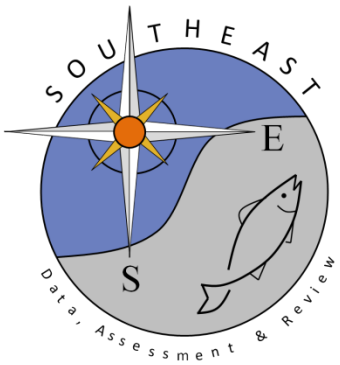
Standardized catch rates of Gray Triggerfish from the United States Gulf of America commercial handline fishery, 1993-2024

Kevin Thompson and Michaela Pawluk

SEDAR100-DW-15

18 August 2025



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Kevin Thompson[1] and Michaela Pawluk[2]

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This document describes the development of the SEDAR 100 commercial logbook index for Gray Triggerfish from the commercial handline fishery. Gray Triggerfish indices of abundance using the Commercial Fisheries Logbook Program data were constructed through 2017 in the most recent SEDAR for the species, SEDAR 62 (SEDAR62-DW-05). All indices in this document use data from the Coastal Fisheries Logbook Program and were developed following standardization methodologies consistent with more recent assessments since SEDAR 62. Improved data filtering techniques, modifications to the trip selection approach, and recent standardization practices were implemented.

Commercial Fisheries Logbook Program (CFLP) overview

Landings and fishing effort of commercial vessels operating in the Gulf of America and southeast U.S. Atlantic are monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects trip-level information from all vessels holding federal permits to fish in waters managed by the regional Fishery Management Councils. Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal fisheries, and since then has maintained the objective of a complete census of federally permitted vessels across the entire southeast U.S (Atkinson et al. 2021).

For each fishing trip, the CFLP records a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings. Fishing effort data available for vertical line gear (manual and electric) includes number of lines fished, hours fished, and number of hooks per line.

[1] National Marine Fisheries Service, Southeast Fisheries Science Center, 75 Virginia Beach Dr, Key Biscayne, FL 33149; 2 National Marine Fisheries Service, Southeast Fisheries Science Center, 4700 Avenue U, Galveston, TX 77551

Background

For the SEDAR 62 Gray Triggerfish assessment, two indices were constructed using the commercial logbook data for the handline fishery. They generally followed the methods first established in SEDAR 43 (SEDAR43-DW-05). Two indices were generated for this species, with one for the east region of the Gulf and one for the west using the break between SEAMAP zones 12 and 13 as the dividing line between the two (Fig. 1). Additionally, at the request of assessment analysts, a gulf-wide index was also provided to support testing of a one-area assessment model in SEDAR 100.

Data Description

Catch per unit effort (CPUE), defined as whole weight per hook hour, from the CFLP logbooks was used to develop an index of abundance for Gray Triggerfish landed with handlines (manual handline and electric reel). Thus, the size and age range of fish included in the index is the same as that of landings from the commercial handline fleet.

1. Outlier removal

Extreme values occur more frequently in self-reported data because there are limited opportunities to validate data. Recent SEDAR stock assessments have removed values at the extreme tail of the distribution for CPUE and associated fields in self-reported fishery-dependent data. Values falling outside the 99th percentile of the data were excluded from the analyses conducted in SEDAR 100.

2. Data exclusions and assumptions (delayed reporting, multiple gears, area reported, closures)

Data were restricted to include only those trips with landings and effort data reported within 45 days of the completion of the trip to minimize the potential for recall bias (some reporting delays were longer than one year). Also excluded were trips that reported use of multiple gears fished, which prevents designating trip-level catch and effort records to specific gears. Therefore, only trips which reported one gear fished were included in these analyses. For trips that reported fishing in more than one area, the first area reported was used to determine the spatial zone associated with the trip.

3. Areas included in the model

Previous indices with this species for east and west Gulf limited the zones included for each of the regions. For the east index, they included only areas 6-11, and the west included the discontinuous zones of 16,17, and 21 (SEDAR62-DW-05: Table 2). While it is considered best practice to limit the spatial extent of these analyses to include only the core areas, therefore removing spatial edges of the available data, this piecemeal approach to area inclusion is not preferred in index development. As such, an initial investigation into the proportion of positive catches of Gray Triggerfish by SEAMAP zone was conducted with numbers after the Stephens and MacCall trip selection approach illustrated in Table 1. These data indicate that there is sufficient data from zone 5 north and west to zone 12 in the east and 13 through 20 in the west, leaving out the more southern portion of Florida and the Texas-

Mexico border.

4. Time period

Implemented in 1992, the CFLP did not require reporting from all Gulf of Mexico and US Atlantic commercial fishermen until 1993. Therefore, 1993 was chosen as the starting year for the constructed indices. While the terminal year of these initial indices is 2024, truncation to an earlier year is possible if deemed necessary by the Data Workshop panel.

Evaluation of explanatory variables

YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993-2024

SEASON – Season included four levels: (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec).

AREA – The SEAMAP zone as a factor with the east model including zones 5-12, and the west with zones 13-20 (8 levels each)

DAYS AT SEA – Days at sea (sea days) were pooled into four levels as quartiles of the data for the respective dataset (east, west, or Gulfwide)

CREW SIZE – Crew size was included as a factor with levels from 1-6 (min to max value)

HOOK HOURS – Trip total hook hours as a four-level factor pooled into quartiles of the data for the respective dataset (east, west, or Gulfwide)

Analytical decisions

1. Subsetting trips - Use Stephens and MacCall (2004) method
2. Species included in Stephens and MacCall approach: limit to snapper-grouper complex and remove species with full-year closures, ID issue, or large shifts in desirability over the index period
3. Apply Stephens and MacCall for handline trips

Subsetting trips

Effective effort was based on those trips from areas where Gray Triggerfish were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred, which was done here using the method of Stephens and MacCall (2004). The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip.

A backwards stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables, where the most general model included all listed species as main effects. In this procedure, a generalized linear model with a Bernoulli response was used to relate presence/absence of Gray Triggerfish in each trip to presence/absence of other species. A trip was then included if its associated probability of

catching Gray Triggerfish was higher than a threshold probability. The threshold was designed to be that which resulted in the same number of predicted and observed positive trips, as suggested by Stephens and MacCall (2004). This procedure was completed independently for the east and west indices, and the combined dataset was used to construct the Gulfwide index.

Standardization

CPUE was modeled using the delta-GLM approach (Lo, Jacobson, and Squire 1992; Dick 2004; Maunder and Punt 2004). This approach combines two separate generalized linear models (GLMs), one to describe presence/absence of the focal species, and one to describe catch rates of successful trips (trips that caught the focal species). Estimates of variance were based on 1,000 bootstrap runs where trips were chosen randomly with replacement (Efron and Tibshirani 1993). All analyses were programmed in R, with much of the code adapted from Dick (2004).

Bernoulli submodel

The Bernoulli component of the delta-GLM is a logistic regression model designed to predict the presence/absence (i.e., availability to be caught) of Gray Triggerfish on any given trip. Initially, all explanatory variables were included in the model as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. In this case, the stepwise AIC procedure did not remove any explanatory variables for any of the indices (east, west, or Gulfwide). As such, the binomial component for each region included all possible variables for the final index.

Positive CPUE submodel

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. For both distributions, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. For both distributions, the best model fit included all explanatory variables. The two distributions were compared using AIC. Gamma outperformed lognormal, and was therefore applied in the final delta-GLM. Similar to the binomial component, the stepwise AIC procedure did not remove any explanatory variables for any of the indices (east, west, or Gulfwide) for the positive catch sub-model.

Results and Discussion

East Gulf

Stephens and MacCall results showed several species as strong predictors of Gray Triggerfish presence including Vermilion Snapper, White Grunt, Black Seabass, and Scamp (Fig. 2). Only Whitebone Porgy was negatively associated among the snapper-grouper complex with Gray Triggerfish (Fig. 2). Both the binomial and positive CPUE model showed residual patterns that indicate a good fit for the final model with the variables included (Figs. 4-6). The CVs for this model are low (mean 8%; range: 6-14%), also indicating a good fit for this model (Table 2).

The final index pattern was similar to SEDAR 62, though some peaks were different, particularly at the beginning of the time series in the early 1990's and the new index showed a much higher abundance in 2003 comparatively (Fig. 7). Differences in trends between this and the previous assessment can't be fully verified given the information and data available, but some of the deviation is likely due to the change in the areas included in the index across the zones. Additionally, differences could be due to variation that can occur in the Stephen's and MacCall procedure given updates to the data or changes in the fitting process. The species retained in SEDAR 62 do show several more pelagic species being retained in that process (SEDAR62-DW-05)

West Gulf

Stephens and MacCall results showed several of the same species as the east as strong predictors of Gray Triggerfish presence including Vermilion Snapper, Lane Snapper, Black Grouper and Gag with Warsaw Grouper and Scamp, additionally (Fig. 2). Only Yellowedge Grouper was negatively associated among the snapper-grouper complex with Gray Triggerfish (Fig. 2). Both the binomial and positive CPUE model showed residual patterns that indicate a good fit for the final model with the variables included (Figs. 8-10). The CVs for this model are moderate (mean: 18%, range: 8-47%), diverging from the east index in this regard likely due to the reduced number of trips retained and catching Gray Triggerfish comparatively (Table 3).

The final index pattern was somewhat similar to SEDAR 62 with the two indices showing similar patterns but at different magnitudes, particularly through the 1990s (Fig. 11). The two indices begin to diverge in 2012 with the SEDAR 62 staying stable and a steady decline in the current model from that point until the terminal year of 2024 (Fig. 11). Similar to the east, differences are likely due to the inclusion of more zones across this region compared to SEDAR 62 as well as potential changes in the Stephen's and MacCall results regarding species associations.

Gulfwide

The species associations discussed in the subregion sections were applied to this dataset. Both the binomial and positive CPUE model showed residual patterns that indicate a good fit for the final model with the variables included (Figs.12-14). The overall pattern shows what would be expected as it is between the west and east index trends in most years, with more similarity to the pattern in the east (Fig. 15) given the greater catch and proportion positive in that subregion (Table 2 vs. 3). The CVs for this model are low (mean: 7%, range: 5-12%), also indicating a good fit for this model (Table 4).

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Table 1. Spatial breakdown of the proportion of trips with Gray Triggerfish in the subset dataset following the regional Stephens and MacCall procedure. For analyses for index subsetting, the removed zones (less than 5 in the east and 21 in the west) were not included in determining species associations and subsequent retained trips.

SEAMAP Zone	GTF Present	Selected Trips	Prop Present
1	4	16	0.250
2	5	75	0.067
3	39	152	0.257
4	148	685	0.216
5	698	2093	0.333
6	1863	3869	0.482
7	1504	2949	0.510
8	4507	6578	0.685
9	1118	2176	0.514
10	1477	3266	0.452
11	1326	2642	0.502
12	376	1443	0.261
13	536	1289	0.416
14	546	818	0.667
15	1196	1636	0.731
16	1536	2116	0.726
17	1946	2641	0.737
18	1442	2599	0.555
19	401	839	0.478
20	100	349	0.287
21	94	427	0.220

Table 2. Standardized index for Gray Triggerfish from the commercial handline fishery for the **east** Gulf (zones 5-12).

Year	N	Proportion Positive	Nominal CPUE	Relative nominal	Std. Index	CV
1993	428	0.442	0.049	1.132	1.384	0.142
1994	563	0.520	0.068	1.553	1.591	0.098
1995	459	0.584	0.062	1.423	1.260	0.090
1996	680	0.512	0.049	1.115	0.910	0.083
1997	747	0.503	0.047	1.068	0.887	0.085
1998	585	0.518	0.050	1.142	0.977	0.110
1999	871	0.567	0.047	1.076	0.992	0.076
2000	647	0.555	0.036	0.823	0.754	0.087
2001	686	0.517	0.040	0.907	1.002	0.098
2002	944	0.549	0.065	1.486	1.556	0.086
2003	1025	0.663	0.086	1.980	2.153	0.065
2004	877	0.601	0.070	1.615	1.610	0.075
2005	872	0.562	0.064	1.466	1.451	0.079
2006	780	0.538	0.051	1.177	1.064	0.080
2007	805	0.549	0.045	1.028	0.982	0.072
2008	972	0.524	0.030	0.689	0.755	0.066
2009	1165	0.541	0.030	0.699	0.815	0.063
2010	739	0.599	0.027	0.625	0.679	0.084
2011	874	0.645	0.034	0.780	1.058	0.062
2012	1050	0.295	0.016	0.372	0.475	0.089
2013	778	0.440	0.019	0.445	0.585	0.079
2014	915	0.392	0.013	0.295	0.358	0.078
2015	884	0.421	0.024	0.540	0.570	0.080
2016	982	0.419	0.024	0.560	0.605	0.067
2017	921	0.360	0.030	0.698	0.612	0.077
2018	791	0.346	0.037	0.852	0.794	0.083
2019	794	0.474	0.044	1.018	1.148	0.069
2020	536	0.522	0.043	0.986	0.993	0.079
2021	653	0.545	0.049	1.120	0.991	0.073
2022	618	0.558	0.054	1.228	0.973	0.068
2023	611	0.591	0.049	1.133	1.042	0.067
2024	591	0.611	0.042	0.971	0.975	0.069

Table 3. Standardized index for Gray Triggerfish from the commercial handline fishery for the **west** Gulf (zones 13-20).

Year	N	Proportion Positive	Nominal CPUE	Relative nominal	Std. Index	CV
1993	186	0.462	0.022	1.300	1.366	0.161
1994	209	0.651	0.056	3.288	3.121	0.149
1995	245	0.800	0.055	3.267	2.942	0.124
1996	346	0.697	0.037	2.190	2.312	0.125
1997	740	0.680	0.030	1.754	1.870	0.092
1998	914	0.666	0.033	1.967	1.764	0.080
1999	1008	0.672	0.028	1.667	1.655	0.077
2000	775	0.631	0.027	1.596	1.490	0.107
2001	812	0.682	0.021	1.247	1.307	0.099
2002	912	0.705	0.031	1.806	1.781	0.094
2003	957	0.731	0.025	1.502	1.664	0.081
2004	905	0.712	0.024	1.416	1.665	0.090
2005	720	0.636	0.013	0.786	0.974	0.093
2006	696	0.662	0.014	0.835	0.939	0.085
2007	315	0.717	0.017	0.991	1.363	0.101
2008	210	0.733	0.015	0.909	1.213	0.130
2009	184	0.739	0.013	0.782	1.139	0.176
2010	163	0.626	0.009	0.555	0.624	0.146
2011	140	0.636	0.010	0.605	0.830	0.163
2012	202	0.366	0.006	0.341	0.322	0.277
2013	179	0.480	0.004	0.209	0.257	0.169
2014	154	0.370	0.003	0.157	0.155	0.196
2015	166	0.373	0.006	0.349	0.190	0.235
2016	184	0.342	0.006	0.333	0.154	0.248
2017	142	0.303	0.003	0.164	0.110	0.208
2018	143	0.259	0.003	0.204	0.137	0.336
2019	144	0.174	0.003	0.189	0.068	0.315
2020	94	0.234	0.017	1.026	0.218	0.467
2021	113	0.204	0.002	0.113	0.067	0.340
2022	99	0.273	0.003	0.182	0.130	0.306
2023	119	0.336	0.004	0.211	0.116	0.251
2024	114	0.307	0.001	0.060	0.057	0.237

Table 4. Standardized index for Gray Triggerfish from the commercial handline fishery for the complete Gulf of America (zones 5-20).

Year	N	Proportion Positive	Nominal CPUE	Relative nominal	Std. Index	CV
1993	614	0.448	0.041	1.147	1.347	0.117
1994	772	0.556	0.064	1.800	2.028	0.087
1995	704	0.659	0.060	1.667	1.738	0.081
1996	1026	0.574	0.045	1.249	1.299	0.082
1997	1487	0.591	0.038	1.066	1.225	0.070
1998	1499	0.608	0.040	1.110	1.262	0.063
1999	1879	0.623	0.037	1.030	1.221	0.057
2000	1422	0.596	0.031	0.867	1.084	0.082
2001	1498	0.607	0.030	0.825	1.099	0.072
2002	1856	0.626	0.048	1.340	1.583	0.063
2003	1982	0.696	0.057	1.590	1.838	0.051
2004	1782	0.657	0.047	1.308	1.568	0.060
2005	1592	0.595	0.041	1.146	1.166	0.062
2006	1476	0.597	0.034	0.943	0.931	0.058
2007	1120	0.596	0.037	1.031	1.138	0.060
2008	1182	0.561	0.027	0.767	0.855	0.063
2009	1349	0.568	0.028	0.786	0.835	0.059
2010	902	0.604	0.024	0.671	0.656	0.077
2011	1014	0.644	0.031	0.858	0.979	0.059
2012	1252	0.307	0.015	0.406	0.406	0.087
2013	957	0.447	0.016	0.459	0.498	0.074
2014	1069	0.389	0.011	0.318	0.305	0.073
2015	1050	0.413	0.021	0.579	0.473	0.073
2016	1166	0.407	0.021	0.599	0.491	0.064
2017	1063	0.353	0.027	0.747	0.491	0.076
2018	934	0.333	0.032	0.893	0.612	0.075
2019	938	0.428	0.038	1.063	0.870	0.068
2020	630	0.479	0.039	1.094	0.833	0.077
2021	766	0.495	0.042	1.171	0.804	0.069
2022	717	0.519	0.047	1.301	0.789	0.071
2023	730	0.549	0.042	1.171	0.817	0.062
2024	705	0.562	0.036	0.996	0.759	0.072

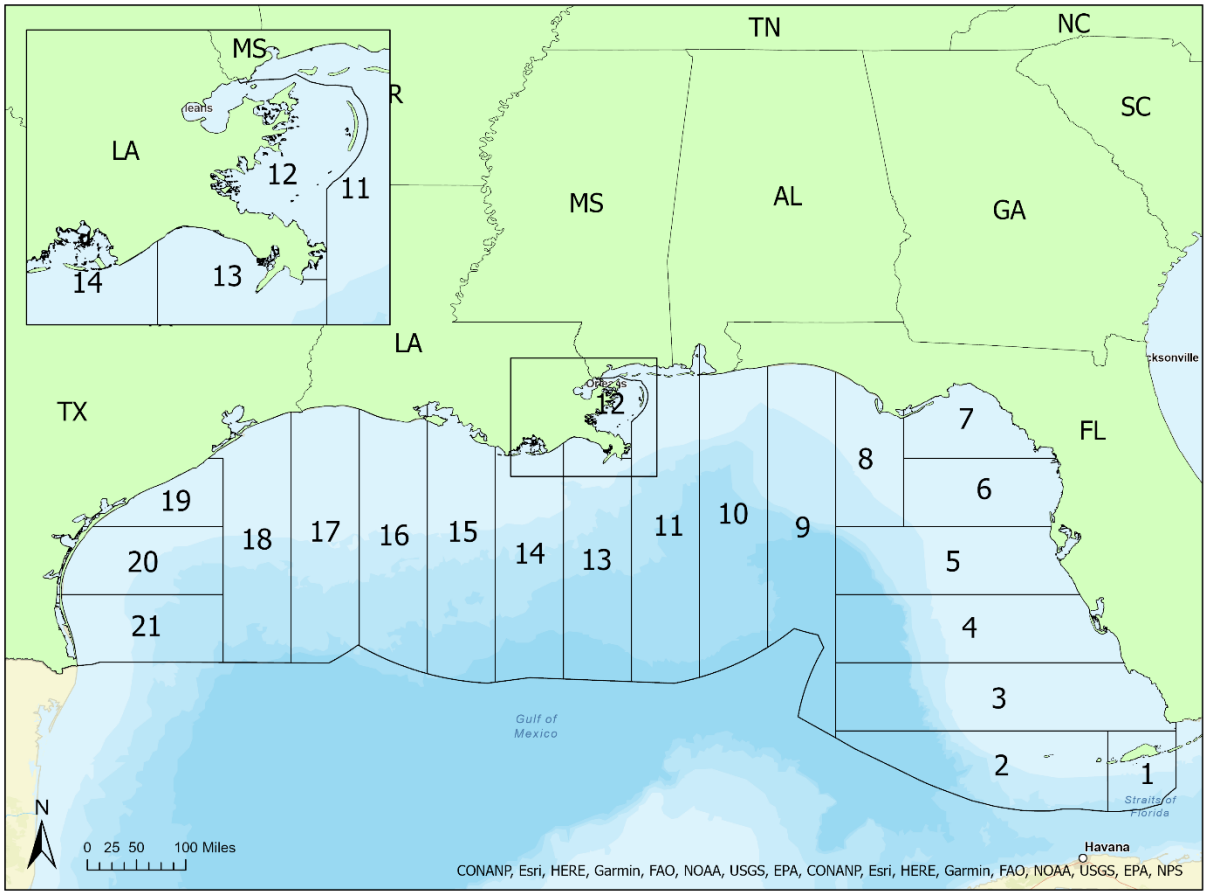

Figure 1. Map of Gulf of America SEAMAP fishing zones.

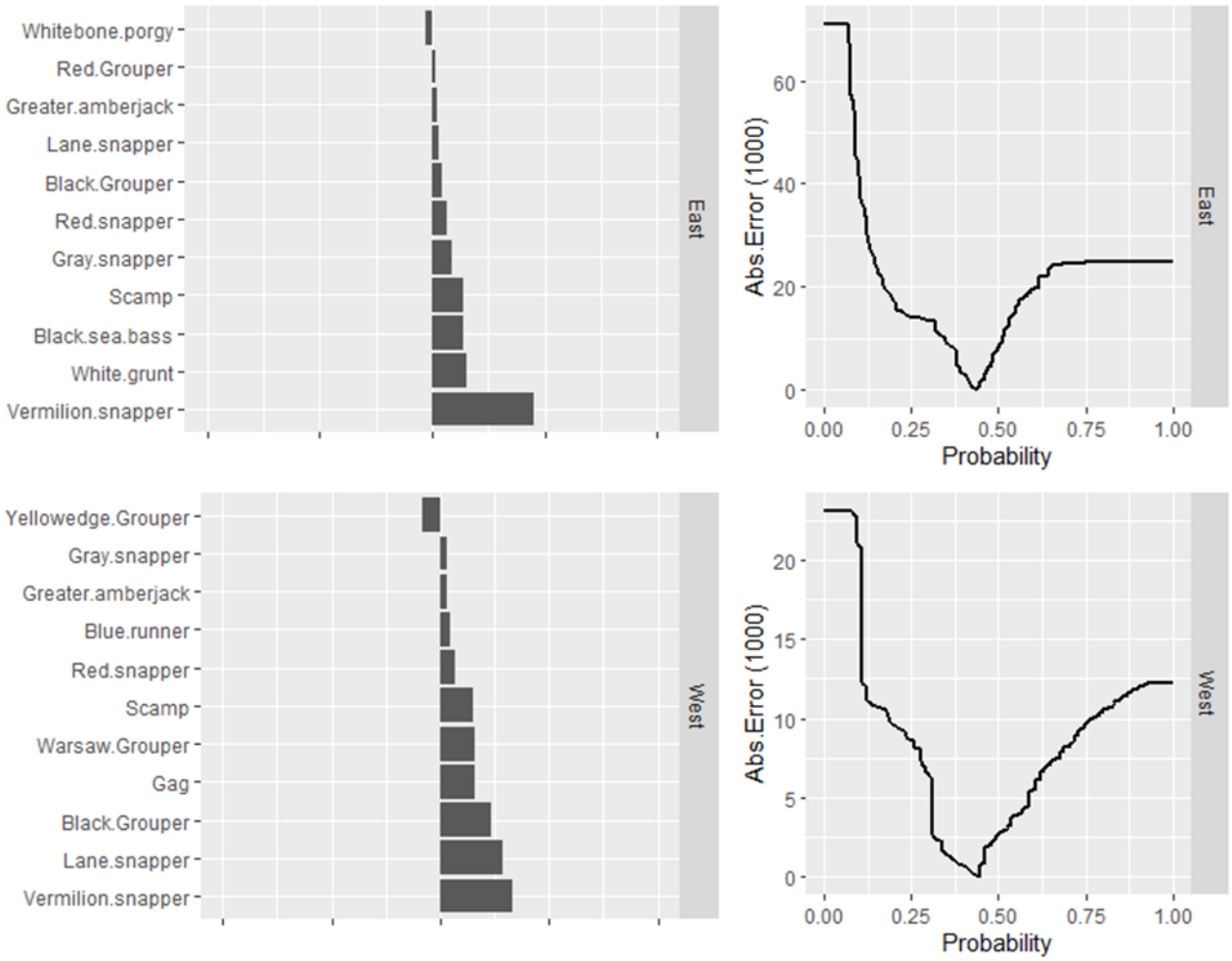

Figure 2. Estimates of species-specific regression coefficients used for east and west Gulf to predict each trip's probability of catching the focal species (left panels). The absolute difference between observed and predicted number of positive trips across a range of probability cutoff values (right panels).

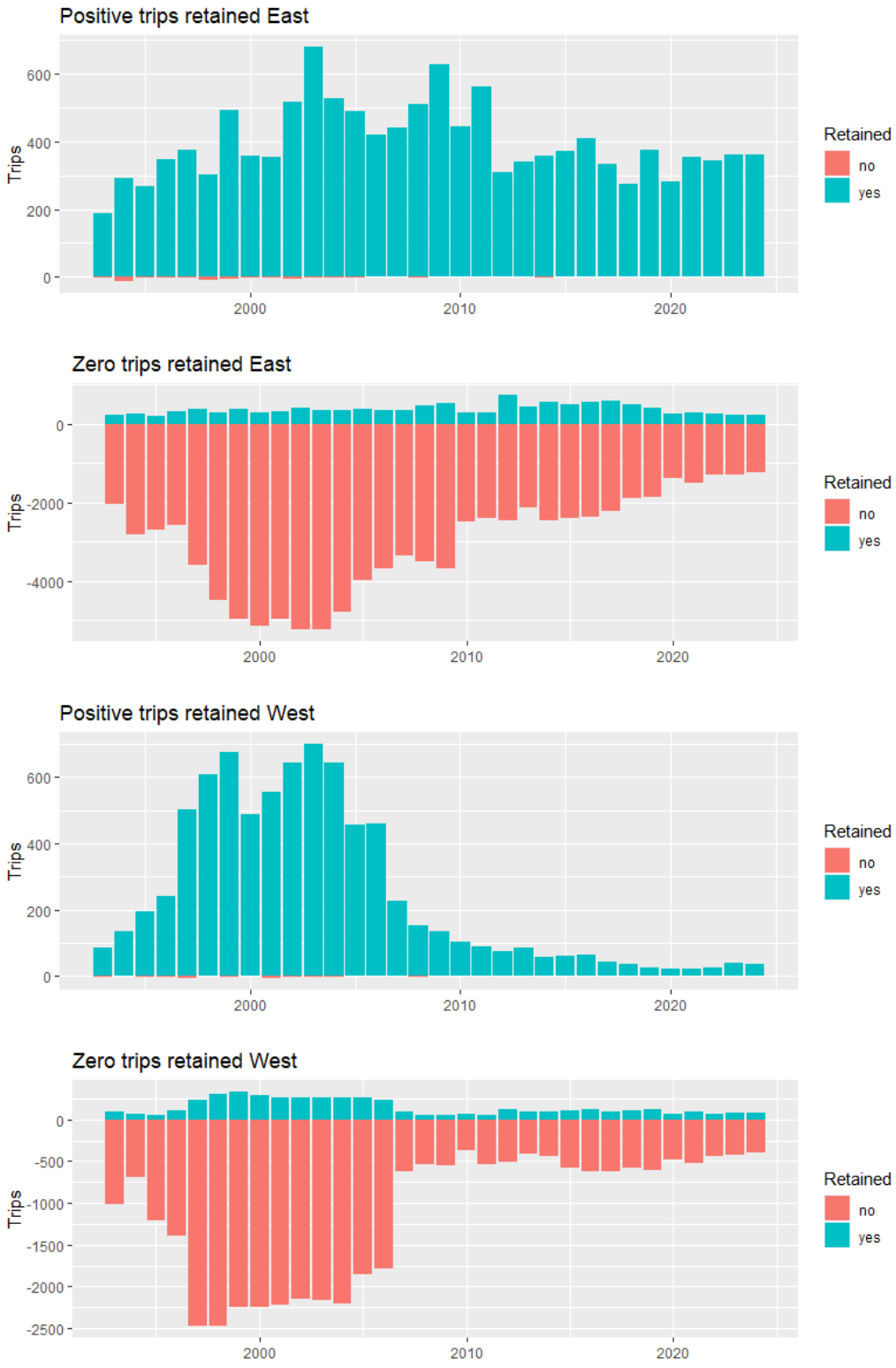

Figure 3. Commercial handline positive and zero trips retained after subsetting using the Stephens and MacCall approach by year for Gray Triggerfish.

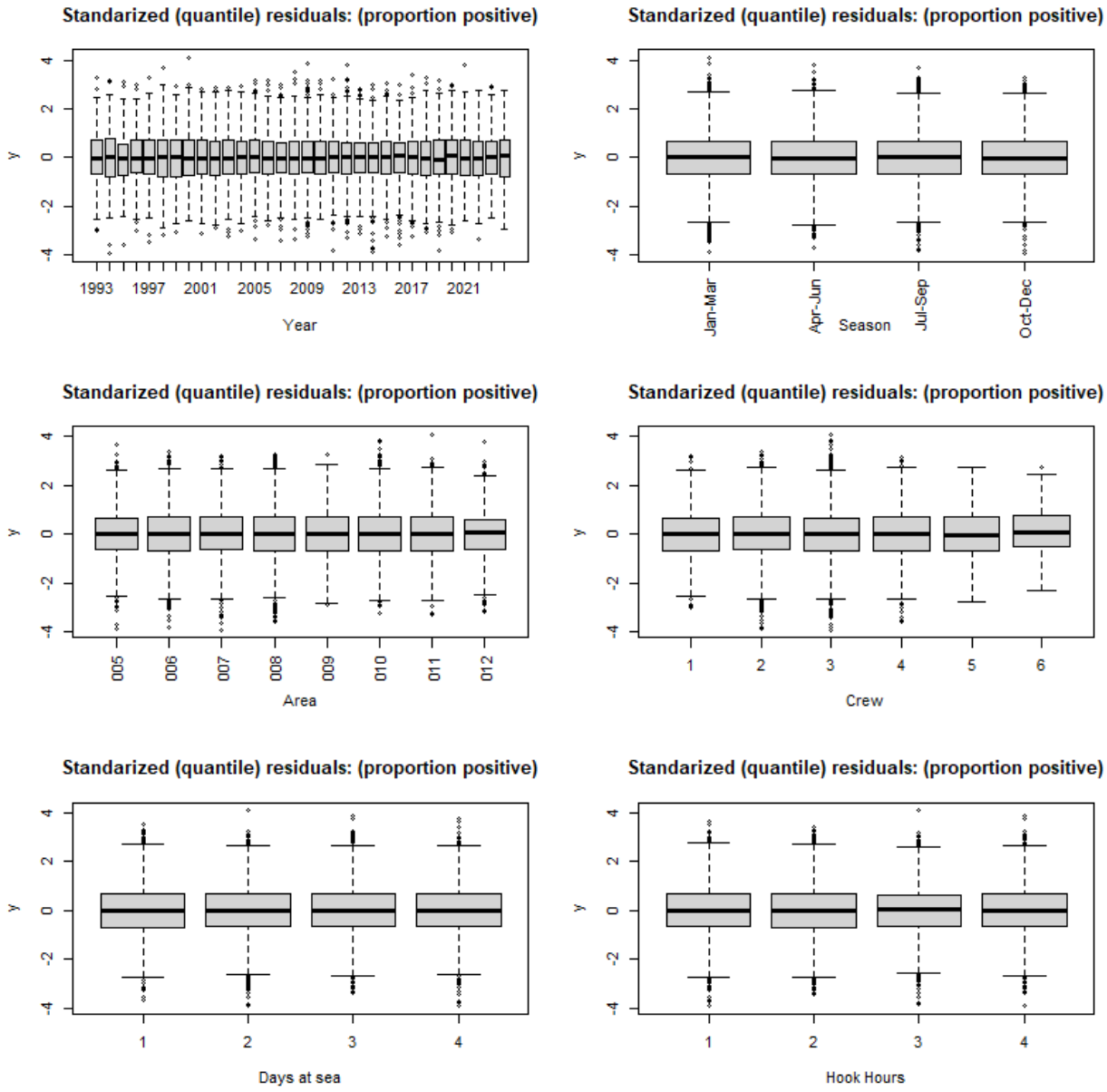

Figure 4 Handline index diagnostics of gamma submodel fits to binomial data for the **east** region. Top left panel shows the distribution of positive cpue. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

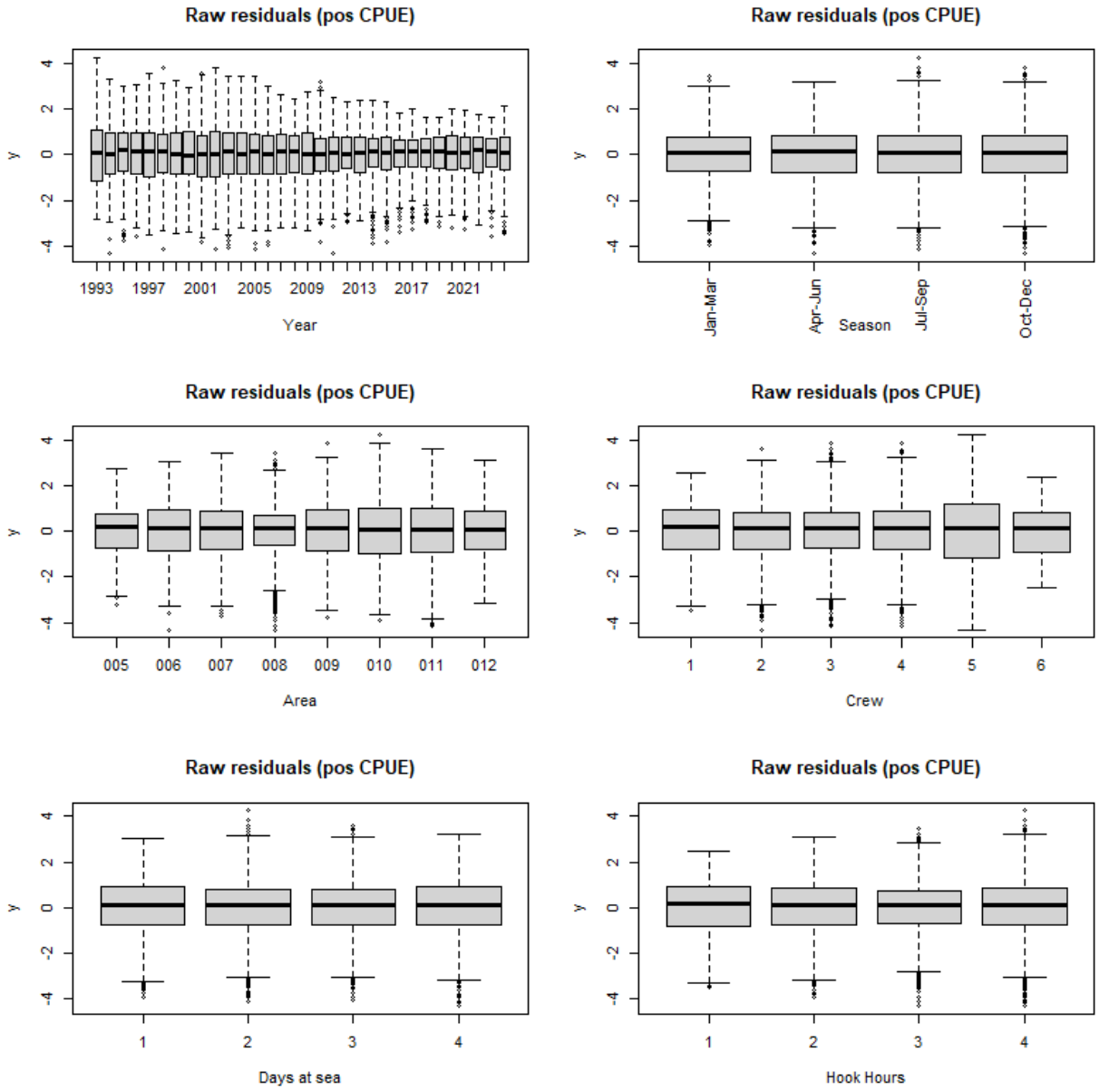

Figure 5. Handline index diagnostics of gamma submodel fits to positive catch (CPUE) for the **east** region. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

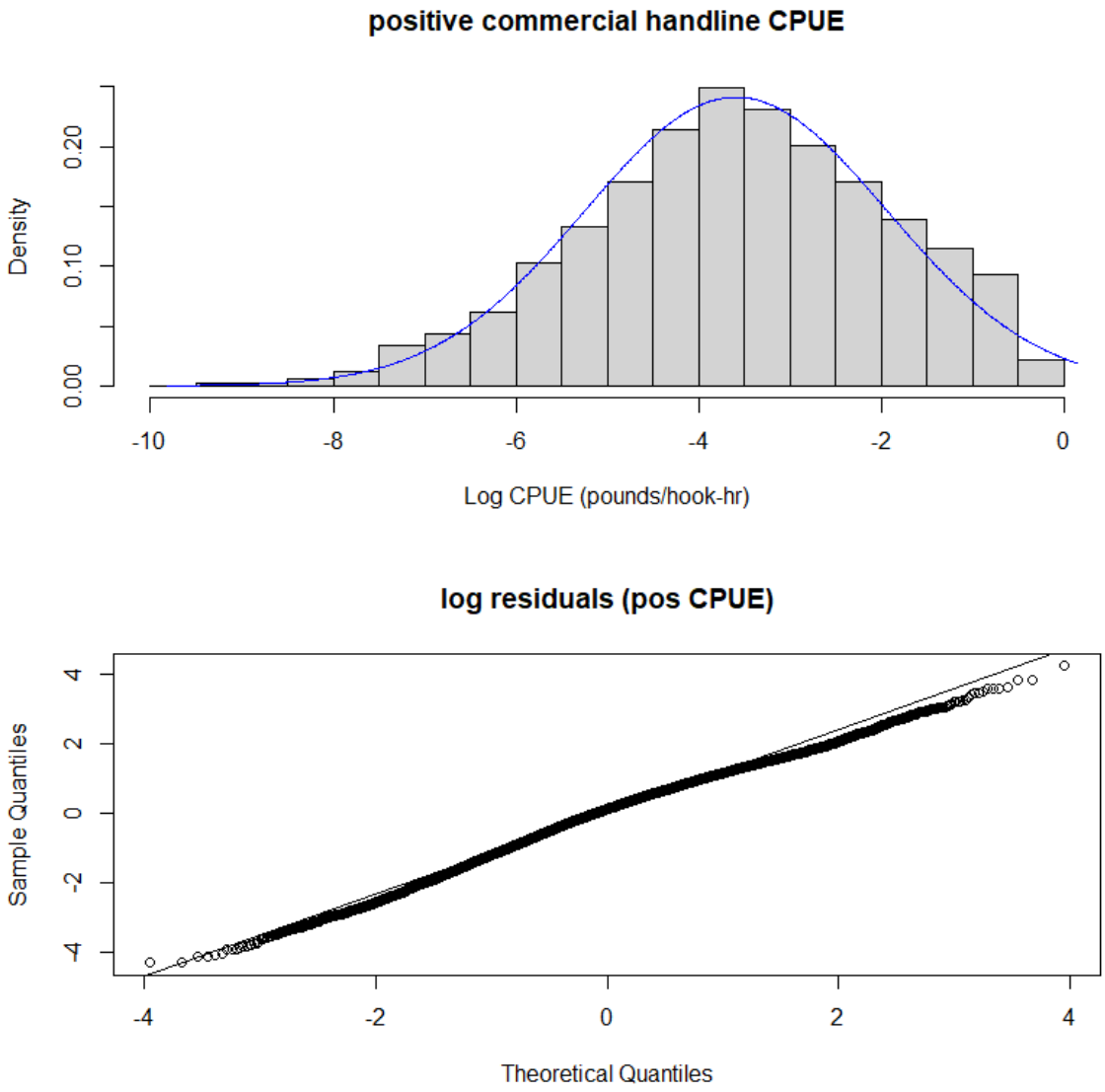

Figure 6. Histogram of empirical CPUE for the **east** Gulf, with the gamma distribution overlaid. Quantile-quantile plot of residuals from the fitted gamma submodel to the positive cpue catch.

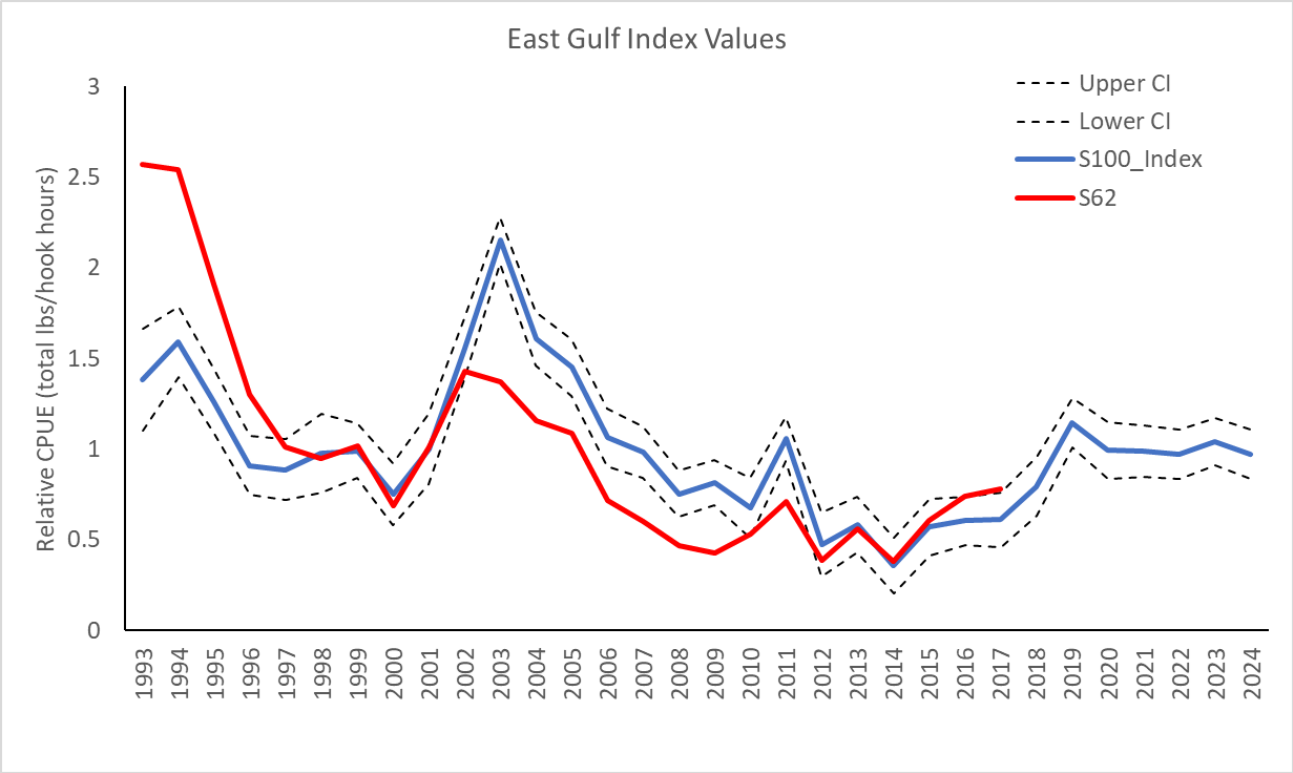

Figure 7. Standardized index trends for the **east** region through 2024 and associated 95% confidence intervals. SEDAR 62 index values are shown for comparison.

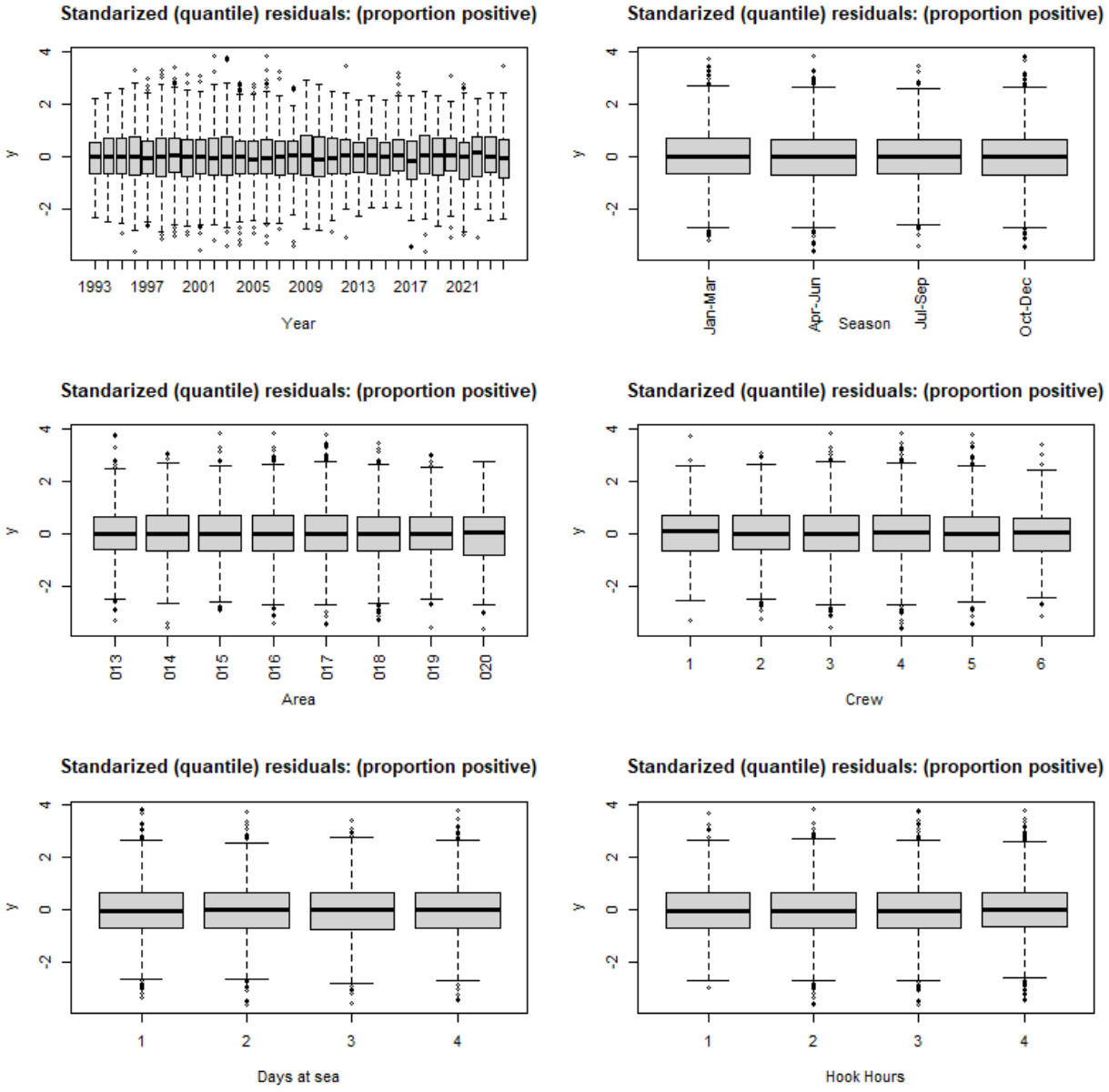

Figure 8. Handline index diagnostics of gamma submodel fits to binomial data for the **west** region. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

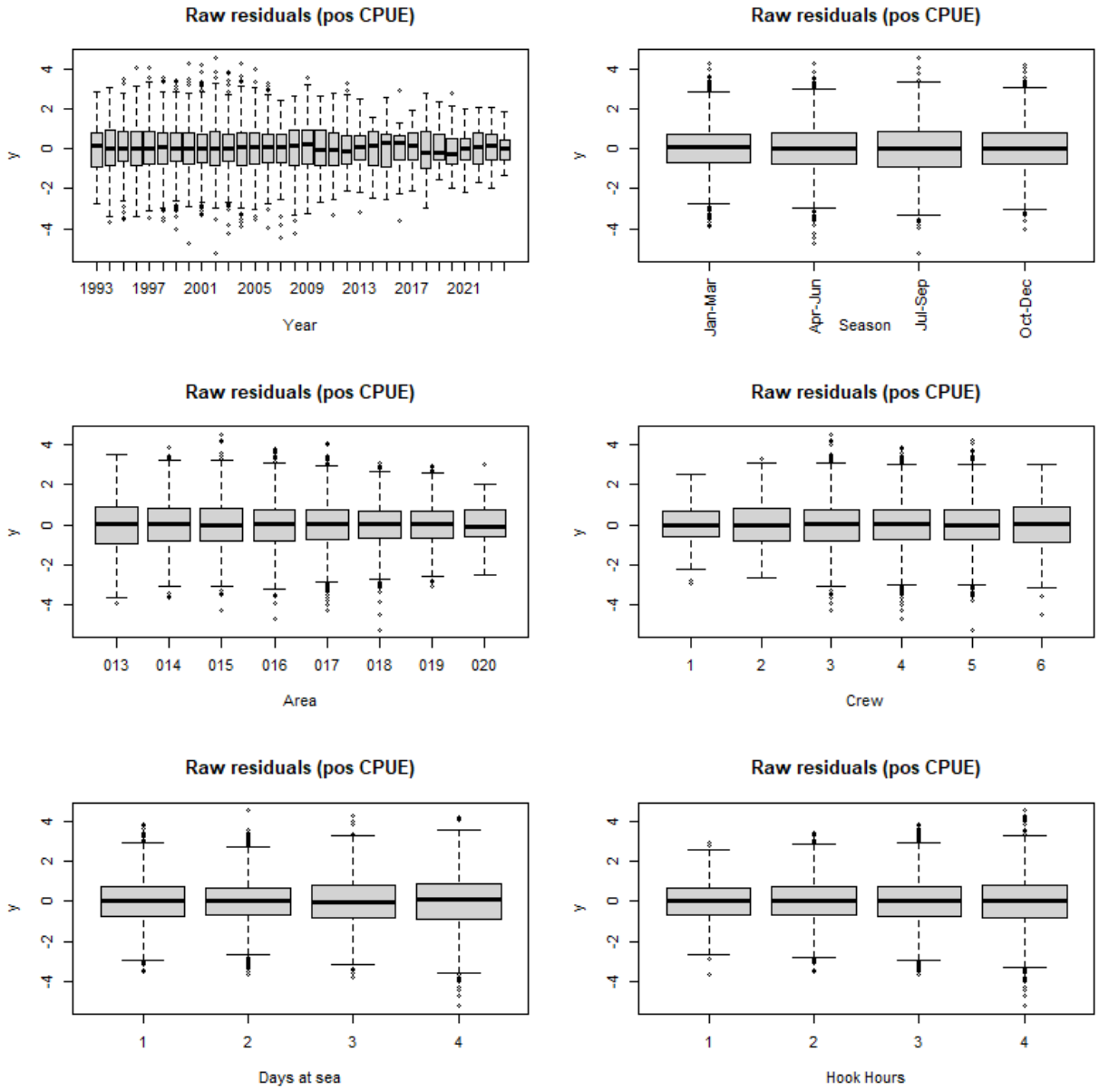

Figure 9. Handline index diagnostics of gamma submodel fits to positive catch (CPUE) for the **west** region. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

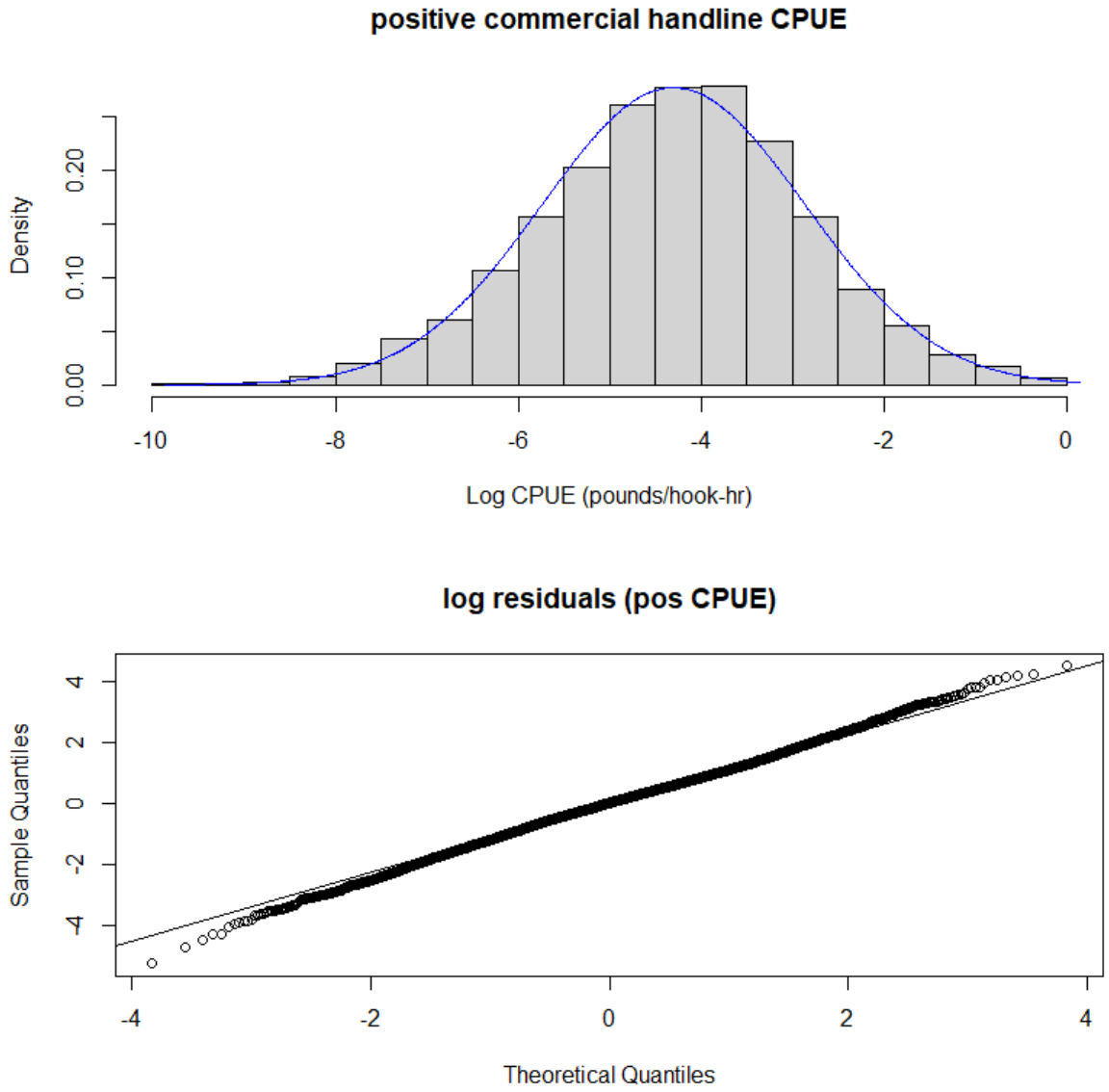

Figure 10. Histogram of empirical CPUE for the **west** Gulf, with the gamma distribution overlaid. Quantile-quantile plot of residuals from the fitted gamma submodel to the positive cpue catch.

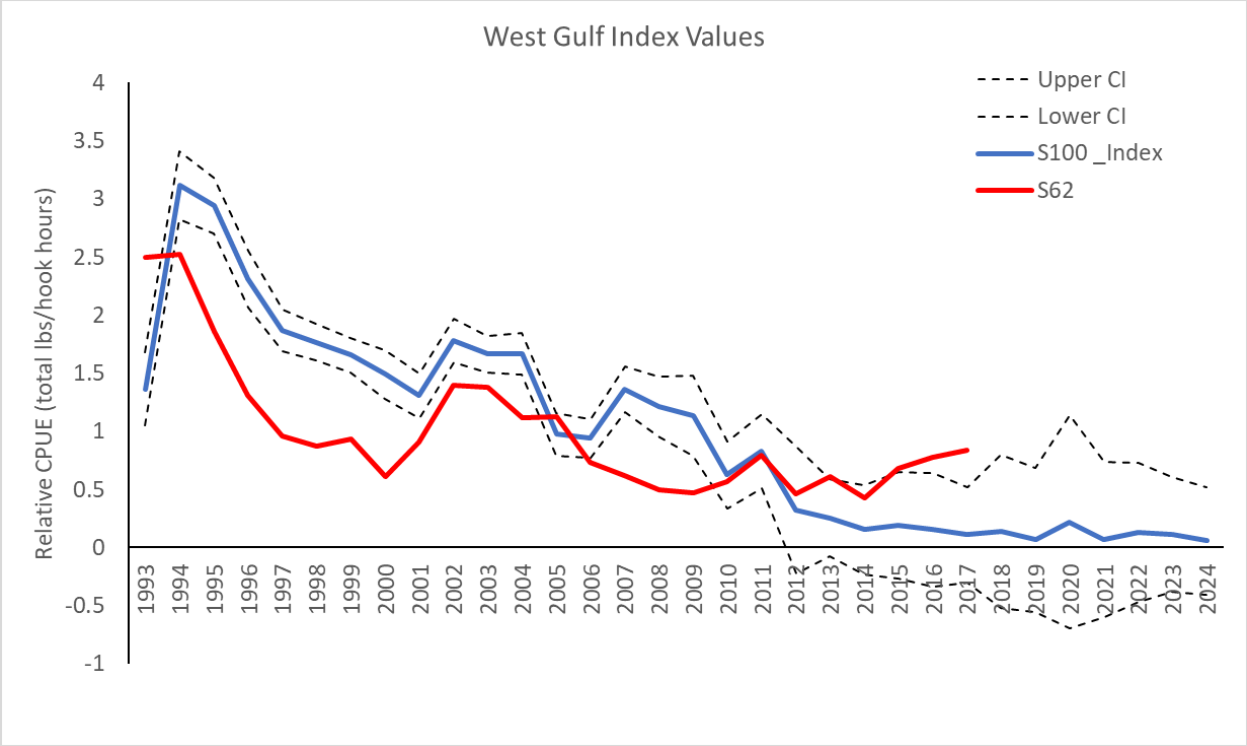

Figure 11. Standardized index trends for the **west** region through 2024 and associated 95% confidence intervals. SEDAR 62 index values are shown for comparison.

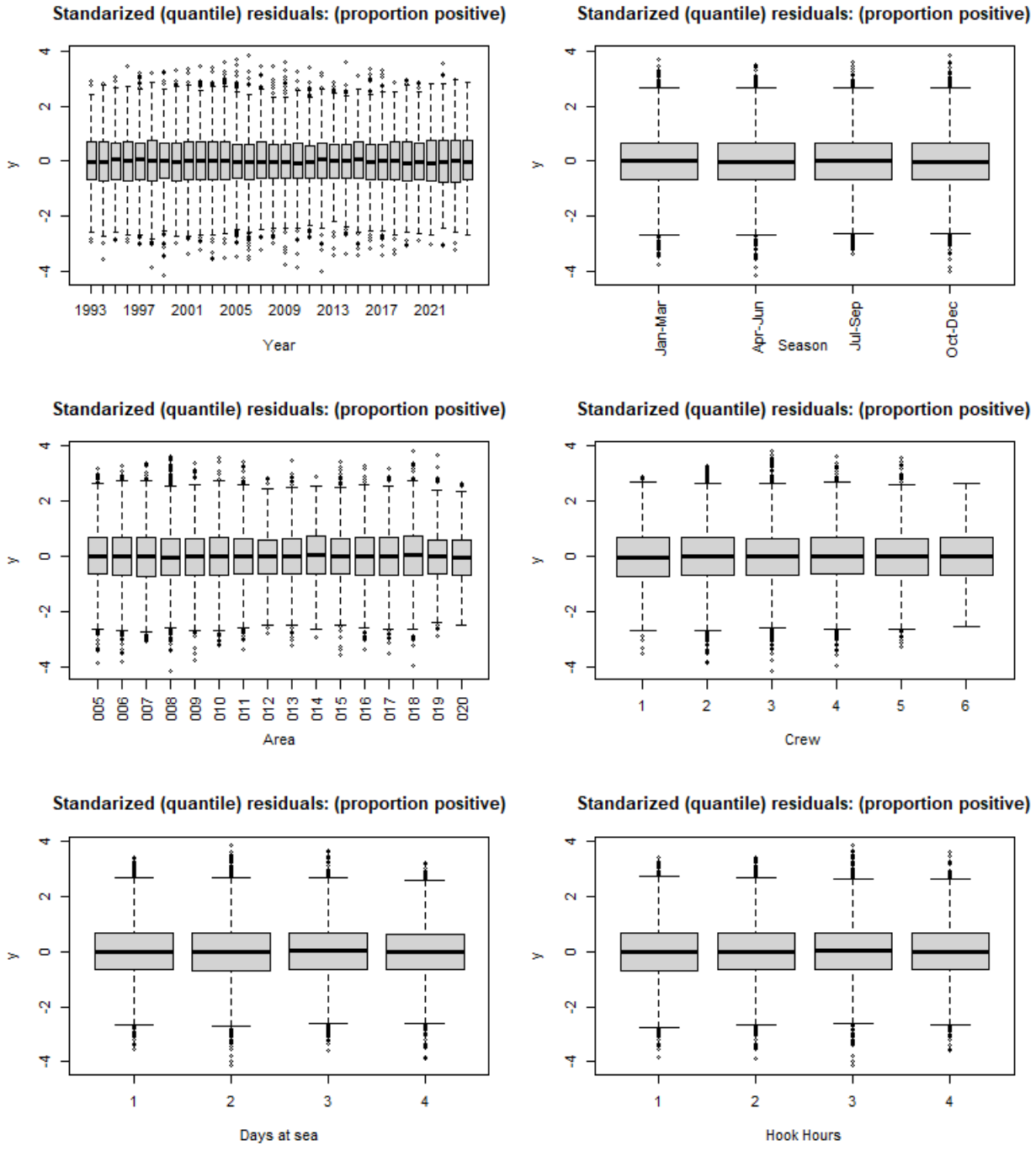

Figure 12. Handline index diagnostics of gamma submodel fits to binomial data Gulf-wide. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

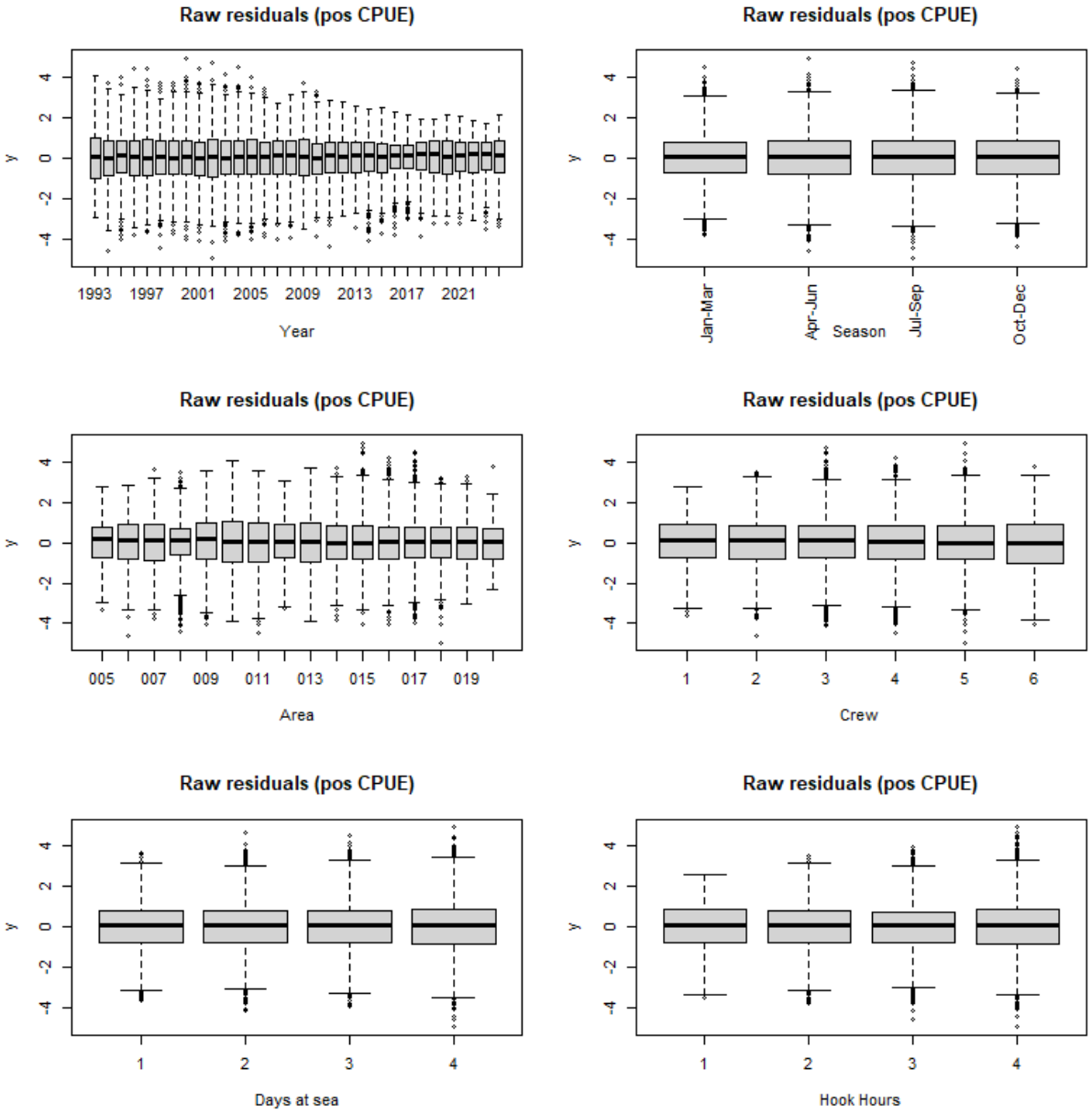

Figure 13. Handline index diagnostics of gamma submodel fits to positive catch (CPUE) Gulf-wide.. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

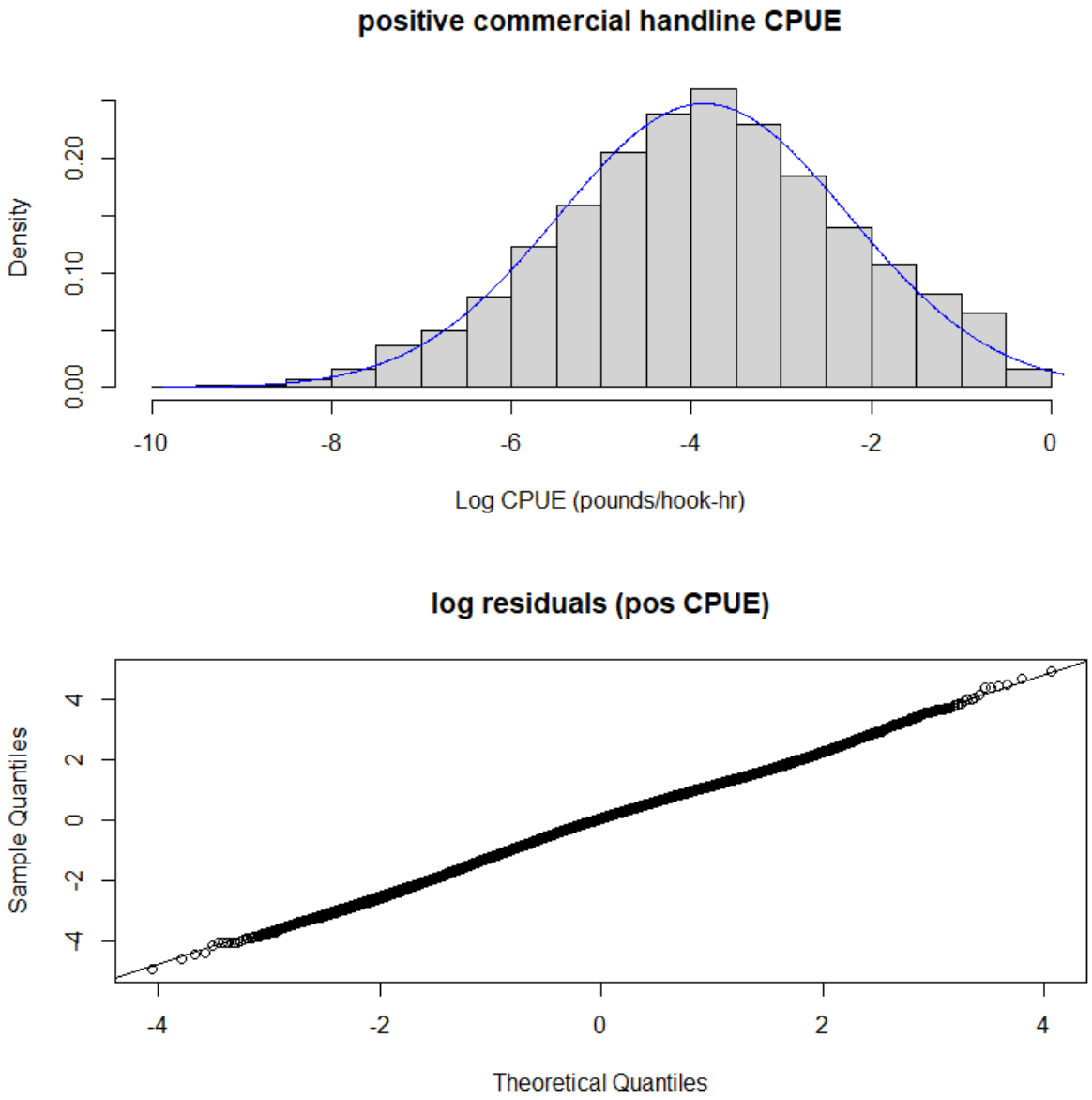

Figure 14. Histogram of empirical CPUE for the Gulf of America, with the gamma distribution overlaid. Quantile-quantile plot of residuals from the fitted gamma submodel to the positive cpue catch.

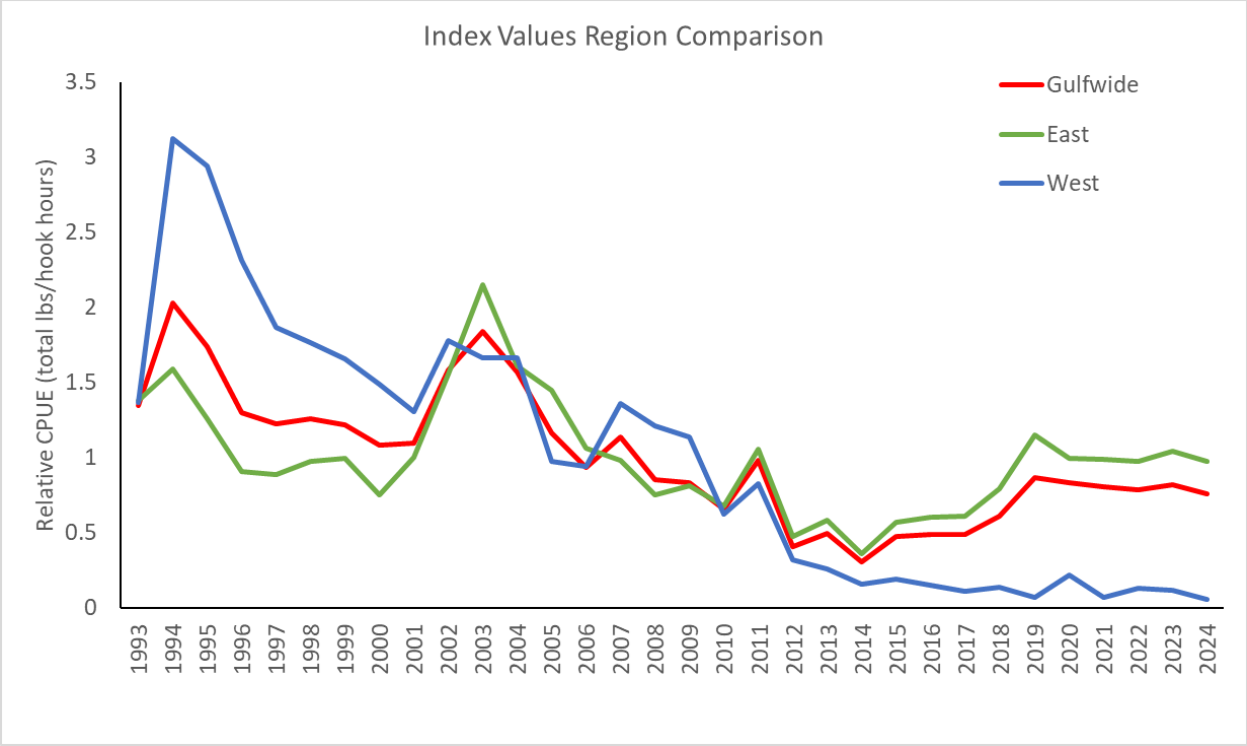

Figure 15. Standardized index trends for the Gulfwide index region through 2024 with the regional index values shown for comparison.