STANDARDIZED CATCH RATES OF KING MACKEREL FROM FLORIDA COMMERCIAL TRIP TICKET DATA GULF AND SOUTH ATLANTIC 1986-2006

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SUMMARY

This paper presents three 'Continuity case' indices constructed of king mackerel abundance constructed from Florida trip ticket data and three 'New' indices constructed from the same data but with three fixed zones: Atlantic, Mixing and Gulf. Continuity case standardized catch per unit effort indices were constructed for three regions: Florida Panhandle, Southwest Florida and South Atlantic Florida. These indices use the same data subsetting criteria and SAS GLM as the Florida trip ticket indices used in the 2004 king mackerel stock assessment (Bob Muller, FWRI, pers. comm.) and represents continuity case indices with updated information through 2007. They also potentially could be used as indices for a three region (Gulf, mixing and Atlantic) assessment model, though the South Atlantic index overlaps the mixing zone. The major subsetting criteria involve using only positive trips for king mackerel, only hook and line, handline or bandit gear and limiting the spatial and temporal extent of the samples as follows: Panhandle index, only Okaloosa and Bay counties in July through October; Southwest Florida, only Collier and Monroe counties in November and December with an exclusion threshold of 3,000 lbs per trip; South Atlantic, all counties from Monroe north, excluding St. Johns and Nassau counties from April through October. These criteria were determined by the 1996 MSAP to most accurately account for the influence of trip limits and seasonal closures. The 'new' indices also use only positive trips but include more extensive spatial extent and use a fraction of king mackerel to the total to subset trips (>50% king mackerel).

KEY WORDS

Catch/effort, abundance, trip ticket, king mackerel

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1. INTRODUCTION

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This paper presents six indices of king mackerel abundance derived from Florida commercial trip tickets. Since 1984, fish dealers in Florida have been required to fill out a marine fisheries trip ticket documenting catch and effort for each commercial fishing trip that they handle or purchase from fisherman. Data from 1986 onwards is used in these indices. The first three indices represent "continuity" case indices obtained with the same methods used for the 2003 king mackerel stock assessment. The next three represent indices obtained using the new definition of three zones (Atlantic, Mixing and Gulf) with seasonal estimates. These "new" indices differ from the continuity case indices in that year is treated as a random, rather than a fixed effect and a new variable, king mackerel fraction (fraction of king mackerel to total catch per trip) is used to restrict the dataset to trips that have a fraction greater than 50%.

2. MATERIALS AND METHODS

2.1 Data inputs Florida trip tickets

Since 1984 the state of Florida has required that dealers report catch and effort data from each commercial fishing trip they purchase on a trip ticket. These tickets include information about the fishermen, the dealer, the time, gear, area, county, amount and size of fish landed by species. At a certain date the completed tickets are sent to the Florida Fish and Wildlife Conservation Commission. Continuous time series of trip ticket data exist from 1986 to the present for the State of Florida. Trip ticket data also exists for Alabama and Louisiana though it only dates from recent years and is not used in this analysis. Documentation for FL trip tickets is available from FWRI http://www.floridamarine.org/features/view_article.asp?id=23423.

2.2 "Continuity cases"

Three indices, two for the Gulf of Mexico and one for the Atlantic migratory group were constructed using similar methodology and the same SAS GLM code as the previous assessment (Ortiz, 2003, Bob Muller[2], *pers comm*)**.** The first index (**Panhandle**) comes from the Florida Panhandle (Escambia and Bay counties in the months of July through October) and was applied to ages 3 through 6. The second index **(Southern Gulf)** included trips with 3500 pounds or less from Southwest Florida (Collier and Monroe counties) during November and December only and was applied to ages 3 through 8. The third index uses data from the Florida Atlantic coast counties from Nassau to Monroe from April to October (Nassau through Monroe counties) when catches were believed to be relatively unrestricted by catch limits.

These indices used only positive king mackerel trips the log (pounds) of king mackerel per day assuming that every record is a 12 hour day is the time fished was recorded in days or as a fraction of a 12 hour day if time fished was recorded in hours. Only single day trips and hook and line or unknown gear types were used. Months and counties included in the indices (Figure 1) follow the recommendations of the 1996 1997 MSAP (Mackerel Stock Assessment Panel) and are designed to be most representative of the migratory components of the stock and to reflect times and locations less influenced by catch restrictions and time/area closures.

Descriptions of the data inputs, factors and model are given in Table 1. As in the 2003 index, unknown gear types are included which extends the time series back to 1986 as gear was not recorded prior to 1991. This allows the inclusion of some very high run-around gill net catches, however, removing the studentized residuals presumably reduces the influence of these high gill net catches. If it is desired to use only data with specified hook and line gear then the data series would only start at 1991.

2.3 "New" trip ticket indices

Three indices, one for each zone (Atlantic, Mixing and Gulf of Mexico) were constructed. For the SS2 model formulation the three zones are the Atlantic (Atlantic waters north of Volusia county, FL), Mixing zone (Florida counties from and including Volusia to the Collier-Monroe border, excluding Collier) and the Gulf non-mixing zone (All Gulf of Mexico counties to the Collier-Monroe border, including Collier). For

[2] Bob Muller, FWRI, 2008.

this index only data from Florida Trip tickets was used (Figure 2). Descriptions of the data inputs, factors and model are given in Table 2. Indices were constructed seasonally for four seasons: winter (Jan, Feb, Mar,) spring (Apr, May, June) summer (July, Aug, Sept, Oct), fall (Nov, Dec).

Only successful king mackerel trips were used and the dependent variable was the log(lbs) king mackerel per day, assuming a 12 hour day. CPUE could also be computed hourly, however time fished is often recorded in the trip ticket data base as a 'day' and 12 hours was used as a day as it represents the mode of the 'hours fished' when it is recorded. Only hook and line, troll, hand line, bandit gear and unknown gear types were included. As for the continuity indices, this leaves some very high gillnet catches in early years which were likely excluded by excluding all trips landing >3000lbs of king mackerel.

All three indices were estimated using SAS proc mixed (Littell et al 1996) using year and year*seasons as random effects. A forward stepwise regression procedure was used to determine the set of fixed factors and interaction terms that explained a significant portion of the observed variability. Fixed factors and interaction terms were selected for final analysis if: 1) the percent reduction in\ scaled deviance per degree of freedom explained by adding the factor exceeded one percent and 2) the χ^2 test was significant. If an interaction effect was significant than both main effects were also included in the model.

To model YEAR*FACTOR interactions these terms were entered in the mixed model as random effects. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 loglikelihood statistics between successive model formulations (Littell et al. 1996). Models were fit with SAS procedure PROC MIXED (SAS Institute Inc. 1997). Least square means for each year were obtained as year-specific indices. To estimate seasonal means, the least-square means for year*season interaction were obtained output. In cases of significant year*season random effects, these terms were dropped from the model to estimate year*season least squares and a year*season fixed effect was added.

As commercial king mackerel fishing is fairly species-specific we attempted to isolate 'king mackerel'-specific trips from general bottom or other fishing trips by using a fraction of king mackerel landed to the total fish landed. We explored a cut-off where king mackerel represented between 10-90% of the total catch and settled up a value of 50%. We compared the results of excluding data under a certain cut-off by plotting the successive pair-wise correlations between indices constructed using successive percent cut-offs. We found that changing the fraction of king mackerel did not change the indices greatly beyond a cut-off of 20% (Figure 9).

We are currently working on a delta-lognormal index which incorporates the potential for unsuccessful catches of king mackerel, i.e., trips which landed a fish that is commonly caught with king mackerel but did not land any kings. Given the nature of the fishery and the biased nature of trip tickets (a trip ticket would not exist for a trip with no landings of any species) it is unknown whether this approach will yield more appropriate results. However, the logbook CPUE index derived from presumably the same data as the trip ticket index has been constructed using a delta-lognormal approach (McCarthy 2008).

3. RESULTS AND DISCUSSION

3.1 "Continuity cases"

Type III fixed effects tables and likelihood ratio tests of the fixed factors for the continuity case indices are shown in Tables 2-4. Diagnostic plots of the log(CPUE), residuals over time, histograms of residuals and qqplots of residuals do not indicate severe departures from normality (Figure 3-5).The final model chosen for all continuity case indices was:

Log(CPUE) ~ year month county

Nominal catch rates, predicted and standardized indices and confidence intervals for the continuity case indices are shown in tables 5-7 and standardized indices are plotted against the index values from the 2003

assessment in figure 6, indicating that the indices were basically the same as in 2003 but updated in with current data.

Regarding the adequacy and applicability of the continuity case indices, the issues regarding applicability remain the same as those discussed in the previous stock assessment report (SEDAR 5). Primarily questions revolve around the applicability of the indices give the effects of trip limits, with a second issue being the inclusion of potential gillnet catches by allowing unknown gear types in earlier years. Recommendations regarding the age classes to apply each index are detailed in Table 1.

3.1 "New indices"

Table 8 describes the data inputs, factors and model for each index. The major differences between these indices and the continuity cases are the spatial extent and the methods of restricting the data. We attempted to obtain 'king-mackerel' trips by removing a fraction of trips that had less then 50% king mackerel to the total. The distribution of fraction of king mackerel to the total is highly bimodal (Figure 7) suggestive that there are two primary types of hook and line trips; those that target king mackerel primarily and those that likely target other species and catch a small fraction of king mackerel. We explored various fractions to exclude by examining the pairwise correlation between successive GLM season*area predictions using an increasing percentage cutoff. We did not have time to run this analysis on the current mixed model formulation however it could be possible. Figure 8 shows the pairwise correlation between successive models with an increasing fraction of king mackerel. For the Atlantic and Mixing zone, the indices are relatively unchanged if we allow a fraction of king mackerel to the total down to 20%. Requiring from 20-90% king mackerel has very little effect upon the indices, with the exception the Gulf index (Figure 9c) for which the lack of correlation is due to the inclusion of a single outlier datapoint in winter of 1986. Removing this datapoint increases the correlation to 97.9%. Essentially for any cutoff above 20% the indices use essentially the same data, but allowing very low fractions of king mackerel dramatically alter the index. As for which is correct, that should be a decision of the working group whether to allow trips with a very small fraction of king mackerel. For now we have arbitrarily chosen a value of 50%.

We also imposed a cap of 3000lbs per day on all of the datasets. The rationale behind this is to try to exclude high gillnet catches during the period where gear type was not recorded (1986-1991). Figure 9 shows the time series of all hook and line or unknown catches showing some 'outlier' unknown catches that likely are from gillnets prior to 1991, particularly the catches above 3000 lbs in the mixing zone prior to 1991. While this cutoff is rather arbitrary, the continuity case indices also use a similarly arbitrary cutoff of +/- 3 studentized residuals and 3500 lbs in the Southern Gulf region, both of which serve likely serve to trip off outliers and reduce the influence of the unclassified high catches early in the time series.

Deviance table analyses and likelihood ratio tests of fixed and fixed effect interactions are shown in tables 9 and 10. Year*Random effect were chosen on the basis of a significant reduction in the –2 loglikelihood statistics (Table 11). The final models chosen are as follows where random effects are in italics:

Atlantic new: **LCPUE2 = year** ***year*season year*county***
Mixing Zone: **LCPUE2 = year season county season*county** ***year*season year*county***
Gulf new: **LCPUE2 = year season county** ***year*season year*county***

Diagnostic plots of the log(CPUE), residuals over time, histograms of residuals and qqplots of residuals do not indicate severe departures from normality except at the extreme tails of the distributions (Figure 10-12).

Nominal catch rates, predicted and standardized indices and confidence intervals for the continuity case indices are shown in for annual means in tables 13-15 and for year season means in tables 16-18. Standardized indices are plotted with confidence intervals (Figure 13) and with seasonal means in Figure 14.

With regards to the applicability of the catch rates the effect of management regulations remains one of the greatest unknowns in this study and for all commercial indices. In the last assessment (SEDAR 5) a panel was supposed to have documented dates and times when quotas were adjusted, however an updated list has

either not been created or made available to SEDAR participants at the time of this writing. As mentioned previously we are continuing to work on a trip ticket index that uses a species targeting strategy to subset trips.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

McCARTHY. K. 2008. Standardized catch rates of king (*Scomberomorus cavalla*) from vessel logbooks. SEDAR-16-DW-XX.

LITTELL, R.C., G.A. Milliken, W.W. Stroup, and R.D Wolfinger. 1996. SAS® System for Mixed Models, Cary NC, USA:SAS Institute Inc., 1996. 663 pp.

ORTIZ, M. 2003. Standardized catch rates of king (*Scomberomorus cavalla*) and Spanish mackerel (*S. maculatus)* from U.S. Gulf of Mexico and South Atlantic recreational fisheries. National Marine Fisheries Service, Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution SFD-02/03-006.

SAS Institute Inc. 1997, SAS/STAT® Software: Changes and Enhancements through Release 6.12. Cary, NC, USA: SAS Institute Inc., 1997. 1167 pp.

SEDAR 2003. Complete Stock Assessment Report of SEDAR 5 Atlantic and Gulf of Mexico King Mackerel SEDAR5-AR-1.

Table 1. Description of data inputs for "Continuity" case trip ticket indices

Continuity case index
Data: Florida trip ticket
Coverage: all Florida seafood dealers, from 1986-2007
Sampling intensity: census
Factors: year county month
Gears: hook and line and unknown with the +/-3sd studentized residuals removed (this removes much of the unknown, early years gill net effort)
Method: SAS PROC GLM
Dependent variable: log(catch pounds of km/day) for positive trip tickets
- day is defined as one 12 hour day or fraction of a day if time fished is less than 12 hours, only single day trips used
Year is calender year NOT fishing year but it is the same for this index
Gears: hook and line and unknown
Filtering:
1. +/-3sd studentized residuals removed (this removes much of the unknown, early years gill net effort)
2. Only 1 day or less trips used

Continuity case 1: Southern Atlantic
Model: lg(CPUE) ~ year county month
Area: East coast of Florida from Monroe to Duval county
Brevard, Broward, Dade, Duval, Flagler, Indian River, Martin, Monroe, Palm Beach, St Lucie, Volusia
Time frame: April to October (spring to summer)
Applied to ages: 2-11

Continuity case 2: Southern Gulf of Mexico
Model: lg(CPUE) ~ year county month
Area: Collier and Monroe counties
Time frame: November and December
Year is calender year NOT fishing year but it is the same for this index
Gears: hook and line and unknown
Filtering: anything >3500lbs removed.
Applied to ages: 3-8

Continuity case 3: Florida panhandle
Model: lg(CPUE) ~ year county month
Area: panhandle, bay and escambia counties
Time frame: July-October (summer)
Year is calender year NOT fishing year but it is the same for this index
Applied to ages: 3-6

Table 2. A) Type III test of fixed effects and B) Likelihood ratio test for the fixed factors and interactions terms for the ***Continuity Case – Atlantic***.

a) Type III test of fixed effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	21	3934.46495	187.35547	155.25	<.0001
MONTH	6	10438.10639	1739.68440	1441.57	<.0001
COUNTY	10	17329.63106	1732.96311	1436.00	<.0001

b) LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year	21	3095.87	<.0001
MONTH	6	8000.39	<.0001
COUNTY	10	12720.6	<.0001

Table 3. A) Type III test of fixed effects and B) Likelihood ratio test for the fixed factors and interactions terms for the ***Continuity Case – Southern Gulf***.

a) Type III test of fixed effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	20	1261.113990	63.055699	39.67	<.0001
MONTH	1	1198.427361	1198.427361	753.91	<.0001
COUNTY	1	1240.346903	1240.346903	780.28	<.0001

b) LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year	20	763.96	<.0001
MONTH	1	727.39	<.0001
COUNTY	1	751.86	<.0001

Table 4.. A) Type III test of fixed effects and B) Likelihood ratio test for the fixed factors and interactions terms for the ***Continuity Case - Panhandle***.

a) Type III test of fixed effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	21	841.7650639	40.0840507	39.01	<.0001
MONTH	3	440.0803213	146.6934404	142.78	<.0001
COUNTY	1	22.7107955	22.7107955	22.10	<.0001

b) LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year	21	739.13	<.0001
MONTH	3	383.61	<.0001
COUNTY	1	20.36	<.0001

Table 5. Nominal CPUE, number of trips, and abundance index statistics for the ***Continuity Case - Panhandle***.

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	50.250	28	39.551	26.666	56.544	0.779	0.702	0.865	0.052
1987	32.143	70	27.560	21.568	34.701	0.543	0.505	0.584	0.037
1988	31.404	156	26.319	22.354	30.783	0.518	0.493	0.545	0.025
1989	34.075	53	18.436	13.892	23.995	0.363	0.330	0.400	0.048
1990	37.771	105	27.451	22.486	33.183	0.541	0.509	0.574	0.030
1991	39.744	180	27.556	23.646	31.924	0.543	0.518	0.569	0.023
1992	52.861	223	37.778	32.903	43.168	0.744	0.716	0.773	0.019
1993	97.185	157	32.847	27.866	38.458	0.647	0.617	0.678	0.024
1994	75.804	373	40.618	36.519	45.047	0.800	0.777	0.824	0.014
1995	64.563	245	40.091	35.206	45.461	0.790	0.762	0.818	0.018
1996	145.419	708	72.852	67.502	78.509	1.435	1.410	1.461	0.009
1997	222.343	770	95.688	88.778	102.989	1.885	1.854	1.917	0.008
1998	111.564	385	64.335	58.048	71.112	1.267	1.236	1.299	0.012
1999	147.307	540	74.129	67.879	80.795	1.460	1.430	1.491	0.010
2000	110.774	513	64.984	59.368	70.983	1.280	1.253	1.308	0.011
2001	144.223	533	78.773	72.080	85.915	1.552	1.520	1.584	0.010
2002	113.511	362	61.855	55.582	68.637	1.219	1.187	1.251	0.013
2003	103.542	371	54.487	49.025	60.386	1.073	1.045	1.102	0.013
2004	79.600	210	51.732	44.962	59.227	1.019	0.983	1.056	0.018
2005	88.106	132	53.886	45.109	63.866	1.062	1.015	1.110	0.022
2006	101.418	318	65.454	58.339	73.191	1.289	1.254	1.326	0.014
2007	70.500	100	60.383	49.105	73.470	1.190	1.131	1.251	0.025

Table 6. Nominal CPUE, number of trips, and abundance index statistics for the ***Continuity Case – Southern Gulf***.

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	27.719	302	33.086	28.330	38.407	0.385	0.368	0.402	0.022
1987	48.960	400	50.723	44.234	57.889	0.590	0.569	0.611	0.017
1988	111.832	191	70.248	58.056	84.237	0.817	0.781	0.854	0.022
1989	86.699	581	65.753	58.326	73.856	0.764	0.743	0.787	0.014
1990	140.539	785	86.047	77.482	95.293	1.000	0.977	1.024	0.012
1991	131.010	575	87.573	77.845	98.173	1.018	0.992	1.046	0.013
1992	315.346	812	203.636	183.400	225.477	2.368	2.321	2.415	0.010
1993	141.271	682	91.404	81.802	101.816	1.063	1.037	1.089	0.012
1994	57.005	378	57.063	49.607	65.317	0.663	0.641	0.687	0.017
1995	174.002	474	80.989	71.833	90.982	0.942	0.916	0.968	0.014
1996	156.725	874	95.145	86.001	104.989	1.106	1.082	1.131	0.011
1997	96.877	617	80.001	71.481	89.249	0.930	0.906	0.955	0.013
1998	120.886	369	88.679	77.107	101.487	1.031	0.999	1.064	0.016
1999	109.607	333	56.077	48.568	64.412	0.652	0.629	0.676	0.018
2000	180.628	331	100.632	86.955	115.837	1.170	1.133	1.208	0.016
2001	256.331	335	106.973	92.532	123.017	1.244	1.206	1.283	0.016
2002	99.469	254	76.084	64.428	89.231	0.885	0.851	0.919	0.019
2003	136.081	406	97.168	84.743	110.891	1.130	1.096	1.164	0.015
2004	110.394	254	75.694	64.019	88.875	0.880	0.847	0.915	0.019
2005	243.304	382	121.031	105.082	138.705	1.407	1.366	1.449	0.015
2006	189.744	242	82.163	69.448	96.523	0.955	0.920	0.992	0.019

Table 7. Nominal CPUE, number of trips, and abundance index statistics for the ***Continuity Case – South Atlantic***.

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	164.220	6899	74.303	69.892	78.916	1.024	1.010	1.039	0.007
1987	209.443	5932	71.539	67.237	76.041	0.986	0.972	1.001	0.007
1988	355.950	4504	84.818	79.555	90.333	1.169	1.152	1.186	0.007
1989	193.684	4456	74.748	70.107	79.613	1.030	1.015	1.046	0.008
1990	142.512	5096	67.223	63.118	71.522	0.927	0.913	0.941	0.008
1991	119.531	6548	65.121	61.252	69.168	0.898	0.884	0.911	0.007
1992	110.806	6417	60.404	56.809	64.165	0.833	0.820	0.845	0.008
1993	127.413	6554	61.676	58.048	65.469	0.850	0.838	0.863	0.007
1994	115.305	6716	60.387	56.818	64.120	0.832	0.820	0.845	0.008
1995	114.423	5483	56.557	53.127	60.147	0.780	0.767	0.792	0.008
1996	136.453	6351	70.011	65.827	74.389	0.965	0.951	0.979	0.007
1997	141.250	7031	70.404	66.245	74.753	0.970	0.956	0.985	0.007
1998	129.468	7217	71.173	66.975	75.563	0.981	0.967	0.995	0.007
1999	145.302	6664	71.978	67.697	76.457	0.992	0.978	1.007	0.007
2000	118.706	7058	62.584	58.879	66.458	0.863	0.850	0.876	0.007
2001	119.811	7111	65.648	61.760	69.715	0.905	0.892	0.918	0.007
2002	112.621	6868	59.931	56.378	63.646	0.826	0.814	0.839	0.008
2003	161.780	6224	79.291	74.548	84.255	1.093	1.077	1.109	0.007
2004	192.856	8119	93.869	88.371	99.616	1.294	1.277	1.311	0.007
2005	148.740	6331	70.641	66.418	75.058	0.974	0.960	0.988	0.007
2006	213.273	7873	106.175	99.951	112.681	1.463	1.444	1.483	0.007

Table 8. Description of data inputs for "New" trip ticket indices

Data: Florida trip ticket, data is catch of km in pounds per day, assuming a 12 hour day, using either the hours or days fished to standardize
Coverage: all Florida seafood dealers, from 1986-2007
Sampling intensity: census
Factors: year county season year*season
Year is calender year NOT fishing year
Gears: hook and line and unknown
Method: SAS PROC MIXED
Dependent variable: log(catch pounds of km/day) for positive trip tickets
- day is defined as one, 12 hour day or fraction of a day if time fished is less than 12 hours
Time frame: seasons
winter (1,2,3,) spring (4,5,6) summer (7,8,9,10), fall (11,12)
Filtering:
1. data limited to records which king is > 50% of the total landings,
2. total king mackerel CPUE < 3000 lbs/day to eliminate early gillnet catches

New Index 1: Atlantic
Area: FL Atlantic counties from north of Volusia (Flagler, St Johns, Duval and Nassau)
Model: lg(CPUE) ~ year season county *year*season year*county*

New Index 2: Mixing zone:
Area: Florida counties from and including Volusia to the Collier-Monroe border, excluding Collier
Model: lg(CPUE) ~ year season county season*county *year*season year*county*

New Index 3: Gulf of Mexico zone:
Area: All Gulf counties to the Collier-Monroe border, including Collier
Model: lg(CPUE) ~ year season county *year*season year*county*

Table 9. Pecent reduction in deviance per degree of freedom explained by adding the factor for the fixed factors and interactions terms for A. *New trip ticket –Atlantic*.B. *New trip ticket –Mixing Zone* and C. *New trip ticket –Gulf*

A) *New trip ticket –Atlantic* LR Statistics For Type 3 Analysis

Criterion			DF	Deviance	Value/DF
year2			3936	3940.6500	1.0012
year2	county		3934	3897.9165	0.9908
year2	season		3933	3280.2725	0.8340
year2	season	county	3931	3265.1750	0.8306
year2	season	county season*county	3925	3238.6334	0.8251

B) *New trip ticket –Mixing Zone* LR Statistics For Type 3 Analysis

Criterion			DF	Deviance	Value/DF
year2			19E4	211029.0921	1.1320
year2	county		19E4	202765.3880	1.0877
year2	season		19E4	207231.7561	1.1116
year2	season	county	19E4	197207.2924	1.0579
year2	season	county season*county	19E4	191092.6569	1.0252

C) *New trip ticket –Gulf*

Criterion			DF	Deviance	Value/DF
year2			5864	7308.0991	1.2463
year2	county		5864	7308.0991	1.2463
year2	season		5861	6293.0962	1.0737
year2	season	county	5847	6008.9460	1.0277
year2	season	county season*county	5817	5674.3647	0.9755

Table 10. Type-III tests of fixed factors and interactions terms for A. *New trip ticket –Atlantic.*B. *New trip ticket –Mixing Zone* and C. *New trip ticket –Gulf*

A) *New trip ticket –Atlantic* LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year2	21	110.67	<.0001
season	3	73.13	<.0001
COUNTY	2	1.78	0.4114
season*COUNTY	6	32.30	<.0001

B) *New trip ticket –Mixing Zone* LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year2	21	4215.02	<.0001
season	3	2345.06	<.0001
COUNTY	7	4768.43	<.0001
season*COUNTY	21	5872.55	<.0001

C) *New trip ticket –Gulf* LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
year2	21	281.10	<.0001
season	3	9.05	0.0287
COUNTY	14	199.06	<.0001
season*COUNTY	30	337.21	<.0001

Table 11. Analysis of the mixed model formulations of the A. *New trip ticket –Atlantic.*B. *New trip ticket – Mixing Zone* and C. *New trip ticket –Gulf* .The likelihood ratio was used to test the difference of –2 REM log likelihood between two nested models. The final models are indicated with gray shading.

King mackerel mixed model random effects- Atlantic new trip ticket index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
model					
LCPUE2 = year	11286.2	11288.2	11294.5		
LCPUE2 = year *year*season*	10545.7	10551.7	11294.5	740.5	0.0000
LCPUE2 = year *year*county*	10599.4	10603.4	10608.4	-53.7	NA
LCPUE2 = year *year*season year*county*	10545.7	10551.7	10559.1	53.7	0.0000

King mackerel mixed model random effects- Mixing Zone new trip ticket index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
model					
LCPUE2 = year season county year*season year*county	534051.1	534053.1	534063.3		
LCPUE2 = year season county year*season year*county *year*season*	530349.4	530353.4	534063.3	3701.7	0.0000
LCPUE2 = year season county year*season year*county *year*county*	527543.7	527547.7	527554	2805.7	0.0000
LCPUE2 = year season county year*season year*county *year*season yea*	525336	525342	525351.5	2207.7	0.0000

King mackerel mixed model random effects- Gulf new trip ticket index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
model					
LCPUE2 = year season county	16616	16618	16624.7		
LCPUE2 = year season county *year*season*	16345.2	16349.2	16624.7	270.8	0.0000
LCPUE2 = year season county *year*county*	16288	16292	16298.5	57.2	0.0000
LCPUE2 = year season county *year*season year*county*	16180.3	16186.3	16196.1	107.7	0.0000

Table 13. Nominal CPUE, number of trips, and abundance index statistics for the *New trip ticket –Atlantic*.

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	131.915	200	100.827	47.759	188.320	0.746	0.640	0.870	0.077
1987	120.599	188	117.073	55.109	219.617	0.866	0.745	1.006	0.075
1988	138.165	218	104.938	50.876	192.832	0.776	0.670	0.900	0.074
1989	215.416	261	116.950	56.292	215.997	0.865	0.748	1.001	0.073
1990	166.097	346	155.639	77.382	280.937	1.151	1.009	1.313	0.066
1991	166.750	494	140.181	70.591	250.738	1.037	0.909	1.183	0.066
1992	131.779	299	84.032	41.859	151.477	0.622	0.535	0.722	0.075
1993	96.471	121	80.014	38.950	146.614	0.592	0.506	0.692	0.078
1994	163.977	141	120.509	59.029	219.842	0.891	0.774	1.027	0.071
1995	204.615	130	159.622	78.764	289.683	1.181	1.034	1.348	0.066
1996	377.314	150	204.965	102.069	369.555	1.516	1.339	1.717	0.062
1997	209.408	232	154.340	77.617	276.330	1.142	1.003	1.300	0.065
1998	293.847	199	155.940	78.352	279.374	1.154	1.013	1.313	0.065
1999	178.188	106	116.552	57.048	212.736	0.862	0.748	0.994	0.071
2000	207.586	124	148.688	73.240	270.177	1.100	0.961	1.258	0.067
2001	167.189	121	109.367	52.462	202.476	0.809	0.697	0.938	0.074
2002	219.157	85	139.686	66.281	260.584	1.033	0.896	1.192	0.072
2003	180.955	133	148.906	73.178	271.017	1.101	0.963	1.261	0.068
2004	270.857	96	160.835	77.767	296.104	1.190	1.039	1.363	0.068
2005	194.718	124	168.761	82.018	309.579	1.248	1.092	1.427	0.067
2006	243.760	111	160.263	78.419	292.580	1.185	1.037	1.355	0.067

Table 14. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Mixing zone***.

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	309.615	9617	156.461	120.130	200.339	0.814	0.773	0.857	0.026
1987	304.020	8014	167.003	128.314	213.708	0.869	0.826	0.914	0.025
1988	459.699	4457	207.395	156.823	269.119	1.079	1.024	1.136	0.026
1989	395.861	5496	165.699	127.033	212.447	0.862	0.819	0.907	0.026
1990	328.359	7736	180.641	138.836	231.097	0.940	0.894	0.988	0.025
1991	277.473	7352	175.206	134.565	224.280	0.911	0.866	0.959	0.025
1992	285.626	6906	168.829	129.736	216.016	0.878	0.835	0.924	0.025
1993	323.196	8403	164.370	126.201	210.469	0.855	0.812	0.900	0.026
1994	253.963	8685	146.088	111.960	187.359	0.760	0.721	0.801	0.026
1995	274.018	8164	163.015	125.078	208.856	0.848	0.805	0.893	0.026
1996	308.324	9733	204.269	156.642	261.839	1.062	1.011	1.116	0.025
1997	323.292	9704	213.899	164.545	273.429	1.113	1.060	1.168	0.024
1998	280.546	9590	198.945	153.016	254.348	1.035	0.985	1.087	0.025
1999	334.169	8442	204.662	157.390	261.693	1.065	1.014	1.118	0.024
2000	273.062	9716	186.668	143.595	238.621	0.971	0.924	1.020	0.025
2001	307.225	10463	198.824	152.960	254.141	1.034	0.985	1.086	0.025
2002	333.073	9148	198.426	152.657	253.627	1.032	0.983	1.084	0.025
2003	379.541	9707	231.477	178.128	295.809	1.204	1.148	1.263	0.024
2004	420.113	9819	228.970	176.063	292.803	1.191	1.135	1.249	0.024
2005	421.766	8560	239.519	184.243	306.194	1.246	1.188	1.306	0.024
2006	419.777	9599	226.734	174.375	289.899	1.179	1.124	1.237	0.024

Table 15. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Gulf.***

year	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	522.852	172	187.567	102.485	316.080	0.990	0.886	1.105	0.055
1987	198.425	214	128.810	71.486	214.555	0.680	0.605	0.763	0.058
1988	288.095	120	182.591	97.131	313.851	0.963	0.858	1.082	0.058
1989	232.919	202	128.363	70.340	215.847	0.677	0.601	0.763	0.059
1990	278.002	133	112.678	62.301	188.208	0.595	0.527	0.671	0.060
1991	336.591	113	136.480	74.289	230.642	0.720	0.640	0.811	0.059
1992	306.042	116	155.469	79.018	276.243	0.820	0.722	0.932	0.064
1993	331.731	102	131.934	71.618	223.414	0.696	0.618	0.785	0.060
1994	339.114	376	144.711	79.945	241.867	0.764	0.681	0.856	0.057
1995	381.334	268	132.288	72.427	222.593	0.698	0.620	0.786	0.059
1996	364.731	476	218.920	112.659	385.507	1.155	1.027	1.299	0.059
1997	367.348	547	150.793	84.428	249.511	0.796	0.712	0.889	0.056
1998	336.156	312	269.594	145.661	458.112	1.423	1.280	1.580	0.053
1999	433.800	516	222.379	124.722	367.489	1.173	1.059	1.300	0.051
2000	396.877	358	233.358	128.207	391.640	1.231	1.108	1.368	0.053
2001	415.977	371	220.207	121.580	368.213	1.162	1.046	1.291	0.053
2002	426.349	280	345.464	192.009	574.785	1.823	1.655	2.007	0.048
2003	318.057	239	237.263	131.336	395.963	1.252	1.129	1.389	0.052
2004	339.288	237	156.684	87.755	259.195	0.827	0.741	0.923	0.055
2005	454.660	159	208.458	110.637	358.919	1.100	0.982	1.232	0.057
2006	528.038	283	220.625	122.913	366.430	1.164	1.049	1.292	0.052

Table 16. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket – Atlantic by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	1986	fall	192.767	779	134.406	108.728	164.314	0.698	0.669	0.729
1986	1986	spring	390.412	2879	164.490	134.281	199.453	0.855	0.822	0.889
1986	1986	summer	271.515	3372	121.998	99.632	147.877	0.634	0.608	0.661
1986	1986	winter	304.546	2587	221.130	180.329	268.388	1.149	1.107	1.193
1987	1987	fall	272.881	825	182.177	147.630	222.369	0.947	0.909	0.985
1987	1987	spring	410.503	2958	191.310	156.403	231.669	0.994	0.957	1.033
1987	1987	summer	275.130	2124	119.130	97.267	144.431	0.619	0.593	0.646
1987	1987	winter	195.846	2107	186.685	152.041	226.848	0.970	0.933	1.009
1988	1988	fall	326.470	742	226.969	183.544	277.560	1.179	1.134	1.226
1988	1988	spring	624.830	2143	281.029	228.993	341.332	1.460	1.408	1.514
1988	1988	summer	297.736	1563	124.105	101.032	150.861	0.645	0.618	0.673
1988	1988	winter	251.603	9	220.419	104.822	410.553	1.145	1.005	1.305
1989	1989	fall	351.136	1022	210.725	171.062	256.811	1.095	1.053	1.138
1989	1989	spring	512.588	2403	224.398	183.248	272.011	1.166	1.123	1.210
1989	1989	summer	304.936	1842	124.754	101.721	151.434	0.648	0.622	0.676
1989	1989	winter	101.961	229	135.709	105.476	171.916	0.705	0.670	0.742
1990	1990	fall	433.050	1911	259.748	212.084	314.906	1.350	1.302	1.400
1990	1990	spring	389.403	2957	204.967	167.617	248.141	1.065	1.026	1.106
1990	1990	summer	161.931	2163	98.912	80.798	119.867	0.514	0.492	0.537
1990	1990	winter	299.161	705	208.894	168.318	256.287	1.085	1.043	1.130
1991	1991	fall	361.554	1579	245.296	200.131	297.590	1.275	1.229	1.322
1991	1991	spring	344.392	2840	171.370	140.183	207.414	0.891	0.857	0.926
1991	1991	summer	163.401	2547	121.602	99.456	147.198	0.632	0.606	0.659
1991	1991	winter	193.869	386	192.711	152.788	239.869	1.001	0.958	1.046
1992	1992	fall	405.541	1572	232.215	189.087	282.219	1.207	1.162	1.253
1992	1992	spring	278.821	2314	140.699	114.966	170.463	0.731	0.702	0.761
1992	1992	summer	201.713	2077	123.050	100.505	149.132	0.639	0.613	0.667
1992	1992	winter	287.244	943	176.505	143.177	215.250	0.917	0.881	0.955
1993	1993	fall	279.534	1396	171.932	139.881	209.114	0.893	0.858	0.930
1993	1993	spring	390.173	2601	162.002	132.182	196.526	0.842	0.809	0.876
1993	1993	summer	208.935	2043	105.094	85.702	127.554	0.546	0.523	0.570
1993	1993	winter	374.056	2363	190.725	155.398	231.667	0.991	0.953	1.030
1994	1994	fall	294.363	738	162.862	131.272	199.751	0.846	0.811	0.883
1994	1994	spring	312.188	2981	144.005	117.318	174.936	0.748	0.718	0.780
1994	1994	summer	223.928	2016	117.953	95.972	143.451	0.613	0.587	0.640
1994	1994	winter	205.545	2950	141.294	114.960	171.843	0.734	0.704	0.765
1995	1995	fall	247.972	993	164.582	133.453	200.781	0.855	0.821	0.891
1995	1995	spring	309.451	2882	172.059	140.319	208.820	0.894	0.860	0.930
1995	1995	summer	215.584	1229	116.574	94.691	141.989	0.606	0.580	0.633
1995	1995	winter	272.569	3060	193.762	157.922	235.290	1.007	0.969	1.047
1996	1996	fall	325.991	1646	227.784	185.249	277.142	1.184	1.140	1.229
1996	1996	spring	376.322	2938	225.907	183.941	274.565	1.174	1.130	1.219
1996	1996	summer	251.330	1939	159.484	129.746	193.986	0.829	0.796	0.863
1996	1996	winter	271.455	3210	214.081	174.369	260.115	1.112	1.071	1.156
1997	1997	fall	381.558	1666	253.083	206.646	306.821	1.315	1.268	1.364
1997	1997	spring	403.818	3240	241.986	198.157	292.601	1.257	1.213	1.304
1997	1997	summer	202.746	1903	131.320	107.317	159.080	0.682	0.655	0.711
1997	1997	winter	278.880	2895	217.803	178.242	263.511	1.132	1.091	1.175
1998	1998	fall	356.867	1292	229.599	187.051	278.912	1.193	1.149	1.239
1998	1998	spring	304.338	2999	193.423	158.349	233.936	1.005	0.968	1.044
1998	1998	summer	224.232	2593	156.423	127.995	189.271	0.813	0.781	0.846
1998	1998	winter	271.702	2706	212.123	173.422	256.866	1.102	1.062	1.144
1999	1999	fall	258.110	702	167.742	135.915	204.772	0.872	0.837	0.908
1999	1999	spring	369.569	3732	206.150	168.927	249.117	1.071	1.032	1.112
1999	1999	summer	223.834	1496	136.532	111.412	165.614	0.709	0.681	0.739
1999	1999	winter	368.539	2512	261.256	213.667	316.263	1.358	1.310	1.407
2000	2000	fall	303.924	1032	206.273	167.809	250.899	1.072	1.031	1.114
2000	2000	spring	266.553	3710	158.710	130.026	191.826	0.825	0.793	0.858
2000	2000	summer	232.153	2412	154.506	126.400	186.988	0.803	0.772	0.835
2000	2000	winter	308.571	2562	213.314	174.498	258.172	1.108	1.068	1.151
2001	2001	fall	495.157	929	290.407	236.063	353.492	1.509	1.455	1.565
2001	2001	spring	265.551	3560	151.095	123.781	182.629	0.785	0.755	0.817
2001	2001	summer	225.414	2521	146.577	119.944	177.351	0.762	0.732	0.793

Table 16, continued Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Atlantic by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
2001	winter	359.360	3453	221.767	181.602	268.151	1.152	1.111	1.196	0.018
2002	fall	434.702	1036	233.232	189.690	283.758	1.212	1.167	1.259	0.019
2002	spring	323.708	2980	183.298	149.990	221.783	0.952	0.917	0.990	0.019
2002	summer	182.767	2059	122.008	99.777	147.707	0.634	0.608	0.661	0.021
2002	winter	408.602	3073	308.531	252.300	373.532	1.603	1.548	1.660	0.017
2003	fall	367.578	1390	240.681	196.350	292.013	1.251	1.205	1.298	0.018
2003	spring	354.351	2391	206.769	169.193	250.187	1.074	1.035	1.115	0.019
2003	summer	344.122	2551	204.910	167.674	247.935	1.065	1.026	1.106	0.019
2003	winter	429.085	3375	279.992	229.290	338.543	1.455	1.404	1.507	0.018
2004	fall	279.621	519	170.299	137.232	208.919	0.885	0.849	0.923	0.021
2004	spring	459.272	3985	261.936	214.531	316.676	1.361	1.313	1.411	0.018
2004	summer	353.311	2373	201.212	164.516	243.636	1.046	1.007	1.086	0.019
2004	winter	445.738	2942	278.687	228.174	337.029	1.448	1.398	1.500	0.018
2005	fall	371.124	741	221.090	179.258	269.736	1.149	1.105	1.194	0.019
2005	spring	399.700	3058	221.251	181.155	267.560	1.150	1.108	1.193	0.018
2005	summer	265.074	1640	170.027	138.885	206.055	0.884	0.850	0.919	0.020
2005	winter	537.747	3121	322.020	263.589	389.519	1.673	1.617	1.732	0.017
2006	fall	297.423	719	193.061	156.281	235.881	1.003	0.964	1.044	0.020
2006	spring	474.210	3576	244.140	199.963	295.151	1.269	1.224	1.315	0.018
2006	summer	338.404	2172	188.599	154.264	228.284	0.980	0.943	1.018	0.019
2006	winter	442.146	3132	253.563	207.450	306.851	1.318	1.271	1.366	0.018
2007	spring	295.647	2874	179.521	146.893	217.222	0.933	0.898	0.969	0.019
2007	summer	223.218	2309	143.445	117.244	173.743	0.745	0.716	0.776	0.020
2007	winter	412.173	1954	248.513	202.809	301.421	1.291	1.245	1.340	0.018

Table 17. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Mixing zone by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	fall	192.77	779	134.406	108.728	164.314	0.698	0.669	0.729	0.022
1986	spring	390.41	2879	164.490	134.281	199.453	0.855	0.822	0.889	0.020
1986	summer	271.52	3372	121.998	99.632	147.877	0.634	0.608	0.661	0.021
1986	winter	304.55	2587	221.130	180.329	268.388	1.149	1.107	1.193	0.019
1987	fall	272.88	825	182.177	147.630	222.369	0.947	0.909	0.985	0.020
1987	spring	410.50	2958	191.310	156.403	231.669	0.994	0.957	1.033	0.019
1987	summer	275.13	2124	119.130	97.267	144.431	0.619	0.593	0.646	0.021
1987	winter	195.85	2107	186.685	152.041	226.848	0.970	0.933	1.009	0.020
1988	fall	326.47	742	226.969	183.544	277.560	1.179	1.134	1.226	0.019
1988	spring	624.83	2143	281.029	228.993	341.332	1.460	1.408	1.514	0.018
1988	summer	297.74	1563	124.105	101.032	150.861	0.645	0.618	0.673	0.021
1988	winter	251.60	9	220.419	104.822	410.553	1.145	1.005	1.305	0.065
1989	fall	351.14	1022	210.725	171.062	256.811	1.095	1.053	1.138	0.019
1989	spring	512.59	2403	224.398	183.248	272.011	1.166	1.123	1.210	0.019
1989	summer	304.94	1842	124.754	101.721	151.434	0.648	0.622	0.676	0.021
1989	winter	101.96	229	135.709	105.476	171.916	0.705	0.670	0.742	0.025
1990	fall	433.05	1911	259.748	212.084	314.906	1.350	1.302	1.400	0.018
1990	spring	389.40	2957	204.967	167.617	248.141	1.065	1.026	1.106	0.019
1990	summer	161.93	2163	98.912	80.798	119.867	0.514	0.492	0.537	0.022
1990	winter	299.16	705	208.894	168.318	256.287	1.085	1.043	1.130	0.020
1991	fall	361.55	1579	245.296	200.131	297.590	1.275	1.229	1.322	0.018
1991	spring	344.39	2840	171.370	140.183	207.414	0.891	0.857	0.926	0.019
1991	summer	163.40	2547	121.602	99.456	147.198	0.632	0.606	0.659	0.021
1991	winter	193.87	386	192.711	152.788	239.869	1.001	0.958	1.046	0.022
1992	fall	405.54	1572	232.215	189.087	282.219	1.207	1.162	1.253	0.019
1992	spring	278.82	2314	140.699	114.966	170.463	0.731	0.702	0.761	0.020
1992	summer	201.71	2077	123.050	100.505	149.132	0.639	0.613	0.667	0.021
1992	winter	287.24	943	176.505	143.177	215.250	0.917	0.881	0.955	0.020
1993	fall	279.53	1396	171.932	139.881	209.114	0.893	0.858	0.930	0.020
1993	spring	390.17	2601	162.002	132.182	196.526	0.842	0.809	0.876	0.020
1993	summer	208.93	2043	105.094	85.702	127.554	0.546	0.523	0.570	0.022
1993	winter	374.06	2363	190.725	155.398	231.667	0.991	0.953	1.030	0.019
1994	fall	294.36	738	162.862	131.272	199.751	0.846	0.811	0.883	0.021
1994	spring	312.19	2981	144.005	117.318	174.936	0.748	0.718	0.780	0.021
1994	summer	223.93	2016	117.953	95.972	143.451	0.613	0.587	0.640	0.022
1994	winter	205.55	2950	141.294	114.960	171.843	0.734	0.704	0.765	0.021
1995	fall	247.97	993	164.582	133.453	200.781	0.855	0.821	0.891	0.020
1995	spring	309.45	2882	172.059	140.319	208.820	0.894	0.860	0.930	0.020
1995	summer	215.58	1229	116.574	94.691	141.989	0.606	0.580	0.633	0.022
1995	winter	272.57	3060	193.762	157.922	235.290	1.007	0.969	1.047	0.019
1996	fall	325.99	1646	227.784	185.249	277.142	1.184	1.140	1.229	0.019
1996	spring	376.32	2938	225.907	183.941	274.565	1.174	1.130	1.219	0.019
1996	summer	251.33	1939	159.484	129.746	193.986	0.829	0.796	0.863	0.020
1996	winter	271.45	3210	214.081	174.369	260.115	1.112	1.071	1.156	0.019
1997	fall	381.56	1666	253.083	206.646	306.821	1.315	1.268	1.364	0.018
1997	spring	403.82	3240	241.986	198.157	292.601	1.257	1.213	1.304	0.018
1997	summer	202.75	1903	131.320	107.317	159.080	0.682	0.655	0.711	0.021
1997	winter	278.88	2895	217.803	178.242	263.511	1.132	1.091	1.175	0.019
1998	fall	356.87	1292	229.599	187.051	278.912	1.193	1.149	1.239	0.019
1998	spring	304.34	2999	193.423	158.349	233.936	1.005	0.968	1.044	0.019
1998	summer	224.23	2593	156.423	127.995	189.271	0.813	0.781	0.846	0.020
1998	winter	271.70	2706	212.123	173.422	256.866	1.102	1.062	1.144	0.019
1999	fall	258.11	702	167.742	135.915	204.772	0.872	0.837	0.908	0.020
1999	spring	369.57	3732	206.150	168.927	249.117	1.071	1.032	1.112	0.019
1999	summer	223.83	1496	136.532	111.412	165.614	0.709	0.681	0.739	0.021
1999	winter	368.54	2512	261.256	213.667	316.263	1.358	1.310	1.407	0.018
2000	fall	303.92	1032	206.273	167.809	250.899	1.072	1.031	1.114	0.019
2000	spring	266.55	3710	158.710	130.026	191.826	0.825	0.793	0.858	0.020
2000	summer	232.15	2412	154.506	126.400	186.988	0.803	0.772	0.835	0.020
2000	winter	308.57	2562	213.314	174.498	258.172	1.108	1.068	1.151	0.019
2001	fall	495.16	929	290.407	236.063	353.492	1.509	1.455	1.565	0.018
2001	spring	265.55	3560	151.095	123.781	182.629	0.785	0.755	0.817	0.020
2001	summer	225.41	2521	146.577	119.944	177.351	0.762	0.732	0.793	0.020

Table 17, Continued. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Mixing zone by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
2001	winter	359.36	3453	221.767	181.602	268.151	1.152	1.111	1.196	0.018
2002	fall	434.70	1036	233.232	189.690	283.758	1.212	1.167	1.259	0.019
2002	spring	323.71	2980	183.298	149.990	221.783	0.952	0.917	0.990	0.019
2002	summer	182.77	2059	122.008	99.777	147.707	0.634	0.608	0.661	0.021
2002	winter	408.60	3073	308.531	252.300	373.532	1.603	1.548	1.660	0.017
2003	fall	367.58	1390	240.681	196.350	292.013	1.251	1.205	1.298	0.018
2003	spring	354.35	2391	206.769	169.193	250.187	1.074	1.035	1.115	0.019
2003	summer	344.12	2551	204.910	167.674	247.935	1.065	1.026	1.106	0.019
2003	winter	429.08	3375	279.992	229.290	338.543	1.455	1.404	1.507	0.018
2004	fall	279.62	519	170.299	137.232	208.919	0.885	0.849	0.923	0.021
2004	spring	459.27	3985	261.936	214.531	316.676	1.361	1.313	1.411	0.018
2004	summer	353.31	2373	201.212	164.516	243.636	1.046	1.007	1.086	0.019
2004	winter	445.74	2942	278.687	228.174	337.029	1.448	1.398	1.500	0.018
2005	fall	371.12	741	221.090	179.258	269.736	1.149	1.105	1.194	0.019
2005	spring	399.70	3058	221.251	181.155	267.560	1.150	1.108	1.193	0.018
2005	summer	265.07	1640	170.027	138.885	206.055	0.884	0.850	0.919	0.020
2005	winter	537.75	3121	322.020	263.589	389.519	1.673	1.617	1.732	0.017
2006	fall	297.42	719	193.061	156.281	235.881	1.003	0.964	1.044	0.020
2006	spring	474.21	3576	244.140	199.963	295.151	1.269	1.224	1.315	0.018
2006	summer	338.40	2172	188.599	154.264	228.284	0.980	0.943	1.018	0.019
2006	winter	442.15	3132	253.563	207.450	306.851	1.318	1.271	1.366	0.018
2007	spring	295.65	2874	179.521	146.893	217.222	0.933	0.898	0.969	0.019
2007	summer	223.22	2309	143.445	117.244	173.743	0.745	0.716	0.776	0.020
2007	winter	412.17	1954	248.513	202.809	301.421	1.291	1.245	1.340	0.018

Table 18. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Gulf by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
1986	fall	77.99	25	59.889	33.744	98.626	0.309	0.270	0.354	0.067
1986	spring	784.98	100	326.131	180.403	544.557	1.685	1.527	1.858	0.049
1986	summer	88.63	42	76.520	43.948	124.195	0.395	0.349	0.447	0.062
1986	winter	1152.12	5	969.527	329.326	2245.635	5.008	4.333	5.788	0.072
1987	fall	175.67	15	75.048	36.163	138.500	0.388	0.330	0.455	0.080
1987	spring	182.11	111	95.796	58.542	148.199	0.495	0.446	0.549	0.052
1987	summer	214.51	73	139.438	83.586	218.983	0.720	0.652	0.796	0.050
1987	winter	263.61	15	149.535	72.545	274.655	0.772	0.673	0.886	0.069
1988	fall	285.04	37	92.341	51.414	153.434	0.477	0.421	0.540	0.062
1988	spring	540.13	30	509.401	269.612	878.856	2.631	2.387	2.900	0.049
1988	summer	150.79	51	90.797	53.651	144.191	0.469	0.419	0.525	0.056
1988	winter	65.40	2	61.511	11.834	192.656	0.318	0.221	0.458	0.184
1989	fall	299.04	50	117.120	71.709	180.918	0.605	0.548	0.668	0.050
1989	spring	87.25	27	71.085	41.321	114.319	0.367	0.325	0.415	0.061
1989	summer	223.39	122	115.422	73.369	173.079	0.596	0.543	0.654	0.046
1989	winter	829.67	3	170.480	45.909	450.785	0.881	0.697	1.113	0.117
1990	fall	432.22	52	185.232	106.661	300.048	0.957	0.864	1.059	0.051
1990	spring	165.85	19	88.788	49.555	147.264	0.459	0.405	0.520	0.062
1990	summer	165.40	43	97.652	56.087	158.492	0.504	0.449	0.567	0.058
1990	winter	222.92	19	55.203	27.576	99.311	0.285	0.242	0.336	0.083
1991	fall	495.45	45	184.565	107.124	297.160	0.953	0.862	1.054	0.050
1991	spring	67.79	13	43.519	21.872	77.951	0.225	0.189	0.268	0.087
1991	summer	139.25	38	127.156	71.695	209.289	0.657	0.586	0.736	0.057
1991	winter	562.75	17	207.005	98.498	385.416	1.069	0.937	1.220	0.066
1992	fall	342.47	53	155.981	87.166	258.469	0.806	0.721	0.900	0.055
1992	spring	49.50	1	80.270	7.266	339.133	0.415	0.253	0.680	0.251
1992	summer	155.63	53	76.644	44.607	123.144	0.396	0.351	0.446	0.060
1992	winter	1005.82	9	380.753	156.567	782.399	1.967	1.710	2.262	0.070
1993	fall	285.90	39	129.983	73.736	212.960	0.671	0.600	0.751	0.056
1993	spring	36.00	4	42.100	11.808	108.874	0.217	0.159	0.298	0.158
1993	summer	204.85	43	79.625	47.461	125.600	0.411	0.367	0.461	0.057
1993	winter	858.38	16	347.508	167.769	640.470	1.795	1.595	2.020	0.059
1994	fall	450.93	228	182.353	117.265	270.921	0.942	0.867	1.023	0.041
1994	spring	217.81	43	128.899	79.028	198.902	0.666	0.604	0.734	0.049
1994	summer	143.17	99	55.260	34.721	83.633	0.285	0.255	0.319	0.056
1994	winter	192.50	6	202.168	76.218	439.214	1.044	0.880	1.239	0.086
1995	fall	468.62	167	147.224	92.179	223.444	0.760	0.694	0.833	0.045
1995	spring	296.60	18	89.130	46.662	155.006	0.460	0.401	0.528	0.069
1995	summer	151.15	71	54.317	32.383	85.667	0.281	0.248	0.318	0.063
1995	winter	655.58	12	277.272	134.233	510.024	1.432	1.267	1.618	0.061
1996	fall	488.17	160	229.604	140.106	355.615	1.186	1.086	1.295	0.044
1996	spring	302.72	32	132.518	73.807	220.140	0.685	0.610	0.768	0.058
1996	summer	302.18	284	143.690	86.668	224.580	0.742	0.673	0.819	0.049
1997	fall	427.13	148	164.724	106.385	243.881	0.851	0.783	0.925	0.042
1997	spring	271.19	22	136.412	73.491	232.296	0.705	0.625	0.795	0.060
1997	summer	358.26	358	96.378	61.221	144.603	0.498	0.452	0.548	0.048
1997	winter	184.23	19	133.872	69.158	235.086	0.692	0.608	0.786	0.064
1998	fall	462.28	116	243.589	157.065	361.117	1.258	1.164	1.360	0.039
1998	spring	1020.78	15	436.511	217.195	787.499	2.255	2.022	2.514	0.055
1998	summer	197.18	179	122.917	79.427	181.907	0.635	0.581	0.694	0.044
1998	winter	324.25	2	213.282	42.000	660.748	1.102	0.838	1.448	0.137
1999	fall	596.81	173	315.719	205.318	464.838	1.631	1.517	1.754	0.036
1999	spring	227.34	21	123.378	68.561	205.305	0.637	0.567	0.716	0.059
1999	summer	287.35	233	128.290	82.018	191.494	0.663	0.606	0.725	0.045
1999	winter	549.07	89	278.564	172.745	426.006	1.439	1.325	1.562	0.041
2000	fall	347.24	71	210.654	130.096	323.201	1.088	0.997	1.187	0.044
2000	spring	157.75	4	131.646	41.939	316.715	0.680	0.548	0.845	0.109
2000	summer	206.21	150	133.637	84.627	201.000	0.690	0.631	0.756	0.045
2000	winter	645.61	133	452.725	271.952	709.843	2.339	2.158	2.534	0.040
2001	fall	635.39	103	291.799	180.048	448.014	1.507	1.388	1.637	0.041
2001	spring	224.00	27	100.461	55.530	167.840	0.519	0.459	0.587	0.062
2001	summer	259.38	188	179.496	109.568	277.931	0.927	0.846	1.016	0.046
2001	winter	642.84	53	258.656	148.702	419.496	1.336	1.214	1.470	0.048

Table 18, continued. Nominal CPUE, number of trips, and abundance index statistics for the ***New trip ticket –Gulf by year and season.***

year	season	Nominal CPUE	N	Index	L95CI	U95CI	Rel.Index	STD_LCI	STD_UCI	CV
2002	fall	428.22	47	267.967	163.877	414.316	1.384	1.271	1.507	0.043
2002	spring	763.40	5	432.107	143.191	1015.739	2.232	1.887	2.640	0.084
2002	summer	239.55	153	167.131	107.626	248.028	0.863	0.794	0.939	0.042
2002	winter	783.77	75	628.647	352.152	1039.805	3.247	2.979	3.540	0.043
2003	fall	267.48	40	168.404	99.792	266.850	0.870	0.788	0.960	0.049
2003	spring	325.00	21	181.803	96.365	313.323	0.939	0.836	1.055	0.058
2003	summer	191.40	143	137.595	82.724	215.596	0.711	0.643	0.785	0.050
2003	winter	889.17	35	484.454	267.177	810.738	2.502	2.282	2.744	0.046
2004	fall	282.67	58	129.434	81.231	196.079	0.669	0.609	0.734	0.046
2004	spring	229.82	13	97.694	46.909	180.741	0.505	0.434	0.587	0.076
2004	summer	262.92	83	125.917	77.283	194.135	0.650	0.590	0.717	0.049
2004	winter	472.36	83	216.015	128.885	340.481	1.116	1.017	1.224	0.046
2005	fall	601.91	27	284.999	148.835	496.541	1.472	1.319	1.643	0.055
2005	spring	313.13	45	167.130	95.302	272.746	0.863	0.777	0.959	0.053
2005	summer	160.98	24	100.280	48.915	183.479	0.518	0.447	0.601	0.074
2005	winter	604.52	63	251.088	138.881	419.282	1.297	1.170	1.437	0.051
2006	fall	832.02	62	237.308	142.027	373.149	1.226	1.120	1.342	0.045
2006	spring	401.39	118	148.329	93.264	224.365	0.766	0.700	0.838	0.045
2006	summer	198.16	62	135.648	78.228	219.475	0.701	0.629	0.781	0.054
2006	winter	931.69	41	293.167	169.315	473.812	1.514	1.380	1.662	0.046
2007	fall	380.28	4	332.875	94.983	852.680	1.719	1.411	2.095	0.099
2007	spring	286.63	44	178.978	105.774	284.193	0.925	0.838	1.019	0.049
2007	summer	220.33	30	140.869	68.968	257.071	0.728	0.634	0.835	0.069
2007	winter	645.12	214	337.410	197.608	539.513	1.743	1.595	1.904	0.044

Figure 1. Locations and seasons for the continuity case trip ticket indices.

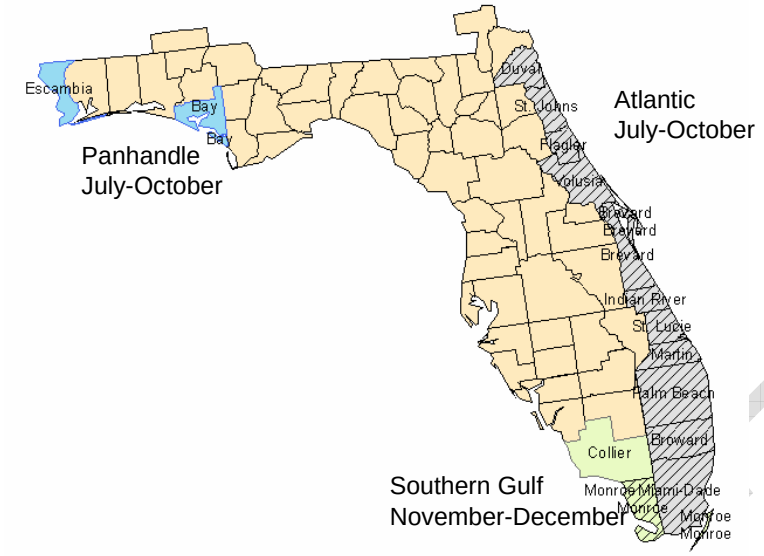


Figure 2. Locations and seasons for the New trip ticket indices.

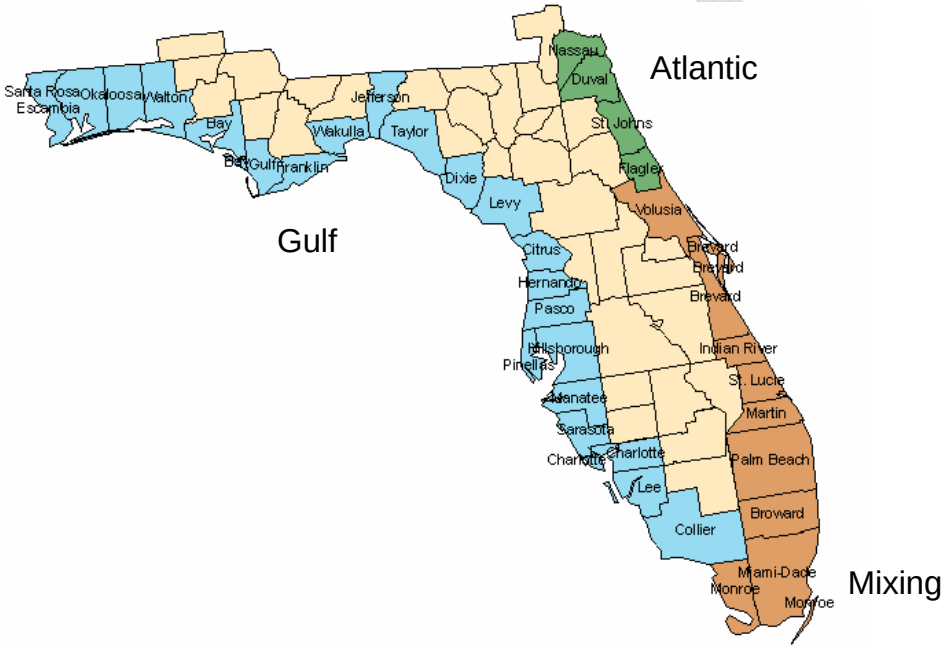


Figure 3. Panhandle zone continuity case index diagnostics. (A) histogram of Log(lbs per day). B) residuals for CPUE by year and (C) chi-square residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

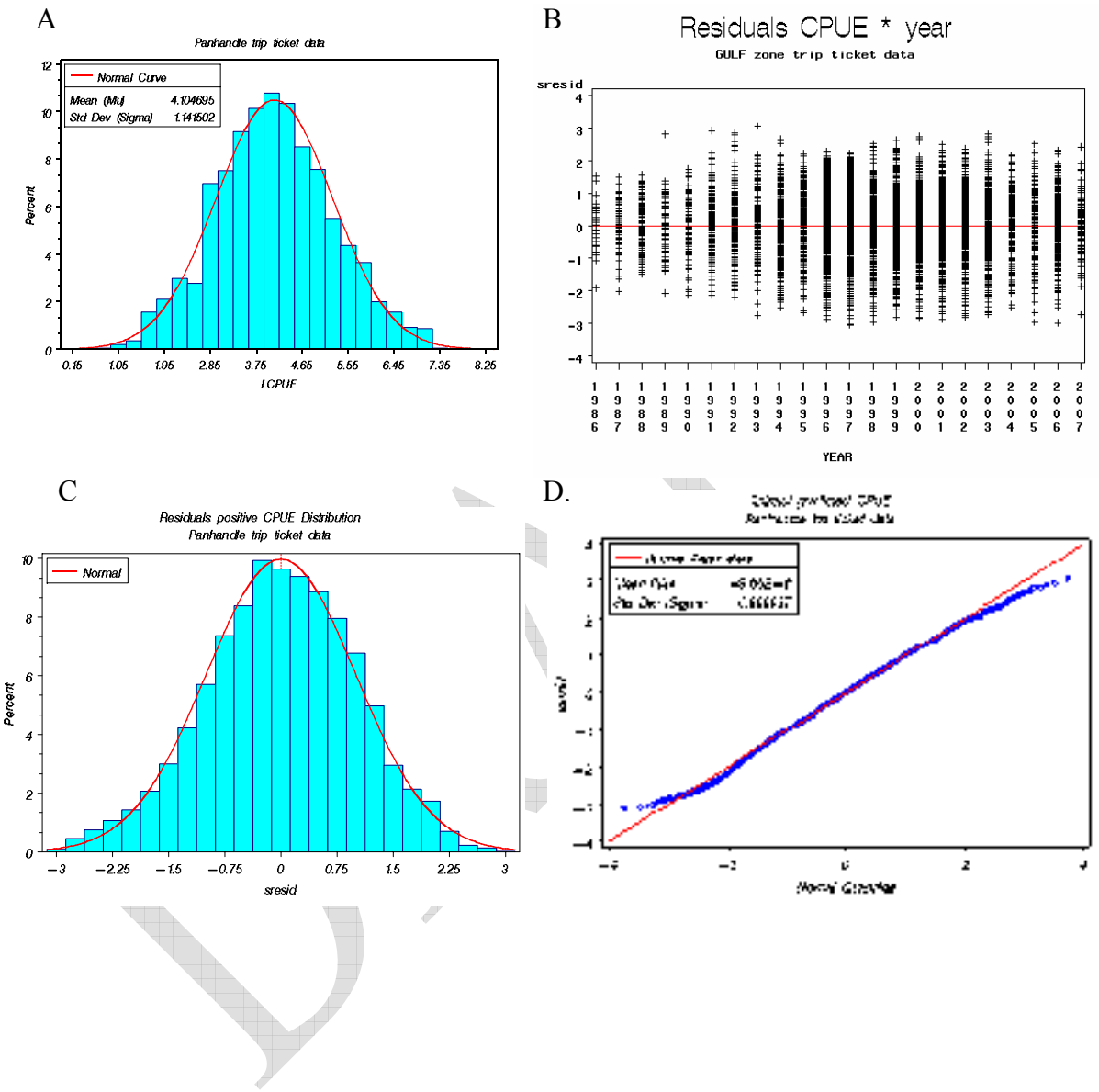
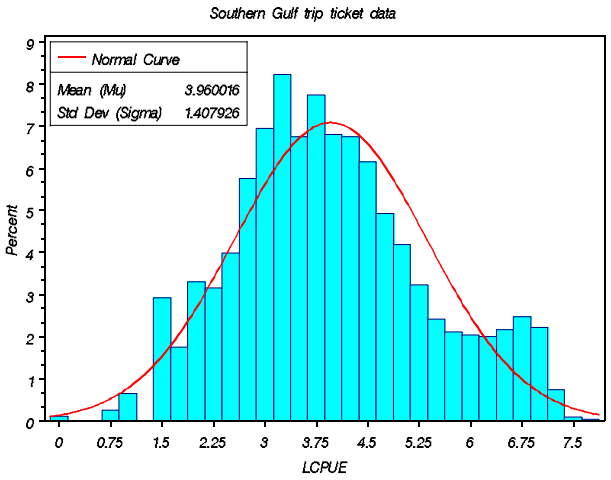
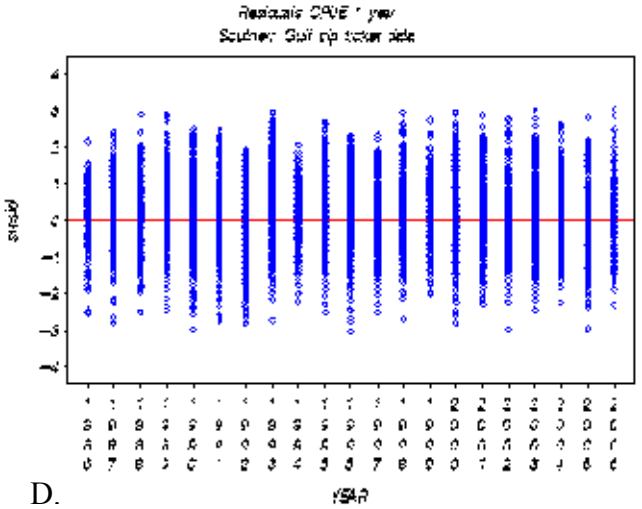


Figure 4. Collier and Monroe (Southern Gulf) zone continuity case index diagnostics. (A) histogram of Log(lbs per day). B) residuals for CPUE by year and (C) chi-square residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

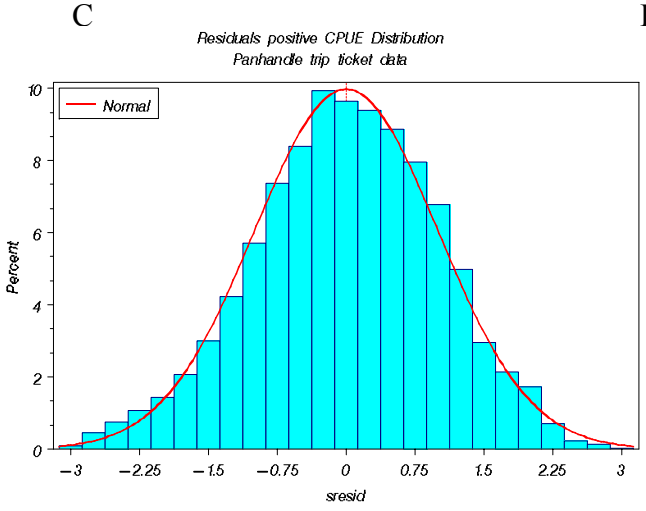
A



B



C



D.

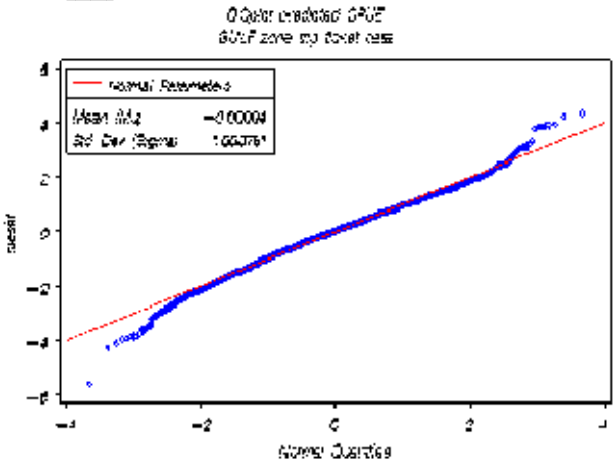
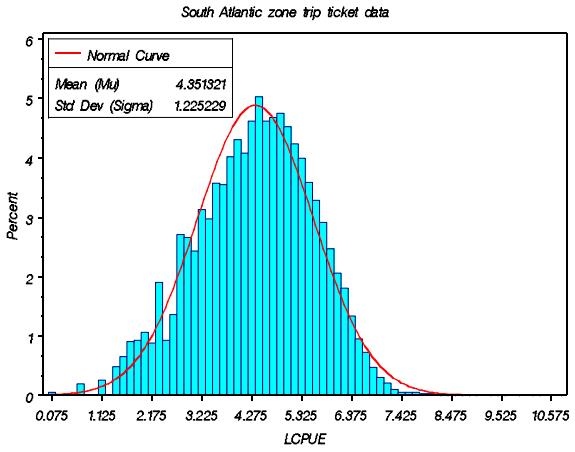
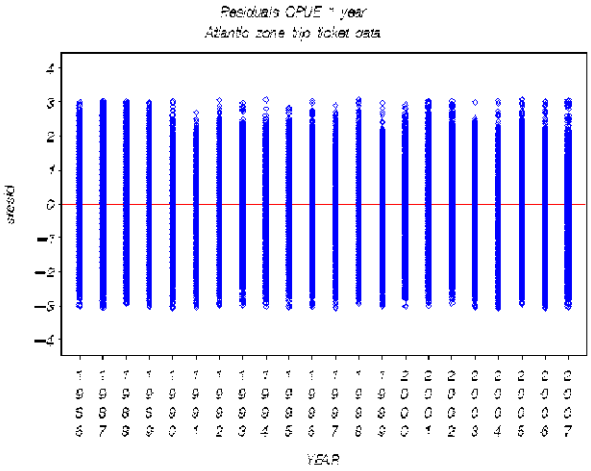


Figure 5. Atlantic zone continuity case index diagnostics. (A) histogram of Log(lbs per day). B) residuals for CPUE by year and (C) chi-square residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

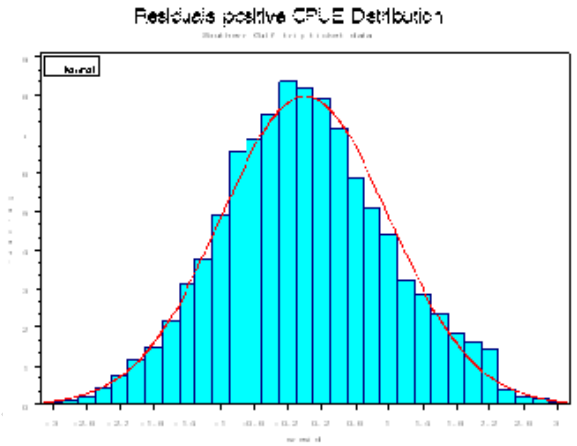
A



B



C



D.

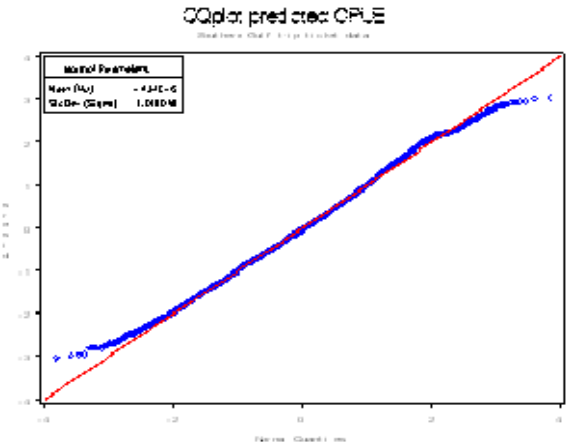


Figure 6. Standardized indices of king mackerel abundance for the continuity case indices.

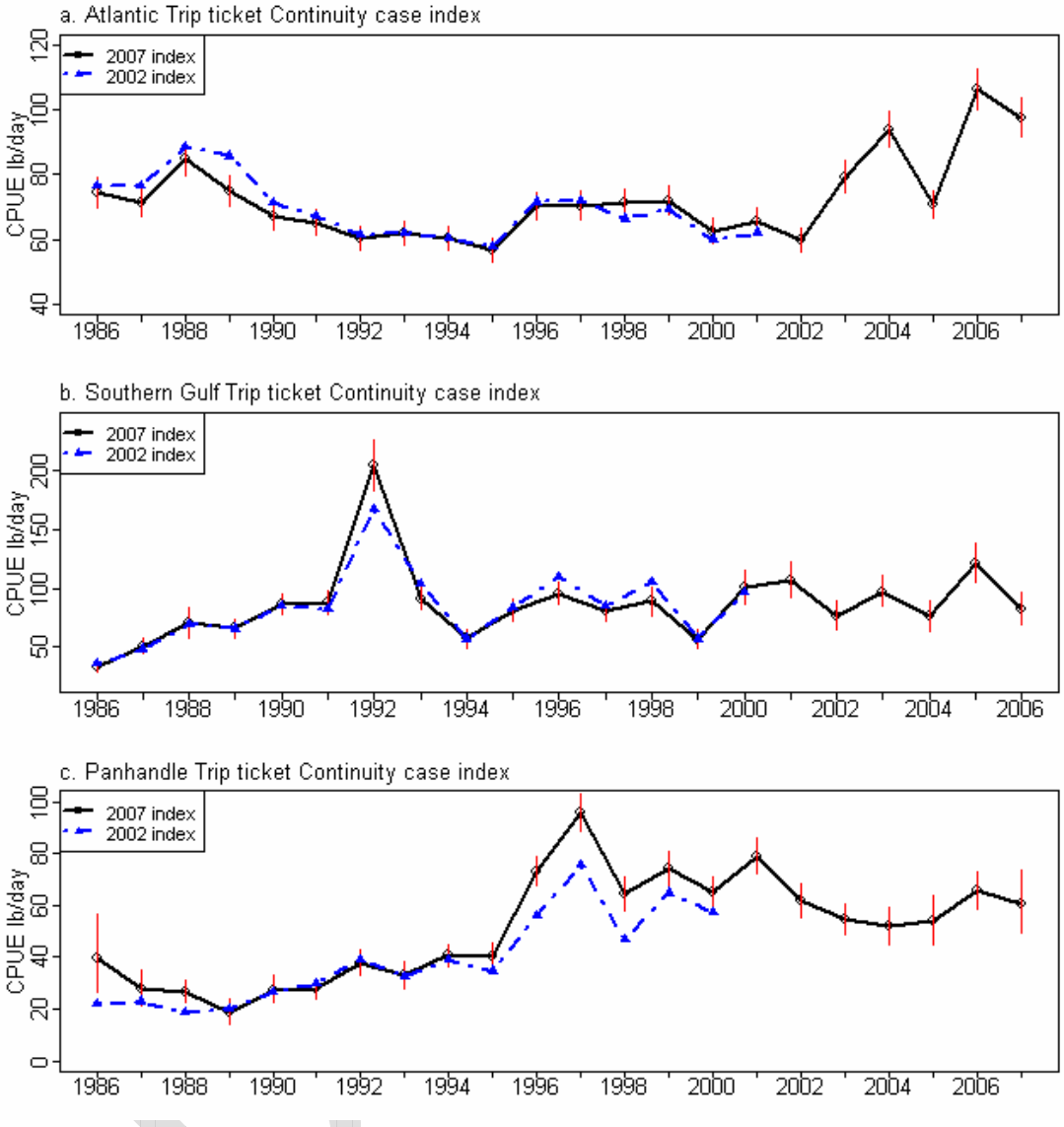


Figure 7. Histograms of the fraction of king mackerel to the total showing the apparent distinction between 'king mackerel' trips and 'other trips' that happened to catch a several king mackerel. A Overall, B. Atlantic, C. Mixing Zone, D. Gulf.

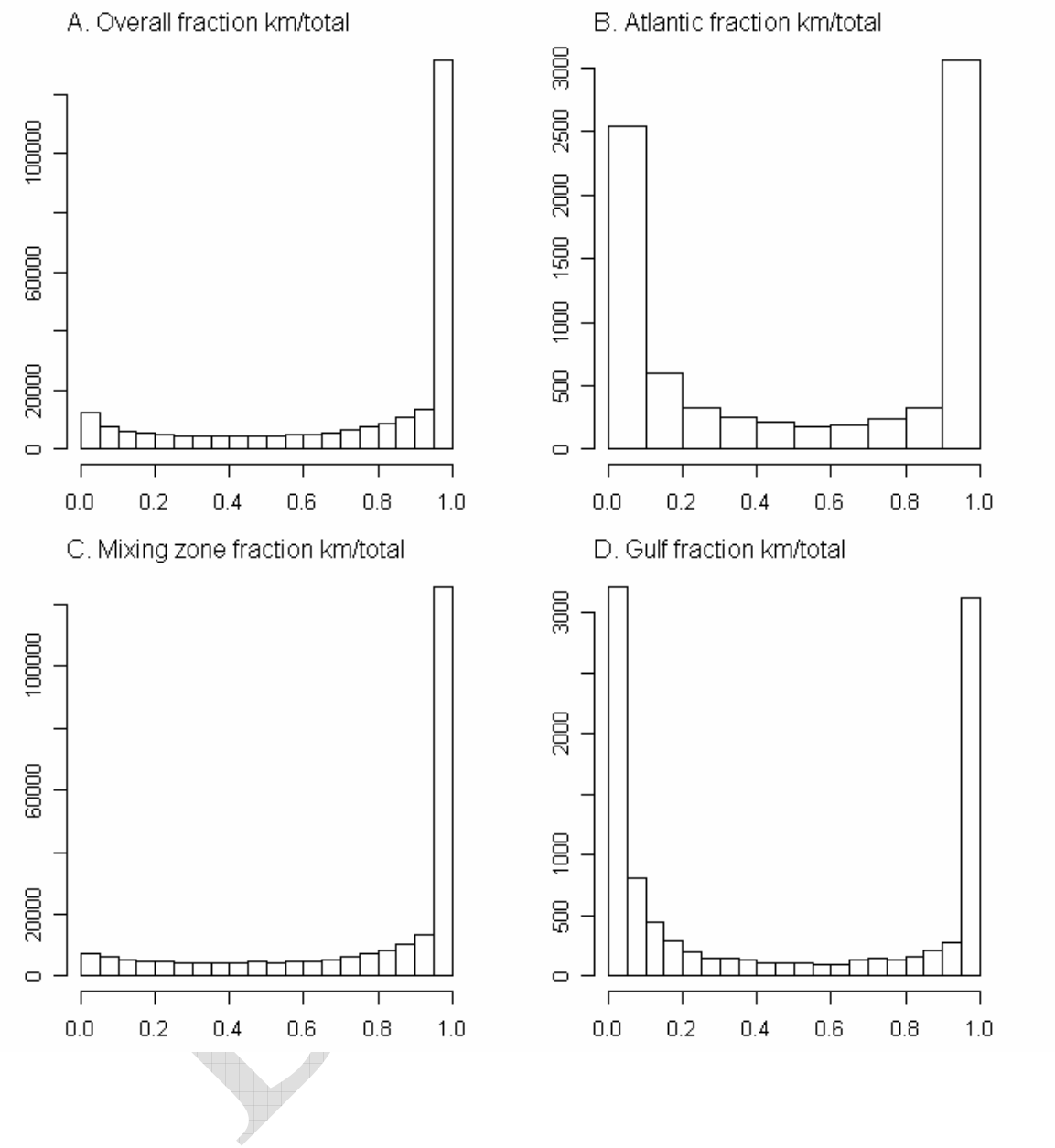


Figure 8. Pairwise correlation for different cutoffs of king mackerel fraction. a-c. Atlantic, Mixing zone and Gulf zones. d. Outlier that causes low correlation, winter 1986 which is represented by 2 samples. Removing this datapoint increases the correlation.

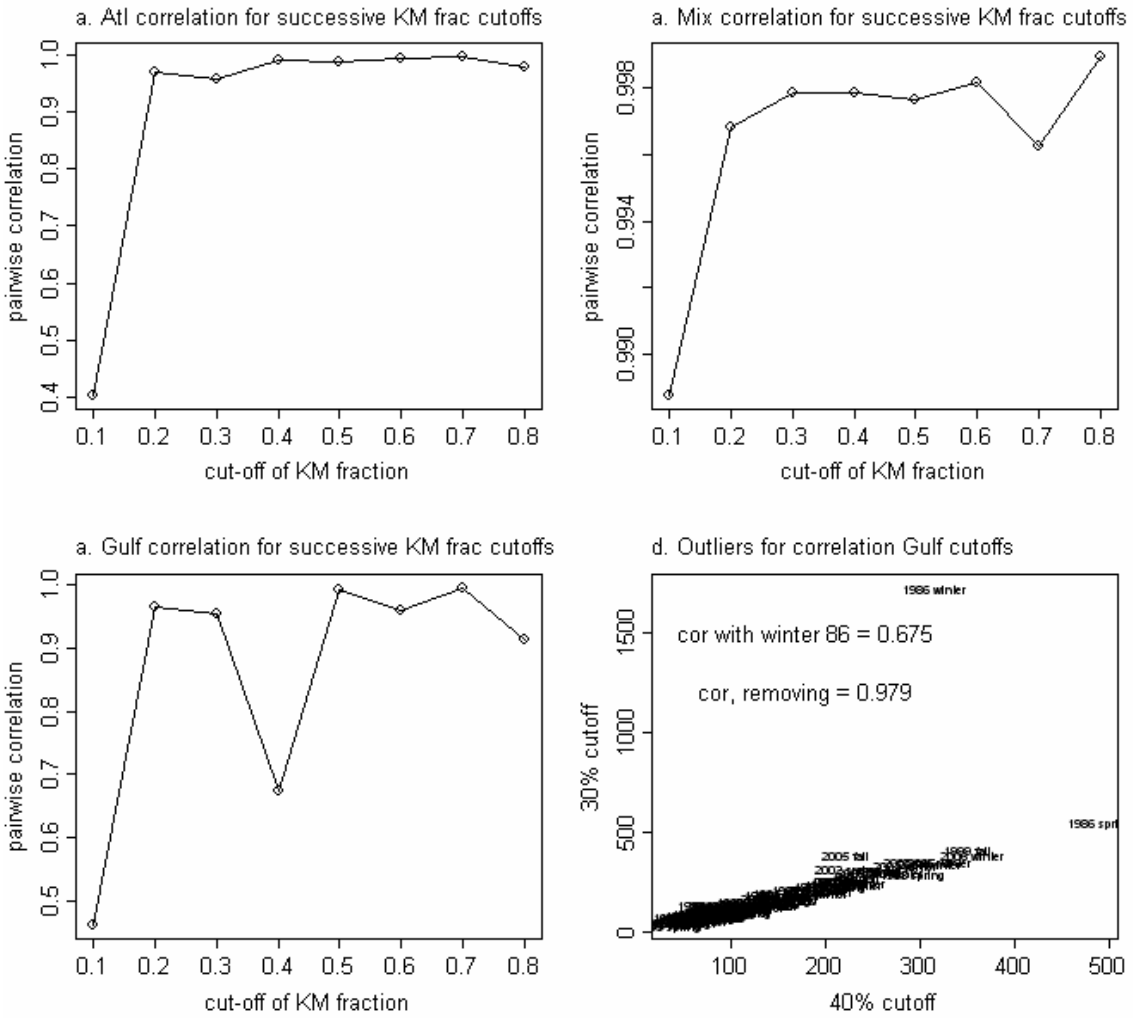


Figure 9. Plot of CPUE (pounds king mackerel per day) for hook and line gear and unknown gear types (red, jittered values). The horizontal line is the 3000lb cutoff used in the 'new' indices.

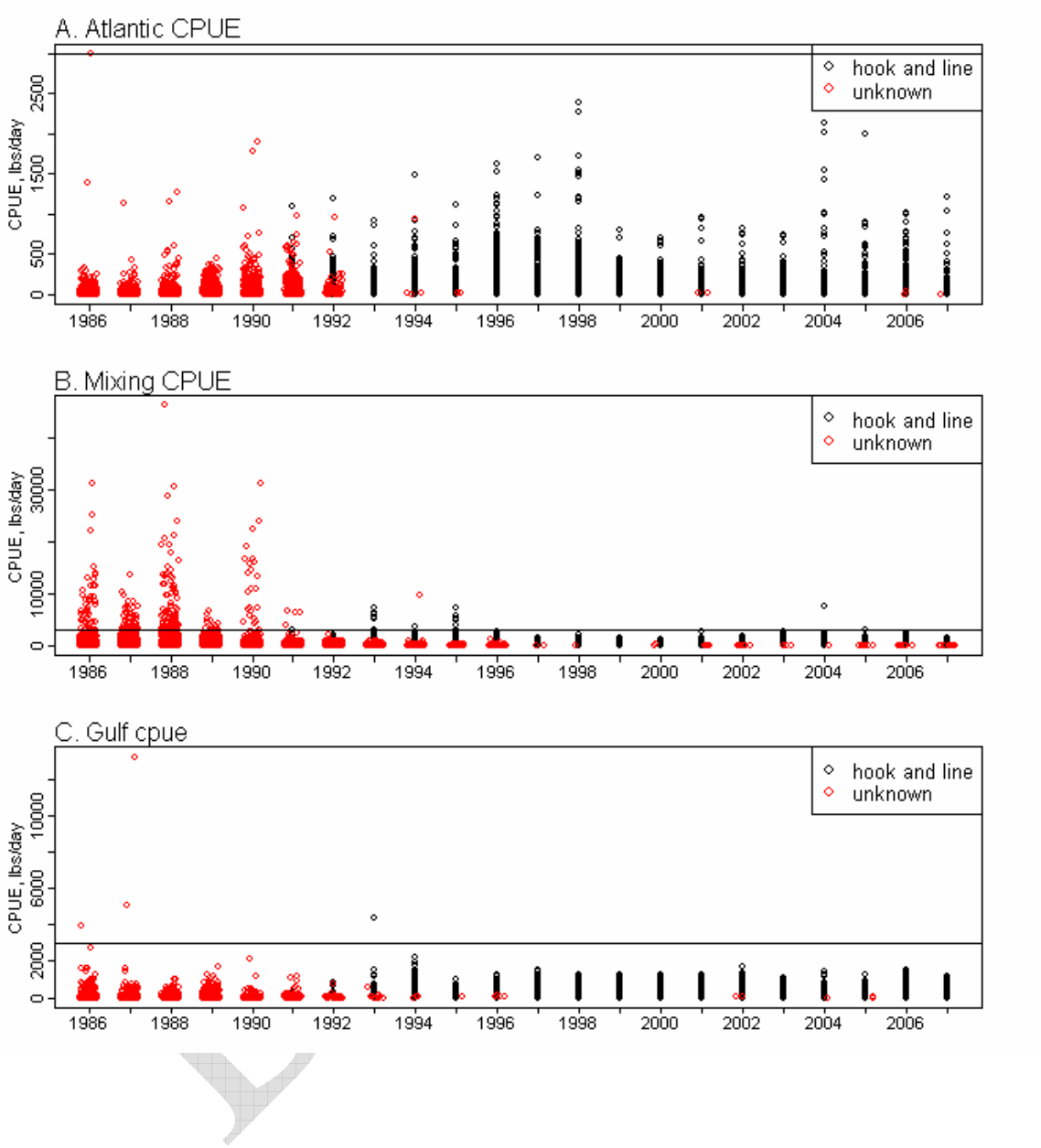


Figure 10. "New" trip ticket Atlantic zone diagnostics. (A) histogram of log(lbs per day). B) residuals for CPUE by year and (C) histogram of residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

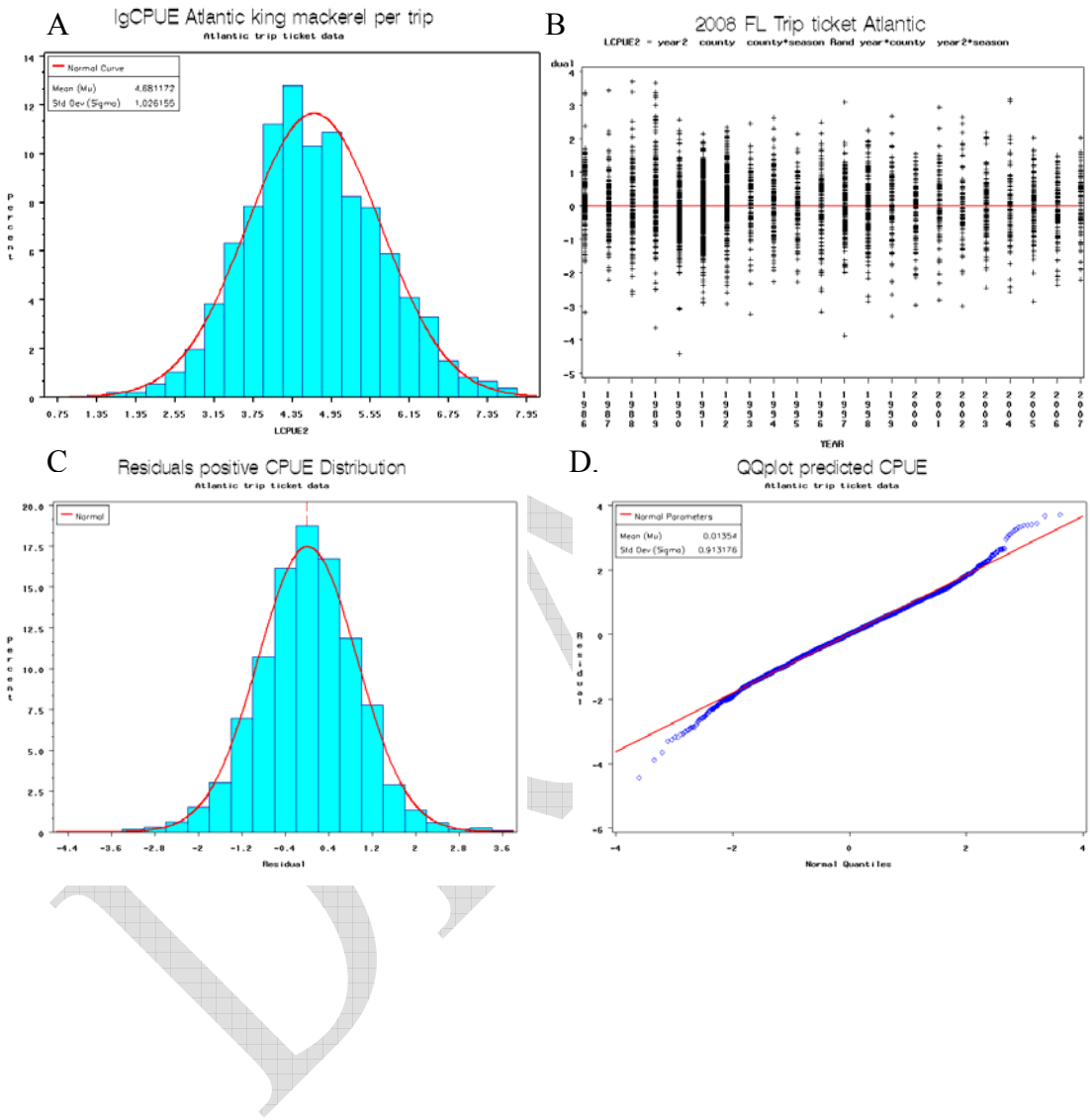


Figure 11. "New" trip ticket Mixing zone diagnostics. (A) histogram of log(lbs per day). B) residuals for CPUE by year and (C) histogram of residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

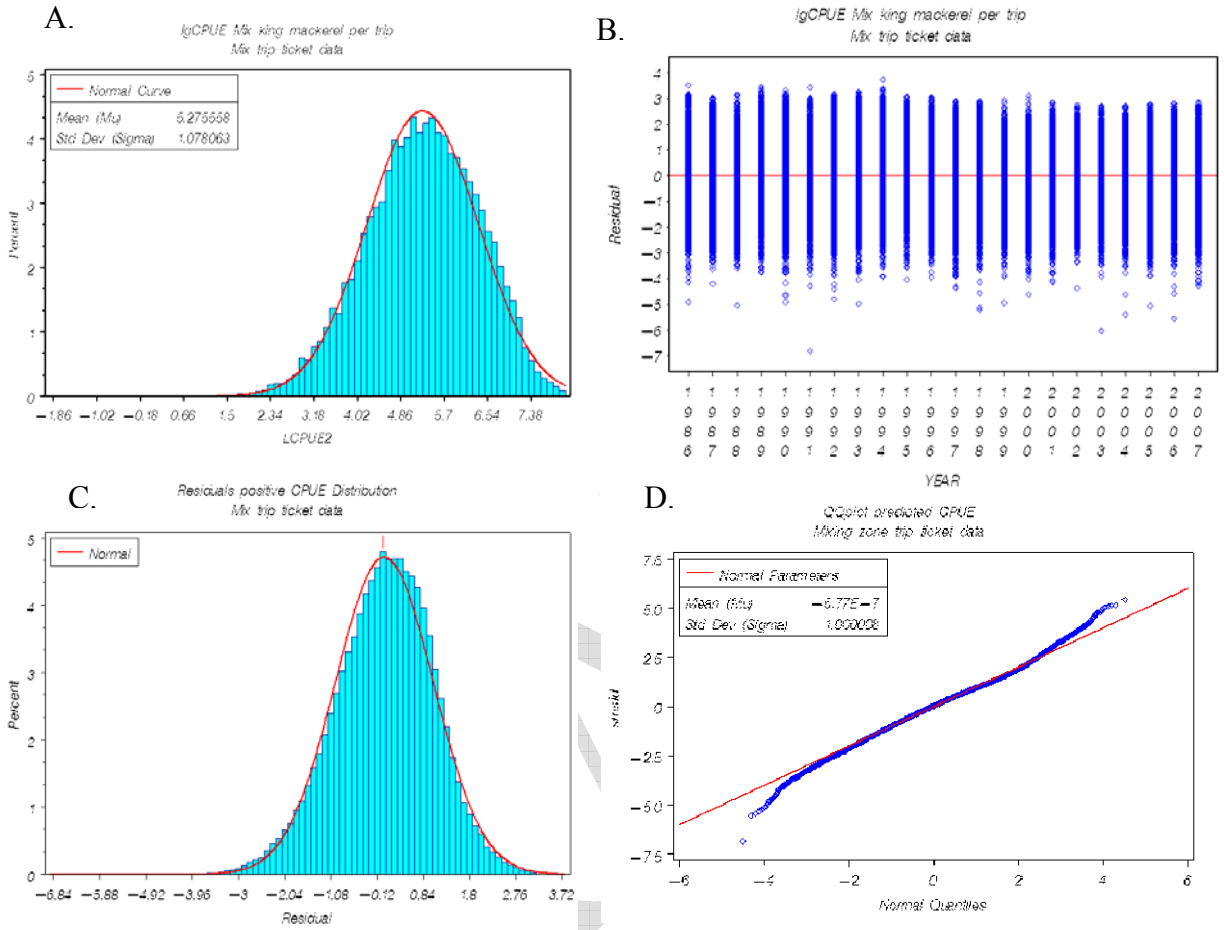


Figure 12. "New" trip ticket Gulf diagnostics. (A) histogram of log(lbs per day). B) residuals for CPUE by year and (C) histogram of residuals by year. (D) Q-Q plot of cumulative normalized CPUE.

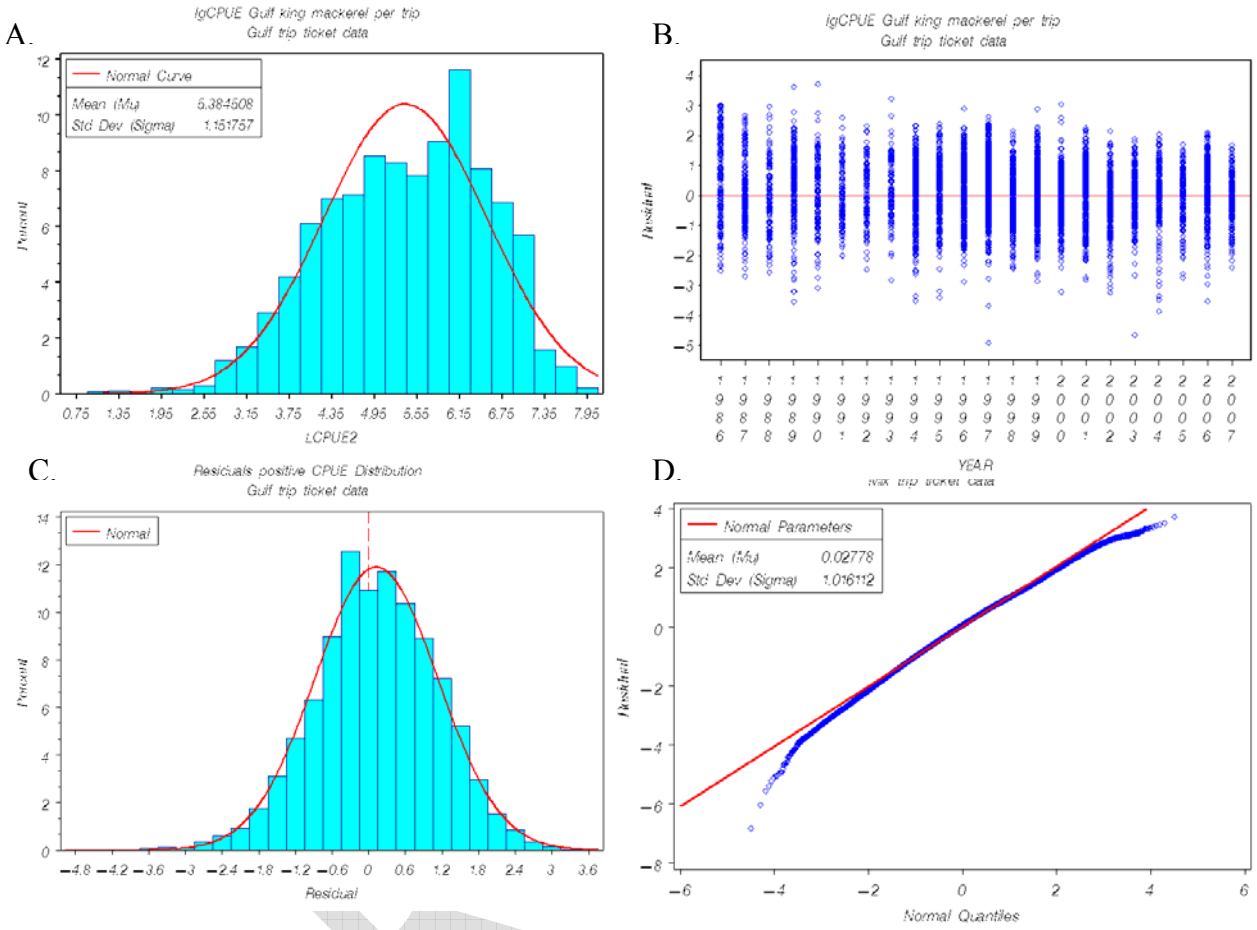


Figure 13.a-c. Standardized Atlantic, Mixing zone and Gulf of Mexico trip ticket indices with 95% confidence intervals.

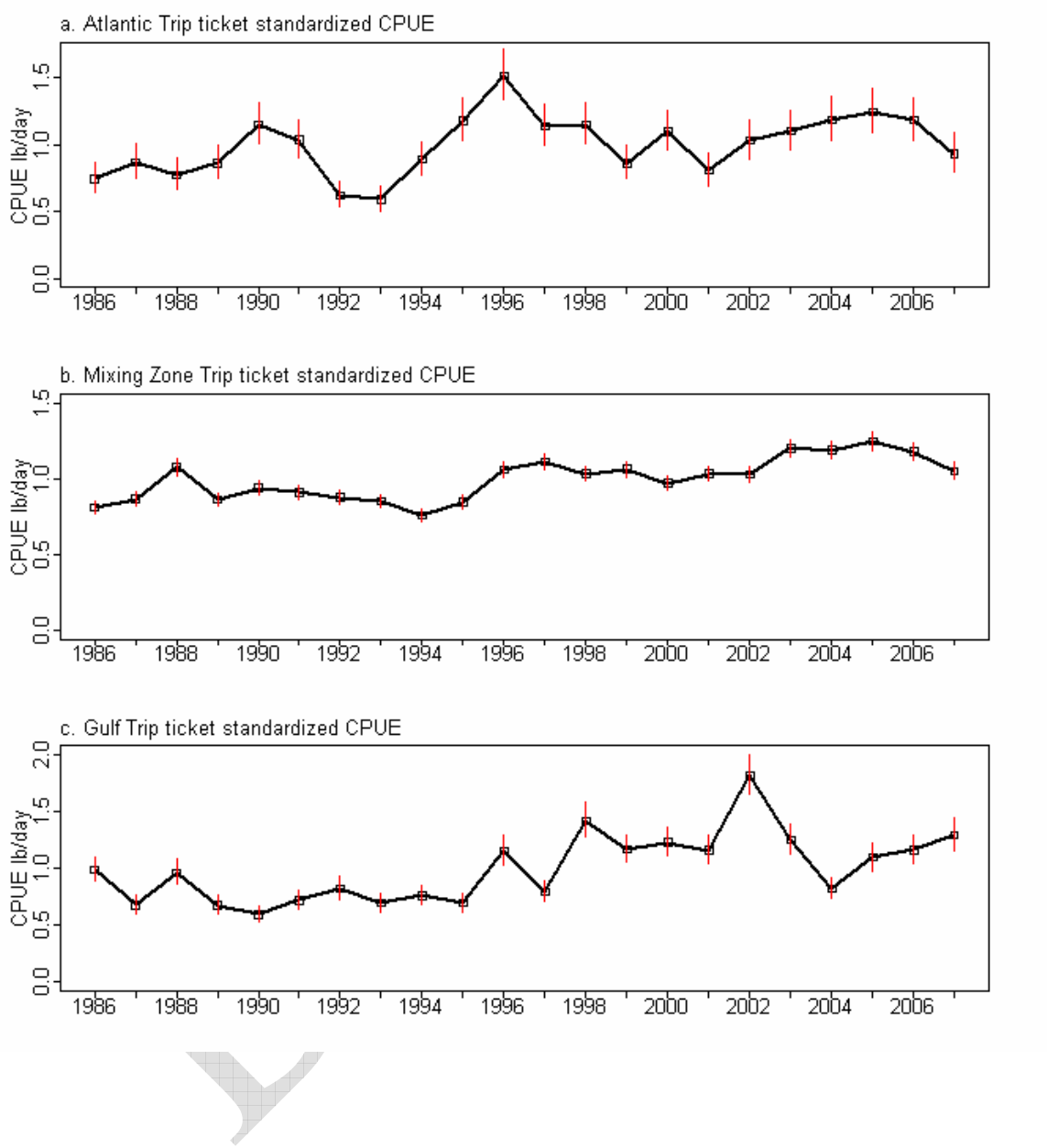


Figure 14.a-c. Standardized Atlantic, Mixing zone and Gulf of Mexico trip ticket indices by season and annual mean index.