Gulf of Mexico Commercial Brown, Pink and White Shrimp Landings

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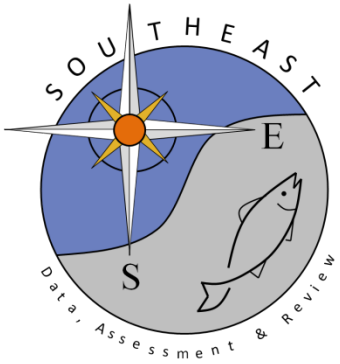

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Introduction

The Gulf Shrimp System (GSS) was initiated to provide comprehensive landings data for all food shrimp species caught and landed at ports in the Gulf of Mexico. Shrimp landings data were collected by port agents employed by the National Marine Fisheries Service located along the coast of the Gulf of Mexico. These data were collected from the seafood dealers who purchased shrimp at the location where the shrimp were unloaded. Information gathered by the port agents included species, gear, value, size range, average price per pound, and the statistical area where the shrimp were caught. As fisheries data needs changed over time, each of the Gulf states developed and implemented State Trip Ticket (STT) programs. These programs were implemented by the states in different years according to their needs and capacity, and all are currently the primary method for collecting landings data in the Gulf states. The objective of the STT programs is to collect commercial seafood landings and associated fishing information for each commercial fishing trip from the seafood dealers who purchase from the fishermen. Information gathered includes species and quantity harvested, gear used, market category, the primary area of harvest and the value of the catch sold. Note that throughout this document we are using the term "landings" to refer to shrimp caught in the Gulf of Mexico as reported by the area of catch variable in GSS or the trip ticket.

Methods

For SEDAR 87, commercial Gulf of Mexico shrimp landings (brown, pink, and white) were compiled using data from several sources: (1) Oracle databases related to the Gulf Shrimp System, housed at the Southeast Fisheries Science Center (SEFSC); (2) the Gulf of Mexico Fisheries Information Network (GulfFIN) housed at the Gulf States Marine Fisheries Commission (GSMFC); and (3) Atlantic coast fishery-dependent data housed at Atlantic Coastal Cooperative Statistics Program (ACCSP).

Data Sources

Gulf Shrimp System (GSS)

For this assessment we are considering GSS data beginning in 1960, which is consistent

with that used in previous assessments (e.g. Nichols, 1984 and Nance et al. 1989). The data collection procedures have changed over the years. From 1960 to 1983, the federal port agents interviewed seafood dealers and recorded the landings data on paper forms. These were sent for processing to the Bureau of Commercial Fisheries (1960-1971) in Washington, DC and then, after its founding in 1971, to National Marine Fisheries Service (NMFS) Headquarters in Silver Spring, MD. Some changes were made during this period, including sporadic inclusion of the vessel identification number (i.e. The Coast Guard documentation number) in later records. Beginning in 1984, responsibility for processing the collected data was assumed by the SEFSC. NMFS port agents began collecting and recording landings data in standard size bins from seafood dealers after the trips were unloaded. Because the number of fishing trips that occurred within the Gulf Shrimp fishery was so large, it was nearly impossible to record every trip. Therefore, the process for data collection was broken into two parts, depending on the size of the vessel. Port agents recorded landings data for individual trips made by large vessels (5 net tons or larger) that were mostly fishing offshore. For smaller boats (less than 5 net tons) that were mostly fishing inshore, the port agents consolidated the data and aggregated it to monthly totals of pounds, sizes, value and number of trips, leading to the loss of vessel identifiers. Pounds and value were collected within market size ranges in which the shrimp were purchased by the dealer. The primary objective of the Gulf Shrimp System was to provide catch, value, and area caught for individual commercial fishing trips. This information was entered into a desktop program with the GSS coding standard. The shrimp data was processed through the Desktop application then it was exported and sent to the Galveston Laboratory for final processing. The final data are stored and maintained at the SEFSC.

State Trip Ticket (STT)

Concurrent with the GSS data collection, state trip ticket reporting systems were implemented by each Gulf state in different years. Generally, the commercial seafood dealers are responsible for completing the tickets within 72 hours of taking possession of seafood purchased directly from commercial fishermen. Completed tickets must be submitted to the respective State office by the 10th of the month for the preceding month. Trip tickets may be submitted as often as dealers like as long as all of the trip tickets

generated during a month are sent by the 10th of the following month. There are two methods in which the dealers can complete and submit the trip tickets. The first method, an electronic computer program, allows a dealer to enter trip ticket data directly into a computer and submit it to the state office. The second method involves the completion of trip tickets on the paper forms provided by states. Most states have more than one type of form, which each state has developed to accommodate specific landing occurrences. The state then translates the gear, species, area fished, market/grade, disposition codes from the state code system to the Fisheries Information Network (FIN) coding standard and submits the data to GSMFC or ACCSP. All shrimp landings reported on Texas, Louisiana, Mississippi, or Alabama trip ticket systems were extracted from GSMFC. All shrimp landings reported on Florida or Atlantic state trip ticket systems were extracted from ACCSP.

Based on an evaluation of all trip ticket systems in Gulf and Atlantic waters, there were no shrimp landings caught in Gulf of Mexico waters reported by non-Gulf state trip ticket programs. Dealers from non-Gulf states purchasing shrimp caught in Gulf waters reported landings using a Gulf state trip ticket. Only Texas and Louisiana trip ticket systems had Gulf of Mexico shrimp catch landed in an Atlantic state and this accounted for a very small fraction of the data.

Stock Boundary

The Gulf of Mexico Fishery Management Council (GMFMC) boundary is a line from Riley's Hump, the Tortugas and US 1, where the area North of US 1 falls under the jurisdiction of the GMFMC and the area South of US 1 falls under the jurisdiction of the South Atlantic FMC (SAFMC) region (Figure 2). For SEDAR 87 landings, all of fishing areas 1-21 were considered (Figure 1). This decision was based on two criteria: (1) area reporting under GSS did not delineate at the Council boundary and (2) Florida trip ticket reporting in the Keys (areas 1 and 2) was inconsistent over time. Figure 2 is a map of the sub area codes reported on the Florida state trip ticket form. Since most of the shrimp landings fished in the Florida Keys are from the Tortugas (area 2), analyses were focused here to avoid presenting confidential data. Figure 3 shows the percent of shrimp landings reported by sub area for the Tortugas from 1996-2022. Between 1997-2003 and 2006-2007,

more than 75 percent of the landings were reported from area 2.9 which is considered SAFMC waters. Starting in 2009, almost all landings are reported under 2.8 which is considered GSFMC waters. Given this discrepancy, we suspect that area 2.9 was entered in error, therefore all sub area codes 1 and 2 were included to avoid excluding landings that would be considered Gulf of Mexico waters under GSS. Additionally, landings reported in fishing areas 744.1 and 748.1 (Florida Bay) were considered Gulf of Mexico landings (Figure 2). If the fishing area was unknown, county and state landed fields were used to assign Gulf of Mexico landings of brown, pink, and white shrimp.

Conversion Factors

Food shrimp in the Gulf of Mexico are landed in both heads-on (whole) and heads-off (tail) weight, i.e. the heads are removed at sea. There are three sources to consider for heads-on weight to heads-off weight conversion factors for brown, pink, and white shrimp (Table 1). The historical conversion factors (Kutkuhn, 1962b), calculated from unweighted regressions through the origin, have been used in the GSS database to convert all landings to heads-off weight. Samples for this report were collected in a portion of Texas and Louisiana waters for brown and white shrimp and two locations in south Florida for pink shrimp. Brunenmeister (1980) does not explicitly state where the samples were collected, and conversion factors are calculated using unweighted regressions with an intercept. To our knowledge, the Brunenmeister (1980) factors have not been used, but are provided here as an additional source of conversion factors. The GSMFC (2020) report specifically aimed at collecting samples throughout the entire Gulf of Mexico region by every state for each species. With the goal of using the most representative conversion factors for the Gulf of Mexico, it is recommended that the GSMFC (2020) data be used to calculate conversion factors for SEDAR 87 landings.

Unlike the original factors in Kutkuhn (1962b), GSMFC (2020) conversion factors were calculated by taking the ratio of the mean heads-on to heads-off weight for each species. That is, where y = heads-on weight and x = heads-off weight, conversion factors were calculated as mean(y)/mean(x). The methods section, however, describes taking a mean of ratios, that is mean(y/x). This calculation would be equivalent to running a weighted regression through the origin, with regression weights equal to $1/x^2$. Due to the

heteroscedastic nature of these data, that is, increased variability in the relationship between y and x as shrimp weight increases, weighted regression in this manner would be necessary to provide a more robust model fit. However, it was noted by SEFSC that the best fitting models were non-linear for all species, and better approximated statistically by weighted second-order regressions through the origin ($p < 0.0001$). This is due to the fact that heads-off weight as a proportion of total weight decreases as shrimp size increases (more evident for pink and white shrimp; less so for brown). This introduces a bias when using mean(y/x), as it assumes a linear relationship through the origin, and rather, the ratio estimator mean(y)/mean(x) should be used to obtain a single parameter conversion factor that results in unbiased estimates equal to those of the best fitting model when predictions are summed in aggregate. The ratio estimator is known to be unbiased and approximately normally distributed at large sample sizes (Lohr 2021), and this was demonstrated using resampling methods with the GSMFC (2020) data. The ratio estimator also has the desirable property of yielding identical conversion factors when inverted (switching x and y), which is not so for the mean of the ratios.

Figure 4 illustrates differences between the various regressions fit to GSMFC (2020) brown, pink, and white shrimp head-off weights. Though the second-order models provide superior fits, use of these models in practice would require knowing the weights of each individual shrimp being converted, whereas the ratio estimator allows a single parameter to be applied to aggregate weights and results in unbiased predictions of the total assuming the shrimp sampled in the study are representative of the size distribution of those encountered by the fleet. The disadvantage of using a linear estimator comes when analyzing size classes in isolation, as it will tend to under or over predict for weights near the extremes. Coefficients of the second-order models are provided in Table 2 to give an idea of these biases.

Beyond differences in calculation methodology, deviations of current conversion parameters from historical regressions may also arise from differences in sample collection (spatial, temporal, etc.), size distribution, and/or processing methods. It is worth noting, for instance, that the mean heads-on weight of pink shrimp in GSMFC (2020) was 23.85 grams vs. 14.2 grams in Brunenmeister (1980), though ratio estimators yield nearly identical conversion factors in both studies for all three species.

Data Compilation

Landings of brown, pink, and white shrimp are provided in heads-off weight. The codes reported for each species are identified in Table 3. Data from GSS databases are stored in only heads-off weights where all landings have already been converted using the historical conversion factors. From 1960-1983, prior to SEFSC responsibility for shrimp data, documentation of coding systems was lacking. The variable that denotes the original condition of landing (heads-on vs. heads-off weight) is unreliable. This is highlighted in Figure 5 which shows periods of years where condition of landing is unknown or has a percentage of landings where catch is in mixed units. Consequently, landings from 1960-1983 are provided in heads-off weight as stored in the GSS database using the historical conversion factors. Starting in 1984, GSS landings reported heads-on were converted back to the original weight units using the historical (Kutkuhn 1962b) conversion factors. These landings reported heads-on were then converted to heads-off weight using the new GSMFC (2020) conversion factors. This procedure was done similarly for trip ticket data where only landings reported in heads-on units were converted to heads-off weight using the GSMFC (2020) conversion factors.

Additional data processing steps performed:

- All NMFS codes were translated to the FIN coding standard. This is the coding standard being used by state trip ticket programs.
- For consistency in the time series, bait and aquarium shrimp are removed from brown, pink, and white shrimp trip ticket landings because GSS did not include bait shrimp. Additionally, according to Amendment 15, total landings from the bait shrimp fishery cannot be estimated for all states (GMFMC, 2015).
- Informed by industry expertise, only the bait shrimp fishery reports landings as the number of individuals. Therefore, Louisiana trip ticket data from 2009-2022 reported in number are assumed bait shrimp and excluded for this assessment.
- Unclassified penaeid shrimp landings appear in the state trip ticket data under ITIS code (095601). This code is specifically reported by Texas and Florida. The conversion factor used for unclassified penaeid shrimp is 1.53. Annual proportions of

brown, pink, and white shrimp by respective states and areas were used to assign unclassified penaeid landings to species. Unclassified shrimp landings account for no more than 0.4 percent of total landings in a given year (Table 4).

Transition from GSS To STT by State

For each state, we needed to identify the best year to transition from GSS to STT reporting. The main consideration was when the individual state reported that their STT system was mature and reliable to be the primary source for shrimp landings. However, other considerations were made for completeness of the trip ticket data (e.g., not all dealers reporting to the STT program, key variables with a high percentage of missing values, etc.) and reliability of the processing procedure of GSS.

Over time, port agent coverage began to decline as port agents retired or were reassigned and were not replaced and/or were asked to cover larger geographical areas. Port agent coverage by state for 2009-2024 is shown in Table 5. Additionally, GSS databases began processing state trip ticket data and merging those data with port agent interviews. It is for these reasons we aimed to transition from GSS to state trip ticket data promptly upon their deemed reliability to avoid potential errors in the merging process that might result in duplication of trips in GSS. Table 6 highlights the recommended years for switching from GSS to STT.

For Alabama, Mississippi, and Louisiana we transitioned to using landings from the STT programs in the year recommended by the state. This corresponds with the year where GSS and STT data are comparable (Figure 6A-C).

Texas began its trip ticket program in 2008 but did not have complete coverage of their shrimp dealers in the early years of the program. This corresponds with Figure 6D where the first few years of trip ticket data are less than GSS total landings. Texas staff indicated that complete coverage of shrimp dealers was realized in 2014 and that would be the appropriate year to switch from using GSS to using Texas trip ticket landings data.

Florida began its trip ticket program in 1985. In a GSS and STT comparison, total landings

across all species are comparable from 1985-2001 (Figure 6E). In 2002 and 2004, GSS landings totaled more than Florida trip ticket landings for the three penaeids combined. Close examination of these years suggests additional processing was being conducted in the GSS database to merge port agent data with trip ticket landings. In this merge, two important variables used to identify matched landings are market bin size (minimum and maximum values) and unique vessel number. Unlike other state trip ticket systems, the FL trip ticket program did not collect market minimum and maximum ranges, but rather a market category (small, medium, large, etc.). Since port agents collected a minimum and maximum market size for GSS, it was likely difficult to cross match across programs. Additionally, unique vessel numbers were not collected consistently on the FL trip ticket form. For 2002 and 2004, unique vessel ID is missing for 52 percent and 34 percent of the data, respectively (Table 7). This means trip ticket landings by dealer were likely grouped across several vessels, again making it difficult to crossmatch. These differing levels of data collection across programs meant merging of trip ticket landings with port agent interviews within the GSS database likely resulted in double counting of landings in GSS. To avoid these potential errors in additional processing, trip ticket data are considered more reliable starting in 2002. Issues with missing values for gear and area prevented us from using the FL trip ticket landings in earlier years (Table 7). Given these considerations, beginning use of Florida trip ticket data in 2002 was justified by better reporting of key fields in subsequent years. This decision was supported by Florida Fish and Wildlife Conservation Commission staff (C. Bradshaw, pers. comm.).

Data Stratification

Annual Gulf of Mexico brown, pink, and white shrimp landings in heads-off weight were provided using the following aggregations. The Gulf of Mexico fishing areas 1-21 were aggregated into three statistical areas for the assessment based on areas 1-10, areas 11-17, and areas 18-21 (Figure 7). Landings were also classified into inshore and offshore categories following Dettloff (2023) definitions. Shrimp market sizes were grouped into three “market size bins” based on aggregations of fixed historical size bins (Table 8): more than 67 shrimp tails per pound (S), between 31 and 67 shrimp tails per pound (M), and fewer than 31 shrimp tails per pound (L) (Table 9). Landings were provided by month, but also aggregated into three seasons, January to April (JFMA), May to August (MJJA), and

September to December (SOND).

Imputation of Missing Data

Value

Value is missing for about 0.01 percent of the data across all years. Before summing pounds and values by strata, values were imputed by replacing missing values with their averages. In GSS from 1960-1991, both the pounds and price per pound variables are in heads-off (tail) weight units. Starting in 1992, price per pound reflected the original price. Therefore, average price per pound was calculated separately for each time period (1960-1991 and 1992-2022).

From 1960-1991, the average price per pound was calculated by year, season, state, species, and market bin size where all data are in heads-off weight units. From 1992-2022, the average price per pound was calculated by year, season, state, species, market bin size, and grade code to estimate an average price by condition landed (heads-on vs. heads-off weight). For cells missing the value field, pounds were multiplied by the corresponding average price per pound.

Area

Area is missing for about 30 percent of the landings in FL from 1960-1964 and less than 8 percent of the landings for all other states and years (Figure 8). Landings with missing area information are proportioned using the finest strata possible. The general method involves calculating the proportion of pounds and value by year, season, state, species, and fishing area. These proportions are applied to the annual landings missing area by month and state. For cases where area is still missing, proportions are calculated with less granularity until all data are assigned a fishing area.

Market Size Bins

Market size (count per pound) data varies depending on the data source and year in which the data were collected. From 1960-1983, size categories were assigned using the fixed codes from 0 to 9 as shown in Table 7. From 1984 to the start year for each trip ticket program, size categories were reported as minimum and maximum values. If the range was 0 or greater than 300, the market size was considered unknown. Lastly, for trip ticket data, market size is

either a minimum or maximum range or a market category (i.e. small, medium, large, etc.). For the purposes of summarizing landings into three market bin size categories defined for this assessment, the small, medium and large classifications reported on the trip ticket were considered unknown because the definitions are unclear. The resulting percentage of data missing market size varies by state (Figure 9).

Similar to applying proportions to fill in data missing fishing areas, proportions were applied to landings missing market bin size. However, this method was applied to only landings reported by Texas, Louisiana, Mississippi, and Alabama. Since Florida is missing for up to 60 percent of the data in a given year, market bin size remained unknown. If a standard market bin size is desired for Florida, a separate project would need to be funded to tease apart the complex datastreams described in this working paper.

Results and Discussion

Total landings by state and data source (GSS and STT) are shown in Figure 10 from 1960-2022. Annual landings of brown, pink, and white shrimp are shown in Table 10 and Figure 11. Pink shrimp landings are relatively stable from 1960-2022 and comprise a small portion of total penaeid shrimp landings. Brown shrimp have the most reported landings from 1960-2004. Between 2005-2018, both brown and white shrimp landings reported about 60 million pounds each year. Starting in 2019, white shrimp have the most reported landings compared to the other penaids. Table 11 shows the uncertainty estimates by state and time period, where data collected by NMFS Headquarters assumes a 20 percent uncertainty estimate and trip ticket data assumes 5 percent uncertainty.

From 1984-2022, shrimp landings were converted to heads-off weight only when landed in heads-on units. Figure 12 shows the percentage of landings reported in heads-off weight for each species overtime. Starting in 1986, about 50 percent of brown and white shrimp landings were reported heads-on and this has remained consistent for brown shrimp. White shrimp landings are up to 90 percent landed heads-on starting in 2010. Pink shrimp landings have steadily increased overtime where the majority of landings are landed heads-on in more recent years. Since over half of the landings are converted from heads-on to heads-off weight

for SEDAR 87, an analysis was conducted to determine the impact of the conversion factors used to provide all landings in heads-off weight. Figure 13 shows that on average brown shrimp landings for SEDAR 87 are 3 percent more using the GSMFC (2020) conversion factors compared to using the historical conversion factors. White shrimp landings are on average 1 percent less and pink shrimp landings are about 2 percent more using the GSMFC (2020) conversion factors.

Comparison to Amendment 17B

SEDAR 87 landings were compared to Amendment 17B as the last published document of annual landings of brown, pink, and white shrimp (Figure 14 & Table 12). Amendment 17B provided annual species-level landings in heads-off weight from 2003-2014 (GMFMC 2017). SEDAR 87 landings for 2003-2014 were processed using the historical conversion factors for consistency with Amendment 17B. There are notable discrepancies between the Amendment 17B and SEDAR 87 time series for each species. In general, landings are higher for Amendment 17B in the earlier years and lower in the latter years compared to SEDAR 87.

Both time series were produced using a combination of port agent and state trip ticket data, but the processing procedures differed. As described above, SEDAR 87 landings switched from port agent to state trip ticket data during the first year in which the trip ticket was deemed complete and reliable (Table 6). For 2003-2014, SEDAR 87 landings were exclusively from state trip tickets for Alabama, Florida, and Louisiana, and from port agent data for Mississippi. For Texas, SEDAR 87 landings were based on port agent data from 2003-2013 and on trip tickets for 2014. In contrast, landings for Amendment 17B were produced by merging port agent and state trip ticket data in years where both types of data were available: 2003-2014 for Alabama, Florida, and Louisiana, and 2014 for Texas. This dataset is referred to as the "analyst file". As described above, this merging process was prone to errors that potentially resulted in duplication of trip records and subsequent overestimation of landings (J. Primrose, pers. comm.). The potential for errors in the merging process was especially high for Florida, where key trip matching variables (vessel ID, etc.) were missing for a high percentage of trip records. These merging problems are the likely culprit for the higher landings for Amendment 17B compared to SEDAR 87 for the earlier portion of the time series shown in Fig. 14, particularly for pink shrimp which are

mostly landed in Florida.

Higher landings for SEDAR 87 would be expected for the latter years of the time series if the data for Amendment 17B were based on incomplete reporting from the various states. Landings for a given year are typically not finalized until 1-2 years later. To investigate, we obtained an updated analyst file of landings produced by the port agent-trip ticket merging process for 2003-2014. These landings were also substantially higher than Amendment 17B for 2014, indicating incomplete reporting for the Amendment 17B series. Additionally, Figure 15 shows the comparison of annual pink shrimp landings between Amendment 17B, SEDAR 87, and the updated analyst file. This figure confirms that a version of the analyst file was used to produce Amendment 17B totals. It also shows the merging process improved over time, but there were still persistent issues with this process for FL data given that the landings from the updated analyst file are consistently higher than SEDAR 87 in each year.

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Points of Contact

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State Trip Ticket

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Tables

Table 1. Conversion Factors from heads-off (tail) to heads-on (whole) weight for each species and source. “Unknown” indicates information was not provided in the report.

Species	Reference	Years Collected	Spatial Range	Method	Conversion Factor	Sample Size
Brown Shrimp	Kutkuhn, 1962b	Unknown	East Texas-west Louisiana	Regression through origin	1.610	267
	Brunenmeister, 1980	1978-1979	Unknown	Regression	1.606	10,174
	GSMFC, 2020	2019-2020	FL through TX	Ratio of means	1.548	2,929
White Shrimp	Kutkuhn, 1962b	Unknown	East Texas-west Louisiana	Regression through origin	1.543	1,306
	Brunenmeister, 1980	1978-1979	Unknown	Regression	1.590	3,288
	GSMFC, 2020	2019-2020	FL through TX	Ratio of means	1.568	3,668
Pink Shrimp	Kutkuhn, 1962b	Unknown	Biscayne Bay, FL and north of the Dry Tortugas	Regression through origin	1.599	1,617
	Brunenmeister, 1980	1978-1979	Unknown	Regression	1.585	2,174
	GSMFC, 2020	2019-2020	FL through TX	Ratio of means	1.565	1,466

Table 2. Coefficients of weighted second-order polynomial regressions fit to GSMFC (2020) head-off weights. x is heads-on weight in grams.

Species	x	x^2
Brown	0.652883	-0.000393242
White	0.677174	-0.00166256
Pink	0.707917	-0.00214601

Table 3. Shrimp species codes as present in the Gulf Shrimp System (GSS), FIN, and NMFS standards.

Common Name	GSS	FIN	NMFS
Brown Shrimp	1	551570	7310
White Shrimp	3	551680	7340
Pink	2	551574	7320
Unclassified Penaeid	0	095601	7360

Table 4. Percent of landings reported as unclassified penaids based on combined brown, pink, and white shrimp landings in heads-off weight. This species code is reported by only Florida and Texas trip ticket forms.

Year	Percent (%)
2003	0.072
2004	0.094
2005	0.123
2006	0.135
2007	0.102
2008	0.097
2009	0.087
2010	0.090
2011	0.138
2012	0.174
2013	0.233
2014	0.311
2015	0.386
2016	0.412
2017	0.105
2018	0.189
2019	0.217
2020	0.150
2021	0.273
2022	0.184

Table 5. Number of port agents by state over time.

Year	FL	AL and MS	LA	TX	Total
2009	6	2	6	5	19
2010	6	2	6	4	18
2011	6	2	5	4	17
2012	6	1	4	4	15
2013	6	1	4	4	15
2014	6	1	4	4	15
2015	6	1	4	3	14
2016	6	1	4	3	14
2017	6	1	4	3	14
2018	5	1	4	3	13
2019	5	1	3	3	12
2020	5	1	3	2	11
2021	5	1	3	2	11
2022	5	1	3	2	11
2023	5	1	3	2	11
2024	5	1	3	2	11

Table 6. Transition from GSS to state trip ticket (STT) data by state.

State	Start of Trip Ticket Program	GSS years used	STT years used
Florida (West Coast)	1984	1960-2001	2002-2022
Alabama	2001	1960-2000	2001-2022
Mississippi	2012	1960-2015	2016-2022
Louisiana	1999	1960-1999	2000-2022
Texas	2008	1960-2013	2014-2022

Table 7. Percent of landings for Florida missing gear, area fished, and market bin size information between GSS and state trip ticket (STT) programs.

	Gear		Area Fished		Market Bin Size		Unique Vessel Number	
Year	STT	GSS	STT	GSS	STT	GSS	STT	GSS
1985	0.92	0	0.01	0	100	1.16	0.94	14.40
1986	100	0	63.44	0	100	7.69	100	14.02
1987	100	0	62.48	0.25	100	2.05	100	12.48
1988	100	0	63.76	0	100	2.06	100	15.94
1989	100	0	64.85	0	100	2.21	100	19.89
1990	99.56	0	67.61	0	100	1.20	100	16.64
1991	60.48	0	68.65	0	100	0.50	100	16.02
1992	26.08	0	70.57	0	100	1.53	100	11.88
1993	5.50	0	69.95	0	100	0.83	100	6.24
1994	1.08	0	63.90	0	100	0.64	100	9.45
1995	0.36	0	26.64	0	100	0.66	100	9.64
1996	0.19	0	2.16	0	100	1.00	100	9.91
1997	0.52	0	0.31	0	100	1.92	100	11.18
1998	0.55	0	0.31	0	98.02	1.30	98.92	8.05
1999	0.78	0	1.90	0	94.37	1.06	98.72	8.00
2000	0.70	0	1.43	0	70.38	0.83	41.97	13.35
2001	0.21	0	1.81	0	86.40	1.38	49.02	9.49
2002	0	0	3.05	0	69.90	1.34	51.84	6.96
2003	0.72	0	4.82	0.07	55.71	49.68	41.99	1.84
2004	0	0.05	3.86	0.01	51.98	5.37	34.27	5.73
2005	0	0.28	1.76	0	51.12	38.08	33.60	3.69

Table 8. GSS size codes (1960-1983) where Min/Max Ranges refers to the minimum and maximum sizes of shrimp tails per pound (e.g. Size Code = 1 is the largest category with the fewest shrimp tails per pound).

Size Code	Min/Max Ranges
0	No sizes
1	01/14
2	15/20
3	21/26
4	26/30
5	31/40
6	41/50
7	51/67
8	68/100
9	Pieces

Table 9. Historical market categories defined in Table 5 were aggregated into three market size bins as defined during the SEDAR 87 Data Scoping Call.

Size Bin	Market Size Ranges
Large (L)	Less than 31 tails per pound
Medium (M)	Between 31 and 67 tails per pound
Small (S)	Greater than 67 tails per pound
Unknown (U)	NULL

Table 10. Gulf of Mexico annual landings of brown, pink and white shrimp in heads-off pounds.

Year	Brown Shrimp	Pink Shrimp	White Shrimp
1960	61,787,343	20,658,592	28,128,567
1961	29,337,308	9,457,389	13,286,812
1962	26,620,055	15,329,969	18,376,826
1963	44,595,570	17,998,991	37,911,412
1964	33,170,644	20,986,099	35,949,464
1965	49,586,453	14,106,139	26,353,833
1966	50,881,790	12,986,068	23,698,216
1967	83,993,526	8,972,168	19,877,150
1968	63,881,322	10,168,061	26,363,949
1969	56,516,843	9,891,776	39,441,753
1970	68,679,925	11,929,699	40,579,303
1971	75,525,205	10,124,270	38,176,369
1972	75,945,771	10,811,607	32,809,222
1973	47,873,467	13,992,645	30,722,335
1974	50,759,468	14,374,393	26,874,478
1975	48,279,340	13,747,431	25,742,846
1976	77,863,267	13,021,513	36,518,116
1977	96,919,453	16,204,603	46,209,815
1978	87,508,037	16,011,393	48,036,180
1979	71,403,312	13,846,691	34,856,133
1980	68,269,927	12,877,492	42,705,545
1981	99,508,484	18,773,126	46,108,156
1982	74,804,488	11,644,028	39,219,608
1983	61,352,577	12,628,671	42,189,194
1984	82,204,088	14,698,527	55,958,235
1985	87,155,338	15,930,980	58,854,018
1986	100,564,407	11,723,343	70,052,138
1987	94,070,956	10,486,082	52,833,598
1988	82,840,325	9,135,939	44,638,937
1989	96,348,265	8,622,144	36,117,305
1990	105,912,096	7,454,083	43,701,940
1991	89,467,559	6,790,159	45,244,280
1992	70,831,209	6,341,170	47,342,282
1993	69,832,922	9,488,603	38,577,835
1994	68,881,037	10,088,773	45,334,632
1995	78,839,517	14,058,321	48,662,618
1996	76,339,327	19,341,126	35,430,587
1997	68,274,442	12,688,112	38,566,210
1998	81,615,721	17,164,094	54,187,635
1999	83,684,364	8,029,582	54,098,203
2000	98,932,949	7,447,382	70,635,889
2001	91,692,069	9,697,033	53,882,461
2002	77,478,385	8,055,429	52,647,979
2003	87,295,206	8,072,700	60,080,446

2004	76,981,943	8,613,703	66,674,049
2005	60,218,104	7,270,807	63,825,452
2006	90,114,767	6,474,199	85,117,985
2007	73,833,069	3,461,935	65,033,011
2008	52,776,230	4,874,778	64,908,634
2009	77,549,679	4,028,248	73,683,853
2010	45,815,047	5,434,330	57,987,614
2011	74,496,273	4,551,515	56,981,681
2012	66,147,560	3,829,903	66,355,424
2013	67,611,609	4,029,532	55,550,691
2014	68,075,256	6,404,250	60,054,484
2015	64,960,821	5,536,597	53,687,668
2016	49,575,404	5,243,166	69,073,085
2017	57,019,097	11,394,487	68,765,459
2018	71,207,036	12,989,394	51,608,632
2019	41,008,599	7,755,248	65,769,998
2020	41,602,300	7,729,692	58,843,276
2021	43,048,733	7,930,843	62,806,461
2022	32,461,721	9,975,079	68,189,356

Table 11. Estimates of uncertainty (CV) by state and collection program.

Year	TX	LA	MS	AL	FL	Comments
1960-1983	0.2	0.2	0.2	0.2	0.2	Data collected and maintained by NMFS Headquarters
1984-1999	0.1	0.1	0.1	0.1	0.1	SEFSC responsible for collecting and maintaining GSS in 1984
2000-2001	0.1	0.05	0.1	0.1	0.1	LA starts state trip ticket in 1999; used starting in 2000
2002	0.1	0.05	0.1	0.05	0.1	AL starts state trip ticket; used starting in 2002
2003-2013	0.1	0.05	0.1	0.05	0.05	FL starts state trip ticket in 1984; used starting in 2003
2014-2015	0.05	0.05	0.1	0.05	0.05	TX starts state trip ticket in 2008; used starting in 2014
2016-2022	0.05	0.05	0.05	0.05	0.05	MS starts state trip ticket in 2012; used starting in 2016

Table 12. SEDAR 87 landings for brown, pink, and white shrimp compared to Amendment 17B. For consistency, SEDAR 87 landings were produced using historical conversion factors.

A. Brown Shrimp

Year	Amendment 17B	SEDAR 87	Percent Difference
2003	83,949,224	84,892,419	1.12 %
2004	74,430,438	74,850,017	0.56 %
2005	58,574,505	58,722,186	0.25 %
2006	87,441,817	87,970,920	0.61 %
2007	70,560,173	71,969,689	2.00 %
2008	50,236,551	51,557,595	2.63 %
2009	75,500,221	75,830,328	0.44 %
2010	45,236,923	44,862,304	-0.83 %
2011	73,107,015	72,661,685	-0.61 %
2012	65,204,529	64,481,402	-1.11 %
2013	66,305,319	65,842,765	-0.70 %
2014	62,295,521	66,239,156	6.33 %

B. White Shrimp

Year	Amendment 17B	SEDAR 87	Percent Difference
2003	60,996,687	60,951,192	-0.07 %
2004	72,873,648	67,690,634	-7.11 %
2005	65,314,218	64,808,263	-0.77 %
2006	86,216,341	86,384,171	0.19 %
2007	64,305,379	66,036,603	2.69 %
2008	63,728,659	65,920,679	3.44 %
2009	75,296,070	74,850,542	-0.59 %
2010	59,596,612	58,995,125	-1.01 %
2011	58,265,392	57,900,690	-0.63 %
2012	67,246,784	67,493,401	0.37 %
2013	56,360,746	56,501,950	0.25 %
2014	58,472,474	61,083,734	4.47 %

C. Pink Shrimp

Year	Amendment 17B	SEDAR 87	Percent Difference
2003	9,943,414	7,954,404	-20.00 %
2004	10,133,819	8,487,605	-16.24 %
2005	8,722,912	7,160,350	-17.91 %
2006	7,654,077	6,395,996	-16.44 %
2007	3,414,746	3,415,388	0.02 %
2008	4,888,385	4,795,911	-1.89 %
2009	4,621,755	3,961,976	-14.28
2010	5,796,471	5,324,682	-8.14 %
2011	4,709,564	4,459,858	-5.30 %
2012	3,412,738	3,752,626	9.96 %
2013	3,182,863	3,949,627	24.09 %
2014	3,800,713	6,278,205	65.18 %

Figures

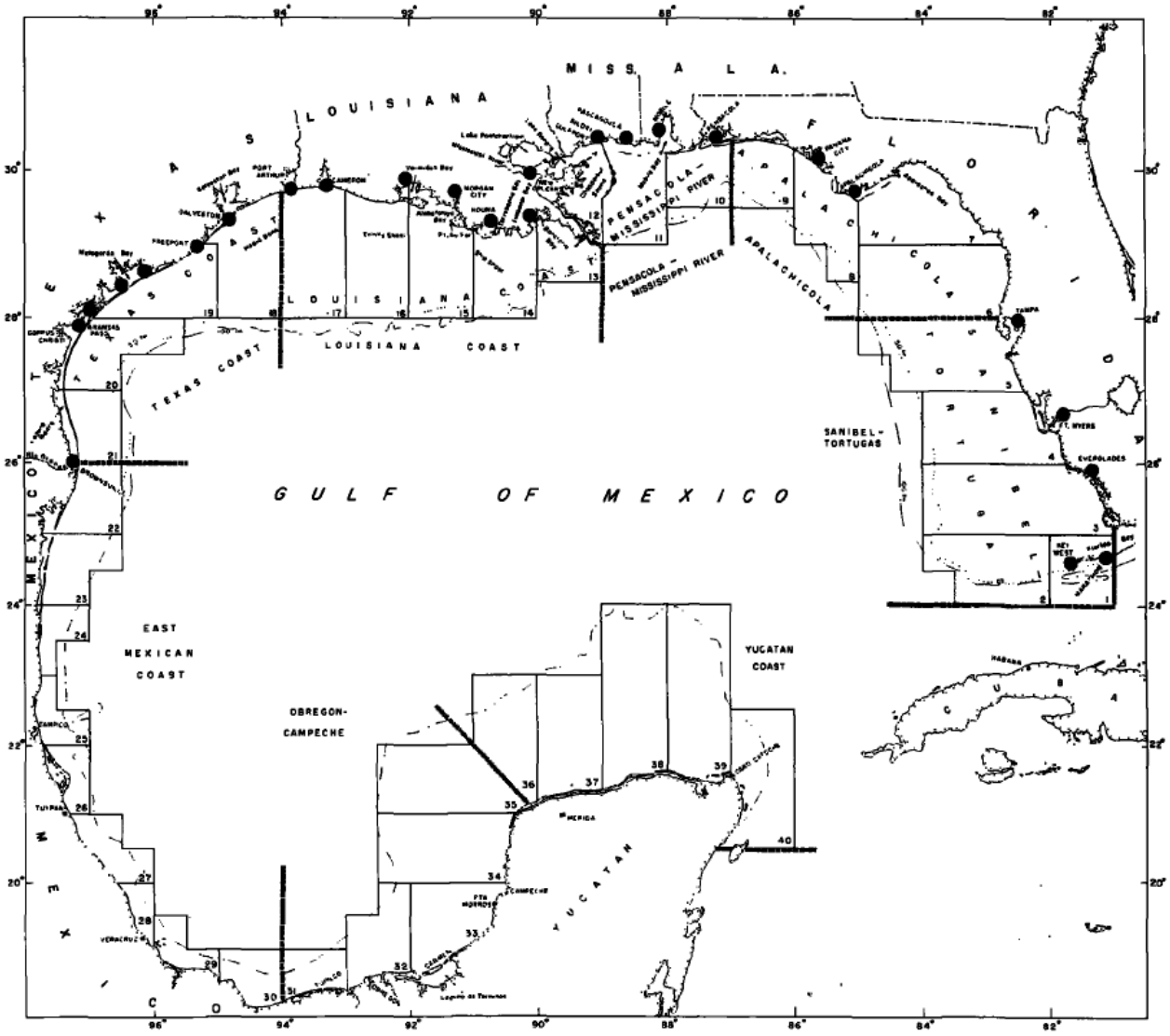

Figure 1. Fishing area coding system for Gulf of Mexico shrimp landings. Reprinted from Kutkuhn (1962a).

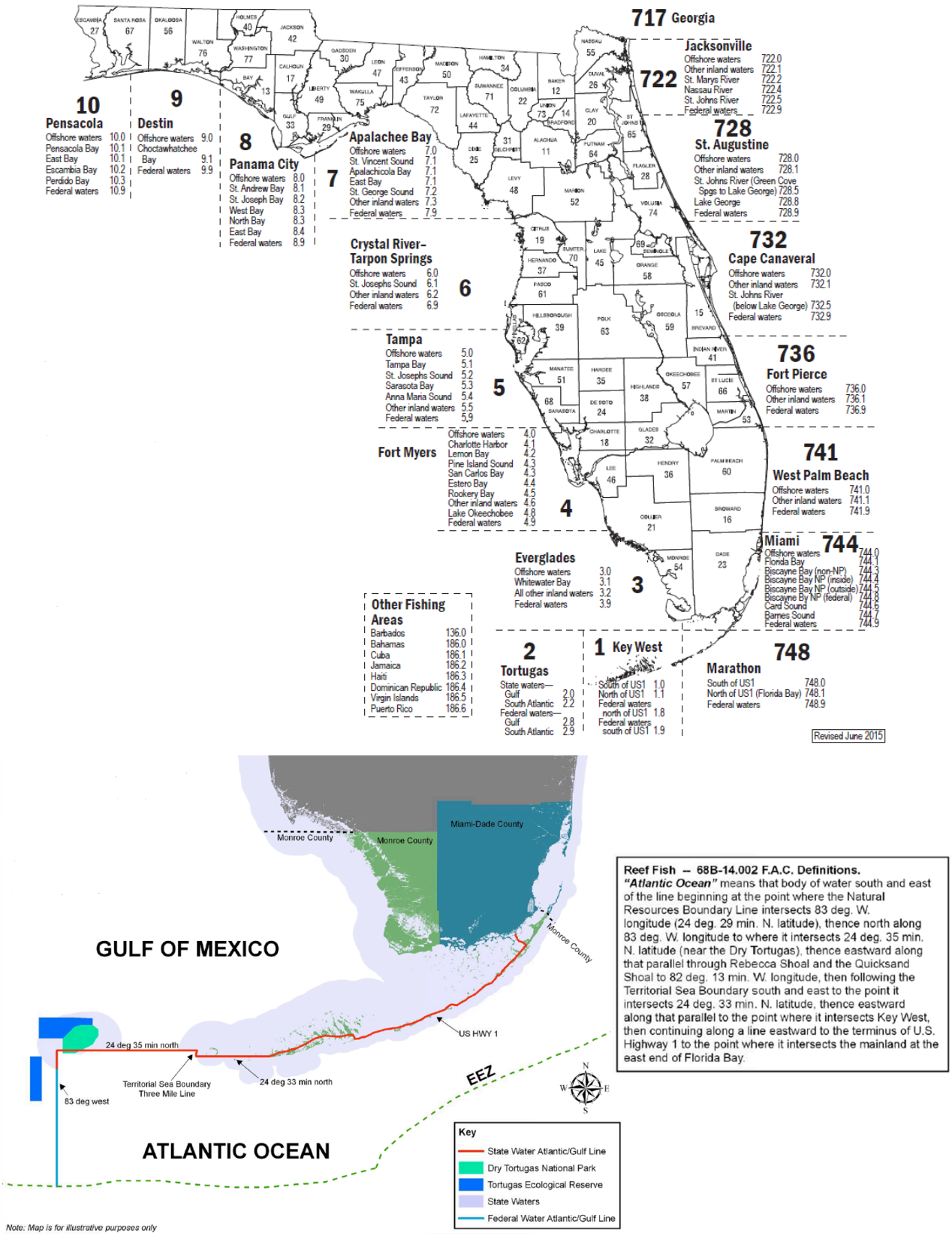

Figure 2. Florida state trip ticket fishing area and sub area codes as well as Council boundary definitions (FWC).

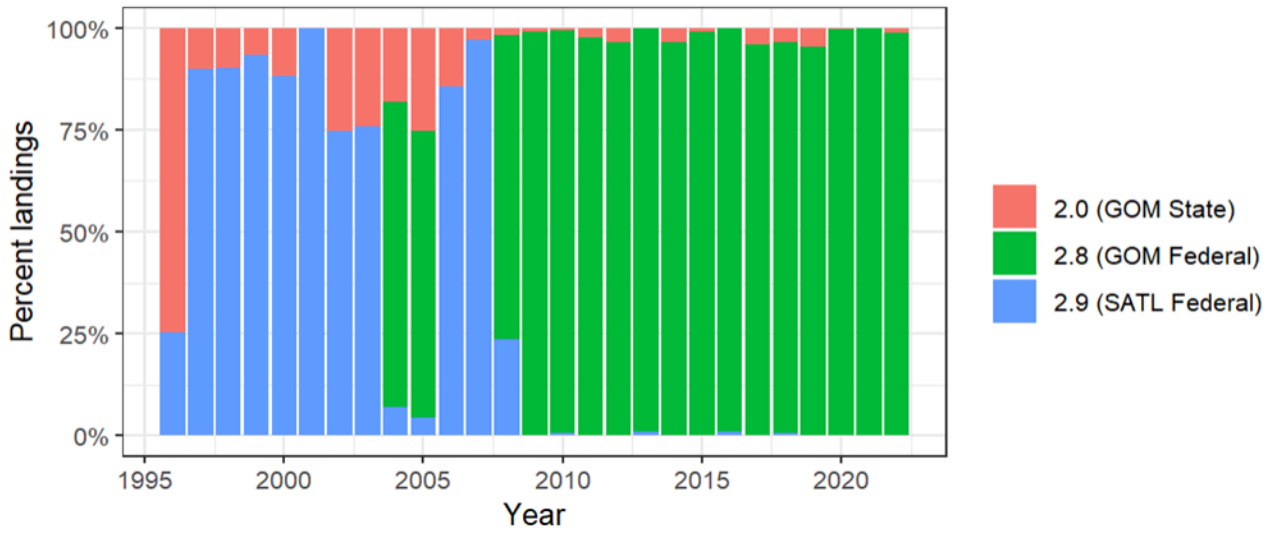

Figure 3. Florida trip ticket landings for area 2 (Tortugas) between 1996-2022. While the trip ticket program started in 1984, area was not reported for a majority of the landings until 1996. Gulf of Mexico (GOM) and South Atlantic (SATL) waters in the Tortugas are based on the Council boundaries defined in Figure 2. While reported, area 2.2 was removed for confidentiality purposes.

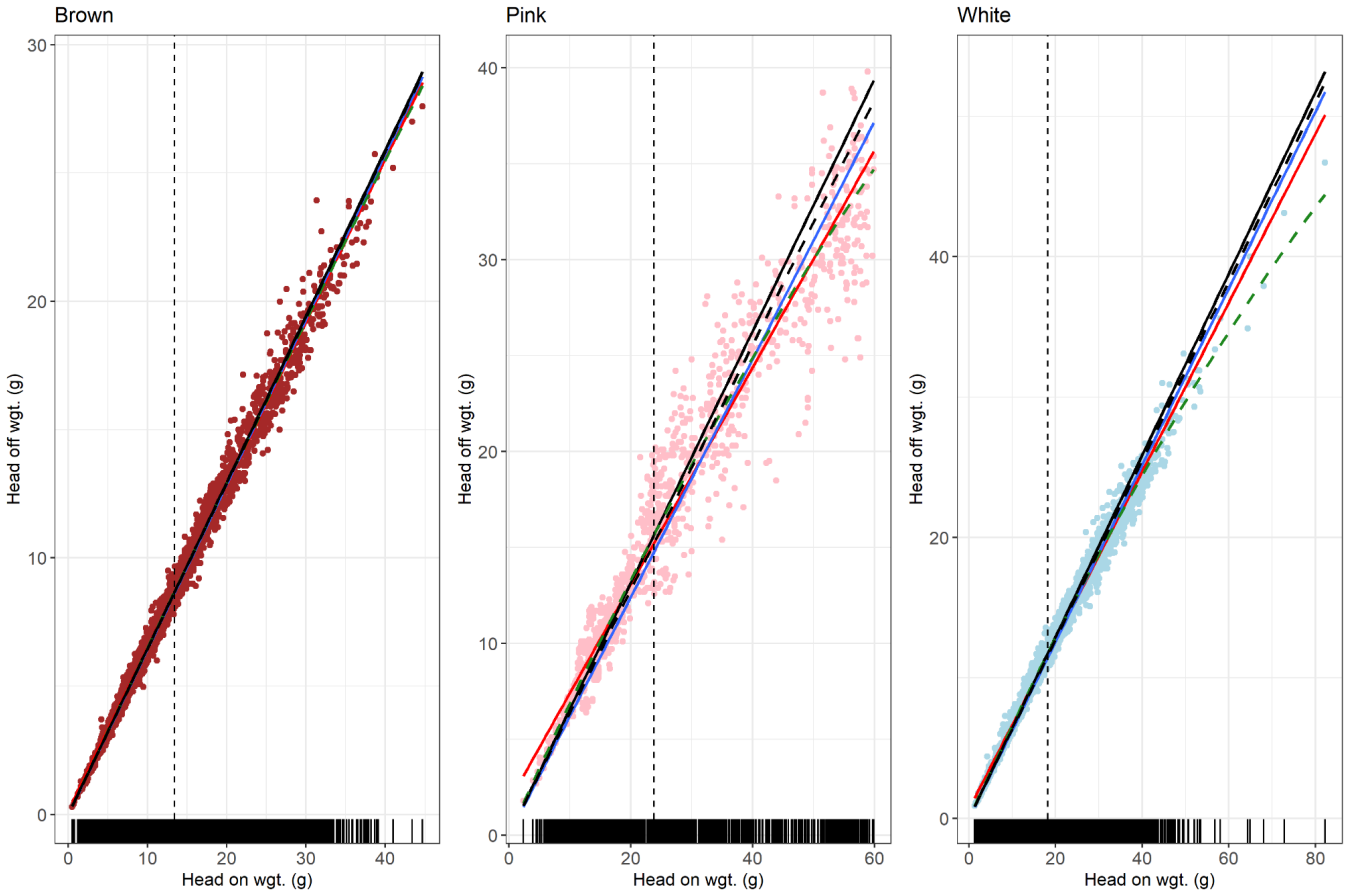

Figure 4. Comparison of regression methods for GSMFC brown (left), pink (middle), and white (right) shrimp heads-off vs. heads-on weights. Solid lines represent linear model fits (red = linear regression, blue = linear regression through origin, black = weighted linear regression through origin (i.e., mean of ratios)). Note increased variability of y-values as x-values increase, suggesting need for weighted models. Dashed green line represents weighted second-order regression through origin (best fitting model; all $p < 0.0001$), and yields aggregate predictions equivalent to the ratio estimator (dashed black line). Observe bias between ratio estimator and other linear regression methods. Dashed vertical lines represent mean heads-on weights of shrimp in the study.

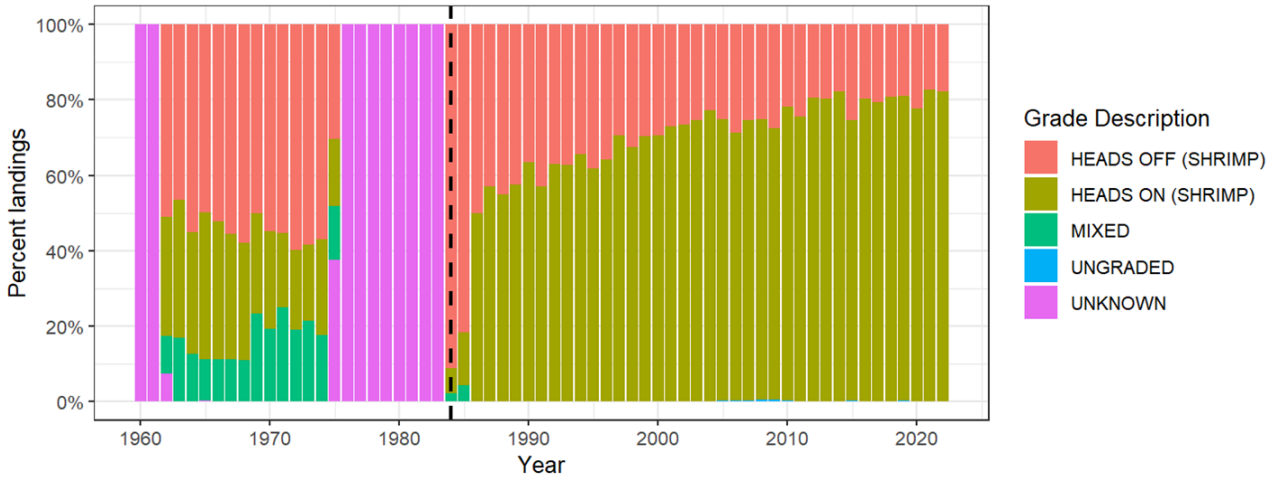

Figure 5. Annual percent of penaeid shrimp landings by grade code from GSS. The vertical line indicates 1984. This is the year in which collection of shrimp landings under the Gulf Shrimp System was under SEFSC control.

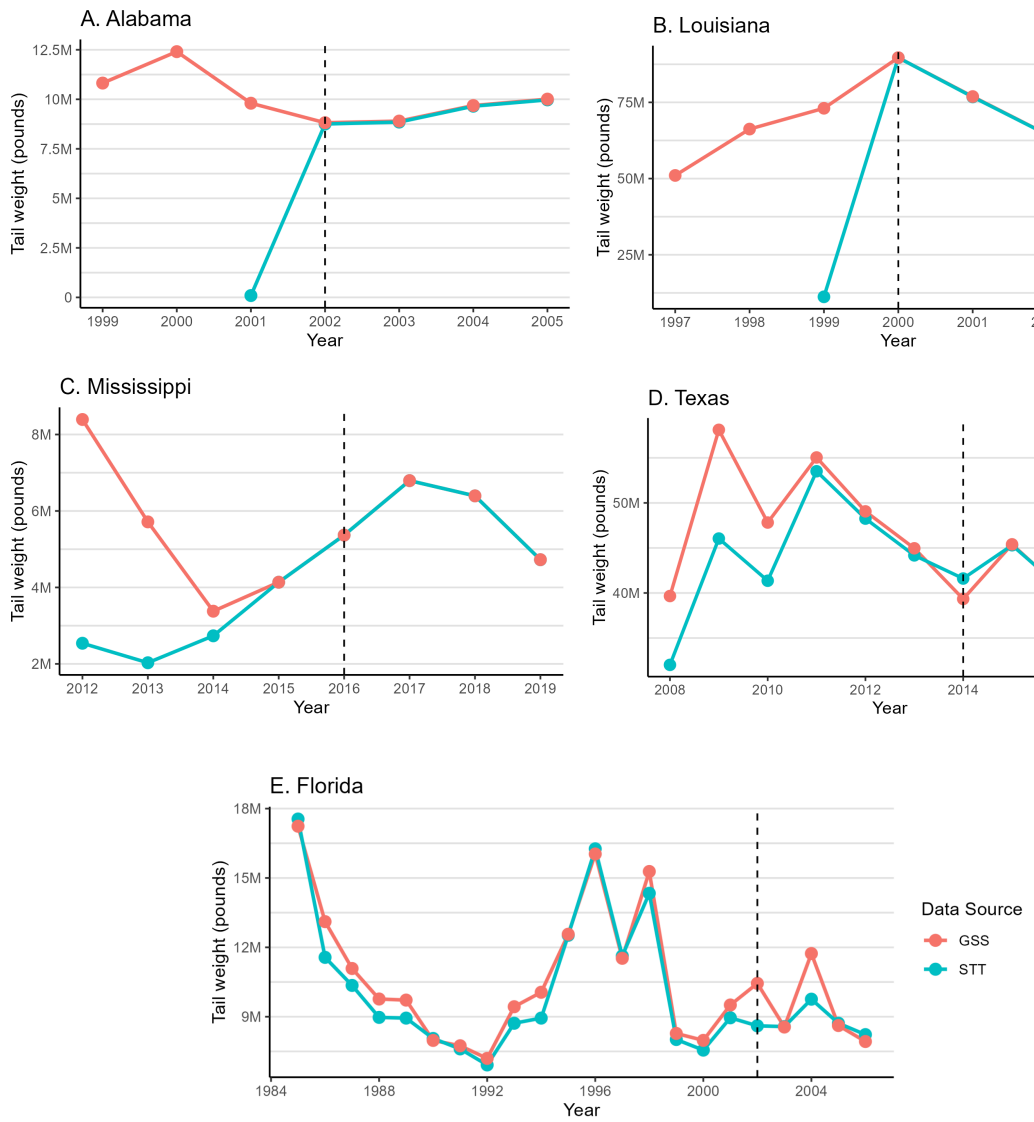

Figure 6. GSS and State Trip Ticket (STT) comparison of annual total landings of brown, pink, and white shrimp. The vertical dashed lines denote the year to switch from GSS to trip ticket data.

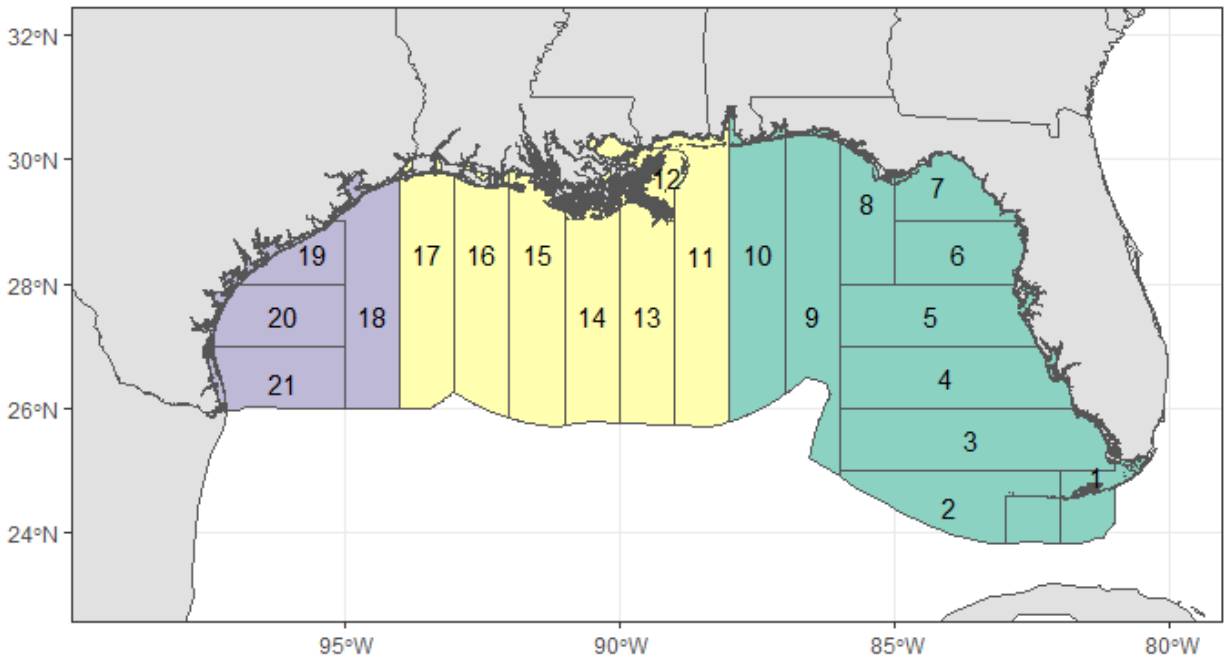

Figure 7. Shrimp statistical grid zones for the Gulf of Mexico SEDAR 87 landings grouped into three areas (1-10, 11-17, and 18-21).

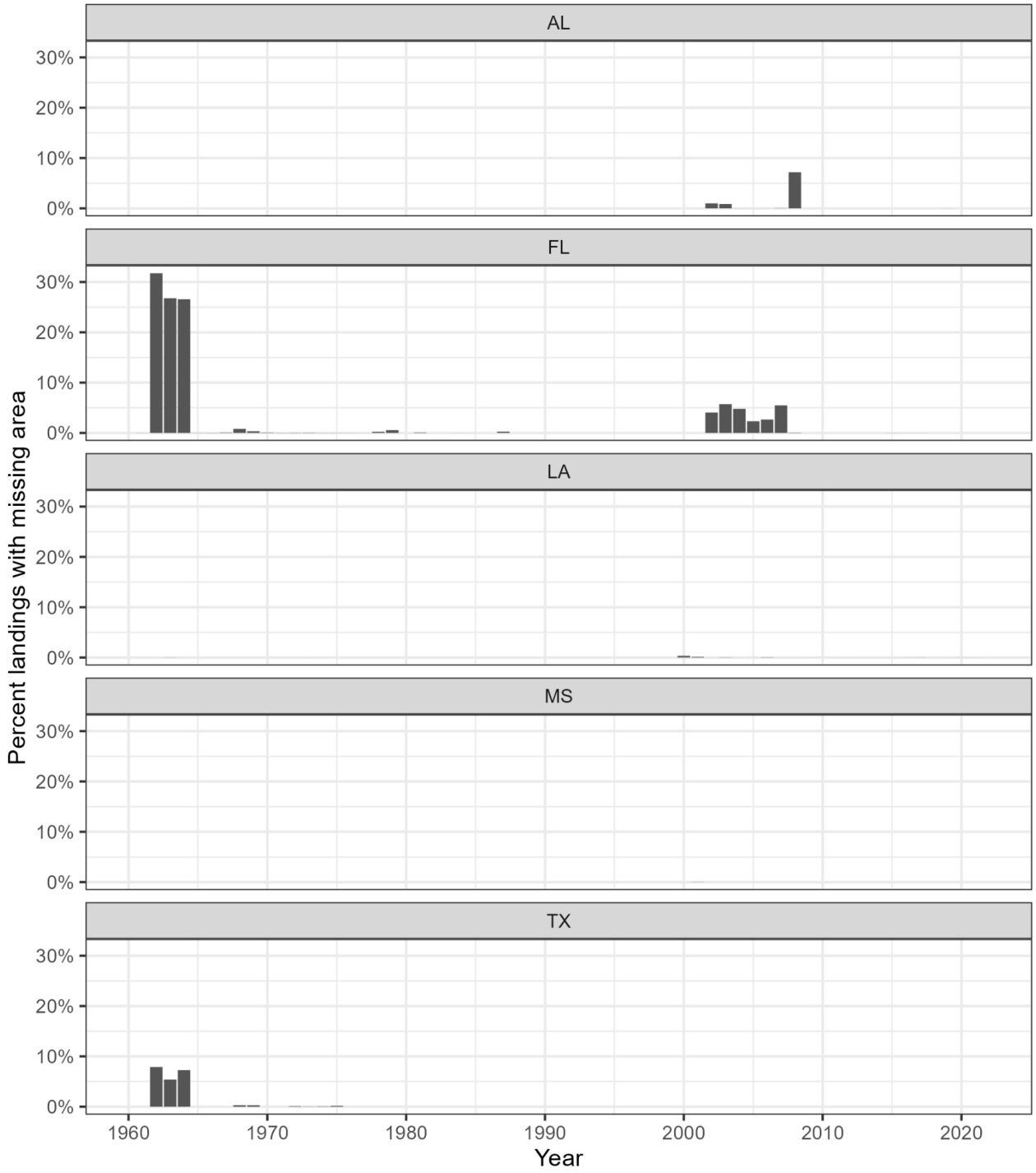

Figure 8. Percent landings records missing fishing area by year and state.

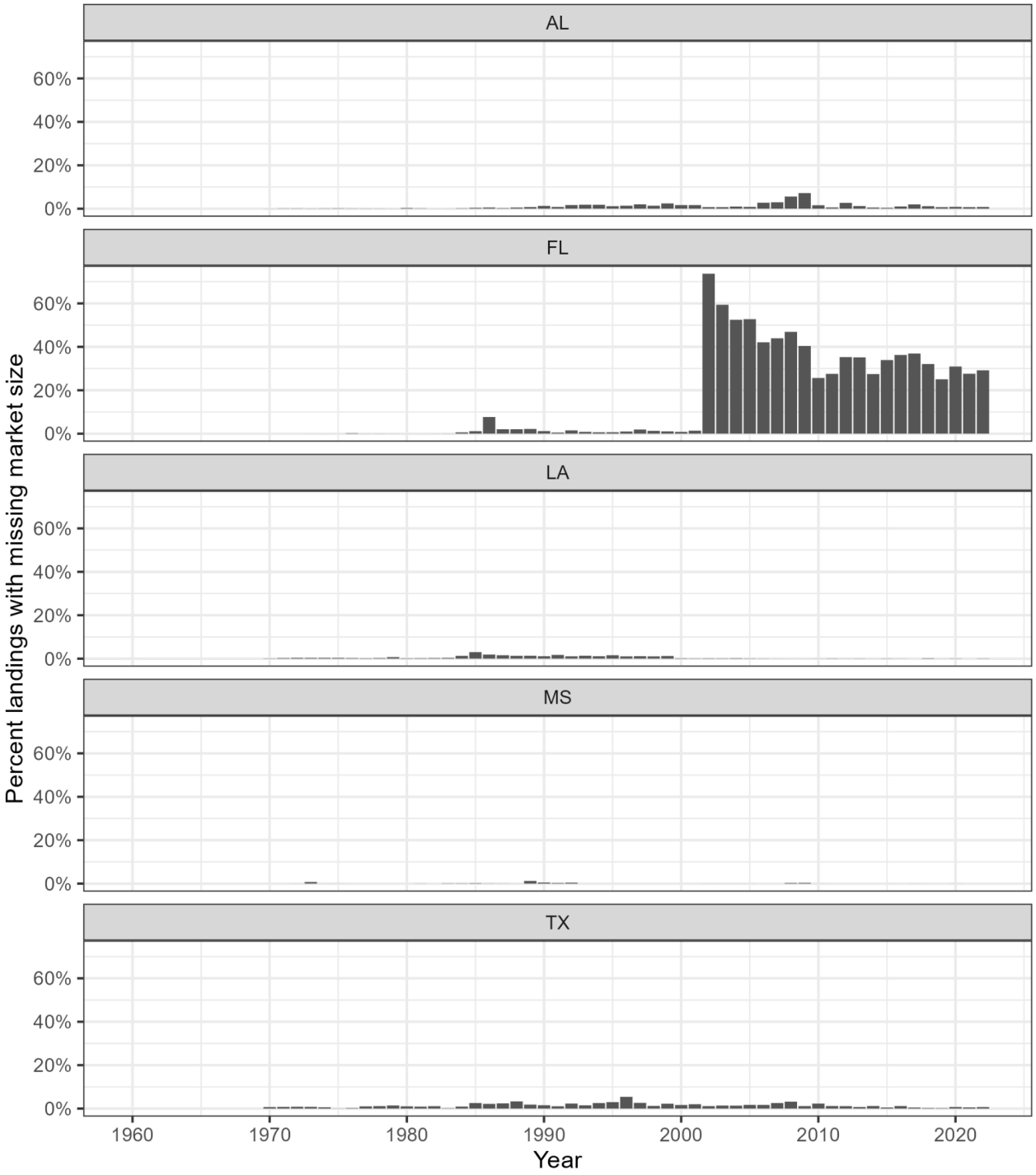

Figure 9. Percent landings records missing market size bins by year and state.

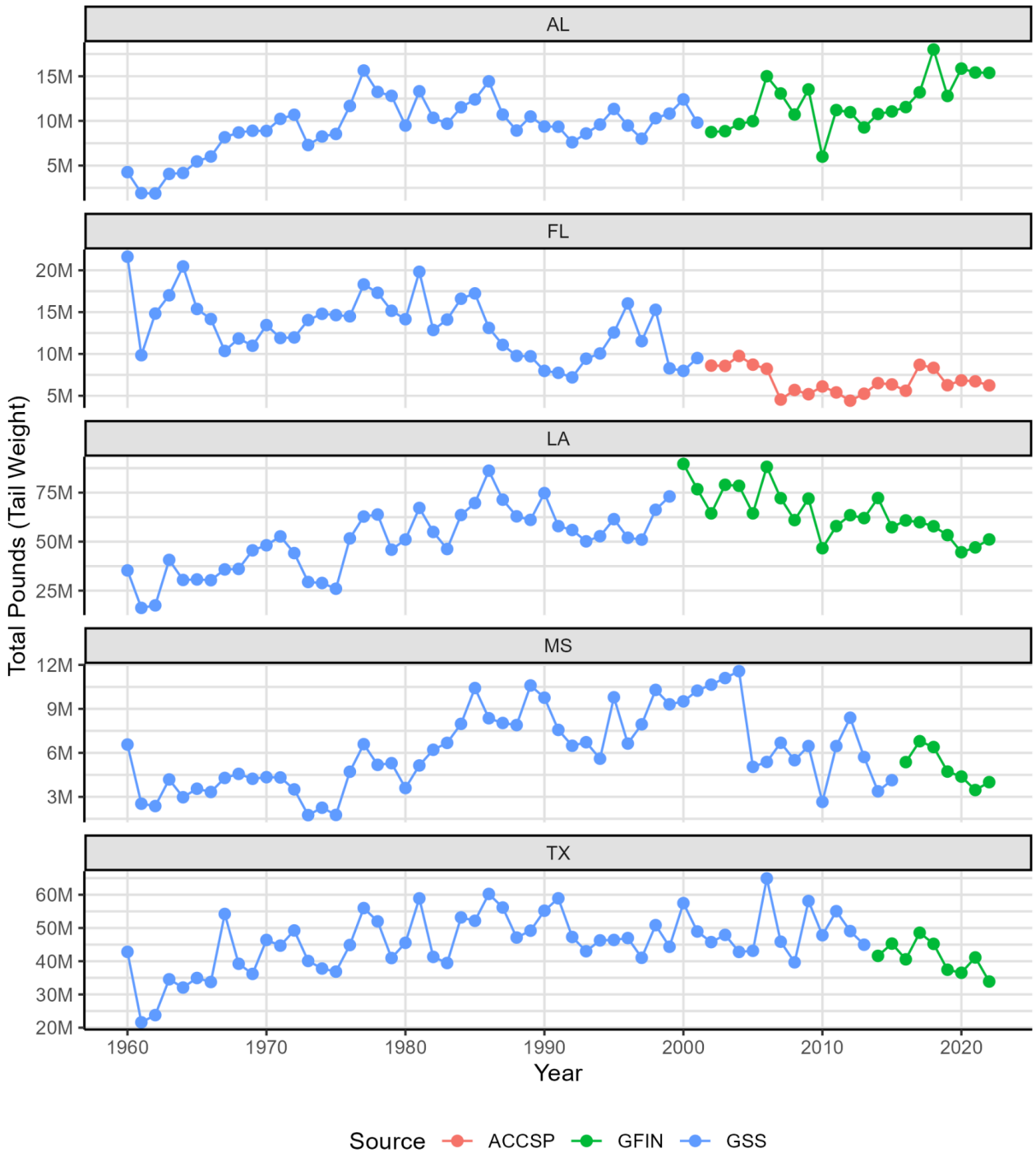

Figure 10. Total penaeid shrimp landings (in heads-off pounds) by state and data source.

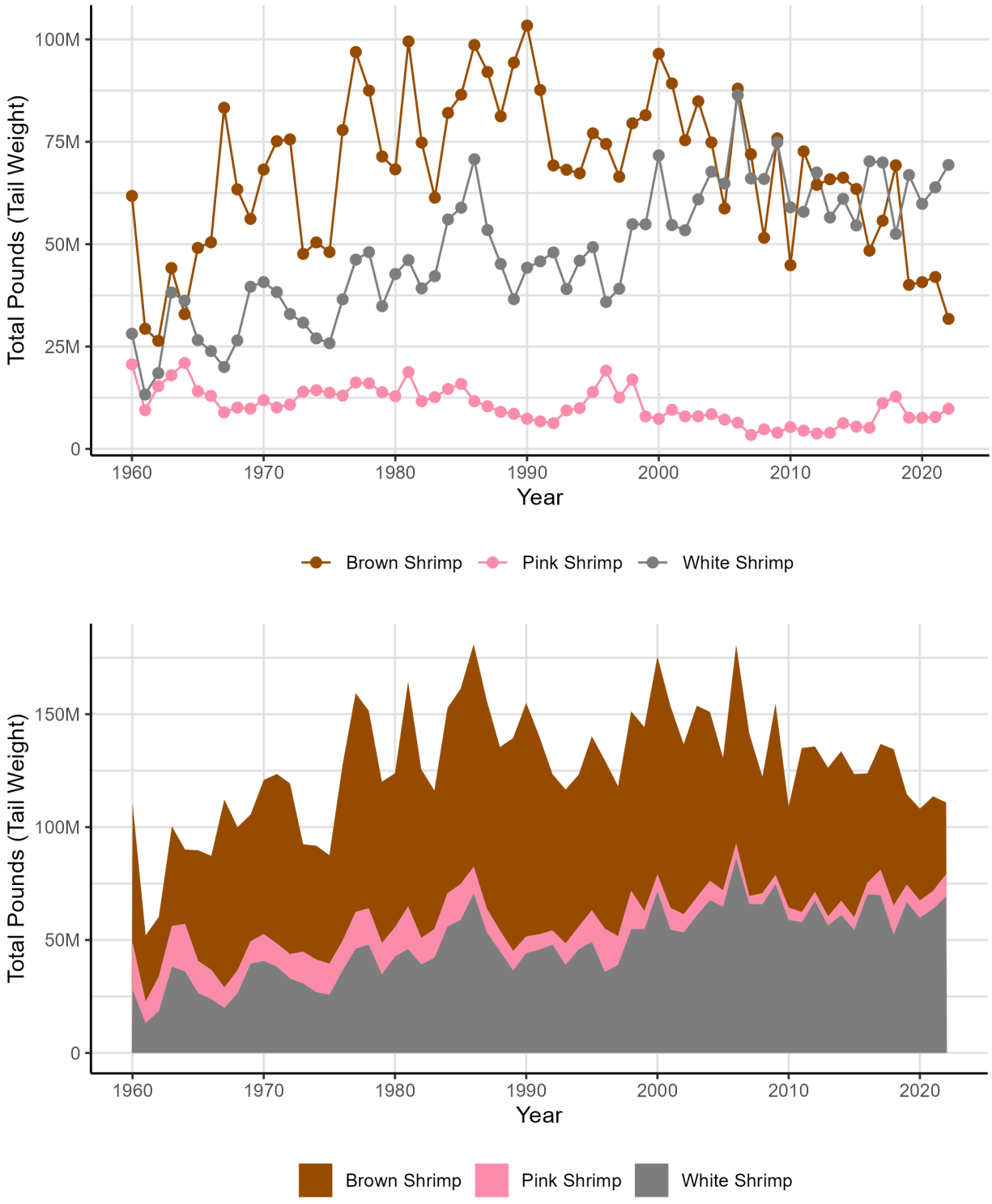

Figure 11. Shrimp landings by species (brown, pink, white) in the Gulf of Mexico (top), 1960-2022, and accumulated landings (bottom) for the same species and periods.

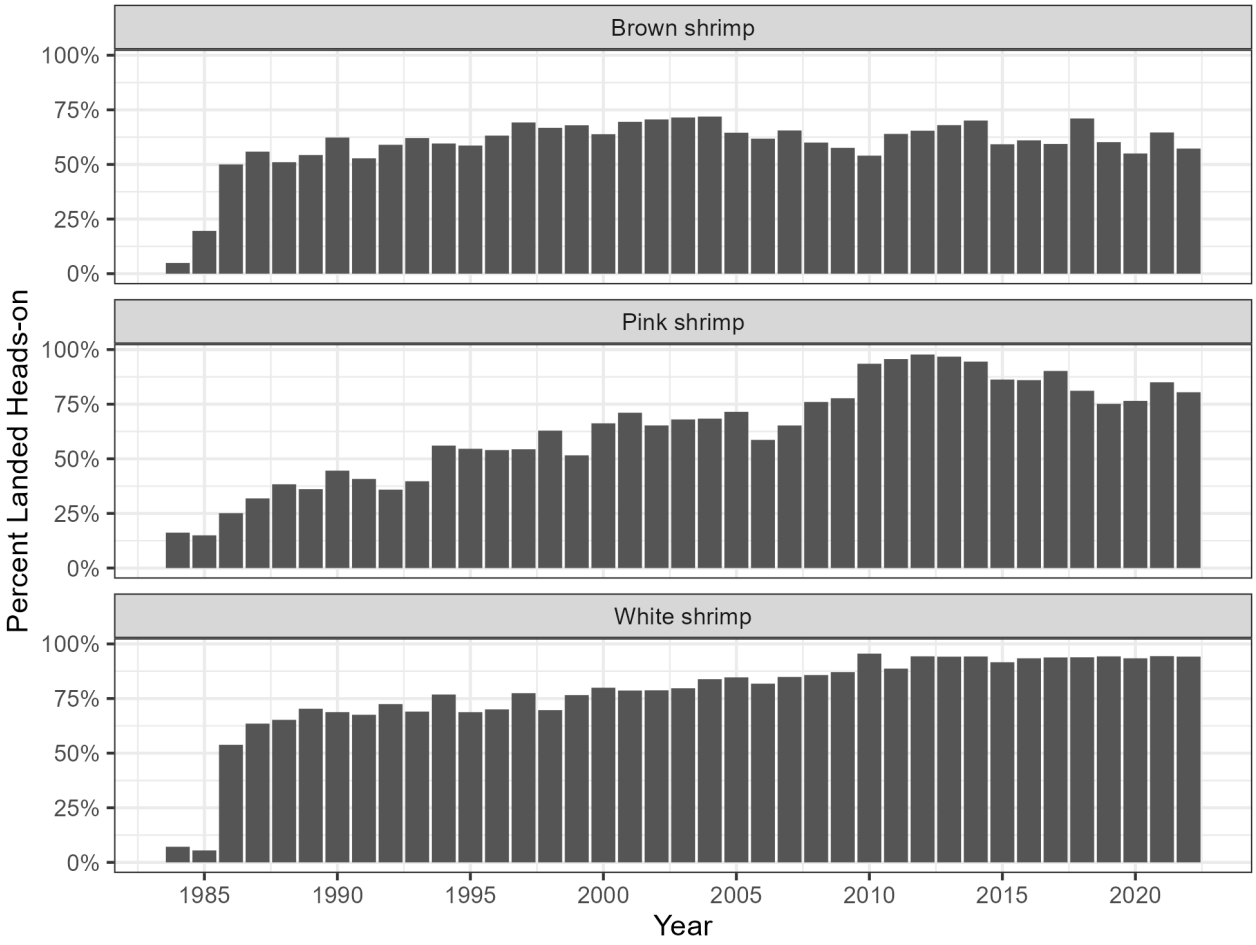

Figure 12. Percentage of landings records reported heads-on from 1984-2022 by species.

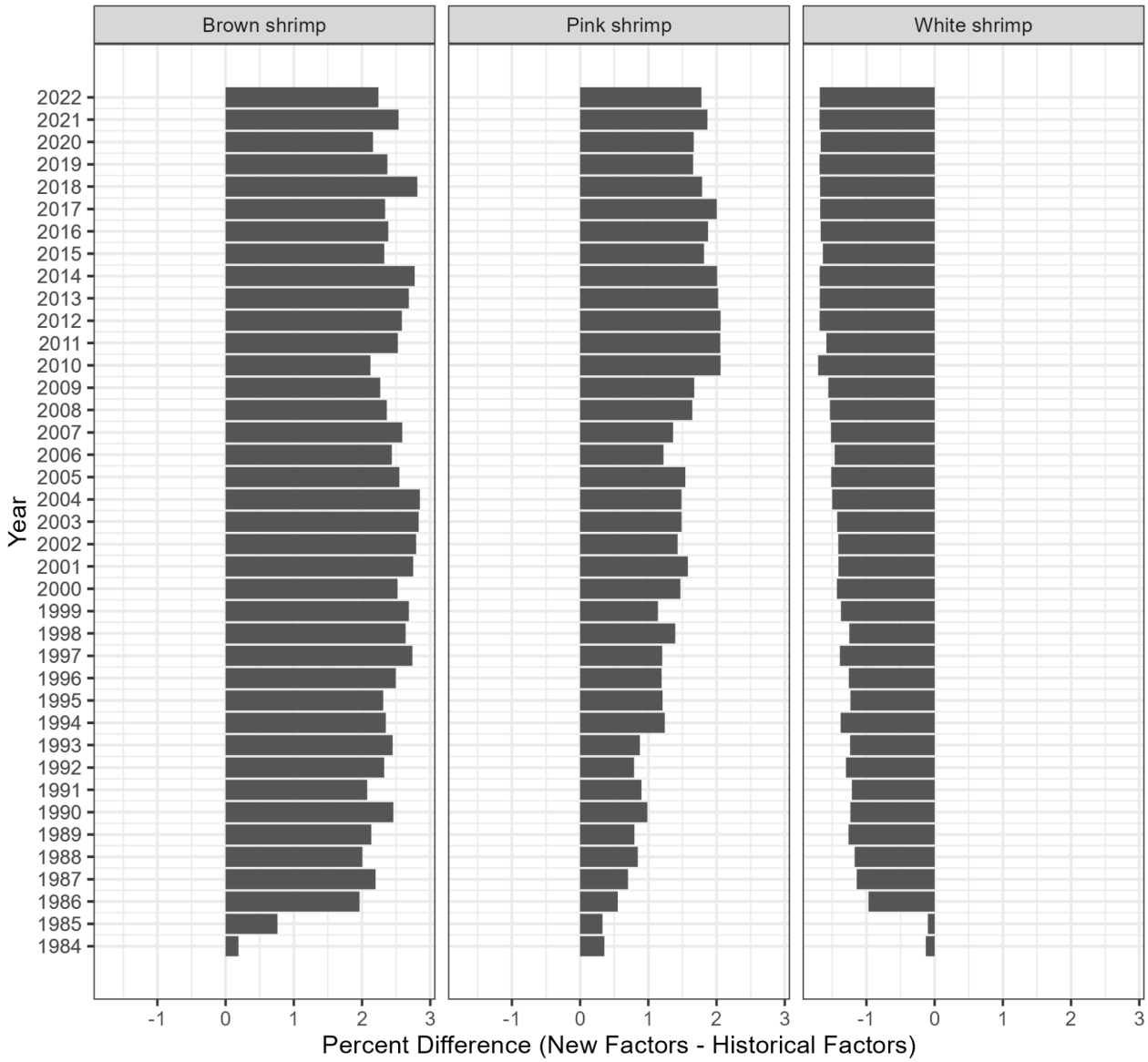

Figure 13. Annual percent difference of landings in weight between using historical conversion factors and GSMFC (2020) conversion factors from 1984-2022. A positive number indicates the new conversion factor results in more landings and a negative number means the new conversion factor results in less landings.

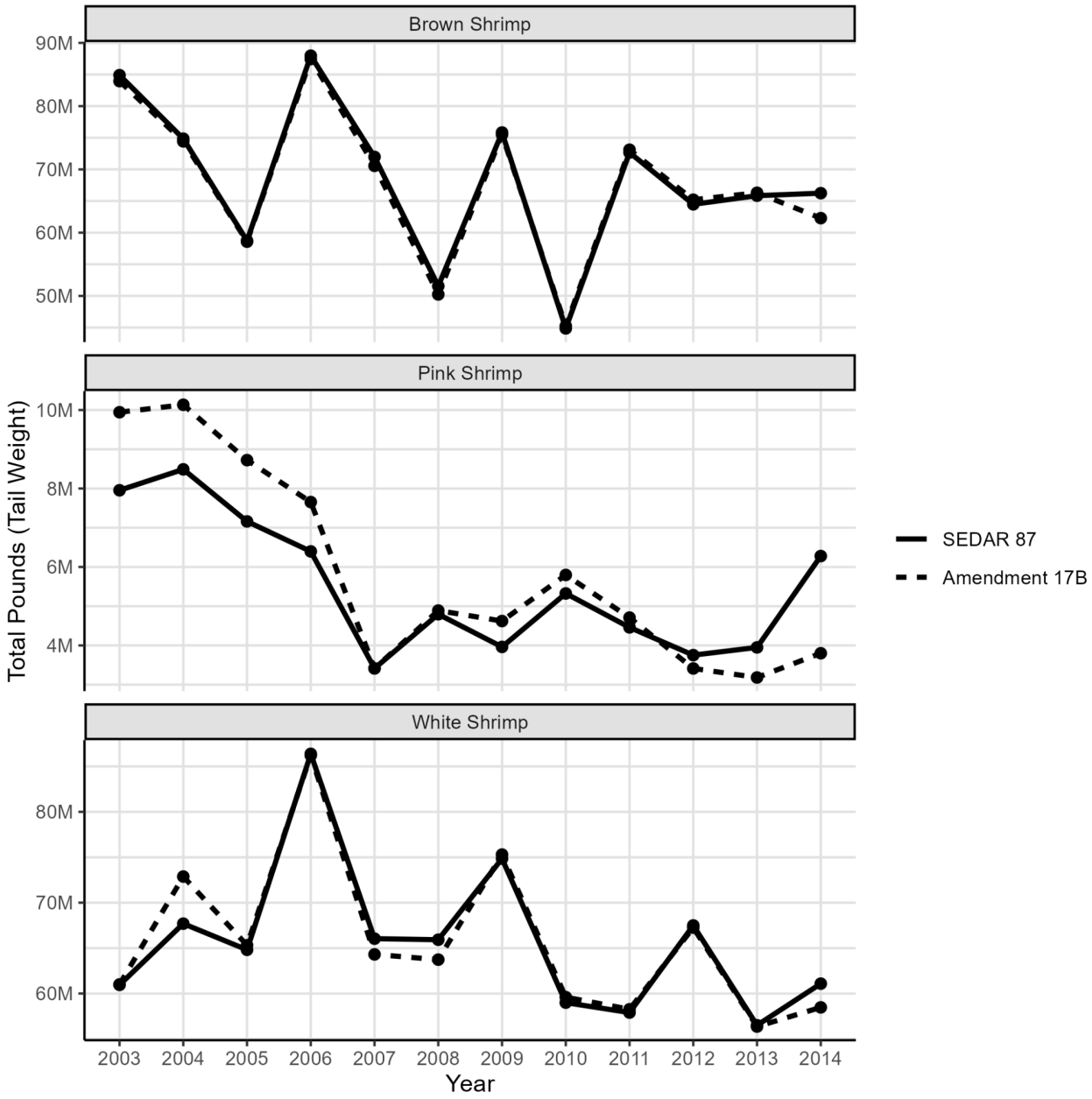

Figure 14. SEDAR 87 landings for brown, pink, and white shrimp compared to landings presented in Amendment 17B. Note y-axes scales differ.

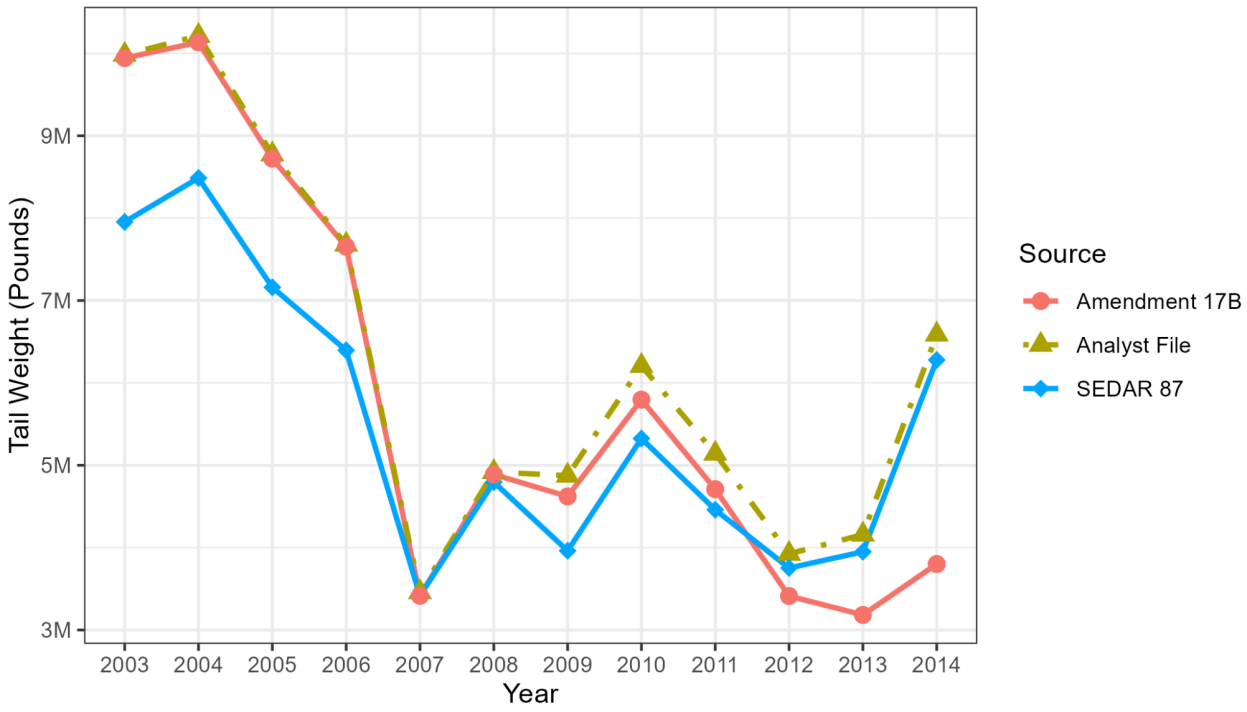

Figure 15. Pink shrimp landings from 2003-2014 across four sources (Amendment 17B, analyst file, and SEDAR 87 (i.e., FL trip ticket).