

## Appendix 1: Updated headboat survey indices for SEDAR16 “updated” stock assessment models.

### SUMMARY

*This manuscript discusses revisions (as per the SEDAR16 DW recommendations) to indices of abundance of king mackerel from the United States headboat fishery in the Gulf of Mexico and the U.S. South Atlantic. The revised indices were constructed for the U.S. Gulf of Mexico, the U.S. South Atlantic and a “Mixing Area” using Generalized Linear Mixed Models, and a delta-lognormal approach. As recommended by the SEDAR 16 DW panel, the datasets used to construct the indices were “filtered” using a species composition approach. This procedure is intended to restrict datasets to trips that fished in the habitat of king mackerel. All revised indices also used the “repeated measures” procedure to account for the variance in catch rates between vessels.*

### SEDAR 16 DW Recommendations:

The working group was concerned about the effect of management regulations on the standardized indices, and the effect of the trip selection procedure (Stephens and MacCall, 2004). Therefore, the group made the following recommendations:

- 1) Ensure that the sampling coverage annually, seasonally and by fishing area is not significantly degraded by the trip selection procedure. If the distribution of samples remains adequate, the working group recommends the use of the updated indices developed using the Stephens and MacCall (2004) trip selection.
- 2) Examine the impact of management regulations, particularly the bag limit. Determine what fraction of trips reach the bag limit, by year and other pertinent factors.
- 3) To the extent necessary and /or possible, construct indices that take into account management regulations.

### Actions taken to comply with SEDAR 16 DW working group recommendations:

**Recommendation 1)** Upon further examination, it is apparent that the trip selection procedure resulted in a dataset that was considerably unbalanced. To correct this problem some strata had to be aggregated. The details are as follows:

#### A) Gulf of Mexico Index:

- i. Very few selected trips were reported in the Florida Middle Grounds during time series (132 of 34K selected trips). Therefore, that area was combined with “Naples Crystal River” where 891 selected trips occurred.

#### B) Mixing Zone Index:

- i. Very few selected trips reported fishing in the “Dry Tortugas” during the time series (106 of 75K selected trips). Therefore, that area was combined with “Florida Keys - Atlantic Vessels”, where 10,504 selected trips took place.

**C) Atlantic Index:**

- i. Only 25 of 13,323 selected trips reported fishing in the “Cape Fear - Inshore” area during the time series. Therefore, that area was combined with “Cape Fear – Offshore” where 1045 selected trips took place.
- ii. Only 117 of 13,323 selected trips reported fishing in the “Cape Lookout - Inshore” area during the time series. Therefore, that area was combined with “Cape Lookout – Offshore” where 1878 selected trips took place.
- iii. Only 288 of 13,323 selected trips reported fishing in the “Savannah, GA” area during the time series, and none were reported before 1995. Therefore, that area was combined with “North East Florida” where 2859 selected trips took place, and trips were reported in all years (except 1979 and 1989).

**Recommendation 2)** King mackerel recreational landings are managed using three types of fishing regulations, minimum size limits, bag limits and fishing closures. These vary by year and management region (ATL, GOM), and are summarized in **Table 1**. Analyses undertaken to examine the effects of management regulations on fisheries dependent indicators, including the HB indices, are described in SEDAR16-AW-02.

- A) Bag Limits:** Although various bag limits have been mandated during the time series (**Table 1**), no significant effect of the bag limit was found for the Atlantic (**Fig. 1**) or Gulf (**Fig. 2**) headboat fisheries. This result agrees with the testimony of headboat captains present at the SEDAR16 DW. They reported that catches of king mackerel (on headboat trips) were not often restricted by the bag limit since the individual bag limit is multiplied by the large number of anglers on board.
- B) Size Limits:** The working group recommended that changes in selectivity caused by increasing the minimum size limit be estimated by the SS3 model directly. Therefore, they did not recommend breaking the indices at the changes in size limit. Previous king mackerel assessments did not break the indices at the changes in size limit. Therefore, the continuity indices were constructed as unbroken time-series.
- C) Fishing Closures:** Several fishing closures were enacted during the time-series (**Table 1**.) According to regulation §622.43 paragraph (a)(3)(ii), a person aboard a vessel for which valid charter vessel/headboat permits for Gulf coastal migratory pelagic fish or South Atlantic coastal migratory pelagic fish and a valid commercial vessel permit for king or Spanish mackerel have been issued may continue to retain fish under a bag and possession limit specified in § 622.39(c), provided the vessel is operating as a charter vessel or headboat. However, sale of the closed species is prohibited. No data was presented to the SEDAR16 DW to determine which headboat vessels also possessed a commercial permit during the time-series, nor is it clear whether these boats fish in the same manner during open and closed seasons.

For these reasons, all trips that occurred during recreational fishing closures were excluded from the analyses.

**Recommendation 3)** The HB indices were reconstructed applying the techniques discussed above. All other methods are identical to those described in SEDAR16-DW-16 (Section 2.3).

**Recommendation 4) Adequacy of the headboat index for updated assessment models.**

Diagnostic plots were constructed to examine the fits of the components of the revised delta-lognormal models (**Figure 3**). All the diagnostics indicate that the fits to the delta-lognormal models are adequate (e.g., residuals are distributed evenly above and below zero; distributions resemble the expected normal distribution). Therefore, the working group recommends that the revised indices be used in the base case updated model runs (e.g. SS3).

The nominal CPUE series and the delta-lognormal catch rate indices, with 95% confidence intervals, are shown in **Figure 4** and summarized in **Tables 2-4**.

**Literature Cited:**

STEPHENS, A. and A. McCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. *Fisheries Research* 70:299-310.

SEDAR16-DW-16. (Cass-Calay, S.L.) Standardized catch rates of king mackerel(*Scomberomorus cavalla*) from the headboat fishery in the U.S. Gulf of Mexico and U.S. South Atlantic.

SEDAR16-AW-02. (McCarthy, K.M., Cass-Calay, S.L. Ortiz, M. and J. Walter). Effects of king mackerel fishing regulations on the construction of fisheries dependent indices of abundance.

**Table 1.** King Mackerel recreational fishing regulations.

Fishing Year			Bag Limit		Closures		
Year	Atlantic	Gulf	Size Limit	Atlantic	Gulf	Atlantic	Gulf
1983-1984 <sup>1</sup>			--	--	--	--	--
1984-1985 <sup>1</sup>			--	--	--	--	--
1985-1986 <sup>2</sup>	4/1 - 3/31	7/1 - 6/30	--	--	--	--	--
1986-1987	4/1 - 3/31	7/1 - 6/30	--	Private = 2/person/trip; Charterboat = greater of 2/person incl capt&crew or 3/person excl capt&crew		--	--
1987-1988	4/1 - 3/31	7/1 - 6/30	--	3/person/trip	"		Closed 12/16/87 0100h Reopened 7/1/1988 0001h
1988-1989	4/1 - 3/31	7/1 - 6/30	--	2/person/trip FL & 3 GA to NC	"	Closed 10/17/88 0100h Reopened 4/1/89 0001h	Closed 12/17/88 0001h Reopened 7/1/1989 0001h
1989-1990	4/1 - 3/31	7/1 - 6/30	--	2/person/trip FL & 3 GA to NC	"		
1990-1991 <sup>3</sup>	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	2 FL; 3 GA-NY	Same as above <sup>4</sup>		Closed 12/20/90 0001h Reopened 7/1/1991 0001h
1991-1992	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	5 FL-NY	"		Closed 01/13/92 Reopened 7/1/1992
1992-1993	4/1 - 3/31	7/1 - 6/30	20 in FL	2 FL; 5 GA-NY	2 per person including captain & crew		--
1993	Calendar Year		20 in FL	"	"		--
1994	Calendar Year		20 in FL	"	"		--
1995	Calendar Year		20 in FL	2 FL; 3 GA-NY	"		--
1996	Calendar Year		20 in FL	"	"		--
1997	Calendar Year		20 in FL	"	2 per person, 0 capt&crew as of 6-97		--
1998	Calendar Year		20 in FL	"	2 per person, 2 capt&crew as of 2-98		--
1999	Calendar Year		24 in FL	"	2 per person, 0 capt&crew as of 9-99		--
2000	Calendar Year		24 in FL	"	2 per person, 2 capt&crew as of 6-00		--
2001	Calendar Year		24 in FL	"	"		--
2002	Calendar Year		24 in FL	"	"		--
2003	Calendar Year		24 in FL	"	"		--
2004	Calendar Year		24 in FL	"	"		--
2005	Calendar Year		24 in FL	"	"		--
2006	Calendar Year		24 in FL	"	"		--
2007	Calendar Year		24 in FL	"	"		--

<sup>1</sup>One stock

<sup>2</sup>Two management groups (Atlantic & Gulf migratory) from this point forward

<sup>3</sup>Management area expands from TX through NC to TX through NY

<sup>4</sup>Redefined as daily bag limits; 1-day possession except for-hire on multi-day can have 2-day possession

**Table 2.** Nominal CPUE, number of trips, number of positive trips, proportion positive trips (PPT), the standardized CPUE index with upper (UCI) and lower (LCI) 95% confidence intervals for the *Revised – Atlantic*.

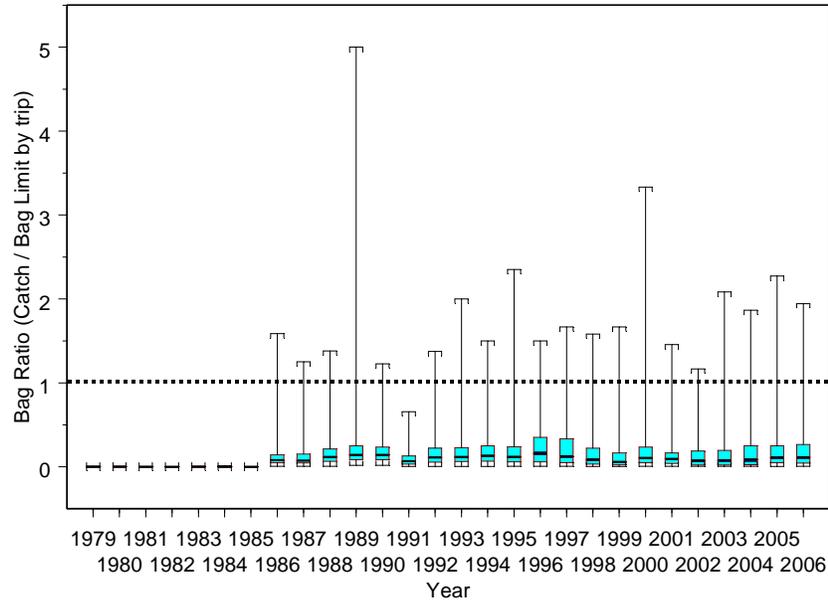
YEAR	NOMINAL CPUE	PROP. POS TRIPS	TRIPS	CV	STD. CPUE	LCI	UCI
1980	11.905	0.410	144	0.406	0.627	0.287	1.371
1981	12.625	0.378	119	0.475	1.506	0.610	3.714
1982	7.811	0.444	189	0.497	0.757	0.296	1.937
1983	5.363	0.512	246	0.387	1.236	0.585	2.610
1984	12.942	0.533	302	0.295	0.769	0.432	1.372
1985	5.450	0.435	338	0.302	0.595	0.330	1.074
1986	9.477	0.465	383	0.235	0.734	0.461	1.168
1987	14.785	0.444	462	0.235	0.858	0.540	1.366
1988	9.488	0.504	391	0.238	0.816	0.510	1.304
1989							
1990							
1991	32.567	0.591	531	0.242	1.170	0.727	1.883
1992	25.357	0.606	579	0.224	1.517	0.975	2.361
1993	18.536	0.443	645	0.238	0.805	0.504	1.287
1994	10.704	0.412	629	0.249	0.614	0.377	1.003
1995	9.230	0.420	690	0.232	0.617	0.390	0.974
1996	8.702	0.345	721	0.240	0.464	0.289	0.744
1997	44.527	0.477	856	0.206	1.218	0.810	1.832
1998	45.124	0.526	803	0.209	1.243	0.822	1.879
1999	15.717	0.459	764	0.218	0.976	0.635	1.502
2000	54.354	0.616	841	0.209	1.854	1.226	2.802
2001	31.463	0.515	680	0.213	1.288	0.844	1.964
2002	25.447	0.479	632	0.241	0.885	0.550	1.425
2003	40.718	0.503	485	0.227	0.912	0.582	1.428
2004	40.020	0.369	691	0.223	0.896	0.576	1.392
2005	34.851	0.499	487	0.254	1.496	0.907	2.468
2006	43.320	0.511	626	0.219	1.147	0.744	1.768

**Table 3.** Nominal CPUE, number of trips, number of positive trips, proportion positive trips (PPT), the standardized CPUE index with upper (UCI) and lower (LCI) 95% confidence intervals for the *Revised – Mix*.

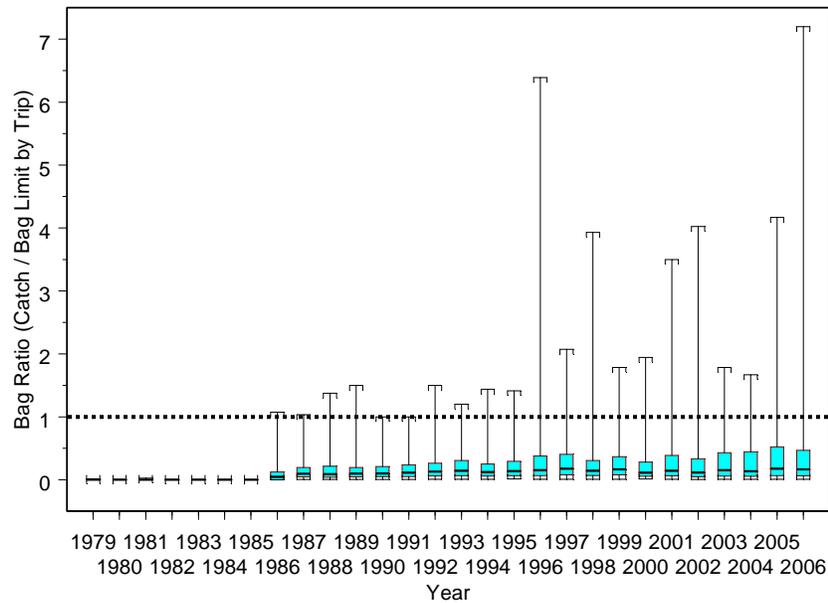
YEAR	NOMINAL CPUE	PROP. POS TRIPS	TRIPS	CV	STD. CPUE	LCI	UCI
1979	74.385	0.680	2403	0.146	1.075	0.804	1.438
1980	87.619	0.675	3600	0.135	1.033	0.790	1.350
1981	95.783	0.621	4222	0.132	1.128	0.866	1.469
1982	49.648	0.623	5062	0.138	0.757	0.576	0.995
1983	51.257	0.613	5020	0.134	0.880	0.674	1.150
1984	67.529	0.664	3756	0.140	0.947	0.717	1.252
1985	48.235	0.634	3579	0.155	0.739	0.543	1.007
1986	49.781	0.658	4442	0.139	0.660	0.501	0.871
1987	59.512	0.676	4516	0.134	0.910	0.697	1.189
1988	47.480	0.621	2585	0.183	0.668	0.465	0.961
1989	59.088	0.693	3157	0.160	1.000	0.727	1.376
1990	56.162	0.656	3869	0.151	0.944	0.699	1.275
1991	84.153	0.688	3074	0.150	1.135	0.842	1.529
1992	53.448	0.647	3400	0.140	0.806	0.611	1.065
1993	63.630	0.651	3649	0.127	0.963	0.747	1.241
1994	57.703	0.633	3005	0.136	0.824	0.629	1.079
1995	57.522	0.582	2869	0.145	0.804	0.602	1.073
1996	79.839	0.587	1467	0.146	1.323	0.990	1.768
1997	85.966	0.677	1835	0.126	1.486	1.155	1.912
1998	69.527	0.621	1387	0.148	1.212	0.902	1.628
1999	50.990	0.517	1049	0.182	0.842	0.587	1.209
2000	55.523	0.627	941	0.178	1.117	0.785	1.589
2001	50.213	0.654	751	0.177	0.952	0.669	1.353
2002	42.893	0.553	418	0.215	0.921	0.602	1.410
2003	62.864	0.596	349	0.229	1.015	0.646	1.594
2004	43.615	0.566	429	0.219	0.853	0.554	1.315
2005	95.254	0.761	503	0.188	1.503	1.035	2.182
2006	108.931	0.776	428	0.212	1.501	0.988	2.281

**Table 4.** Nominal CPUE, number of trips, number of positive trips, proportion positive trips (PPT), the standardized CPUE index with upper (UCI) and lower (LCI) 95% confidence intervals for the *Revised – Gulf*.

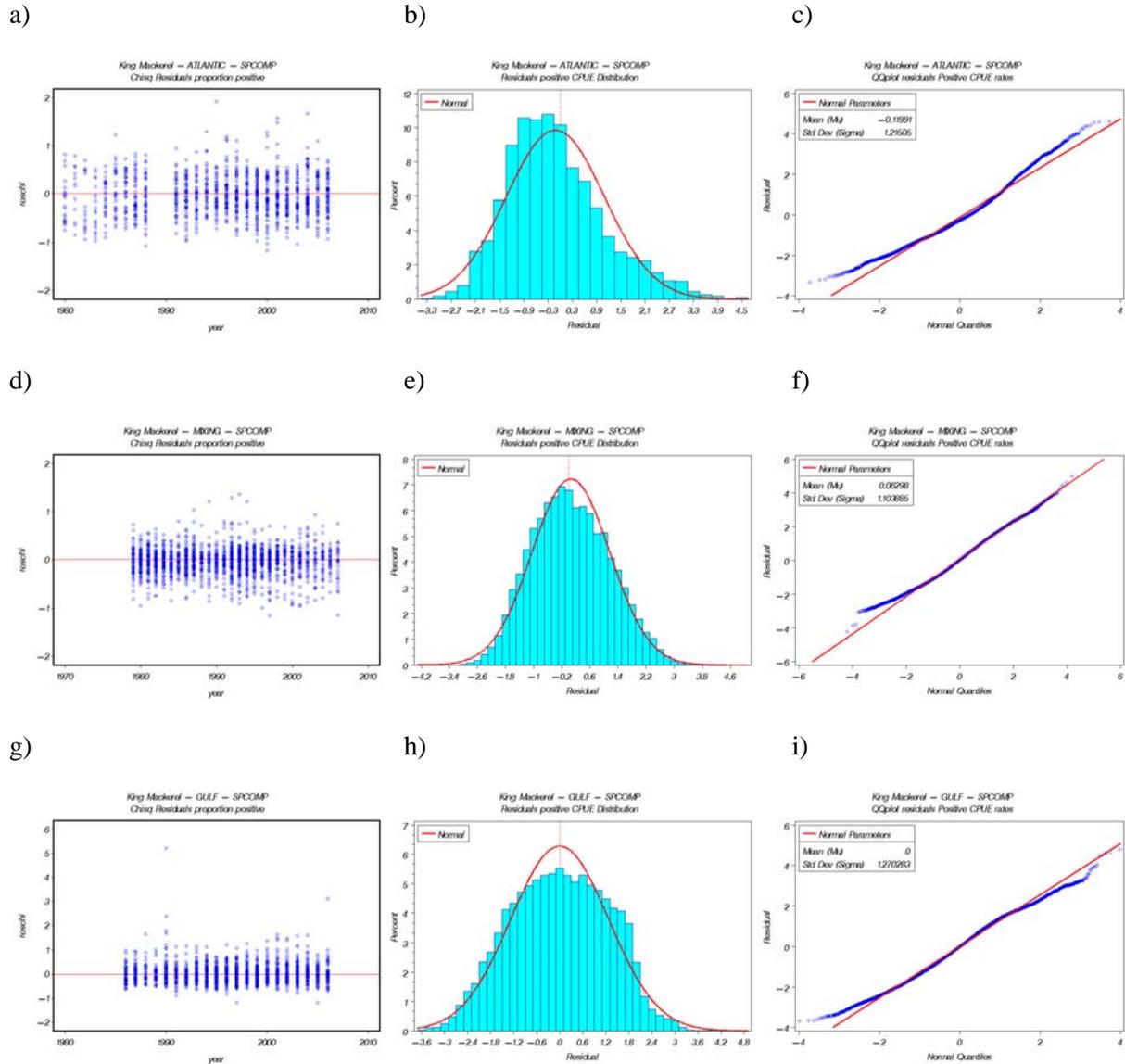
YEAR	NOMINAL CPUE	PROP. POS TRIPS	TRIPS	CV	STD. CPUE	LCI	UCI
1986	46.563	0.550	958	0.184	0.677	0.470	0.974
1987	40.731	0.514	1142	0.175	0.699	0.494	0.988
1988	58.422	0.599	738	0.193	0.809	0.551	1.186
1989	68.352	0.614	824	0.186	0.799	0.552	1.155
1990	37.857	0.431	1521	0.170	0.558	0.399	0.782
1991	58.926	0.657	970	0.156	1.371	1.005	1.871
1992	70.125	0.642	1218	0.153	1.233	0.910	1.672
1993	46.016	0.503	1623	0.151	0.838	0.621	1.130
1994	50.206	0.599	2101	0.133	1.205	0.925	1.570
1995	63.156	0.629	2123	0.134	1.295	0.991	1.693
1996	68.161	0.636	1611	0.142	1.437	1.083	1.906
1997	64.423	0.631	1908	0.140	1.307	0.990	1.726
1998	50.681	0.581	1823	0.145	1.083	0.812	1.446
1999	63.380	0.564	1685	0.150	1.286	0.955	1.732
2000	52.064	0.557	1724	0.152	0.890	0.657	1.205
2001	54.179	0.528	1578	0.160	0.686	0.499	0.944
2002	48.896	0.525	1888	0.150	0.729	0.541	0.981
2003	73.492	0.620	1591	0.153	1.055	0.779	1.430
2004	62.361	0.560	1547	0.162	0.654	0.474	0.901
2005	79.031	0.597	1450	0.163	1.038	0.752	1.434
2006	79.151	0.671	1812	0.148	1.351	1.005	1.815



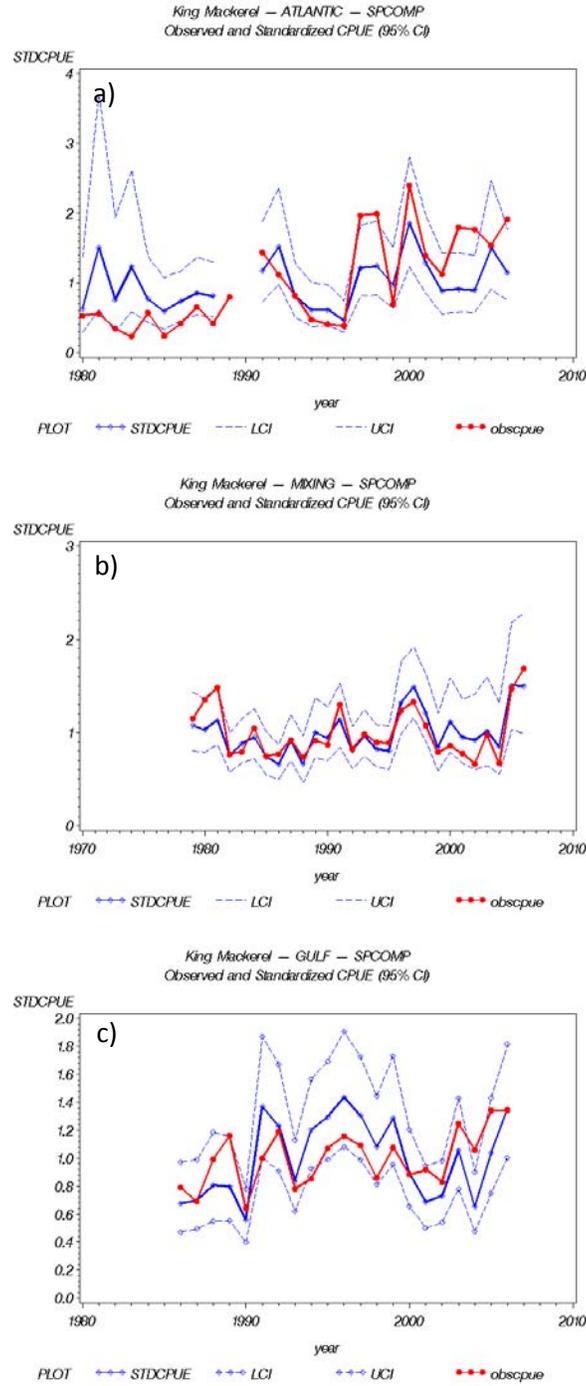
**Figure 1.** Bag limit ratio, by year, for positive trips in the “Atlantic” management region. The bag limit ratio is defined as the total catch allowed under the bag limit, by trip, divided by the total bag limit in place on that trip. The filled box indicates the 95% confidence intervals. The median is indicated by the line within the box. The range of the data is shown by the “whiskers”.



**Figure 2.** Bag limit ratio, by year, for positive trips in the “Gulf” management region. The bag limit ratio is defined as the total catch allowed under the bag limit, by trip, divided by the total bag limit in place on that trip. The filled box indicates the 95% confidence intervals. The median is indicated by the line within the box. The range of the data is shown by the “whiskers”.



**Figure 3.** Diagnostic plots used to assess the goodness of fit of the delta-lognormal models for the Atlantic (a-c), Mixing Zone (d-f) and Gulf of Mexico (g-i). The plots in the left hand column (a,d and g) show the residuals of the binomial model, year. The middle column (b,e and h) shows the distribution of log(CPUE) on positive trips. The red line is the expected normal distribution. The right hand column (c, f and i) shows the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.



**Figure 4.** The revised standardized indices (solid blue line open symbols) and nominal CPUE series (solid red line filled symbols) with 95% confidence intervals (dashed lines) for the a) Atlantic, b) Mixing zone and c) Gulf Mexico.

