Length Frequency Analysis For the Gray Triggerfish (*Balistes capriscus*) Recreational Fishery In the Gulf of Mexico

Steven Saul

University of Miami
Cooperative Institute for Marine and Atmospheric Studies
4600 Rickenbacker Cswy.
Miami, FL 33149

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Preliminary Draft

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Introduction

The distribution of length and age within a given population is critical information often used in the assessment of that population. Three recreational data collection programs in the Gulf of Mexico assemble length and weight data for a sample of the fish landed by recreational anglers in the region. The Marine Recreational Fisheries Statistics Survey (MRFSS) provides accurate fisheries dependent information across the entire Gulf of Mexico, with the exception of Texas, which collects its own recreational catch information. The Southeast Region Headboat Survey, facilitated by the NOAA Beaufort Laboratory, collects fisheries dependent biological data to support stock management activities. The Headboat Survey includes all Gulf States, except for Mississippi. Finally, the Texas Parks and Wildlife Department Survey collects catch and size compositional information from recreational anglers within their state. The purpose of this paper is to present length at catch information from these three data sources in order to explore the feasibility of combining data sources across various strata and achieving a more holistic understanding of patterns across the Gulf of Mexico (SEFSC Website).

Methods

Similar methodology and treatment was applied to each of the three datasets in order to maintain consistency. The first step in the process was to remove any records located outside of the Gulf of Mexico management area. This treatment was only applicable to the headboat and MRFSS surveys, as the Texas survey is only taken within that state. Data from the headboat survey was removed for all areas defined as Atlantic (including Area 12 in the Florida Keys). In the MRFSS survey, states located outside of the Gulf of Mexico management area were not included; Florida in this survey is divided into two different state codes, one for the East and the other for the West (Gulf management area).

Calculation of Weight-Length Relationship

Once that data was constrained to the Gulf of Mexico management area, the length and weight values had to be converted such that they were all in the same units, inches and pounds respectively. Those data where weight or length equaled zero were removed. In addition, if the length units were in both total or fork length, they were all converted to fork length. The following conversion factors from Goodyear and Thompson (1993) were used to obtain fork (FL) and total length (TL), where length is in inches:

$$TL = 1.214FL – 0.754$$
$$FL = 0.621 + 0.824TL$$

Once the length and weight data was in a uniform unit of measurement, the data was plotted and a nonlinear regression was used to perform an initial fit of the weight length relationship to the points where $WW = aTL^b$ with fork length in inches and whole weight in pounds. Residuals were calculated for this initial fit and the frequency distribution of the residuals was calculated. The upper and lower 0.5 percentile of the residuals was removed and a nonlinear regression using the weight to length relationship was calculated with the remaining data yielding parameters for the relationship. This treatment was applied successfully to the MRFSS data to yield a clean set of data for analysis (Figures 1

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through 5). The headboat data required that prior to fitting a nonlinear regression, two points visually confirmed as existing well outside of the curve be removed (Figure 26). Once this was done, the nonlinear regression had to be fit two times with the calculation and removal of residuals in the upper and lower 0.5 percentile occurring each time (Figures 27 through 31). The length data from the Texas Parks and Wildlife Department did not contain any weight information and therefore the same treatment could not be applied. As a result, a length frequency distribution of all the data was done and illustrated that the length data was all distributed normally and not in need of cleaning (Figure 54).

Length Frequency Analysis

   An analysis of length frequency across various strata was performed to ascertain whether differences in length are present. The records remaining after the cleaning process described above was used in this analysis. Length frequency was calculated across the following strata: year, month or wave (bimonthly), season, state, area (if present), distance from shore (if given), gear (if given), region, and fishing mode. Interactions between year and some of these strata were also explored, depending on the sample size across those particular strata. The mean, 95 and 50 percent confidence intervals, and standard deviation were calculated for each stratum and the interactions. Results are displayed in box plots in Appendix A, and in the diagrams in Appendix B.

Results and Discussion

Marine Recreational Fisheries Statistics Survey

   Figure 6 illustrates the significance of year on fork length across the time series. The significance of region and interaction of region and year on fork length was examined; the majority of the length sampling was done in the Eastern portion of the Gulf (Figures 7 through 9). Analysis by state illustrates differences in mean size one state to another, with most of the samples from Alabama and Florida (Figures 10 through 14). Month and wave, where wave is a bimonthly sampling period, show some variation in mean size (Figures 15 through 22), while season shows that small individuals are caught during the fall and winter (Figure 23). The dominating gear used is hook and line (Figure 24).

NMFS Headboat Survey

   Year, month and season are analyzed with little variation in mean size (Figures 32 through 34). Across year, there appears to be seasonal variation in the fall and winter (Figures 35 through 38). Regionally, more samples were taking in the east, which appears to have a slightly smaller mean size (Figures 39 through 41); this is also evident when looking at mean size across states (Figures 42 through 46). Sample size and mean size vary across the areas defined by the Headboat Survey (Figures 47 through 53).

Texas Parks and Wildlife Department Survey

   Variation in mean size exists across year (Figure 55), slightly across month (Figure 56) and seasonally, with winter signaling a larger means size (Figure 57). Bay area, as defined specifically by the Texas Parks and Wildlife Survey exhibits variation in

mean size, as does fishing mode (Figures 58 and 59). It is important to keep in mind that data from the fishing mode headboat was only collected from 1986 to 1991, and only for headboats operating in the bay (inshore) areas (Figures 59 through 62). Distance from shore indicates that larger individuals are captured further off shore (Figure 63).

Literature Cited

Goodyear, C. Philip and Nancy B. Thompson. 1993. "An evaluation of data on size and catch limits for gray triggerfish in the Gulf of Mexico." National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. 75 Virginia Beach Drive, Miami, Florida. Miami Laboratory Contribution No. MIA-92/93-70.

SEFSC Website. 2005. "Marine Recreational Fisheries Statistics Survey." Southeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic Atmospheric Administration. Accessed 17 June 2005. http://www.st.nmfs.gov/st1/recreational

Appendix A: Graphs and Charts

MRFSS Analysis
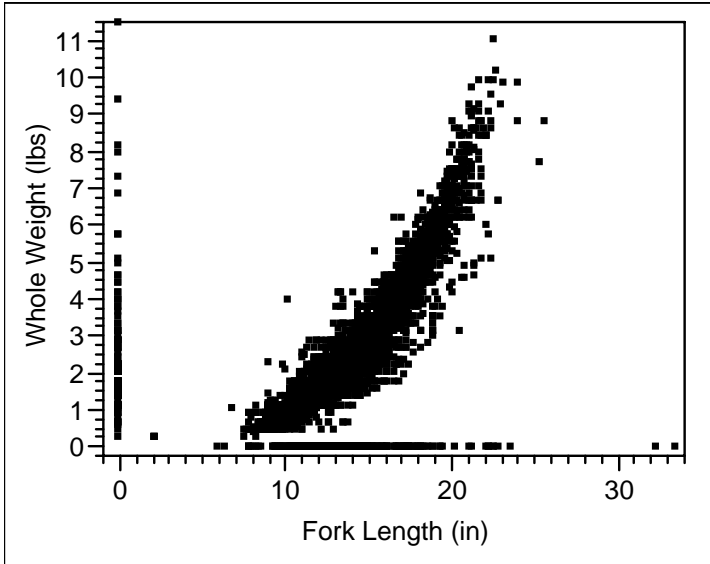
Figure 1: Preliminary plot of fork length against whole weight (n = 21,364).
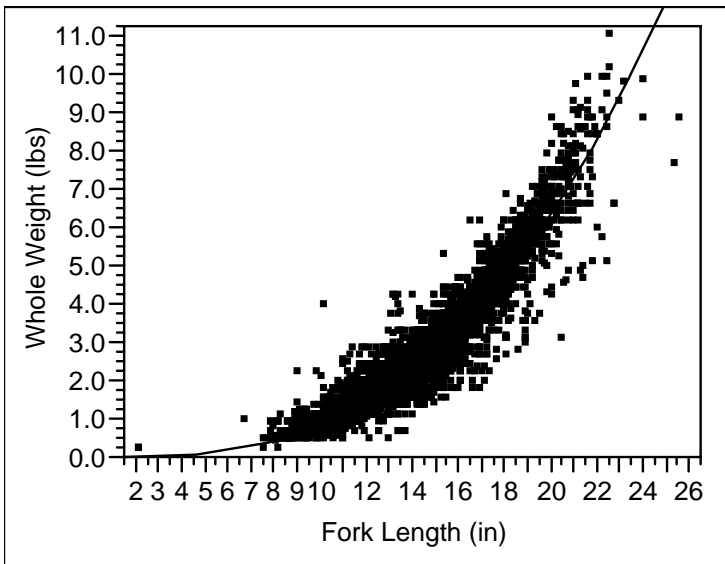
Figure 2: Initial fit of nonlinear regression to the weight length relationship (n = 20,801).
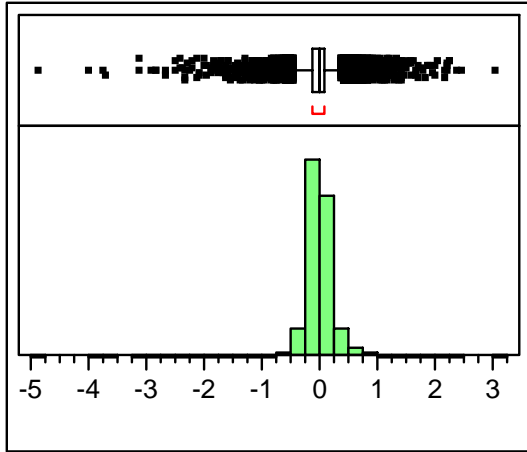
Figure 3: Distribution of residuals calculated during the initial nonlinear regression.
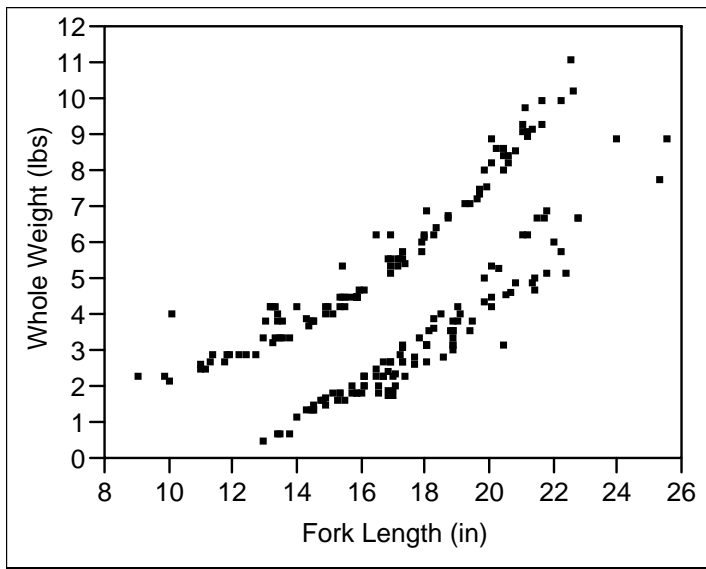
Figure 4: Plot of the length and weight records located in the upper and lower 0.5 percentile of the residual distribution (n = 209).
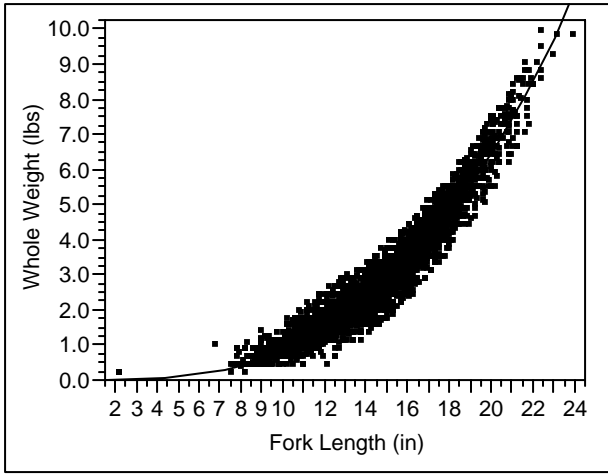
Figure 5: Final Plot of remaining points from which the residuals have been removed (n = 20,592).
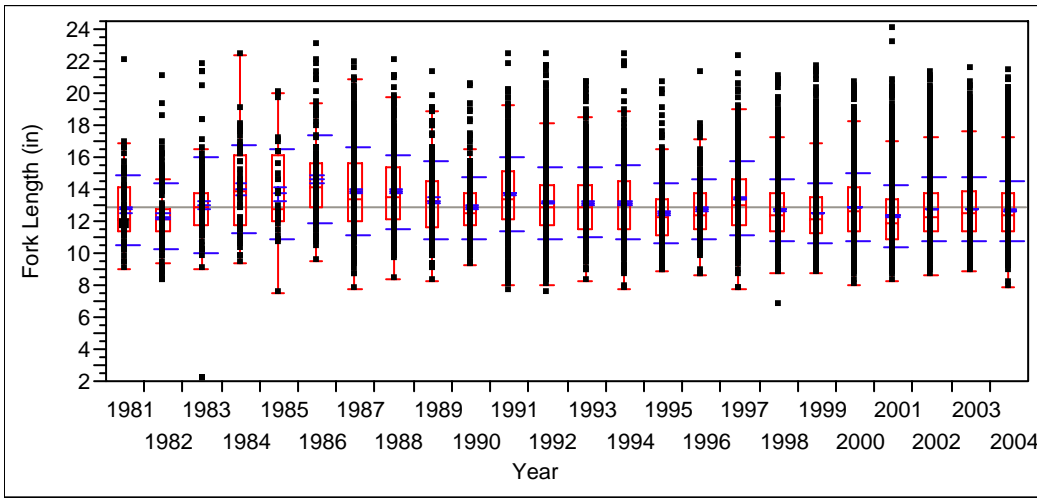
Figure 6: The significance of year on fork length (n = 20,592). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
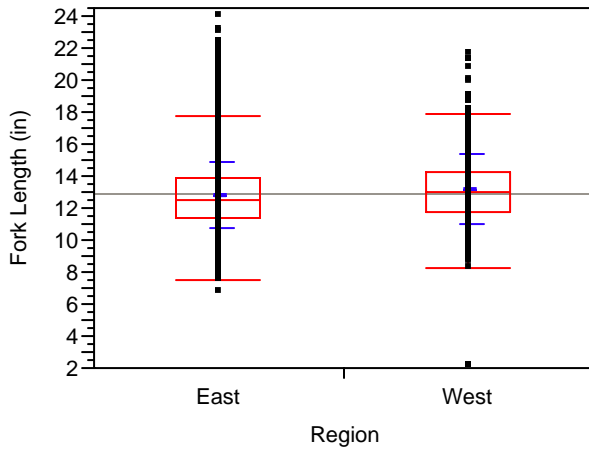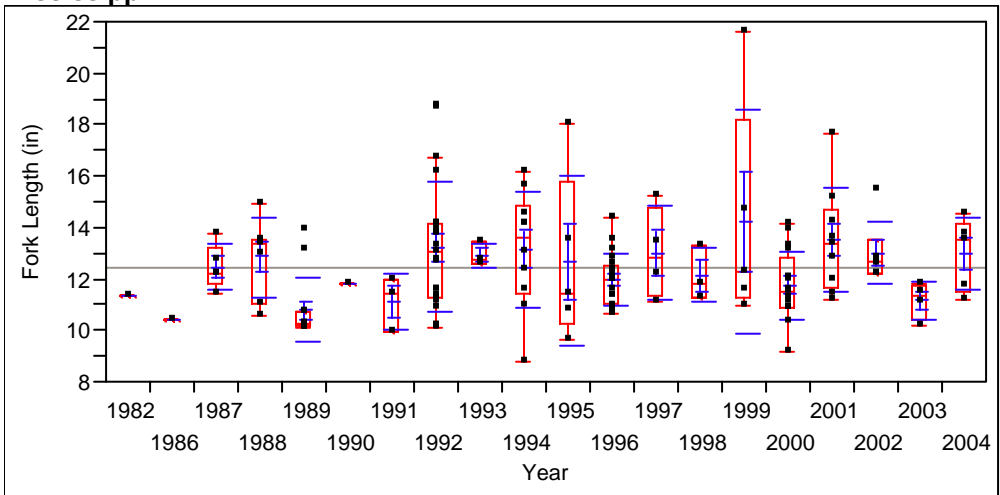
Figure 7: The significance of region on fork length (n = 20,592). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
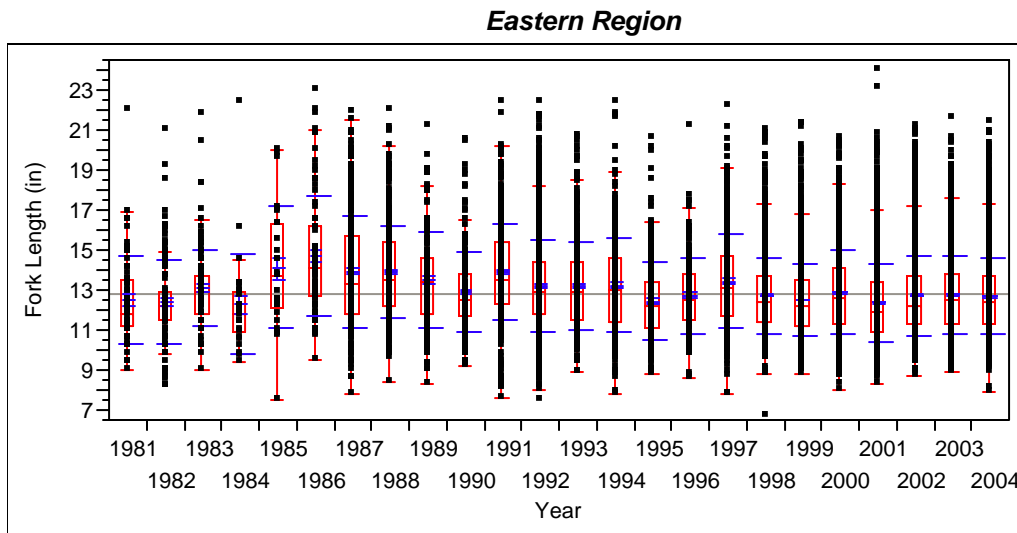
Eastern Region

Figure 8: The interaction of the eastern region and year on fork length (n = 19,749). The eastern region is defined as the states Alabama and Florida. The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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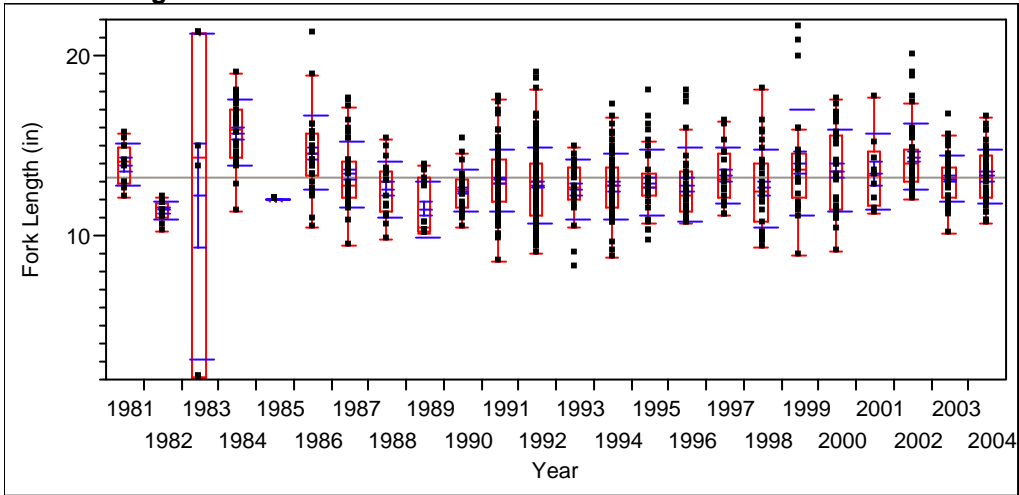
Western Region

Figure 9: The interaction of the western region and year on fork length (n = 843). The western region is defined as the states Texas, Louisiana, and Mississippi. The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
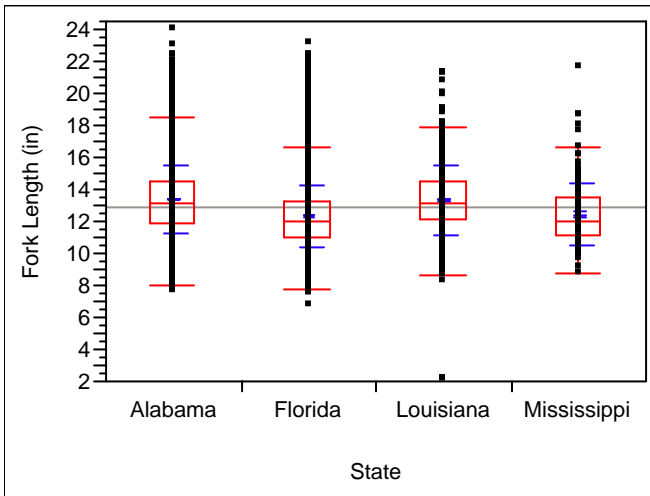

Figure 10: The significance of state on gray triggerfish fork length (n = 20,592).

Louisiana
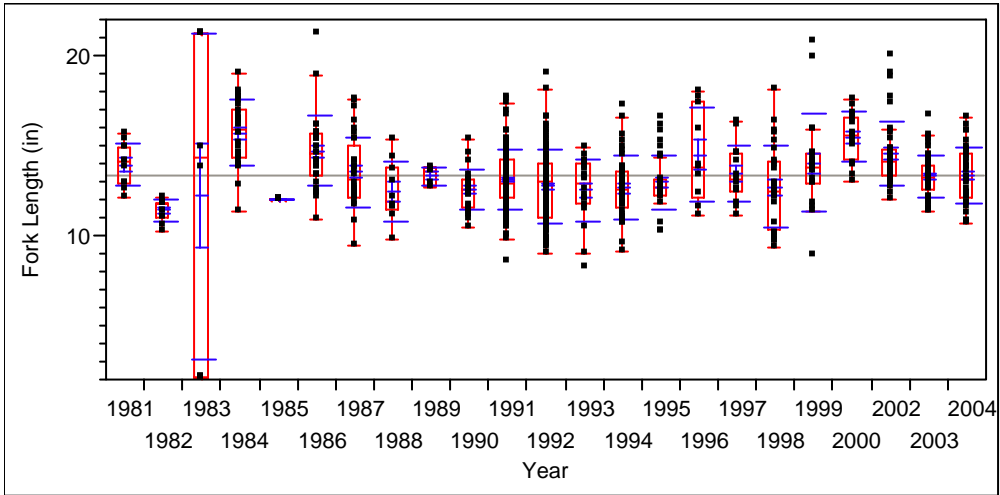
Figure 11: The interaction of the state of Louisiana and year on fork length (n = 699). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
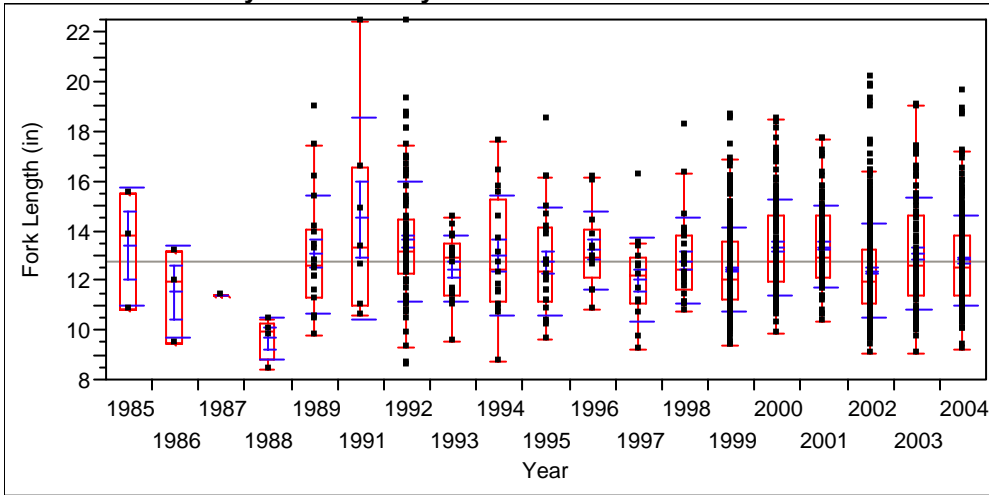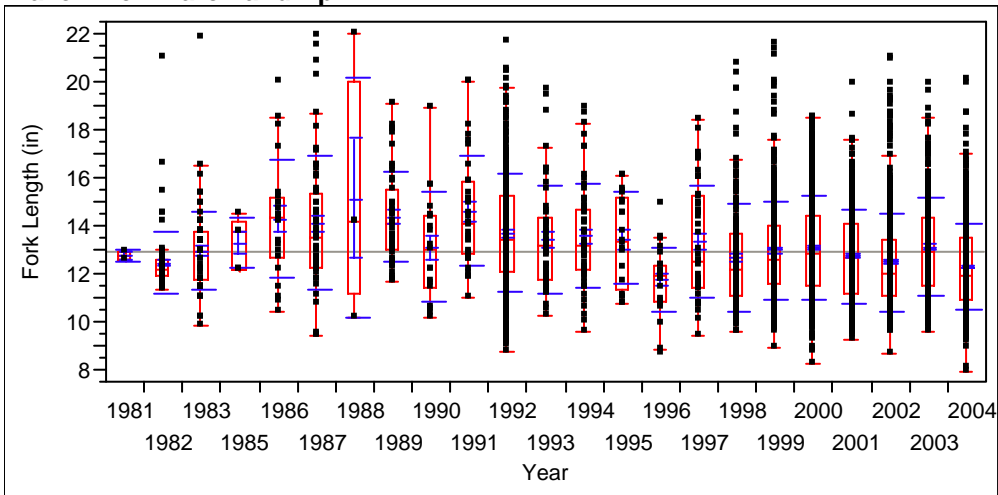
Mississippi

Figure 12: The interaction of the state of Mississippi and year on fork length (n = 144). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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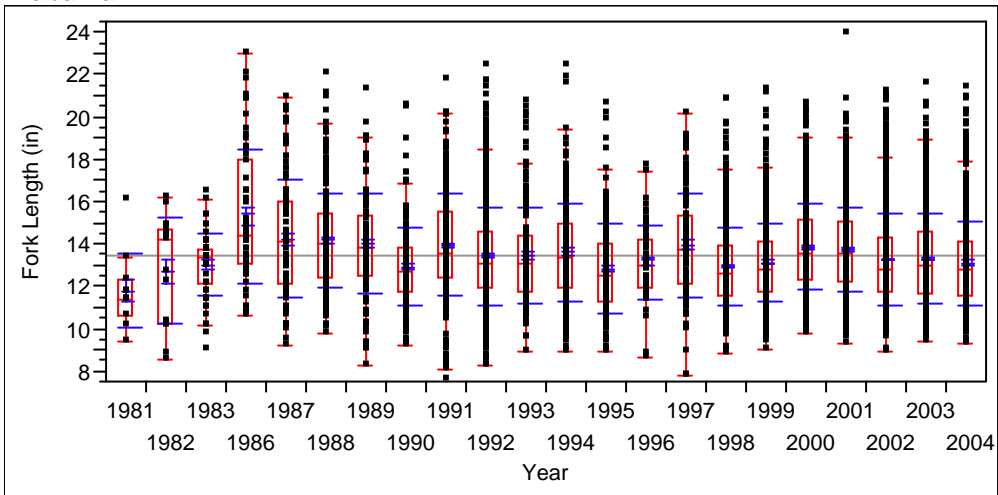
Alabama

Figure 13: The interaction of the state of Alabama and year on fork length (n = 8,713). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
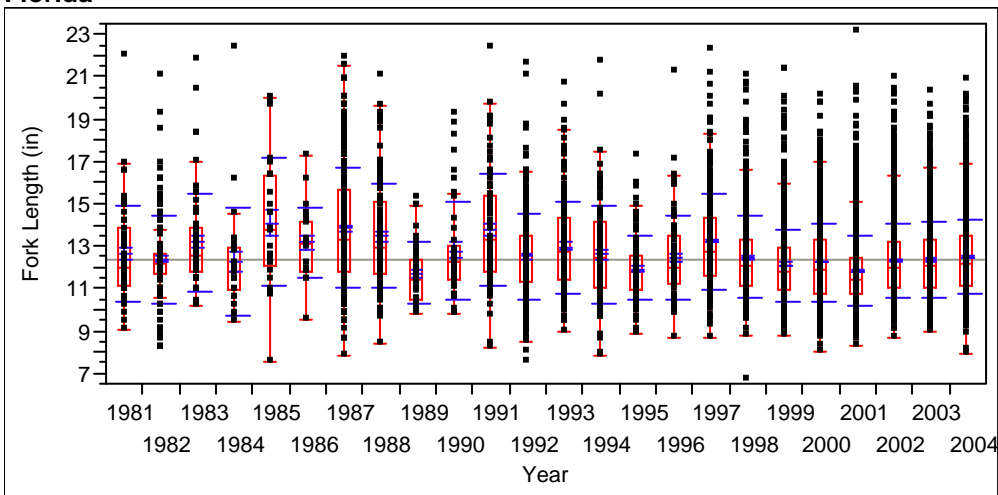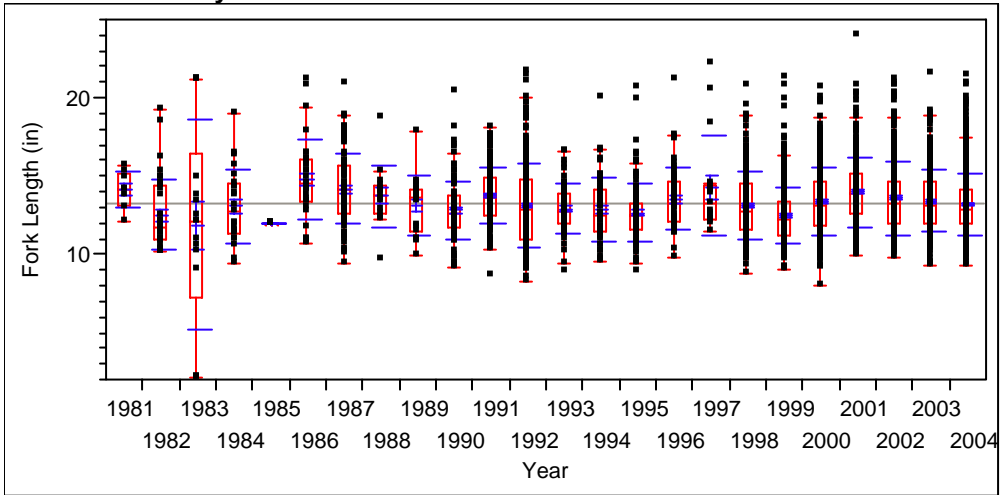
Florida

Figure 14: The interaction of the state of Florida and year on fork length (n = 11,036). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
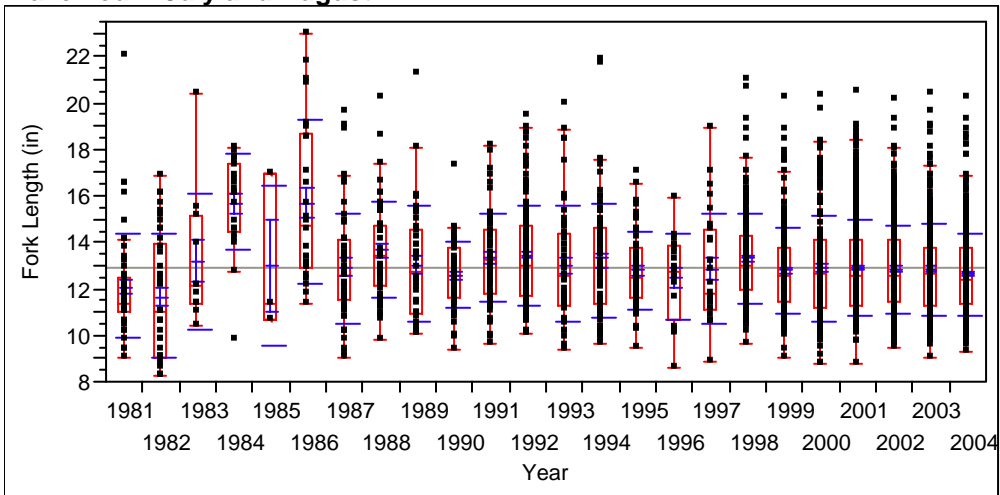
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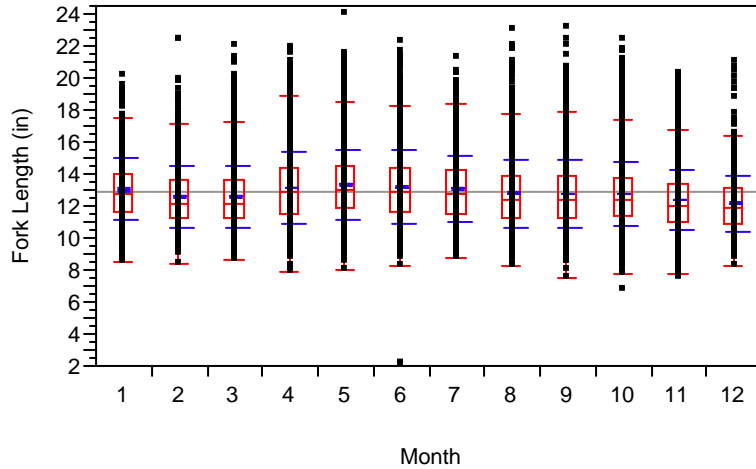
Figure 15: The significance of month on fork length (n = 20,592). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
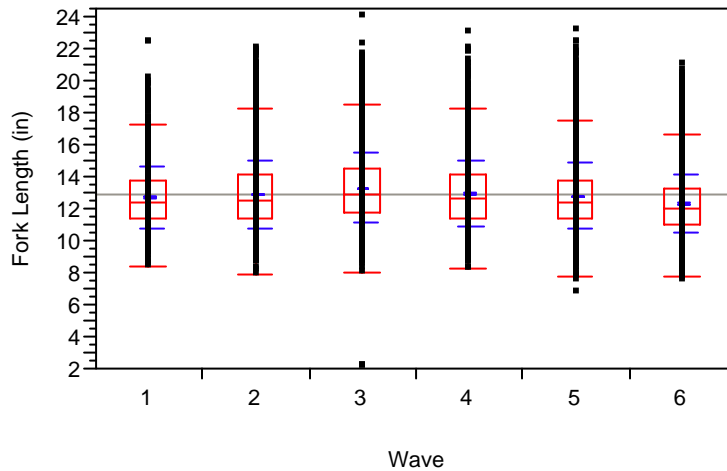

Figure 16: The significance of wave (bimonthly) on fork length (n = 20,592). Wave represents the bimonthly division of each year. The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
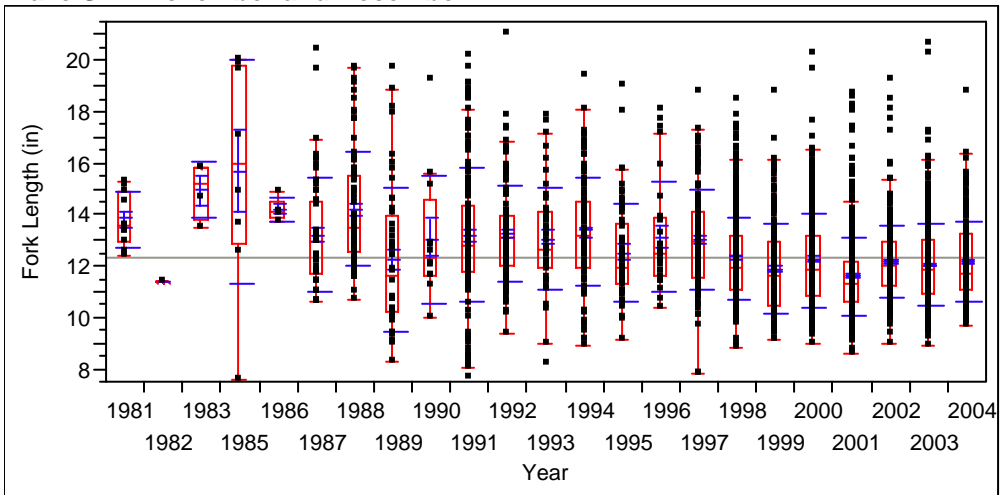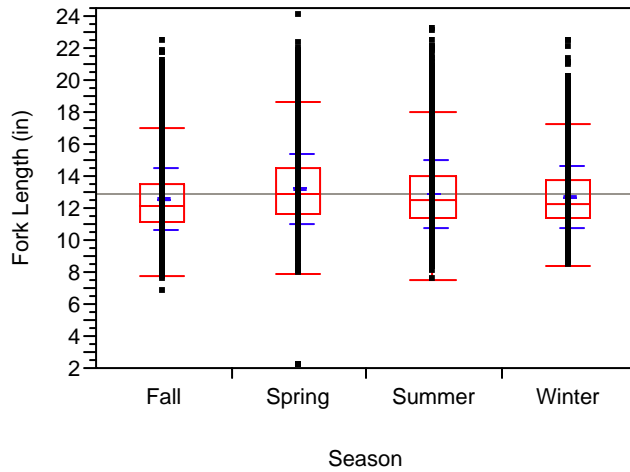
Wave One: January and February

Figure 17: The interaction of wave one on year (n = 1,532). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
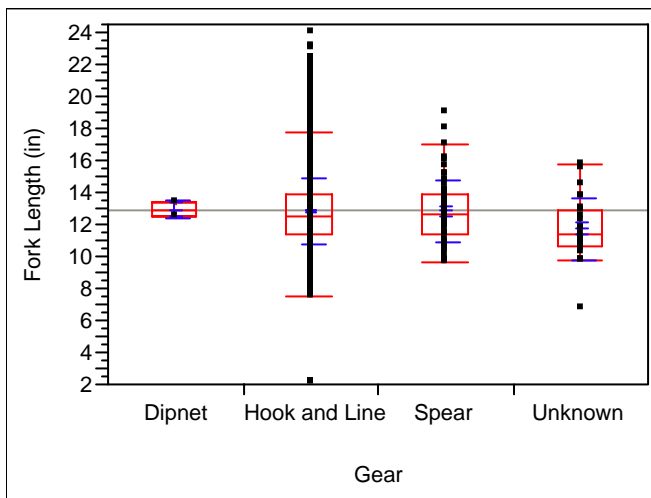
Wave Two: March and April

Figure 18: The interaction of wave two on year (n = 3,559). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Wave Three: May and June

Figure 19: The interaction of wave three on year (n = 3,522). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Wave Four: July and August

Figure 20: The interaction of wave four on year (n = 2,819). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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Wave Five: September and October
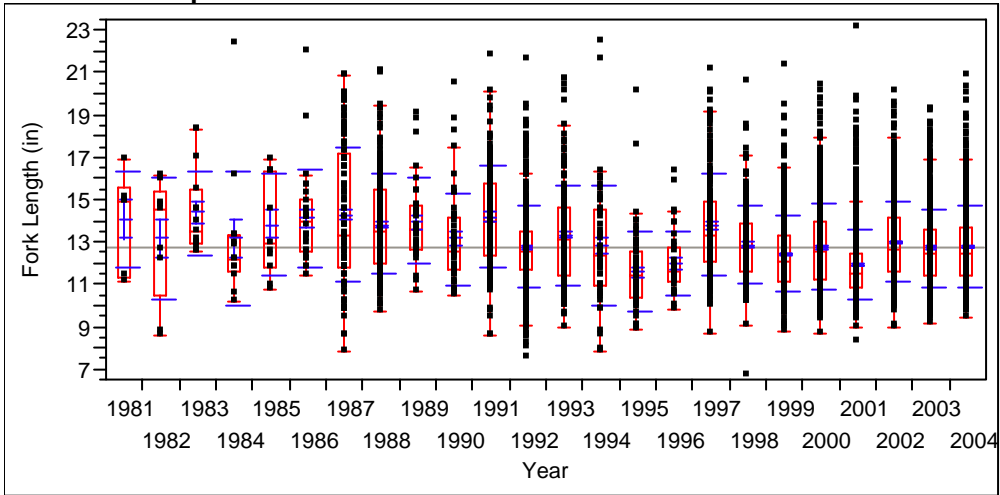
Figure 21: The interaction of wave five on year (n = 5,699). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Wave Six: November and December

Figure 22: The interaction of wave six on year (n = 3,461). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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Figure 23: The significance of season on fork length (n = 20,592). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Figure 24: the significance of gear on fork length (n = 20,592). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Headboat Analysis

Length Distribution

Weight Distribution
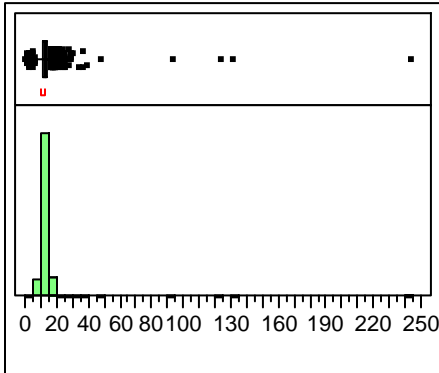
Quantile

100.0%	maximum	244.61
99.5%		19.99
97.5%		17.32
90.0%		15.04
75.0%	quartile	13.46
50.0%	median	12.09
25.0%	quartile	10.91
10.0%		10.12
2.5%		9.13
0.5%		8.25
0.0%	minimum	1.10

Moment

Mean	12.407799
Std Dev	2.8432112
Std Err Mean	0.0180402
upper 95% Mean	12.443159
lower 95% Mean	12.372439
N	24839
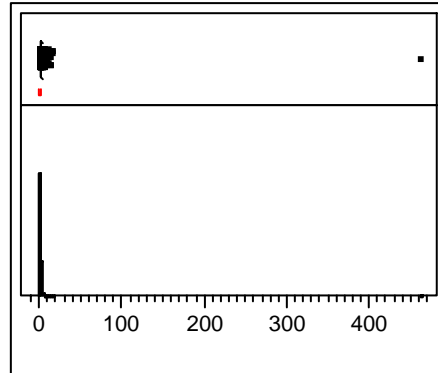
Quantile

100.0%	maximum	462.97
99.5%		6.69
97.5%		4.31
90.0%		2.78
75.0%	quartile	2.01
50.0%	median	1.46
25.0%	quartile	1.08
10.0%		0.86
2.5%		0.64
0.5%		0.46
0.0%	minimum	0.04

Moment

Mean	1.7190703
Std Dev	3.2480709
Std Err Mean	0.0217327
upper 95% Mean	1.7616679
lower 95% Mean	1.6764727
N	22337

Figure 25
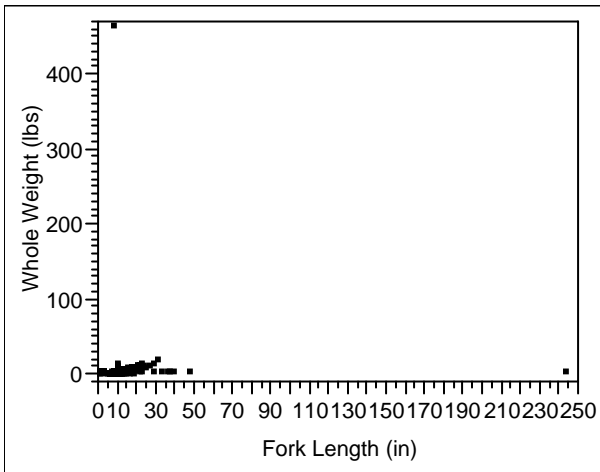
Figure 26: Initial plot of data after the conversion of units and removal of records where length or weight equals zero. The two apparent outlying points (one in the bottom right of the axis and the other at the top left) were removed prior to fitting a nonlinear model (n = 21, 495).
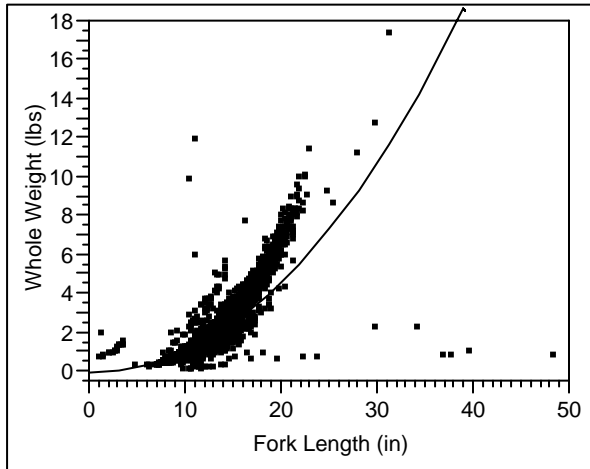
Figure 27: Fit one of nonlinear regression to data after the removal of the two outlying points illustrated in Figure 26 (n = 21,493).
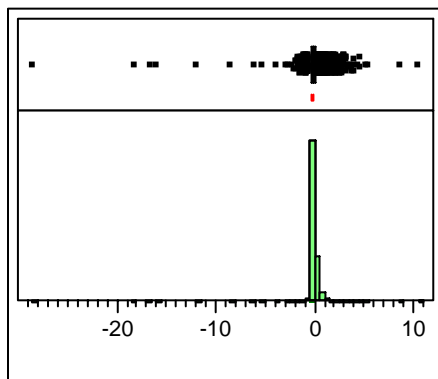
Quantile

100.0%	maximum	10.57
99.5%		2.11
97.5%		1.00
90.0%		0.29
75.0%	quartile	0.01487
50.0%	median	-0.14
25.0%	quartile	-0.24
10.0%		-0.30
2.5%		-0.39
0.5%		-0.85
0.0%	minimum	-28.42

Moment

Mean	-0.053601
Std Dev	0.4968075
Std Err Mean	0.0033888
upper 95% Mean	-0.046958
lower 95% Mean	-0.060243
N	21493

Figure 28: Residuals resulting from fit one of the nonlinear regression (Figure 27). Residuals in the upper and lower 0.5 percentile were removed (n = 215).
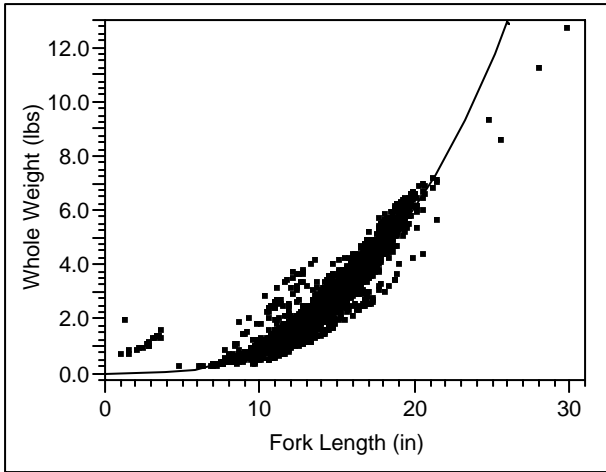
Figure 29: Nonlinear fit two of length weight curve to data after residuals in 0.5 upper and lower percentile of the distribution were removed (n = 21,278).
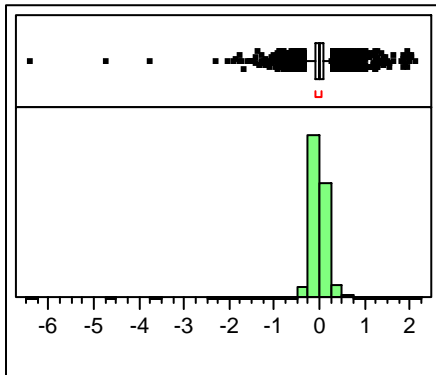
Quantile

100.0%	maximum	2.148
99.5%		0.831
97.5%		0.423
90.0%		0.180
75.0%	quartile	0.064
50.0%	median	-0.020
25.0%	quartile	-0.097
10.0%		-0.174
2.5%		-0.306
0.5%		-0.612
0.0%	minimum	-6.387

Moment

Mean	-0.005677
Std Dev	0.2043222
Std Err Mean	0.0014007
upper 95% Mean	-0.002932
lower 95% Mean	-0.008423
N	21278

Figure 30: Residuals resulting from fit two of the nonlinear regression (Figure 29). Residuals in the upper and lower 0.5 percentile were removed (n = 212).
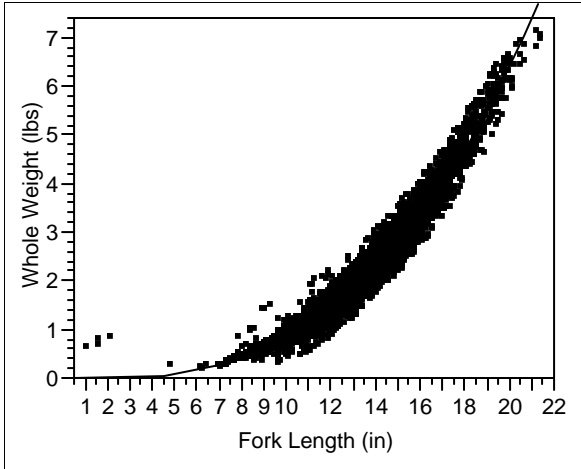
Parameter	Estimate	Low	High
a	0.0009471166	0.0009	0.001
b	2.9434482286	2.923	2.9639

Figure 31: Final nonlinear fit of length weight data (n = 21,066).
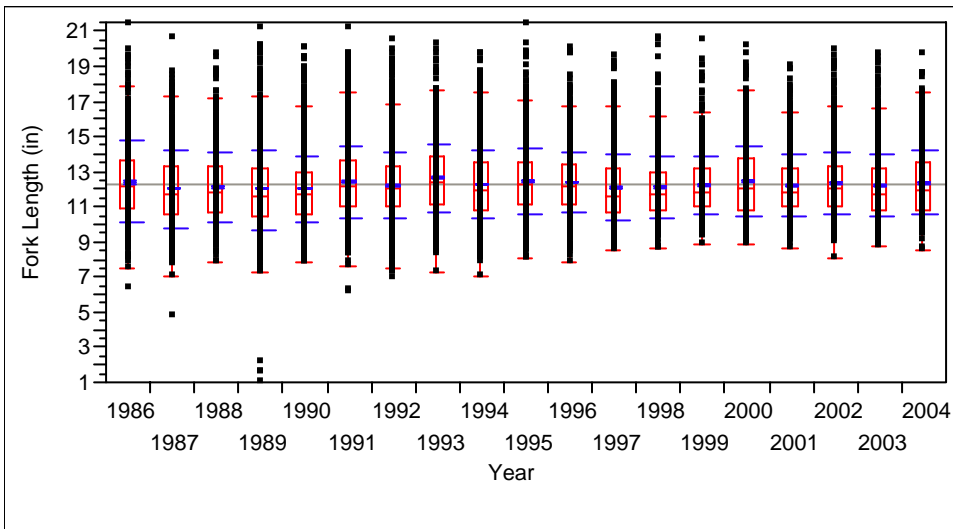
Figure 32: The significance of year on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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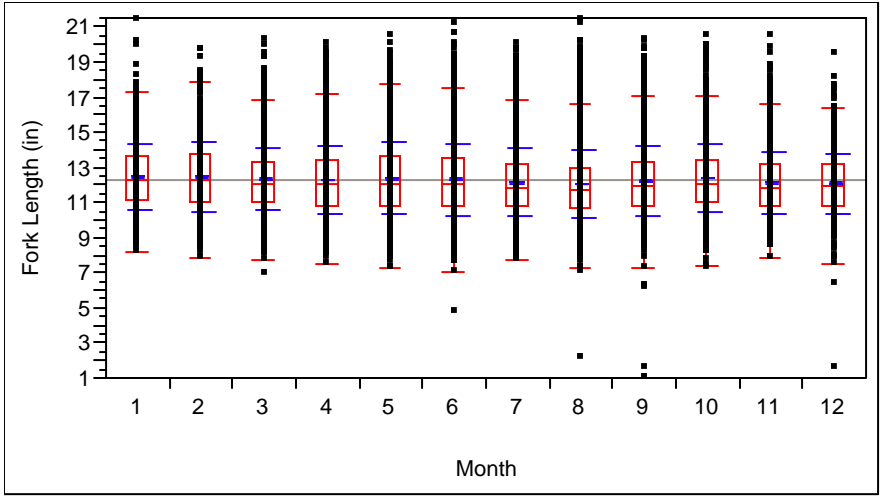
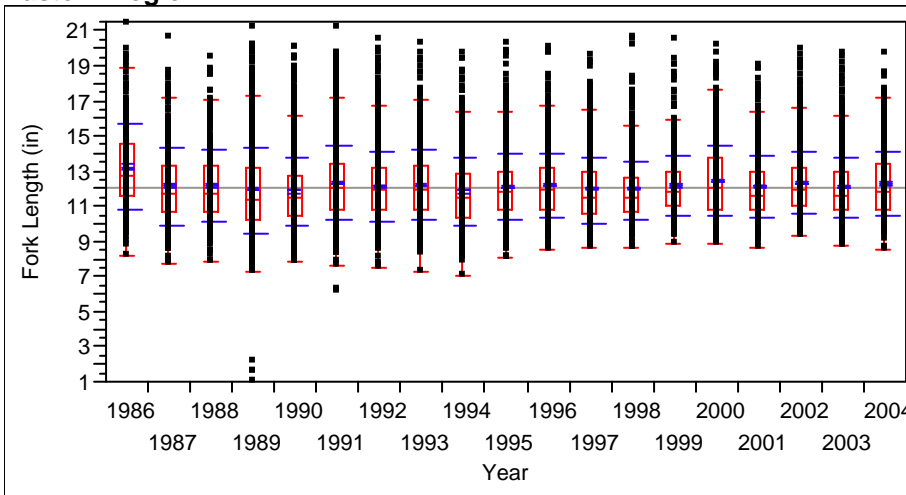**Figure 33: The significance of month on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.**
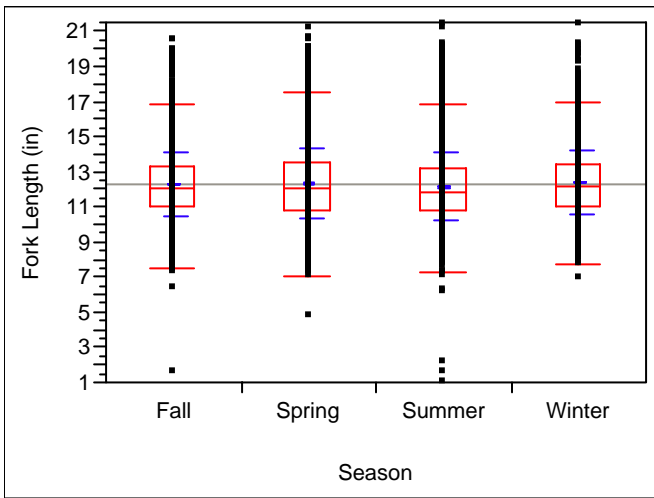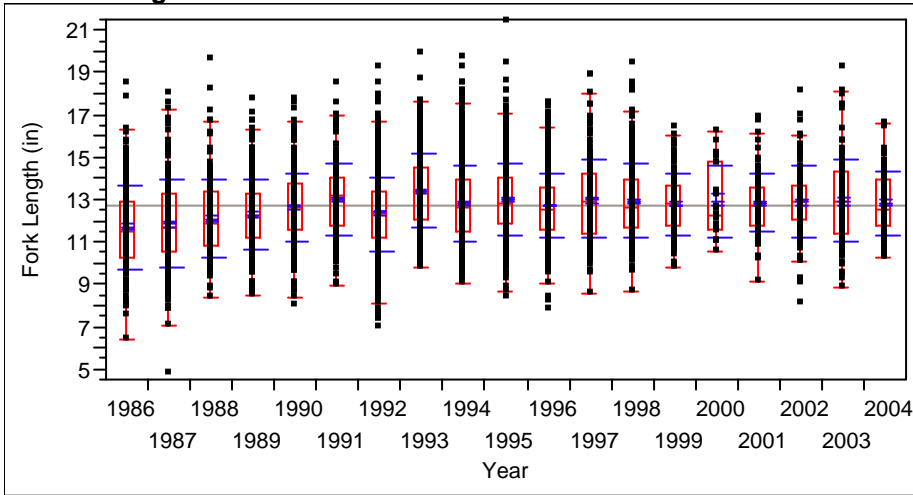

Figure 34: The significance of season on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
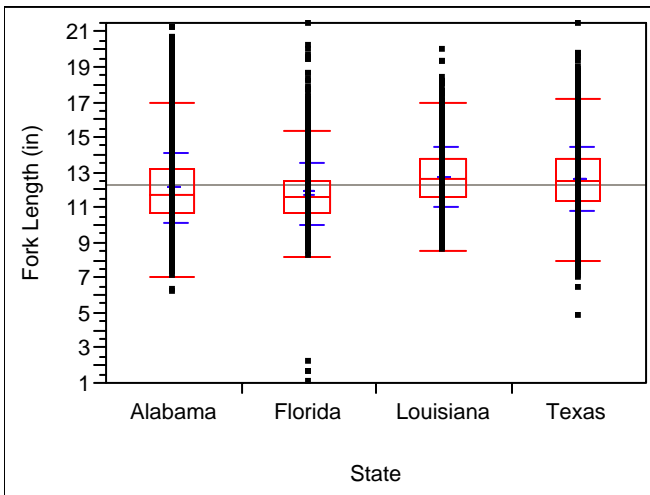
Fall
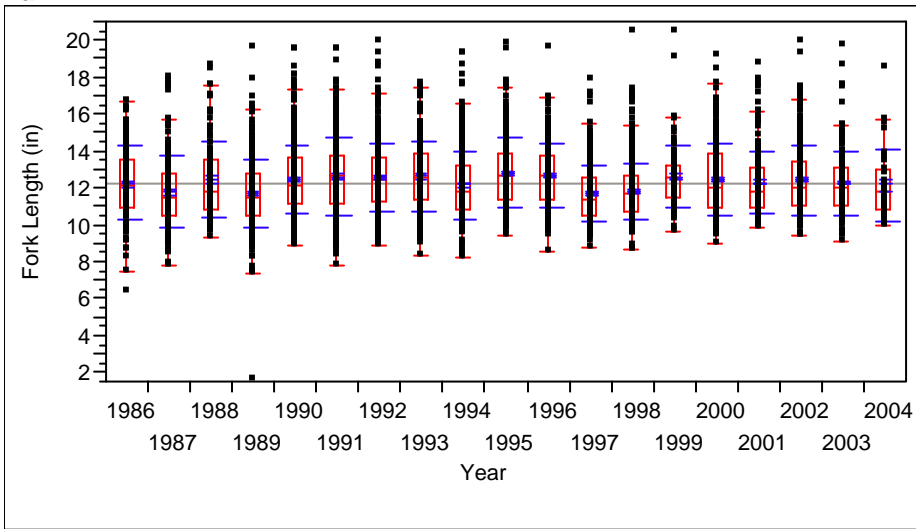
Figure 35: The interaction of the season fall and year on fork length (n = 4,876). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
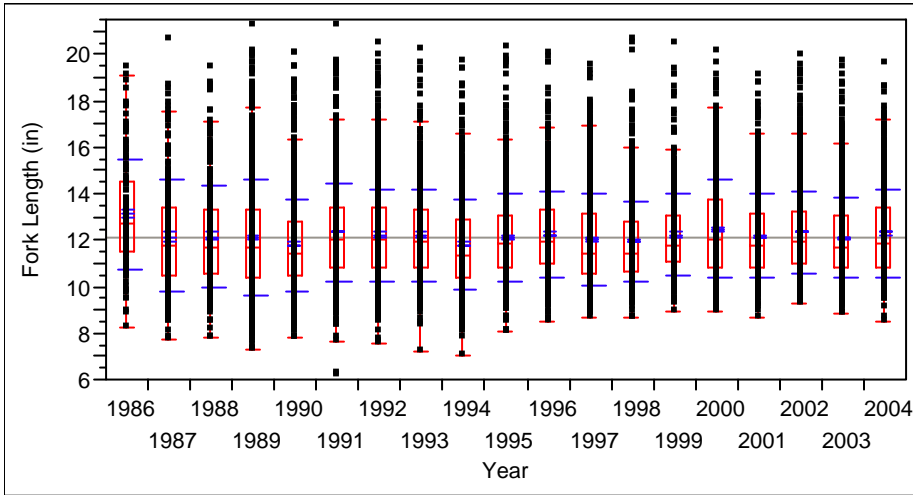
Spring
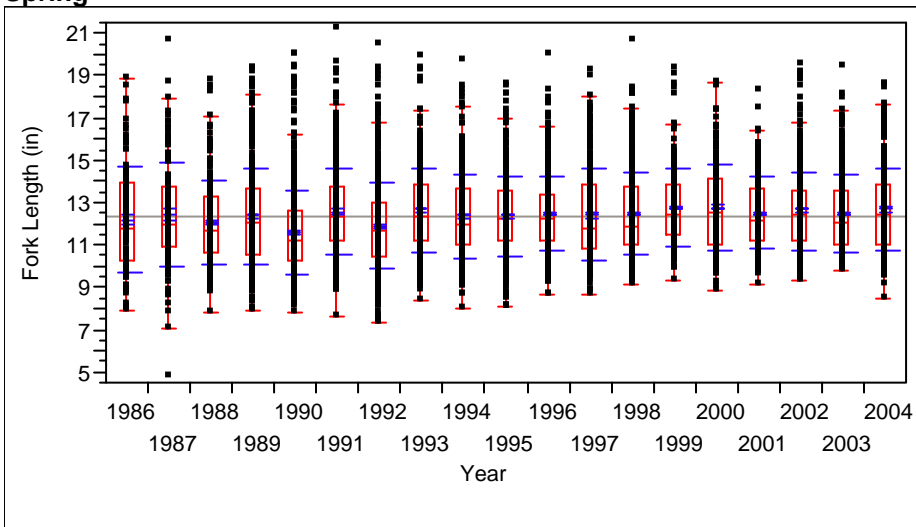
Figure 36: The interaction of the season spring and year on fork length (n = 6,522). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
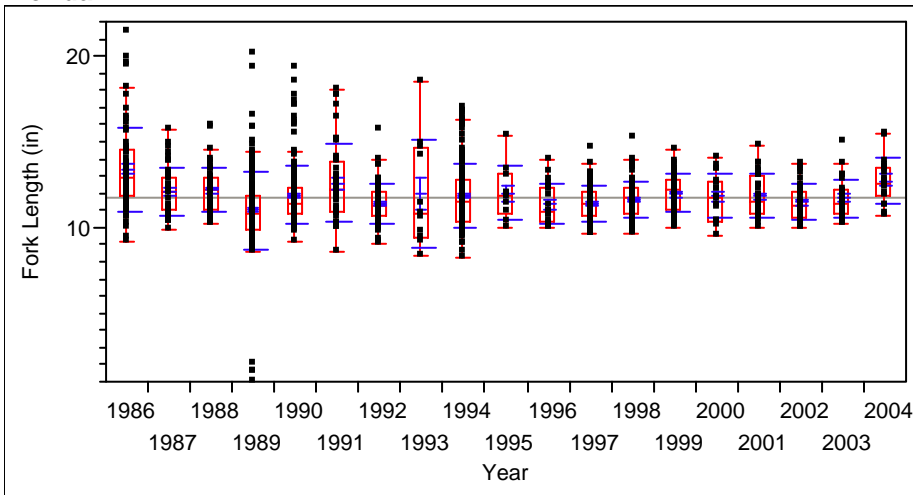
Summary
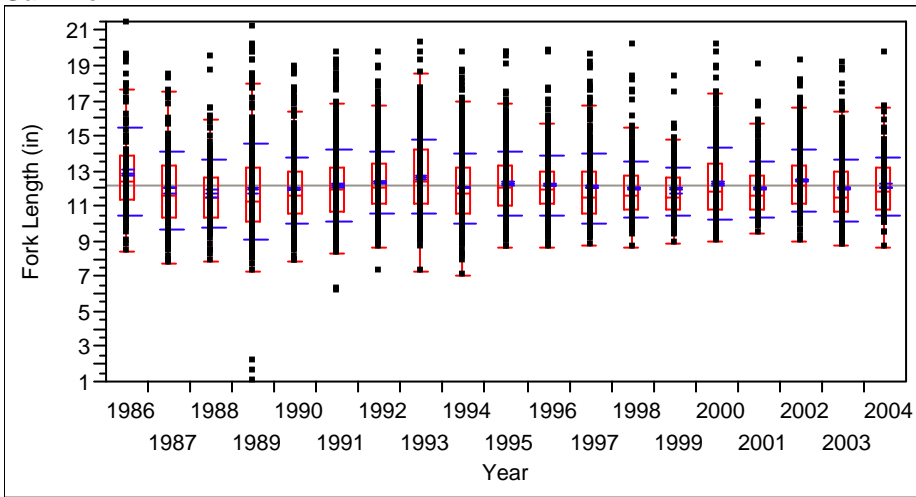
Figure 37: The interaction of the season summer and year on fork length (n = 6,557). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
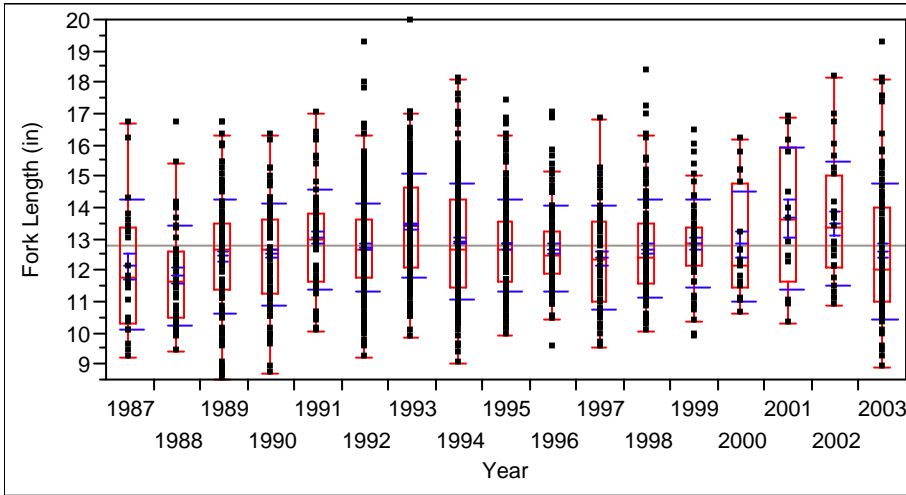
Winter
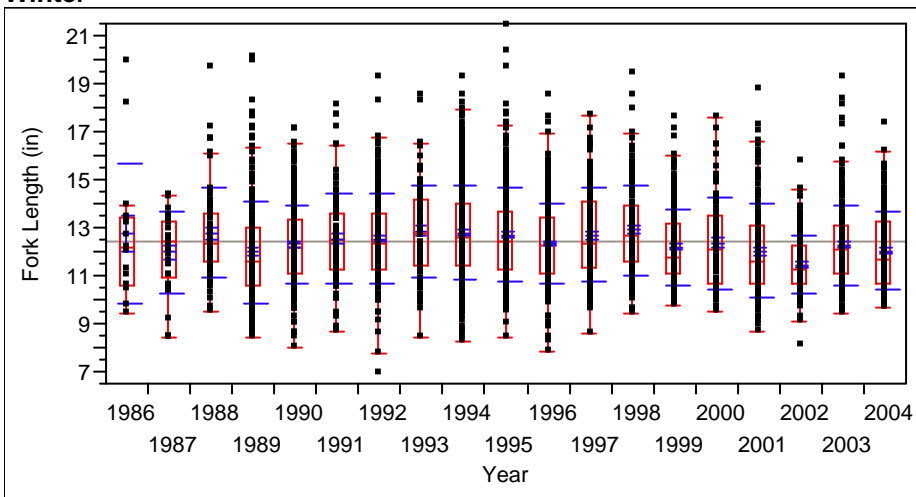
Figure 38: The interaction of the season winter and year on fork length (n = 3,074). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
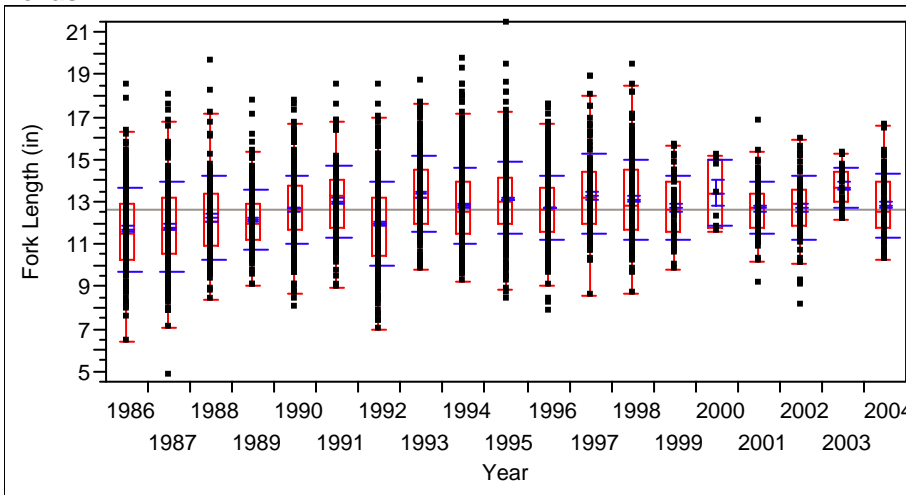
24
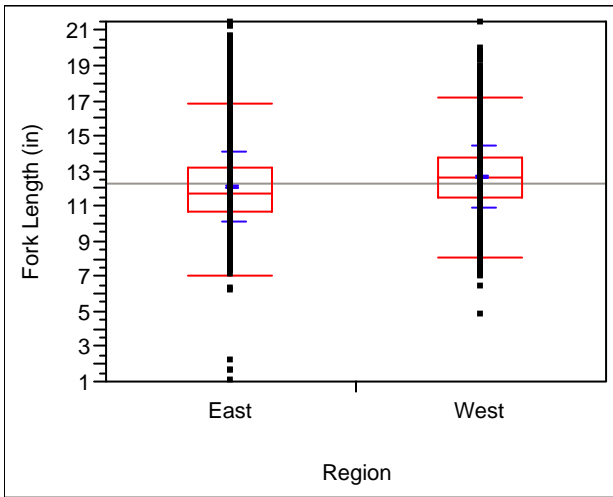
Figure 39: The significance of region on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Eastern Region

Figure 40: The interaction between eastern region and year on fork length (n = 15,433). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
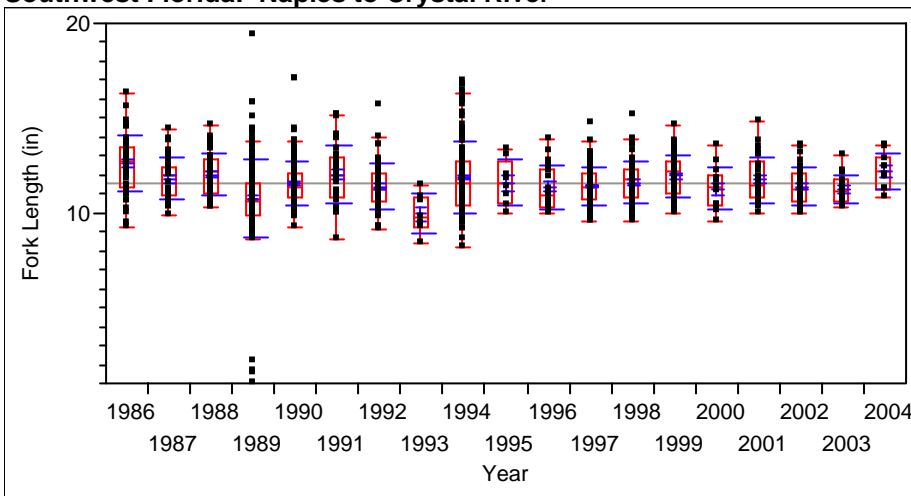
Western Region

Figure 41: The interaction between western region and year on fork length (n = 5,633). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Figure 42: The significance of state on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
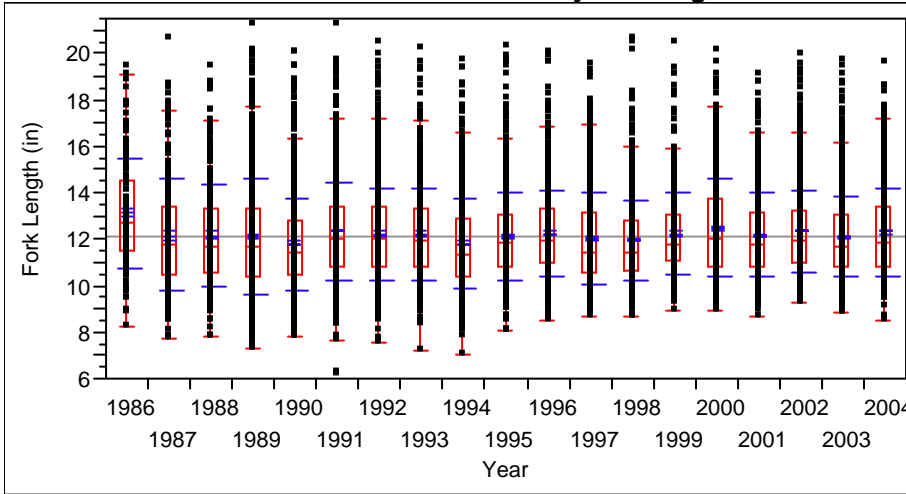
26

Alabama

Figure 43: The interaction between Alabama and year on fork length (n = 14,225). The continuous horizontal line represents the mean across the strata w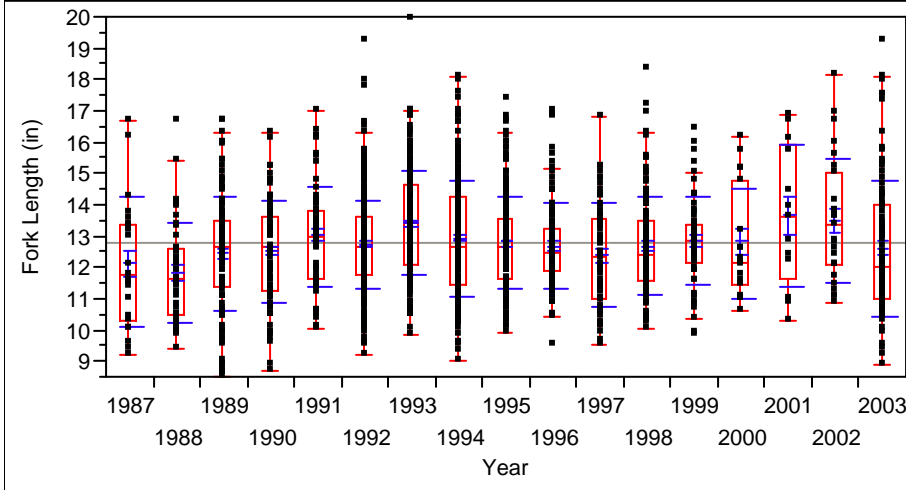hile the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
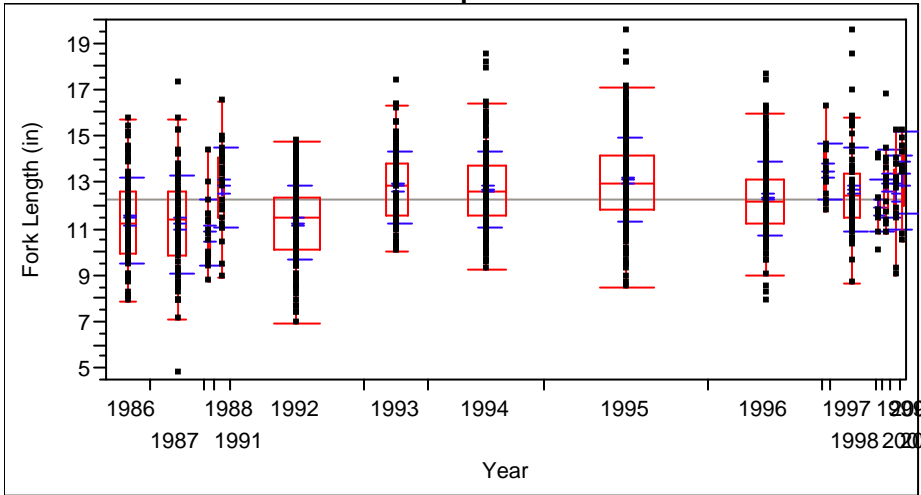
Florida

Figure 44: The interaction between Florida and year on fork length (n = 1,208). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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Louisiana

Figure 45: The interaction between Louisiana and year on fork length (n =1,867). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
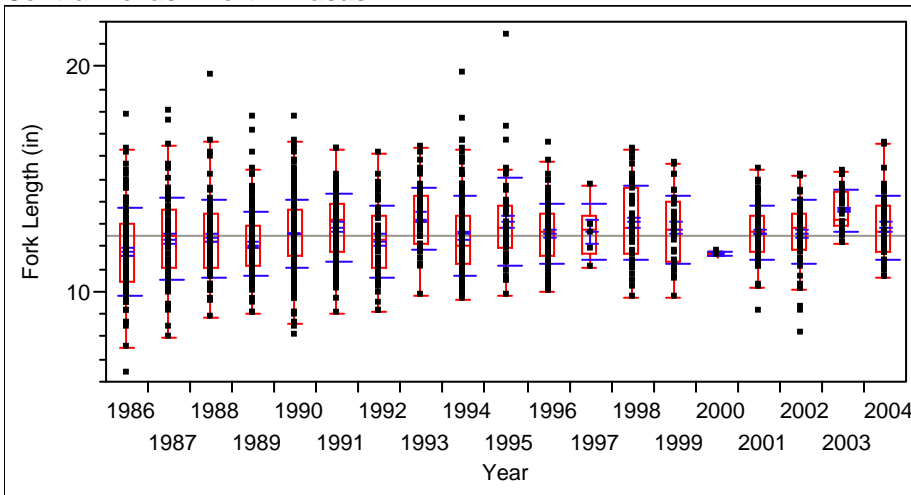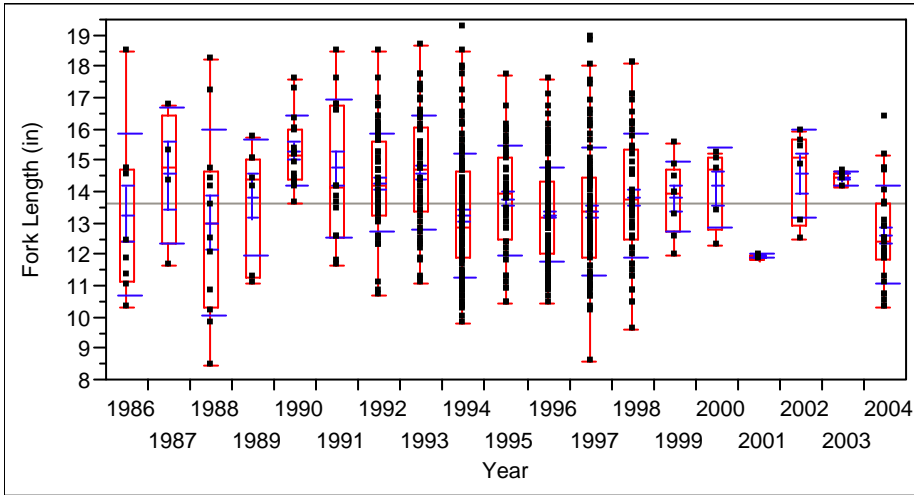
Texas

Figure 46: The interaction between Alabama and year on fork length (n = 3,729). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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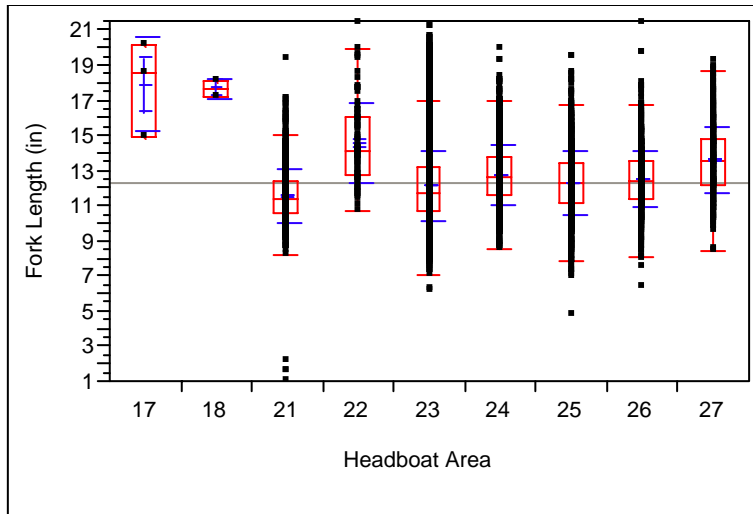
Area Code	Area Description
12	Keys (Atl. based vessels)
17	Dry Tortugas (Keys based vessels)
18	Dry Tortugas (Gulf based vessels)
21	SW Florida - Naples to Crystal River
22	Florida Middle Grounds (west coast and Panhandle)
23	NW Florida and Alabama (Panama City to Orange Beach)
24	Louisiana
25	NE Texas (Sabine to Freeport)
26	Central Texas (Port Aransas)
27	South Texas (Port Isabel and Brownsville)

Figure 47: The significance of area on fork length (n = 21,066). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Southwest Florida: Naples to Crystal River

**Figure 48: The interaction of Southwest Florida and year on fork length (n = 1,122). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data**

represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Northwest Florida and Alabama: Panama City to Orange Beach

Figure 49: The interaction of Northwest Florida and year on fork length (n =14,225). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Louisiana

Figure 50: The interaction of Louisiana and year on fork length (n =1,867). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Northeastern Texas: Sabine to Freeport

Figure 51: The interaction of Northeastern Texas and year on fork length (n =1,415). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
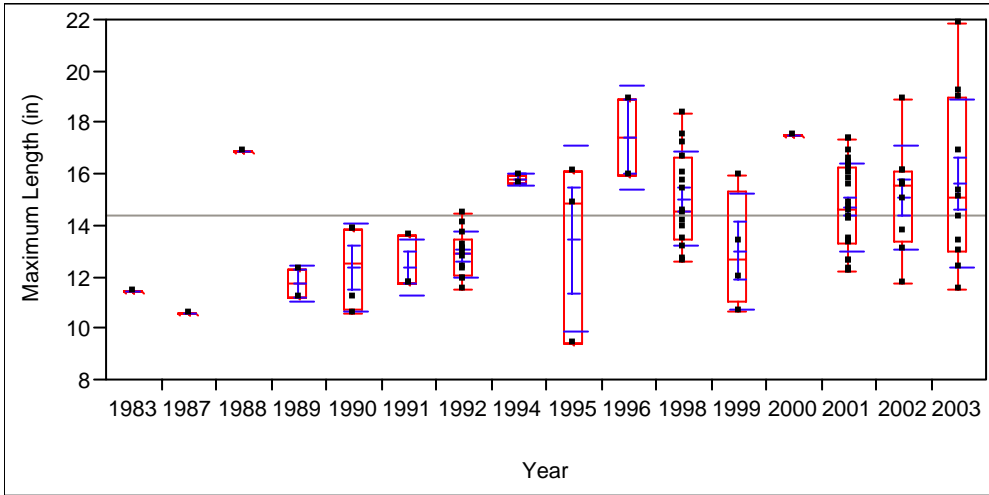
Central Texas: Port Arnasas

Figure 52: The interaction of Central Texas and year on fork length (n =1,598). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

South Texas: Prot Isabel and Brownsville

Figure 53: The interaction of South Texas and year on fork length (n =716). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Texas Analysis

Note that fish in this dataset are measured in maximum length, NOT fork length and the data is presented in maximum length.
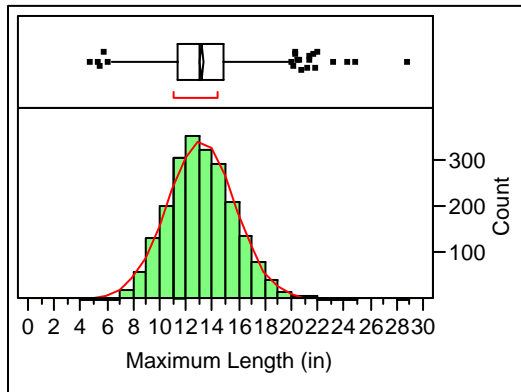
Quantile

100.0%	maximum	28.937
99.5%		20.820
97.5%		18.346
90.0%		16.417
75.0%	quartile	14.843
50.0%	median	13.071
25.0%	quartile	11.417
10.0%		10.039
2.5%		8.598
0.5%		7.287
0.0%	minimum	4.843

Moment

Mean	13.204778
Std Dev	2.5605192
Std Err Mean	0.0544053
upper 95% Mean	13.311468
lower 95% Mean	13.098087
N	2215

Figure 54: Distribution of all Texas data in order to discern any erroneous length values.
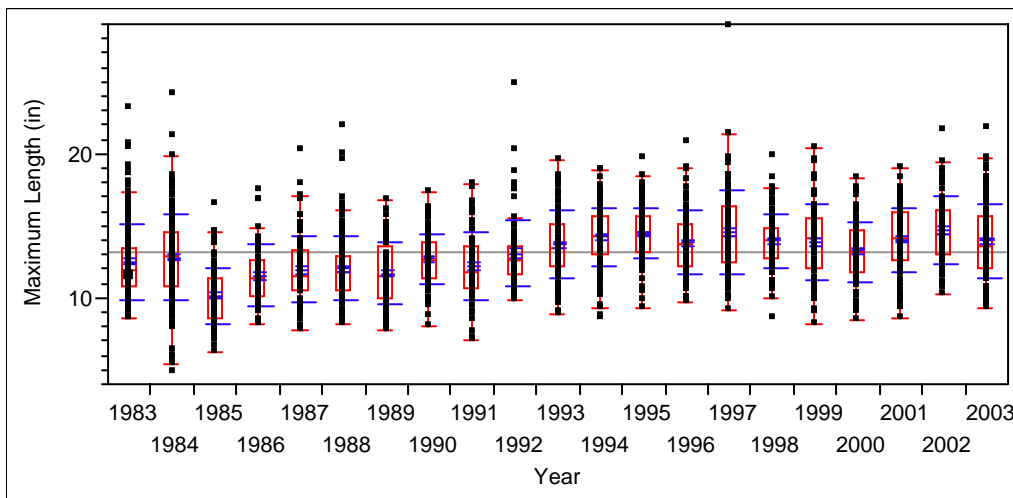
Figure 55: The significance of year on maximum length (n =2,215). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
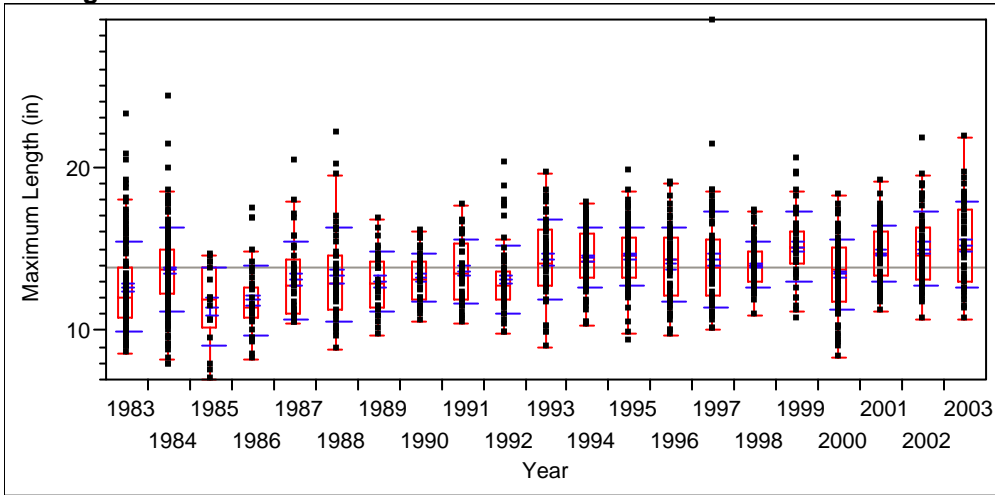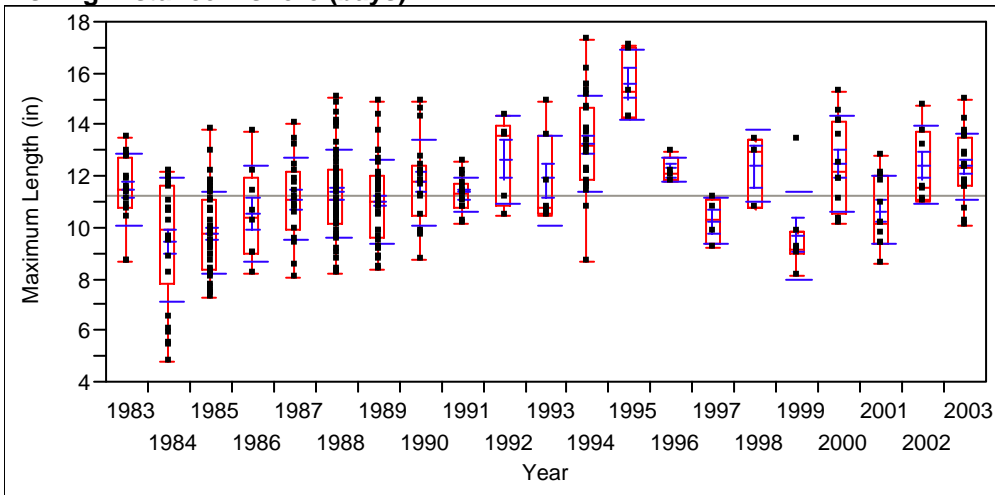
33
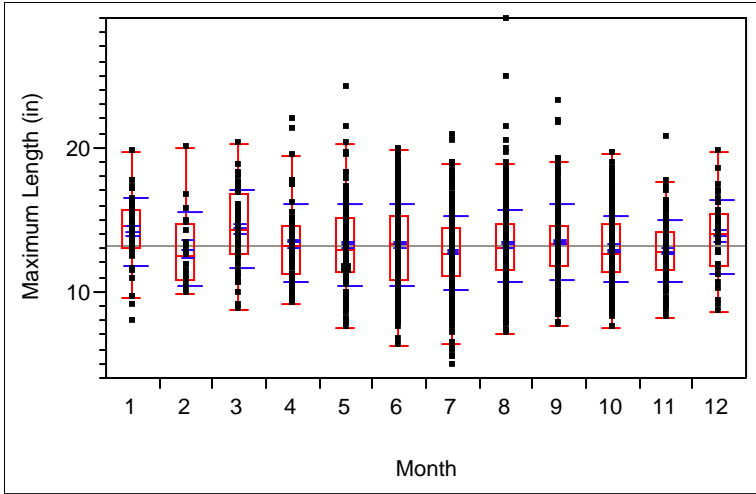
Figure 56: The significance of month on maximum length (n =2,215). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
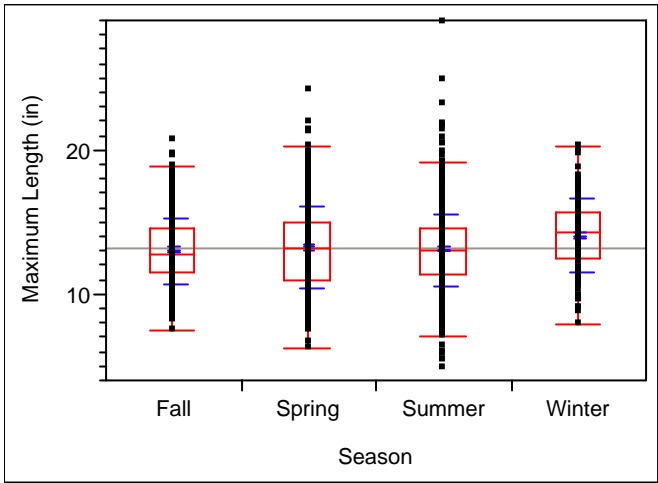
Figure 57: The significance of season on maximum length (n =2,215). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
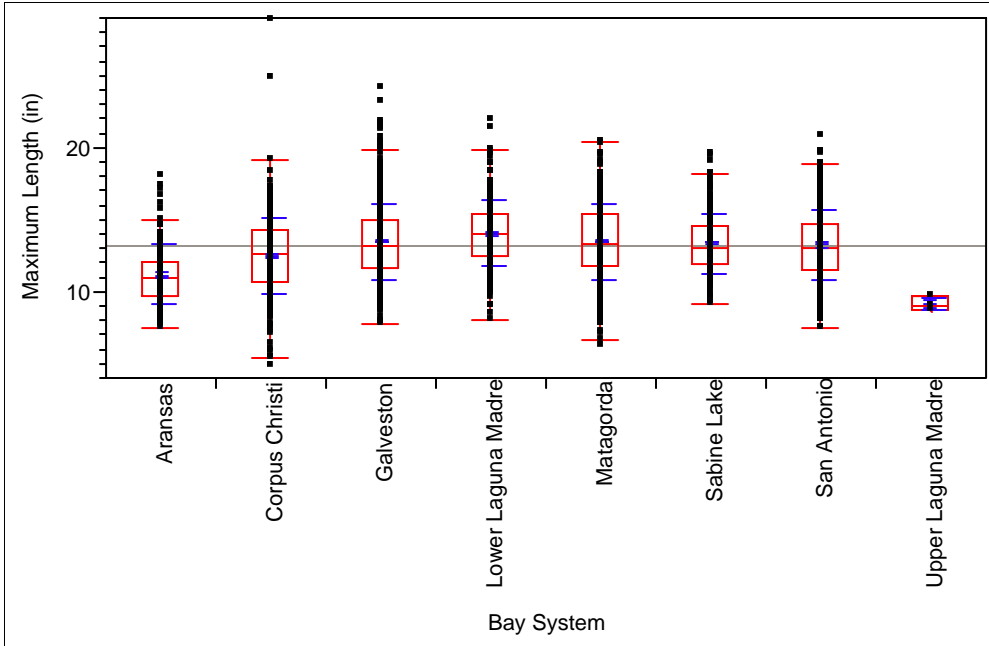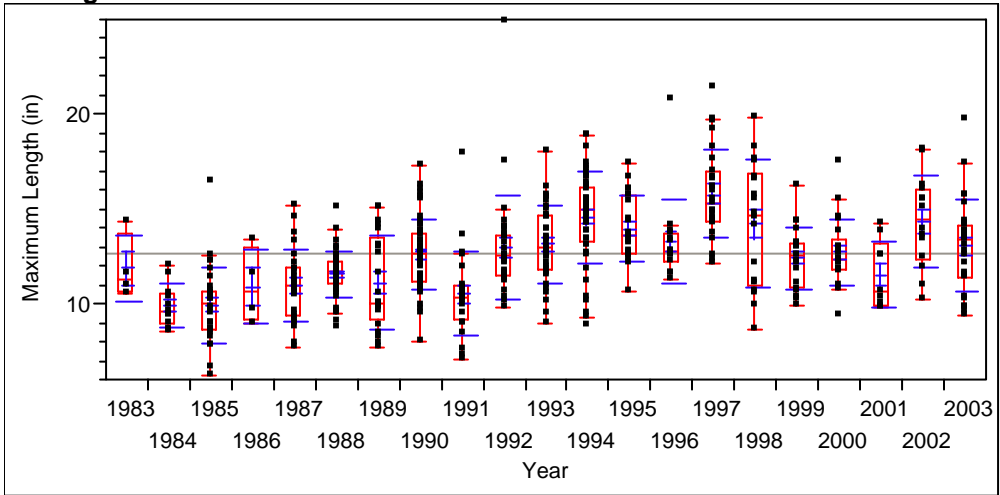
Figure 58: The significance of bay area on maximum length (n =2,215). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
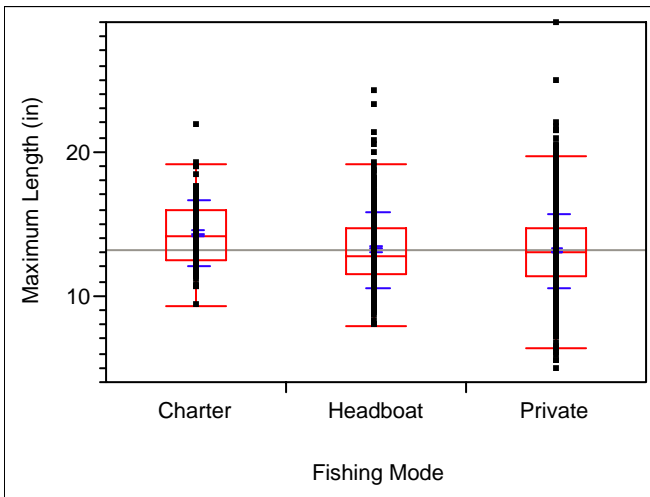
Figure 59: The significance of fishing mode on maximum length (n =2,215). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Charter Boat

Figure 60: The interaction of charter boat fishing mode and year on maximum length (n = 96). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.
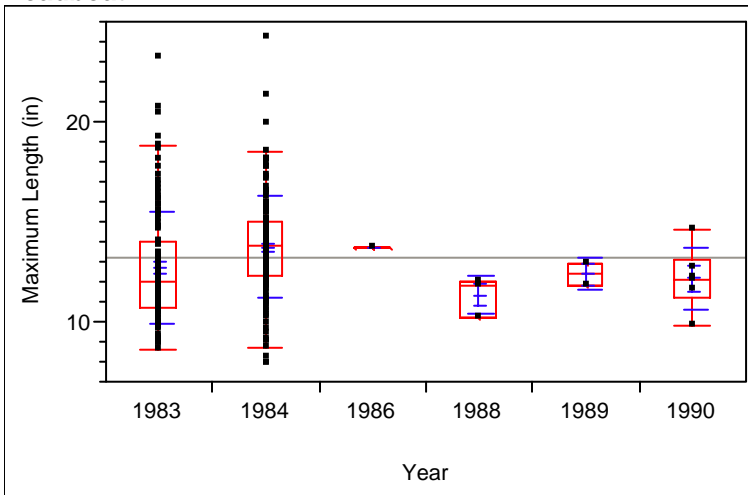
Headboat

Figure 61: The interaction of headboat fishing mode and year on maximum length (n = 268). It is important to note that only bay headboats were surveyed from 1986 to the present. Prior, to 1986, headboats fishing everywhere were surveyed by TPWD. The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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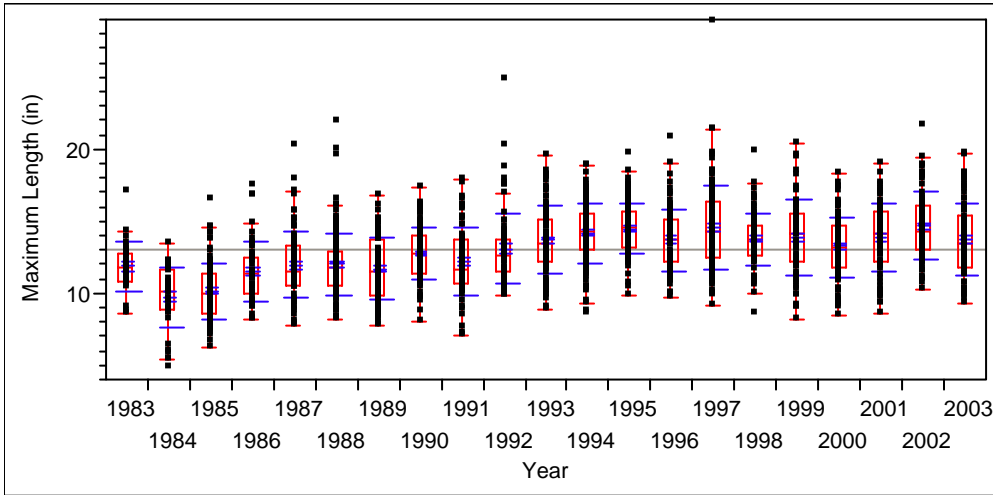
Private Boat

Figure 62: **The interaction of private boat fishing mode and year on maximum length (n = 1,851). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.**
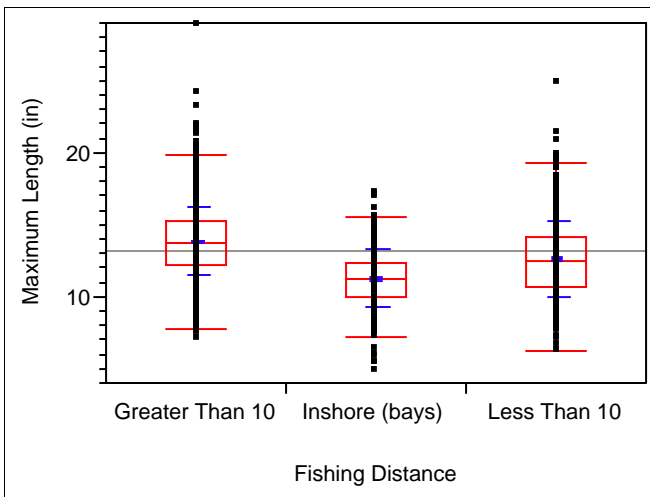
Figure 63: **The significance of fishing distance from shore on maximum length (n =2,215). Fishing distance is defined as the miles from shore; inshore indicates fishing occurred in the bay, while the other two designations refer to fishing in the Gulf. The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.**

Fishing Distance Greater Than 10 Miles

Figure 64: The interaction of fishing distance greater than 10 miles and year on maximum length (n =1,364). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Fishing Distance Inshore (bays)

Figure 65: The interaction of fishing inshore and year on maximum length (n =353). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

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Fishing Distance Less Than 10 Miles

Figure 66: The interaction of fishing less than 10 miles offshore and year on maximum length (n =498). The continuous horizontal line represents the mean across the strata while the red boxes constraining the data represent 95% confidence intervals. The smaller blue lines represent standard deviation, and larger red lines furthest from the mean represent 50% confidence intervals.

Appendix B: Length Frequency
MRFSS Length Frequency Distributions

1981
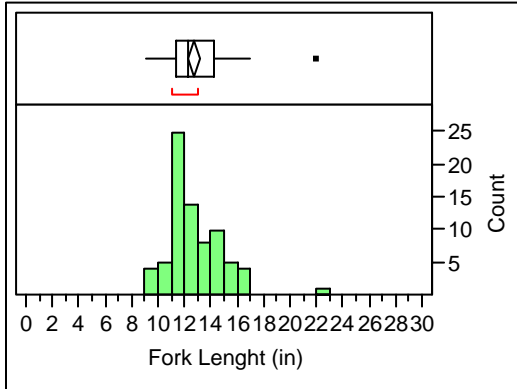
Mean	12.752279
Std Dev	2.1302977
Std Err Mean	0.2443619
upper 95% Mean	13.239073
lower 95% Mean	12.265485
N	76

1983
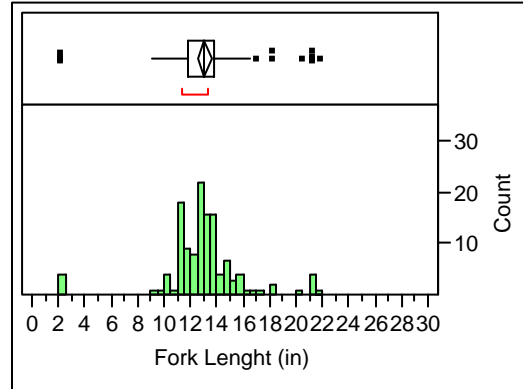
Mean	13.079717
Std Dev	3.0398341
Std Err Mean	0.2676425
upper 95% Mean	13.609293
lower 95% Mean	12.55014
N	129

1982
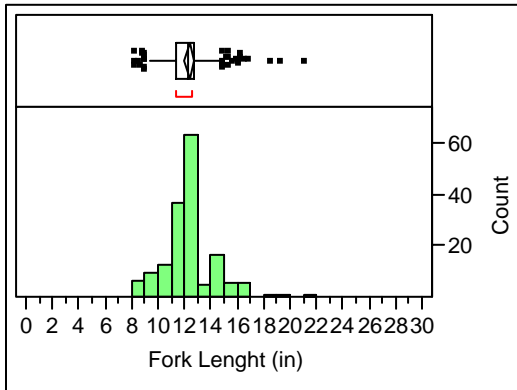
Mean	12.351425
Std Dev	2.0389248
Std Err Mean	0.1573065
upper 95% Mean	12.66199
lower 95% Mean	12.040859
N	168

1984
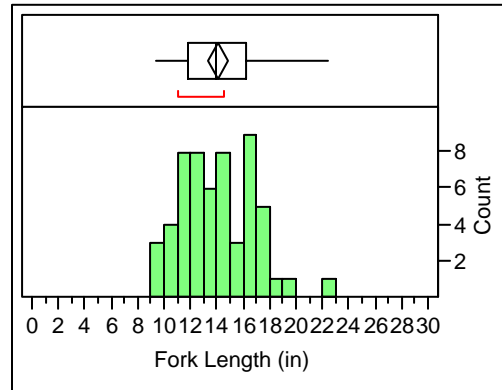
Mean	14.097942
Std Dev	2.7251547
Std Err Mean	0.3609556
upper 95% Mean	14.821023
lower 95% Mean	13.374861
N	57

40

1985
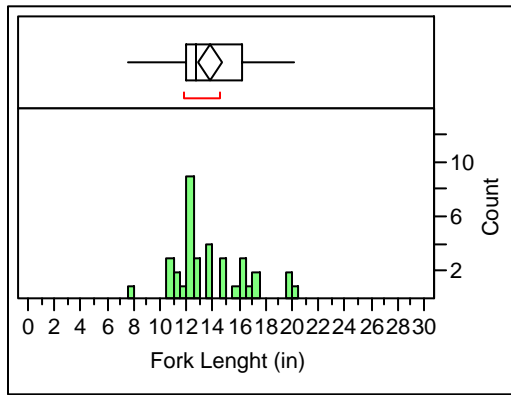
Mean	13.770779
Std Dev	2.8283756
Std Err Mean	0.4713959
upper 95% Mean	14.727763
lower 95% Mean	12.813794
N	36

1986

Mean	14.682011
Std Dev	2.7164624
Std Err Mean	0.251137
upper 95% Mean	15.179419
lower 95% Mean	14.184602
N	117

1987

Mean	13.93448
Std Dev	2.7227287
Std Err Mean	0.1352935
upper 95% Mean	14.200448
lower 95% Mean	13.668513
N	405

1988

Mean	13.886588
Std Dev	2.3063786
Std Err Mean	0.120392
upper 95% Mean	14.123335
lower 95% Mean	13.649842
N	367

1989

Mean	13.358136
Std Dev	2.4014035
Std Err Mean	0.1661086
upper 95% Mean	13.685608
lower 95% Mean	13.030664
N	209

1990
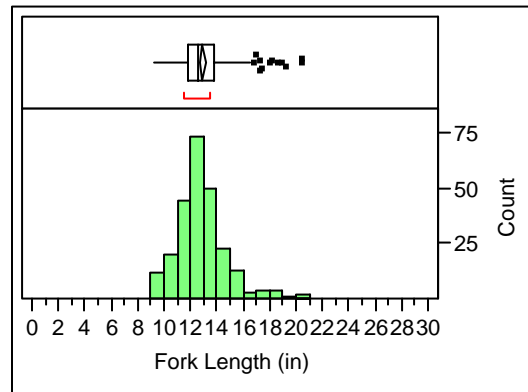
Mean	12.896759
Std Dev	1.9013086
Std Err Mean	0.1200095
upper 95% Mean	13.133118
lower 95% Mean	12.660401
N	251

1991
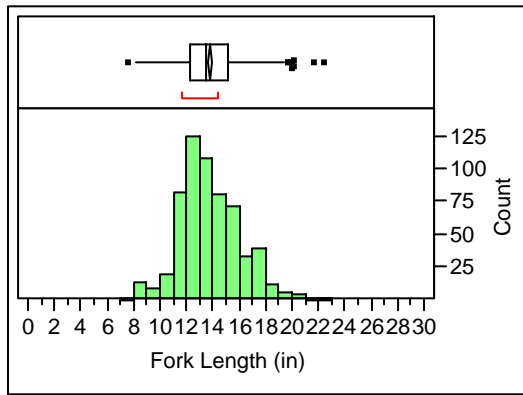
Mean	13.766426
Std Dev	2.2894118
Std Err Mean	0.0929244
upper 95% Mean	13.948919
lower 95% Mean	13.583933
N	607

1994
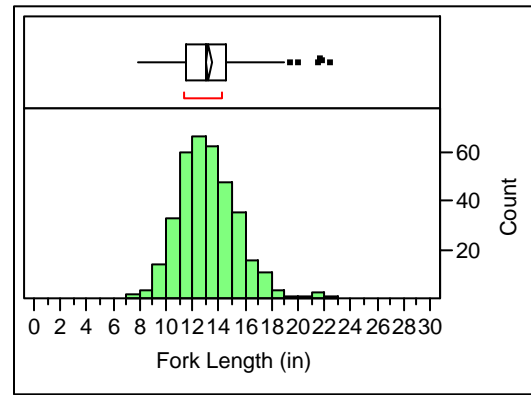
Mean	13.218288
Std Dev	2.3087848
Std Err Mean	0.1210132
upper 95% Mean	13.456263
lower 95% Mean	12.980313
N	364

1992
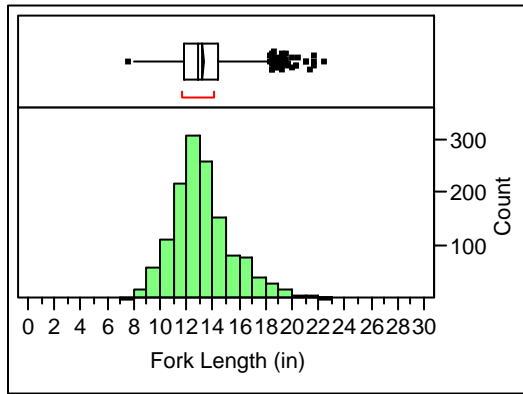
Mean	13.228004
Std Dev	2.2719373
Std Err Mean	0.0611807
upper 95% Mean	13.348021
lower 95% Mean	13.107987
N	1379

1995
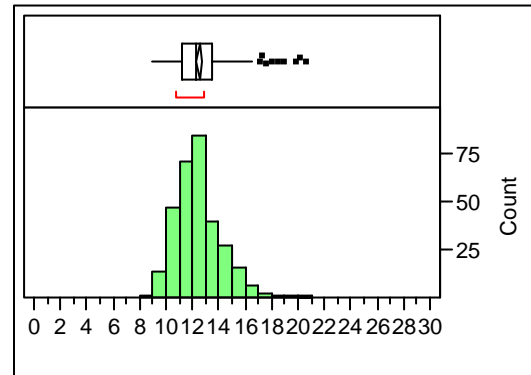
Mean	12.550169
Std Dev	1.9189648
Std Err Mean	0.1074414
upper 95% Mean	12.761555
lower 95% Mean	12.338783
N	319

1993
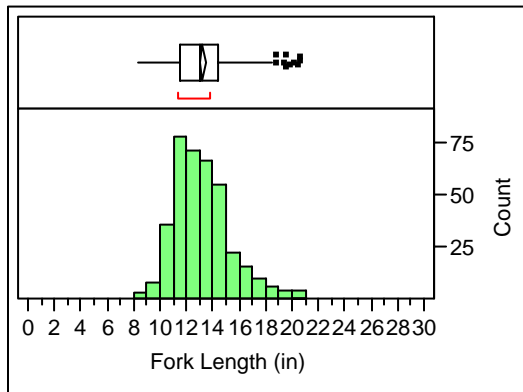
Mean	13.194205
Std Dev	2.1937055
Std Err Mean	0.1119471
upper 95% Mean	13.414313
lower 95% Mean	12.974097
N	384

1996
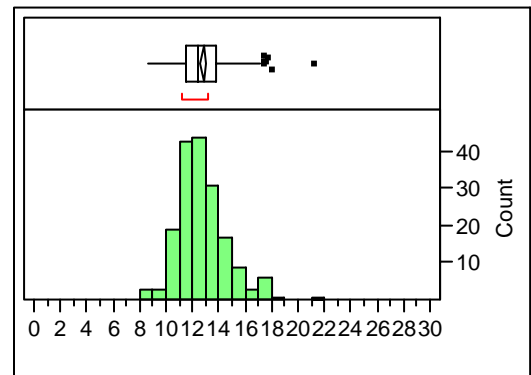
Mean	12.80315
Std Dev	1.9208926
Std Err Mean	0.1431749
upper 95% Mean	13.085677
lower 95% Mean	12.520622
N	180

42

1997
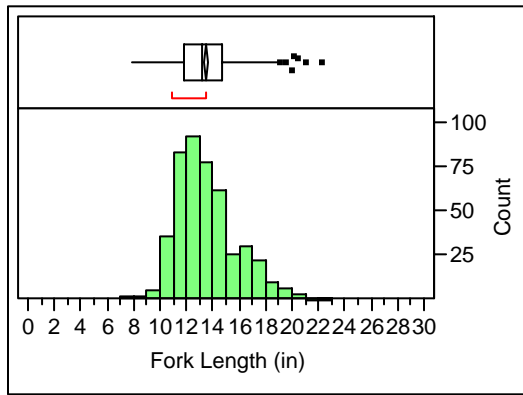
Mean	13.490956
Std Dev	2.2914779
Std Err Mean	0.1067248
upper 95% Mean	13.700684
lower 95% Mean	13.281227
N	461

1998

Mean	12.76897
Std Dev	1.9052512
Std Err Mean	0.0522624
upper 95% Mean	12.871496
lower 95% Mean	12.666444
N	1329

1999

Mean	12.572084
Std Dev	1.8552836
Std Err Mean	0.0407484
upper 95% Mean	12.651996
lower 95% Mean	12.492171
N	2073

2000

Mean	12.938326
Std Dev	2.0971963
Std Err Mean	0.0475165
upper 95% Mean	13.031514
lower 95% Mean	12.845137
N	1948

2001

Mean	12.411493
Std Dev	1.9332232
Std Err Mean	0.0369391
upper 95% Mean	12.483924
lower 95% Mean	12.339062
N	2739

2002
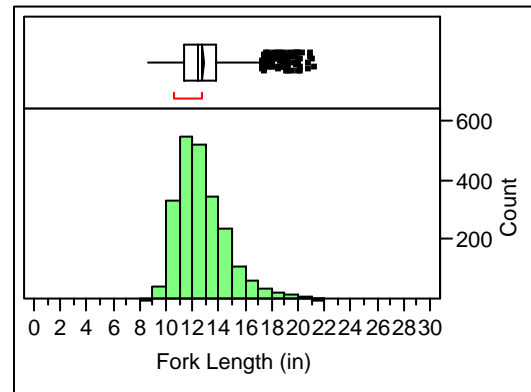
Mean	12.792953
Std Dev	1.9856068
Std Err Mean	0.0412062
upper 95% Mean	12.873757
lower 95% Mean	12.712148
N	2322

2003
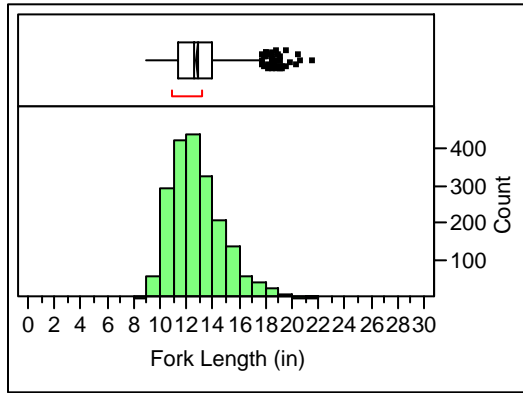
Mean	12.81672
Std Dev	1.9496079
Std Err Mean	0.0432074
upper 95% Mean	12.901456
lower 95% Mean	12.731985
N	2036

Western Region
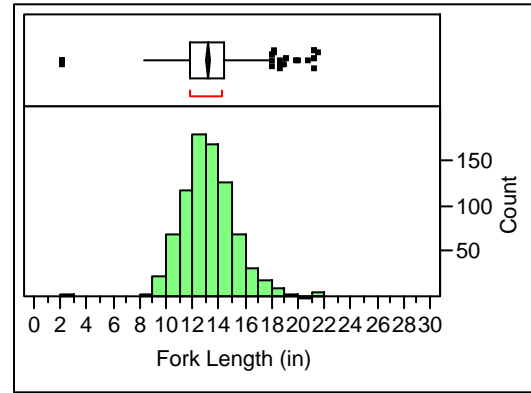
Mean	13.234184
Std Dev	2.1884109
Std Err Mean	0.0753729
upper 95% Mean	13.382125
lower 95% Mean	13.086243
N	843

2004
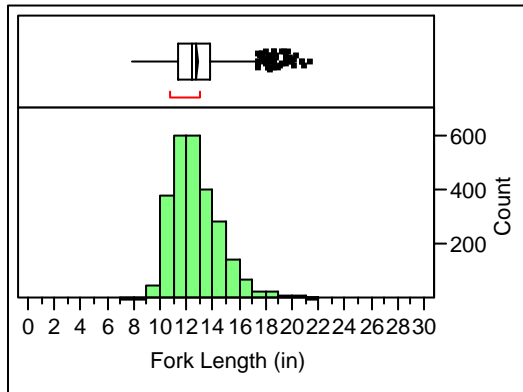
Mean	12.739984
Std Dev	1.8687578
Std Err Mean	0.0363982
upper 95% Mean	12.811356
lower 95% Mean	12.668612
N	2636

Alabama
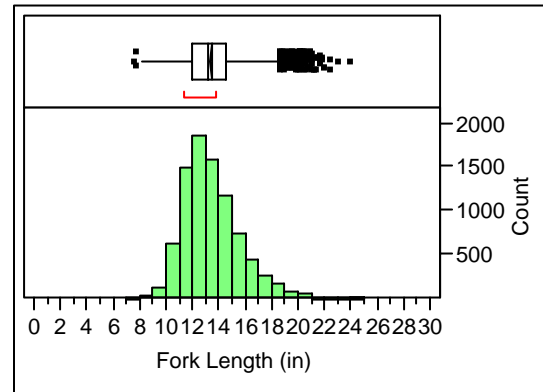
Mean	13.453506
Std Dev	2.1332314
Std Err Mean	0.0228536
upper 95% Mean	13.498304
lower 95% Mean	13.408707
N	8713

Eastern Region
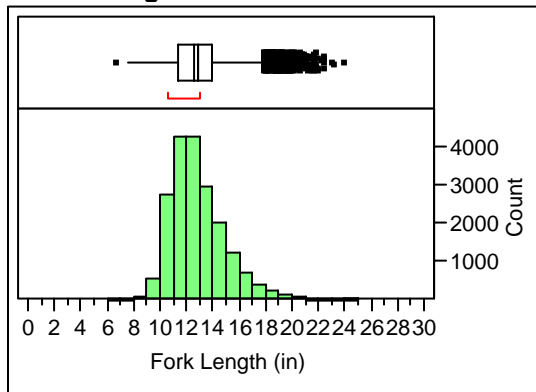
Mean	12.860274
Std Dev	2.0754609
Std Err Mean	0.0147687
upper 95% Mean	12.889222
lower 95% Mean	12.831327
N	19749

Florida
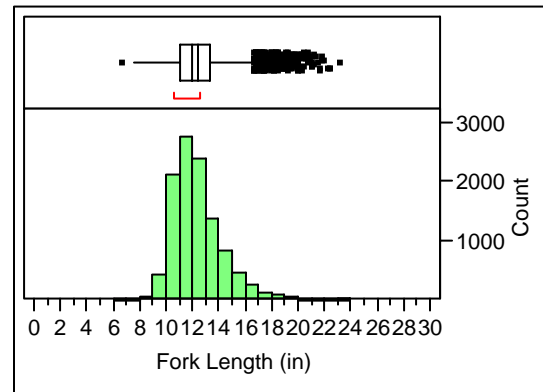
Mean	12.391914
Std Dev	1.9022937
Std Err Mean	0.0181081
upper 95% Mean	12.427409
lower 95% Mean	12.356419
N	11036

Louisiana
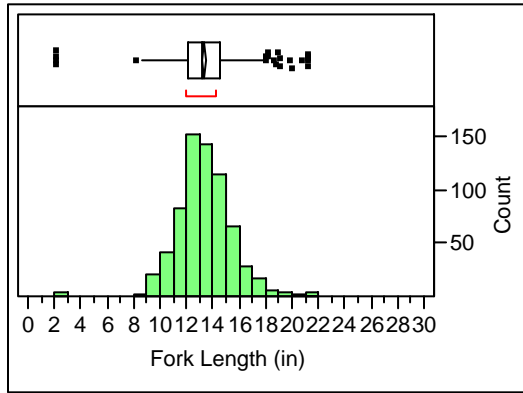
Mean	13.387911
Std Dev	2.1980925
Std Err Mean	0.0831395
upper 95% Mean	13.551144
lower 95% Mean	13.224677
N	699

Mississippi

Mean	12.48797
Std Dev	1.9847153
Std Err Mean	0.1653929
upper 95% Mean	12.814901
lower 95% Mean	12.161039
N	144

Wave One: January and February

Mean	12.792783
Std Dev	1.9452352
Std Err Mean	0.0496984
upper 95% Mean	12.890267
lower 95% Mean	12.695299
N	1532

Wave Two: March and April

Mean	12.9503
Std Dev	2.1203113
Std Err Mean	0.0355415
upper 95% Mean	13.019984
lower 95% Mean	12.880616
N	3559

Wave Three: May and June

Mean	13.329857
Std Dev	2.1934645
Std Err Mean	0.0369603
upper 95% Mean	13.402323
lower 95% Mean	13.257391
N	3522

Wave Four: July and August
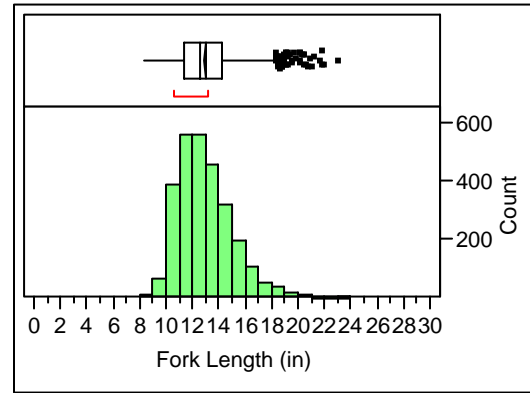
Mean	12.97587
Std Dev	2.0819518
Std Err Mean	0.0392124
upper 95% Mean	13.052757
lower 95% Mean	12.898982
N	2819

Wave Five: September and October
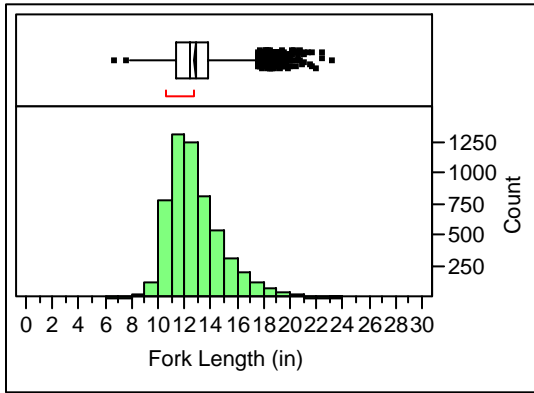
Mean	12.827627
Std Dev	2.0738722
Std Err Mean	0.0274715
upper 95% Mean	12.881482
lower 95% Mean	12.773772
N	5699

Hook and Line
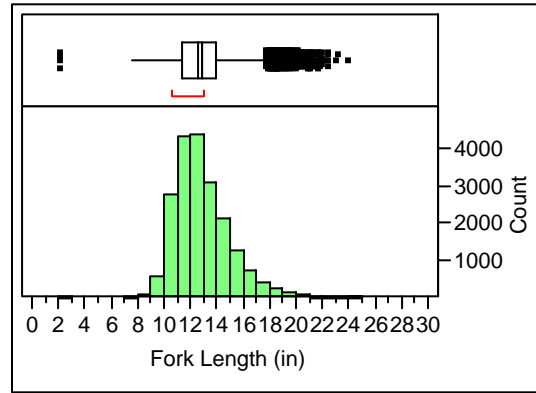
Mean	12.877
Std Dev	2.0817567
Std Err Mean	0.0145396
upper 95% Mean	12.905499
lower 95% Mean	12.848501
N	20500

Wave Six: November and December
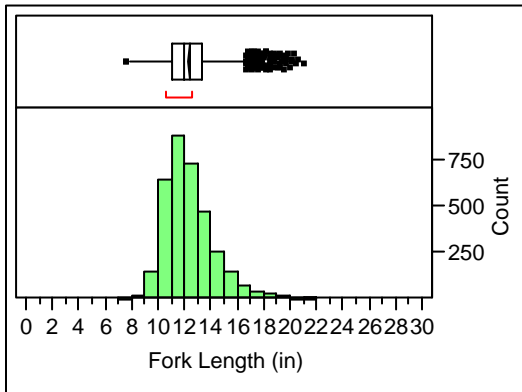
Mean	12.370395
Std Dev	1.8683399
Std Err Mean	0.0317581
upper 95% Mean	12.432662
lower 95% Mean	12.308128
N	3461

Dipnet A-frame
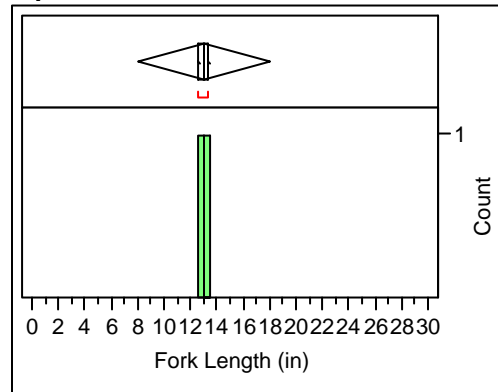
Mean	12.992126
Std Dev	0.556777
Std Err Mean	0.3937008
upper 95% Mean	17.994569
lower 95% Mean	7.9896832
N	2

Unknown Gear
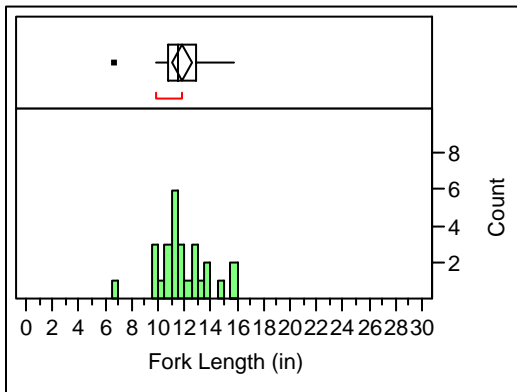
Mean	11.790609
Std Dev	1.9269809
Std Err Mean	0.3708476
upper 95% Mean	12.552898
lower 95% Mean	11.028321
N	27

Spear
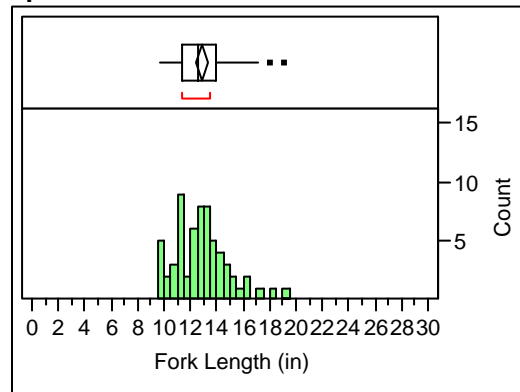
Mean	12.875266
Std Dev	1.9890843
Std Err Mean	0.2506011
upper 95% Mean	13.37621
lower 95% Mean	12.374321
N	63

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MRFSS Length Frequency Distributions

1986
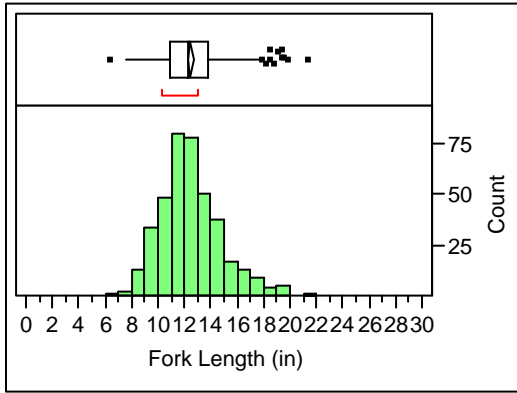
Mean	12.499752
Std Dev	2.3273927
Std Err Mean	0.1168085
upper 95% Mean	12.729394
lower 95% Mean	12.27011
N	397

1988
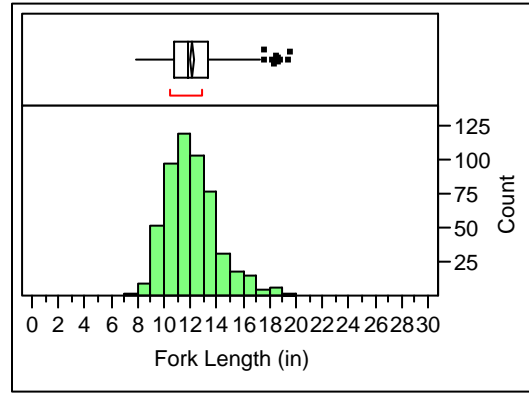
Mean	12.174322
Std Dev	2.0089264
Std Err Mean	0.0864504
upper 95% Mean	12.344143
lower 95% Mean	12.004501
N	540

1987
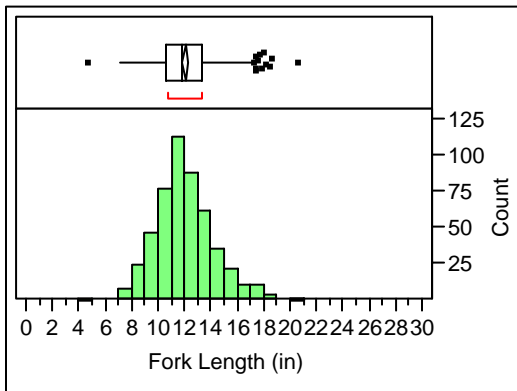
Mean	12.046618
Std Dev	2.1857842
Std Err Mean	0.0974593
upper 95% Mean	12.238096
lower 95% Mean	11.85514
N	503

1989
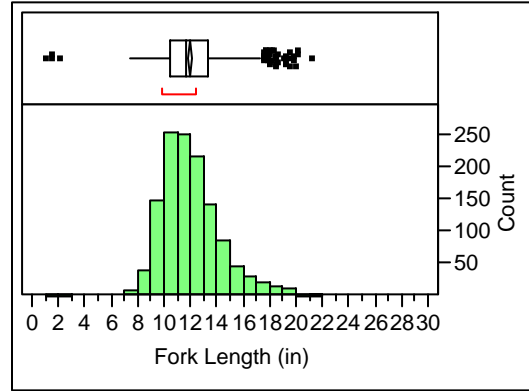
Mean	12.017732
Std Dev	2.2954529
Std Err Mean	0.0641098
upper 95% Mean	12.143504
lower 95% Mean	11.89196
N	1282

1990
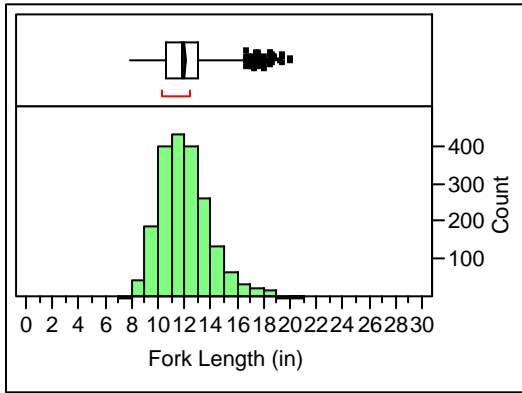
Mean	12.038582
Std Dev	1.9102777
Std Err Mean	0.0425242
upper 95% Mean	12.121978
lower 95% Mean	11.955186
N	2018

1993
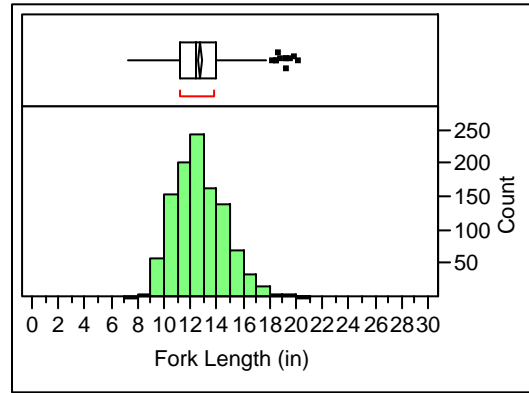
Mean	12.698269
Std Dev	1.9736016
Std Err Mean	0.0592377
upper 95% Mean	12.8145
lower 95% Mean	12.582039
N	1110

1991
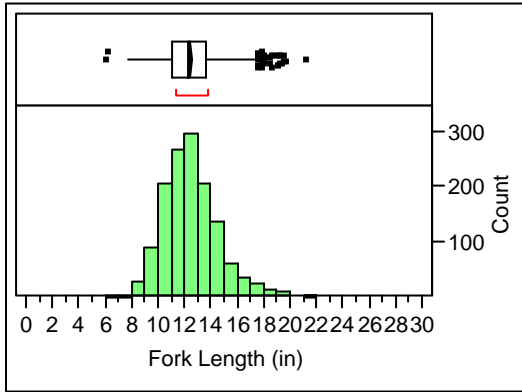
Mean	12.483308
Std Dev	2.0436009
Std Err Mean	0.054992
upper 95% Mean	12.591185
lower 95% Mean	12.375431
N	1381

1994
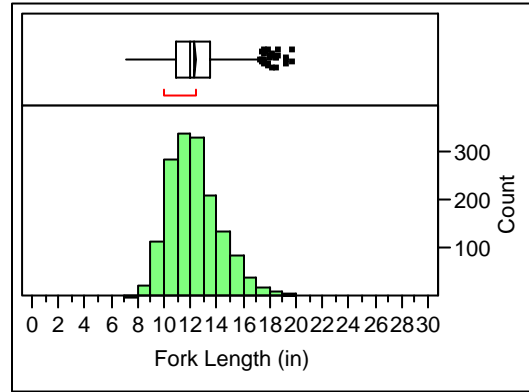
Mean	12.305137
Std Dev	1.9561301
Std Err Mean	0.0489798
upper 95% Mean	12.401208
lower 95% Mean	12.209065
N	1595

1992
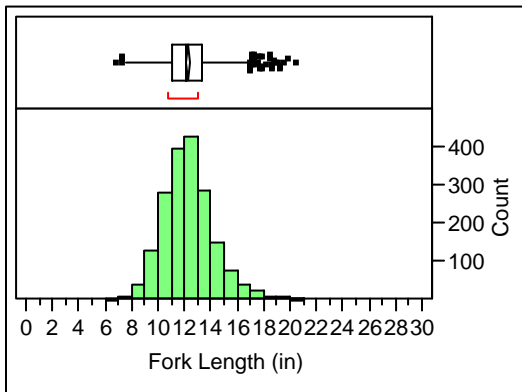
Mean	12.271269
Std Dev	1.9036165
Std Err Mean	0.0438803
upper 95% Mean	12.357328
lower 95% Mean	12.185209
N	1882

1995
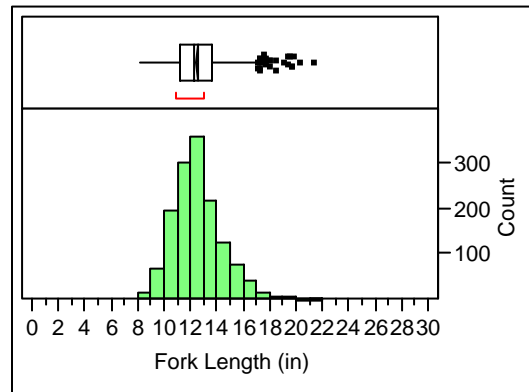
Mean	12.518975
Std Dev	1.8727007
Std Err Mean	0.0493158
upper 95% Mean	12.615714
lower 95% Mean	12.422237
N	1442

1996
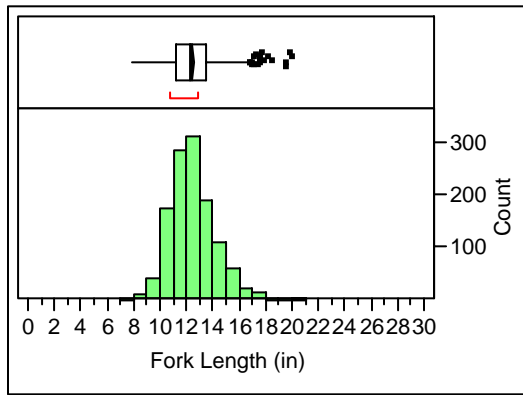
Mean	12.45238
Std Dev	1.7179289
Std Err Mean	0.0488648
upper 95% Mean	12.548247
lower 95% Mean	12.356513
N	1236

1997

Mean	12.150658
Std Dev	1.9214818
Std Err Mean	0.0599878
upper 95% Mean	12.268371
lower 95% Mean	12.032945
N	1026

1998

Mean	12.183237
Std Dev	1.7461922
Std Err Mean	0.0463391
upper 95% Mean	12.274138
lower 95% Mean	12.092337
N	1420

1999

Mean	12.307855
Std Dev	1.6461474
Std Err Mean	0.0610103
upper 95% Mean	12.427632
lower 95% Mean	12.188077
N	728

2000

Mean	12.512948
Std Dev	2.0193366
Std Err Mean	0.0738343
upper 95% Mean	12.657895
lower 95% Mean	12.368001
N	748

2001
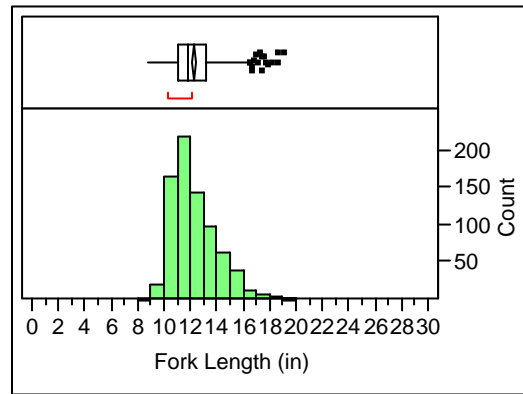
Mean	12.263525
Std Dev	1.7226558
Std Err Mean	0.0619196
upper 95% Mean	12.385076
lower 95% Mean	12.141975
N	774

2002

Fork Length (in)
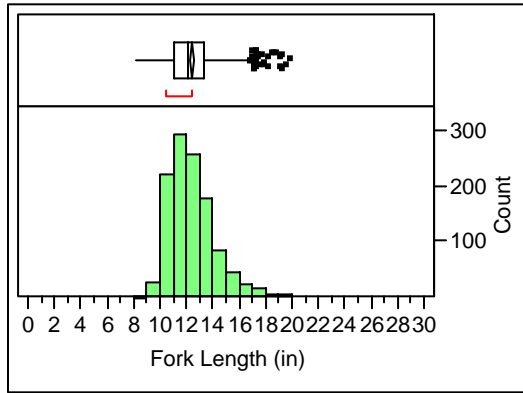
Mean	12.404954
Std Dev	1.7694038
Std Err Mean	0.0518399
upper 95% Mean	12.506664
lower 95% Mean	12.303244
N	1165

Fall

Fork Length (in)
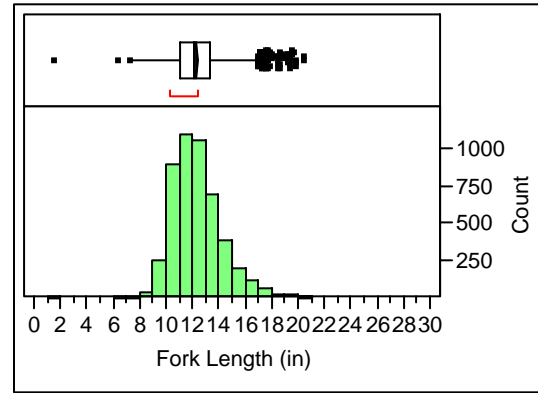
Mean	12.300396
Std Dev	1.8336675
Std Err Mean	0.0262596
upper 95% Mean	12.351877
lower 95% Mean	12.248916
N	4876

2003

Fork Length (in)
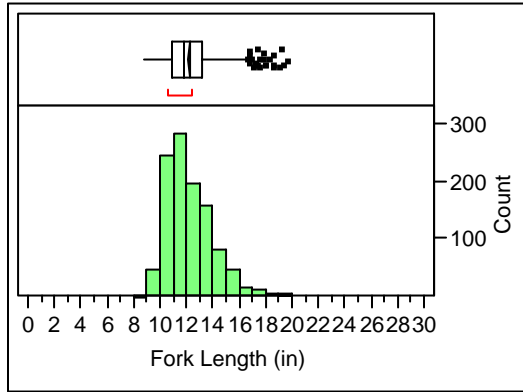
Mean	12.230614
Std Dev	1.769175
Std Err Mean	0.0533184
upper 95% Mean	12.335231
lower 95% Mean	12.125996
N	1101

Spring

Fork Length (in)
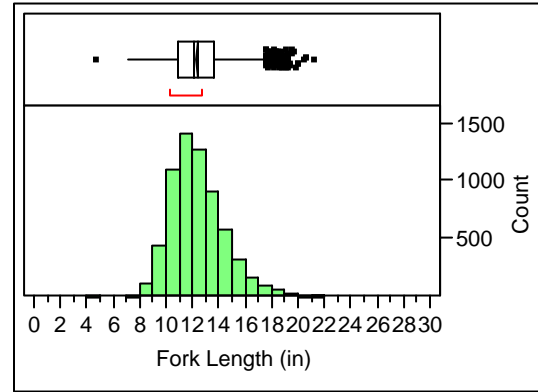
Mean	12.369823
Std Dev	1.9967952
Std Err Mean	0.0247254
upper 95% Mean	12.418293
lower 95% Mean	12.321353
N	6522

2004

Fork Length (in)
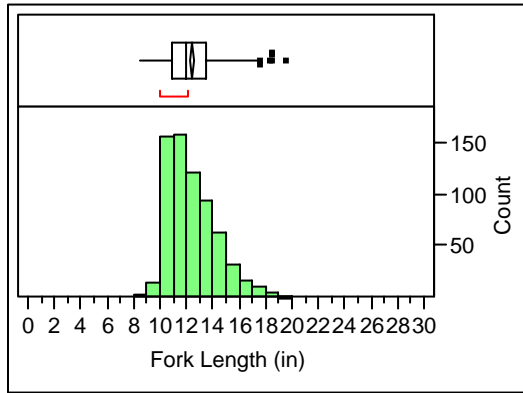
Mean	12.39244
Std Dev	1.8300408
Std Err Mean	0.0701273
upper 95% Mean	12.530133
lower 95% Mean	12.254748
N	681

Summer

Fork Length (in)
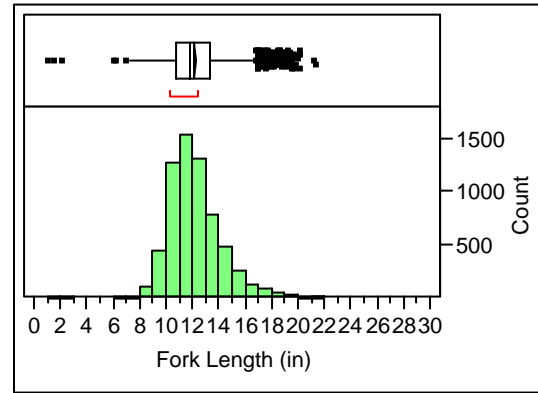
Mean	12.184034
Std Dev	1.9546464
Std Err Mean	0.0241388
upper 95% Mean	12.231354
lower 95% Mean	12.136714
N	6557

Winter
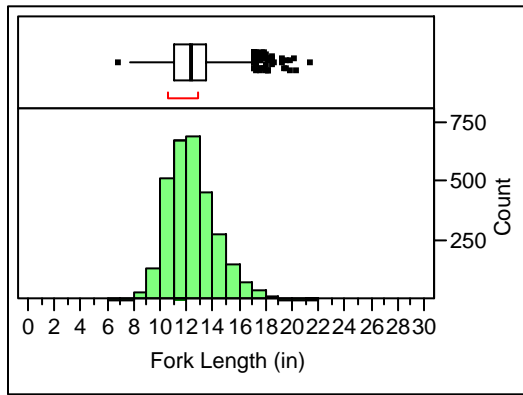
Mean	12.422861
Std Dev	1.8418623
Std Err Mean	0.0332204
upper 95% Mean	12.487997
lower 95% Mean	12.357724
N	3074

Alabama
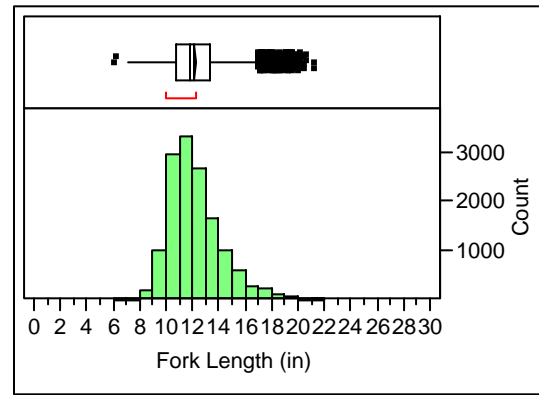
Mean	12.17816
Std Dev	1.9684634
Std Err Mean	0.0165045
upper 95% Mean	12.210511
lower 95% Mean	12.145809
N	14225

Eastern Region
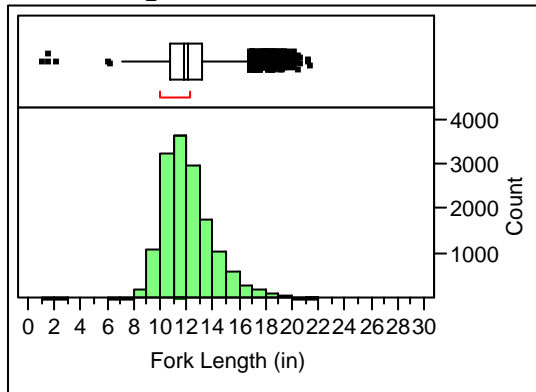
Mean	12.150617
Std Dev	1.9579295
Std Err Mean	0.0157606
upper 95% Mean	12.18151
lower 95% Mean	12.119724
N	15433

Florida
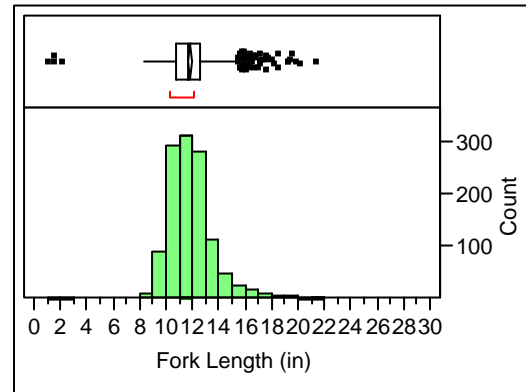
Mean	11.826276
Std Dev	1.7986184
Std Err Mean	0.0517494
upper 95% Mean	11.927805
lower 95% Mean	11.724747
N	1208

Western Region
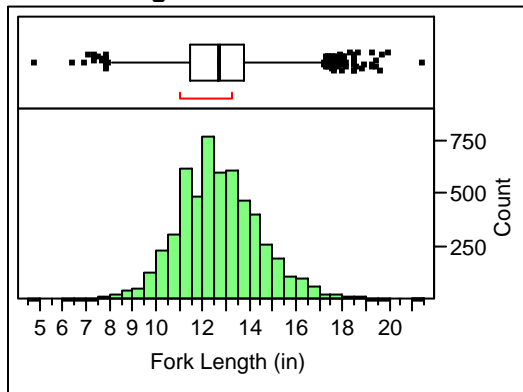
Mean	12.725309
Std Dev	1.7693836
Std Err Mean	0.0236528
upper 95% Mean	12.771677
lower 95% Mean	12.67894
N	5596

Louisiana
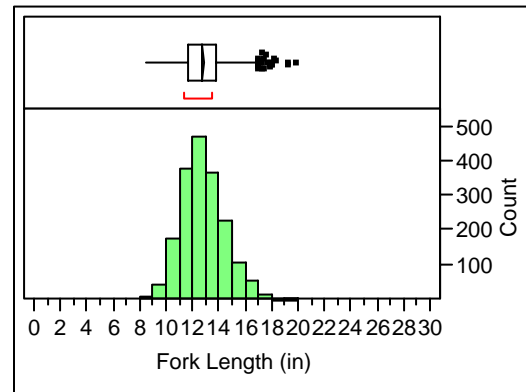
Mean	12.799746
Std Dev	1.6645463
Std Err Mean	0.0385233
upper 95% Mean	12.875299
lower 95% Mean	12.724193
N	1867

Texas
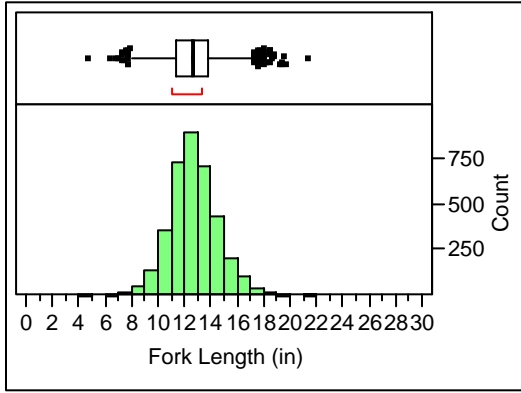
Mean	12.68804
Std Dev	1.8186779
Std Err Mean	0.0297824
upper 95% Mean	12.746431
lower 95% Mean	12.629649
N	3729

SW Florida: Naples to Crystal River
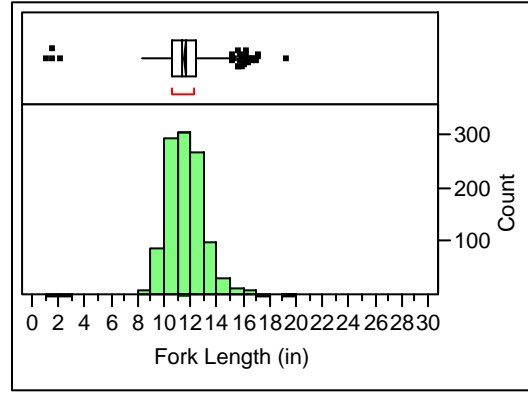
Mean	11.597997
Std Dev	1.5217574
Std Err Mean	0.0454307
upper 95% Mean	11.687136
lower 95% Mean	11.508858
N	1122

Dry Tortugas (Keys Based Vessels)
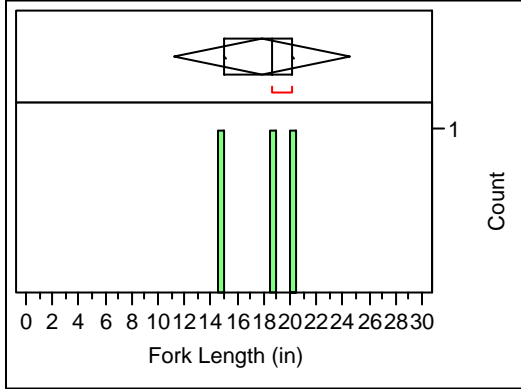
Mean	17.900262
Std Dev	2.6647853
Std Err Mean	1.5385145
upper 95% Mean	24.519956
lower 95% Mean	11.280569
N	3

FL Middle Grounds: Gulf and Panhandle
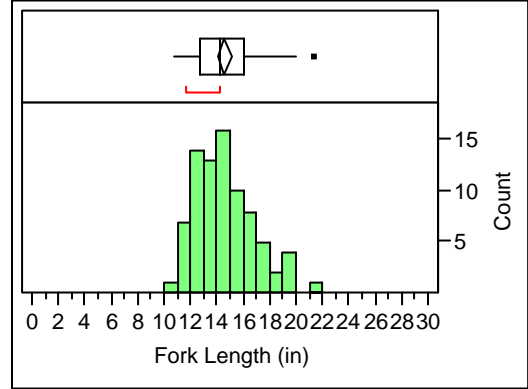
Mean	14.619423
Std Dev	2.3049576
Std Err Mean	0.2561064
upper 95% Mean	15.129091
lower 95% Mean	14.109755
N	81

Dry Tortugas (Gulf Based Vessels)
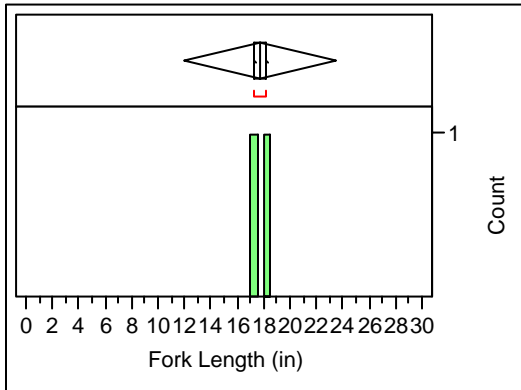
Mean	17.65748
Std Dev	0.6402935
Std Err Mean	0.4527559
upper 95% Mean	23.41029
lower 95% Mean	11.904671
N	2

NW Florida and Alabama
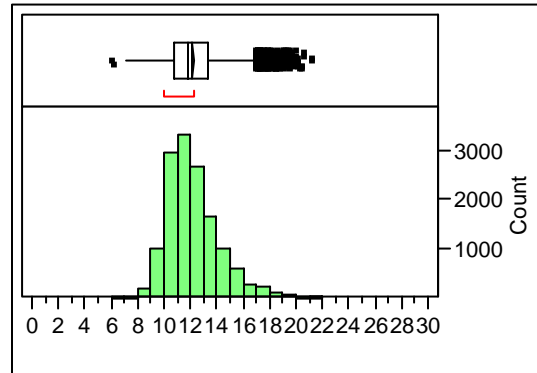
Mean	12.17816
Std Dev	1.9684634
Std Err Mean	0.0165045
upper 95% Mean	12.210511
lower 95% Mean	12.145809
N	14225

52

Louisiana
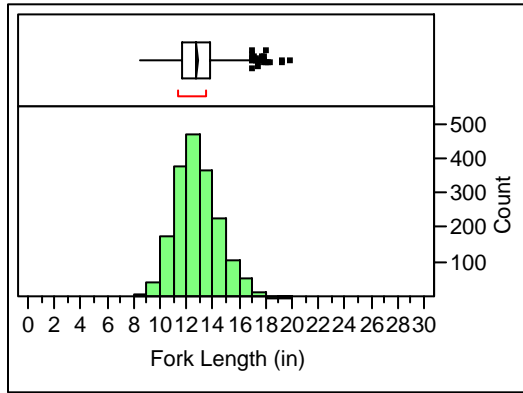
Mean	12.799746
Std Dev	1.6645463
Std Err Mean	0.0385233
upper 95% Mean	12.875299
lower 95% Mean	12.724193
N	1867

Southern Texas
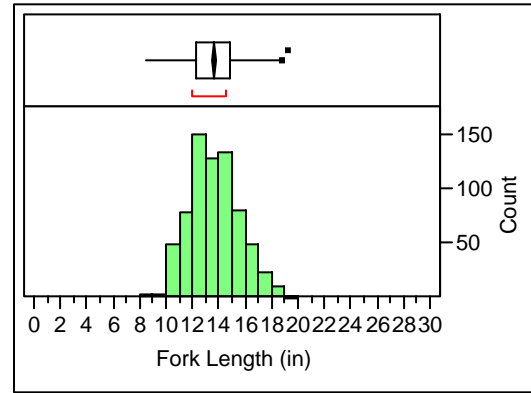
Mean	13.657128
Std Dev	1.8939242
Std Err Mean	0.0707793
upper 95% Mean	13.796088
lower 95% Mean	13.518168
N	716

NE Texas: Sabine to Freeport
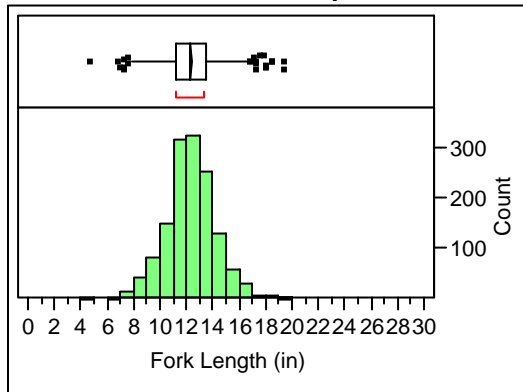
Mean	12.328065
Std Dev	1.8381177
Std Err Mean	0.0488647
upper 95% Mean	12.423921
lower 95% Mean	12.23221
N	1415

Central Texas (Port Aransas)
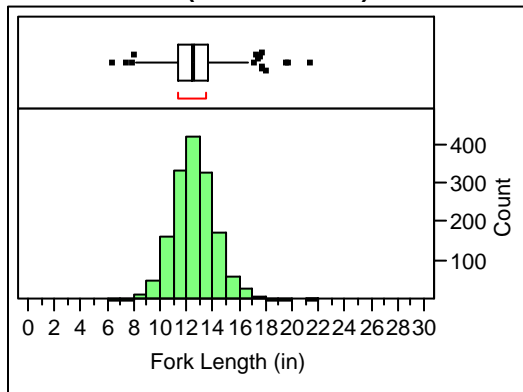
Mean	12.572581
Std Dev	1.6045285
Std Err Mean	0.0401383
upper 95% Mean	12.65131
lower 95% Mean	12.493852
N	1598

Texas Length Data

Note that fish in this dataset are measured in maximum length, NOT fork length and the data is presented in maximum length.

1983
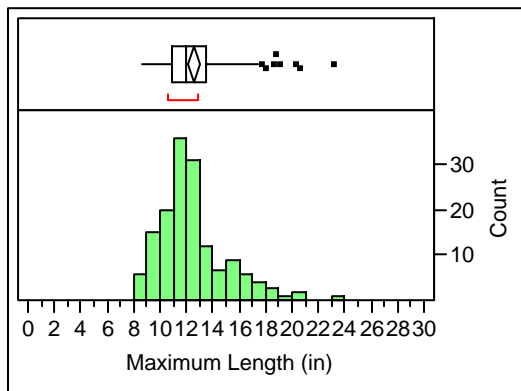
Mean	12.567032
Std Dev	2.6048391
Std Err Mean	0.2105888
upper 95% Mean	12.983091
lower 95% Mean	12.150973
N	153

1985
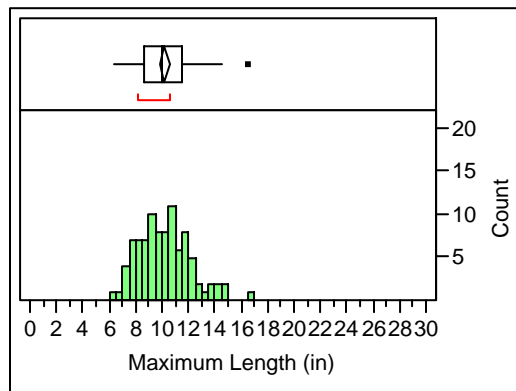
Mean	10.19812
Std Dev	1.9867729
Std Err Mean	0.2060188
upper 95% Mean	10.607291
lower 95% Mean	9.7889494
N	93

1984
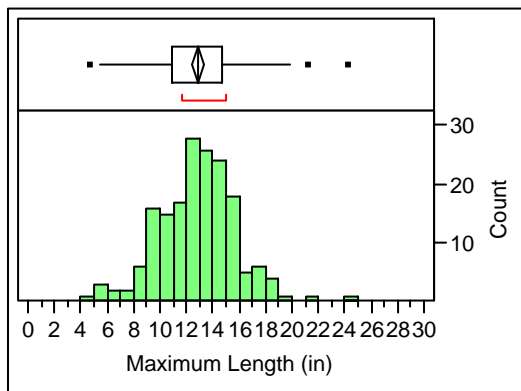
Mean	12.869766
Std Dev	2.9758794
Std Err Mean	0.2243153
upper 95% Mean	13.312477
lower 95% Mean	12.427054
N	176

1986
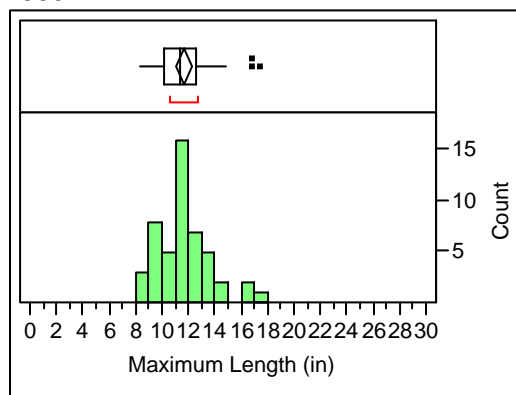
Mean	11.606942
Std Dev	2.1216612
Std Err Mean	0.3030945
upper 95% Mean	12.216354
lower 95% Mean	10.99753
N	49

1987
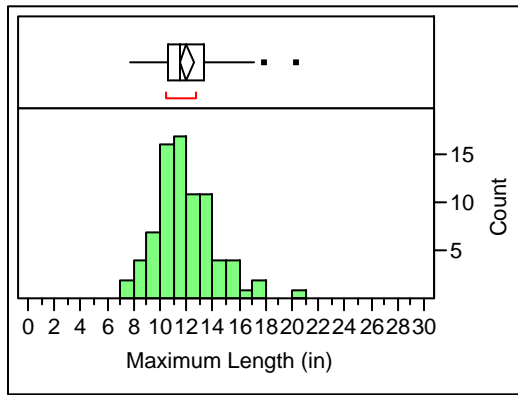
Mean	12.004429
Std Dev	2.3033482
Std Err Mean	0.2575222
upper 95% Mean	12.517014
lower 95% Mean	11.491844
N	80

1990
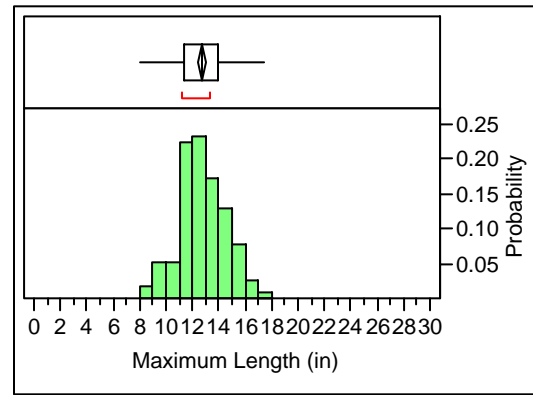
Mean	12.76378
Std Dev	1.7683135
Std Err Mean	0.1648961
upper 95% Mean	13.090437
lower 95% Mean	12.437122
N	115

1988
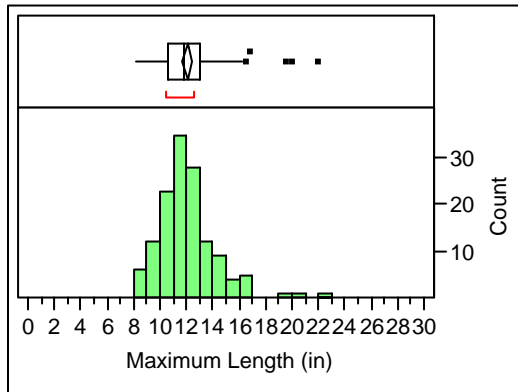
Mean	12.092649
Std Dev	2.2087523
Std Err Mean	0.1887064
upper 95% Mean	12.465827
lower 95% Mean	11.719471
N	137

1991
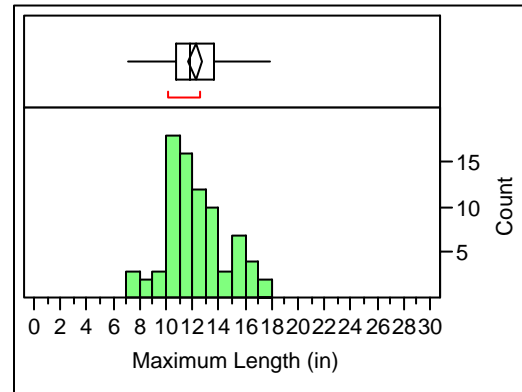
Mean	12.251476
Std Dev	2.3431077
Std Err Mean	0.2619674
upper 95% Mean	12.772909
lower 95% Mean	11.730043
N	80

1989
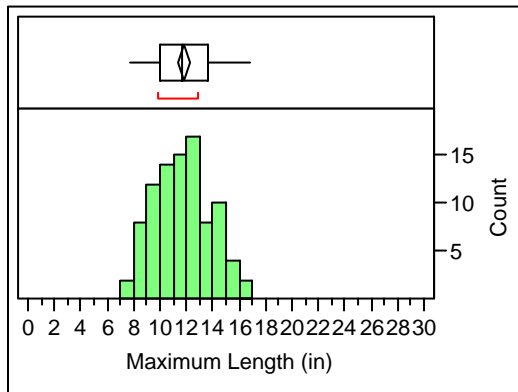
Mean	11.776789
Std Dev	2.1021211
Std Err Mean	0.2191613
upper 95% Mean	12.212126
lower 95% Mean	11.341452
N	92

1992
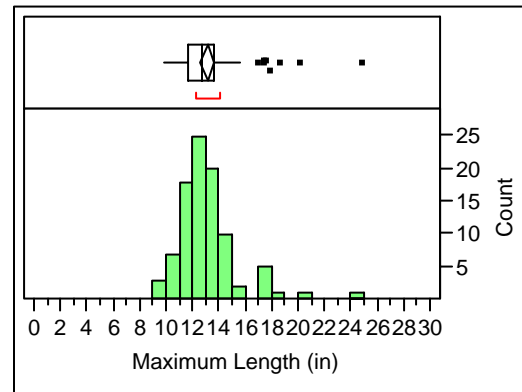
Mean	13.1132
Std Dev	2.2997949
Std Err Mean	0.2384776
upper 95% Mean	13.586837
lower 95% Mean	12.639562
N	93

1993
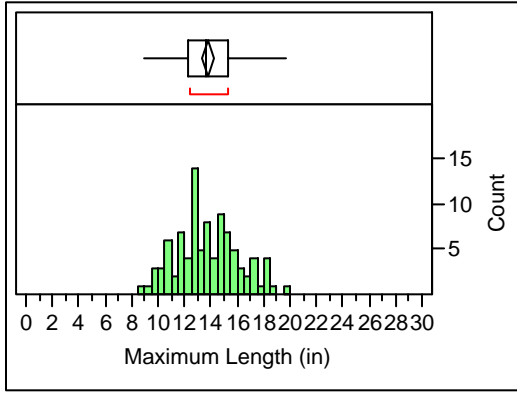
Mean	13.753419
Std Dev	2.3733307
Std Err Mean	0.2434986
upper 95% Mean	14.236891
lower 95% Mean	13.269947
N	95

1994

Mean	14.280241
Std Dev	2.071457
Std Err Mean	0.1697004
upper 95% Mean	14.61559
lower 95% Mean	13.944892
N	149

1995

Mean	14.52844
Std Dev	1.7396712
Std Err Mean	0.1502847
upper 95% Mean	14.825698
lower 95% Mean	14.231183
N	134

1996

Mean	13.872498
Std Dev	2.207514
Std Err Mean	0.2423061
upper 95% Mean	14.354522
lower 95% Mean	13.390474
N	83

1997

Mean	14.615354
Std Dev	2.9537121
Std Err Mean	0.2953712
upper 95% Mean	15.201435
lower 95% Mean	14.029274
N	100

1998
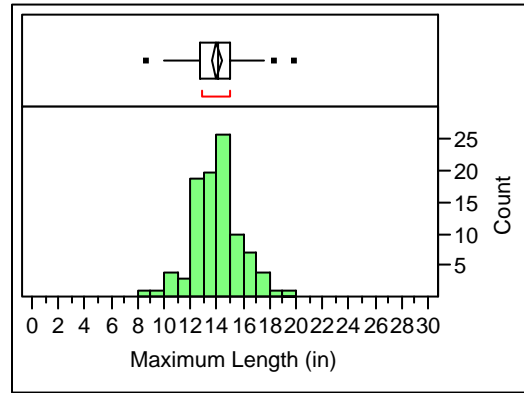
Mean	14.006413
Std Dev	1.8709572
Std Err Mean	0.1899669
upper 95% Mean	14.383494
lower 95% Mean	13.629331
N	97

1999
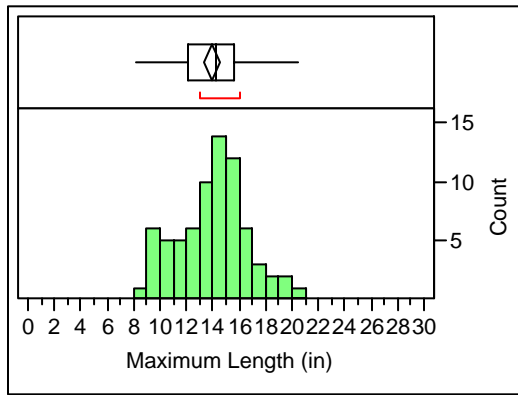
Mean	13.90411
Std Dev	2.6552923
Std Err Mean	0.3107785
upper 95% Mean	14.523635
lower 95% Mean	13.284584
N	73

2000

Mean	13.280229
Std Dev	2.0732701
Std Err Mean	0.1825413
upper 95% Mean	13.641419
lower 95% Mean	12.91904
N	129

2001

Mean	14.105631
Std Dev	2.2367693
Std Err Mean	0.2172542
upper 95% Mean	14.536406
lower 95% Mean	13.674856
N	106

2002

Mean	14.74141
Std Dev	2.3229213
Std Err Mean	0.2476242
upper 95% Mean	15.23359
lower 95% Mean	14.24923
N	88

2003

Mean	14.003048
Std Dev	2.6275378
Std Err Mean	0.272463
upper 95% Mean	14.544183
lower 95% Mean	13.461913
N	93

January
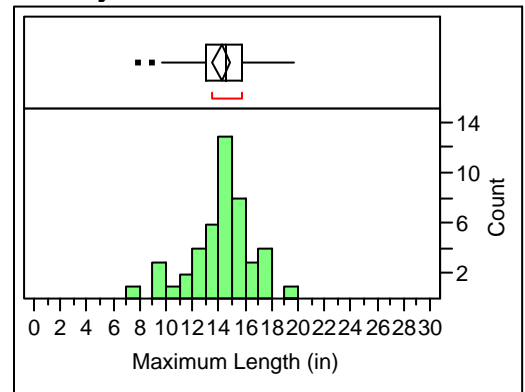
Mean	14.222013
Std Dev	2.3394822
Std Err Mean	0.3449378
upper 95% Mean	14.916753
lower 95% Mean	13.527273
N	46

February
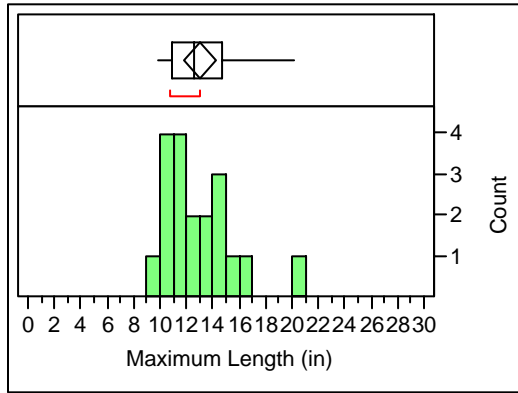
Mean	13.004559
Std Dev	2.576161
Std Err Mean	0.5910119
upper 95% Mean	14.246228
lower 95% Mean	11.762889
N	19

March

Mean	14.437154
Std Dev	2.6748553
Std Err Mean	0.3640017
upper 95% Mean	15.167249
lower 95% Mean	13.707059
N	54

April

Mean	13.371678
Std Dev	2.6819341
Std Err Mean	0.3352418
upper 95% Mean	14.041605
lower 95% Mean	12.701751
N	64

May

Mean	13.305014
Std Dev	2.8629341
Std Err Mean	0.2322146
upper 95% Mean	13.763824
lower 95% Mean	12.846205
N	152

June

Mean	13.247008
Std Dev	2.7603182
Std Err Mean	0.1526459
upper 95% Mean	13.547304
lower 95% Mean	12.946713
N	327

July
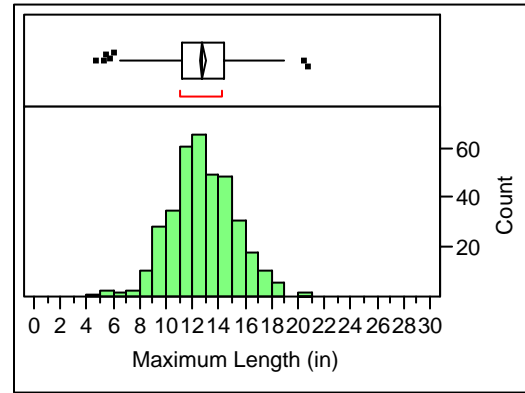
Mean	12.773403
Std Dev	2.5248615
Std Err Mean	0.1298649
upper 95% Mean	13.028754
lower 95% Mean	12.518053
N	378

August
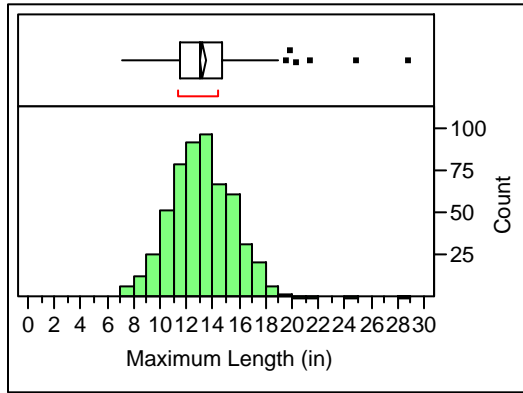
Mean	13.22249
Std Dev	2.4732218
Std Err Mean	0.1046998
upper 95% Mean	13.428145
lower 95% Mean	13.016836
N	558

November
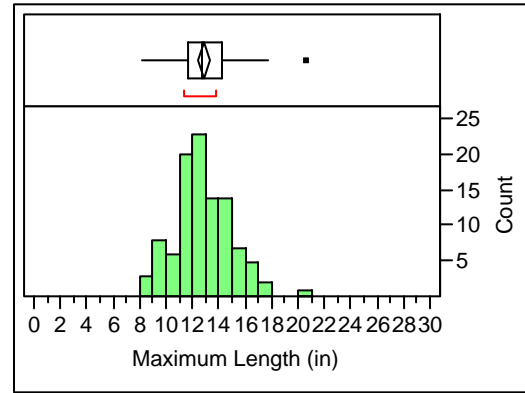
Mean	12.865989
Std Dev	2.1808529
Std Err Mean	0.2148858
upper 95% Mean	13.292214
lower 95% Mean	12.439764
N	103

September
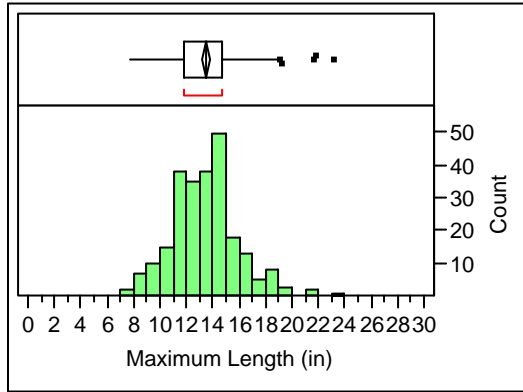
Mean	13.431785
Std Dev	2.533516
Std Err Mean	0.1618604
upper 95% Mean	13.750607
lower 95% Mean	13.112963
N	245

December
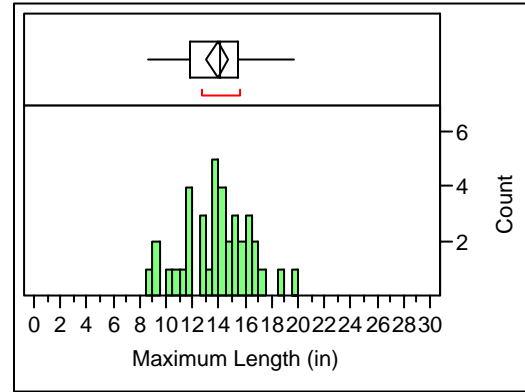
Mean	13.873809
Std Dev	2.5562386
Std Err Mean	0.4146767
upper 95% Mean	14.714023
lower 95% Mean	13.033594
N	38

October
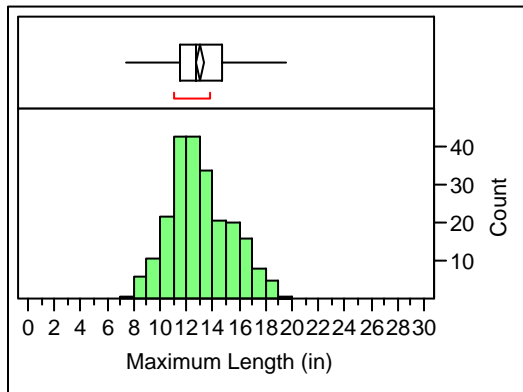
Mean	13.021952
Std Dev	2.3204666
Std Err Mean	0.1526755
upper 95% Mean	13.322773
lower 95% Mean	12.72113
N	231

Fall
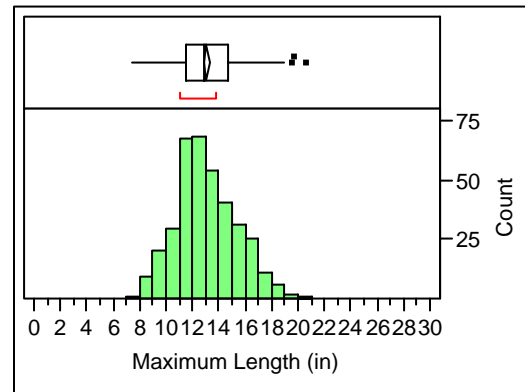
Mean	13.065786
Std Dev	2.3187453
Std Err Mean	0.1202213
upper 95% Mean	13.302187
lower 95% Mean	12.829385
N	372

Spring
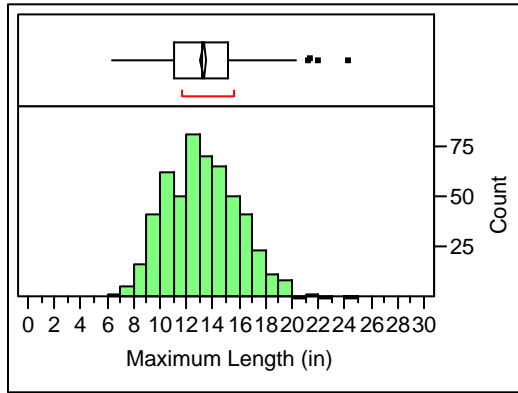
Mean	13.27794
Std Dev	2.7756508
Std Err Mean	0.1191146
upper 95% Mean	13.511922
lower 95% Mean	13.043957
N	543

Charter Boat
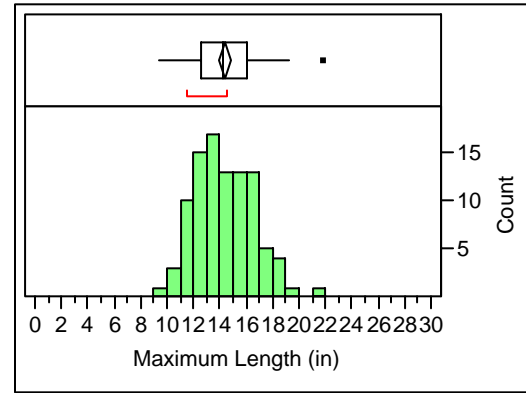
Mean	14.392634
Std Dev	2.2791429
Std Err Mean	0.2326141
upper 95% Mean	14.854432
lower 95% Mean	13.930837
N	96

Summer
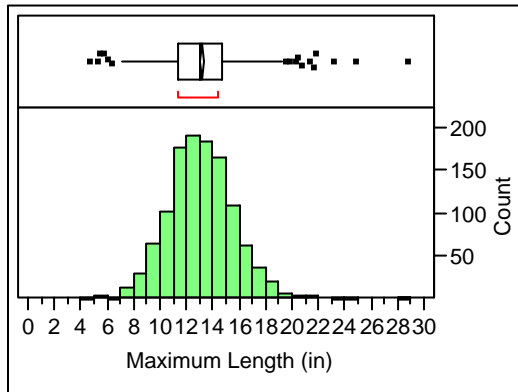
Mean	13.122171
Std Dev	2.5129603
Std Err Mean	0.0731241
upper 95% Mean	13.265638
lower 95% Mean	12.978703
N	1181

Headboat
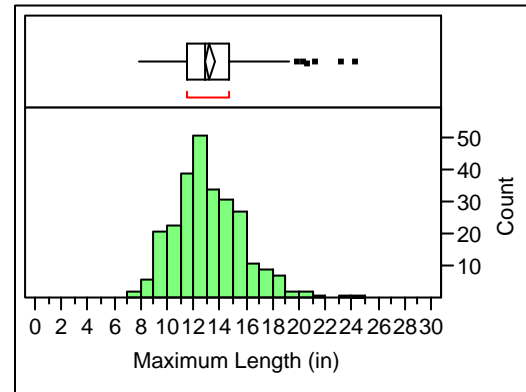
Mean	13.242596
Std Dev	2.6776704
Std Err Mean	0.1635648
upper 95% Mean	13.564637
lower 95% Mean	12.920555
N	268

Winter
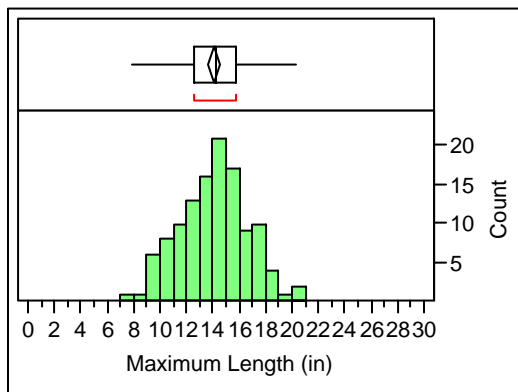
Mean	14.125256
Std Dev	2.5619544
Std Err Mean	0.234854
upper 95% Mean	14.590331
lower 95% Mean	13.660182
N	119

Private Boat
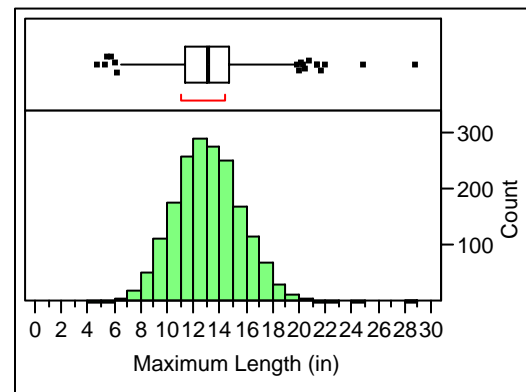
Mean	13.137695
Std Dev	2.5429863
Std Err Mean	0.0591073
upper 95% Mean	13.253619
lower 95% Mean	13.021771
N	1851

Aransas
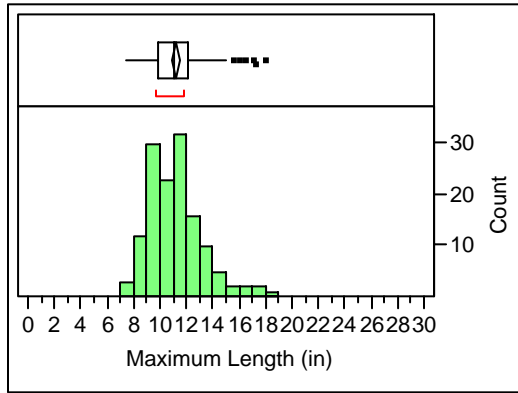
Mean	11.206778
Std Dev	2.0091254
Std Err Mean	0.1710281
upper 95% Mean	11.544975
lower 95% Mean	10.868582
N	138

Lower Laguna Madre
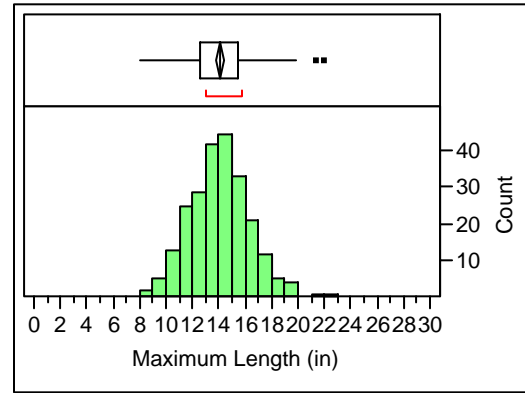
Mean	14.099285
Std Dev	2.3081026
Std Err Mean	0.1496121
upper 95% Mean	14.394025
lower 95% Mean	13.804546
N	238

Corpus Christi
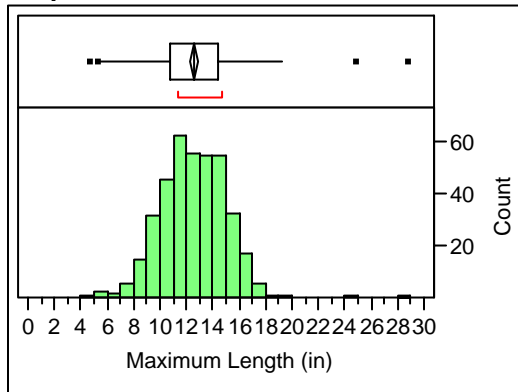
Mean	12.559355
Std Dev	2.6156662
Std Err Mean	0.1317754
upper 95% Mean	12.818428
lower 95% Mean	12.300282
N	394

Matagorda
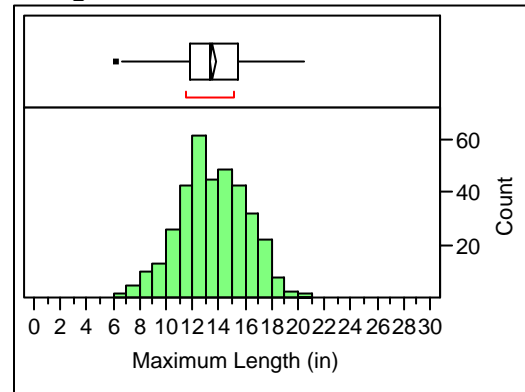
Mean	13.538561
Std Dev	2.5966241
Std Err Mean	0.1359135
upper 95% Mean	13.805835
lower 95% Mean	13.271287
N	365

Galveston
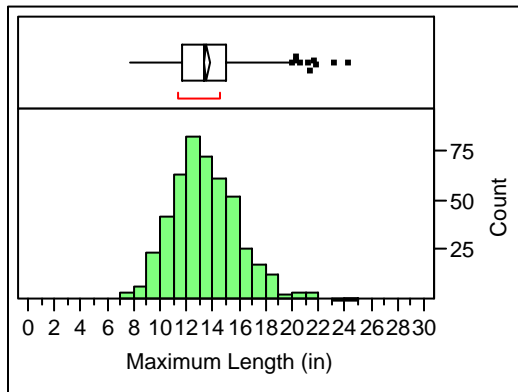
Mean	13.499992
Std Dev	2.6029346
Std Err Mean	0.1189311
upper 95% Mean	13.733684
lower 95% Mean	13.266299
N	479

Sabine Lake
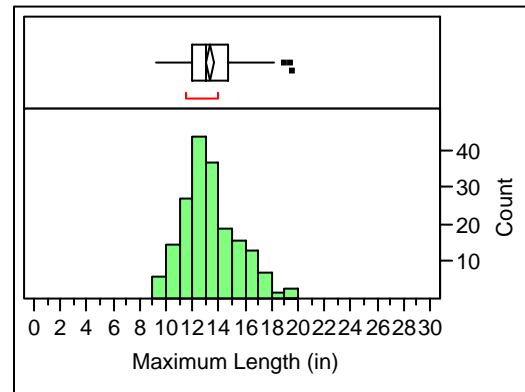
Mean	13.380411
Std Dev	2.0945459
Std Err Mean	0.1523558
upper 95% Mean	13.680957
lower 95% Mean	13.079864
N	189

San Antonio
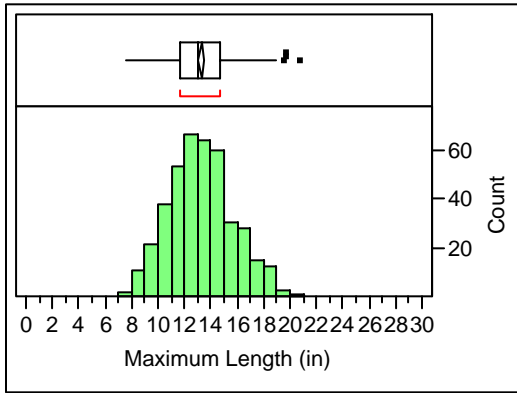
Mean	13.284754
Std Dev	2.4498284
Std Err Mean	0.1211362
upper 95% Mean	13.522883
lower 95% Mean	13.046625
N	409

Upper Laguna Madre
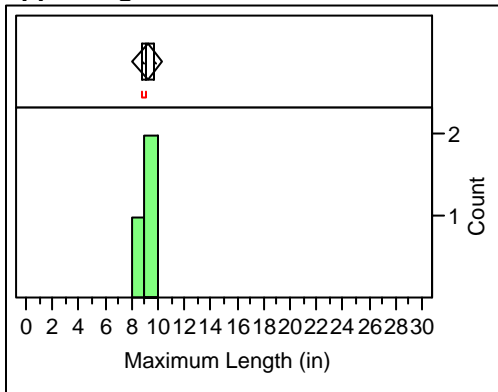
Mean	9.1994751
Std Dev	0.469699
Std Err Mean	0.2711808
upper 95% Mean	10.366272
lower 95% Mean	8.0326782
N	3