NOAA Technical Memorandum NMFS-SEFSC-703
doi: 10.25923/fpe8-r440

SUMMARY OF ECONOMIC DATA COLLECTED BY THE GULF OF MEXICO AND SOUTH ATLANTIC HEADBOAT LOGBOOKS: 2015

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NATIONAL MARINE FISHERIES SERVICE
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February 2017

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This report should be cited as follows:
Carter, David W. and Christopher Liese. 2017. Summary of Economic Data Collected by the Gulf of Mexico and South Atlantic Headboat Logbooks: 2015. NOAA Technical Memorandum NMFS-SEFSC-703. 34 p. doi: 10.25923/fpe8-r440

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1 Introduction and Methods

Large for-hire fishing vessels, called headboats or partyboats, play an important role in the southeast region's recreational fisheries.[1] Headboats provide an affordable way for individual, often unscheduled, customers to participate in a half or full day (or longer) of bottom or drift fishing. The customer is typically charged $40 to $100 for a fishing trip that includes the gear, bait, and fishing instructions. The Beaufort Laboratory of NOAA Fisheries has been collecting catch and effort data from headboat vessels with a logbook system (Southeast Region Headboat Survey) since 1972 along the southeast coast of the U.S. (hereafter South Atlantic) and since 1986 along the coast of the Gulf of Mexico. In 2014, shortly after moving to an electronic reporting platform, four questions related to economics were added to the logbook. For each trip, the new questions asked about the number of crew, the number of non-fishing passengers, the gallons of fuel used, and the price paid per gallon of fuel. This report summarizes the data collected from vessels during 2015.[2] Vessel information from the permit records maintained by the NOAA Fisheries Southeast Regional Office (SERO) was added to the dataset.[3]

Although longer trips occur, we only consider trips less than 13 hours in the analysis because the U.S. Coast Guard (USCG) recommends that trips over 12 hours should have 2 captains and 2 deckhands.[4] The requirement of extra captain and crew increases the cost of these longer trips, effectively defining a product and market distinct from the trips

[1]This document was generated using the `knitr` (Xie 2015) package for `R` (R Core Team 2016) in `RStudio` (RStudio Team 2015). Tables were generated using either `xtable` (Dahl 2016) or `texreg` (Leifeld 2013). Other key packages used are referenced throughout the document.

[2]The remaining data from non-permitted vessels may be examined in future work.

[3]Headboats fishing in Federal waters are required to have a permit.

[4]The USCG Marine Safety Manual, Vol. III: Marine Industry Personnel (p. B3-18) states: 46 U.S.C. 8104(b) provides that licensed individuals (credentialed officers) on oceangoing vessels of not more than 100 GRT "may not be required" to work more than 12 hours in a 24-hour period while at sea. Credentialed operators serving as OUPV may voluntarily work more than 12 hours in a 24-hour period. However, Officer in Charge, Marine Inspections should strongly encourage uninspected passenger vessels operating in excess of 12 hours to have at least two credentialed operators assigned to prevent fatigue.

of 12 hours or less. In order to focus on headboat-type vessels and trips we removed vessels that are not permitted to take more than six passengers and removed trips that took less than seven passengers. We also removed vessels with fewer than 10 trips in 2015.

We cleaned the dataset by removing or fixing obvious outliers. Specifically, the trips reporting fuel prices less than or equal to one, lasting less than 3 hours, or using 5 or less gallons of fuel were removed. Trips reporting more fuel use than the fuel capacity of the headboat and more use than 999 gallons were examined. In all cases, the reported high usage was the result of extra digits during data entry. There were also some trips reporting more than 9 crew members. High crew numbers that were not the result of an extra digit were removed. There were some vessels with zeros for crew, fuel, and fish box capacity in the SERO vessel permit file. We replaced the zeros with the means for these variables from the remaining vessels.

The data analysis results are reported first for the entire Southeast and then separately for the Gulf of Mexico (GOM) and South Atlantic (SA) regions. Both the Southeast and the regional analyses include summary statistics for the key headboat characteristics and trip variables overall and by trip duration. The price of headboat trips generally varies according to the length of the trip with 1/2 day (3-5.5 hours), 3/4 day (6-7.5 hours), and full day (8-9.5 hours), and full day plus (10-12 hours) among the most common durations. Each of the three summaries (Southeast, GOM, and SA) also includes figures depicting the share of total annual gallons used per month and the average gallons per hour used in each month.

The analysis of the combined (GOM and SA) Southeast data includes three additional components. The first is an attempt to establish the validity of the data by comparing the average weekly fuel prices reported in the headboat dataset with average prices reported by the U.S. Energy Information Administration (EIA) for the same period.[5] In the second additional analysis component, we present maps to illustrate the spatial distribution of key trip characteristics. The maps delineate the average trip characteristics according to headboat homeport county. In the third additional part of the combined (GOM and SA) Southeast data analysis we estimate a series of regressions to explore the determinants of variations in headboat fuel usage. We regress the gallons of fuel used on the price of fuel, the duration of the trip, the number of passengers, and the maximum depth fished while controlling for vessel characteristics:[6]

$$
\begin{aligned}
ln(gallons_{ij}) = \alpha &+ \beta_1 price_{ij} + \beta_2 hours_{ij} + \beta_3 passengers_{ij} + \beta_4 depth_{ij} \\
&+ \beta_5 \overline{price}_j + \beta_6 \overline{hours}_j + \beta_7 \overline{passengers}_j + \beta_8 \overline{depth}_j \\
&+ \beta_9 length_j + \beta_{10} net\ \ tons_j + \beta_{11} passenger\ \ capacity_j + \beta_{12} horsepower_j \\
&+ r_j + u_{ij}
\end{aligned}
\tag{1}
$$

on trip i by headboat j where the overline indicates a vessel-level average and a variable without a i subscript is a headboat characteristic that does not vary by trip (length, net tons, passenger capacity, horsepower). The first random component, r_j, represents unobserved variation at the headboat level and the second random component, u_{ij}, is the unobserved variation at the trip level. If the unobserved headboat variation, r_j, is uncorrelated with the observed trip-level regressors (conditional on the vessel-level averages and characteristics), then the parameters of the equation can be consistently estimated using feasible generalized least squares (GLS). This modeling approach is known as the corre-

[5]Some headboats pay wholesale prices rather than the retail prices reported by the EIA. However, we are interested in the general trend of prices and wholesale and retail prices tend to move together.

[6]Later work will explore other potential covariates, especially trip catch.

lated random effects (CRE) estimator (Wooldridge 2015). In theory, CRE estimates of the coefficients on the trip-level variables will be identical to the coefficients obtained via fixed effects (FE) estimation using ordinary least squares (OLS) because these methods are two different ways of estimating the same exact model: the FE estimator subtracts the vessel-level averages before OLS estimation whereas the CRE estimator includes the vessel-level averages separately in GLS estimation of the model. Note that simply estimating the equation above via OLS does not deal with the systematic heteroskedasticity related to the unobserved vessel-level heterogeneity, r_j, and could generate biased estimates and predictions.

We conduct a series of tests to evaluate the validity of CRE model assumptions and fit. The first is a test of the null hypothesis that there are no unobserved vessel effects, $r_j = 0$ (Wooldridge 2010). Rejecting the null hypothesis of no unobserved effects in the model suggests that estimating the CRE equation via OLS is not appropriate. If we reject the hypothesis of no unobserved effects, then the next test evaluates whether the unobserved effects are fixed or random because there are efficiency gains to modeling the effects as random if they are not correlated with the other variables in the model. The standard random effects (RE) model estimator is appropriate when $\beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$. This hypothesis can be tested using a Wald test. If we cannot reject the null hypothesis of this Wald test, then the expanded CRE model applies. Lastly, we estimate a CRE model without the vessel characteristics and conduct another Wald test to evaluate the null hypothesis that $\beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = 0$. If we cannot reject the null hypothesis of this Wald test, then the full CRE model applies.

The standard errors from all of the regression coefficients and hypothesis tests are adjusted (upward) to account for the fact that trip observations from the same headboat are correlated. Specifically, we use White's covariance estimator clustered on vessel. Note that the dependent variable, *gallons*, is transformed with a natural logarithm prior to estimation of the model parameters. We compute maximum log-likelihoods over a range of the Box-Cox power transformation parameter for a version of the model equation to examine the validity of the logarithmic transformation.[7] If the confidence interval of the Box-Cox power transformation parameter is suitably close to zero, then the logarithmic transformation is appropriate.

2 Results

2.1 Southeast Analysis

The 2015 headboat logbook dataset consisted of 26,911 trips taken by 141 vessels. Removing vessels without permits to harvest in federal waters leaves 120 vessels taking 20,793 trips. Further cleaning the dataset to remove a) vessels with less than 10 trips; b) trips less than 3 hours and greater than 12 hours; c) trips with prices less than or equal to 1; and d) trips reporting 5 or less gallons used, leaves a set of 114 vessels taking 19,291 trips. Most of the vessels and trips removed from consideration operate in the South Atlantic. The final list of vessels included in the study is shown in the Appendix.

2.1.1 Summary

The descriptive statistics for the key characteristics of all GOM and SA headboats are presented in Table 1. Descriptive statistics for all trips in the SA and GOM are presented

[7] The Box-Cox power transformation is given by

$$gallons_{ij}^{(\lambda)} = \begin{cases} \frac{gallons_{ij}^{\lambda}-1}{\lambda} & (\lambda \neq 0) \\ ln(gallons_{ij}) & (\lambda = 0) \end{cases}$$

where λ is the transformation parameter. We use the `boxcox` function from the `R` package `MASS` (Venables & Ripley 2002).

in Table 2. Headboats took around 180 trips on average during 2015, but at least one vessel that took more than 2 trips per day. The average headboat in our Southeast sample is 30 years old, around 60 feet long, weighing 50 (net) tons, with the capacity to take up to 70 passengers per trip. The average headboat carries 3 crew members and can hold around 1,000 gallons of fuel to operate engines with more than 1,000 horsepower.

The average headboat trip in the Southeast during 2015 used 80 gallons of fuel to carry 30 anglers/passengers and 2 crew members. Headboats paid about $3 per gallon for fuel. Interestingly, though, the price of fuel ranged from less than 2 dollars to over 6 dollars per gallon. The range of fuel usage on a trip was also quite wide, going from 6 to 900 gallons.

The average trip characteristics by duration of the selected trips in the GOM and SA are shown in Table 3. Longer trips use more fuel on average, nearly doubling with each duration increment. The remaining trip characteristics also seem to increase with duration. However,the difference between each trip duration for each characteristic is not large.

The distribution of total annual gallons used on headboat trips across the year in the GOM and SA is shown in Figure 1, and the average gallons per hour by month is shown in Figure 2. The majority of headboat fuel usage takes place during the summer months. Headboats also tend to use the most fuel per hour during the summer months.

2.1.2 Fuel Price Validation

This is the first attempt to systematically collect economic data at the trip level for headboats in the Southeast U.S. Therefore, it is difficult to find estimates that can be used to verify our results. At least one variable, the price per gallon of fuel, can be verified in aggregate using an external data source. Figure 3 compares the average weekly

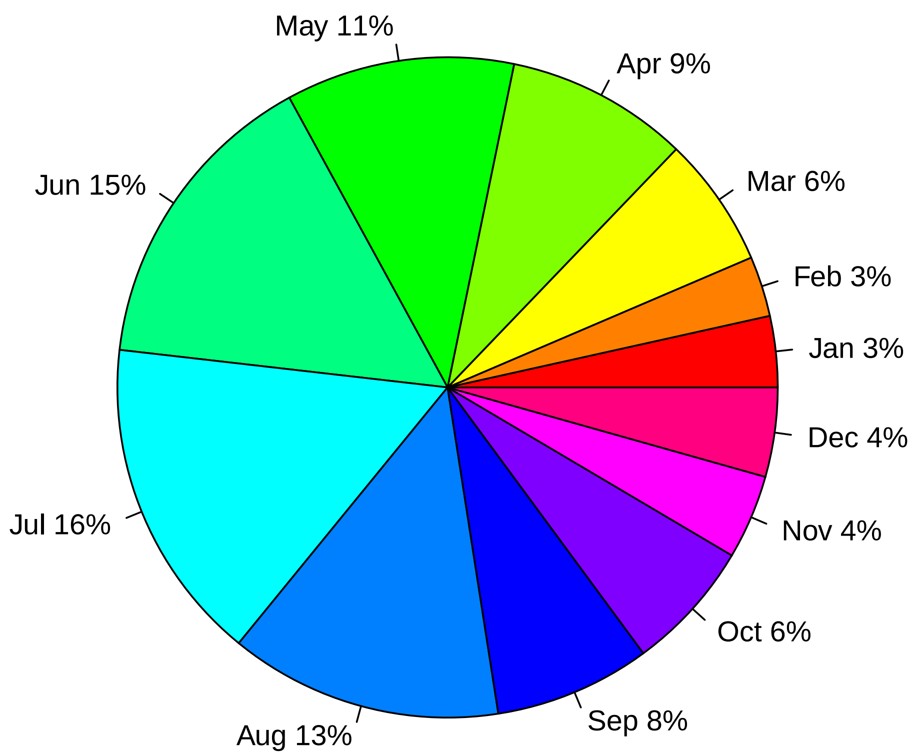

Figure 1: Monthly Distribution of Total Gallons of Fuel Used by Headboats in the Southeast

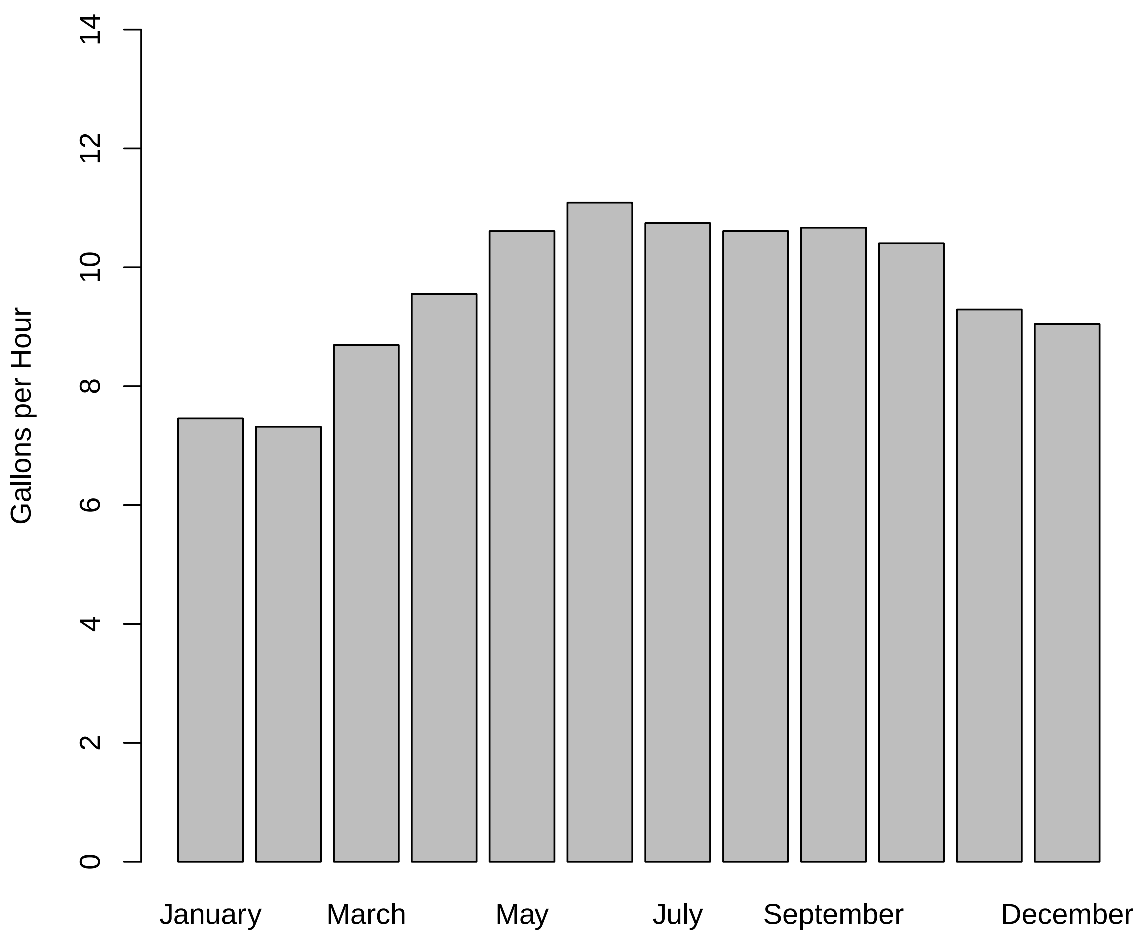

Figure 2: Gallons of Fuel Used per Hour on Southeast Headboat Trips by Month

Table 1: Southeast Headboat Characteristics from SERO Permit File (N=114)

Statistic	Mean	St. Dev.	Min	Median	Max
Trips per Vessel	178.30	142.55	15	139	772
Gross Tonage	64.41	23.26	15	66	99
Net Tonage	47.03	16.07	11	48	82
Passenger Capacity	69.40	34.28	16	64	150
Age	29.36	11.62	1	29	52
Length	62.71	11.95	36	64.5	85
Horsepower	1,088.58	491.17	300	1,000	3,150
Crew Size	3.15	1.08	2.00	3.00	6.00
Fish Box Capacity	1,612.78	1,777.31	100.00	1,342.02	12,000.00
Fuel Capacity	1,166.71	757.88	250.00	1,000.00	4,000.00

Table 2: Southeast Headboat Trip Characteristics (N=19,291)

Statistic	Mean	St. Dev.	Min	Median	Max
Gallons	82.10	84.52	6	52	900
Price per Gallon	3.02	0.75	1.26	3.00	6.63
Anglers	30.29	18.06	1	26	127
Passengers	30.61	18.40	7	26	160
Crew	2.10	1.02	1	2	8

Table 3: Southeast Headboat Trip Characterstics by Trip Duration

Duration	Gallons	Price per Gallon	Anglers	Passengers	Crew
1/2 day (3-5.99 hours)	35.92	3.44	25.23	25.26	1.63
3/4 day (6-7.99 hours)	69.08	3.30	30.27	30.43	2.24
Full day (8-9.99 hours)	138.85	2.89	31.39	31.56	2.57
Full day plus (10-12 hours)	205.27	2.60	33.29	33.63	2.49

fuel price reported during 2015 from the headboat logbook and the weekly on-highway price of diesel fuel reported by the EIA.[8] The price data collected in the logbook tracks the general downward trend in prices from the EIA through the year. Marine diesel fuel

[8]The EIA diesel fuel prices were obtained from the Gasoline and Diesel Fuel Update website: `http://www.eia.gov/petroleum/gasdiesel/`.

is generally more expensive than diesel fuel purchased at on-highway locations. This is reflected in Figure 3 during every week in 2015.

2.1.3 Spatial Distribution of Trip Characteristics

Before turning to the regression results and the regional summaries we look at three trip characteristics by county across the Southeast. Every trip in the dataset is assigned a county based on the homeport of the corresponding headboat vessel. The top panel of Figure 4 shows the average gallons used per trip from each county. Trips originating from ports in southern Florida use relatively less fuel, perhaps because the Gulf Stream is closer and fuel is more expensive in the urban areas. Similar maps are shown for the number of passengers and the number of crew in the other two panes of Figure 4.

2.1.4 Fuel Use Regression

The data summary statistics and the results of the combined GOM and SA trip fuel use regressions are shown in Tables 4 and 5, respectively.[9] The top five rows in Table 4 report statistics for trip characteristics whereas the bottom five report statistics for headboat characteristics (measured over trips not vessels).

Though not shown in Table 5, the 95% confidence interval for the value of parameter of the Box-Cox transformation (estimated over the range -.25 to .25) that maximizes the log-likelihood of the regression equation is (0.04, 0.06). This range is sufficiently close to zero to justify the logarithmic transformation of the dependent variable, *gallons*, in the regression.

Four regression model results are shown in the columns of Table 5 with the first and last columns representing the full model specification. However, the estimates in the

[9] All regressions were conducted using the `plm` package in `R` (Croissant & Millo 2008).

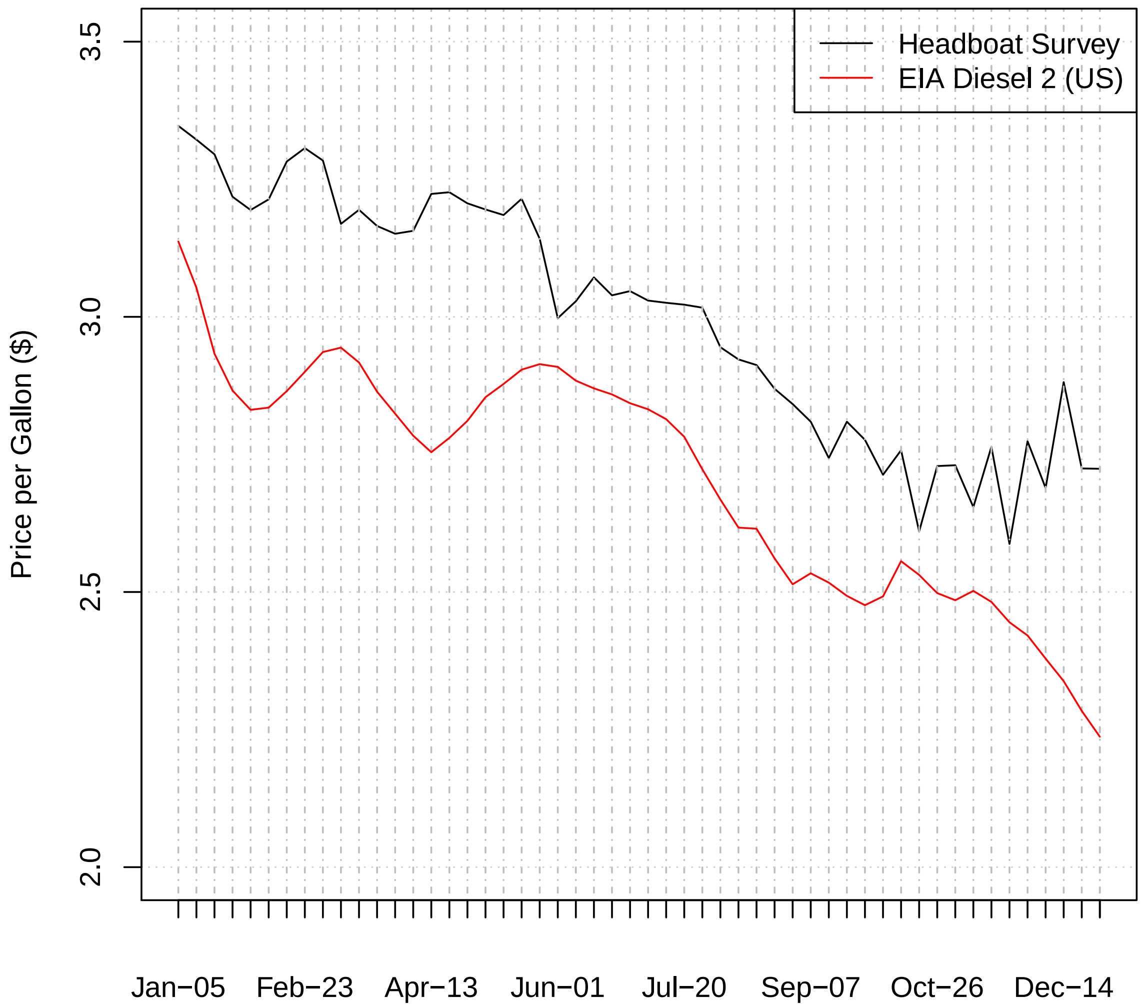

Figure 3: Weekly Fuel Prices in 2015: Southeast Region Headboat Survey and EIA Diesel 2

first column have been estimated via OLS and the estimates in the last column have be estimated via GLS, representing the complete CRE modeling approach. Note that some variables have been scaled by a factor of 10 or 100 to ease presentation. The typical coefficient of determination, R^2, for these models would indicate how well each model fits the dependent variable in logarithms. A more relevant measure of model fit, however, is how well the model fits the dependent variable in level form, i.e. without the logarithmic transformation. This measure is given by the square of the correlation between the actual values of the dependent variable and the antilogarithm of the predicted values from the regression (Wooldridge 2015). The R^2 in levels for each model is shown in the last row of the table. These values indicate that the panel data estimators that explicitly deal with vessel-level variation all predict the level of fuel use better than the pooled OLS estimator. This suggests that there is a considerable amount of vessel-level heterogeneity in the data and that pooled OLS model is not appropriate because it does not adequately control for variations at the vessel-level.

We conduct a series of tests to evaluate the validity of increasing levels of model complexity. The first is a test of the null hypothesis there are no unobserved vessel effects (Wooldridge 2010). We reject the null of no unobserved effects in the model at the 99% level ($4.44 \sim z$), suggesting that the pooled OLS estimates in the first column are not appropriate. This is an important finding because the coefficient and standard error estimates from the pooled estimator are somewhat different than the estimates from the other models in the table.

The next test evaluates whether the unobserved effects are fixed or random because there are efficiency gains to modeling the effects as random if they are not correlated with the other variables in the model. The second column shows that the RE estimates are very similar to the FE estimates in the third column. However, a Wald test that the parameters in the FE model, but not in the RE model are jointly zero is rejected at the 99% level (190.92 $\sim \chi^2$, $df = 4$). This indicates that the FE model is more appropriate than the RE model. Lastly, we conduct another Wald test to determine if the full CRE model in the last column is an improvement over the FE model. The test that the parameters in the CRE model, but not in the FE model are jointly zero is rejected at the 95% level (14.78 $\sim \chi^2$, df =5). Therefore, we focus on the full CRE model in the following discussion of the model parameters.

The price per gallon is not statistically different from zero suggesting that vessels do not adjust fuel usage when prices change. However, we may not have enough variation in prices and fuel usage to conclude that this is always the case. We are only using data collected over one year during which fuel prices were relatively low and fairly stable. Our model measures how any given headboat changes fuel usage during a trip given different prices. Headboat operations are likely to run fewer or no trips when faced with very high fuel prices. This effect is not measured in the current formulation of the fuel use regression model.

Longer trips with more passengers in deeper waters use more fuel on average. In addition, a headboat that takes longer trips on average than other vessels and takes a higher average number of passengers than other vessels has higher fuel usage. Interestingly, though, a headboat with higher passenger capacity uses less fuel than average for the same number of passengers, hours, depth fished, etc. Other headboat characteristics are not statistically different from zero. Caution should be used in interpreting the results related to vessel and average trip characteristics because many of these factors generally relate to the size of the headboat and are, therefore, likely to be correlated.

The semi-elasticity or percent change in gallons for a unit change in an independent variable, x, is given by $exp(x) - 1$. The semi-elasticities for the statistically significant variables are 13.65, 1.52, 0.78, 10.85, 23.66, -4.95 for, respectively, Hours, Passengers/10, Max Depth/10, Vessel Passengersverage Hours, Vessel Passengersverage Passengers, Passenger Capacity/10. For example, fuel usage increases on average by almost 14% for every additional hour of a trip and around three quarters of a percent for each 10 feet deeper fished.

Table 4: Summary Statistics of Variables in Fuel Use Regression (N=19,291)

Statistic	Mean	St. Dev.	Min	Median	Max
Gallons	82.10	84.52	6	52	900
Price per Gallon	3.02	0.75	1.26	3.00	6.63
Hours	5.92	2.14	3.00	5.00	12.00
Passengers	30.61	18.40	7	26	160
Max Depth	101.17	78.62	10	80	1,200
Feet	63.46	10.85	36	65	85
Net Tons	47.80	14.79	11	48	82
Passenger Capacity	74.00	33.43	16	70	150
Horsepower	1,051.76	464.46	300	900	3,150
Age	28.45	10.55	1	29	52

Table 5: Fuel Use Regression Models (N=19,291)

	Pooled (OLS)	RE (GLS)	FE (GLS)	CRE (GLS)
Intercept	1.361^{**}	3.310^{***}	2.081^{***}	1.932^{***}
	(0.495)	(0.119)	(0.345)	(0.388)
Price per Gallon (P)	0.025	0.023	0.025	0.025
	(0.023)	(0.023)	(0.023)	(0.023)
Hours (H)	0.128^{***}	0.128^{***}	0.128^{***}	0.128^{***}
	(0.011)	(0.011)	(0.011)	(0.011)
Passengers/10 (A)	0.015^{***}	0.016^{***}	0.015^{***}	0.015^{***}
	(0.003)	(0.003)	(0.003)	(0.003)
Max Depth/10 (D)	0.008^{**}	0.008^{**}	0.008^{**}	0.008^{**}
	(0.003)	(0.003)	(0.003)	(0.003)
Vessel Average P	-0.009		-0.085	-0.085
	(0.087)		(0.083)	(0.079)
Vessel Average H	0.156^{***}		0.118^{***}	0.103^{***}
	(0.031)		(0.024)	(0.024)
Vessel Average A	0.233^{***}		0.187^{***}	0.212^{***}
	(0.039)		(0.018)	(0.035)
Vessel Average D	-0.000		0.007	0.002
	(0.009)		(0.008)	(0.008)
Feet/10	0.067			0.090
	(0.076)			(0.056)
Net Tons/10	0.011			0.023
	(0.045)			(0.032)
Passenger Capacity/10	-0.042			-0.051^{**}
	(0.023)			(0.017)
Horsepower/100	0.006			0.004
	(0.013)			(0.010)
Age	-0.004			-0.005
	(0.004)			(0.003)
R^2	0.736	0.929	0.930	0.930

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. FE is fixed effects, RE is random effects, CRE is correlated RE.

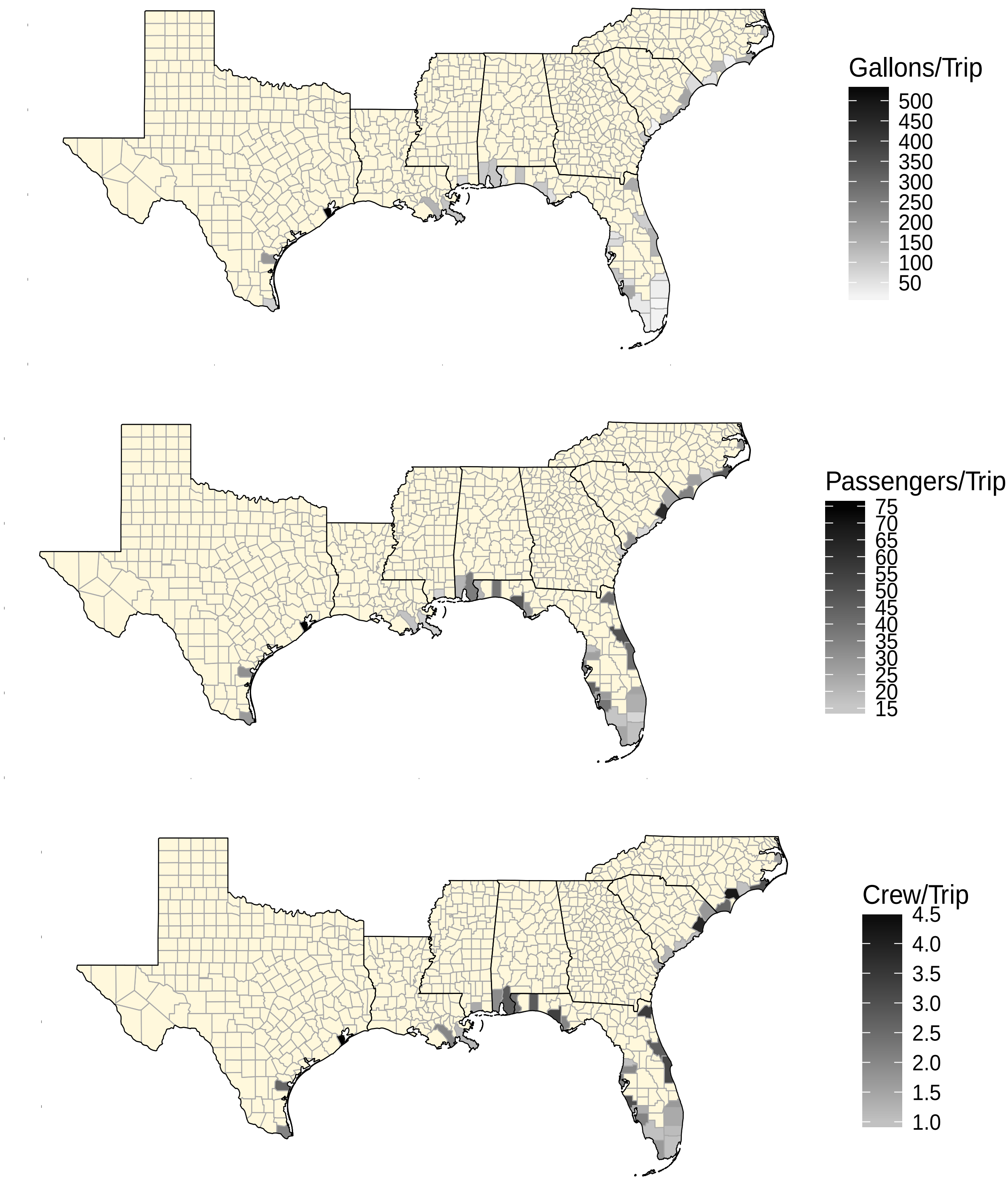

Figure 4: Headboat Trip Characteristics by Homeport County

2.2 Regional Summaries

2.2.1 Gulf of Mexico

The descriptive statistics for the key GOM headboat characteristics are presented in Table 6. There was 1 headboat removed from the original set of permitted GOM vessels, leaving 63 vessels. Headboats in the GOM took around 30 fewer trips on average in 2015 than the average Southeast headboat shown in Table 1. In general, though, average GOM headboat characteristics are similar to the Southeast averages.

Descriptive statistics for trips in the GOM are shown in Table 7. There were 476 trips removed from the original set of trips by permitted vessels in the GOM, leaving a total of 8,854 trips. GOM trips in 2015 used more fuel on average than the average Southeast trip. Trips in the GOM also took more anglers, passengers, and crew on average than Southeast trips overall.

The average characteristics by duration of the 2015 GOM trips are shown in Table 8. Consistent with the general Southeast trip results (Table 3), longer trips used more fuel on average. However, the average 1/2 day trip in the GOM used nearly double the amount of fuel used by the average Southeast trip. The average 3/4 day and full day plus trip in the GOM also used more fuel than the average Southeast trip. Average fuel usage on full day trips, though, was similar on GOM and Southeast trips. The remaining trip characteristics do not vary in a consistent way with duration except trips longer than 10 hours which tend to take more anglers and passengers and carry more crew.

The distribution of total annual gallons used on headboat trips across the year in the GOM is shown in Figure 5, and the average gallons per hour by month is shown in Figure 6. The majority of headboat fuel usage in the GOM takes place during the summer months. Headboats also tend to use the most fuel per hour during the summer months in the GOM. The summer peak of gallons per hour in the GOM is more pronounced than in the Southeast in general shown in Figure 2.

Table 6: Gulf of Mexico Headboat Characteristics from SERO Permit File (N=63)

Statistic	Mean	St. Dev.	Min	Median	Max
Trips per Vessel	148.08	107.27	15	130	543
Gross Tonage	68.90	21.28	26	67	99
Net Tonage	50.43	14.77	19	52	82
Passenger Capacity	68.40	34.00	18	60	150
Age	30.06	12.07	1	29	52
Length	64.54	11.27	39	65	80
Horsepower	1,133.29	527.41	300	1,070	3,150
Crew Size	3.25	1.04	2.00	3.00	6.00
Fish Box Capacity	1,792.00	1,752.00	100.00	1,342.02	10,000.00
Fuel Capacity	1,277.46	733.26	300.00	1,064.04	4,000.00

Table 7: Gulf of Mexico Headboat Trip Characteristics (N=8,854)

Statistic	Mean	St. Dev.	Min	Median	Max
Gallons	108.77	99.58	8	90	900
Price per Gallon	2.66	0.55	1.54	2.53	4.90
Anglers	34.24	18.30	7	31	115
Passengers	34.82	18.85	7	32	127
Crew	2.39	1.01	1	2	8

Table 8: Gulf of Mexico Headboat Trip Characterstics by Trip Duration

Duration	Gallons	Price per Gallon	Anglers	Passengers	Crew
1/2 day (3-5.99 hours)	58.74	2.66	34.01	34.66	2.32
3/4 day (6-7.99 hours)	115.94	2.84	35.36	36.43	2.49
Full day (8-9.99 hours)	115.00	2.62	31.54	31.70	2.21
Full day plus (10-12 hours)	265.26	2.35	40.42	40.80	3.00

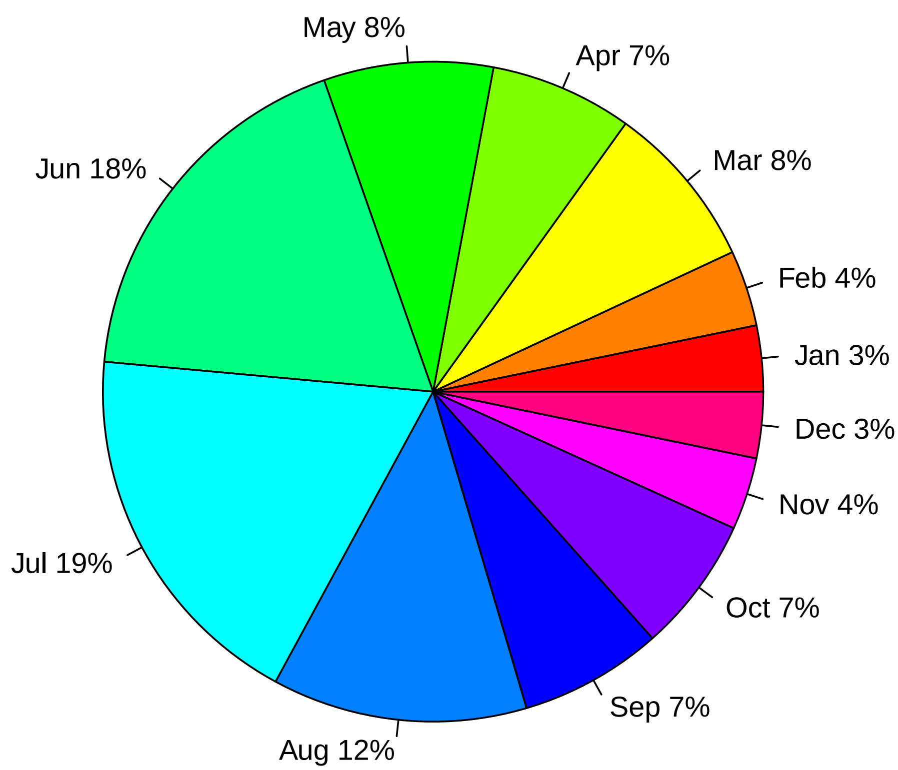

Figure 5: Monthly Distribution of Total Gallons of Fuel Used by Headboats in the Gulf of Mexico

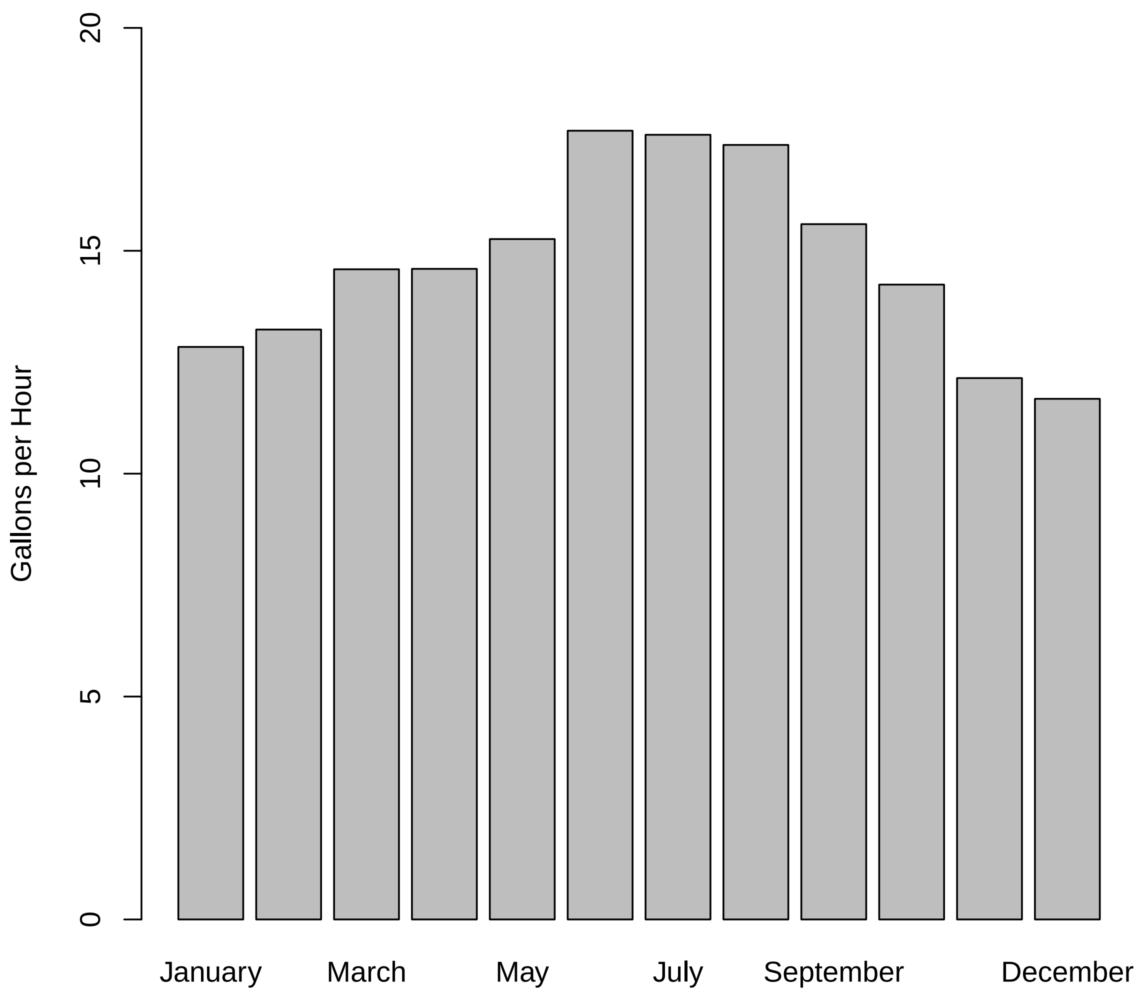

Figure 6: Gallons of Fuel Used per Hour on Gulf of Mexico Headboat Trips by Month

2.2.2 South Atlantic

The descriptive statistics for the key characteristics of SA vessels are presented in Table 9. Five vessels were removed from the original set of permitted vessels in the SA, leaving 51 vessels. Headboats in the SA took 30 more trips on average in 2015 than the average Southeast headboat shown in Table 1. In general, though, average SA headboat characteristics are similar to the Southeast averages.

Descriptive statistics for trips in the SA are presented in Table 10. There were 1,026 trips removed from the original set of trips by permitted vessels in the SA, leaving 10,437 trips. SA trips in 2015 used less fuel on average than the average Southeast trip. Trips in the SA also took fewer anglers, passengers, and crew on average than Southeast trips overall.

The average trip characteristics by duration 2015 trips in the SA are shown in Table 11. Longer trips use more fuel on average, nearly doubling with each duration increment. The remaining trip characteristics also seem to increase with duration. However,the difference between each trip duration for each characteristic is not large, consistent with the overall Southeast averages shown in Table 3.

The distribution of total annual gallons used on headboat trips across the year in the SA is shown in Figure 7, and the average gallons per hour by month is shown in Figure 8. The majority of headboat fuel usage in the SA takes place during the summer months. Headboats also tend to use the most fuel per hour during the summer months in the SA.

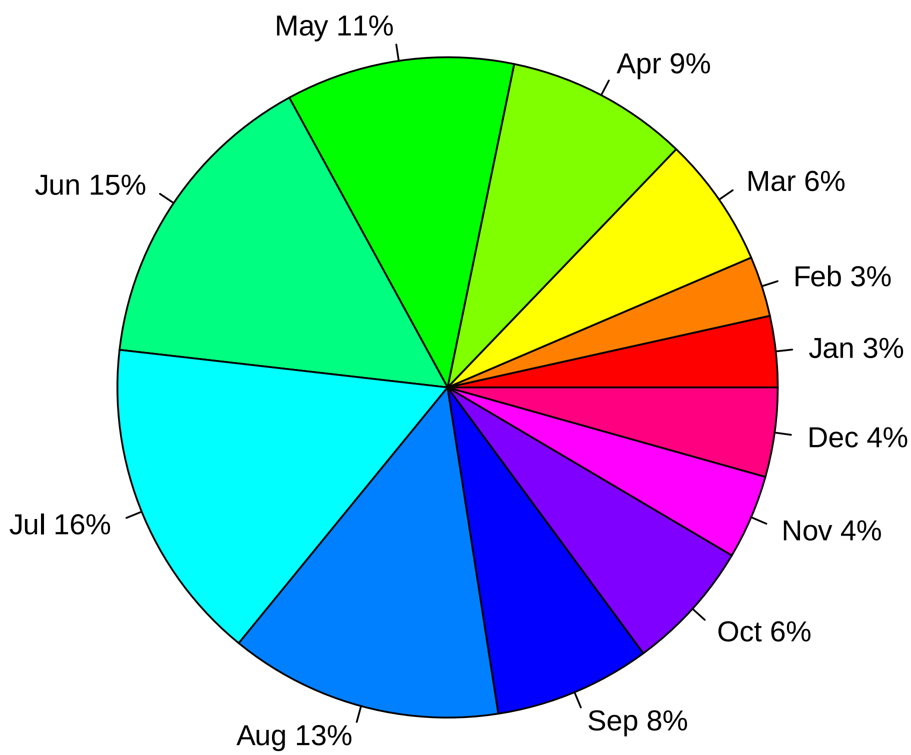

Figure 7: Monthly Distribution of Total Gallons of Fuel Used by Headboats in the South Atlantic

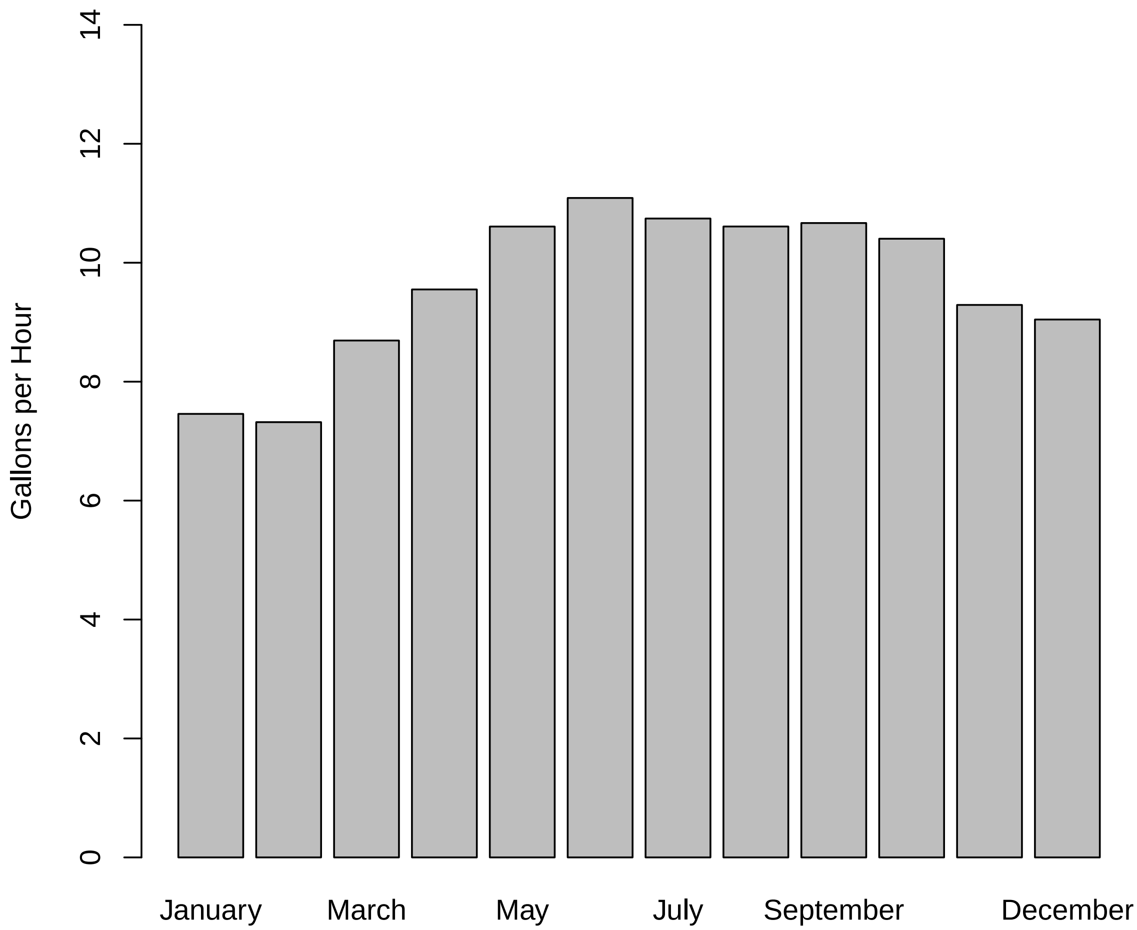

Figure 8: Gallons of Fuel Used per Hour on South Atlantic Headboat Trips by Month

Table 9: South Atlantic Headboat Characteristics from SERO Permit File (N=51)

Statistic	Mean	St. Dev.	Min	Median	Max
Trips per Vessel	215.63	170.54	26	156	772
Gross Tonage	58.86	24.60	15	58	99
Net Tonage	42.82	16.76	11	46	71
Passenger Capacity	70.65	34.93	16	66	150
Age	28.49	11.08	1	29	51
Length	60.45	12.48	36	60	85
Horsepower	1,033.35	441.22	460	900	2,100
Crew Size	3.03	1.14	2.00	2.88	6.00
Fish Box Capacity	1,391.38	1,800.62	100.00	1,000.00	12,000.00
Fuel Capacity	1,029.89	772.56	250.00	800.00	4,000.00

Table 10: South Atlantic Headboat Trip Characteristics (N=10,437)

Statistic	Mean	St. Dev.	Min	Median	Max
Gallons	59.47	60.62	6	30	500
Price per Gallon	3.32	0.76	1.26	3.40	6.63
Anglers	26.95	17.16	1	22	127
Passengers	27.03	17.23	7	22	160
Crew	1.85	0.96	1	2	6

Table 11: South Atlantic Headboat Trip Characterstics by Trip Duration

Duration	Gallons	Price per Gallon	Anglers	Passengers	Crew
1/2 day (3-5.99 hours)	35.92	3.44	25.23	25.26	1.63
3/4 day (6-7.99 hours)	69.08	3.30	30.27	30.43	2.24
Full day (8-9.99 hours)	138.85	2.89	31.39	31.56	2.57
Full day plus (10-12 hours)	205.27	2.60	33.29	33.63	2.49

3 Report Summary

This report summarizes the 2015 results from the first attempt to collect information about fuel usage, fuel prices, crew size, and total passengers on headboat trips in the Gulf of Mexico and the South Atlantic. The information was collected via the Southeast Region

Headboat Survey electronic logbook system. We only report on 114 federally permitted vessels that can reasonably be characterized as headboats, taking 19,291 headboat-type trips lasting less than 13 hours.

The average weekly fuel prices reported in the headboat data follow the general trend of average weekly fuel prices reported by the U.S. Energy Information Administration. Average fuel use, number of passengers, number of crew members all vary by homeport county. This reflects the spatial heterogeneity of the headboat fleet.

Key variables were summarized by Gulf of Mexico and South Atlantic regions and by trip duration within each region. Headboats in the Gulf of Mexico use nearly double the amount of fuel per trip on average than headboats operating in the South Atlantic. This difference could be because the average trip duration in the Gulf of Mexico, 6.61 hours, is higher than the average trip duration, 5.33 hours, in the South Atlantic. Fuel prices are also higher on average in the South Atlantic than the Gulf of Mexico. The distance to fishing grounds tends to be further in the Gulf of Mexico than the South Atlantic. Furthermore, the average vessel size; and passenger and crew load per trip are relatively larger in the Gulf of Mexico.

A regression was used to explore the factors related to expected fuel usage on a headboat trip. We considered the price of fuel, trip duration, the number of passengers, the maximum depth fished as independent variables in the regression. Headboat characteristics such as length, displacement, passenger capacity, and age were also considered. The regression (including vessel fixed factors), explained more than 90% of the variation in fuel use on trips recorded throughout the year in the Gulf of Mexico and South Atlantic. Fuel usage increases on average by almost 14% for every additional hour of a trip and around three quarters of a percent per 10 feet of fishing depth. Each additional passenger increases fuel usage by 1.5%. The price of fuel did not have a statistically significant effect on expected fuel usage which could reflect the limited range of fuel price variation throughout the year and across vessels.

Future work with this dataset could include efforts to create a headboat fuel price index and estimates of aggregate headboat fuel usage and expenditures for the entire Southeast and for the Gulf of Mexico and South Atlantic separately. We would also like to develop methods that can be used to combine the fuel usage and fuel price information along with the data on crew to generate estimates of average variable cost per trip for the region and sub-regions. These cost estimates could be combined with data on the trip passenger fees to calculate estimates of the approximate net operating revenue per trip or passenger on a typical headboat trip. Net operating revenue per trip is an economic measure commonly used in the analysis of fishery management plan amendment alternatives. The ongoing collection of economic data in the headboat survey could contribute to timely estimates of headboat net operating revenues for use in policy analysis.

4 Acknowledgments

We would like to thank Ken Brennan, Steve Turner, and Juan Agar for helping us get the economic questions added to the headboat logbook. Ken Brennan and the Southeast Region Headboat Survey team assisted us with the logbook datasets and reviewed this document. We would also like to thank the headboat operators who continue to respond to the survey and have been willing to share the important information about their operations with us.

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6 Appendix: Headboats Included in the Analysis

Vessel	Region	City	State
ORLANDO PRINCESS	AT	CAPE CANAVERAL	FL
OCEAN OBSESSION II	AT	CAPE CANAVERAL	FL
CANAVERAL PRINCESS	AT	CAPE CANAVERAL	FL
FORT PIERCE LADY	AT	FORT PIERCE	FL
LADY PAMELA III	AT	HOLLYWOOD	FL
CAPT MICHAEL	AT	ISLAMORADA	FL
MISS ISLAMORADA	AT	ISLAMORADA	FL
ISLAND STAR	AT	ISLAMORADA	FL
BLUE HERON II	AT	JUPITER	FL
SAILORS CHOICE	AT	KEY LARGO	FL
GULFSTREAM IV	AT	KEY WEST	FL
TORTUGA	AT	KEY WEST	FL
TORTUGA IV	AT	KEY WEST	FL
LADY K	AT	LANTANA	FL
MARATHON LADY	AT	MARATHON	FL
SEA KING	AT	MARATHON	FL
MAJESTY	AT	MAYPORT	FL
MAYPORT PRINCESS II	AT	MAYPORT	FL
PASTIME PRINCESS	AT	NEW SMYRNA BEACH	FL
ATLANTIS	AT	NORTH MIAMI BEACH	FL
HURRICANE	AT	NORTH MIAMI BEACH	FL
MUCHO-K	AT	NORTH MIAMI BEACH	FL

SEA SPIRIT	AT	PONCE INLET	FL
SUPER CRITTER	AT	PONCE INLET	FL
MISS BLUE HERON	AT	RIVIERA BEACH	FL
SEA LOVE II	AT	ST AUGUSTINE	FL
SEA LOVE III	AT	ST AUGUSTINE	FL
SAFARI I	AT	STUART	FL
LADY STUART I	AT	STUART	FL
REEL 'EM N II	AT	TYBEE ISLAND	GA
SCATT II	AT	TYBEE ISLAND	GA
CAPT STACY IV	AT	ATLANTIC BEACH	NC
GAME ON	AT	CALABASH	NC
NAVIGATOR	AT	CALABASH	NC
FISH SCREAMER III	AT	CALABASH	NC
SS WINNER QUEEN	AT	CAROLINA BEACH	NC
MISS HATTERAS	AT	HATTERAS	NC
STORMY PETREL II	AT	HATTERAS	NC
COUNTRY GIRL	AT	MANTEO	NC
CAROLINA PRINCESS	AT	MOREHEAD CITY	NC
NANCY LEE III	AT	SWANSBORO	NC
VONDA KAY	AT	WRIGHTSVILLE BEACH	NC
DRIFTER	AT	HILTON HEAD	SC
SAFARI IV	AT	LITTLE RIVER	SC
SUNDANCER	AT	LITTLE RIVER	SC
PRIDE OF THE CAROLINAS	AT	LITTLE RIVER	SC
TEASER 2	AT	MOUNT PLEASANT	SC

NEW INLET PRINCESS	AT	MURRELLS INLET	SC
CONTINENTAL SHELF	AT	NORTH MYRTLE BEACH	SC
STARSHIP	AT	NORTH MYRTLE BEACH	SC
SUPER VOYAGER III	AT	NORTH MYRTLE BEACH	SC
ESCAPE	GU	DAUPHIN ISLAND	AL
EMERALD SPIRIT	GU	ORANGE BEACH	AL
REEL SURPRISE	GU	ORANGE BEACH	AL
GULF WINDS II	GU	ORANGE BEACH	AL
AMERICA II	GU	ORANGE BEACH	AL
ZEKE'S LADY	GU	ORANGE BEACH	AL
EXPLORER	GU	ORANGE BEACH	AL
DOUBLE EAGLE III	GU	CLEARWATER	FL
SUPER QUEEN	GU	CLEARWATER	FL
DOUBLE EAGLE II	GU	CLEARWATER	FL
GULF QUEEN	GU	CLEARWATER	FL
DESTIN PRINCESS	GU	DESTIN	FL
SWOOP II	GU	DESTIN	FL
DESTINY	GU	DESTIN	FL
SWEET JODY	GU	DESTIN	FL
SWOOP	GU	DESTIN	FL
VERA MARIE	GU	DESTIN	FL
REEF RAIDER	GU	ENGLEWOOD	FL
FISHIN XPRESS	GU	FORT MYERS BEACH	FL
GREAT GETAWAY	GU	FORT MYERS BEACH	FL
SEA TREK	GU	FORT MYERS BEACH	FL

CHULAMAR	GU	GULF BREEZE	FL
THUNDER	GU	HERNANDO BEACH	FL
FLORIDA FISHERMAN II	GU	MADEIRA BEACH	FL
FRIENDLY FISHERMAN	GU	MADEIRA BEACH	FL
LADY BRETT 45	GU	NAPLES	FL
DALIS	GU	NAPLES	FL
MISS VIRGINIA	GU	NEW PORT RICHEY	FL
FLORIDA QUEEN	GU	PANAMA CITY BEACH	FL
CAPT ANDERSON	GU	PANAMA CITY BEACH	FL
NORTH STAR EXPRESS	GU	PANAMA CITY BEACH	FL
GEMINI QUEEN	GU	PANAMA CITY BEACH	FL
JUBILEE	GU	PANAMA CITY BEACH	FL
TREASURE ISLAND	GU	PANAMA CITY BEACH	FL
STAR QUEEN	GU	PANAMA CITY BEACH	FL
AMERICAN SPIRIT	GU	PANAMA CITY BEACH	FL
NEW FLORIDA GIRL	GU	PANAMA CITY BEACH	FL
MISS E	GU	PENSACOLA	FL
FISH'N XPRESS	GU	PORT ST JOE	FL
FLYING FISH	GU	SARASOTA	FL
MISS PASS A GRILLE	GU	ST PETE BEACH	FL
TWO GEORGES	GU	TARPON SPRINGS	FL
VIKING GULFSTAR	GU	TARPON SPRINGS	FL
LOUISIANA	GU	GOLDEN MEADOW	LA
COUGAR	GU	VENICE	LA
SKIPPER	GU	BILOXI	MS

SILVER DOLLAR III	GU	BILOXI	MS
KEESLER DOLPHIN II	GU	BILOXI	MS
OSPREY II	GU	GALVESTON	TX
CAPT JOHN	GU	GALVESTON	TX
NEW BUCCANEER	GU	GALVESTON	TX
TEXSUN II	GU	GALVESTON	TX
CAVALIER	GU	GALVESTON	TX
LA PESCA	GU	PORT ARANSAS	TX
GULF EAGLE	GU	PORT ARANSAS	TX
WHARF CAT	GU	PORT ARANSAS	TX
KINGFISHER	GU	PORT ARANSAS	TX
PELICAN	GU	PORT ARANSAS	TX
DOLPHIN	GU	PORT ARANSAS	TX
DOLPHIN EXPRESS	GU	PORT ARANSAS	TX
SCAT CAT	GU	PORT ARANSAS	TX
THUNDERBIRD	GU	SOUTH PADRE ISLAND	TX
MURPHY'S LAW	GU	SOUTH PADRE ISLAND	TX