Final Report
U.S. Gulf of Mexico
Commercial Shrimp Conversion Factors Validation
2020

Project Synopsis

This project was a cooperative one-year study with the Gulf of Mexico state partners to improve the quality and accuracy of commercial shrimp landings data. This was done by collecting and analyzing shrimp samples to validate, verify, and update conversion factors used to determine whole (head on) weight of shrimp landings from other reported units, such as tail weight.

Samples were collected across the Gulf of Mexico, including samples independently obtained by State Partners from their respective commercial shrimp fisheries in Florida, Alabama, Mississippi, Louisiana, and Texas. Samples were collected from Summer 2019 to Summer 2020. The wide range of sample collection allowed for both spatial and temporal variability, as well as addressing variability in shrimp processing methods. The data obtained through this study are being used to compare and validate conversion factors currently in use by State Partners, and results are being discussed as to the adoption of new conversion factors for commercial shrimp species. Standardization of conversion factors will result in more accurate data for stock assessments, and development or modification to fisheries management plans.

Introduction

Background

Commercial landings data are a critical component to fishery management. Frequently, commercial landings are reported in units other than the original whole condition (ex. Tail weight reported for shrimp). It is important that the conversions of landings reported in these other units back the original whole condition (ex. Head On weight) are accurate and validated in order to provide the most reliable description of commercial landings for finfish and shellfish.

The most commonly used conversion factors were supplied several decades ago and have been used to convert fisheries products (finfish and shellfish) from landed weights to whole weight or meat weight. The conversion factors were historically provided by NOAA's National Marine Fisheries Service (NMFS) in the early 1990's. However, there is a lack of metadata describing the sample data sets, analytical techniques, and the strength of the regression equations that provided the basis for these original conversion factors and they have not been updated and/or validated since. Additionally, there are some variations in conversion factors used among Gulf of Mexico partners. These inconsistencies may result in uncertainty when comparing landings among partners.

The standardization and validation of currently used conversion factors are vital in depicting fishery trends and will result in more reliable data for use in stock assessments, state and regional quota monitoring, evaluation of the effectiveness of fishery management plans, and data analysis across different fishery management agencies. It is imperative that conversion factors used by fishery managers are accurate and routinely validated in order to provide the most reliable description of commercial landings of finfish and shellfish. This project fits into the FIN Development and Quality Management funding priorities. Developing more accurate commercial conversion factors will not only strengthen GulfFINs ability to provide high quality data for stock assessments, but will also collaboratively result in a standardized method that will be applied to additional species in the future as funding can be obtained.

History

No previous funding for this project in the Gulf of Mexico has been provided. A similar study was conducted in 2011-2012 by ACCSP and participating state partners along the Atlantic Coast. This proposed project will be similar in scope, with exception that the previous study focused on finfish and shellfish, while the current proposed study will focus primarily on brown and white shrimp.

Methodology

In order to validate and update historically used conversion factors provided by NMFS to convert landed product weights to whole fishery product weight, Gulf of Mexico State Partners individually collected and processed commercial shrimp species to estimate conversion factors. Each State Partner attempted to acquire their target shrimp species through various means under direction of their own state's rules for sample acquisition. Due to seasonal or geographic availability, each state focused on the shrimp species that they might be able to acquire with reasonable certainty to achieve the proposed sample sizes in this study. For the purpose of this study, the target sample sizes for each state for each shrimp species was 1000 individual measurements. Brown and White Shrimp were the target species for each state; however, each state had the ability to collect and process other commercially important shrimp species if locally available (i.e. Pink and Royal Red Shrimp).

To ensure we obtained adequate and consistent samples, landings data for target shrimp species were inspected for each state to identify locations and seasons when samples could be collected. Attempts to obtain unprocessed shrimp directly from wholesale seafood dealers or Gulf shrimp boats were made; however, some vessels process shrimp differently (i.e. Gulf Shrimp frozen at sea), so samples were also obtained from multiple vessels for comparison. For each individual shrimp, total length (nearest mm from rostrum to telson) was measured with a digital caliper, the whole weight was measured to the nearest 0.1 g on a digital scale, the shrimp were headed by hand, and then tail weight was obtained from the same scale (to nearest 0.1 g). Each State Partner provided their collected data for compilation, so that the combined data could be QA/QC'd together.

Once the measurement data was obtained, checks for errors and outliers were conducted. Outliers (errors due to data entry or transcription) were identified by visualizing the regression of the measured variables. Any data points that appeared to be well outside the relationship were submitted back to the State Partners to check original datasheets for confirmation. If error was not resolved, the data point was removed. The fit of the collected data for the relationship between shrimp whole (head on) weight and their headed (heads off) weight was estimated through linear regression, with regression equations and their R^2 values obtained. The final conversion factors were estimated from the data by calculating the ratio of the means (mean[y]/mean[x]) of the heads-on and heads-off weight for each shrimp species using the SURVEYMEANS procedure in SAS, which also provided associated estimates of standard error, variance, and confidence limits for the factor (ratio). Also, the results of the linear regression (R^2) of heads-on (y) and heads-off (x) weight were used to assess the suitability of the conversion factor for these shrimp spp., and were compared to current conversion factors in use for these species.

Results

During the project sampling period, 8,849 samples were collected for 4 shrimp species across all Gulf State Partners (Tables 1 and 2). The sample size target for each state for each species was 1000 measurements; however, due to unforeseen seasonal conditions (and COVID-19) affecting availability of some species, not all targets were met. Shrimp species overall sample sizes ranged from 766 to 3,688 across all State Partners.

Results of the linear regression analysis on the head on to tail weight relationship show a good fit of the collected data (i.e. a very high r-squared and a low variance around the calculated ratios). R^2 values for the head on to tail weight relationship of each calculated factor (ratio) ranged from 0.98 to 0.99, with the exception of Florida Pink Shrimp at 0.94. For Brown and White Shrimp, combining data across State Partners, resulted in R^2 values of 0.99 (Table 2, Figures 1-4).

Conversion factor estimates (ratio of head on to tail weight) varied between State Partners and from the original (current) factor being used across the gulf (Table 2, Figures 5-8). The current factor for Brown Shrimp is 1.61, while the states' estimates of the new factor was lower in each case and varied between 1.528 and 1.601, with an overall combined value of 1.548 (n = 2929). The current factor for White Shrimp is 1.54, while the state's estimates of the new factor varied between 1.508 and 1.603, with the combined estimate of 1.568 (n = 3688). Pink Shrimp were only collected by Alabama, Mississippi, and Florida, with 86% of the samples coming from Florida and less than 1% from Mississippi. The current factor for Pink Shrimp is 1.60, with estimates for the new factor ranging from 1.496 to 1.635, and the overall factor was 1.565 (n = 1466). Royal Red Shrimp were only collected by Alabama. The current factor for Royal Red Shrimp is 1.80. The new factor estimated for Royal Red Shrimp was 1.97 (n = 766).

The processed condition of samples varied between states, which may have contributed to differences in factor estimates between states (Table 2). Alabama was able to obtain fresh unfrozen samples; however, the shrimp were then frozen until they could be measured for ratio analysis, at which point they were thawed and processed. Florida, Louisiana, and Mississippi were able to acquire fresh samples and process for conversion measurements in a fresh condition. Texas focused on obtaining gulf shrimp samples, which are typically individually quick frozen (IQF) at sea and stored on vessel until the multiday trip was complete. Texas then acquired the shrimp from the vessel and kept in a frozen state until they

could be thawed for conversion factor processing. These IQF gulf shrimp were also soaked in a solution of sodium bisulfite, a preservative that also helps retain moisture; however, the details of this process were unknown. These gulf shrimp landings are typically reported in the frozen IQF condition, so any weight change due to this processing would be a possible variable. Texas conversion factors for Brown and White Shrimp varied between samples obtained from different dealers (Table 3)

Table 1. Comprehensive list of shrimp sampled by each state for Head On to Tail Weight conversion factor analysis.

Shrimp Species	AL	FL	LA	MS	TX	Combined
Brown Shrimp	887	116	262	531	1,133	**2,929**
White Shrimp	1,718	92	757	506	615	**3,688**
Pink Shrimp	204	1,255		7		**1,466**
Royal Red Shrimp	766					**766**
Total sampled	**3,575**	**1,463**	**1,019**	**1,044**	**1,748**	**8,849**

Table 2. Overall State Partner conversion factor results. The "New Factor" was estimated using the SAS SurveyMeans ratio of Head on (HO) to Tail (T) Weight, with includes the Lower and Upper 95% confidence limits (LCL,UCL). Combined results used all available partner data within the analysis.

Shrimp Species	Current Factor	State	N	Method	Mean HO_WT (g)	Mean T_WT (g)	New Factor	95% LCL	95% UCL	Regression Equation	R^2
Brown	1.61	**AL**	887	Fresh-Frozen-Thawed	14.3	8.7	1.528	1.522	1.534	HEADON_WT = -0.63110 + 1.59520*TAIL_WT	0.990
		FL	116	Fresh	4.1	2.6	1.600	1.580	1.620	HEADON_WT = 0.09324 + 1.56402*TAIL_WT	0.983
		LA	262	Fresh	9.3	6.0	1.537	1.526	1.548	HEADON_WT = -0.17863 + 1.56664*TAIL_WT	0.991
		MS	531	Fresh from slurry	8.4	5.3	1.601	1.596	1.605	HEADON_WT = -0.02110 + 1.60500*TAIL_WT	0.990
		TX	1,133	Vessel IQF - Thawed	16.9	10.9	1.549	1.545	1.553	HEADON_WT = -0.09474 + 1.55806*TAIL_WT	0.985
		Combined	**2929**		**13.4**	**8.5**	**1.548**	**1.545**	**1.551**	**HEADON_WT = -0.10845 + 1.56038*TAIL_WT**	**0.991**
		ACCSP_FL	344				1.575	1.555	1.595	HEADON_WT = 0.0007 + 1.5650*TAIL_WT	0.994
		ACCSP_GA	2082				1.571	1.566	1.576	HEADON_WT = 0.0004 + 1.5084*TAIL_WT	0.958
White	1.54	**AL**	1718	Fresh-Frozen-Thawed	17.9	11.2	1.564	1.560	1.568	HEADON_WT = -1.20782 + 1.66961*TAIL_WT	0.990
		FL	92	Fresh	20.0	13.3	1.508	1.499	1.518	HEADON_WT = -1.02996 + 1.58608*TAIL_WT	0.988
		LA	757	Fresh	12.7	8.2	1.536	1.529	1.544	HEADON_WT = -0.52951 + 1.60072*TAIL_WT	0.993
		MS	506	Fresh from slurry	17.3	11.1	1.566	1.560	1.571	HEADON_WT = -0.29849 + 1.59289*TAIL_WT	0.994
		TX	615	Vessel IQF - Thawed	26.2	16.4	1.603	1.596	1.610	HEADON_WT = -1.08729 + 1.66990*TAIL_WT	0.979
		Combined	**3688**		**18.2**	**11.5**	**1.568**	**1.565**	**1.571**	**HEADON_WT = -0.91144 + 1.64654*TAIL_WT**	**0.990**
		ACCSP_FL	420				1.648	1.673	1.697	HEADON_WT = -0.00220 + 1.78350*TAIL_WT	0.985
		ACCSP_GA	1689				1.635	1.640	1.645	HEADON_WT = -0.00220 + 1.78350*TAIL_WT	0.988
Pink	1.60	**AL**	204	Fresh-Frozen-Thawed	13.5	9.1	1.496	1.484	1.508	HEADON_WT = -0.59527 + 1.56160*TAIL_WT	0.975
		FL	1255	Fresh	25.6	16.3	1.571	1.559	1.584	HEADON_WT = -1.66317 + 1.67334*TAIL_WT	0.939
		MS	7	Fresh from slurry	8.7	5.3	1.635	1.606	1.664	HEADON_WT = 0.13959 + 1.60919*TAIL_WT	0.998
		Combined	**1466**		**23.8**	**15.2**	**1.565**	**1.554**	**1.577**	**HEADON_WT = -1.59022 + 1.66953*TAIL_WT**	**0.945**
Royal Red	1.80	**AL**	766	Fresh-Frozen-Thawed	29.2	14.4	1.970	1.959	1.981	HEADON_WT = -3.12195 + 2.18050*TAIL_WT	0.980

Table 3. Results of Texas Brown and White Shrimp conversion factor (head on to tail weight ratio) analysis for samples collected from various Texas dealers. Ratio = tail to head on weight conversion factor (HO/TW), IQF = Individually Quick Frozen, HO WT = head on weight, LCL/UCL = lower/upper confidence limits, new = estimated ratio, orig = original or currently used ratio.

Shrimp	Orig ratio	TX Dealer	N	Method	Mean HO WT (g)	Std Err	Ratio	95% LCL	95% UCL	ratio diff (new - orig)	diff for 1 million lbs of tails converted to HO WT (new - orig)
Brown	1.61	1	165	IQF - thawed	20.3	0.7	1.571	1.561	1.580	-0.039	-39,256
		2	336	IQF - thawed	15.2	0.2	1.535	1.528	1.541	-0.075	-75,395
		3	399	IQF - thawed	15.5	0.3	1.578	1.572	1.585	-0.032	-31,800
		4	233	IQF - thawed	19.1	0.2	1.512	1.505	1.519	-0.098	-97,914
		All	**1133**		**16.9**	**0.2**	**1.549**	**1.553**	**1.553**	**-0.061**	**-60,644**
White	1.54	1	115	IQF - thawed	35.7	0.5	1.631	1.617	1.645	0.091	90,685
		2	257	IQF - thawed	30.7	0.4	1.613	1.603	1.624	0.073	73,331
		3	243	IQF - thawed	17.0	0.3	1.559	1.550	1.569	0.019	19,239
		All	**615**		**26.2**	**0.4**	**1.603**	**1.596**	**1.610**	**0.063**	**63,428**

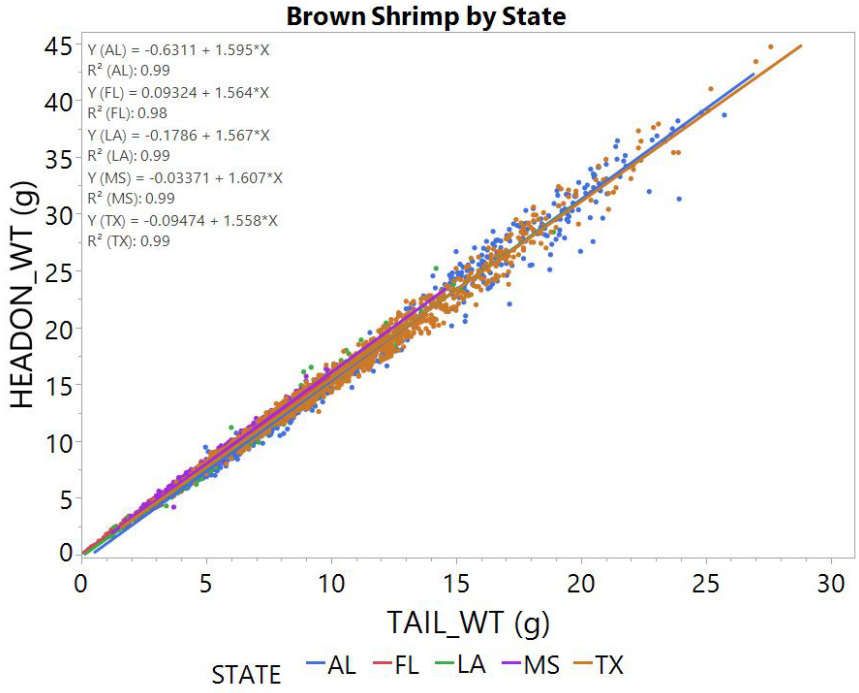

Figure 1. Regression analysis of Brown Shrimp tail to head on weight relationship for each State Partner's samples.

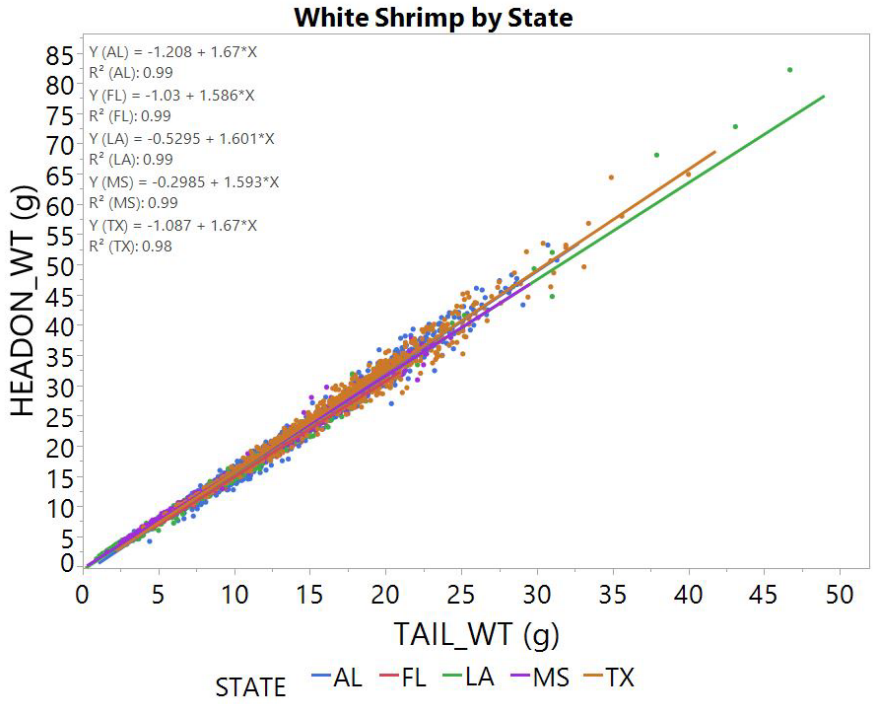

Figure 2. Regression analysis of White Shrimp tail to head on weight relationship for each State Partner's samples.

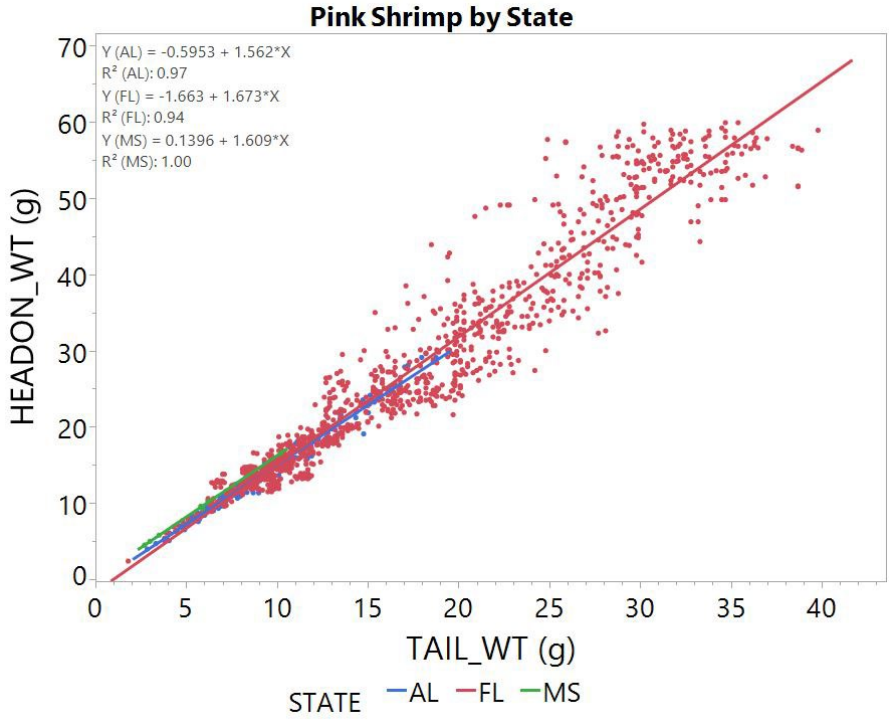

Figure 3. Regression analysis of Pink Shrimp tail to head on weight relationship for each State Partner's samples.

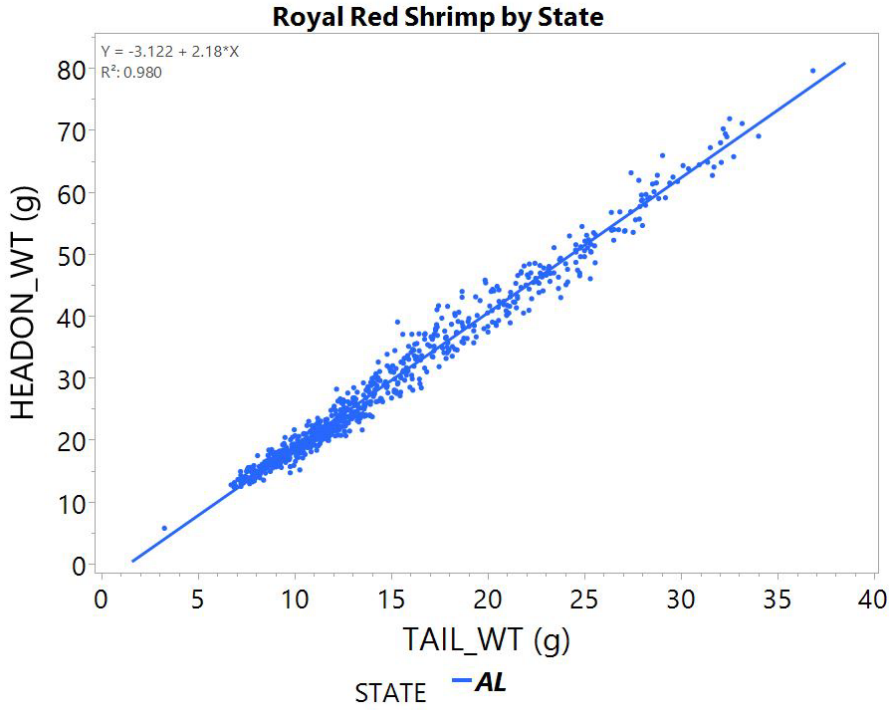

Figure 4. Regression analysis of Royal Red Shrimp tail to head on weight relationship for Alabama's samples.

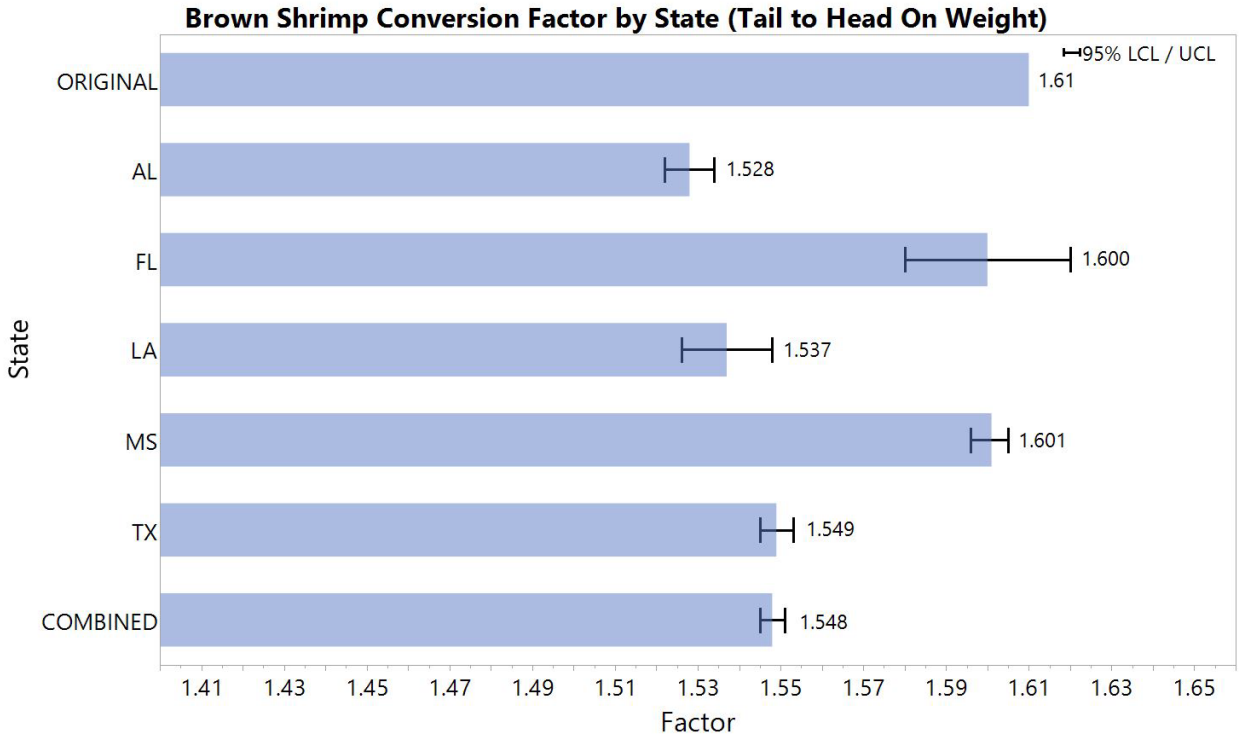

Figure 5. Comparison of each state's Brown Shrimp tail to head on weight conversion factor, including the original and overall new combined factor.

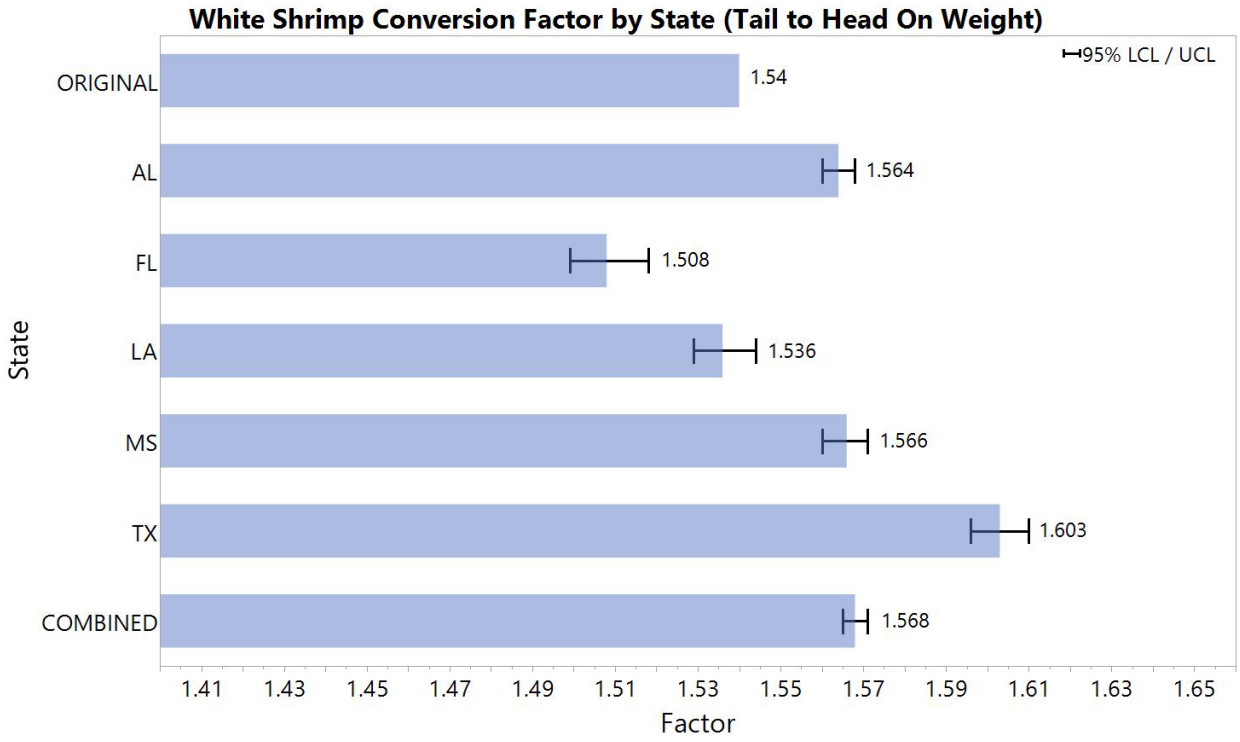

Figure 6. Comparison of each state's White Shrimp tail to head on weight conversion factor, including the original and overall new combined factor.

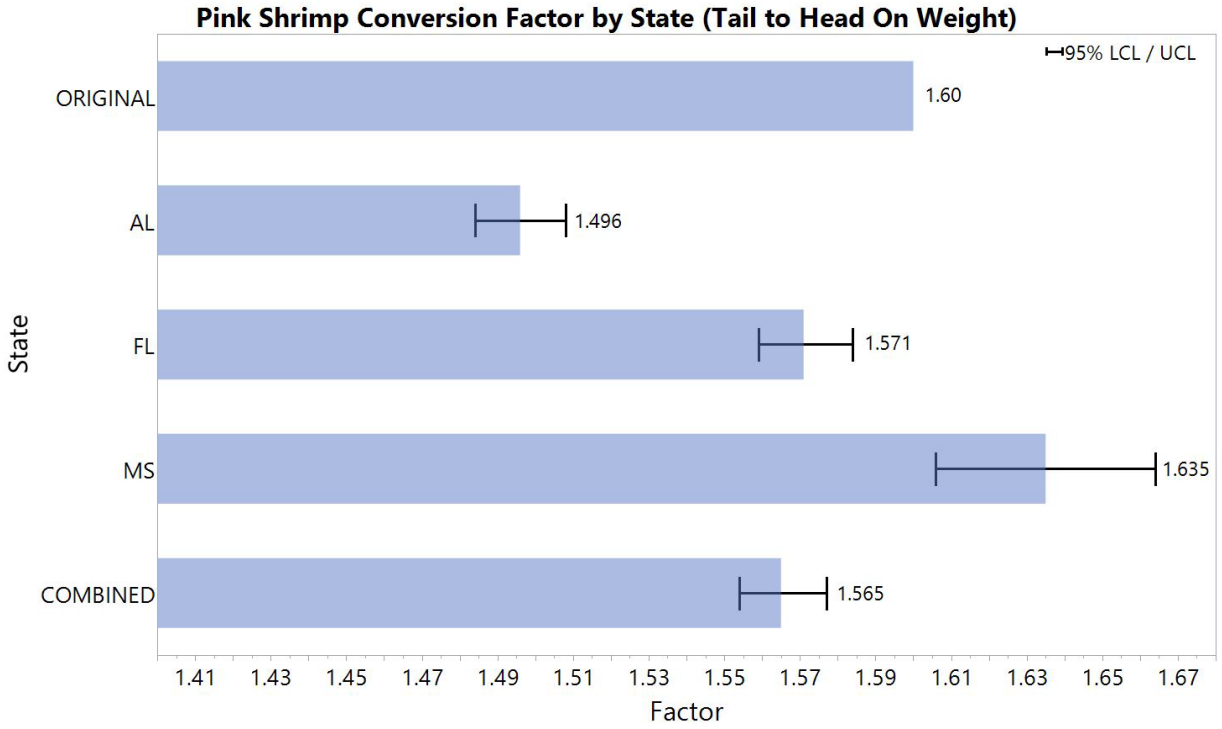

Figure 7. Comparison of each state's Pink Shrimp tail to head on weight conversion factor, including the original and overall new combined factor.

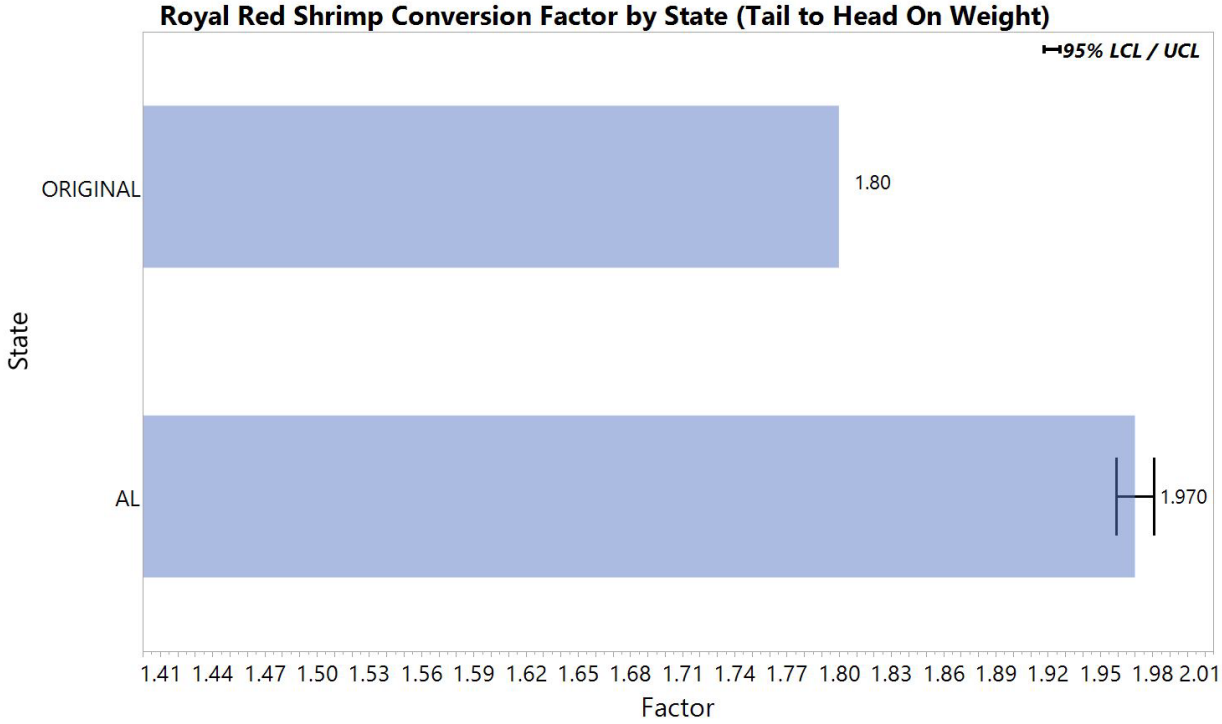

Figure 8. Comparison of Alabama's Royal Red Shrimp tail to head on weight conversion factor, including the original and overall new combined factor.

Recommendations for implementing calculated conversion factors:

The decision of which conversion factors to be used going forward is ultimately up to the individual states. They can choose if they want to continue using their current conversion, the conversion factors calculated by their individual state or the conversion factor calculated by combining data across states (i.e. Vermillion Snapper samples from TX, LA and AL). However, unless there is a biological or stock reason for using separate conversions, states should consider using the same conversions.

Approval for implementing calculated conversion factors:

Species	Old Factor	New Final Factor	Factor Approval for Gulf	Begin Year
Brown Shrimp	1.61			
		Combined 1.548	TX, LA, MS, AL, FL	Jan 1 2020
White Shrimp	1.54			
		Combined 1.568	TX, LA, MS, AL, FL	Jan 1 2020
Pink Shrimp	1.60			
		FL Calculated 1.571	FL	Jan 1 2020
		Combined 1.565	TX, LA, MS, AL	Jan 1 2020
Royal Red Shrimp	1.80	Combined 1.970	TX, LA, MS, AL, FL	Jan 1 2020