Final Report
U.S. Gulf of America
Commercial Fish (King Mackerel, Barracuda, Blue Catfish, Mullet) and Shellfish (Eastern Oyster and Blue Crab) Conversion Factors Validation
2024

Project Synopsis

This project was a cooperative one-year study with the Gulf State Partners to improve the quality and accuracy of commercial fish and shellfish landings data. This was done by collecting and analyzing King Mackerel, Great Barracuda, Blue Catfish, Mullet, Eastern Oyster, and Blue Crab samples to validate, verify, and update conversion factors used to determine either whole weight (from gutted weight of fish species), whole individual weight (mullet and crab), and/or shucked meat of oyster sacks.

Samples were collected across the Gulf, including samples obtained by State Partners from their respective commercial fisheries in Florida, Alabama, Louisiana, and Texas. These fishery dependent samples were collected from December 2023 to December 2024. Some fisheries were unexpectedly closed (i.e. oysters), so some samples were independently collected by the state agency. The wide range of sample collection allowed for both spatial and temporal variability, as well as addressing some variability in handling/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 were discussed as to the adoption of new conversion factors for these commercial fish and shellfish 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. gutted weight reported for fish). It is important that the conversions of landings reported in these other units back the original whole condition (ex. whole 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 1980'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 State 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

A similar project in the Gulf has been completed, with a focus primarily on snapper, grouper, and Black Drum; however, a number of other species were opportunistically sampled. Data analysis for this previous project determined that previous factors were no longer accurate and the Gulf State Partners adopted the new factors for the various commercial fisheries uniformly across the Gulf.

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 State Partners individually collected and processed commercial fish species (i.e. King Mackerel, Great Barracuda, Blue Catfish, Mullet, Eastern Oyster, and Blue Crab) to estimate conversion factors. Each State Partner attempted to acquire their target fish 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 fish and shellfish 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 fish species was 200 individual measurements, while shellfish species had a 1000 sample target. Each state had its own priority species; however, there was some overlap (i.e. Blue Crabs were collected by Florida and Texas).

To ensure we obtained adequate and consistent samples, landings data for target species were inspected for each state to identify locations and seasons when samples could be collected. Attempts to obtain unprocessed (whole) fish and shellfish species directly from wholesale seafood dealers or Gulf commercial fishing boats were made; however, some species had unexpected seasonal closures that necessitated collecting fishery independent samples (i.e. targeted oyster dredges – TX). For each individual fish, at least one length (total length) was taken to the nearest mm. To estimate fish gutted

condition conversion factor, the whole weight was measured to the nearest 0.01 kg on a digital scale, the fish were gutted, and then a gutted weight was obtained from the same scale (to nearest 0.01 kg). Conversion factors relating to the weight per individual (mullet and crab) was obtained through whole weight as represented by pounds, which was converted from the original whole weight measured as kilograms. Oyster data (for converting sack weight to shucked meat weight) included measuring length, width, depth of each oyster to nearest mm. Whole oysters were weighed (nearest 0.1 g), shucked, and the meat and shell weighed separately after draining the liquor. 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 (ex. length-weight relationship, gut-whole weight regression, whole-meat weight regression). Any data points that appeared to be well outside the relationship were submitted back to the State Partners to check original data sheets for confirmation. If an error was not resolved, the data point was removed. Also, the assumption was made that the ratio of whole weight/gutted weight was greater than 1 (i.e. the gutted weight must be less than the whole weight). If the ratio was equal to or less than 1, the data was checked for errors and removed if there was no resolution. The fit of the collected data for the relationship between whole weight and gutted weight (or shucked meat weight) was estimated through linear regression, with regression equations and their R^2 values obtained.

The conversion factor was estimated through analysis of the mean ratios between whole weight and gutted weight. The final conversion factors were estimated from the data by calculating the ratio of the means (mean[y]/mean[x]) of the whole and gutted weight for each fish 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 whole (y) and gutted (x) weight were used to assess the suitability of the conversion factor for these fish species, and were compared to current conversion factors in use for these species. Additionally, alternate linear regression equations were calculated by constraining the y-intercept to zero, which was a method that NOAA used previously for other conversion factors and we also used to compare to the ratio of means results.

Results

A total of 5,887 samples were collected for 7 different species (5 fish species, 2 shellfish species) by the Gulf State Partners, which included 1,720 Blue Crab, 2,522 Eastern Oyster, 55 Silver Mullet, 1,217 Striped Mullet, 200 Blue Catfish, 26 Great Barracuda, and 147 King Mackerel samples. Eastern Oyster samples were collected for three different "Reef" types, which included Public and Private Reefs and Commercial Oyster Mariculture (COM) farms. The sample size target for each state for each fish species was 200 measurements, while the goal for shellfish species was 1000 measurements; however, due to unforeseen seasonal conditions and fishery closures affecting availability of some species, not all targets were met. Samples sizes for individual species across all State Partners ranged from 26 to 2,786.

Conversion factor estimates using the ratio of means (mean[y]/mean[x]) for whole and gutted weight of each fish species varied between species and from the original (historical) factor being used across the Gulf. Conversion factors for individual counts were estimated from the mean of the weight of the factor condition (ex. Individual whole weight average for a species reported by counts). Oyster factors were based on the meat to whole shell ratio and multiplied by the condition (i.e. sack weight, for example a meat ratio of 0.08 would result in a meat weight of 8 lb for a 100 lb sack).

Results of the linear regression analysis for the whole to gutted weight relationships for each fish species show a good fit of the collected data, with a high R^2 (Table 2, Figures 1-5). R^2 values for the whole to gutted weight relationship of each linear regression ranged from 0.99 to 1.00. Results of the linear regressions with the intercept constrained to zero were similar to the results of calculating the conversion factor using the ratio of means (Proc SuveyMeans method). When comparing the two methods, the differences between the regression slope and the ratio of means estimate for all fish species (whole to gut weight analysis) ranged from 0.003 to 0.006 (Table 2). Linear regression analysis for whole shell weight to meat weight relationship showed a lower fit (R^2). R^2 values for the oyster whole shell weight to meat weight relationship of each linear regression (Reef Type: Public, Private, Mariculture) ranged from 0.54 to 0.67 (Figures 6 and 7).

The historical factor for individual count of Silver Mullet is 1, which represents the weight in pounds per individual; however, the updated value was found to be slightly lower at at 0.856 lb per individual with 95% CLs of 0.813 and 0.899 (N = 55 FL). There was no previous factor for the gutted weight condition for Silver Mullet. Using the same sample of Silver Mullet (N=55), the ratio of whole weight to gutted weight was estimated at 1.163, with 95% CLs of 1.145 and 1.181. The historical factor for individual count of Striped Mullet is 1, which represents the weight in pounds per individual; however, the updated value was found to be slightly higher at 1.555 lb per individual with 95% CLs of 1.520 and 1.590 (N = 1,217 FL). While there was no previous factor for the gutted weight condition for Striped Mullet, using the same sample Striped Mullet (N=1,217), the ratio of whole weight to gutted weight was estimated at 1.155, with 95% CLs of 1.151 and 1.159. The historical factor for the gutted weight condition for Blue Catfish is 1.14. The new factor estimated for the gutted weight condition of Blue Catfish using the whole/gut weight ratio is 1.137, with 95% CLs of 1.131 and 1.142 (N=200 LA). The historical factor for the gutted weight condition for Great Barracuda is 1.11. The new factor estimated for the gutted weight condition of Great Barracuda using the whole/gut weight ratio is 1.112, with 95% CLs of 1.096 and 1.127 (N=26 AL). The historical factor for the gutted weight condition for King Mackerel is 1.11. The new factor estimated for the gutted weight condition of King Mackerel using the whole/gut weight ratio is 1.047, with 95% CLs of 1.045 and 1.049 (N=147 AL). The historical factor for Blue Crab is 0.5, which represents the weight in pounds per individual; however, the updated value was found to be relatively similar at 0.454 lb per individual with 95% confidence limits (CLs) of 0.449 and 0.460 (N = 1,456 FL/264 TX; Table 2, Figures 8-11).

The historical factor for the meat weight (lb) of a 110 lb sack of Eastern Oysters is 6.42 in Texas. The new factor estimated for meat weight (lb) of a sack of Eastern Oysters (in Texas) is 7.815 lb for Private Lease oyster sacks (N=179; 95% CLs: 7.610-8.020) and 8.802 for Public Reef sacks (N=1,679; 95% CLs: 8.676-8.928). Also, Private and Public Reef oysters are both wild caught with oyster dredges, but were

not combined for this analysis. Private Reef oysters are generally harvested outside of the public season (Private: May-Oct vs Public: Nov-Apr); however, these samples were obtained in during the public season in December. It is likely that Private Reef oysters have lower meat weight total per sack because meat weights tend to be lower between May-Oct. There were significant seasonal (monthly) differences in conversion factors, with February being significantly higher in meat proportion than in the early season (Nov/Dec; Figure 12). COM oysters tended to show a greater proportion of meat in April.

It is important to know the average weight of an oyster sack. Based on the samples collected, oyster sack weights in Texas will be conservatively estimated at 100 lb, instead of the current 110 lb sack, which was originally based on the upper legal limit for sack weight. Sack values were found to vary with the average size of oyster being harvested. Oyster sacks with smaller oysters pack tighter in the same volume sack, and tend to result in heavier sacks, but in general, sack weights were found to vary between 85 and 104 lb for samples collected from dealers, with an average of 90 lb (N=4 this study). Texas has previously collected oyster dealer invoice data that included sack weights and was used to estimate an average sack weight of 96.6 lb from 699 sacks. So, 100 lb sack is a better estimate than a 110 lb sack. Texas also has a new Commercial Oyster Mariculture (COM) fishery with no historical factor for meat weight, which is the condition used to compare oyster landings across the Gulf. Mariculture oysters are reported as a count of individual whole shells. The average individual COM oyster had 0.0190 lb of meat (N=664; 95% CLs: 0.0187-0.0198). If comparing the proportion of meat, Public Reef oysters had 8.8% meat (of whole shell weight) vs COM oysters at 15.2% meat, which is 72% greater (Figure 13).

Table 1. Comprehensive list of fish and shellfish sampled by each state for conversion factor analysis.

Species	AL	FL	LA	MS	TX	Combined
Blue Crab	0	1,456	0	0	264	1,720
Silver Mullet	0	55	0	0	0	55
Striped Mullet	0	1,217	0	0	0	1,217
Blue Catfish	0	0	200	0	0	200
Barracuda, Unc	26	0	0	0	0	26
King Mackerel	147	0	0	0	0	147
Eastern Oyster	0	0	0	0	2,522	2,522
Total sampled	**173**	**2,728**	**200**	**0**	**2,786**	**5,887**

Table 2. Overall State Partner conversion factor results. The "Estimated Factor" was estimated using the SAS SurveyMeans ratio of Whole to Gutted Weight, which includes the Lower and Upper 95% confidence limits (LCL,UCL). Linear regression results (Regression = slope; Whole WT_kg = slope x Gut WT_kg + Intercept) for both unconstrained and constrained to intercept of zero are provided. Texas' original oyster factor was based on 110 lb sack (6.42 lb meat per 110 lb sack).

Species	State(s)	N	Condition	Orig factor	New Factor	Lower 95% CL	Upper 95% CL	Regression	Intercept	R^2	Regression (Int = 0)	R^2 (Int = 0)
Blue Crab	FL,TX	1,720	Whole (Individual)	0.5	0.454	0.449	0.460					
Silver Mullet	FL	55	Whole (Count)	1	0.856	0.813	0.899					
Striped Mullet	FL	1,217	Whole (Count)	1	1.555	1.520	1.590					
Silver Mullet	FL	55	Gutted	*	1.163	1.145	1.181	1.068	0.032	0.912	1.160	0.997
Striped Mullet	FL	1,217	Gutted	*	1.155	1.151	1.159	1.184	-0.017	0.978	1.160	0.997
Blue Catfish	LA	200	Gutted	1.14	1.137	1.131	1.142	1.125	0.027	0.999	1.131	0.999
Barracuda, Unc	AL	26	Gutted	1.11	1.112	1.096	1.127	1.152	-0.296	0.991	1.115	0.999
King Mackerel	AL	147	Gutted	1.11	1.047	1.045	1.049	1.053	-0.031	0.997	1.048	1.000
Eastern Oyster	TX	664	COM LB Meat per Count	*	0.0190	0.0187	0.0198					
Eastern Oyster	TX	179	Private Reef LB Meat per Sack (100 lb)	6.42	7.815	7.610	8.020					
Eastern Oyster	TX	1,679	Public Reef LB Meat per Sack (100 lb)	6.42	8.802	8.676	8.928					

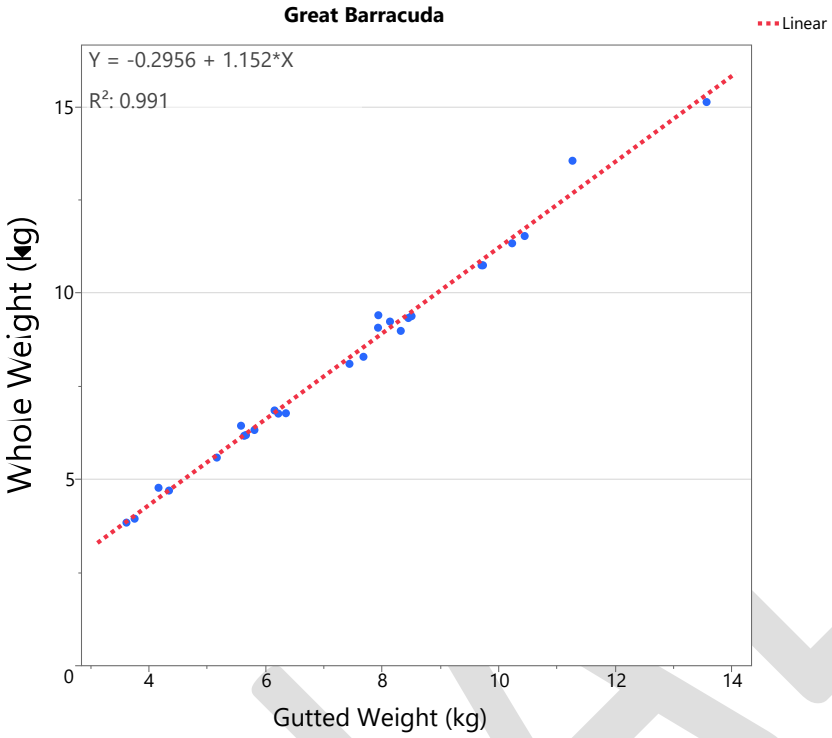

Figure 1. Linear regression analysis of Great Barracuda gutted to whole weight relationship.

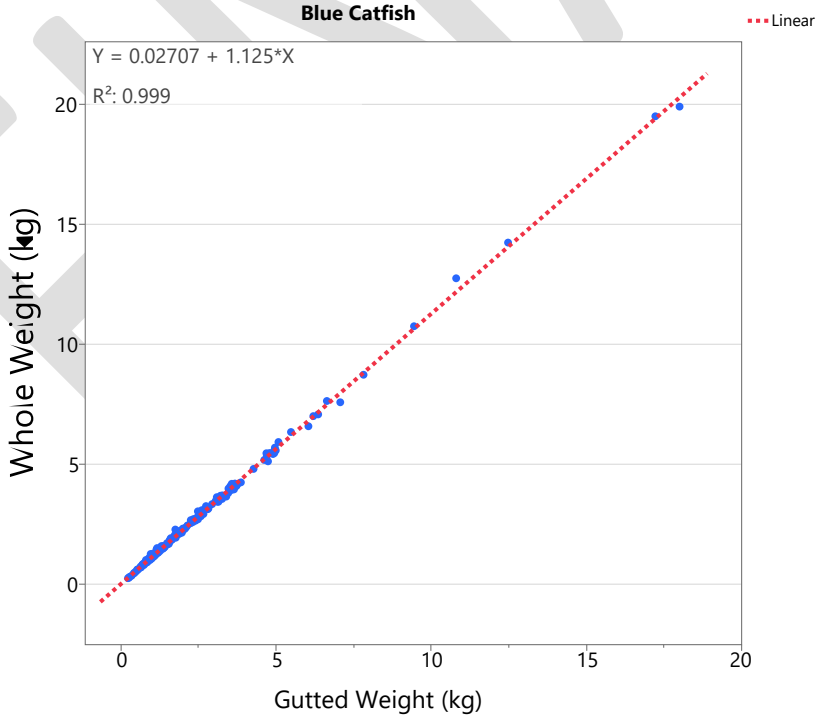

Figure 2. Linear regression analysis of Blue Catfish gutted to whole weight relationship.

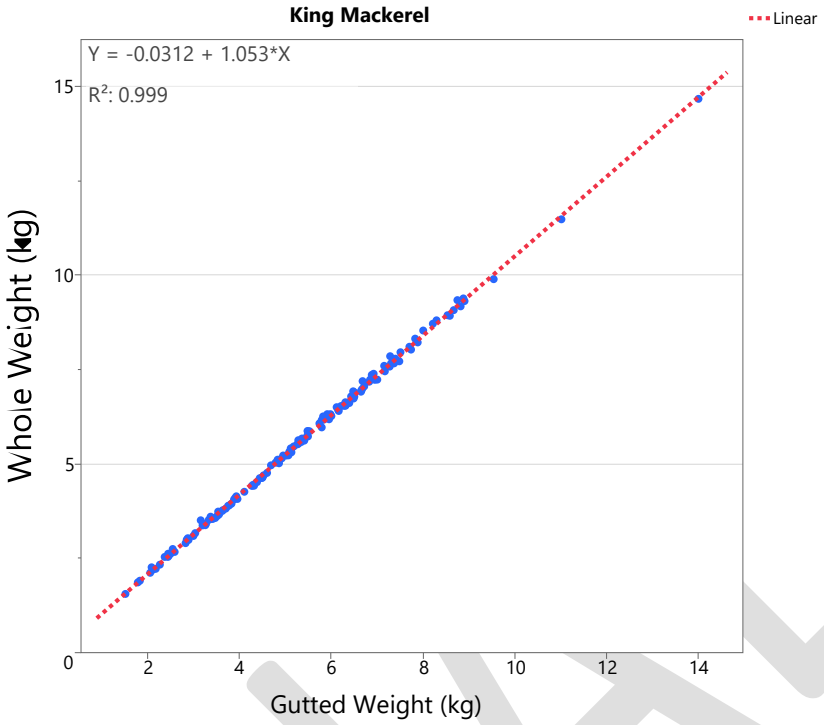

Figure 3. Linear regression analysis of King Mackerel gutted to whole weight relationship.

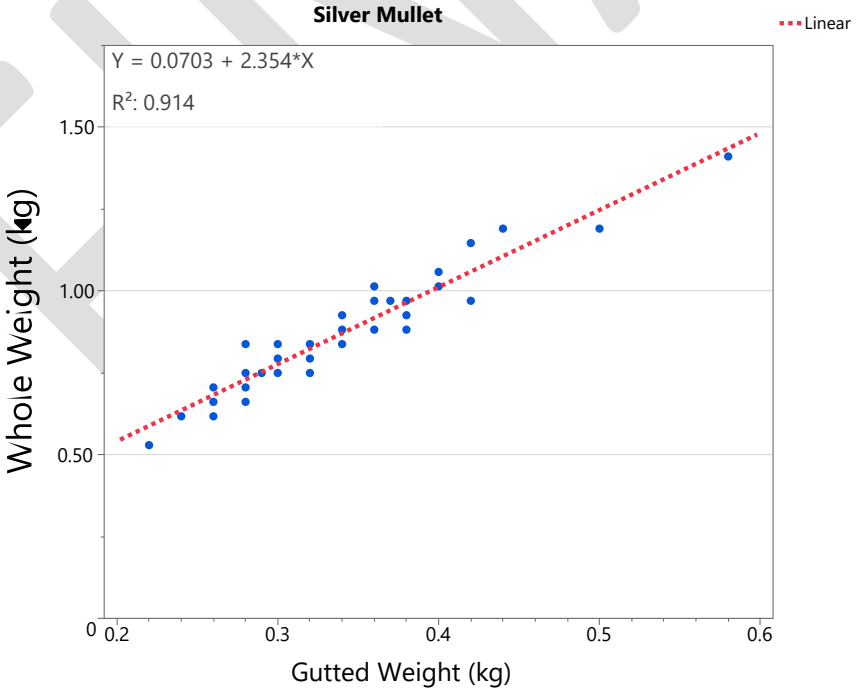

Figure 4. Linear regression analysis of Silver Mullet gutted to whole weight relationship.

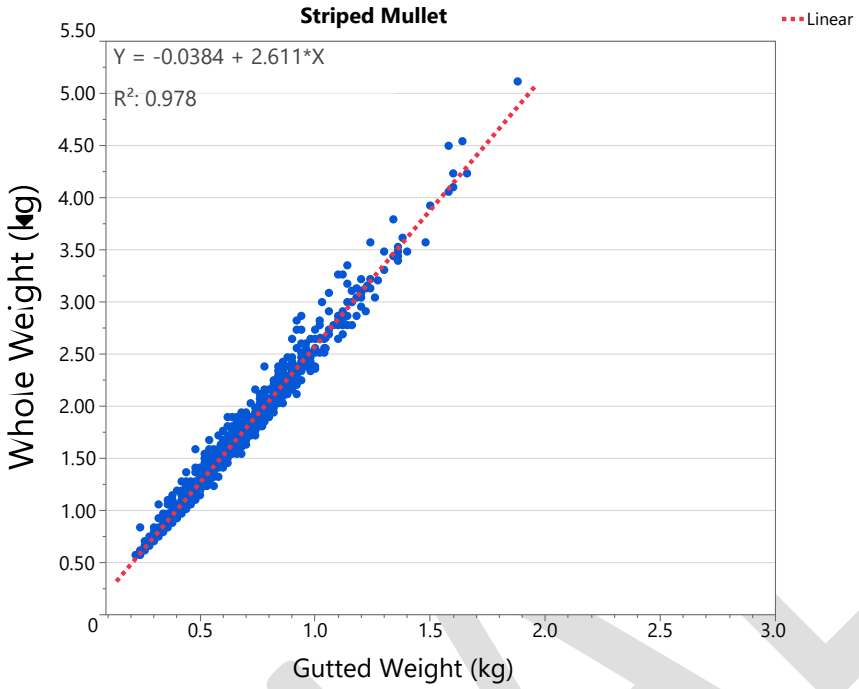

Figure 5. Linear regression analysis of Striped Mullet gutted to whole weight relationship.

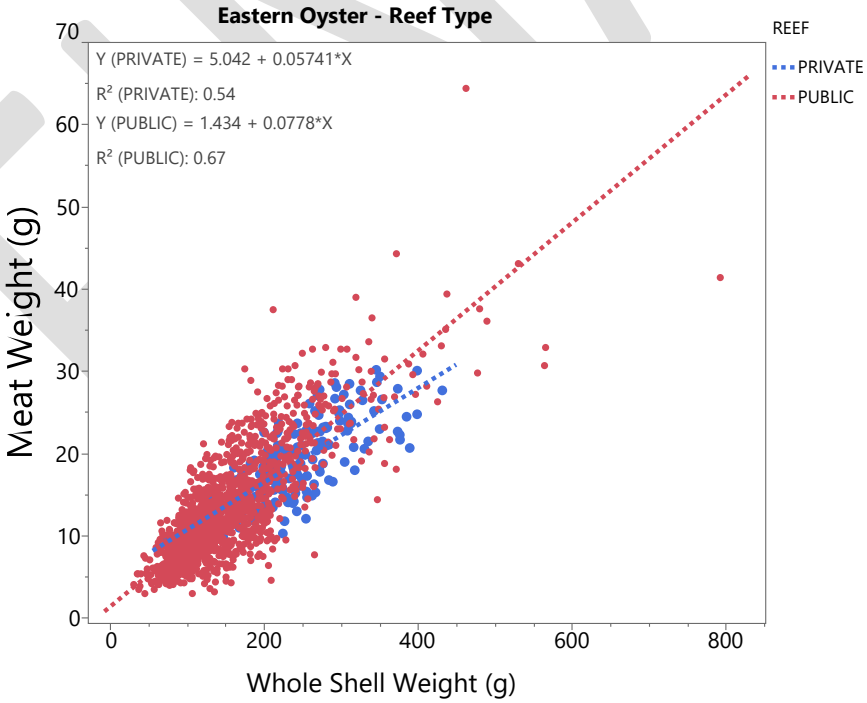

Figure 6. Linear regression analysis of Eastern Oyster (Public and Private Reef) whole shell weight to meat weight relationship.

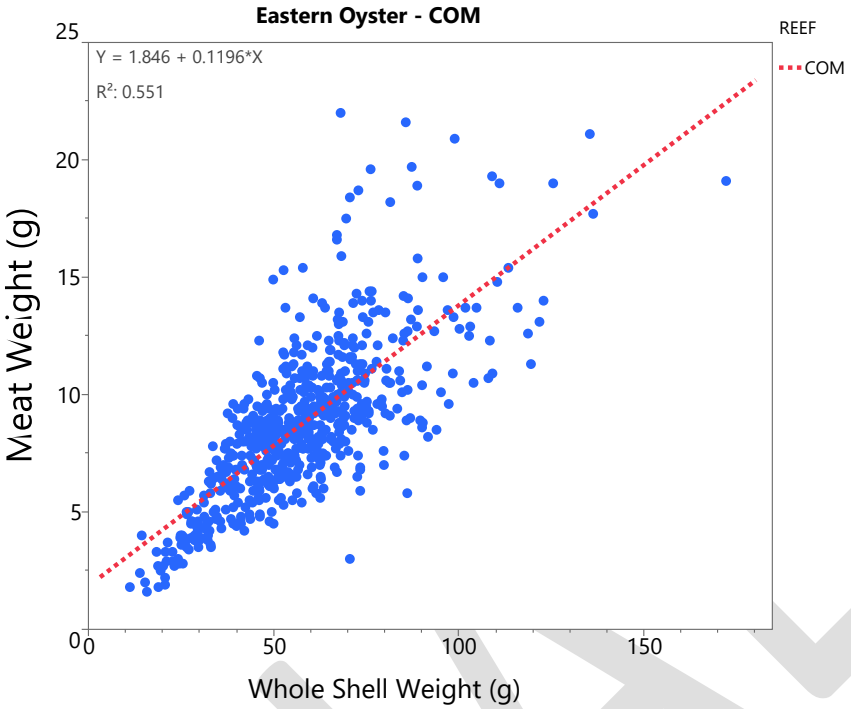

Figure 7. Linear regression analysis of Eastern Oyster (Oyster Mariculture) whole shell weight to meat weight relationship.

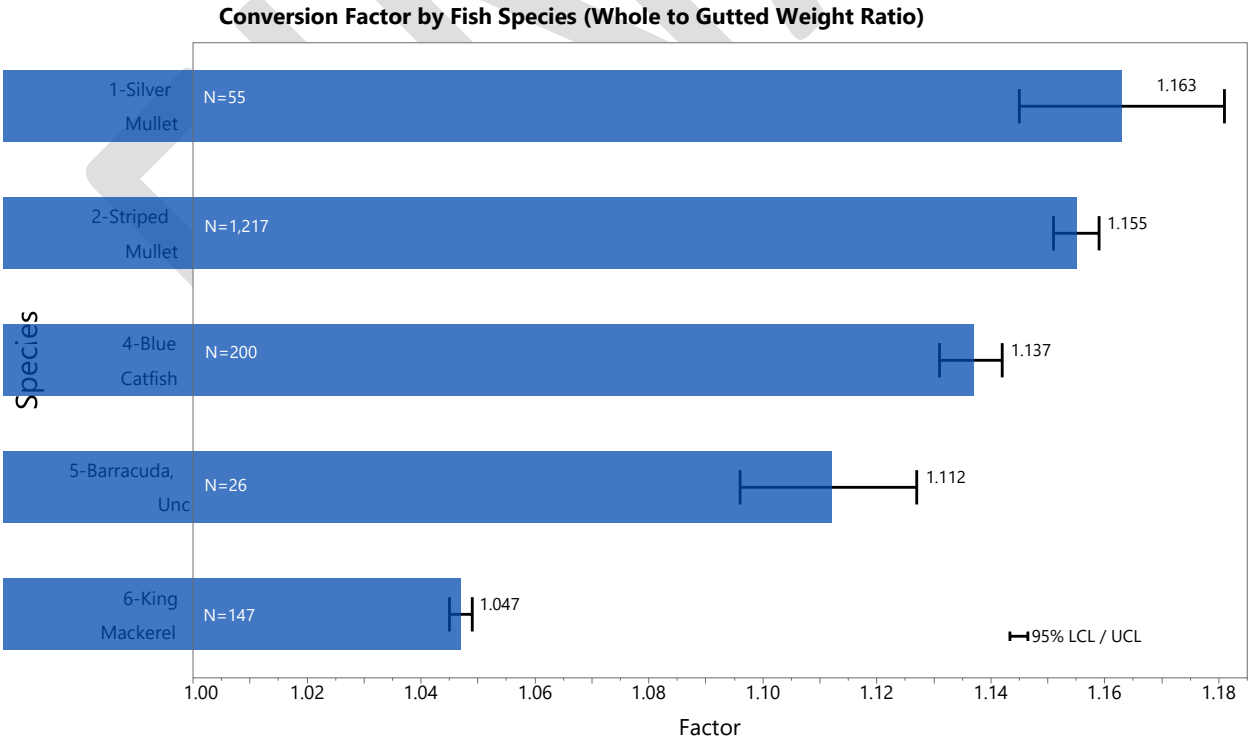

Figure 8. Comparison of each sampled fish species gutted to whole weight conversion factor, including the 95% confidence limits.

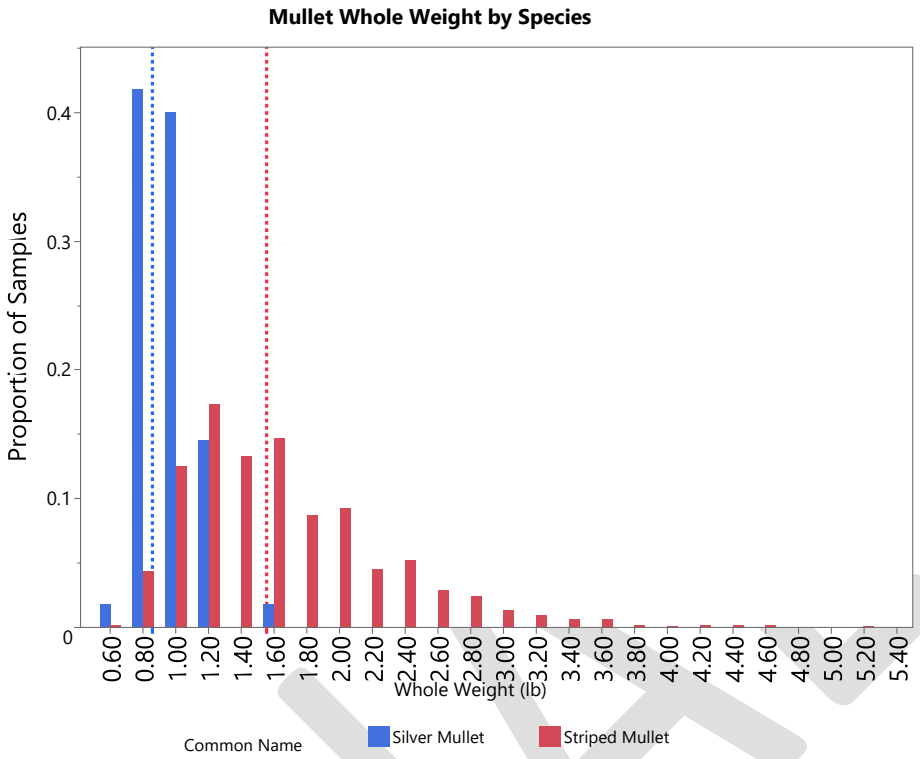

Figure 9. Proportion of mullet species samples within whole weight (lb) bins. Mean weights of Silver Mullet (0.856 lb; blue line) and Striped Mullet (1.555 lb; red line) are shown by dotted lines.

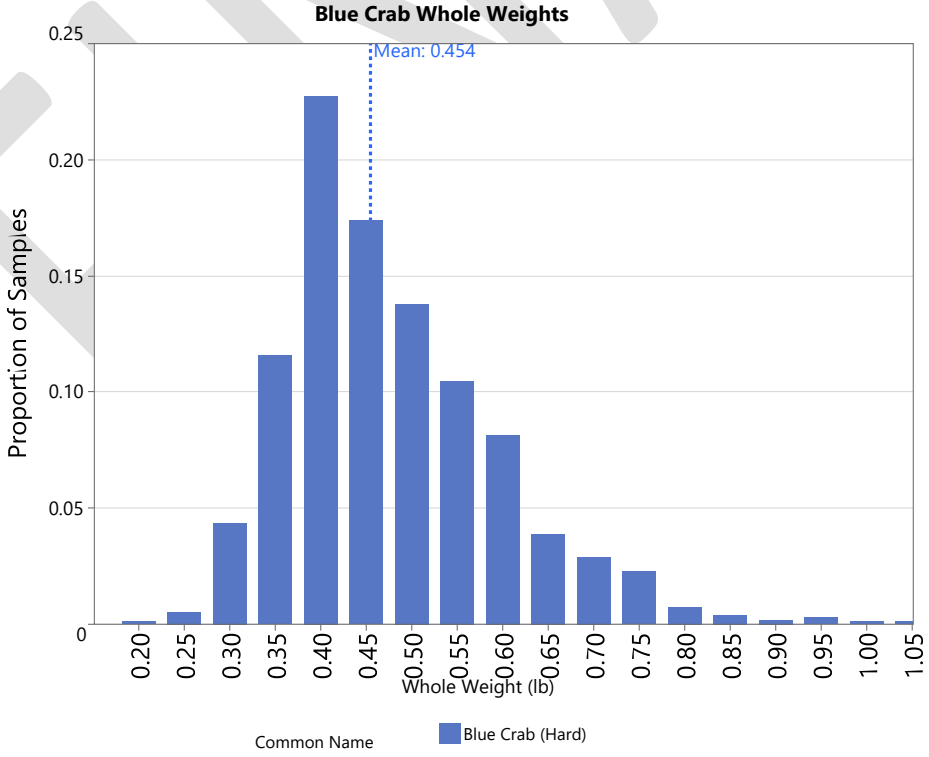

Figure 10. Proportion of Blue Crab samples within whole weight (lb) bins. Mean weight is shown by dotted line.

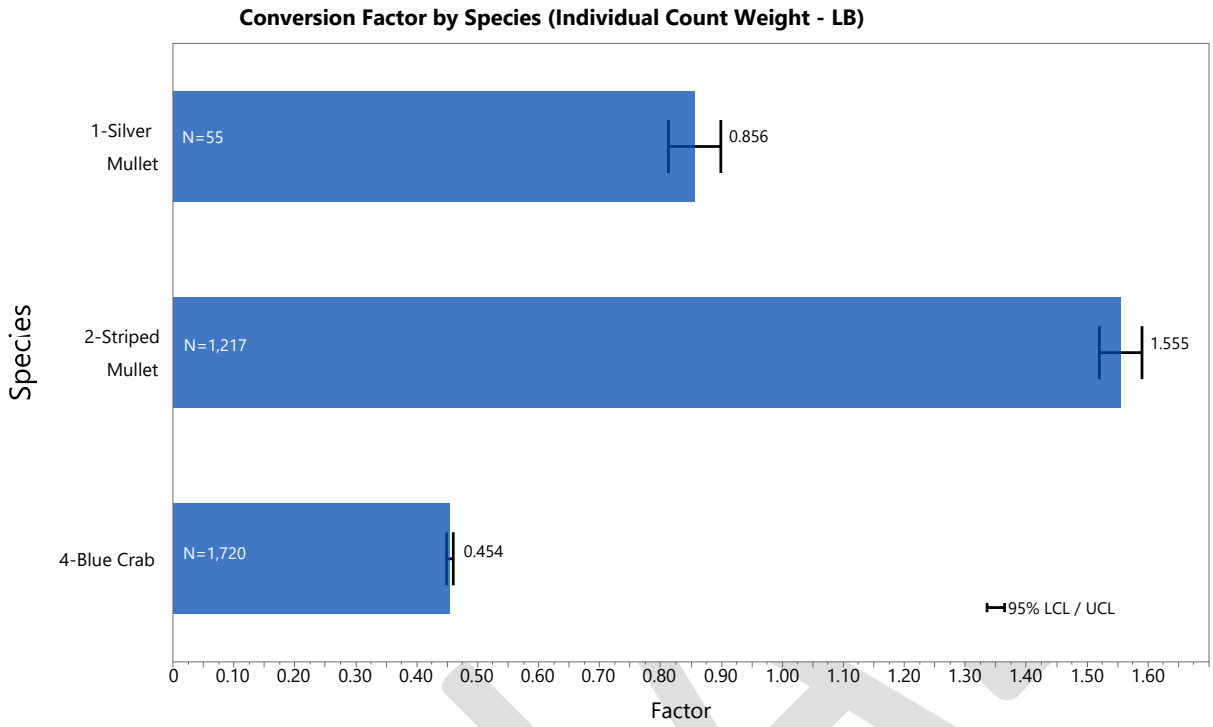

Figure 11. Comparison of Mullet and Blue Crab whole weight conversion factor for individual count weights, including the 95% confidence limits.

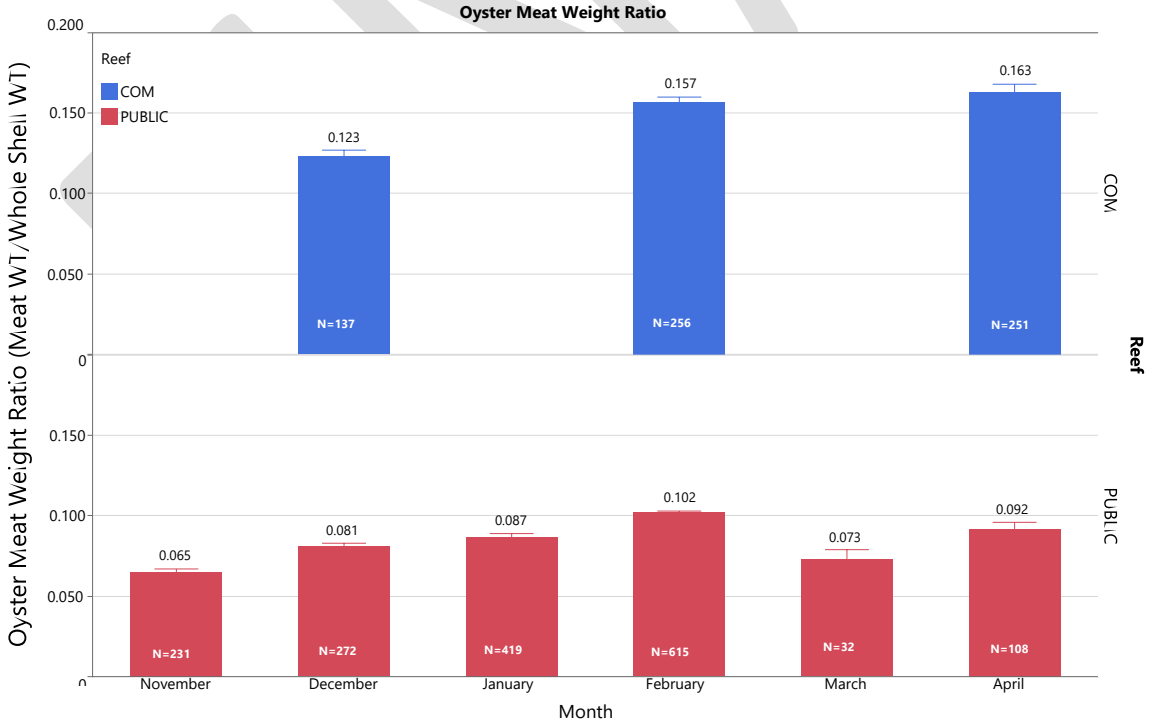

Figure 12. Comparison of estimated Texas monthly oyster meat weight ratios (oyster meat weight / whole shell weight; proportion of meat) from Public Reef and Commercial Oyster Mariculture (COM) areas.

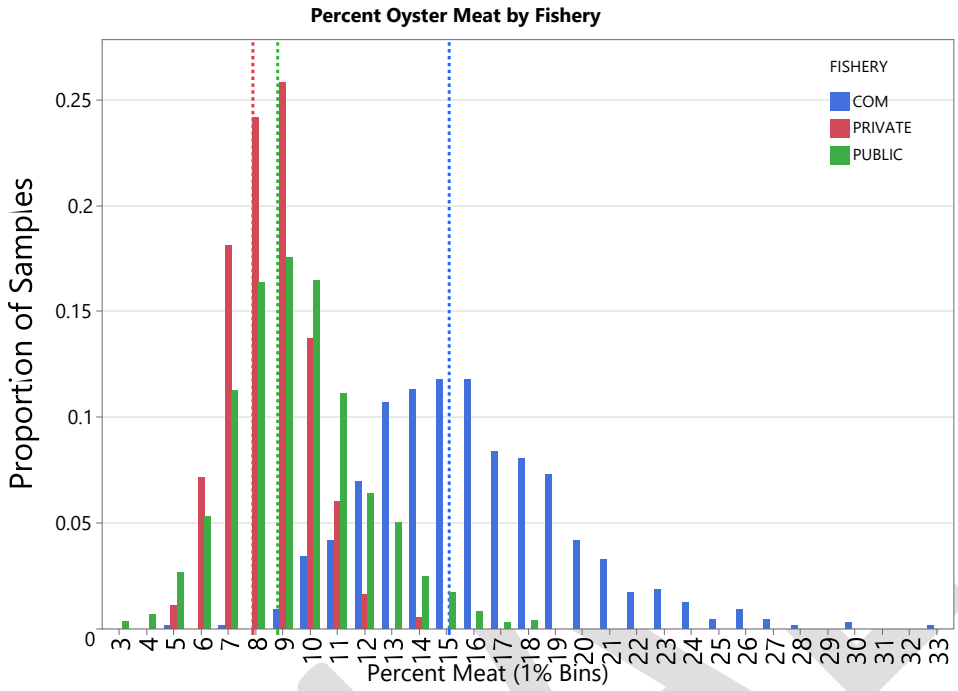

Figure 13. Comparison of estimated Texas oyster meat weight ratios (oyster meat weight / whole shell weight x 100 = percent meat) from Public and Private Reefs and Commercial Oyster Mariculture (COM) areas. Dotted lines represent mean percent meat weights (COM: 15.2%, Private: 7.9%, Public: 8.8%).

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 (ex. Blue Crab samples from TX and FL). However, unless there is a biological or stock reason for using separate conversions, states should consider using the same conversions.

Each State Partner discussed and agreed to accept the same conversion factor for the species in this study. There were differences in the start ("begin year") of use for these conversion factors, with Louisiana deciding to start using the new accepted factors beginning in 1999, while the other Gulf states partners decided to begin use in 2020. There may be some further discussions on begin year and these are subject to change.

Species	Condition	Old Factor	Accepted Factor	Factor Approval for Gulf	Begin Year	Comments
Blue Crab	Whole (Individual)	0.5	0.454	TX, MS, AL, FL LA	Jan 1 2020 Jan 1 1999	
Silver Mullet	Whole (Count)	1	0.856	MS, AL, FL	Jan 1 2020 Jan 1 1999	TX only has bait mullet LA does not have any landings
Stiped Mullet	Whole (Count)	1	1.555	MS, AL, FL	Jan 1 2020 Jan 1 1999	TX only has bait mullet LA has not had landings in 20 years
Silver Mullet	Gutted	*	1.163	MS, AL, FL	Jan 1 2020 Jan 1 1999	LA and TX do not have gutted mullet
Striped Mullet	Gutted	*	1.155	MS, AL, FL	Jan 1 2020 Jan 1 1999	LA and TX do not have gutted mullet
Blue Catfish	Gutted	1.14	1.137	TX, MS, AL, FL LA	Jan 1 2020 Jan 1 1999	
Barracuda, Unc	Gutted	1.11	1.112	TX, MS, AL, FL LA	Jan 1 2020 Jan 1 1999	
King Mackerel	Gutted	1.11 1.04 FL	1.047	TX, MS, AL, FL LA	Jan 1 2020 Jan 1 1999	
Eastern Oyster	Commerial_LB Meat per Count	*	0.019	TX	Jan 1 2020 Jan 1 1999	Other Gulf States have their own conversion
Eastern Oyster	Private_LB Meat per Sack 100 lb sack	*	7.815	TX	Jan 1 2020 Jan 1 1999	Other Gulf States have their own conversion
Eastern Oyster	Public_LB Meat per Sack 100 lb sack	*	8.802	TX	Jan 1 2020 Jan 1 1999	Other Gulf States have their own conversion