999	SC	25	20	24	34
2000	FLE	19,119	11,055	3,137	2,751
2000	GA	349	1,524	269	2,127
2000	NC	715	1,007	289	696
2000	SC	903	1,088	408	1,115
2001	FLE	23,224	23,136	5,406	5,475
2001	GA	1	3	1	6
2001	NC	3,009	4,302	1,005	2,642
2001	SC	123	140	85	170
2002	FLE	34,090	43,978	7,067	8,638
2002	GA	542	1,834	367	2,212
2002	NC	6,470	10,501	1,819	5,204
2002	SC	36	43	40	86
2003	FLE	38,615	26,701	5,578	5,094
2003	GA	1,208	3,176	683	2,732
2003	NC	1,755	2,838	895	2,577
2003	SC	864	2,366	551	1,987
Total		**653,912**	**541,686**	**50,054**	**67,619**

Figure 5: South Atlantic greater amberjack annual estimates for FHS calibrated years (error bars represent ±1 SE).



APPENDIX 2: Model Output

Gamma GLM (log-link)

	FHS TRIPS					
	North Atlantic	Mid Atlantic	South Atlantic	South Atlantic (81-85)	Gulf of Mexico	Gulf of Mexico (81-85)
ESTRIPS	5.25e-5** (2.56e-5)	9.54e-6*** (3.23e-6)	1.82e-6 (3.88e-6)	5.07e-6*** (8.38e-7)	6.88e-6** (3.07e-6)	3.57e-6* (1.85e-6)
ESTRIPS:AREA_X2	-7.71e-5***(2.66e-5)					
ESTRIPS:AREA_X5	-1.21e-5 (2.93e-5)					
ESTRIPS:AREA_X6						
AREA_X1	6.357*** (0.315)		9.999*** (0.191)		5.554*** (0.218)	
AREA_X2	6.851*** (0.280)	0.950*** (0.318)	9.149*** (0.192)		6.609*** (0.219)	
AREA_X3					4.700*** (0.422)	
AREA_X4					5.380*** (0.429)	
AREA_X5	5.928*** (0.315)	1.048*** (0.318)	8.312*** (0.178)		4.756*** (0.228)	
AREA_X6	3.169*** (0.467)	-2.695*** (0.829)				
ST9	-1.920*** (0.350)					
ST12					4.707*** (0.349)	
ST13			-3.689*** (0.271)			
ST22					0.939*** (0.268)	8.267*** (0.142)
ST24		0.526 (0.402)				
ST25	1.142*** (0.332)					
ST28					-0.960*** (0.342)	
ST33	-0.124 (0.369)					
ST34		2.850*** (0.321)				
ST36		2.544*** (0.330)				
ST37			-3.087*** (0.255)	8.999*** (0.109)		
ST44	0.837** (0.330)					
ST45			-4.322*** (0.240)	8.035*** (0.104)		
ST51		-0.442 (0.323)				
STAFW						11.145*** (0.229)
STGFE				10.825*** (0.103)		
WAVE2		5.608*** (0.271)	-0.394* (0.234)	0.317** (0.130)	1.546*** (0.290)	0.644*** (0.202)
WAVE3	1.187*** (0.212)	7.208*** (0.262)	-0.335 (0.232)	1.989*** (0.136)	2.127*** (0.287)	2.156*** (0.202)
WAVE4	2.078*** (0.238)	7.784*** (0.258)	-0.238 (0.235)	2.157*** (0.138)	2.268*** (0.287)	1.947*** (0.201)
WAVE5	0.908*** (0.217)	6.697*** (0.262)	-1.392*** (0.234)	1.357*** (0.129)	0.720** (0.287)	1.469*** (0.202)
WAVE6	-0.317 (0.243)	6.067*** (0.259)	-0.836*** (0.235)	0.146 (0.091)	-0.818*** (0.305)	0.455** (0.201)
AREA_X2:ST9	0.707 (0.475)					
AREA_X2:ST12						

AREA_X2:ST13			1.303*** (0.222)	
AREA_X2:ST22				-0.618*** (0.220)
AREA_X2:ST24		-0.109 (0.499)		
AREA_X2:ST25	1.450*** (0.444)			
AREA_X2:ST28				-1.897*** (0.242)
AREA_X2:ST33	1.551*** (0.474)			
AREA_X2:ST34		-0.354 (0.439)		
AREA_X2:ST36		-0.718 (0.436)		
AREA_X2:ST37			1.343*** (0.194)	
AREA_X2:ST44	-0.477 (0.438)			
AREA_X2:ST45			1.514*** (0.229)	
AREA_X2:ST51		-0.129 (0.436)		
AREA_X2:WAVE2			1.423*** (0.299)	0.824** (0.349)
AREA_X2:WAVE3			1.088*** (0.303)	0.859** (0.351)
AREA_X2:WAVE4			0.788*** (0.299)	0.583* (0.350)
AREA_X2:WAVE5			1.296*** (0.296)	1.323*** (0.349)
AREA_X2:WAVE6			0.820*** (0.300)	0.296 (0.370)
AREA_X3:ST12				
AREA_X3:ST22				
AREA_X3:ST28				
AREA_X3:WAVE2				0.870 (0.606)
AREA_X3:WAVE3				1.162* (0.606)
AREA_X3:WAVE4				1.118* (0.606)
AREA_X3:WAVE5				1.705*** (0.605)
AREA_X3:WAVE6				1.763*** (0.615)
AREA_X4:ST12				
AREA_X4:ST22				
AREA_X4:ST28				
AREA_X4:WAVE2				0.234 (0.607)
AREA_X4:WAVE3				0.425 (0.621)
AREA_X4:WAVE4				0.536 (0.619)
AREA_X4:WAVE5				1.662*** (0.604)
AREA_X4:WAVE6				1.552** (0.616)
AREA_X5:ST9	3.169*** (0.516)			
AREA_X5:ST12				
AREA_X5:ST13			2.405*** (0.222)	
AREA_X5:ST22				2.465*** (0.221)
AREA_X5:ST24		1.677*** (0.502)		
AREA_X5:ST25	0.644 (0.486)			
AREA_X5:ST28				0.493** (0.223)
AREA_X5:ST33	-0.105 (0.574)			

AREA_X5:ST34		-1.390*** (0.431)		
AREA_X5:ST36		-0.690 (0.428)		
AREA_X5:ST37			1.019*** (0.196)	
AREA_X5:ST44	-0.308 (0.456)			
AREA_X5:ST45			2.422*** (0.223)	
AREA_X5:ST51		1.272*** (0.436)		
AREA_X5:WAVE2			1.003*** (0.304)	0.577* (0.340)
AREA_X5:WAVE3			0.416 (0.298)	0.529 (0.337)
AREA_X5:WAVE4			0.308 (0.299)	0.254 (0.336)
AREA_X5:WAVE5			1.100*** (0.301)	1.371*** (0.338)
AREA_X5:WAVE6			1.065*** (0.304)	1.619*** (0.357)
AREA_X6:ST9	0.832 (0.696)			
AREA_X6:ST24		-1.988** (0.998)		
AREA_X6:ST25	-0.647 (0.681)			
AREA_X6:ST33	0.180 (0.762)			
AREA_X6:ST34		-1.771* (0.925)		
AREA_X6:ST36		-1.578* (0.944)		
AREA_X6:ST44	-1.469** (0.648)			
AREA_X6:ST51		-1.579 (1.020)		
ST12:WAVE2				-1.384*** (0.459)
ST12:WAVE3				-2.000*** (0.462)
ST12:WAVE4				-2.509*** (0.461)
ST12:WAVE5				-2.339*** (0.461)
ST12:WAVE6				-0.898* (0.461)
ST13:WAVE2			-0.410 (0.290)	
ST13:WAVE3			0.871*** (0.287)	
ST13:WAVE4			1.087*** (0.287)	
ST13:WAVE5			0.850*** (0.287)	
ST13:WAVE6				
ST22:WAVE2				-1.278*** (0.312)
ST22:WAVE3				-0.830*** (0.307)
ST22:WAVE4				-0.795** (0.309)
ST22:WAVE5				-0.632** (0.306)
ST22:WAVE6				0.047 (0.314)
ST28:WAVE2				0.402 (0.401)
ST28:WAVE3				0.816** (0.400)
ST28:WAVE4				0.938** (0.399)
ST28:WAVE5				1.270*** (0.401)
ST28:WAVE6				1.120*** (0.425)
ST37:WAVE2			0.566* (0.291)	
ST37:WAVE3			2.583*** (0.299)	

ST37:WAVE4			2.867*** (0.304)			
ST37:WAVE5			2.593*** (0.296)			
ST37:WAVE6			1.481*** (0.292)			
ST45:WAVE2			0.622** (0.290)	1.148*** (0.119)		
ST45:WAVE3			1.842*** (0.273)	0.406*** (0.115)		
ST45:WAVE4			2.348*** (0.273)	0.487*** (0.119)		
ST45:WAVE5			1.860*** (0.281)	0.447*** (0.115)		
ST45:WAVE6						
STAFW:WAVE2						-0.173 (0.292)
STAFW:WAVE3						-1.670*** (0.326)
STAFW:WAVE4						-1.500*** (0.298)
STAFW:WAVE5						-1.553*** (0.303)
STAFW:WAVE6						-0.637** (0.285)
STGFE:WAVE2				-0.075 (0.122)		
STGFE:WAVE3				-1.790*** (0.120)		
STGFE:WAVE4				-1.806*** (0.115)		
STGFE:WAVE5				-1.533*** (0.146)		
STGFE:WAVE6						
Observations	178	222	322	78	332	60
Log Likelihood	-1,539.0	-2,076.1	-2,939.3	-775.0	-2,959.7	-656.3
Bayesian Inf. Crit.	3,221.2	4,290.6	6,119.0	1,626.4	6,230.9	1,367.9

Note: Standard errors in parenthesis *p<0.1; **p<0.05; ***p<0.01