Standardized indices of abundance for bonnethead and Atlantic sharpnose sharks caught during the South Carolina Department of Natural Resources red drum longline and Cooperative Atlantic States Shark Pupping and Nursery gillnet surveys

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SEDAR 34 DATA WORKSHOP DOCUMENT

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Summary

This document details shark catches from the South Carolina Department of Natural Resources (SCDNR), Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) gillnet survey and the SCDNR adult red drum longline survey, both conducted in South Carolina's estuarine waters, with additional nearshore stations in the red drum survey. Catch per unit effort (CPUE) in number of sharks per net hour or sharks per hook hour were used to examine bonnethead and/or Atlantic sharpnose shark relative abundance for gillnet and longline surveys, respectively. The SCDNR red drum time series had to be analyzed in two separate time segments (1998-2006 and 2007-2011) due to a change in gear and sampling design. The CPUE for all time series was standardized using a two-step delta-lognormal approach that models the proportion of positive catch with a binomial error distribution separately from the positive catch, which is modeled using a lognormal distribution. Nominal and standardized CPUE results from the COASTSPAN gillnet survey indicate a decreasing trend in bonnethead relative abundance during the survey years. This survey also shows an overall decreasing trend for total Atlantic sharpnose sharks across survey years; but, once young-of-the year sharks are removed from the gillnet catch, an increasing trend is seen in age 1+ sharks. Atlantic sharpnose shark relative abundance begins an increasing trend during the final years of the 1998-2006 red drum survey. The current red drum survey shows a fairly stable trend in Atlantic sharpnose shark relative abundance.

Introduction

In an effort to examine the use of South Carolina's estuarine waters as nursery areas for coastal shark species the South Carolina Department of Natural Resources (SCDNR) Marine Resources Division, in collaboration with the National Marine Fisheries Service's (NMFS) Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey began sampling for sharks using longline and gillnet methods in several estuaries within South Carolina since 1998. In addition to the estuarine areas sampled specifically for sharks, the SCDNR also samples the shark bycatch from a long-term longline survey designed to monitor adult red drum *Sciaenops ocellatus* in the coastal waters of South Carolina. This survey was modified from a fixed station to a random stratified station survey in 2007 in response to the needs of stock assessment biologists and to increase coverage along the coast. In addition, the mainline and number of hooks used for the 2007-2011 SCDNR red drum longline survey were reduced to one third of the original mainline length and hook number per set. For these reasons, the SCDNR red drum longline survey was analyzed as two separate time series (1998-2006 and 2007-2011). Relative abundance indices from the SCDNR red drum survey have been previously generated for Atlantic sharpnose sharks covering the time period from 1998 to 2005 (McCandless et al. 2007). In this document, the time series is updated with data through 2006.

Methods

Sampling design

SC COASTSPAN estuarine sampling locations were selected in the lower reaches of estuaries in depths which would facilitate the deployment and retrieval of gillnets and hand deployed longlines (i.e. current velocity, tidal range, vessel traffic). All gillnet sampling occurred inside of inlets and sampling locations varied with regard to distance from nearshore waters. Estuarine sampling was conducted primarily from April through October with the majority of the effort occurring between May and September. Nearshore sampling stations were those previously selected for adult red drum sampling. Nearshore sampling occurred from immediately outside of the surf zone to 8 km offshore with depths ranging from 3–15 m. These sites were primarily live-bottom areas with low relief, consisting of rock or marl outcrops that were encrusted with sessile invertebrates such as sponges, gorgonians and bryozoans. Nearshore sampling occurred throughout the year with the exception of February; however, nearshore sampling was most intense from September through mid-December. The locations of the SC COASTSPAN and the 1998-2006 SCDNR red drum fixed estuarine and nearshore sampling areas are shown in Figure 1.

In 2007, SCDNR red drum sampling protocol was changed to increase geographical and seasonal coverage. Thirty sites are randomly selected from a predetermined list of sites (40-100 sites/strata) during each sampling period (2- month periods: March/April. May/June, July/August, September/October, November/December). Each of four strata (Winyah Bay, Charleston Harbor, St. Helena Sound and Port Royal

Sound) is sampled once during each time period (Figure 2). Specific sampling locations within each stratum have been identified and chosen due to bottom type, depth, and in some cases from previous sampling or suggestions from local charter captains.

Sampling gear and data collection

The SC COASTSPAN gillnet survey used two anchored sink nets that are both 3 m deep and constructed of #177 monofilament twine with a stretched mesh of 10.3 cm. These nets were approximately 230 m and 50 m in length. Net lengths differ to allow for sampling in different environments (i.e. areas too small for the larger net). The nets were set and inspected for catch at approximately 20-minute intervals to reduce mortality. SCDNR red drum longline gear consisted of a 272 kg test monofilament mainline that was 1829 m in length for the 1998-2006 time series and 610 m for the 2007-2011 time series and both time series had 30.5 m buoy lines attached at each end. The mainline for both red drum time series was equipped with stop sleeves at 30.5 m intervals to prevent gangions from sliding together when a large fish was captured. The gangions consisted of a 0.5 m, 91 kg test monofilament leader, size 120 stainless steel longline snap, 4/0 swivel and either a 14/0 or 15/0 circle hook. For the 1998-2006 SCDNR red drum time series a set consisted of 120 hooks, and for the 2007-2011 time series a set consisted of 40 hooks. Soak times for red drum longline sets were limited to 45 minutes unless conditions or events dictated otherwise.

Station location, water temperature, salinity, and time of day were recorded for each set for all gear types. The sex, weight, fork length, total length, and umbilical scar condition of all sharks were recorded. Umbilical scar condition was recorded in six categories: "umbilical remains," "fresh open," "partially healed," "mostly healed," "well healed," and none. Sharks were then tagged with either a NMFS blue rototag or steel tipped dart tag (M-tag) and released.

Data Analysis

Catch per unit effort (CPUE) in number of sharks per net hour or sharks per hook hour were used to examine bonnethead and/or Atlantic sharpnose shark relative abundance for gillnet and longline surveys, respectively. For the purposes of this SEDAR process, male bonnetheads smaller than 37 cm fork length, female bonnetheads smaller than 36 cm fork length, male Atlantic sharpnose smaller than 38 cm fork length, and female Atlantic sharpnose smaller than 43 cm fork length were considered to be young-of-the-year sharks and excluded from analyses of age 1+ sharks. The CPUEs were standardized using the Lo et al. (2002) method which models the proportion of positive sets separately from the positive catch. This analysis was done for the following dependent variables: SC-COASTSPAN-GN total bonnethead CPUE, SC-COASTSPAN-GN age 1+ bonnethead CPUE, SC-COASTSPAN-GN total Atlantic sharpnose shark CPUE, SC-COASTSPAN-GN age 1+ A. sharpnose shark CPUE, 1998-2006 SCDNR-LL-RED DRUM total A. sharpnose shark CPUE, 1998-2006

SCDNR-LL-RED DRUM age 1+ A. sharpnose shark CPUE, 2007-2011 SCDNR-LL-RED DRUM total A. sharpnose shark CPUE, and 2007-2011 SCDNR-LL-RED DRUM age 1+ A. sharpnose shark CPUE. Factors considered as potential influences on all survey sets were: year, month, depth, salinity, temperature, area (each of the estuaries sampled), and set number. The gillnet survey also included a gear factor for the different net lengths. The proportion of sets with positive catch values was modeled assuming a binomial distribution with a logit link function and the positive catch sets were modeled assuming a lognormal distribution.

Models were fit in a stepwise forward manner adding one potential factor at a time after initially running a null model with no factors included (Gonzáles-Ania et al. 2001, Carlson 2002). Each potential factor was ranked from greatest to least reduction in deviance per degree of freedom when compared to the null model. The factor resulting in the greatest reduction in deviance was then incorporated into the model provided the effect was significant at $\alpha = 0.05$ based on a Chi-Square test, and the deviance per degree freedom was reduced by at least 1% from the less complex model. This process was continued until no additional factors met the criteria for incorporation into the final model. The factor "year" was kept in all final models, regardless of its significance, to allow for calculation of indices. All models in the stepwise approach were fitted using the SAS GENMOD procedure (SAS Institute, Inc.). The final models were then run through the SAS GLIMMIX macro to allow fitting of the generalized linear mixed models using the SAS MIXED procedure (Wolfinger, SAS Institute, Inc). The standardized indices of abundance were based on the year effect least square means determined from the combined binomial and lognormal components.

Results

SC COASTSPAN gillnet survey – total bonnetheads

A total of 2393 bonnetheads were caught during 1103 gillnet sets from 1998 to 2011. The size range of bonnetheads caught by year is displayed in Figure 3. The proportion of sets with positive catch (at least one bonnethead caught) was 67%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 1. Model diagnostic plots reveal that the model fit is acceptable (Figures 4a and 4b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 2 and are plotted by year in Figure 5.

SC COASTSPAN gillnet survey – age 1+ bonnetheads

A total of 2391 age 1+ bonnetheads were caught during 1103 gillnet sets from 1998 to 2011. The proportion of sets with positive catch (at least one age 1+ bonnethead caught) was 67%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 3. Model

diagnostic plots reveal that the model fit is acceptable (Figures 6a and 6b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 4 and are plotted by year in Figure 7.

SC COASTSPAN gillnet survey – total Atlantic sharpnose sharks

A total of 1767 Atlantic sharpnose sharks were caught during 1103 gillnet sets from 1998 to 2011. The size range of A. sharpnose sharks caught by year is displayed in Figure 8. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 42%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 5. Model diagnostic plots reveal that the model fit is acceptable (Figures 9a and 9b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 6 and are plotted by year in Figure 10.

SC COASTSPAN gillnet survey – age 1+ Atlantic sharpnose sharks

A total of 582 A. sharpnose sharks were caught during 1103 gillnet sets from 1998 to 2011. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 15%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 7. Model diagnostic plots reveal that the model fit is acceptable (Figures 11a and 11b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 8 and are plotted by year in Figure 12.

SCDNR red drum survey (1998-2006) – total Atlantic sharpnose sharks

A total of 5033 A. sharpnose sharks were caught during 1041 longline sets from 1998 to 2006. The size range of A. sharpnose sharks caught by year is displayed in Figure 13. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 67%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 9. Model diagnostic plots reveal that the model fit is acceptable (Figures 14a and 14b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 10 and are plotted by year in Figure 15.

SCDNR red drum survey (1998-2006) – age 1+ Atlantic sharpnose sharks

A total of 4731 age 1+ A. sharpnose sharks were caught during 1041 longline sets from 1998 to 2006. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 65%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 11. Model diagnostic plots reveal that the model fit is acceptable (Figures 16a and 16b). The resulting indices of

abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 12 and are plotted by year in Figure 17.

SCDNR red drum survey (2007-2011) – total Atlantic sharpnose sharks

A total of 3873 A. sharpnose sharks were caught during 1983 longline sets from 2007 to 2011. The size range of A. sharpnose sharks caught by year is displayed in Figure 18. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 56%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 13. Model diagnostic plots reveal that the model fit is acceptable (Figures 19a and 19b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 14 and are plotted by year in Figure 20.

SCDNR red drum survey (2007-2011) – age 1+ Atlantic sharpnose sharks

A total of 3452 age 1+ A. sharpnose sharks were caught during 1983 longline sets from 2007 to 2011. The proportion of sets with positive catch (at least one A. sharpnose shark caught) was 49%. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 15. Model diagnostic plots reveal that the model fit is acceptable (Figures 21a and 21b). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 16 and are plotted by year in Figure 22.

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Table 1. Results of the stepwise procedure for development of the SC-COASTSPAN-GN catch rate model for total bonnetheads. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	884	1135.0502	1.2840					
area	881	1090.0945	1.2373	3.6371	3.6371	-575.7292	44.96	<.0001
month	878	1091.2846	1.2429	3.2009		-576.3242	43.77	<.0001
gear	883	1098.6370	1.2442	3.0997		-580.0040	36.41	<.0001
year	871	1099.8096	1.2627	1.6589		-580.5867	35.24	0.0008
temp	880	1118.9646	1.2716	0.9657		-590.1642	16.09	0.0029
set	875	1113.9214	1.2731	0.8489		-587.6426	21.13	0.0121
depth	880	1120.3693	1.2731	0.8489		-590.8666	14.68	0.0054
sal	881	1131.9256	1.2848	-0.0623		-596.6447	3.12	0.3728
area +								
month	875	1041.6723	1.1905	7.2819	3.6449	-551.5181	48.42	<.0001
year	868	1056.5059	1.2172	5.2025	1.5654	-558.9349	33.59	0.0014
gear	880	1073.9230	1.2204	4.9533	1.3162	-567.6434	16.17	<.0001
area + month +								
year	862	1012.0450	1.1741	8.5592	1.2773	-536.7044	29.63	0.0053
gear	874	1027.2562	1.1754	8.4579	1.1760	-544.3100	14.42	0.0001
area + month + year +								
gear	861	997.3671	1.1584	9.7819	1.2227	-529.3655	14.68	0.0001

FINAL MODEL: area + month + year + gear

AIC 1075.2 **BIC** 1192.0 **(-2) Res LL** 1058.7

Type 3 Test of Fixed Effects

Fixed effect	area	month	year	gear
Significance (Pr>Chi)	0.0001	<.0001	0.0049	0.0001
DF	3	6	13	1
CHI SQUARE	20.90	39.86	29.89	14.68

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	655	611.5986	0.9337					
gear	654	507.4911	0.7760	16.8898	16.8898	-846.6321	122.41	<.0001
area	652	526.7130	0.8078	13.4840		-858.8261	98.02	<.0001
year	642	540.0132	0.8411	9.9175		-867.0056	81.66	<.0001
depth	651	568.0181	0.8725	6.5546		-883.5892	48.49	<.0001
set	646	565.5377	0.8754	6.2440		-882.1538	51.36	<.0001
month	649	577.0078	0.8891	4.7767		-888.7396	38.19	<.0001
temp	651	597.2363	0.9174	1.7457		-900.0416	15.59	0.0036
sal	652	598.5522	0.9180	1.6815		-900.7634	14.14	0.0027
gear +								
area	651	485.1367	0.7452	20.1885	3.2987	-831.8562	29.55	<.0001
depth	650	485.3950	0.7468	20.0171	3.1273	-832.0308	29.20	<.0001
set	645	484.9219	0.7518	19.4816	2.5918	-831.7109	29.84	0.0005
month	648	492.8978	0.7606	18.5391	1.6494	-837.062	19.14	0.0039
year	641	487.8253	0.7610	18.4963	1.6065	-833.6690	25.93	0.0174
sal	651	497.3069	0.7639	18.1857	1.2959	-839.983	13.30	0.0040
temp	650	498.6591	0.7672	17.8323	0.9425	-840.8736	11.52	0.0213
gear + area +								
year	638	456.2680	0.7152	23.4015	3.2130	-811.7333	40.25	0.0001
set	642	461.5247	0.7189	23.0052	2.8168	-815.4906	32.73	0.0001
month	645	471.9349	0.7317	21.6344	1.4459	-822.8068	18.10	0.0060
depth	647	474.2456	0.7330	21.4951	1.3066	-824.4088	14.89	0.0049
sal	648	483.0086	0.7454	20.1671	-0.0214202	-830.4143	2.88	0.4099
gear + area + year +								
set	629	439.9934	0.6995	25.0830	1.6815	-799.8201	23.83	0.0046
month	632	446.0795	0.7058	24.4083	1.0067	-804.326	14.81	0.0217
depth	634	452.1714	0.7132	23.6157	0.2142	-808.7751	5.92	0.2055
gear + area + year + set +								
month	623	430.6716	0.6913	25.9612	0.8782	-792.7964	14.05	0.0291

FINAL MODEL: gear + area + year + set

AIC 1655.6 **BIC** 1781.3 **(-2) Res LL** 1599.6

Type 3 Test of Fixed Effects

Fixed effect	gear	area	year	set
Significance (Pr>Chi)	0.0003	<.0001	0.0030	0.0046
DF	1	3	13	9
CHI SQUARE	13.31	45.26	31.34	23.83

Table 2. SC-COASTSPAN-GN total bonnethead analysis number of model observationss per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per net hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	28	12	0.4286	5.1151	2.5158	1.2322	5.1365	0.3686
1999	23	18	0.7826	10.7557	8.9540	5.3182	15.0756	0.2650
2000	30	24	0.8065	7.4842	5.4331	3.2247	9.1540	0.2653
2001	108	67	0.6204	11.1689	5.9016	4.3001	8.0996	0.1593
2002	68	51	0.7500	9.0652	5.1953	3.6999	7.2951	0.1710
2003	89	67	0.7528	11.0675	5.5716	4.1610	7.4605	0.1468
2004	16	8	0.5000	5.9225	2.6048	0.9636	7.0412	0.5296
2005	68	54	0.7941	12.0510	6.2527	4.4543	8.7770	0.1708
2006	153	98	0.6400	4.1262	6.7509	5.2799	8.6318	0.1233
2007	120	84	0.7025	4.7581	5.3404	4.3112	6.6154	0.1074
2008	137	88	0.6423	3.8084	4.7541	3.7761	5.9853	0.1155
2009	55	38	0.6909	6.0589	5.1738	3.7419	7.1538	0.1631
2010	91	61	0.6703	3.6682	4.6343	3.5165	6.1076	0.1387
2011	106	60	0.5660	2.2362	3.4105	2.5431	4.5739	0.1475

Table 3. Results of the stepwise procedure for development of the SC-COASTSPAN-GN catch rate model for age 1+ bonnetheads. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	883	1132.7436	1.2828					
area	880	1088.2047	1.2366	3.6015	3.6015	-574.7843	44.96	<.0001
month	877	1088.4276	1.2411	3.2507		-574.8957	44.32	<.0001
gear	882	1095.8531	1.2425	3.1416		-578.6085	36.89	<.0001
year	870	1096.7765	1.2607	1.7228		-579.0702	35.97	0.0006
temp	879	1116.5690	1.2703	0.9744		-588.9664	16.17	0.0028
set	874	1111.6630	1.2719	0.8497		-586.5134	21.08	0.0123
depth	879	1118.6312	1.2726	0.7951		-589.9975	14.11	0.0069
sal	880	1129.5732	1.2836	-0.0624		-595.4685	3.17	0.3661
area +								
month	874	1039.2685	1.1891	7.3043	3.6673	-550.3162	48.94	<.0001
year	867	1054.1378	1.2158	5.2229	1.5859	-557.7508	34.07	0.00012
gear	879	1071.6839	1.2192	4.9579	1.3208	-566.5239	16.52	<.0001
area + month +								
year	861	1009.4108	1.1724	8.6062	1.3018	-535.3873	29.86	0.0049
gear	873	1024.5938	1.1736	8.5126	1.2083	-542.9788	14.67	0.0001
area + month + year +								
gear	860	994.6557	1.1566	9.8379	1.2317	-528.0098	14.76	0.0001

FINAL MODEL: area + month + year + gear

AIC 1072.5 **BIC** 1189.2 **(-2) Res LL** 1056.0

Type 3 Test of Fixed Effects

Fixed effect	area	month	year	gear
Significance (Pr>Chi)	0.0001	<.0001	0.0048	0.0001
DF	3	6	13	1
CHI SQUARE	20.33	40.05	29.94	14.76

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	655	612.0218	0.9344					
gear	654	508.0926	0.7769	16.8557	16.8557	-847.0206	122.08	<.0001
area	652	527.5166	0.8091	13.4097		-859.3261	97.47	<.0001
year	642	540.1150	0.8413	9.9636		-867.0675	81.99	<.0001
depth	651	568.2484	0.8729	6.5818		-883.7222	48.68	<.0001
set	646	566.1144	0.8763	6.2179		-882.4881	51.15	<.0001
month	649	577.1454	0.8893	4.8266		-888.8178	38.49	<.0001
temp	651	597.2253	0.9174	1.8193		-900.0355	16.05	0.0029
sal	652	598.9479	0.9186	1.6909		-900.9802	14.17	0.0027
gear +								
area	651	485.9730	0.7465	20.1092	3.2194	-832.4211	29.20	<.0001
depth	650	485.8327	0.7474	20.0128	3.1230	-832.3264	29.39	<.0001
set	645	485.5665	0.7528	19.4349	2.5451	-832.1467	29.75	0.0005
month	648	493.3078	0.7613	18.5253	1.6355	-837.3347	19.37	0.0036
year	641	488.1844	0.7616	18.4932	1.6034	-833.9103	26.22	0.0159
sal	651	497.9847	0.7650	18.1293	1.2395	-840.4297	13.18	0.0043
temp	650	498.9319	0.7676	17.8510	0.9612	-841.0530	11.94	0.0178
gear + area +								
year	638	456.8918	0.7161	23.3626	3.2534	-812.1814	40.48	0.0001
set	642	462.4168	0.7203	22.9131	2.8039	-816.1240	32.59	0.0002
month	645	472.6199	0.7327	21.5860	1.4769	-823.2826	18.28	0.0056
depth	647	474.8742	0.7340	21.4469	1.3378	-824.8433	15.16	0.0044
sal	648	483.9105	0.7468	20.0771	-0.0321	-831.0261	2.79	0.4251
gear + area + year +								
set	629	440.7115	0.7007	25.0107	1.6481	-800.3550	23.65	0.0049
month	632	446.6517	0.7067	24.3686	1.0060	-804.7465	14.87	0.0213
depth	634	452.7433	0.7141	23.5766	0.2140	-809.1896	5.98	0.2004
gear + area + year + set +								
month	623	430.6716	0.6913	26.0167	1.0060	-792.7964	14.05	0.0291

FINAL MODEL: gear + area + year + set

AIC 1656.7 **BIC** 1782.3 **(-2) Res LL** 1600.7

Type 3 Test of Fixed Effects

Fixed effect	gear	area	year	set
Significance (Pr>Chi)	0.0003	<.0001	0.0028	0.0049
DF	1	3	13	9
CHI SQUARE	13.23	44.81	31.54	23.65

Table 4. SC-COASTSPAN-GN age 1+ bonnethead analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per net hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	28	12	0.4286	5.1151	2.3577	1.1371	4.8888	0.3771
1999	23	18	0.7826	10.7557	8.3609	4.9799	14.0373	0.2635
2000	30	24	0.8065	7.4842	5.4024	3.3622	8.6807	0.2405
2001	108	67	0.6204	11.1689	5.8642	4.2774	8.0396	0.1587
2002	68	51	0.7500	9.0652	4.9777	3.5288	7.0214	0.1733
2003	89	67	0.7528	11.0675	5.3880	4.0311	7.2015	0.1458
2004	16	8	0.5000	5.9225	3.4016	1.5756	7.3438	0.3995
2005	68	54	0.7941	12.0510	6.7558	4.8803	9.3521	0.1637
2006	153	96	0.6275	4.0453	5.2456	4.1967	6.5565	0.1119
2007	120	84	0.7025	4.7257	4.9168	3.9245	6.1601	0.1131
2008	137	88	0.6423	3.8084	4.7478	3.7792	5.9646	0.1144
2009	55	38	0.6909	6.0589	5.2336	3.7672	7.2708	0.1655
2010	91	61	0.6703	3.6682	4.7118	3.5565	6.2424	0.1413
2011	106	60	0.5660	2.2362	3.5114	2.6093	4.7254	0.1493

Table 5. Results of the stepwise procedure for development of the SC-COASTSPAN-GN catch rate model for total Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	884	1253.7863	1.4183					
year	871	1133.9024	1.3018	8.2141	8.2141	-594.6771	119.88	<.0001
gear	883	1156.0740	1.3093	7.6853		-605.7629	97.71	<.0001
month	878	1160.2633	1.3215	6.8251		-607.8576	93.52	<.0001
area	881	1234.1622	1.4009	1.2268		-644.8070	19.62	0.0002
sal	881	1247.9061	1.4165	0.1269		-651.6789	5.88	0.1176
depth	880	1247.3901	1.4175	0.0564		-651.4209	6.40	0.1714
temp	880	1247.8721	1.4180	0.0212		-651.6620	5.91	0.2056
set	875	1243.5198	1.4212	-0.2045		-649.4858	10.27	0.3293
year +								
month	865	1056.7399	1.2182	14.1084	5.8944	-554.5959	80.16	<.0001
gear	870	1097.5544	1.2616	11.0484	2.8344	-576.5031	36.55	<.0001
area	868	1122.0499	1.2927	8.8557	0.6416	-588.7508	11.85	0.0079
year + month +								
gear	864	1030.5891	1.1928	15.8993	1.7909	-543.0205	23.15	<.0001
area	862	1037.3525	1.2034	15.1519	1.0435	-546.4021	16.39	0.0009
year + month + gear+								
area	861	991.9292	1.1521	18.7689	2.8696	-523.6905	38.66	<.0001

FINAL MODEL: year+ month + gear + area

AIC 1067.7 **BIC** 1184.4 **(-2) Res LL** 1047.4

Type 3 Test of Fixed Effects

Fixed effect	year	month	gear	area
Significance (Pr>Chi)	<.0001	<.0001	<.0001	<.0001
DF	13	6	1	3
CHI SQUARE	42.80	80.13	45.42	38.66

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	409	448.4615	1.0965					
gear	408	370.2380	0.9074	17.2458	17.2458	-560.8525	78.59	<.0001
year	396	364.6023	0.9207	16.0328		-557.7080	84.88	<.0001
month	403	414.8088	1.0293	6.1286		-584.1552	31.98	<.0001
area	406	429.4712	1.0578	3.5294		-591.2763	17.74	0.0005
depth	405	439.3304	1.0848	1.0670		-595.9292	8.43	0.0769
temp	405	444.5651	1.0977	-0.1094		-598.3574	3.58	0.4661
set	401	440.3155	1.0980	-0.1368		-596.3883	7.52	0.4821
sal	406	446.4005	1.0995	-0.2736		-599.20200	1.89	0.5959
gear +								
year	395	316.8484	0.8021	26.8491	9.6033	-528.9294	63.85	<.0001
area	405	350.8346	0.8663	20.9941	3.7483	-549.8171	22.07	<.0001
month	402	350.1932	0.8711	20.5563	3.3105	-549.4420	22.82	0.0009
gear + year +								
area	392	301.2523	0.7685	29.9134	3.0643	-518.5820	20.69	0.0001
month	389	300.5632	0.7727	29.5303	2.6813	-518.1125	21.63	0.0014
gear + year + area +								
month	386	278.2095	0.7208	34.2636	4.3502	-502.2694	32.63	<.0001

FINAL MODEL: gear + year + area + month

AIC 1054.5 **BIC** 1154.9 **(-2) Res LL** 1004.5

Type 3 Test of Fixed Effects

Fixed effect	gear	year	area	month
Significance (Pr>Chi)	<.0001	<.0001	<.0001	<.0001
DF	1	13	3	6
CHI SQUARE	41.75	66.65	31.69	32.63

Table 6. SC-COASTSPAN-GN total Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per net hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	28	16	0.5714	7.8076	5.6006	2.4980	12.5568	0.4207
1999	23	15	0.6522	5.4311	5.2921	2.0531	13.6408	0.5012
2000	30	16	0.5484	5.1465	2.8295	1.0901	7.3445	0.5054
2001	108	51	0.4722	4.6575	2.9826	1.7073	5.2102	0.2844
2002	68	47	0.6912	4.7578	3.3740	2.0573	5.5335	0.2512
2003	89	65	0.7303	29.8741	10.4477	6.7251	16.2309	0.2230
2004	16	4	0.2500	2.4485	1.4546	0.2799	7.5608	0.9860
2005	68	46	0.6765	5.4827	4.0685	2.3850	6.9404	0.2719
2006	153	53	0.3464	2.5299	4.5635	2.7977	7.4439	0.2484
2007	120	35	0.2893	1.9689	2.4863	1.3511	4.5753	0.3122
2008	137	36	0.2628	1.6304	3.3082	1.8244	5.9989	0.3043
2009	55	19	0.3455	9.6496	5.7602	2.6090	12.7175	0.4120
2010	91	27	0.2967	2.3858	2.4040	1.1780	4.9059	0.3683
2011	106	25	0.2358	0.6272	1.4252	0.6746	3.0109	0.3874

Table 7. Results of the stepwise procedure for development of the SC-COASTSPAN-GN catch rate model for age 1+ Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	883	817.0654	0.9253					
month	877	656.2991	0.7483	19.1289	19.1289	-342.0125	160.77	<.0001
temp	879	711.3368	0.8093	12.5365		-369.5313	105.73	<.0001
year	870	754.5196	0.8673	6.2682		-391.1227	Negative of Hessian not positive definite	
gear	882	792.7690	0.8988	2.8639		-410.2475	24.30	<.0001
area	880	805.4074	0.9152	1.0915		-416.5666	11.66	0.0087
depth	879	806.1985	0.9172	0.8754		-416.9622	10.87	0.0281
sal	880	807.9656	0.9181	0.7781		-417.8457	9.10	0.0280
set	874	1243.5198	1.4212	-53.5934		-418.2387	Negative of Hessian not positive definite	
month +								
gear	876	613.2194	0.7000	24.3489	5.2199	-320.4727	43.08	<.0001
year	864	612.3906	0.7088	23.3978	4.2689	-320.0583	43.91	<.0001
temp	873	643.5383	0.7372	20.3285	1.1996	-335.6321	12.76	0.0125
area	874	645.3959	0.7384	20.1989	1.0699	-336.5609	10.90	0.0123
month + gear +								
year	863	577.1449	0.6688	27.7207	3.3719	-302.4354	36.07	0.0006
temp	872	606.0019	0.6950	24.8892		-316.8639	7.22	0.1248
area	873	609.2366	0.6979	24.5758		-318.4812	3.98	0.2633

FINAL MODEL: month + gear + year

AIC 633.0 **BIC** 735.2 **(-2) Res LL** 604.9

Type 3 Test of Fixed Effects

Fixed effect	month	gear	year
Significance (Pr>Chi)	<.0001	<.0001	0.0006
DF	6	1	13
CHI SQUARE	15.93	35.25	36.07

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	153	162.7408	1.0637					
gear	152	139.2598	0.9162	13.8667	13.8667	-210.7695	24.00	<.0001
year	142	135.1203	0.9516	10.5387		-208.4460	28.64	0.0026
month	146	141.1778	0.9604	9.7114		-211.8227	21.89	0.0013
area	150	150.8749	1.0058	5.4433		-216.9379	11.66	0.0086
sal	150	155.7459	1.0383	2.3879		-219.3846	6.77	0.0798
depth	405	156.6479	1.0443	1.8238		-219.8292	5.88	0.1178
temp	150	157.9999	1.0533	0.9777		-220.4910	4.55	0.2076
set	146	158.5015	1.0856	-2.0589		-220.7350	4.06	0.7723
gear +								
area	149	125.6658	0.8434	20.7107	6.8440	-202.8604	15.82	0.0012
year	141	120.2302	0.8527	19.8364	5.9697	-199.4556	22.63	0.0199
month	146	125.8985	0.8623	18.9339	5.0672	-203.0029	15.53	0.0165
gear + area +								
year	138	105.9169	0.7675	27.8462	7.1355	-189.6956	26.33	0.0058
month	143	116.1777	0.8124	23.6251		-196.8155	12.09	0.0600

FINAL MODEL: gear + area + year

AIC 413.4 **BIC** 465.0 **(-2) Res LL** 379.4

Type 3 Test of Fixed Effects

Fixed effect	gear	area	year
Significance (Pr>Chi)	<.0001	0.0002	0.0058
DF	1	3	11
CHI SQUARE	21.34	19.52	26.33

Table 8. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per net hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	28	4	0.1429	0.7264	2.3657	0.5838	9.5862	0.7946
1999	23	0	0.0000	0.0000	.	.	.	.
2000	30	1	0.0323	0.0690	0.0200	0.0020	0.2054	1.6965
2001	108	6	0.0556	0.1667	0.3030	0.0820	1.1188	0.7295
2002	68	14	0.2059	1.0907	1.2849	0.5064	3.2598	0.4919
2003	89	39	0.4382	9.6158	3.9900	2.2353	7.1221	0.2959
2004	16	0	0.0000	0.0000	.	.	.	.
2005	65	9	0.1324	0.6953	0.6120	0.1992	1.8803	0.6085
2006	153	12	0.0784	0.5299	1.2417	0.4631	3.3295	0.5247
2007	120	17	0.1405	0.8710	1.1935	0.5159	2.7608	0.4384
2008	137	22	0.1606	1.2810	2.6116	1.2702	5.3694	0.3724
2009	55	6	0.1091	0.3248	1.1268	0.3150	4.0306	0.7078
2010	91	16	0.1758	1.6787	2.6021	1.0790	6.2750	0.4623
2011	106	17	0.1604	0.4304	1.4302	0.6364	3.2137	0.4220

Table 9. Results of the stepwise procedure for development of the SCDNR-Red Drum-OLD catch rate model for total Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	424	627.1537	1.4791					
depth	423	543.1322	1.2840	13.1905	13.1905	-352.3492	84.02	<.0001
year	416	556.0423	1.3366	9.6342		-358.8042	71.11	<.0001
month	414	576.8013	1.3932	5.8076		-369.1837	50.35	<.0001
sal	421	599.1500	1.4232	3.7793		-380.3581	28.00	<.0001
temp	422	619.5697	1.4682	0.7369		-390.5679	7.58	0.0226
set	418	613.9447	1.4688	0.6964		-387.7554	13.21	0.0398
area	420	626.2660	1.4911	-0.8113		-393.9161	0.89	0.9263
depth +								
year	415	502.9326	1.2119	18.0650	4.8746	-332.2494	40.20	<.0001
month	413	486.1813	1.1772	20.4111		-323.8737	Negative of Hessian not paritive definite	
sal	420	537.9938	1.2809	13.4000		-349.7800	5.14	0.1619

FINAL MODEL: depth + year

AIC 590.0 **BIC** 634.6 **(-2) Res LL** 664.5

Type 3 Test of Fixed Effects

Fixed effect	depth	year
Significance (Pr>Chi)	<.0001	<.0001
DF	1	8
CHI SQUARE	53.11	40.20

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	438	506.7431	1.1569					
month	428	430.5496	1.0060	13.0435	13.0435	-618.6476	71.53	<.0001
year	430	441.1818	1.0260	11.3147		-624.0022	60.82	<.0001
temp	436	479.9391	1.1008	4.8492		-642.4846	23.86	<.0001
depth	437	501.7437	1.1482	0.7520		-652.2370	4.35	0.0370
area	434	499.5485	1.1510	0.5100		-651.2746	6.28	0.1794
set	432	500.4303	1.1584	-0.1297		-651.6617	5.50	0.4811
sal	435	506.2664	1.1638	-0.5964		-654.2067	0.41	0.9375
month +								
year	420	379.2755	0.9030	21.9466	8.9031	-590.8151	55.67	<.0001
temp	426	417.2887	0.9796	15.3254	2.2820	-611.7807	13.73	0.0010
month + year +								
temp	418	372.5621	0.8913	22.9579	1.0113	-586.895	7.84	0.0198

FINAL MODEL: month + year + temp

AIC 1217.8 **BIC** 1307.6 **(-2) Res LL** 1173.8

Type 3 Test of Fixed Effects

Fixed effect	month	year	temp
Significance (Pr>Chi)	<.0001	<.0001	0.0198
DF	10	8	2
CHI SQUARE	52.03	49.77	7.84

Table 10. SCDNR-Red Drum-OLD total Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	117	93	0.7949	0.1060	0.0981	0.0655	0.1470	0.2043
1999	93	73	0.7849	0.0529	0.0539	0.0343	0.0845	0.2282
2000	112	78	0.6964	0.1383	0.1347	0.0906	0.2002	0.2000
2001	94	76	0.8085	0.1646	0.1436	0.1009	0.2042	0.1775
2002	111	72	0.6518	0.1171	0.1169	0.0732	0.1867	0.2375
2003	154	104	0.6774	0.1202	0.1026	0.0721	0.1461	0.1781
2004	93	44	0.4742	0.0408	0.0368	0.0186	0.0728	0.3519
2005	49	24	0.4898	0.0426	0.0471	0.0212	0.1048	0.4159
2006	93	52	0.5638	0.0675	0.0720	0.0439	0.1178	0.2504

Table 11. Results of the stepwise procedure for development of the SCDNR-Red Drum-OLD catch rate model for age 1+ Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	424	635.3053	1.4984					
depth	423	543.3699	1.2846	14.2686	14.2686	-353.8543	91.94	<.0001
year	416	562.9016	1.3531	9.6970		-363.6202	72.40	<.0001
month	414	580.1664	1.4014	6.4736		-372.2525	55.14	<.0001
sal	421	603.2450	1.4329	4.3713		-383.7919	32.06	<.0001
temp	422	623.2411	1.4769	1.4349		-393.7899	12.06	0.0024
set	418	622.9203	1.4902	0.5473		-393.6295	12.38	0.0539
area	420	626.2435	1.4911	0.4872		-395.2911	9.06	0.0596
depth +								
year	415	502.6725	1.2113	19.1604	4.8919	-333.5056	40.70	<.0001
temp	421	535.2362	1.2713	15.1562	0.8876	-349.7875	8.13	0.0171
sal	420	536.7767	1.2780	14.7090	0.4405	-350.5577	6.59	0.0861
month	413	485.6824	1.1760	21.5163	7.2477	-325.0106	Negative of Hessian not paritive definite	
depth + year +								
temp	413	490.9576	1.1888	20.6620	1.5016	-327.6481	11.71	0.0029

FINAL MODEL: depth + year + temp

AIC 583.5 **BIC** 637.0 **(-2) Res LL** 655.3

Type 3 Test of Fixed Effects

Fixed effect	depth	year	temp
Significance (Pr>Chi)	<.0001	<.0001	0.0029
DF	1	8	2
CHI SQUARE	62.58	44.28	11.71

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	431	497.0015	1.1531					
month	421	410.1953	0.9743	15.5060	15.5060	-601.7943	82.93	<.0001
year	423	432.5578	1.0226	11.3173		-613.2602	59.99	<.0001
temp	429	481.0077	1.1212	2.7665		-636.1923	14.13	0.0009
depth	430	490.5976	1.1409	1.0580		-640.4563	5.60	0.0179
area	427	489.5409	1.1465	0.5724		-639.9906	6.53	0.1627
set	425	488.7128	1.1499	0.2775		-639.6249	7.27	0.2970
sal	428	495.1046	1.1568	-0.3209		-642.4316	1.65	0.6477
month +								
year	413	361.5761	0.8755	24.0742	8.5682	-574.5436	54.50	<.0001
depth	420	400.9162	0.9546	17.2145	1.7084	-596.8520	9.88	0.0017
temp	419	401.1680	0.9574	16.9716	1.4656	-596.9877	9.61	0.0082
month + year +								
depth	412	352.4860	0.8555	25.8087	1.7345	-569.0438	11.00	0.0009
temp	411	356.0309	0.8663	24.8721	0.7978	-571.2053	6.68	0.0355

FINAL MODEL: month + year + depth

AIC 1180.1 **BIC** 1265.5 **(-2) Res LL** 1138.1

Type 3 Test of Fixed Effects

Fixed effect	month	year	depth
Significance (Pr>Chi)	<.0001	<.0001	0.0009
DF	10	8	1
CHI SQUARE	79.95	55.62	11.00

Table 12. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
1998	117	90	0.7692	0.1015	0.0786	0.0519	0.1191	0.2102
1999	93	73	0.7849	0.0522	0.0462	0.0297	0.0720	0.2242
2000	112	78	0.6964	0.1296	0.1046	0.0702	0.1556	0.2009
2001	94	74	0.7872	0.1603	0.1408	0.0991	0.2002	0.1771
2002	111	68	0.6161	0.1125	0.1349	0.0839	0.2169	0.2409
2003	154	97	0.6323	0.1023	0.0841	0.0578	0.1223	0.1889
2004	93	43	0.4639	0.0384	0.0299	0.0146	0.0611	0.3692
2005	49	24	0.4898	0.0291	0.0356	0.0162	0.0779	0.4073
2006	93	52	0.5638	0.0636	0.0777	0.0469	0.1287	0.2564

Table 13. Results of the stepwise procedure for development of the SCDNR-Red Drum-NEW catch rate model for total Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	1598	2299.5324	1.4390					
month	1589	2009.2476	1.2645	12.1265	12.1265	-1151.9650	290.28	<.0001
temp	1596	2052.6424	1.2861	10.6254		-1173.6624	246.89	<.0001
sal	1595	2214.2157	1.3882	3.5302		-1254.4491	85.32	<.0001
area	1595	2248.9712	1.4100	2.0153		-1271.8268	50.56	<.0001
depth	1597	2259.2269	1.4147	1.6887		-1276.9546	40.31	<.0001
year	1594	2281.4082	1.4312	0.5420		-1288.0453	18.12	0.0012
set	1580	2280.7045	1.4435	-0.3127		-1287.6935	18.83	0.4025
month +								
sal	1586	1891.9674	1.1929	17.1022	4.9757	-1093.3249	117.28	<.0001
temp	1587	1947.1521	1.2269	14.7394	2.6129	-1120.9173	62.10	<.0001
depth	1588	1961.7288	1.2353	14.1557	2.0292	-1128.2056	47.52	<.0001
area	1586	1963.0534	1.2377	13.9889	1.8624	-1128.8679	46.19	<.0001
year	1585	1988.4545	1.2545	12.8214	0.6949	-1141.5684	20.79	<.0001
month + sal +								
temp	1584	1831.8312	1.1565	19.6317	2.5295	-1087.7584	60.14	<.0001
depth	1585	1868.0029	1.1786	18.0959	0.9937	-1081.3427	23.96	<.0001
area	1583	1880.8343	1.1881	17.4357	0.3336	-1087.7584	11.13	0.0110
year	1582	1882.1885	1.1898	17.3176	0.2154	-1088.4354	9.78	0.0443
month + sal + temp +								
year	1580	1825.1142	1.1551	19.7290	0.0973	-1059.8983	6.72	0.1516

FINAL MODEL: month + sal + year

AIC 2059.5 **BIC** 2153.8 **(-2) Res LL** 2176.9

Type 3 Test of Fixed Effects

Fixed effect	month	sal	temp	year
Significance (Pr>Chi)	<.0001	<.0001	<.0001	0.1516
DF	9	3	2	4
CHI SQUARE	94.01	108.28	57.07	6.72

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	1070	699.0968	0.6534					
month	1062	619.7631	0.5836	10.6826	10.6826	-1226.7589	129.00	<.0001
sal	1067	672.6034	0.6304	3.5200		-1270.5728	41.38	<.0001
area	1067	685.3479	0.6423	1.6988		-1280.6245	21.27	<.0001
year	1066	685.7984	0.6433	1.5458		-1280.9764	20.57	0.0004
depth	1069	690.1708	0.6456	1.1938		-1284.3797	13.76	0.0002
temp	1068	693.7051	0.6495	0.5969		-1286.1149	8.29	0.0158
set	1052	684.1654	0.6503	0.4744		-1279.6997	18.83	0.4025
month +								
sal	1059	584.6559	0.5521	15.5035	4.8209	-1195.5319	62.45	<.0001
area	1059	605.6079	0.5719	12.4732	1.7906	-1214.3865	24.74	<.0001
depth	1061	608.7991	0.5738	12.1824	1.4998	-1217.2008	19.12	<.0001
year	1058	611.7069	0.5782	11.5090	0.8264	-1219.7524	14.01	0.0073
month + sal +								
area	1057	576.6574	0.5456	16.4983	0.9948	-1188.1553	14.75	0.0006
depth	1058	580.0677	0.5483	16.0851	0.5816	-1191.3129	8.44	0.0037
year	1055	582.0022	0.5517	15.5647	0.0612	-1193.0957	4.87	0.3006

FINAL MODEL: month + sal + year

AIC 2420.2 **BIC** 2504.8 **(-2) Res LL** 2386.2

Type 3 Test of Fixed Effects

Fixed effect	month	sal	year
Significance (Pr>Chi)	<.0001	<.0001	0.3006
DF	8	3	4
CHI SQUARE	118.58	53.31	4.87

Table 14. SCDNR-Red Drum-NEW total Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
2007	328	191	0.5836	0.0948	0.0892	0.0685	0.1161	0.1324
2008	560	322	0.5750	0.1088	0.0842	0.0666	0.1065	0.1179
2009	343	222	0.6472	0.1019	0.0890	0.0697	0.1135	0.1224
2010	352	175	0.4972	0.0678	0.0663	0.0504	0.0871	0.1374
2011	361	189	0.5235	0.0681	0.0872	0.0665	0.1144	0.1363

Table 15. Results of the stepwise procedure for development of the SCDNR-Red Drum-NEW catch rate model for age 1+ Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	1598	2313.2783	1.4476					
month	1589	2002.1717	1.2600	12.9594	12.9594	-1157.9476	311.11	<.0001
temp	1596	2102.8045	1.3175	8.9873		-1208.2641	210.47	<.0001
sal	1595	2198.8966	1.3786	4.7665		-1256.3101	114.38	<.0001
depth	1597	2243.2476	1.4047	2.9635		-1278.4856	70.03	<.0001
area	1595	2258.6383	1.4161	2.1760		-1286.1809	54.64	<.0001
year	1594	2306.2557	1.4468	0.0553		-1309.9897	7.02	0.1347
set	1580	2300.5686	1.4561	-0.5872		-1307.1461	12.71	0.8085
month +								
sal	1586	1854.7581	1.1695	19.2111	6.2517	-1084.2409	147.41	<.0001
temp	1587	1938.5963	1.2215	15.6190	2.6596	-1126.1600	63.58	<.0001
area	1586	1942.2616	1.2246	15.4048	2.4454	-1127.9926	59.91	<.0001
depth	1588	1961.7288	1.2353	14.6657	1.7063	-1128.2056	47.52	<.0001
year	1585	1980.0194	1.2492	13.7054	0.7461	-1146.8715	22.15	<.0001
month + sal +								
temp	1584	1793.5263	1.1323	21.7809	2.5698	-1053.6250	61.23	<.0001
depth	1585	1810.8326	1.1425	21.0763	1.8652	-1062.2781	43.93	<.0001
area	1583	1835.8272	1.1597	19.8881	0.6770	-1074.7754	18.93	0.0003
year	1582	1848.9852	1.1688	19.2595	0.0484	-1081.3544	5.77	0.2168
month + sal + temp +								
depth	1583	1746.9020	1.1035	23.7704	1.9895	-1030.3128	46.62	<.0001
year	1580	1791.6078	1.1339	21.6704	-0.1105	-1052.6657	1.92	0.7508
month + sal + temp + depth +								
year	1579	1744.5409	1.1048	23.6806	-0.0898	-1029.1323	2.36	0.6697

FINAL MODEL: month + sal + temp + depth + year

AIC 1938.2 **BIC** 2049.2 **(-2) Res LL** 2058.3

Type 3 Test of Fixed Effects

Fixed effect	month	sal	temp	depth	year
Significance (Pr>Chi)	<.0001	<.0001	<.0001	<.0001	0.6697
DF	9	3	2	1	4
CHI SQUARE	162.87	103.71	60.20	47.07	2.36

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
null	942	639.8727	0.6793					
month	934	565.9016	0.6059	10.8052	10.8052	-1087.2895	115.85	<.0001
year	938	616.9753	0.6578	3.1650		-1138.0312	34.36	<.0001
sal	939	618.4322	0.6586	3.0473		-1139.1432	32.14	<.0001
area	939	623.5437	0.6641	2.2376		-1143.0242	24.38	<.0001
depth	941	634.0006	0.6738	0.8097		-1150.8658	8.69	0.0032
temp	940	635.3799	0.6759	0.5005		-1151.8905	6.64	0.0361
set	924	625.3832	0.6768	0.3680		-1144.4132	21.60	0.2503
month +								
sal	931	536.4624	0.5762	15.1774	4.3721	-1072.1001	50.38	<.0001
year	930	550.1717	0.5916	12.9103	2.1051	-1083.9979	26.58	<.0001
area	931	549.7138	0.5905	13.0723	2.2670	-1083.6053	27.37	<.0001
month + sal +								
area	928	526.6064	0.5675	16.4581	3.5478	-1063.3571	17.49	0.0006
year	927	533.0839	0.5751	15.3393	2.4290	-1069.1213	5.96	0.2023
month + sal + area +								
year	924	523.8081	0.5669	16.5464	0.0883	-1060.8449	5.02	0.2848

FINAL MODEL: month + sal + area + year

AIC 2161.7 **BIC** 2258.7 **(-2) Res LL** 2121.7

Type 3 Test of Fixed Effects

Fixed effect	month	sal	area	year
Significance (Pr>Chi)	<.0001	<.0001	0.0009	0.2848
DF	8	3	3	4
CHI SQUARE	97.49	25.04	16.55	5.02

Table 16. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook hour (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
2007	328	165	0.5046	0.0863	0.0874	0.0652	0.1172	0.1473
2008	560	286	0.5107	0.0993	0.0757	0.0576	0.0995	0.1372
2009	343	188	0.5481	0.0894	0.0778	0.0581	0.1041	0.1466
2010	352	165	0.4688	0.0639	0.0645	0.0479	0.0867	0.1490
2011	361	166	0.4598	0.0529	0.0665	0.0485	0.0913	0.1593

Figure 1. SCDNR COASTSPAN and red drum fixed nearshore and estuarine sampling stations

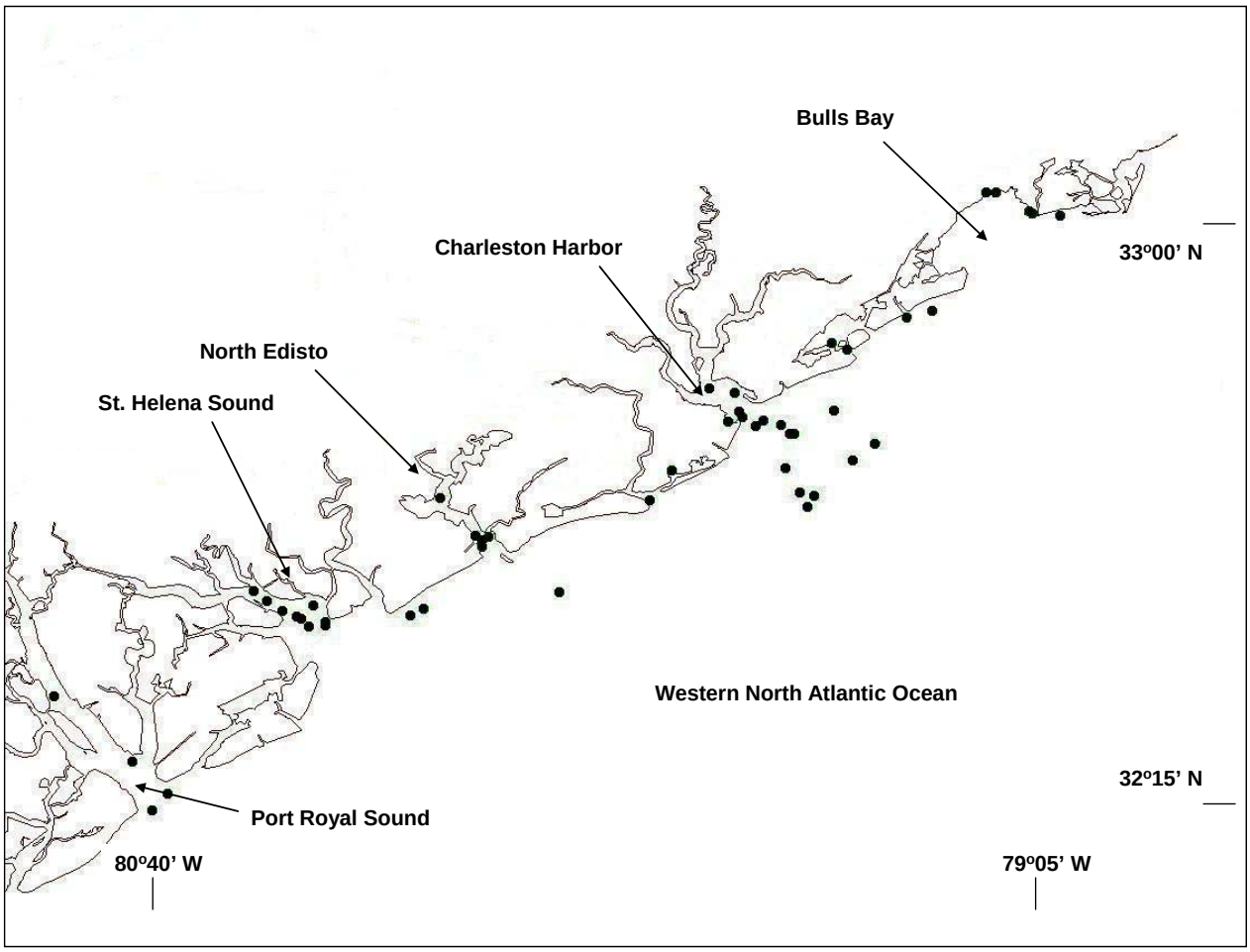


Figure 2. Sampling locations for the 2007-2009 SCDNR red drum longline survey (SEDAR-18-DW-13).

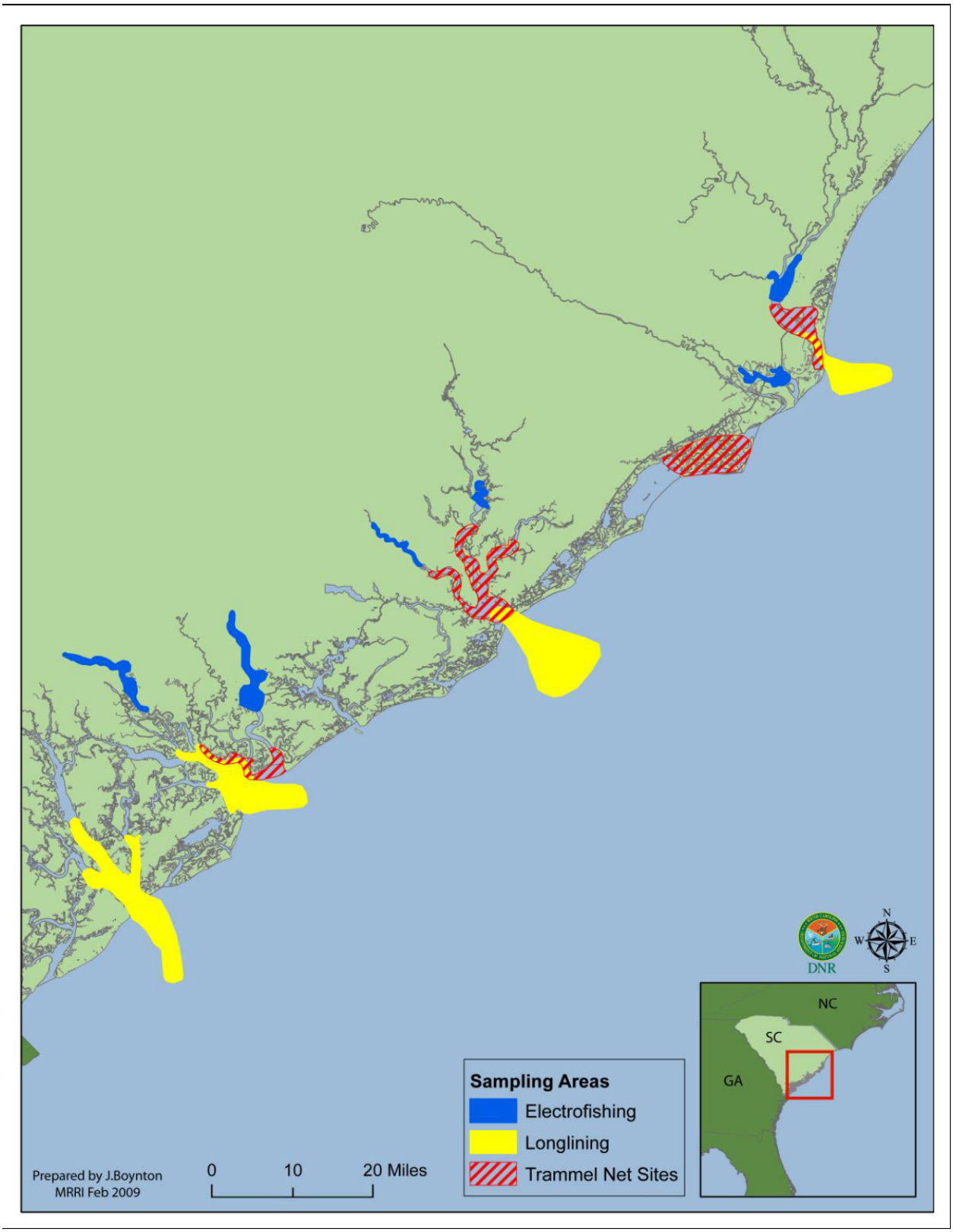


Figure 3. Fork lengths (cm) of bonnetheads caught during the SC COASTSPAN gillnet survey from 1998-2011.

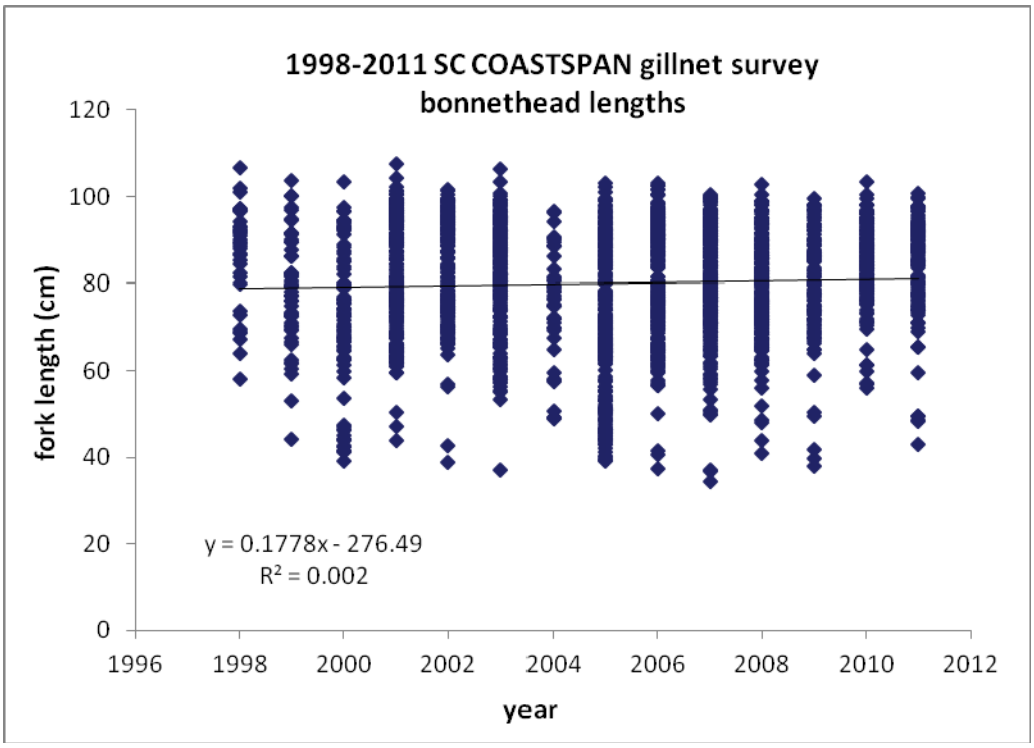


Figure 4a. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the binomial component.

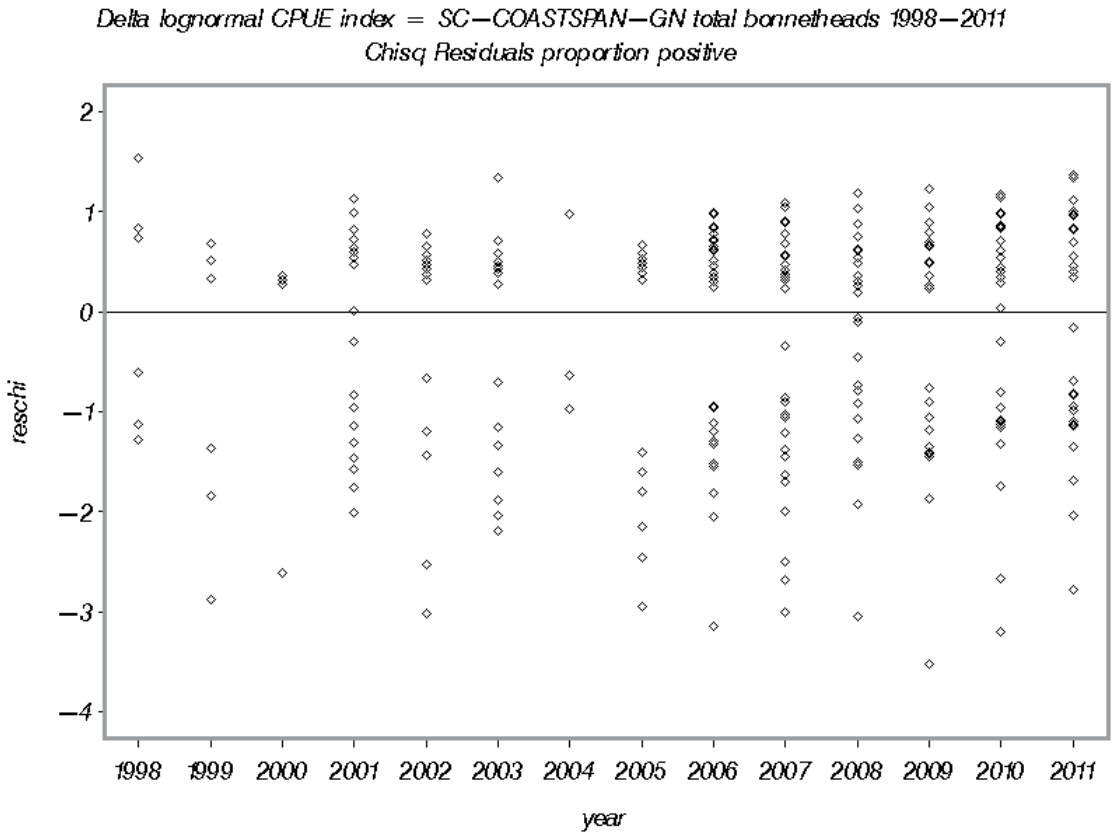
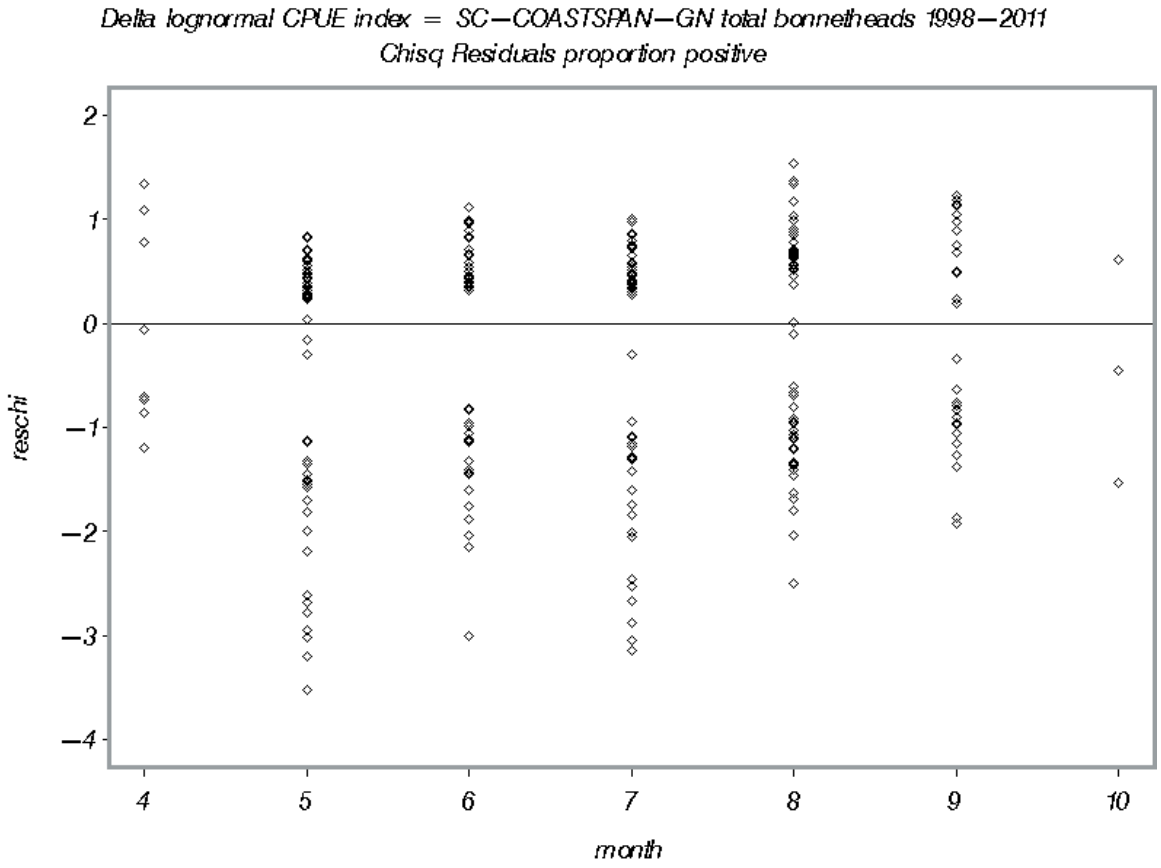


Figure 4a continued. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the binomial component.



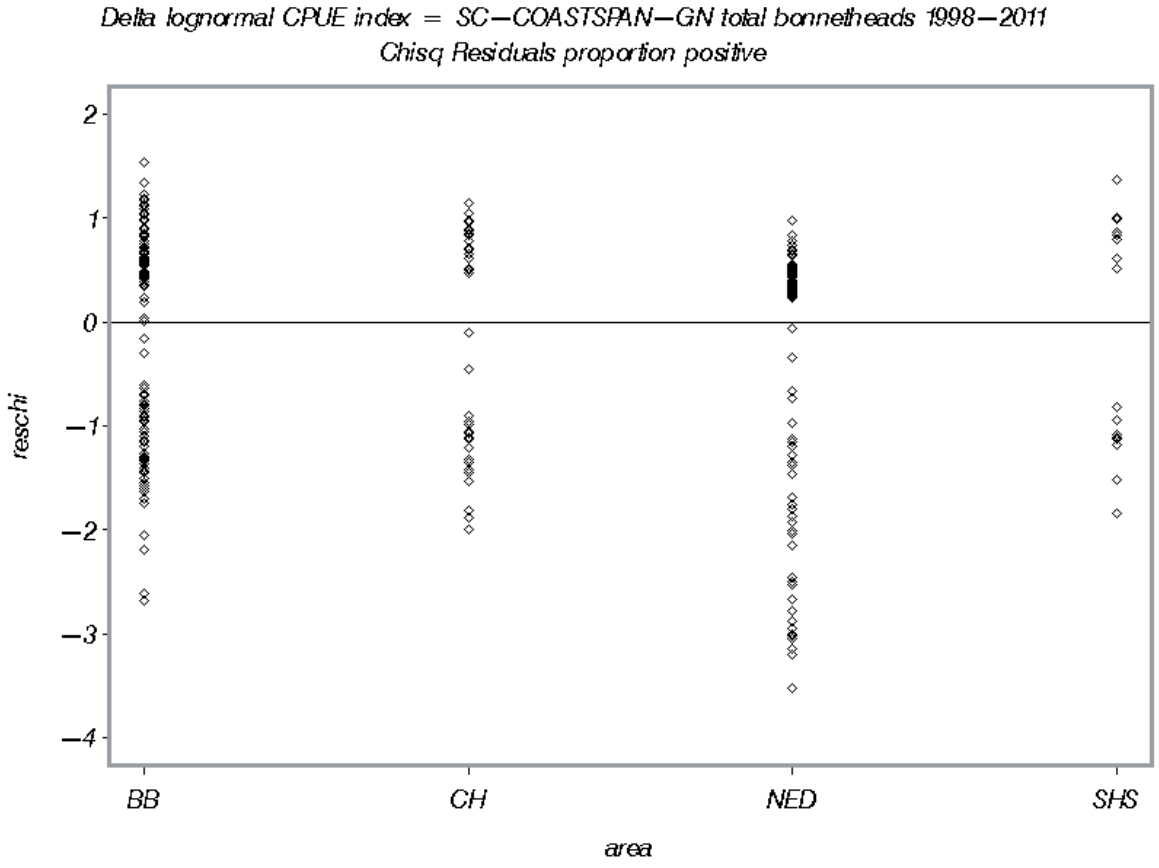
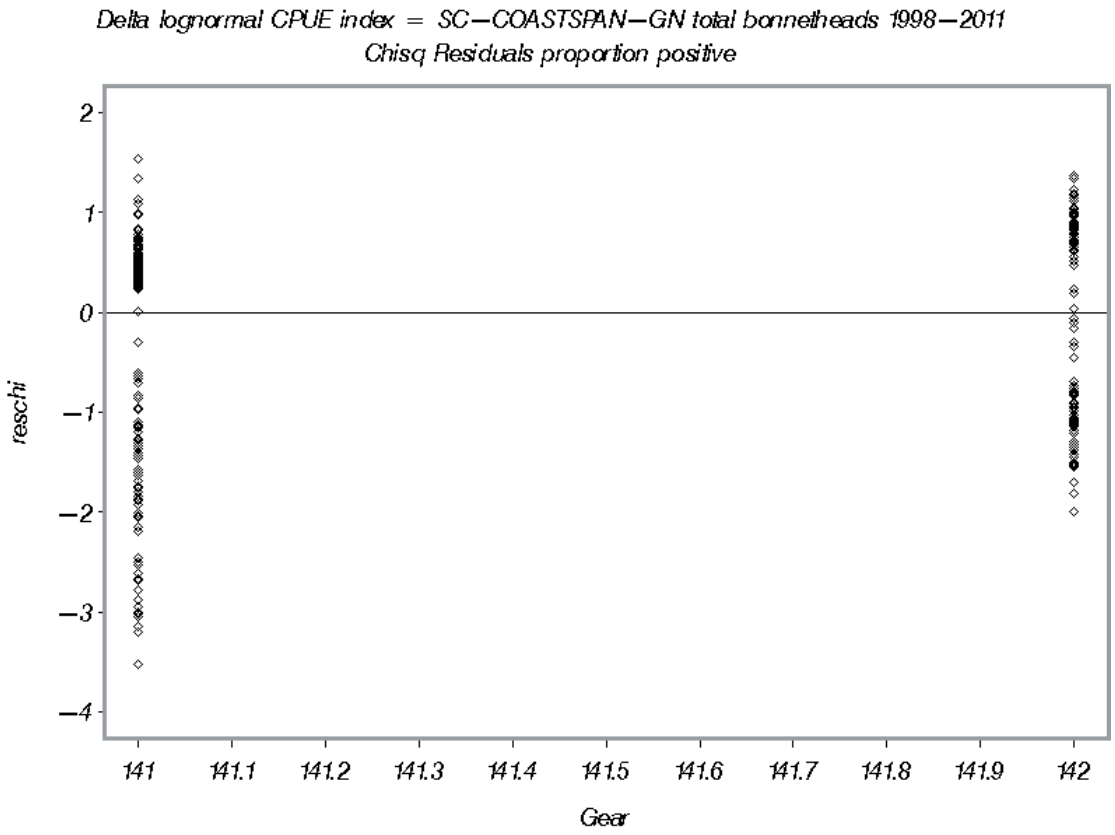


Figure 4a continued. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the binomial component.



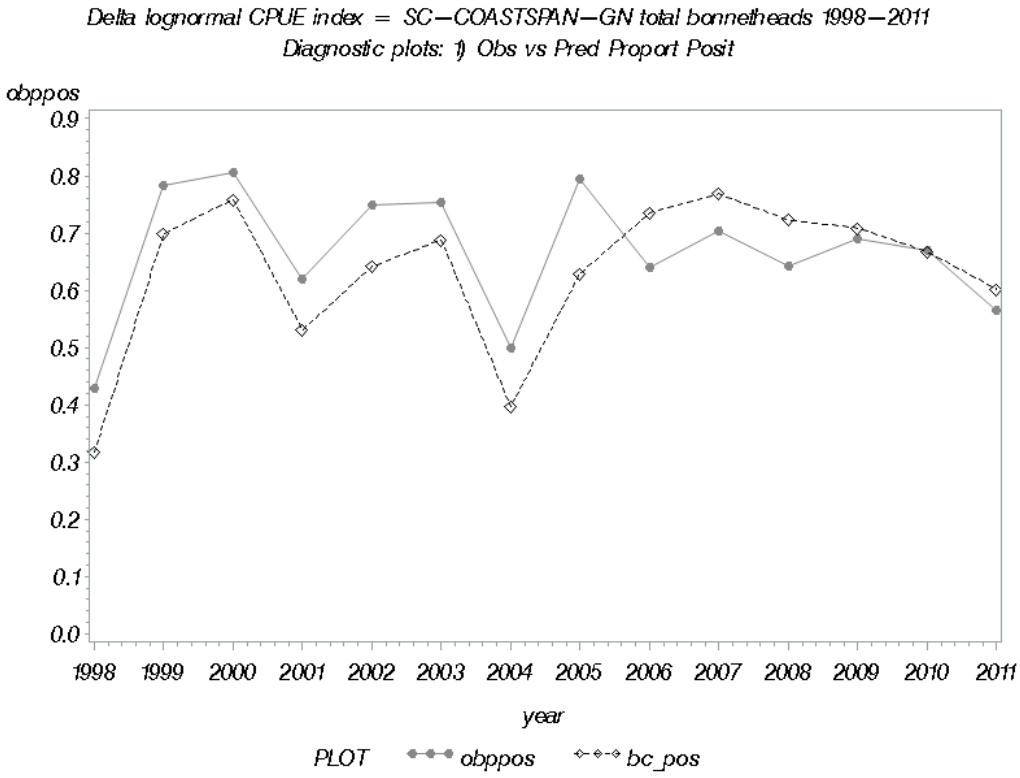
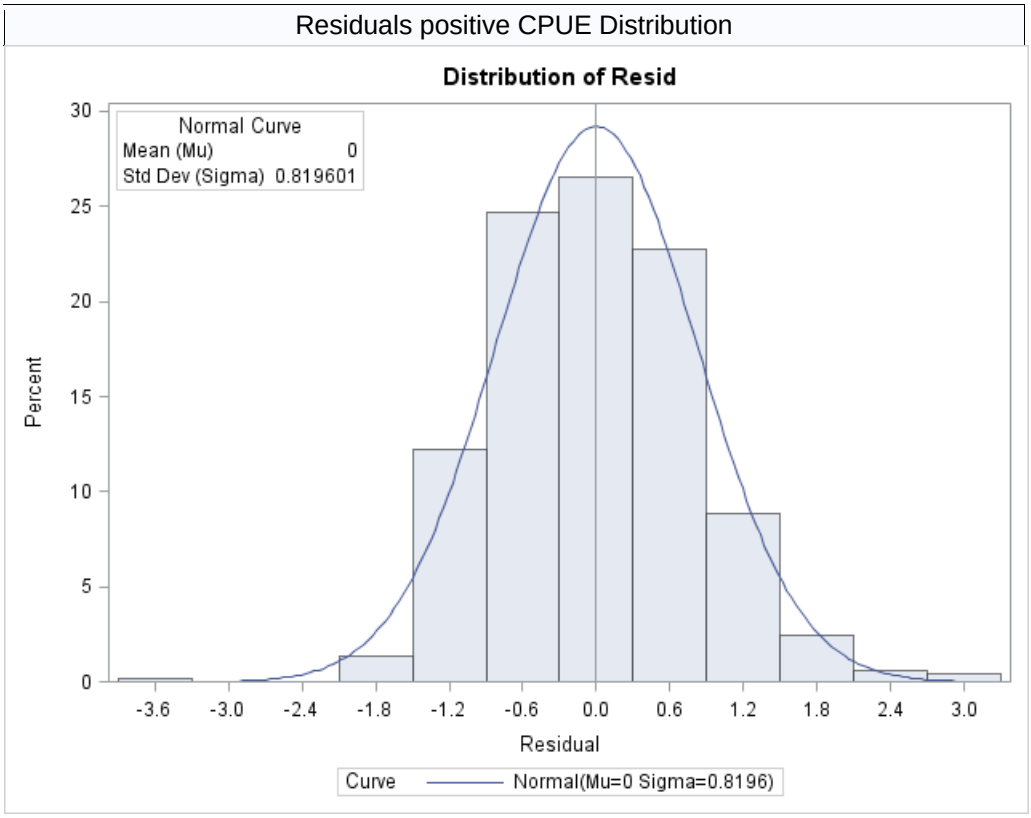


Figure 4b. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the lognormal component.



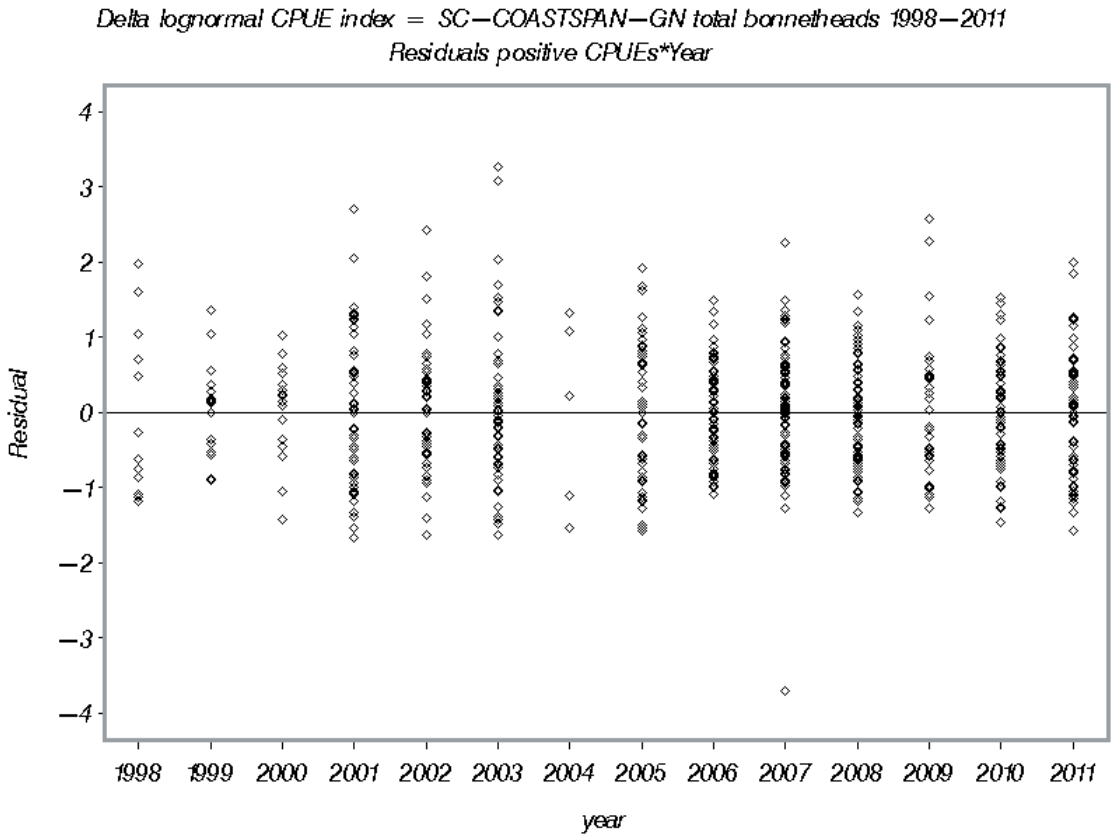
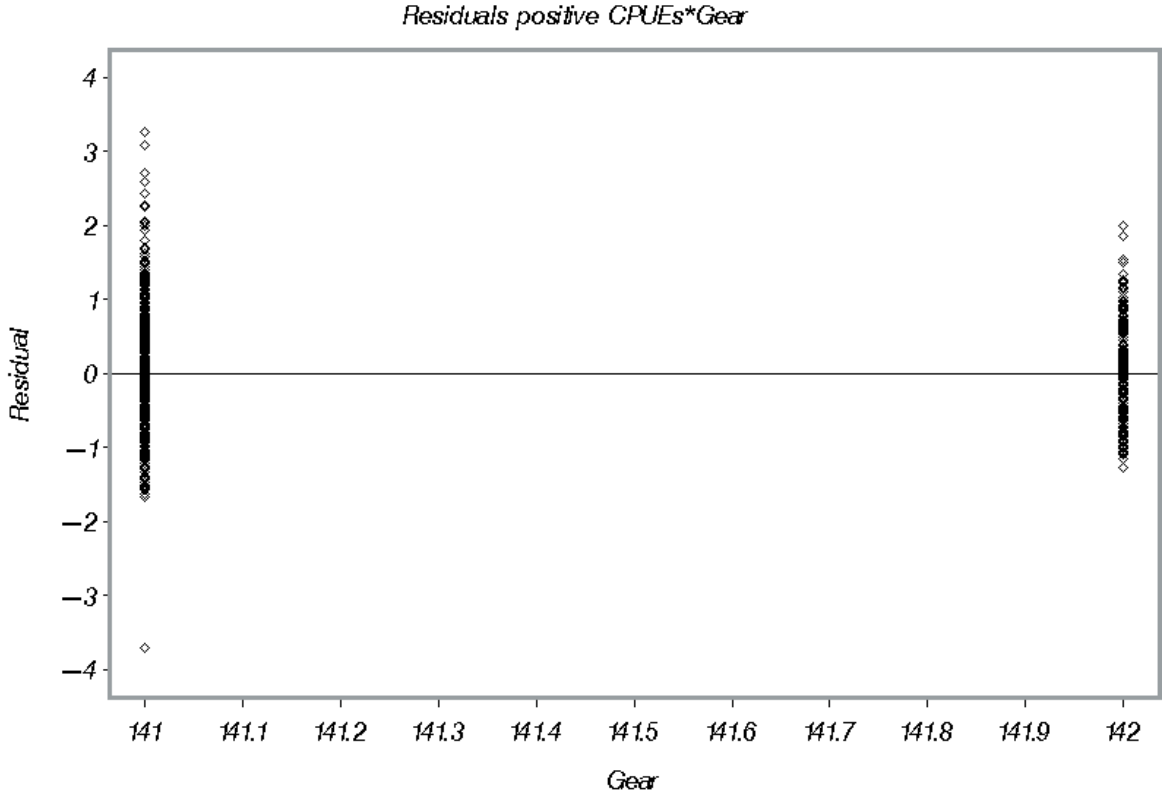


Figure 4b continued. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the lognormal component.



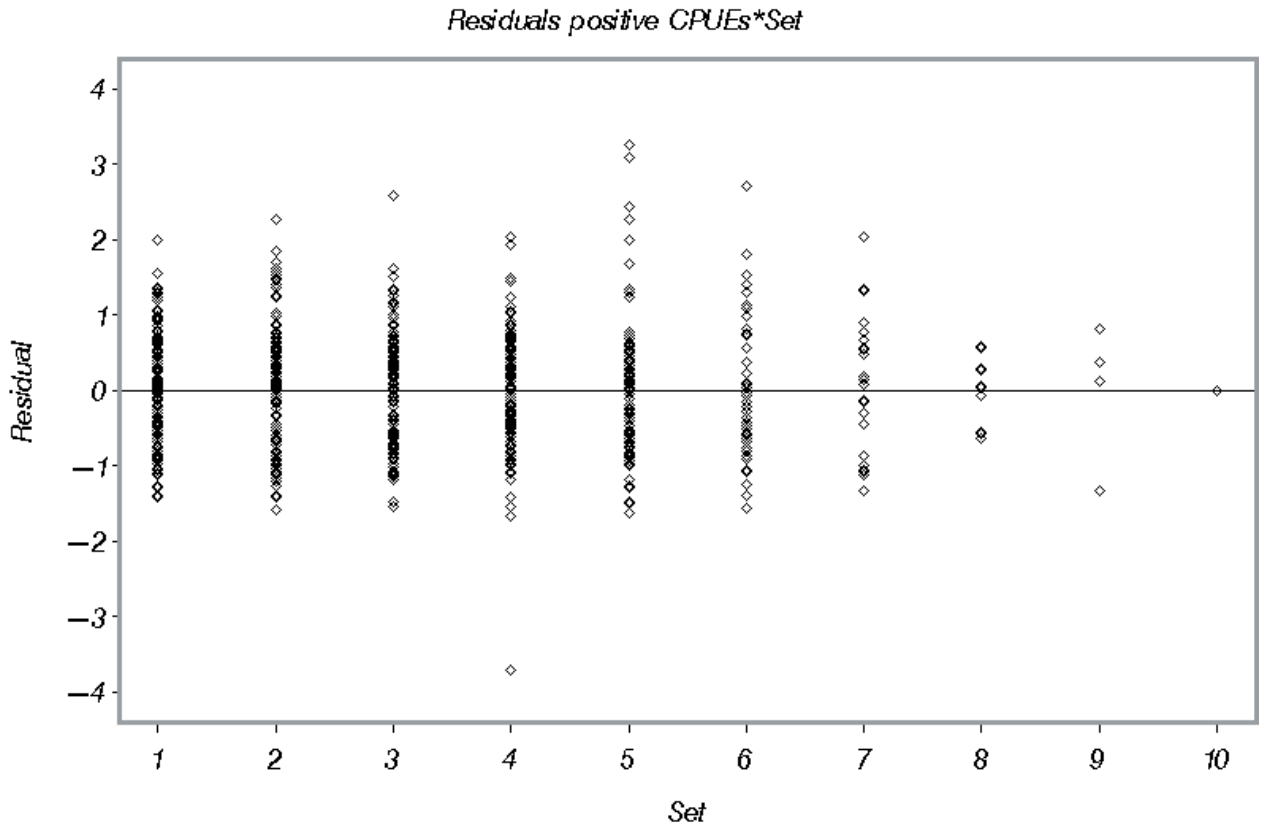
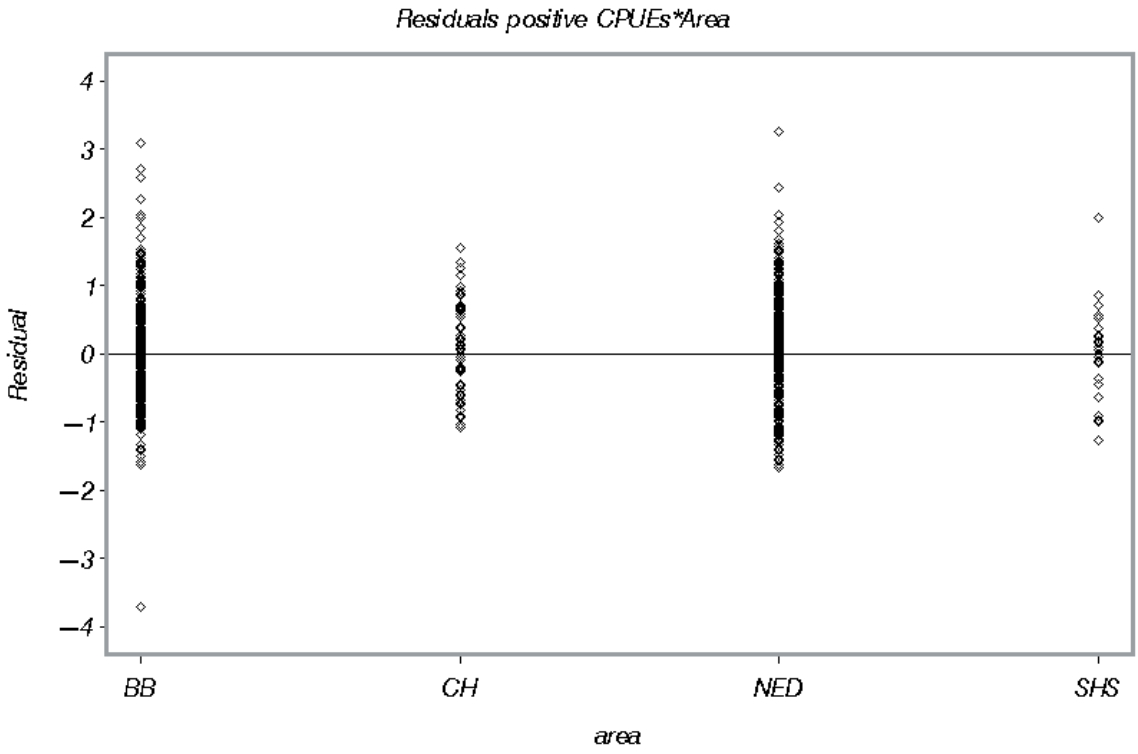


Figure 4b continued. SC-COASTSPAN-GN total bonnethead model diagnostic plots for the lognormal component.



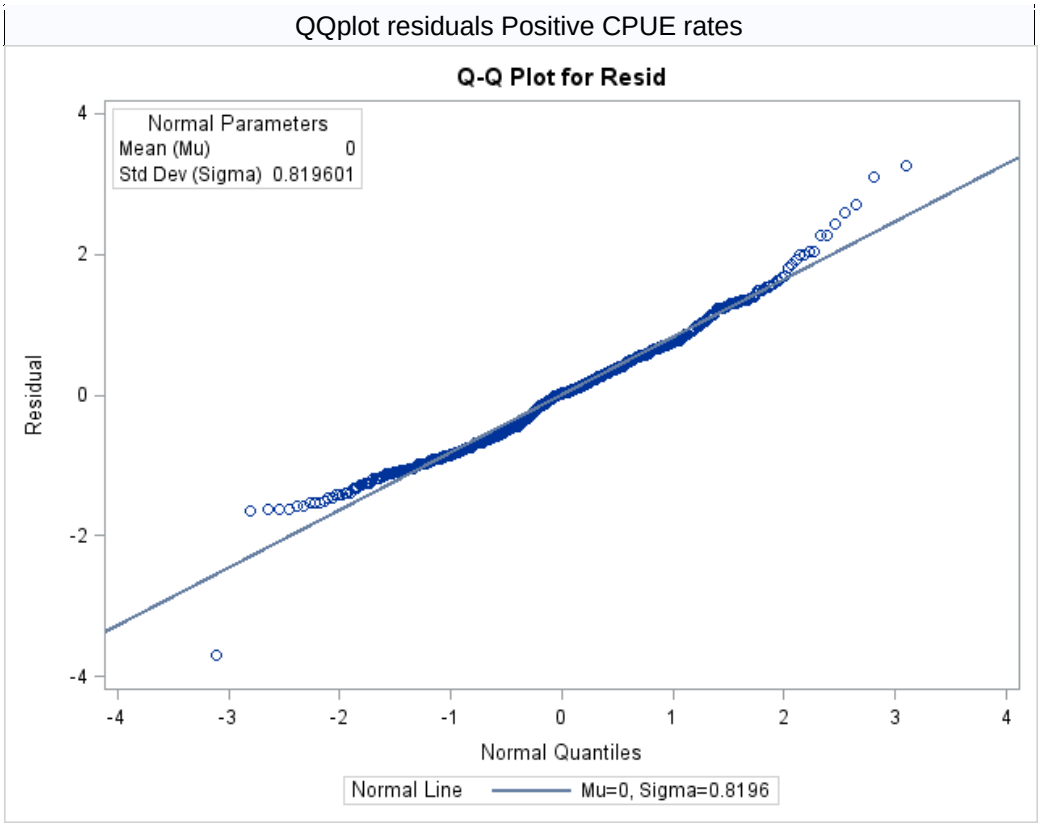


Figure 5. SC-COASTSPAN-GN total bonnethead nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0).

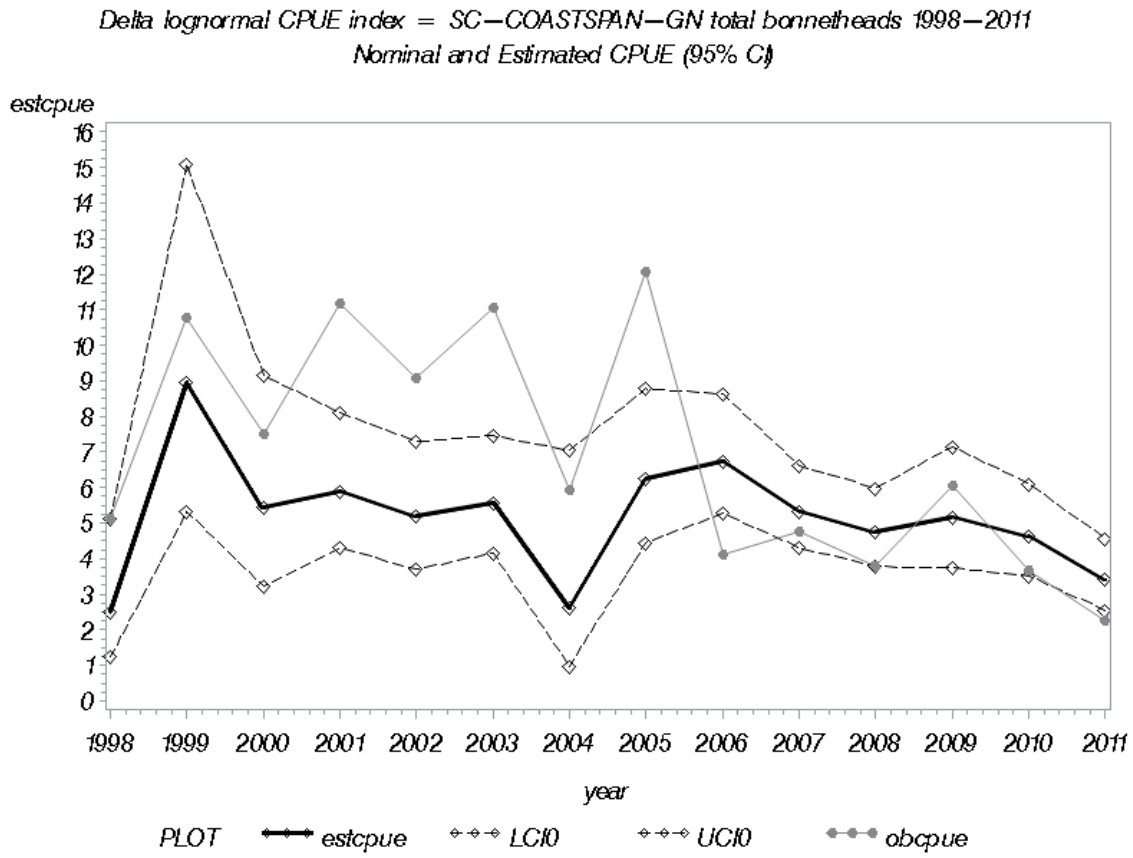


Figure 6a. SC-COASTSPAN-GN age 1 + bonnethead model diagnostic plots for the binomial component.

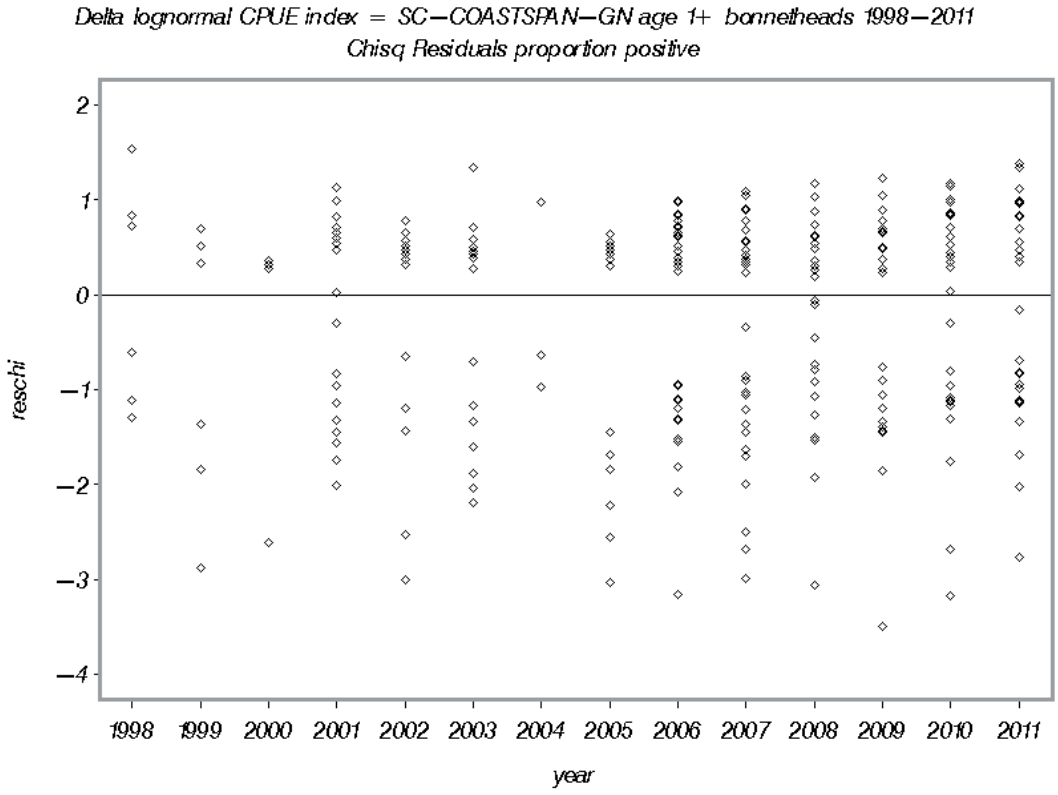
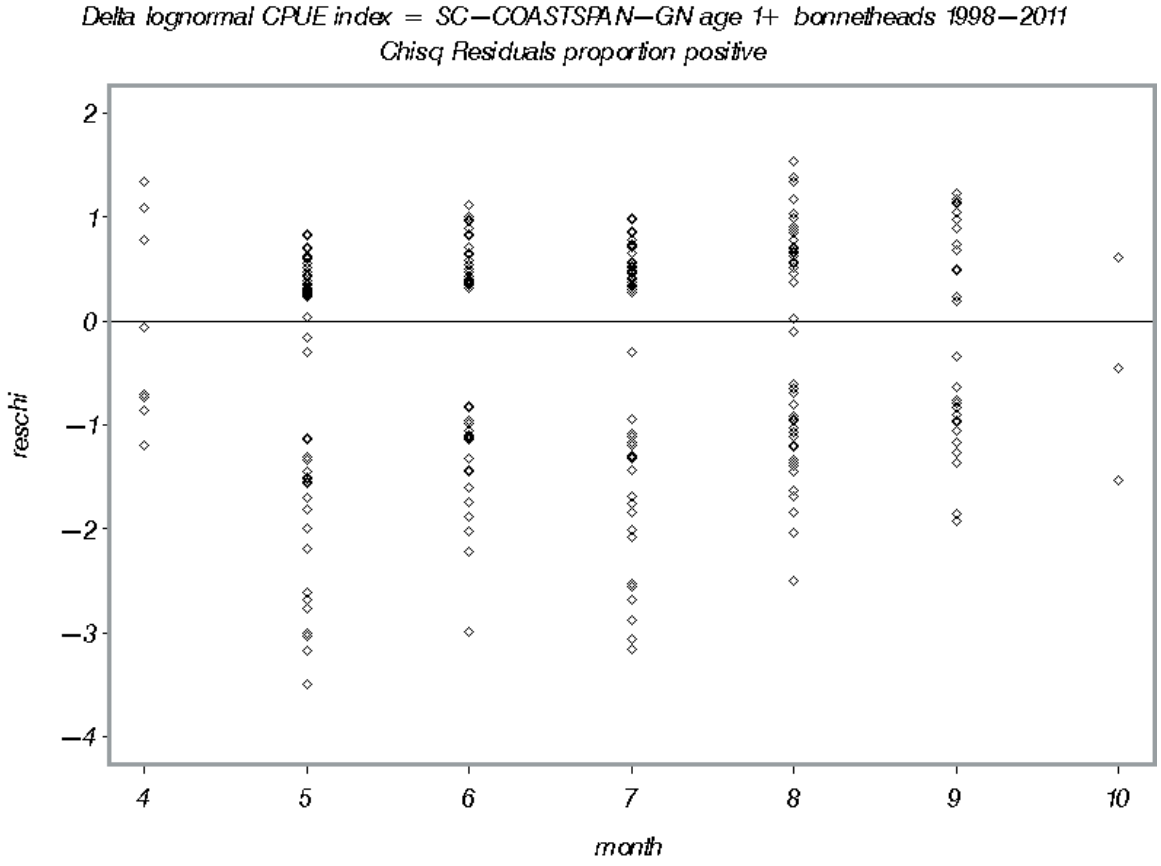


Figure 6a continued. SC-COASTSPAN-GN age 1+ bonnethead model diagnostic plots for the binomial component.



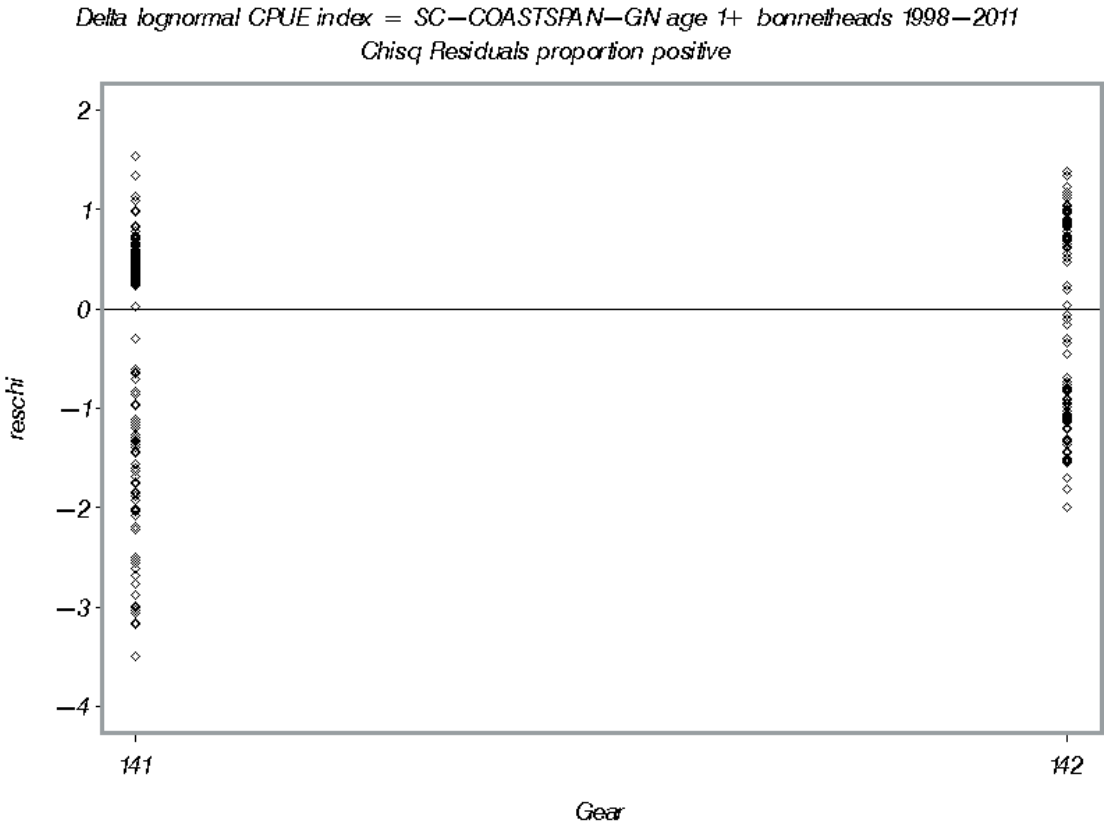
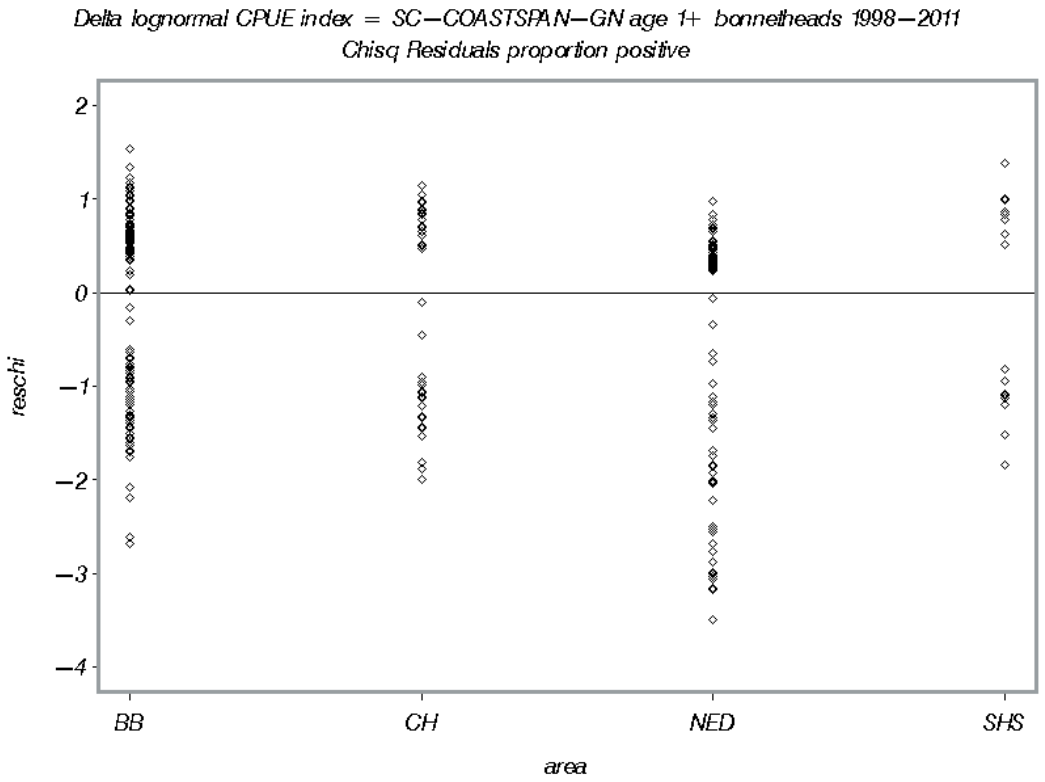


Figure 6a continued. SC-COASTSPAN-GN age 1+ bonnethead model diagnostic plots for the binomial component.



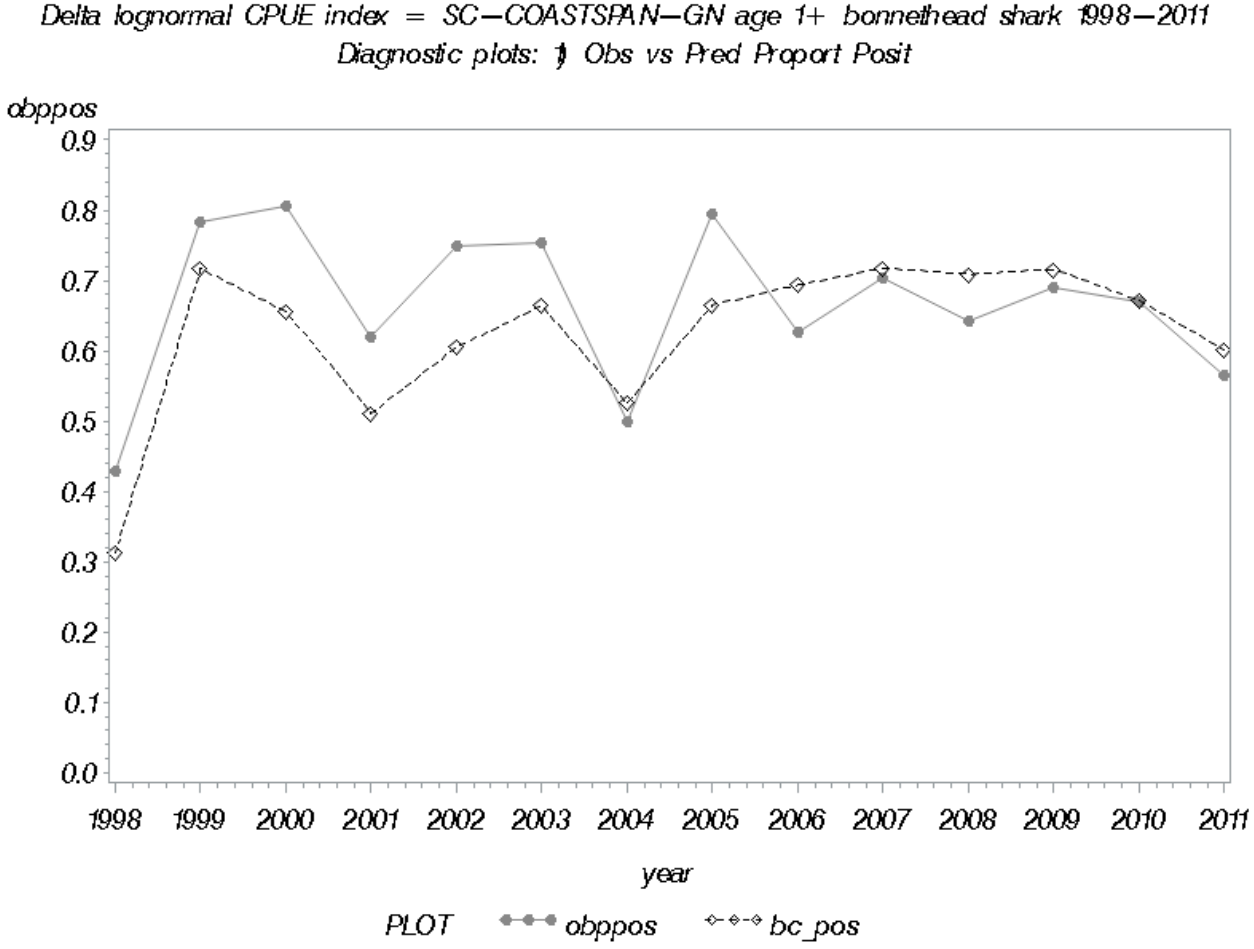
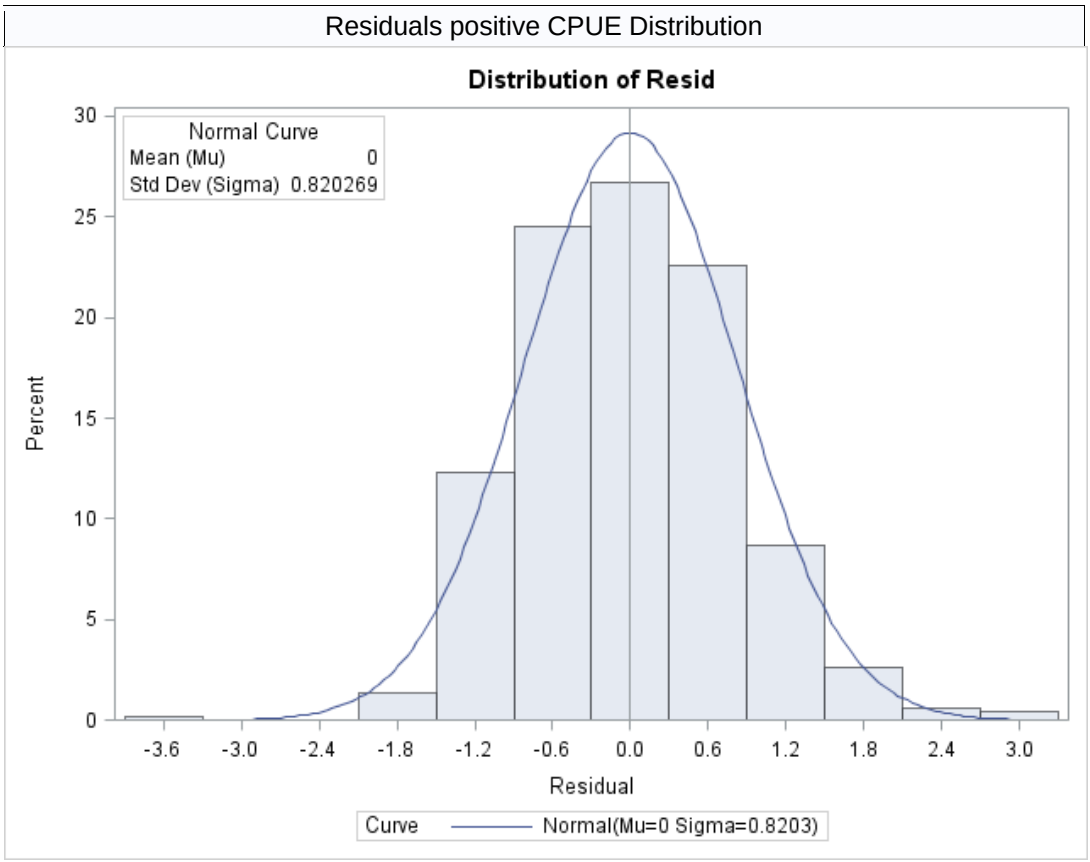


Figure 6b. SC-COASTSPAN-GN age 1 + bonnethead model diagnostic plots for the lognormal component.



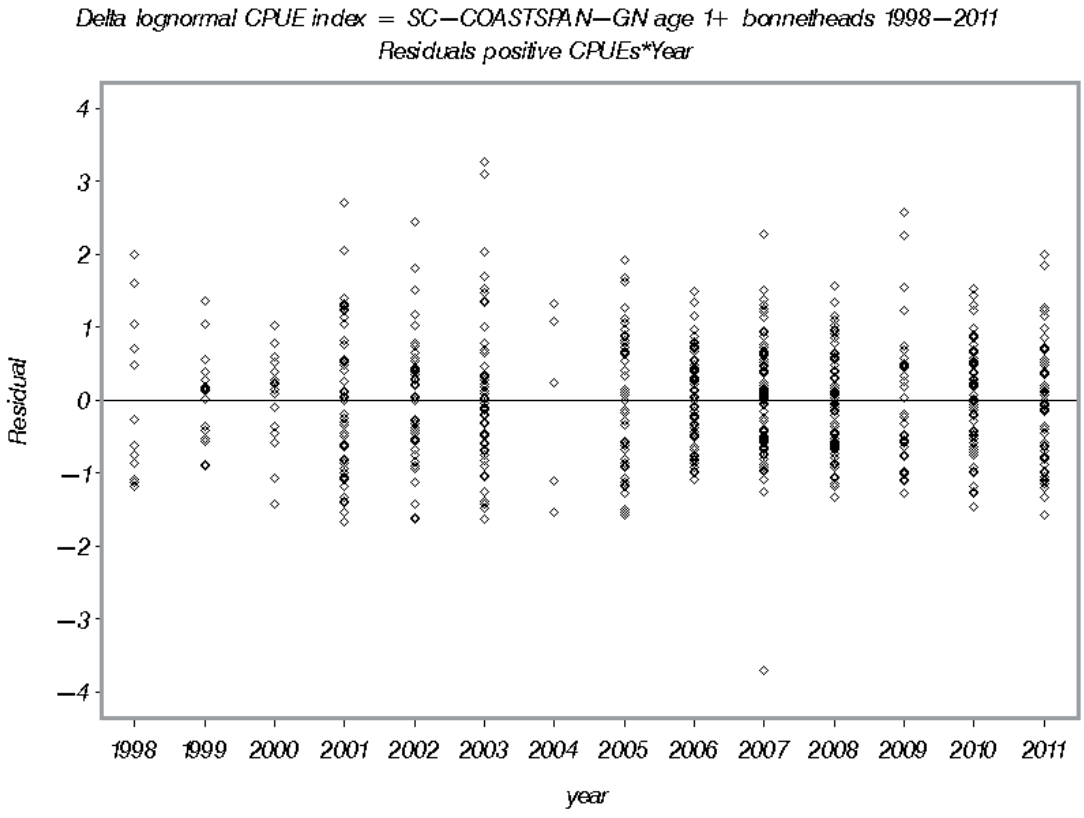
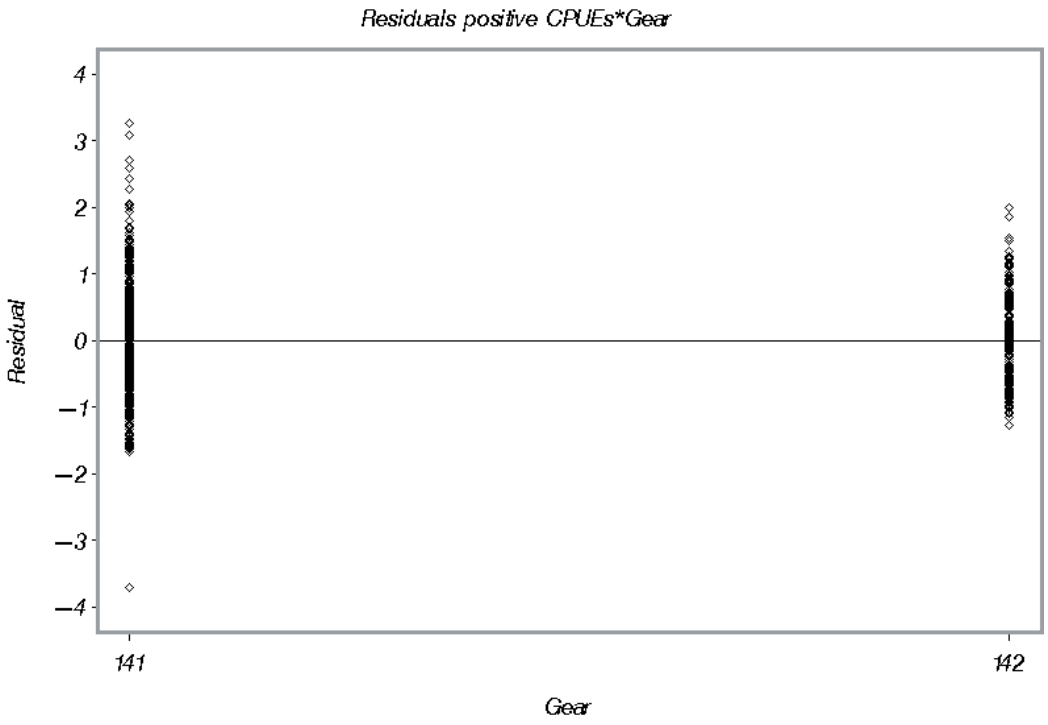


Figure 6b continued. SC-COASTSPAN-GN age 1+ bonnethead model diagnostic plots for the lognormal component.



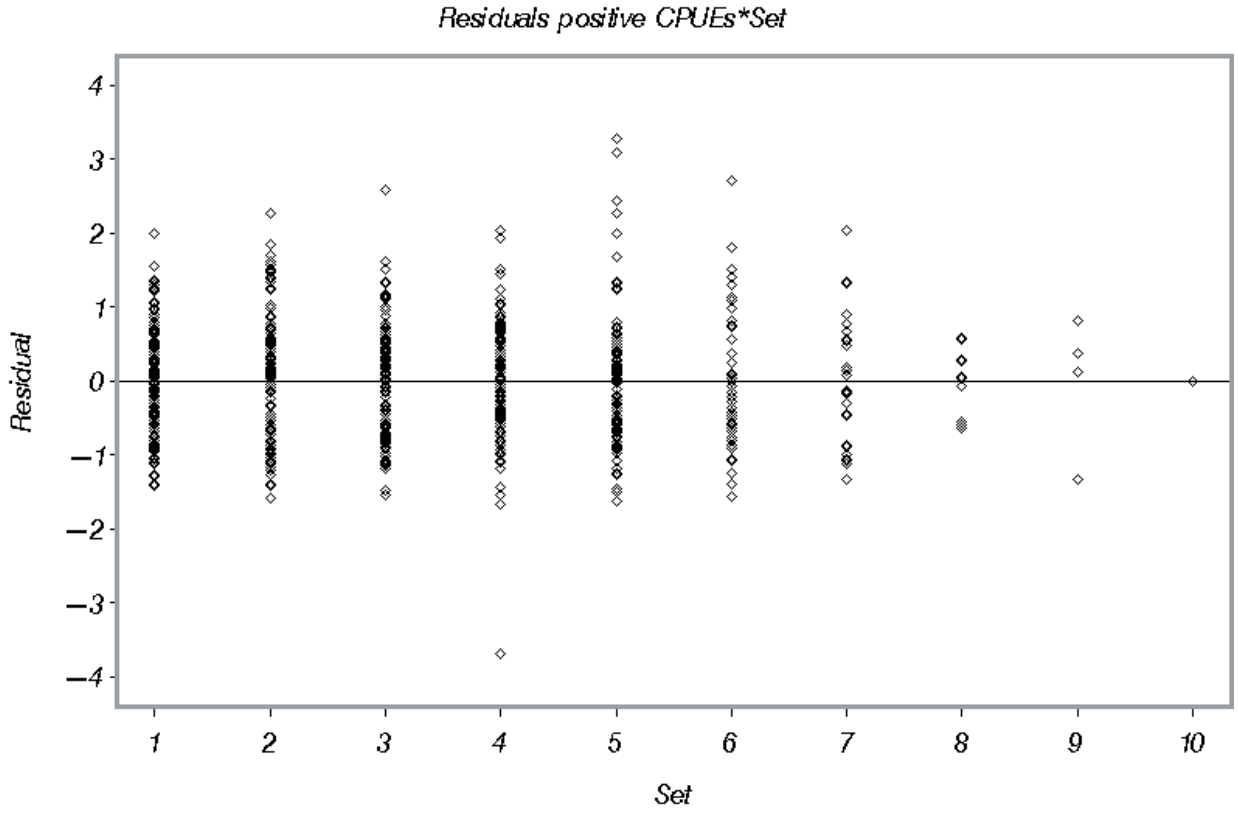
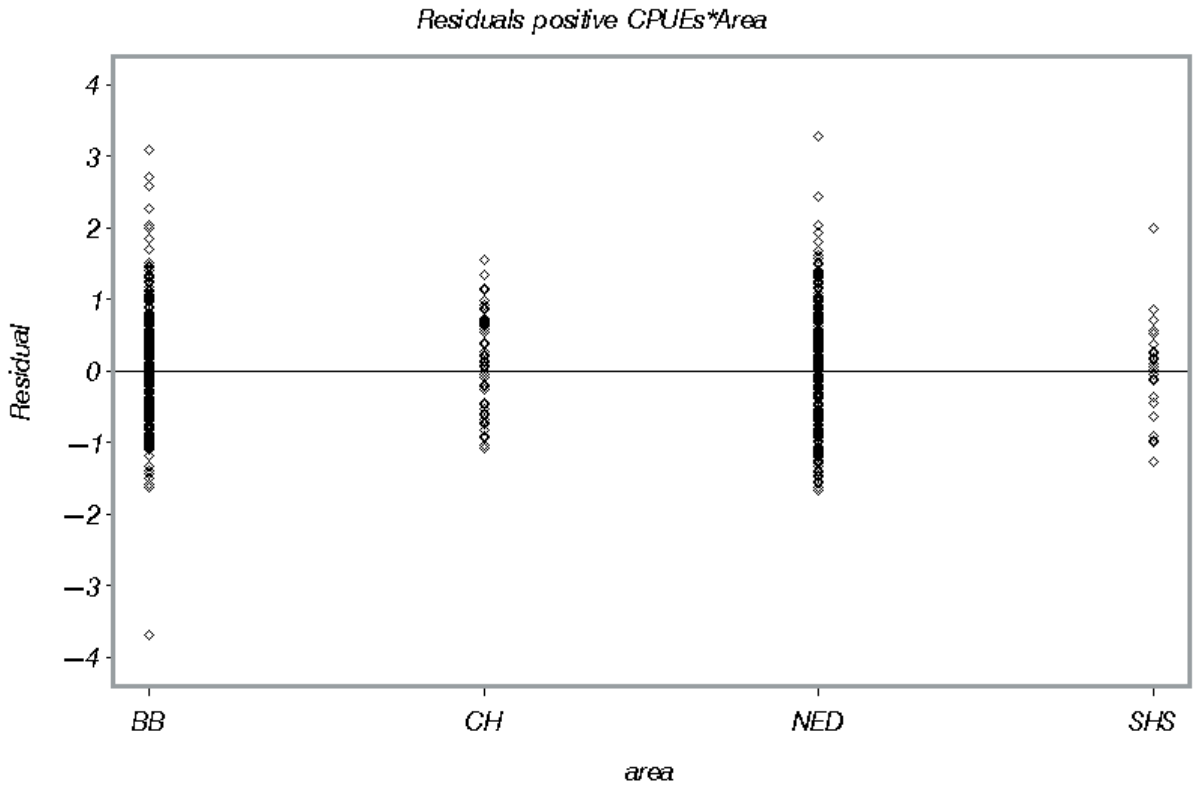


Figure 6b continued. SC-COASTSPAN-GN age 1+ bonnethead model diagnostic plots for the lognormal component.



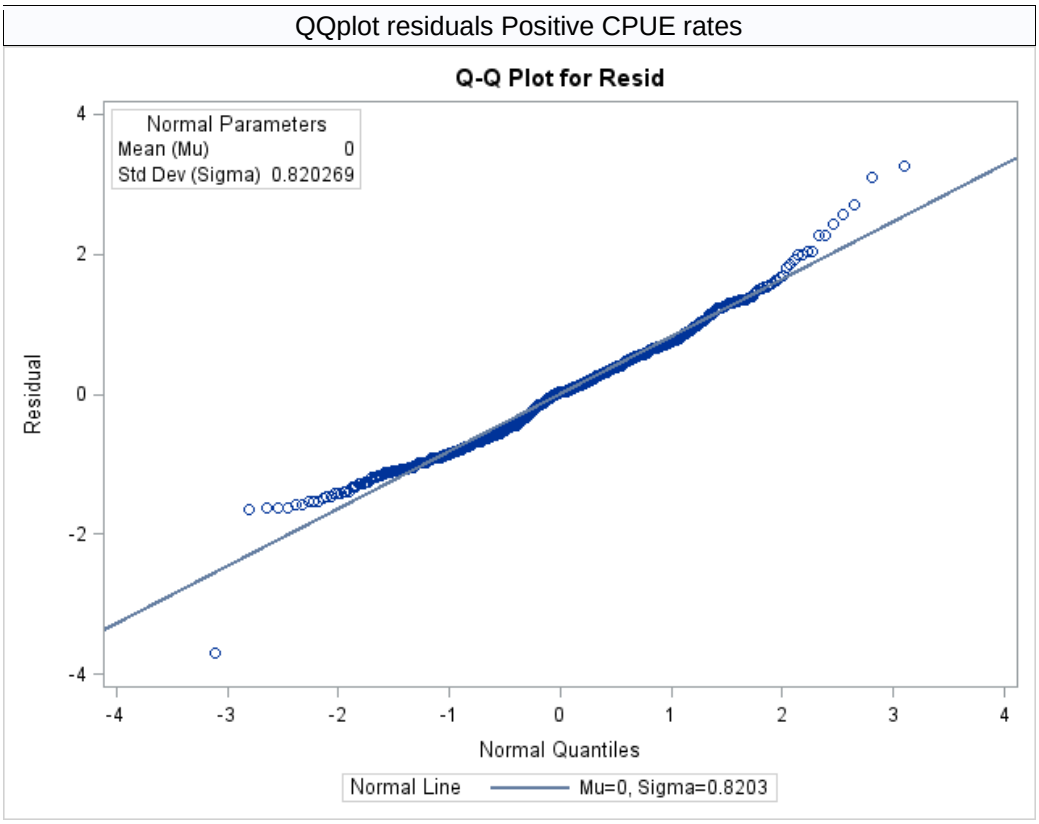


Figure 7. SC-COASTSPAN-GN age 1+ bonnethead nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0).

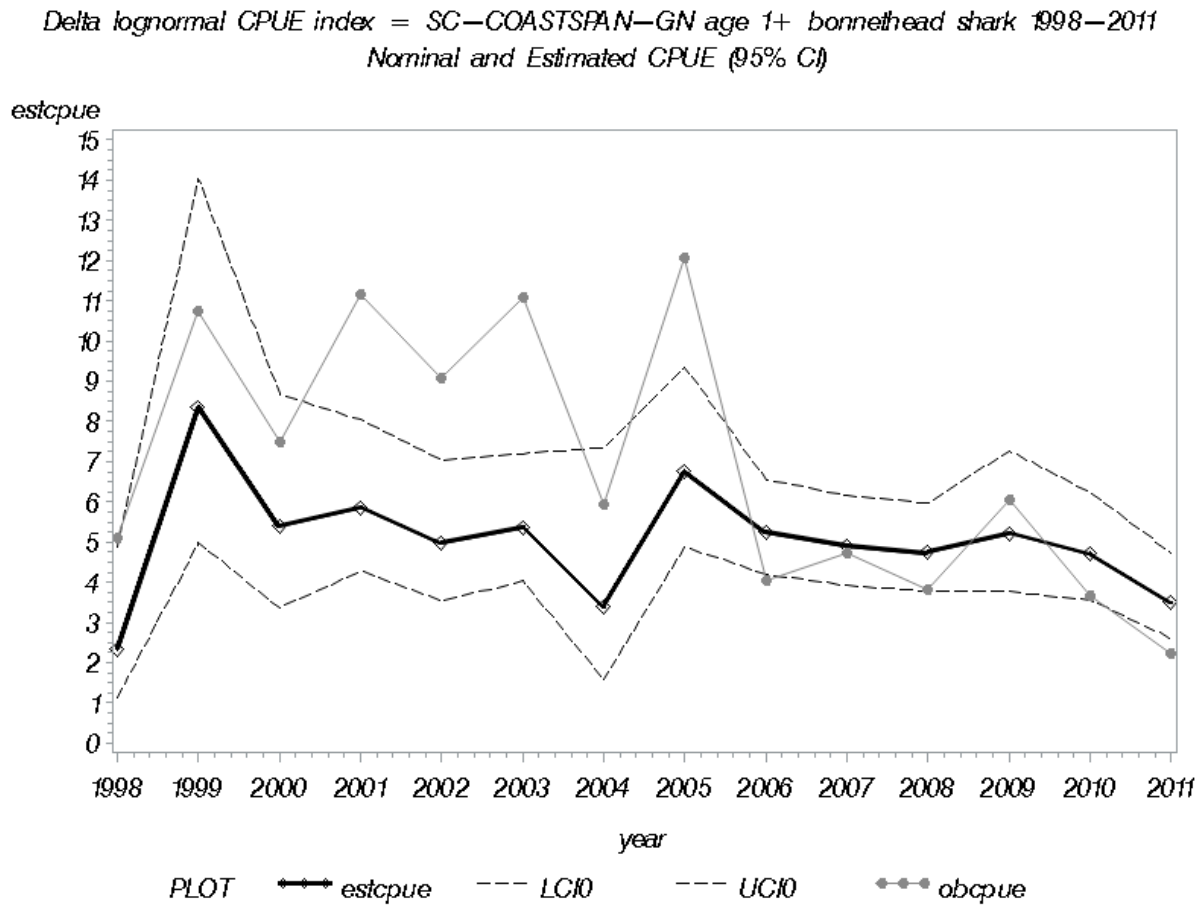


Figure 8. Fork lengths (cm) of Atlantic sharpnose sharks caught during the SC COASTSPAN gillnet survey from 1998-2011.

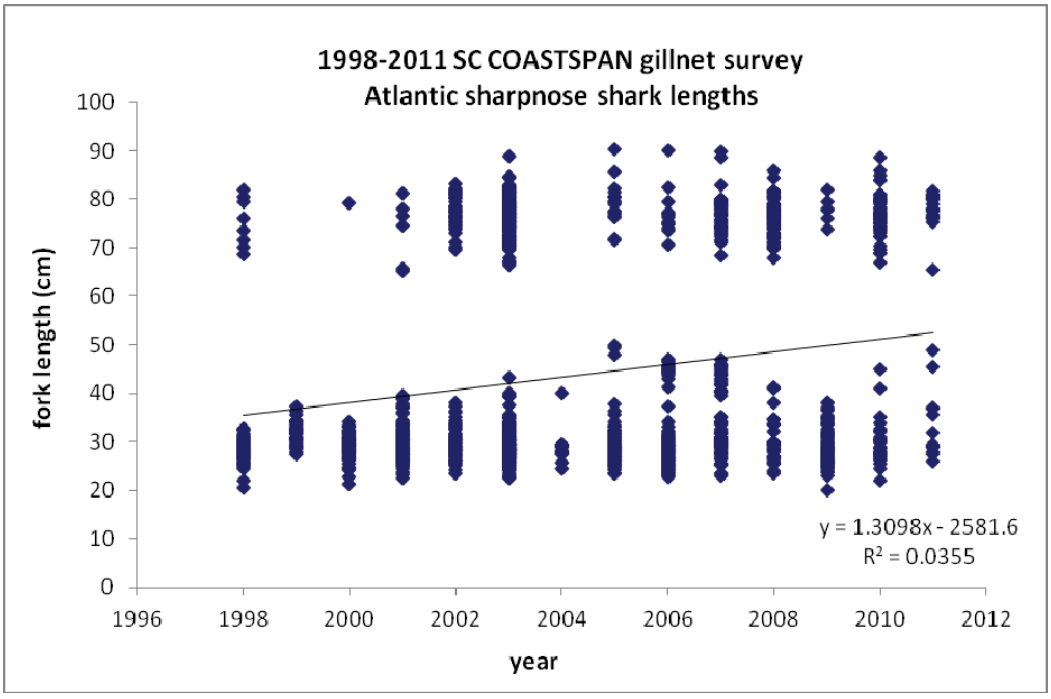
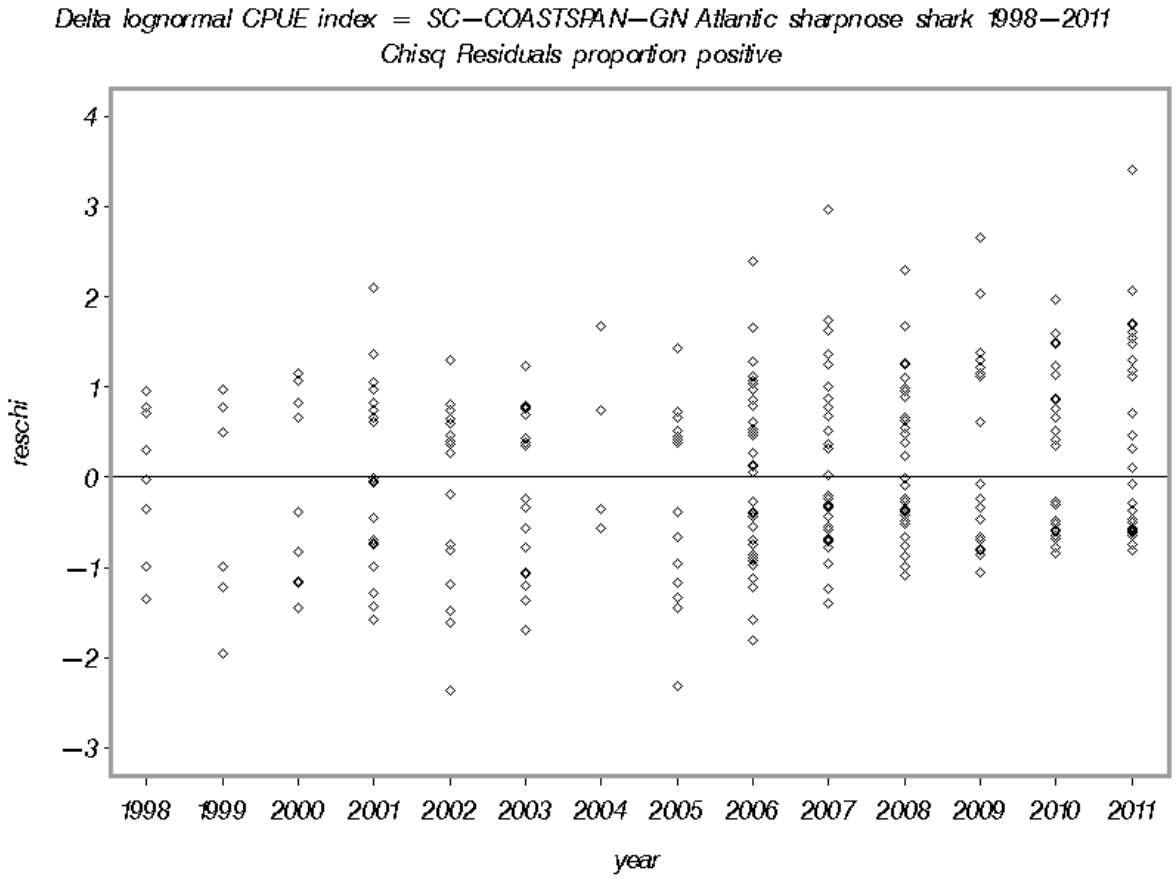


Figure 9a. COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the binomial component.



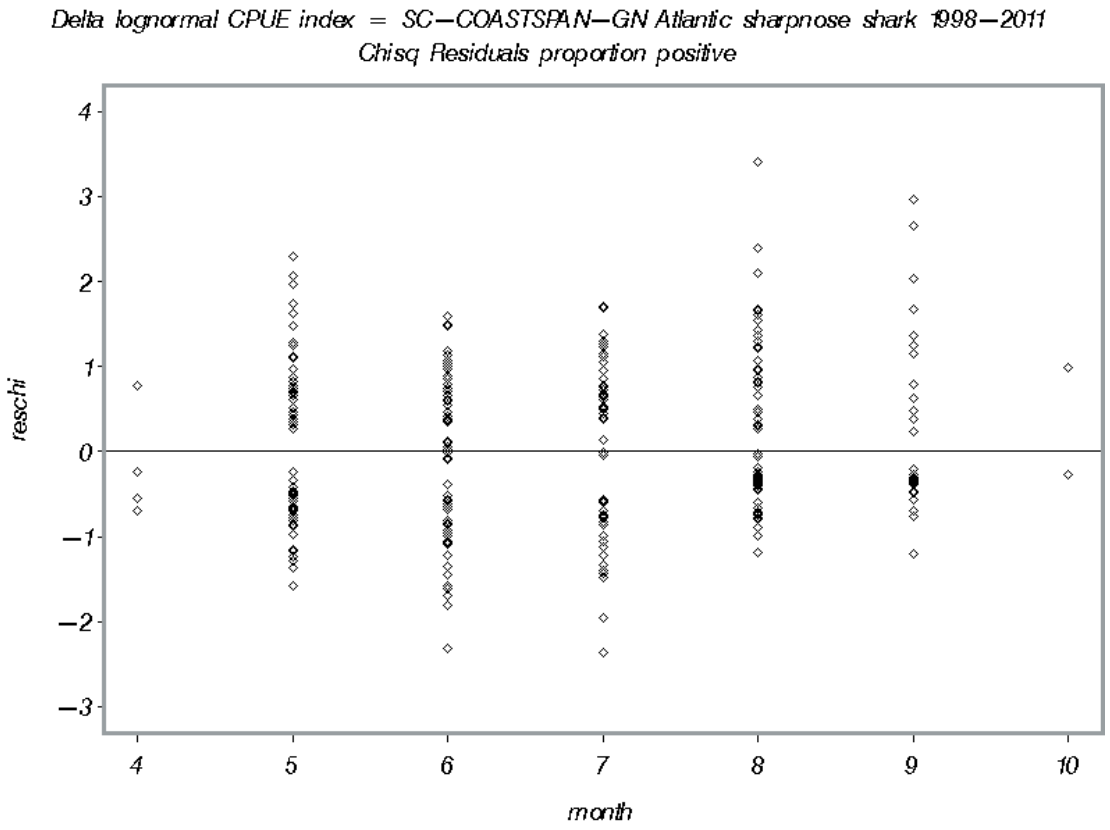
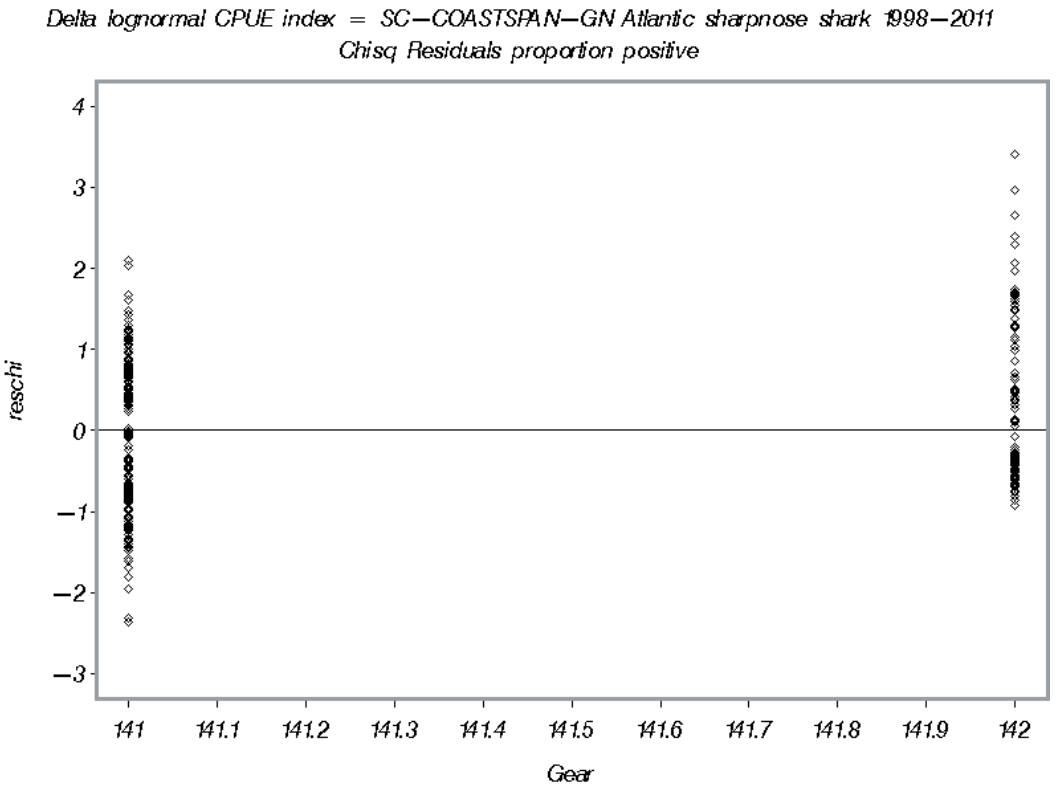


Figure 9a continued. COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the binomial component.



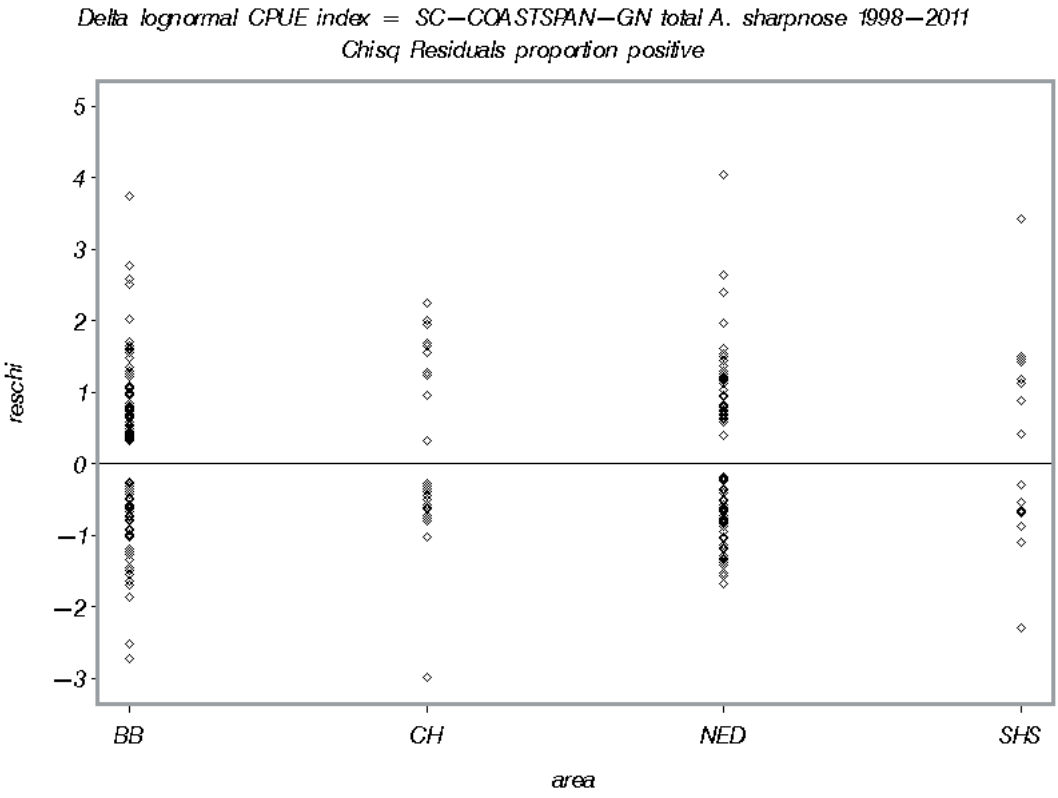


Figure 9a continued. COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the binomial component.

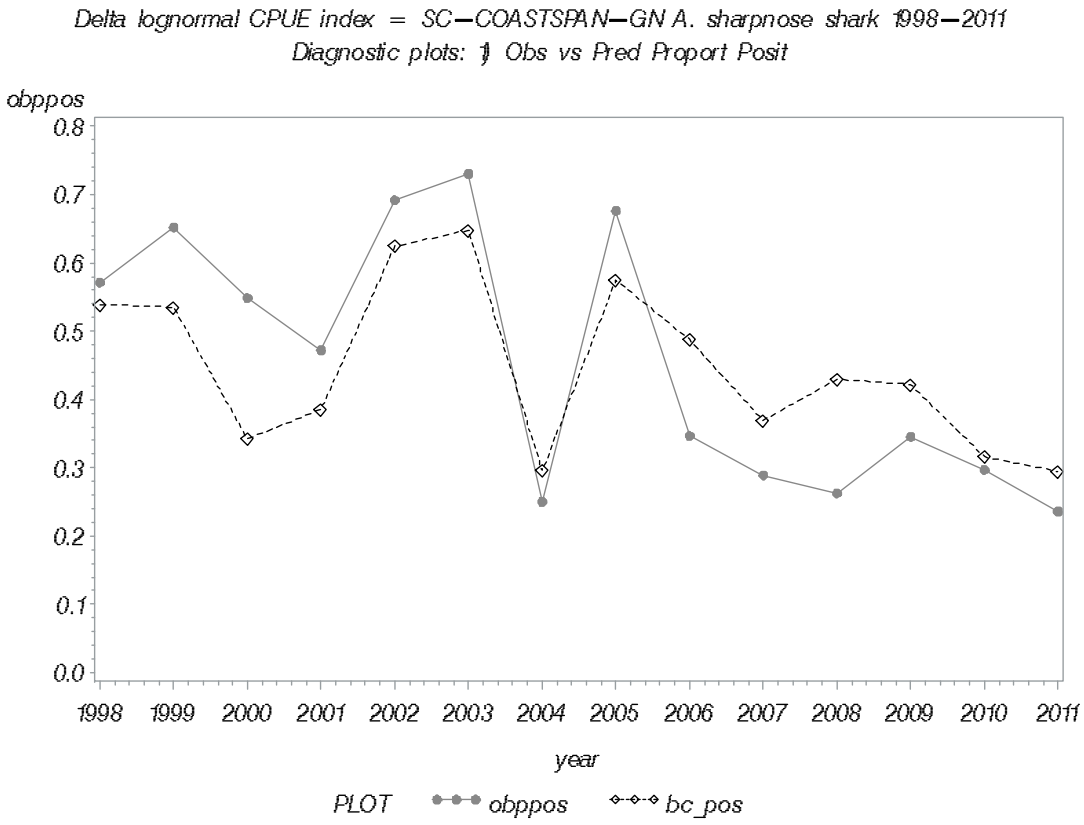


Figure 9b. SC-COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the lognormal component.

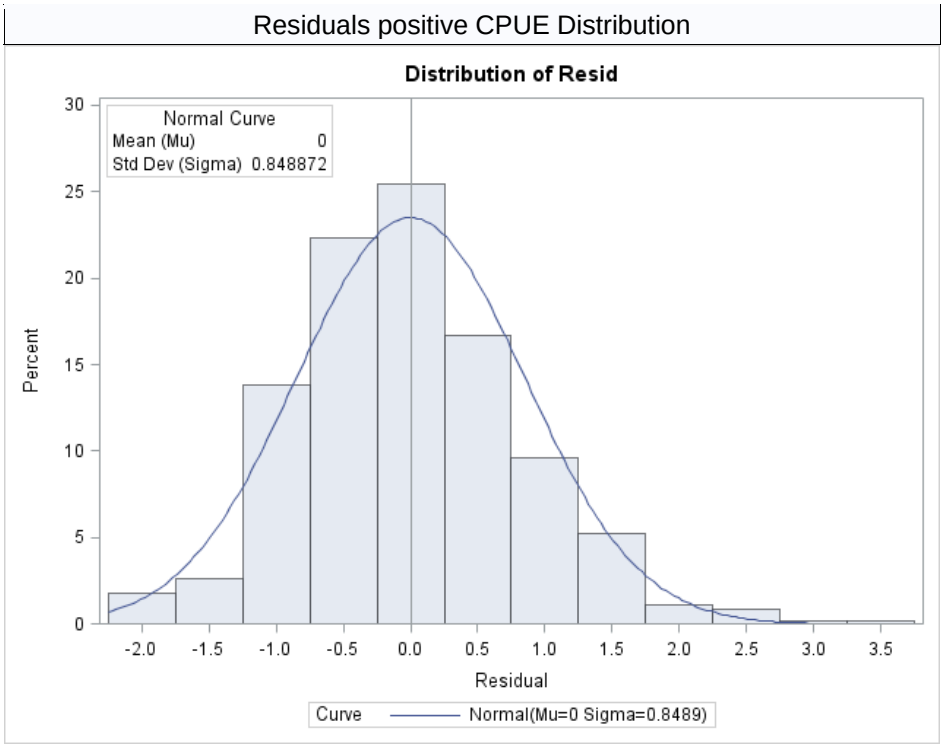
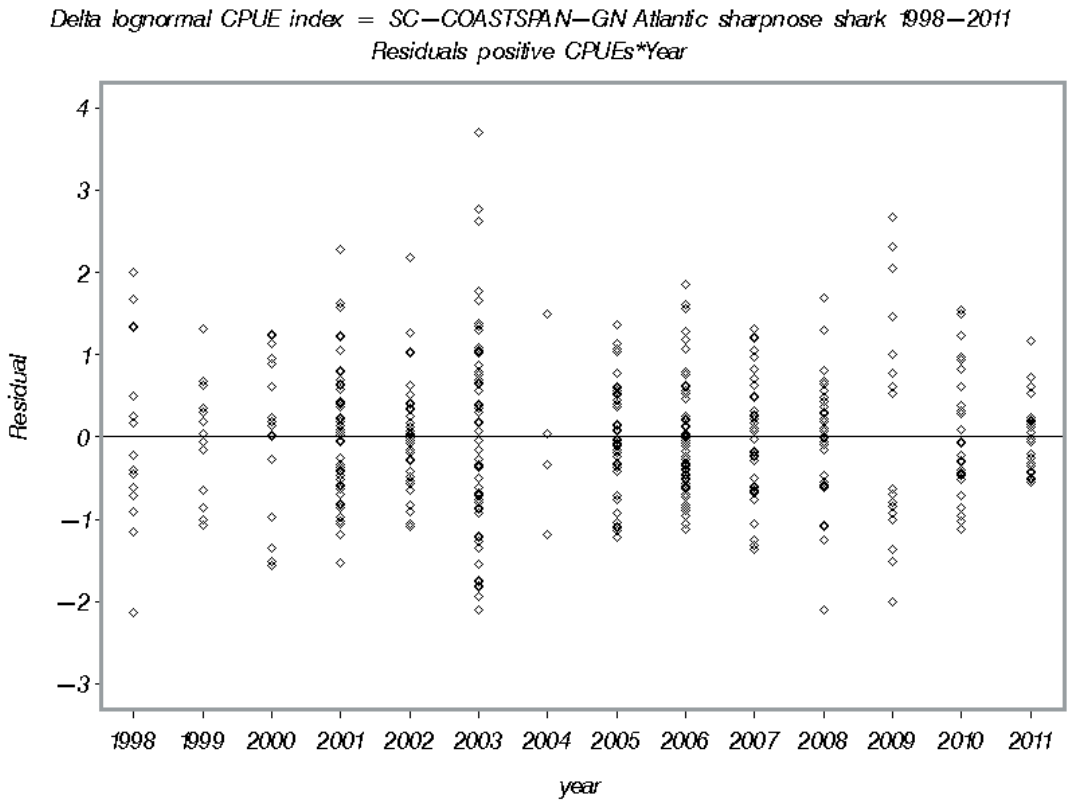


Figure 9b continued. SC-COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



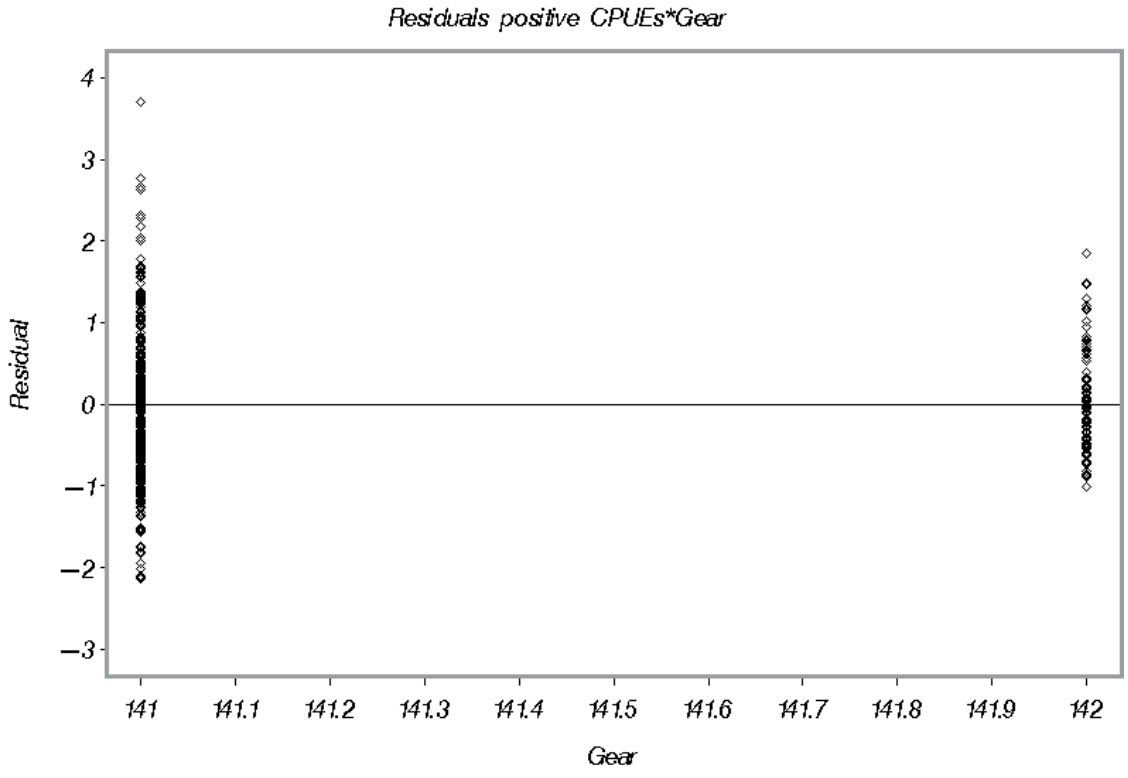
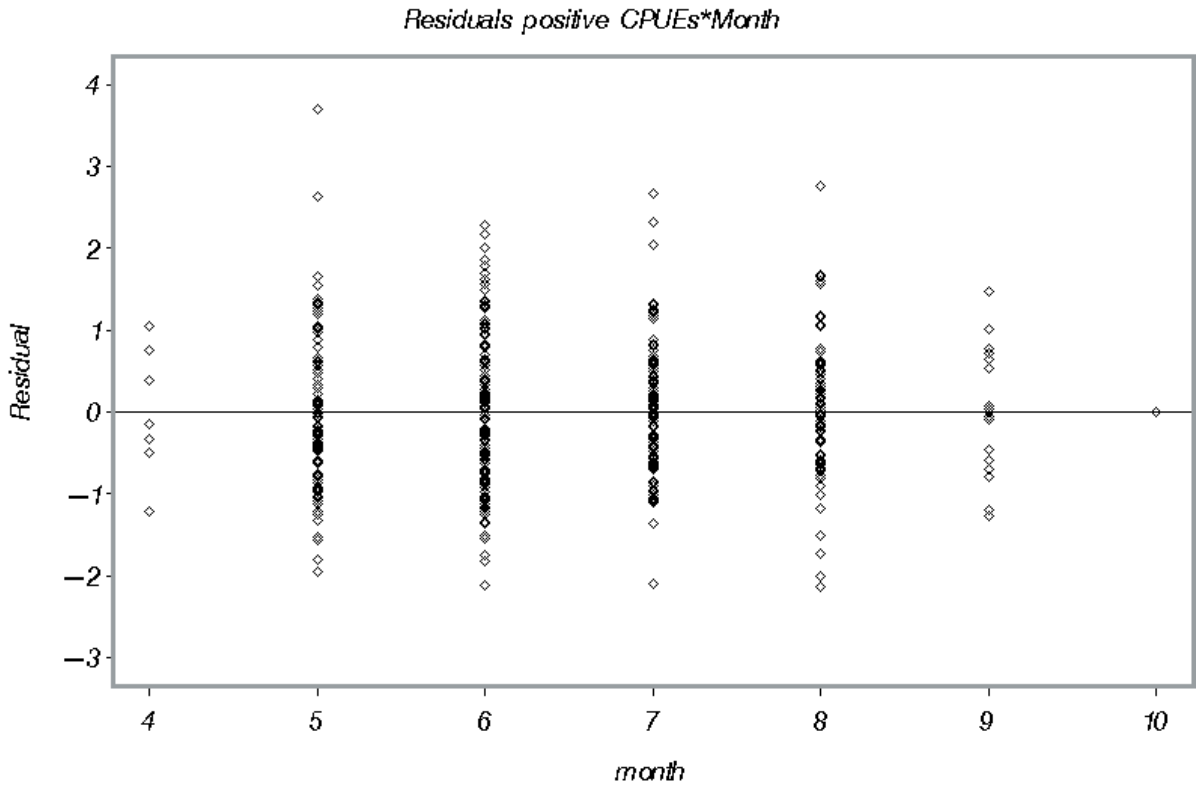


Figure 9b continued. SC-COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



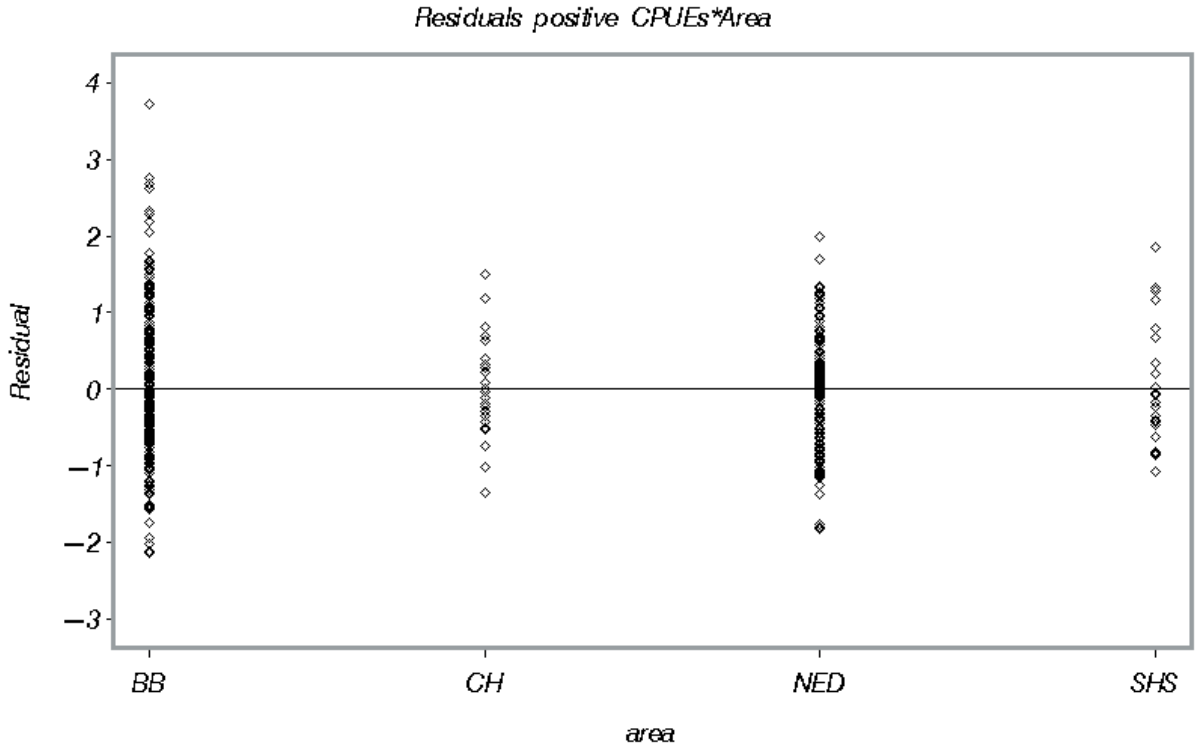


Figure 9b continued. SC-COASTSPAN-GN total Atlantic sharpnose shark model diagnostic plots for the lognormal component.

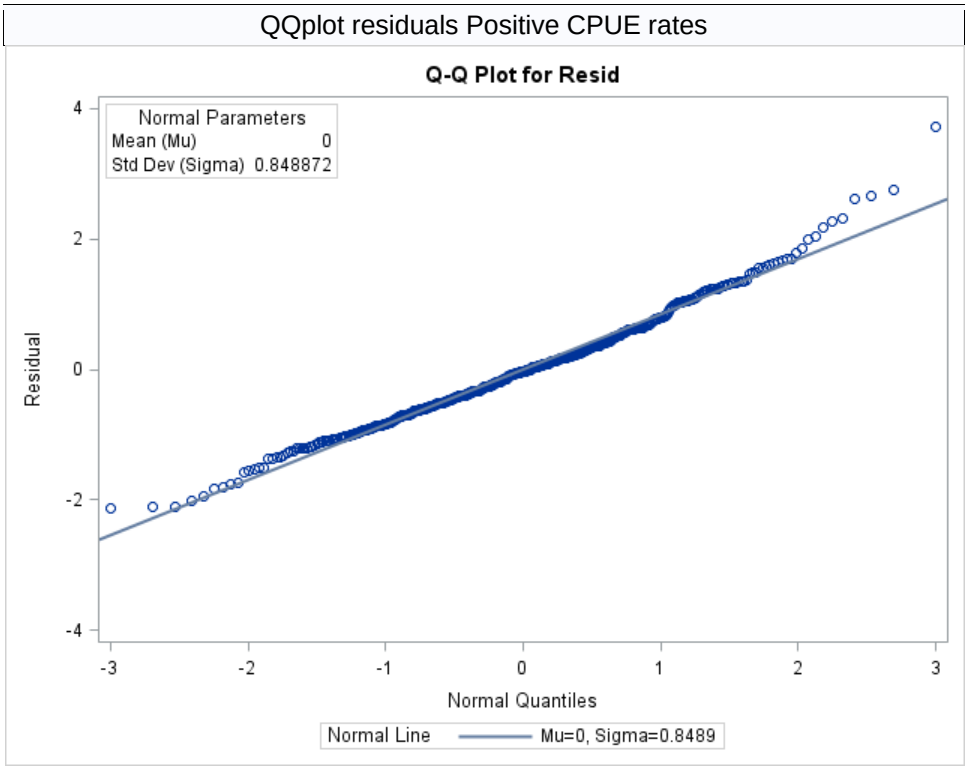


Figure 10. SC-COASTSPAN-GN total Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0).

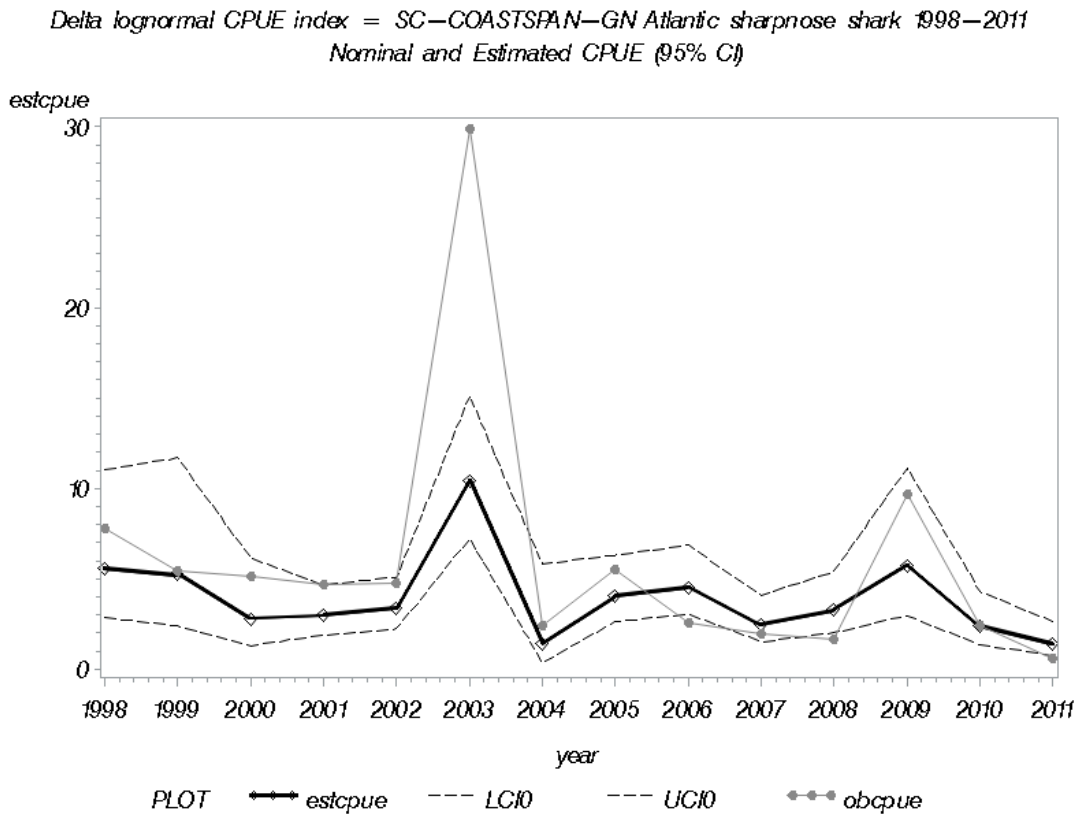
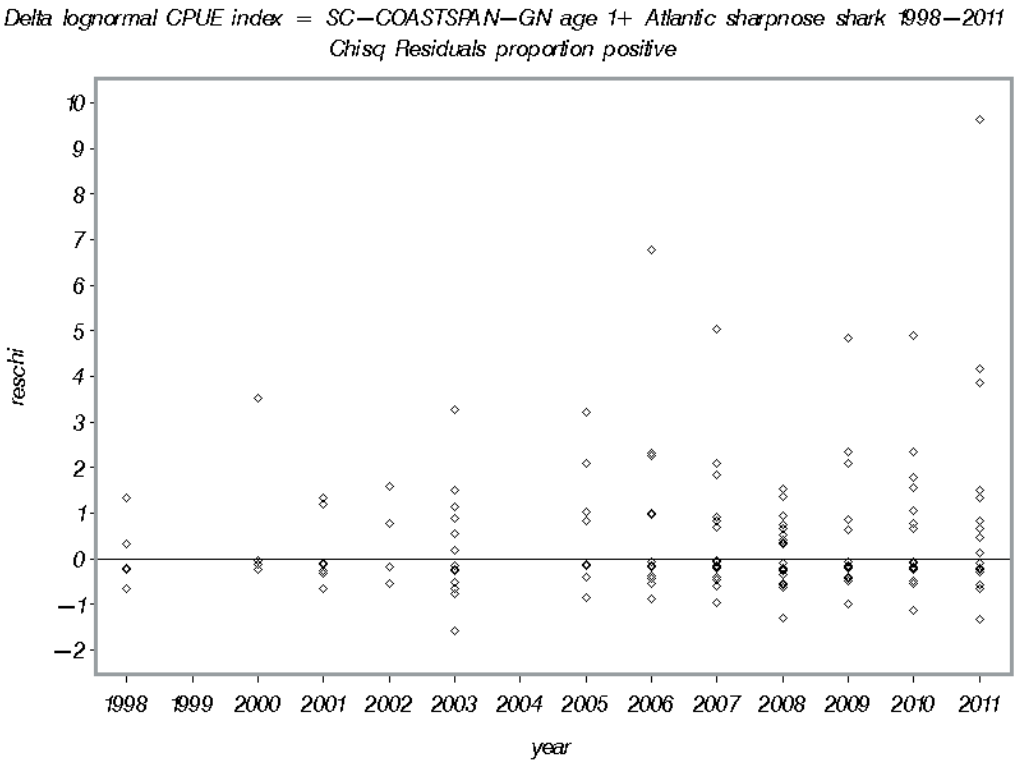


Figure 11a. COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



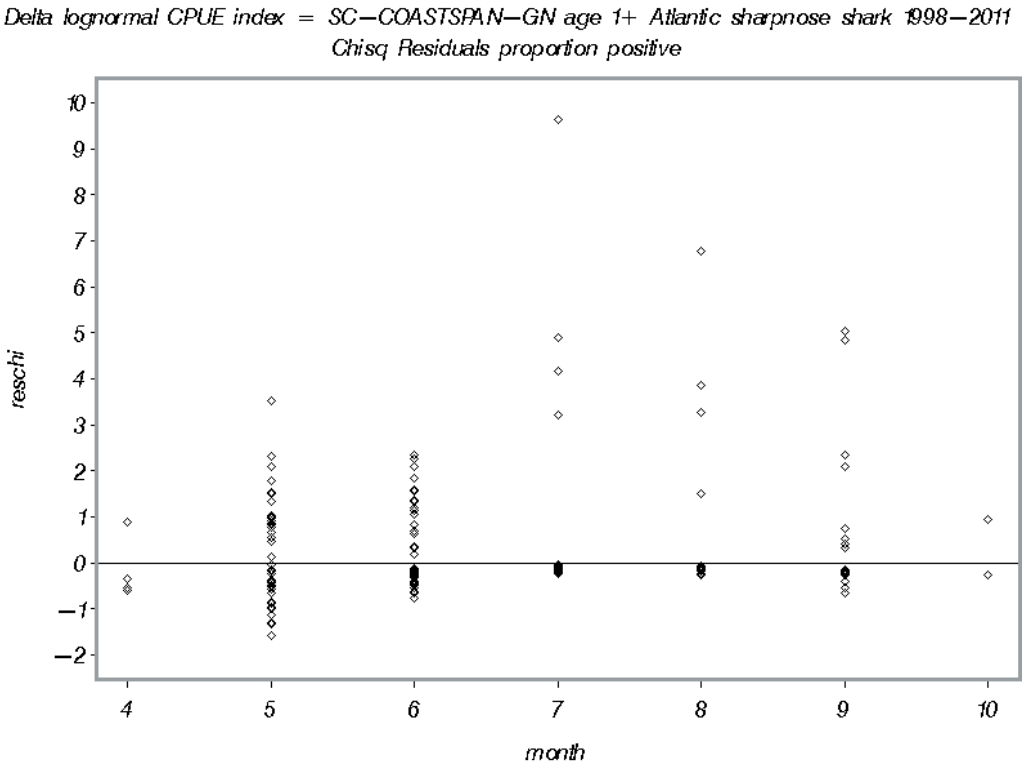


Figure 11a continued. COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.

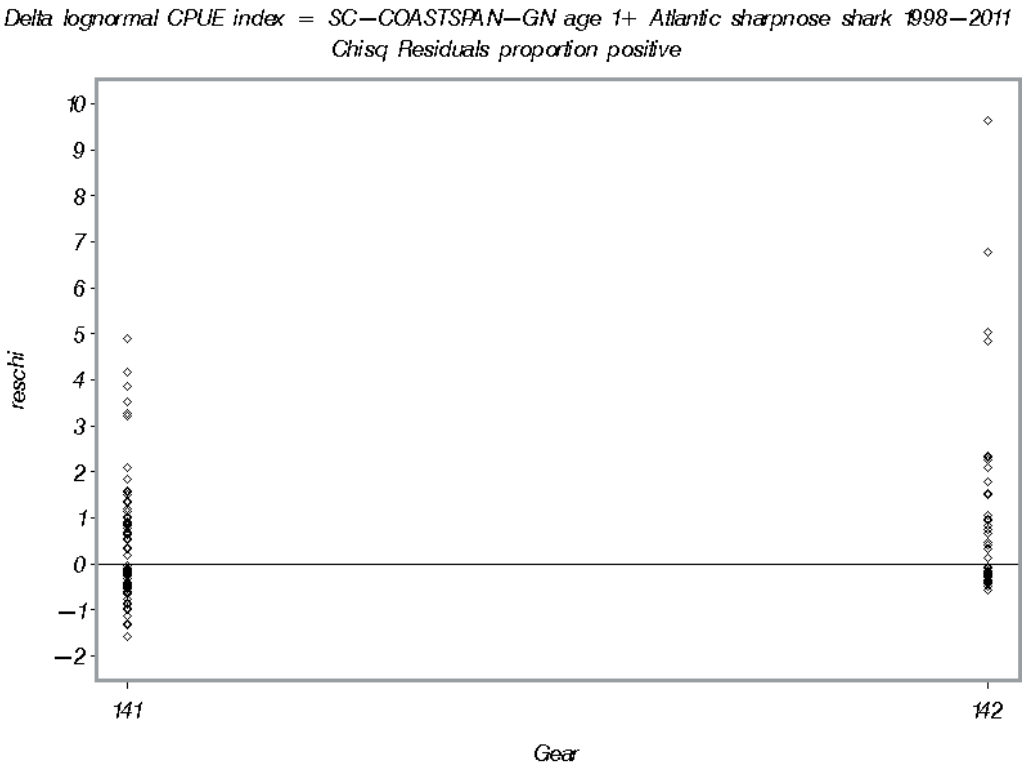


Figure 11b. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.

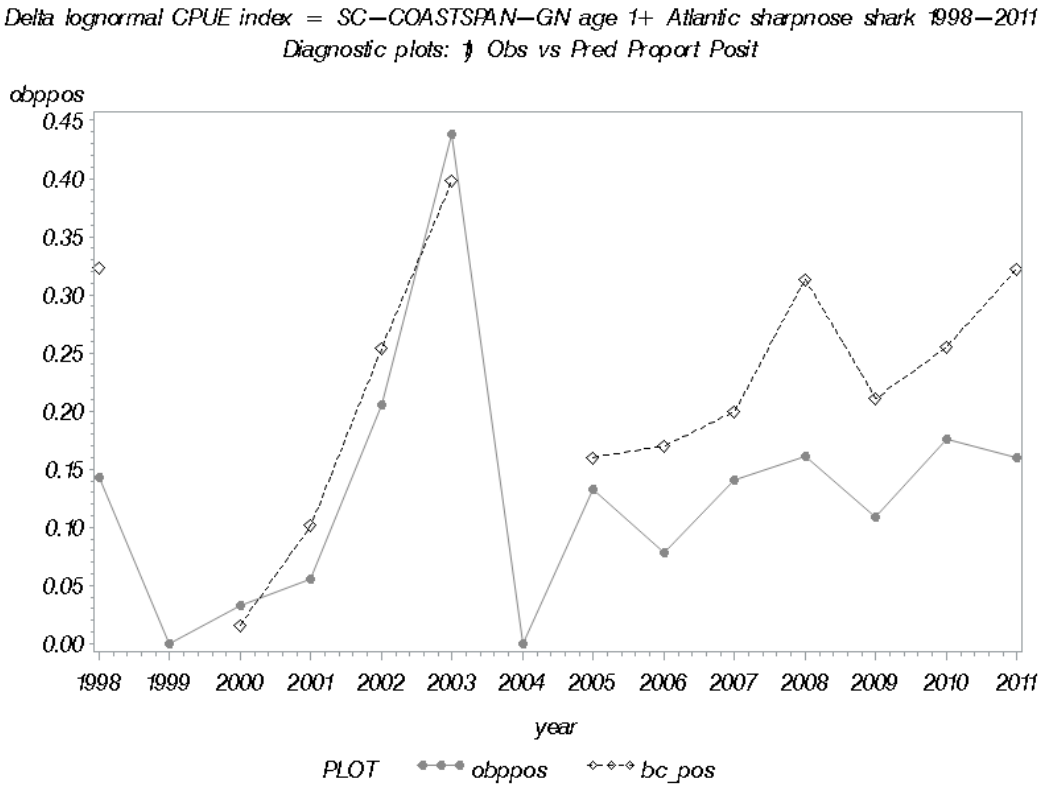
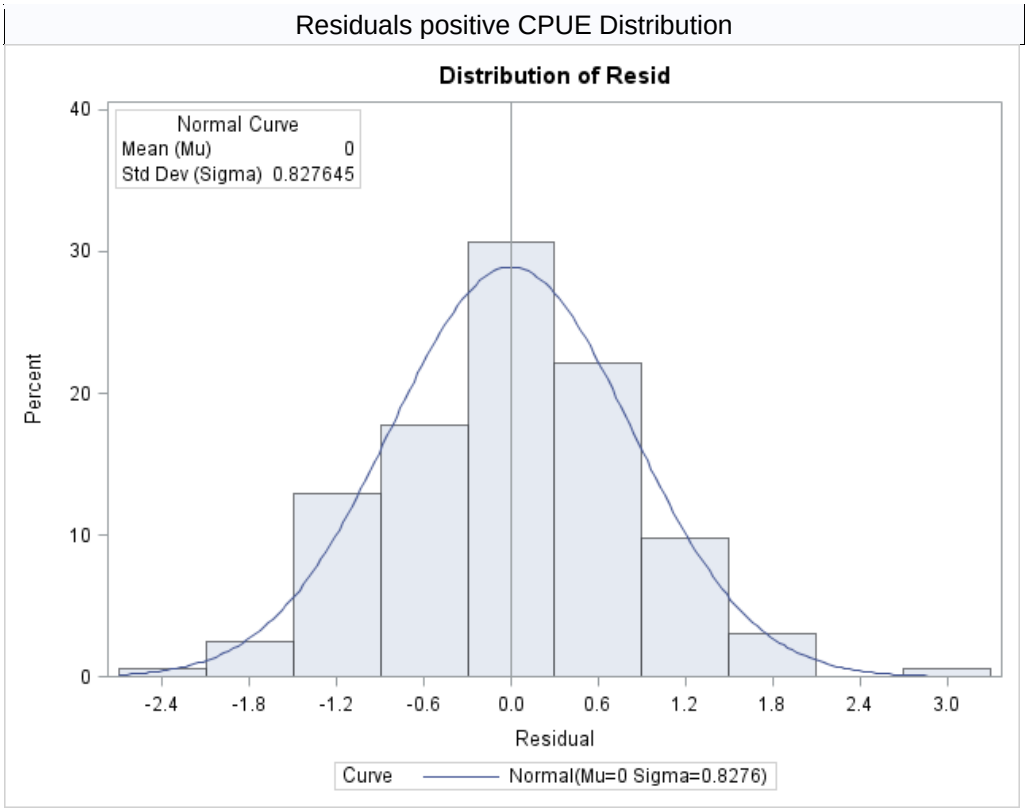


Figure 11b. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



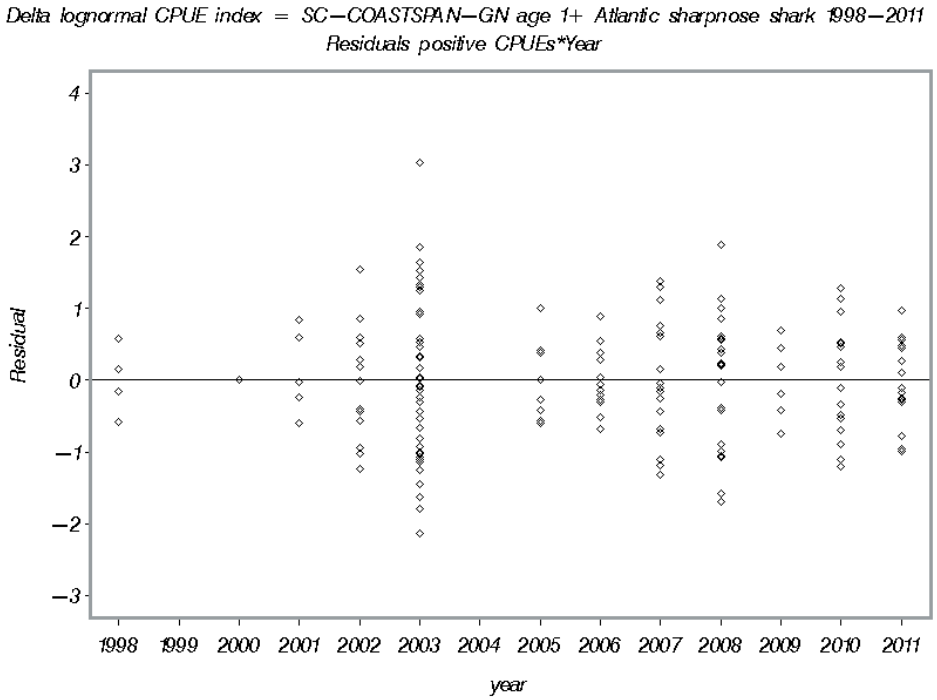
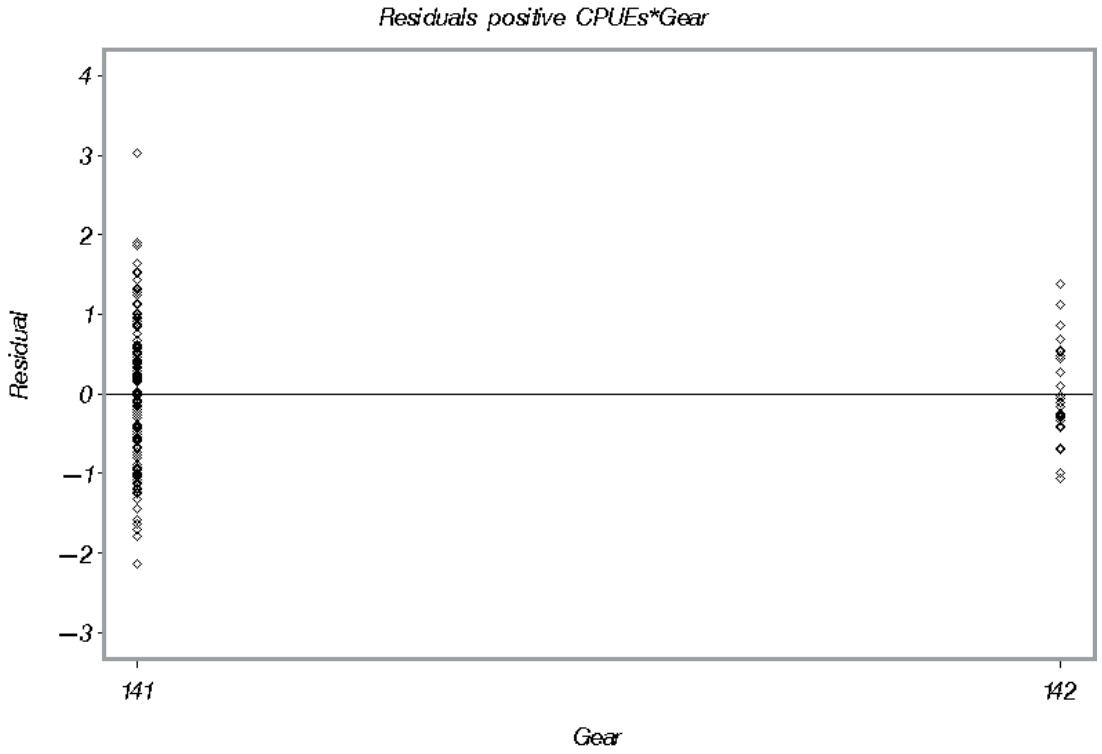


Figure 11b continued. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



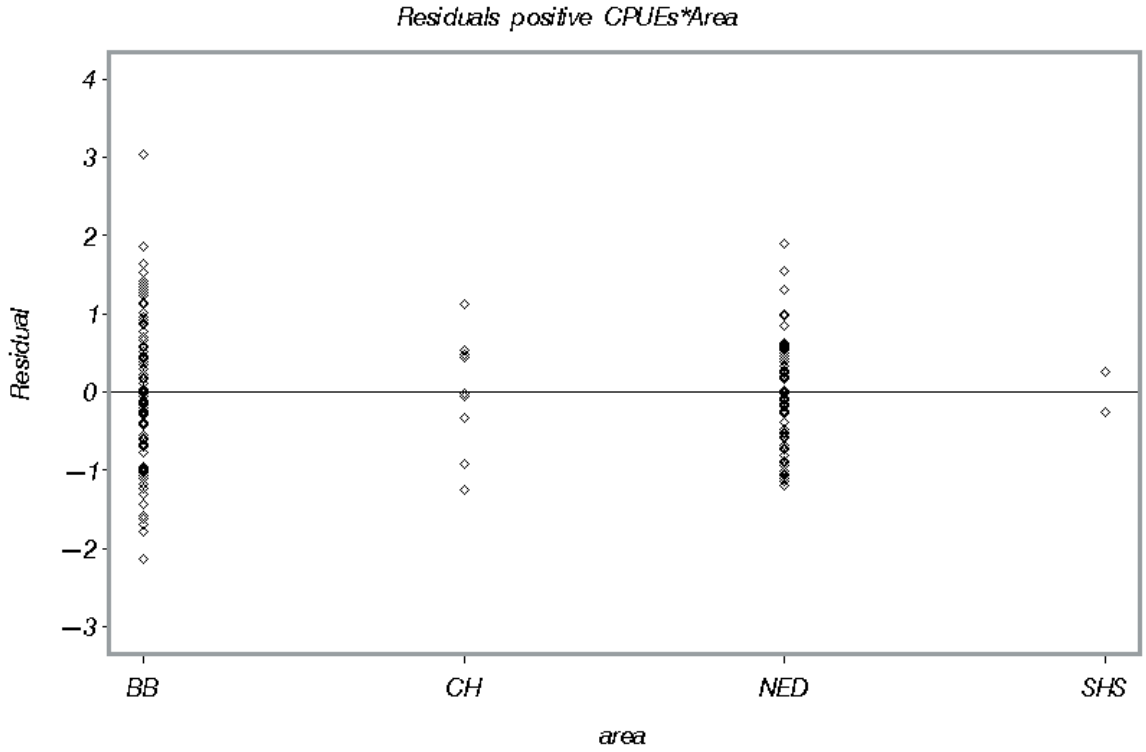


Figure 11b. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.

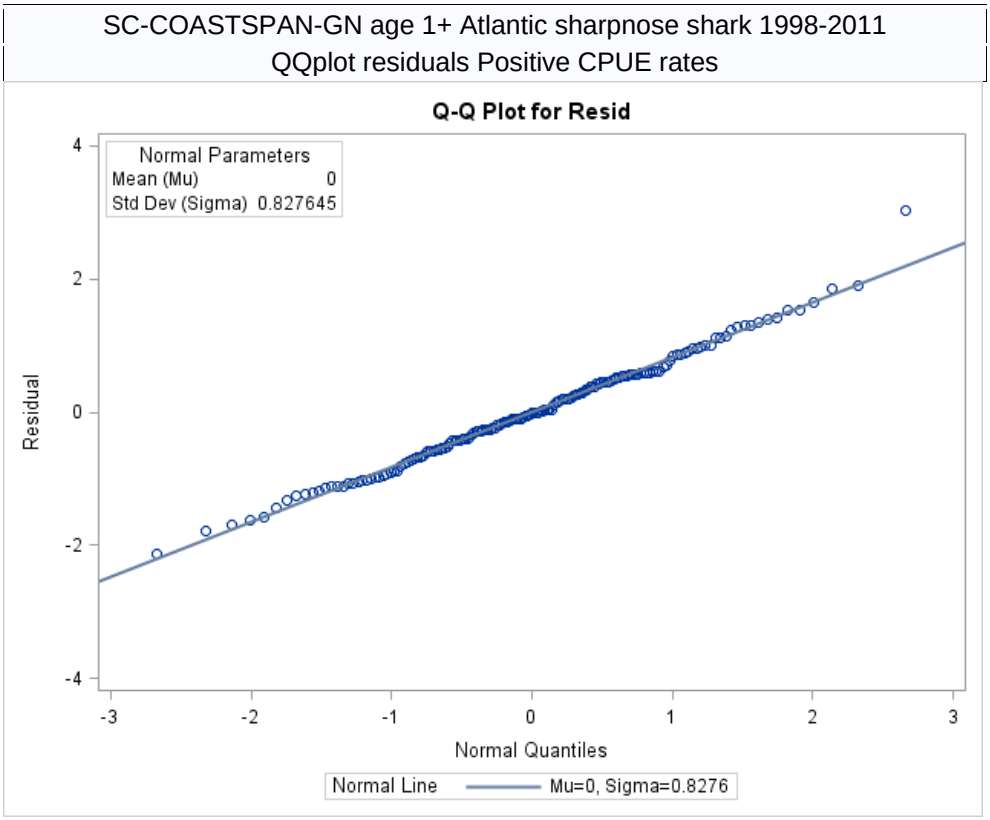


Figure 12. SC-COASTSPAN-GN age 1+ Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0).

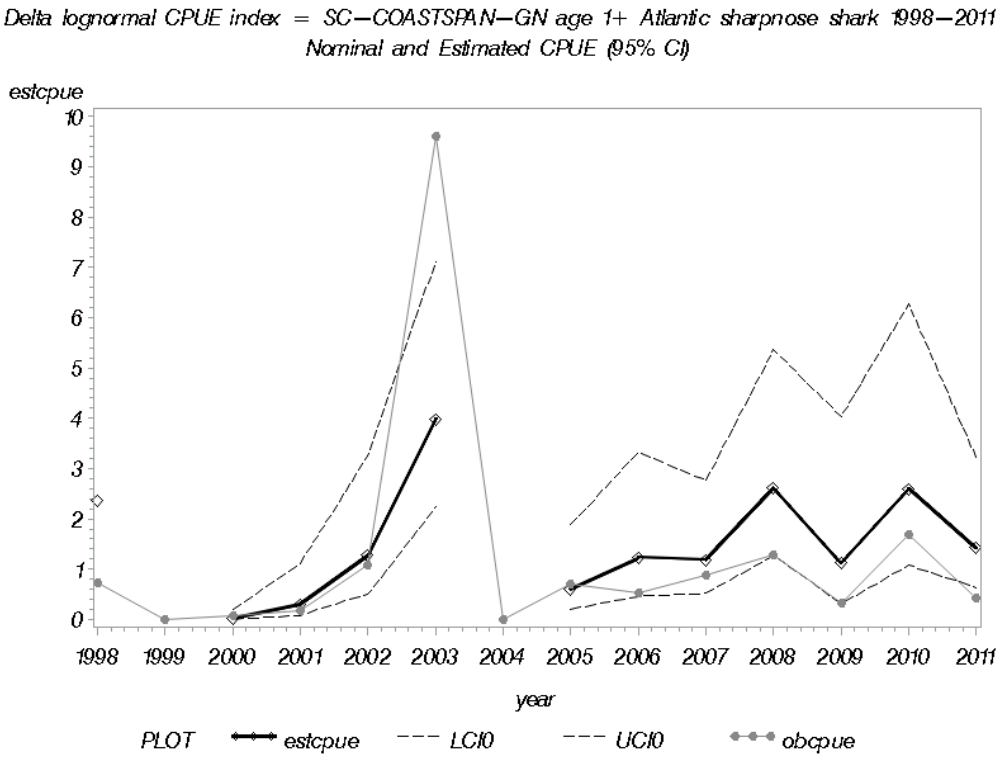


Figure 13. Fork lengths (cm) of Atlantic sharpnose sharks caught during the SCDNR red drum longline survey from 1998-2006.

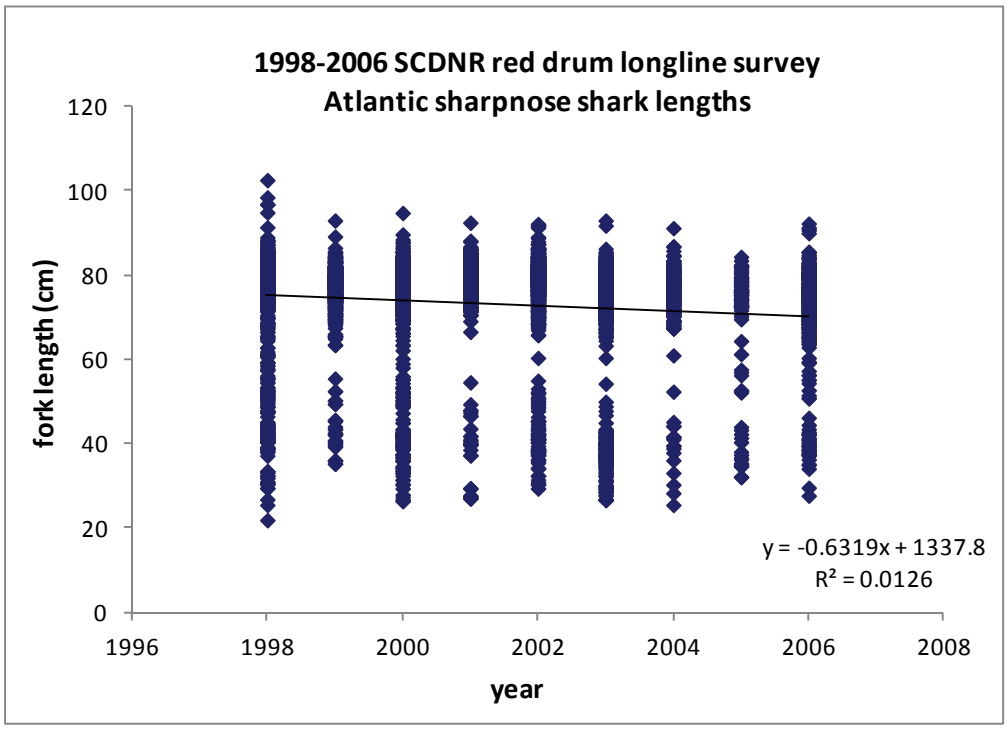


Figure 14a. SCDNR-Red Drum-OLD total Atlantic sharpnose shark model diagnostic plots for the binomial component.

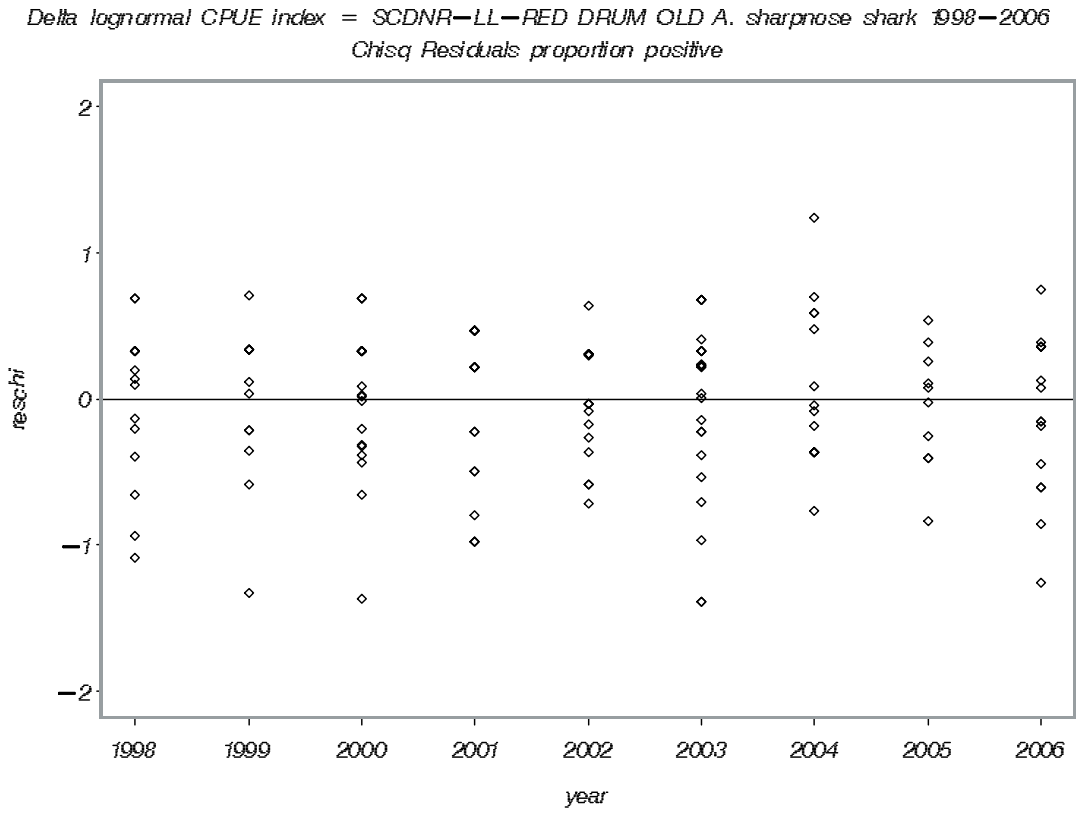
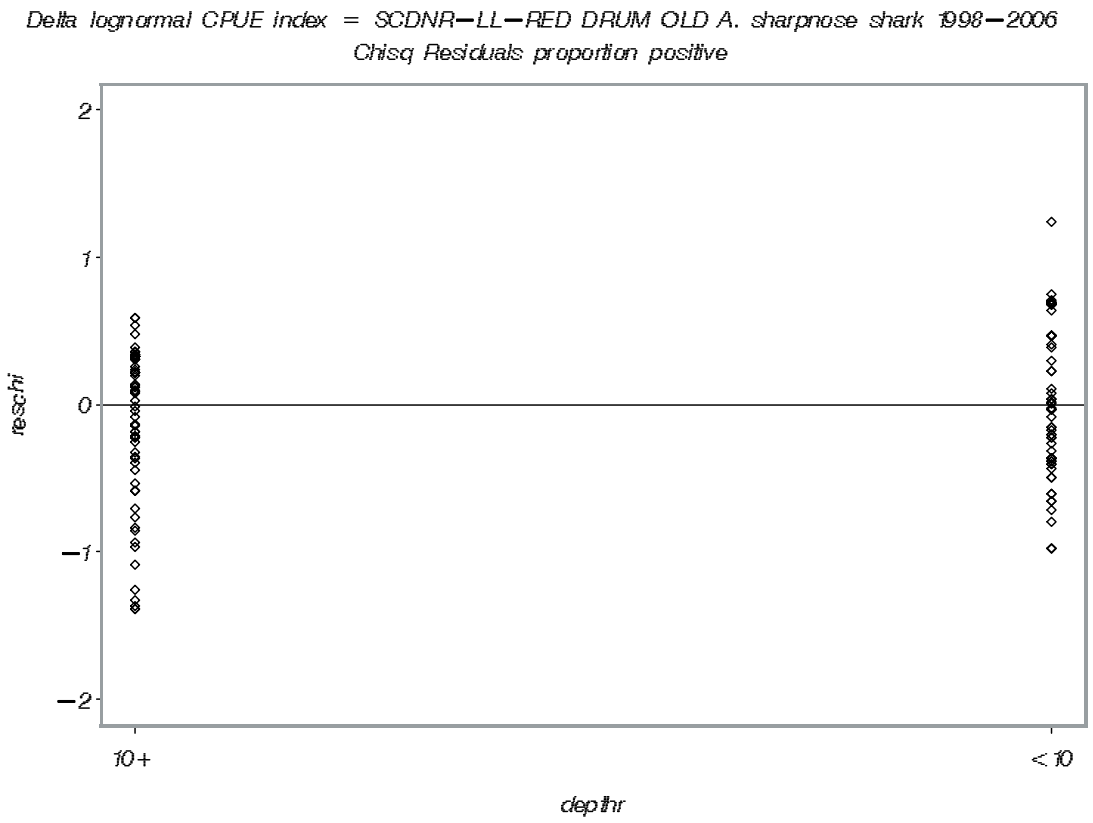


Figure 14a continued. SCDNR-Red Drum-OLD total Atlantic sharpnose shark model diagnostic plots for the binomial component.



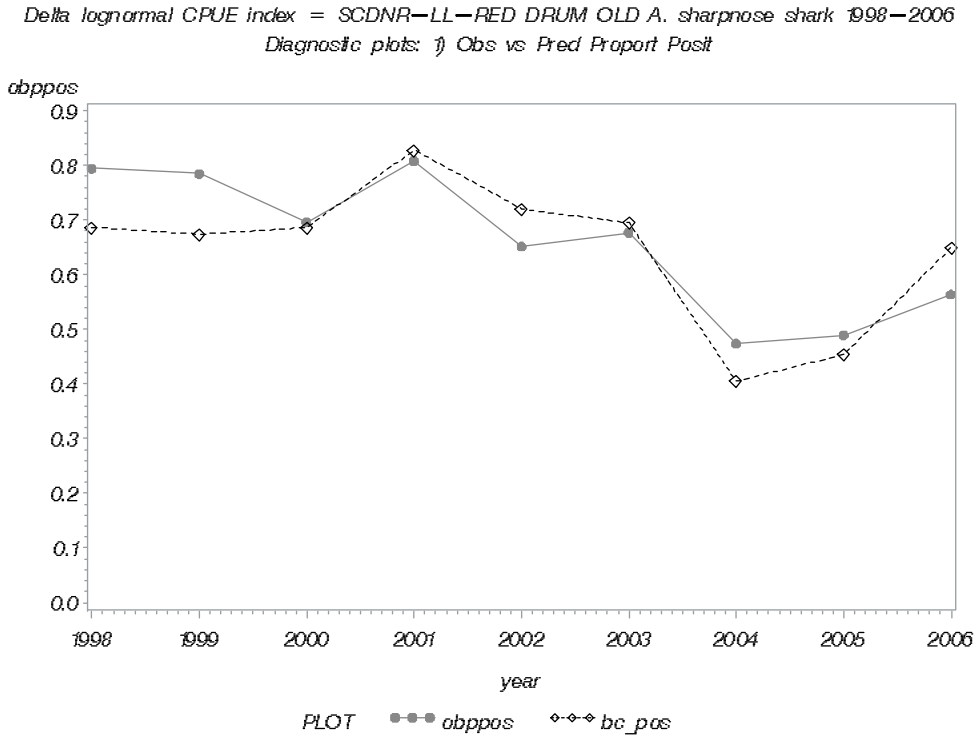
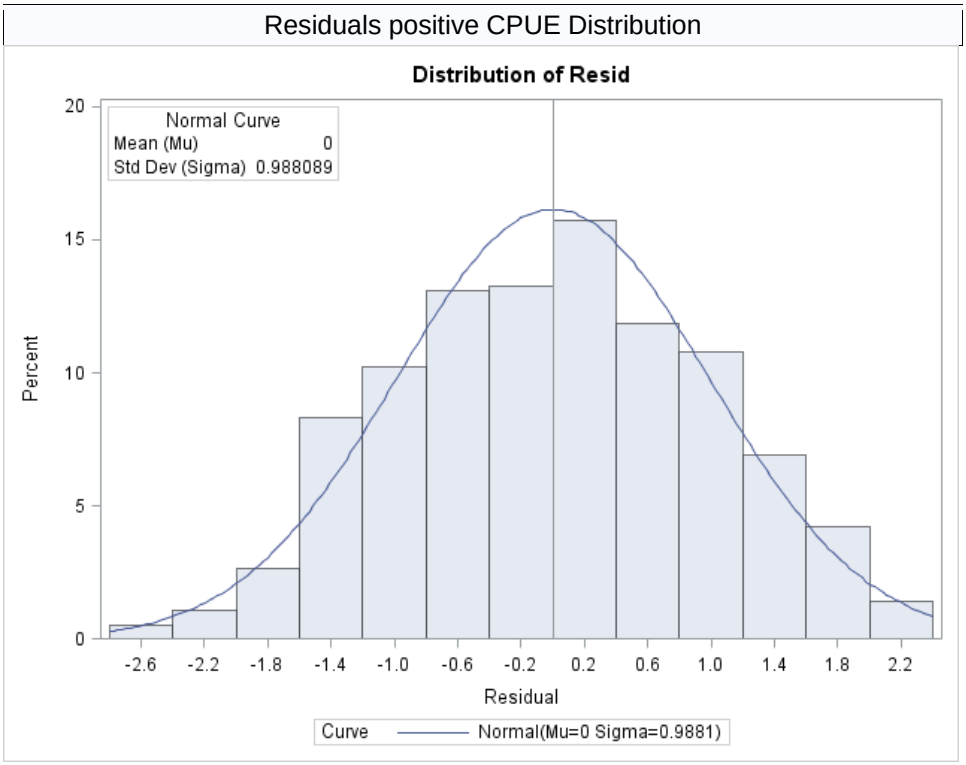


Figure 14b. SCDNR-Red Drum-OLD total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



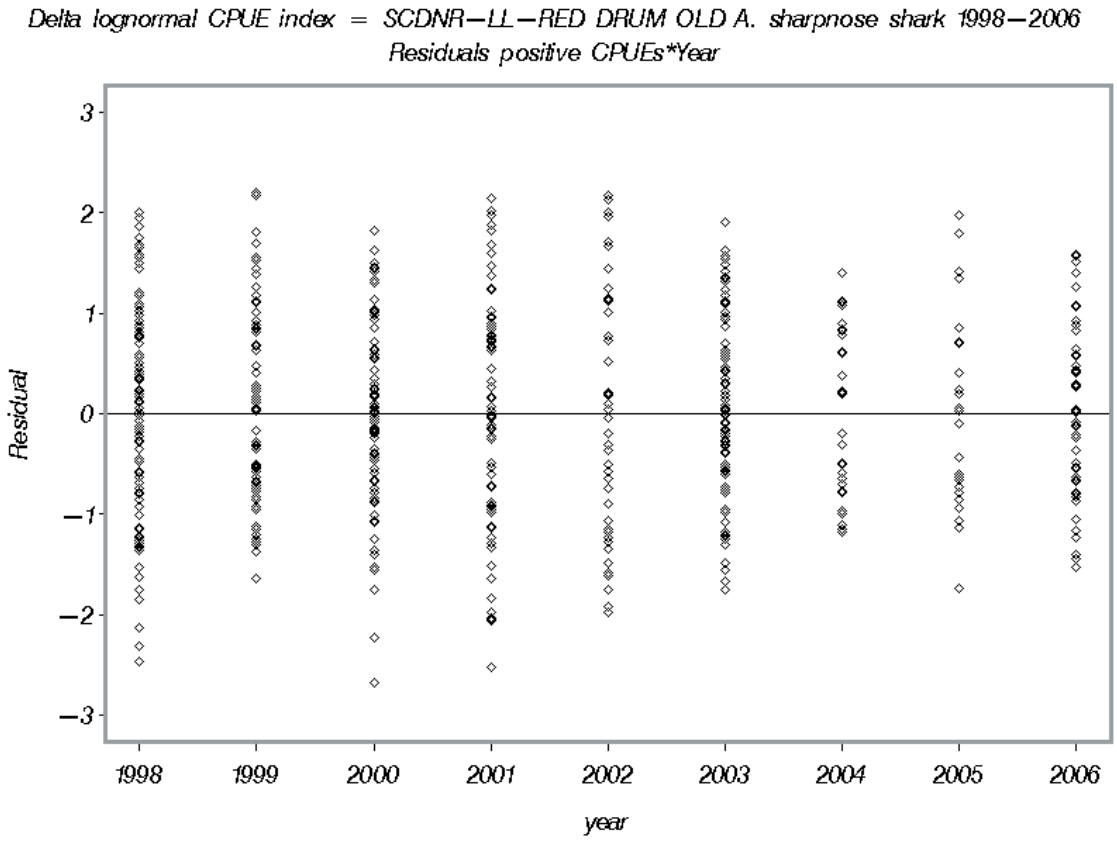
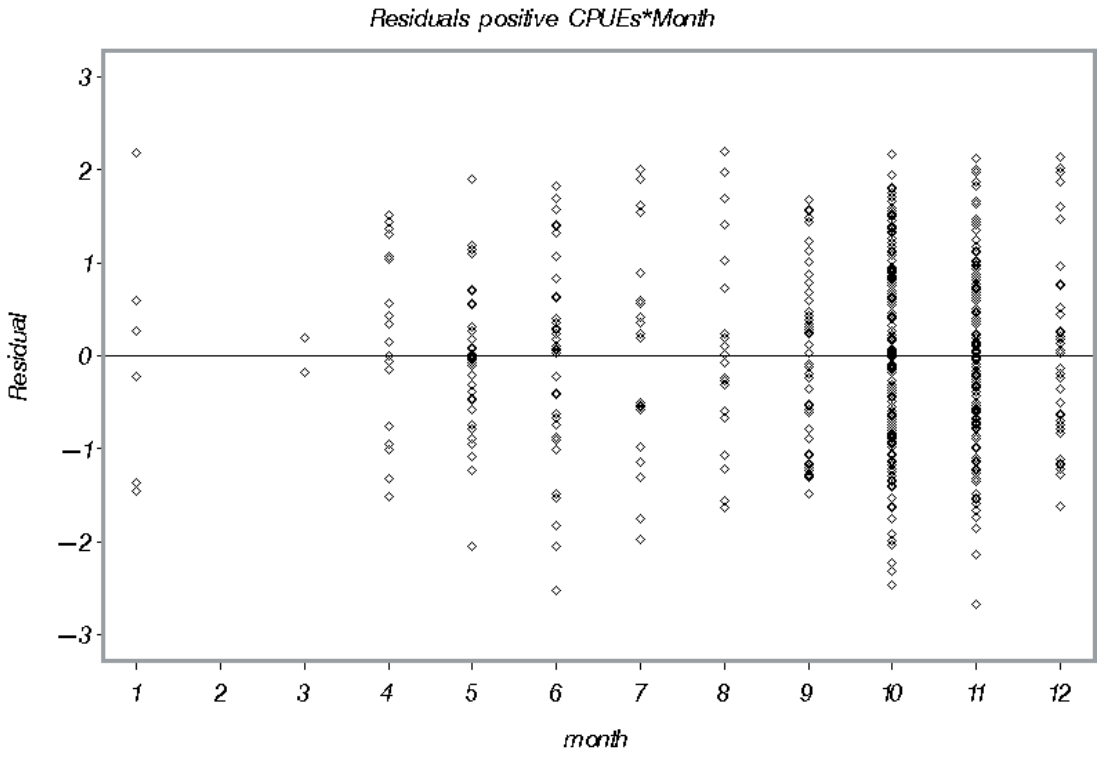


Figure 14b continued. SCDNR-Red Drum-OLD total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



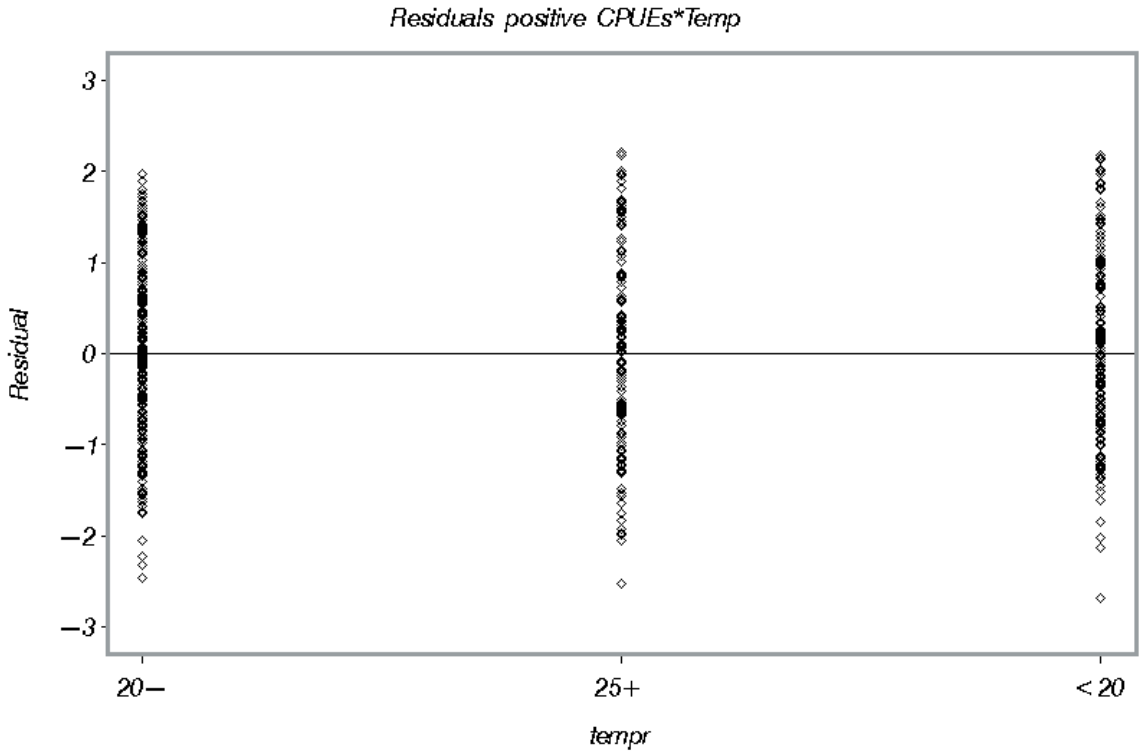


Figure 14b continued. SCDNR-Red Drum-OLD total Atlantic sharpnose shark model diagnostic plots for the lognormal component.

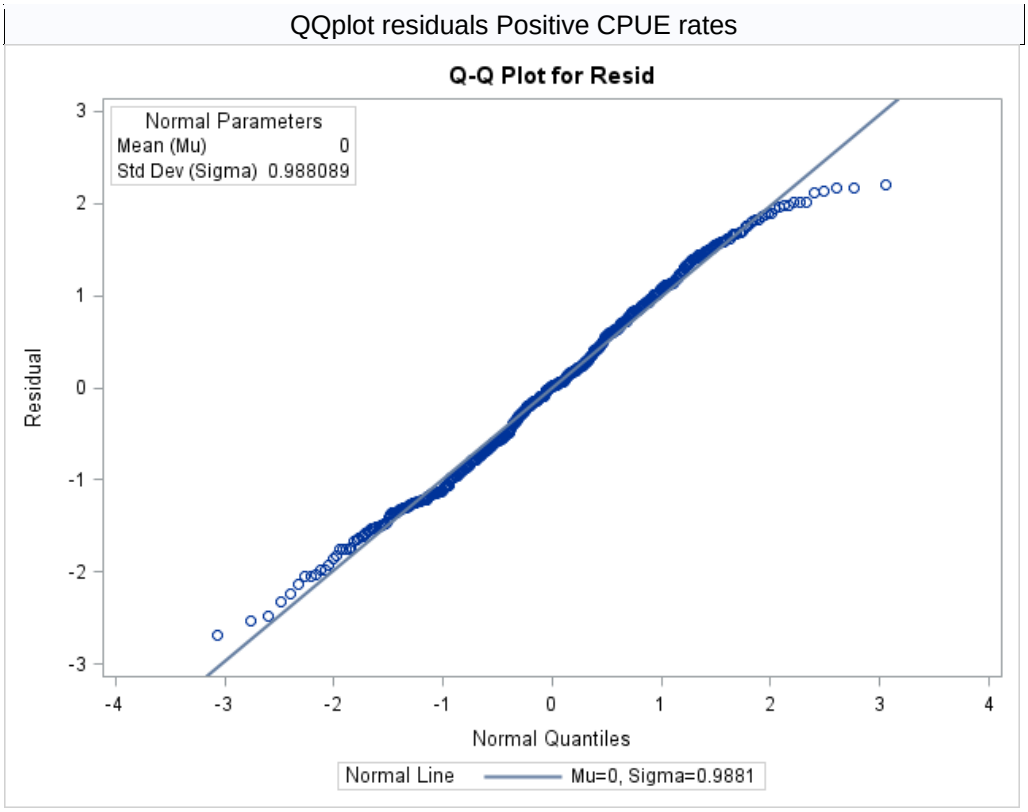


Figure 15. SCDNR-Red Drum-OLD total Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0)

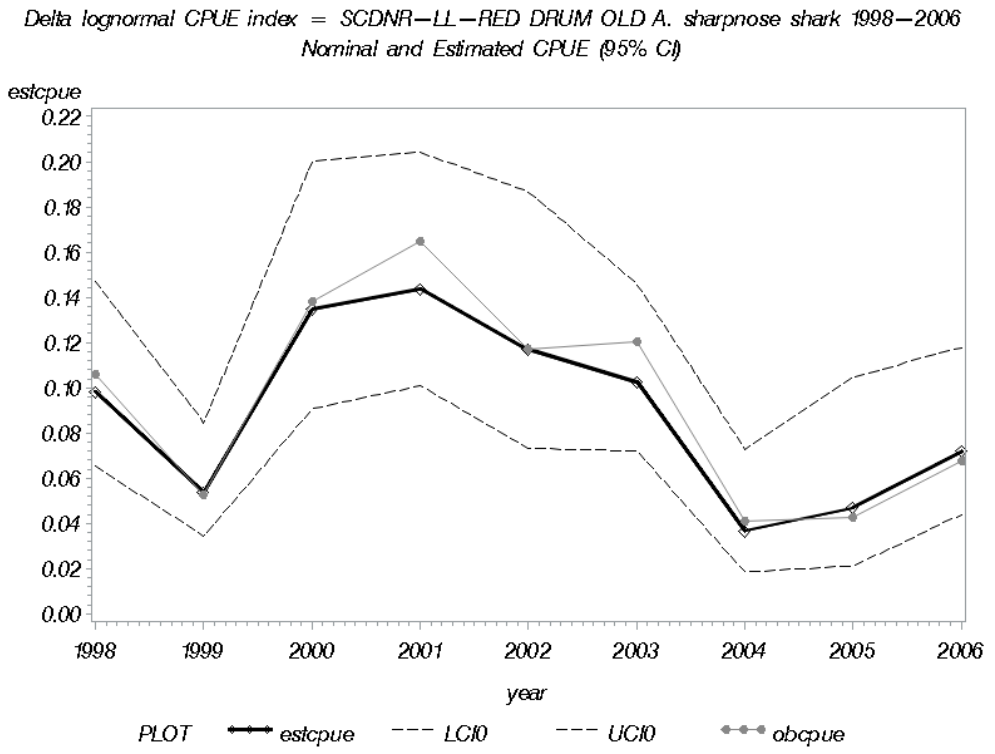
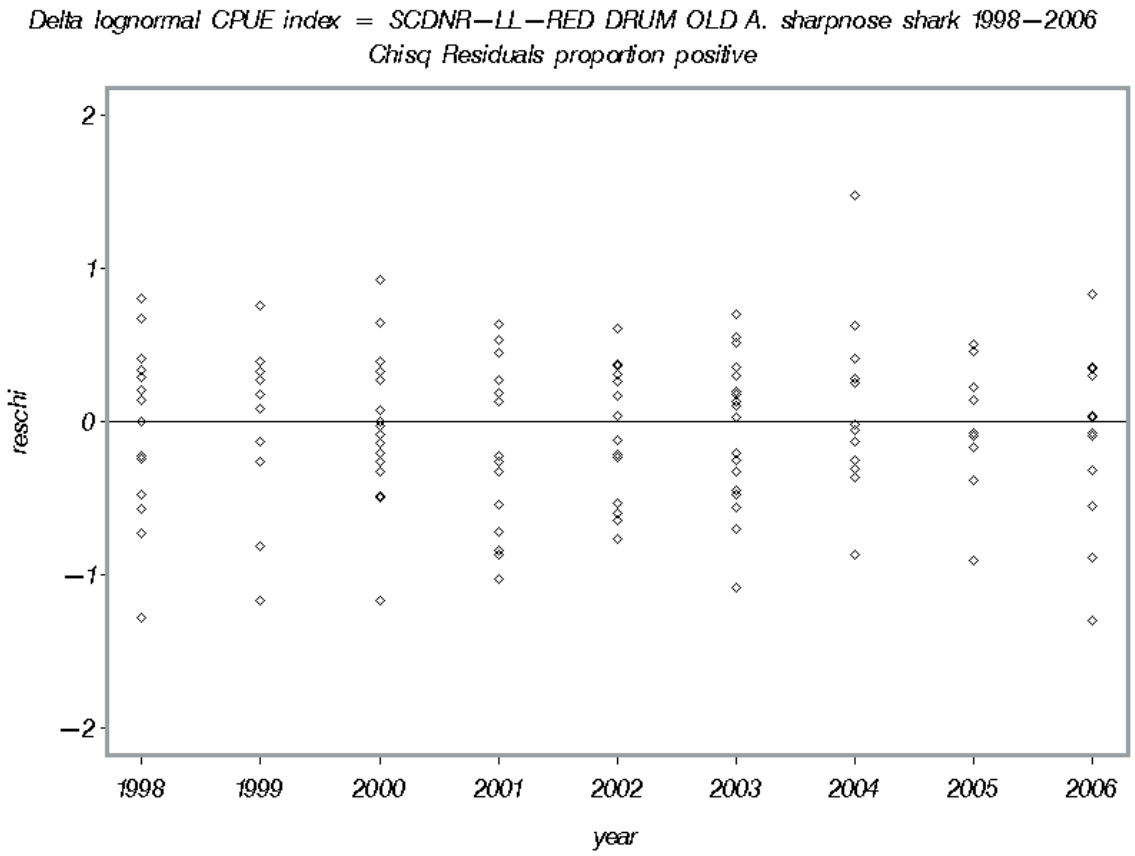


Figure 16a continued. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



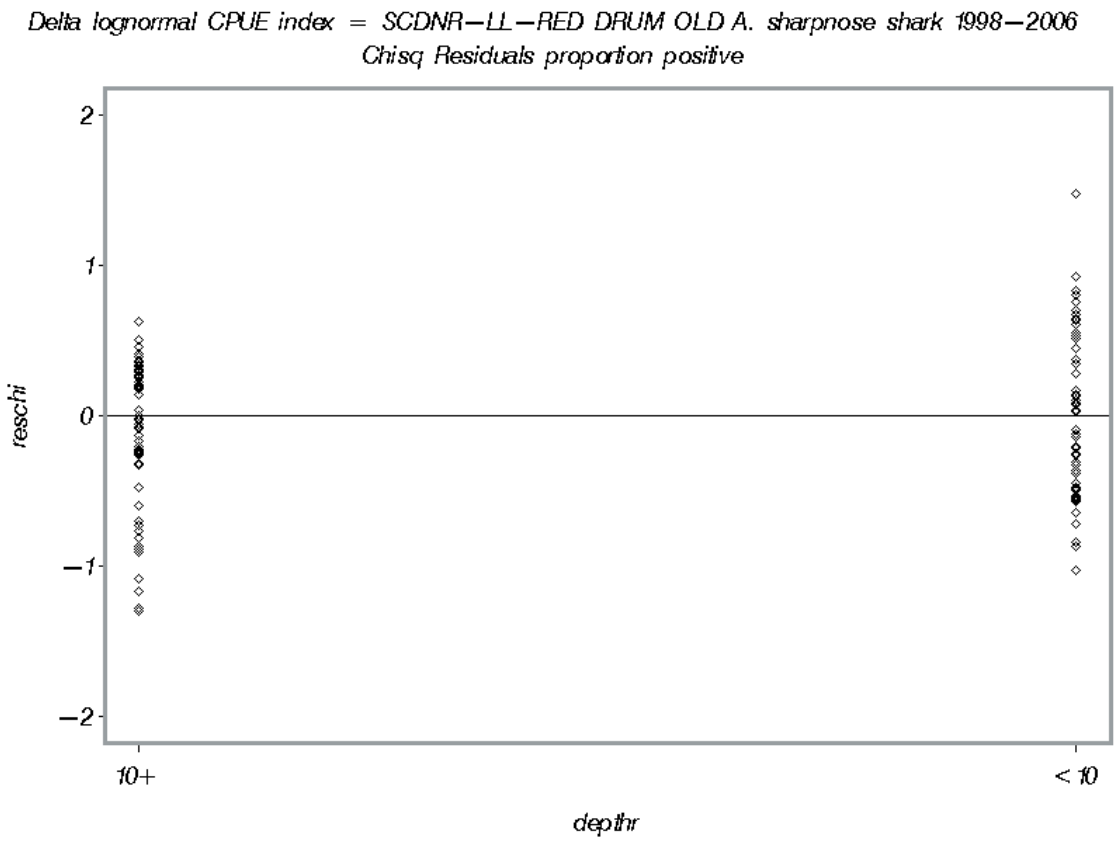
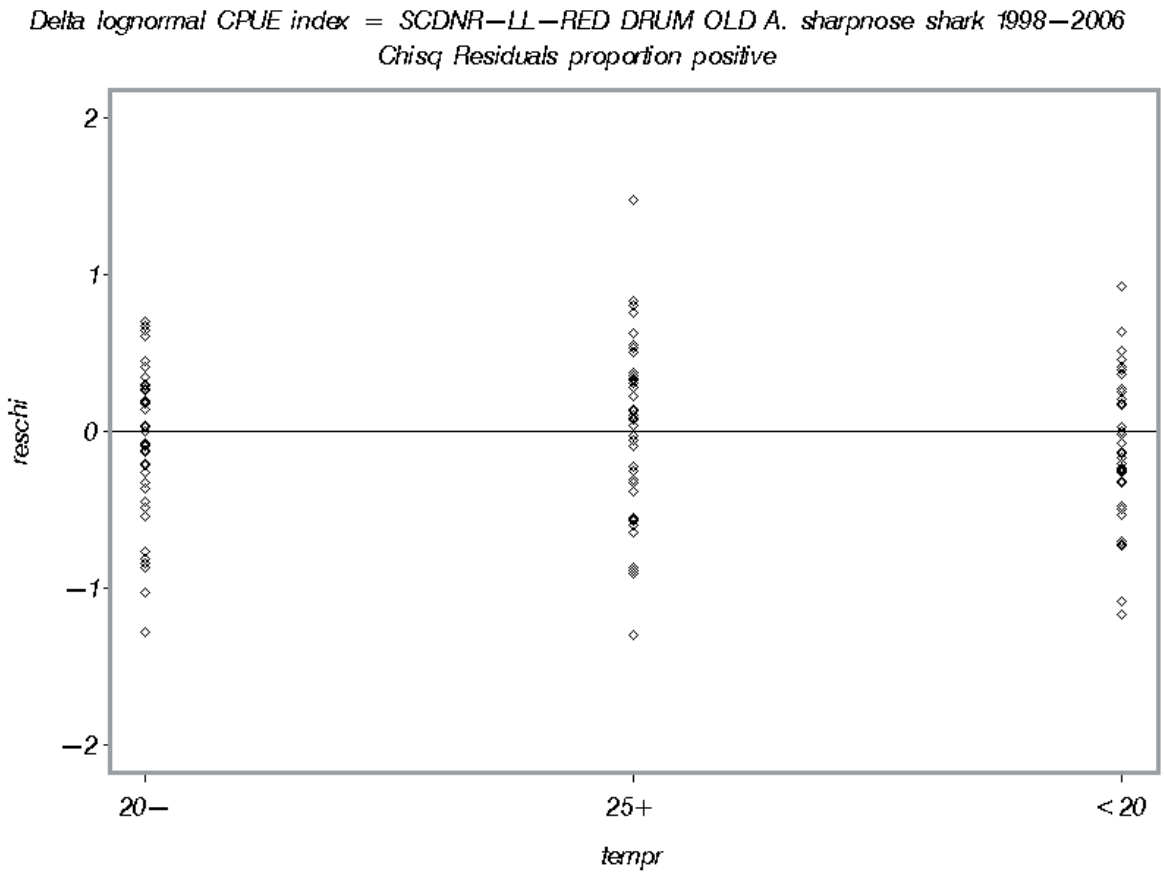


Figure 16a continued. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



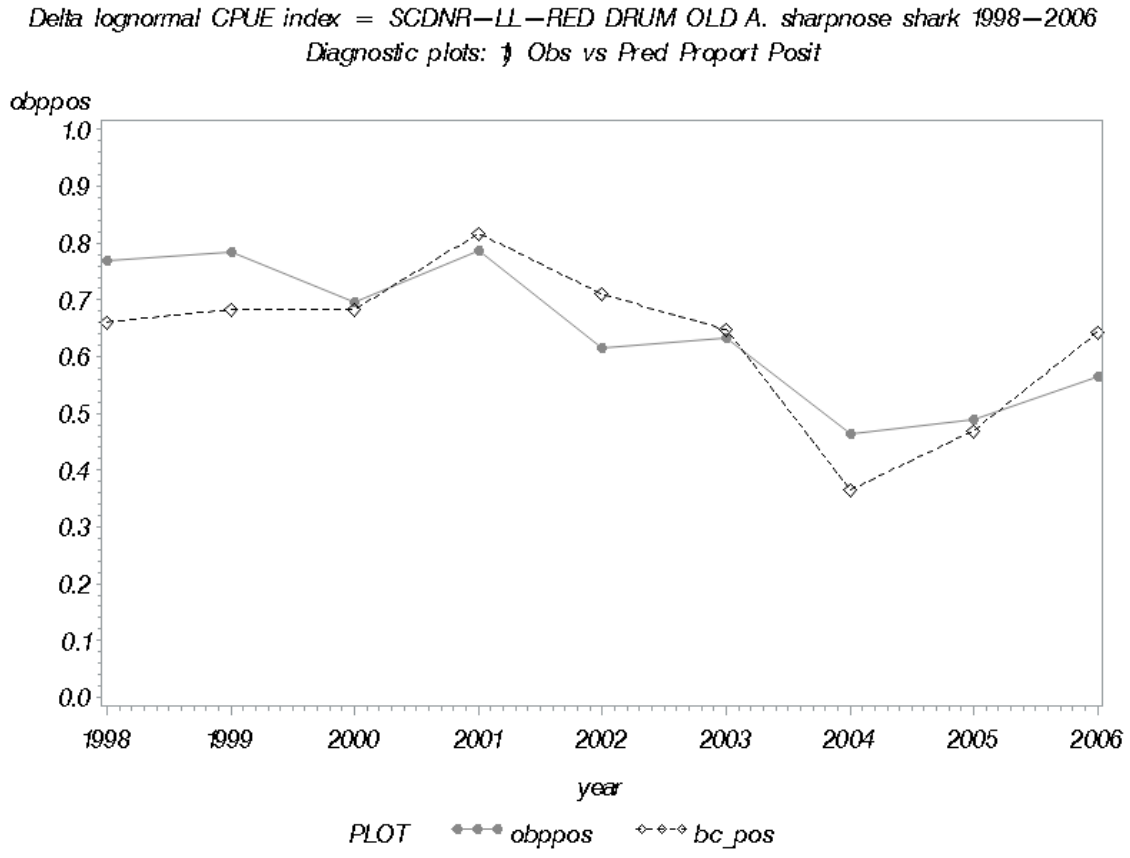
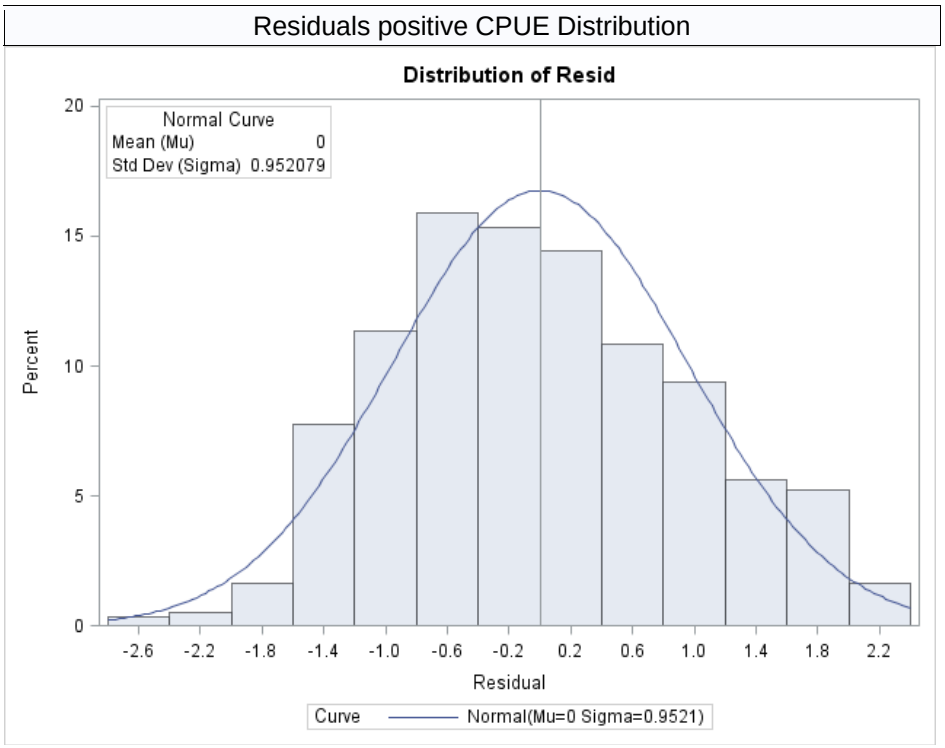


Figure 16b. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



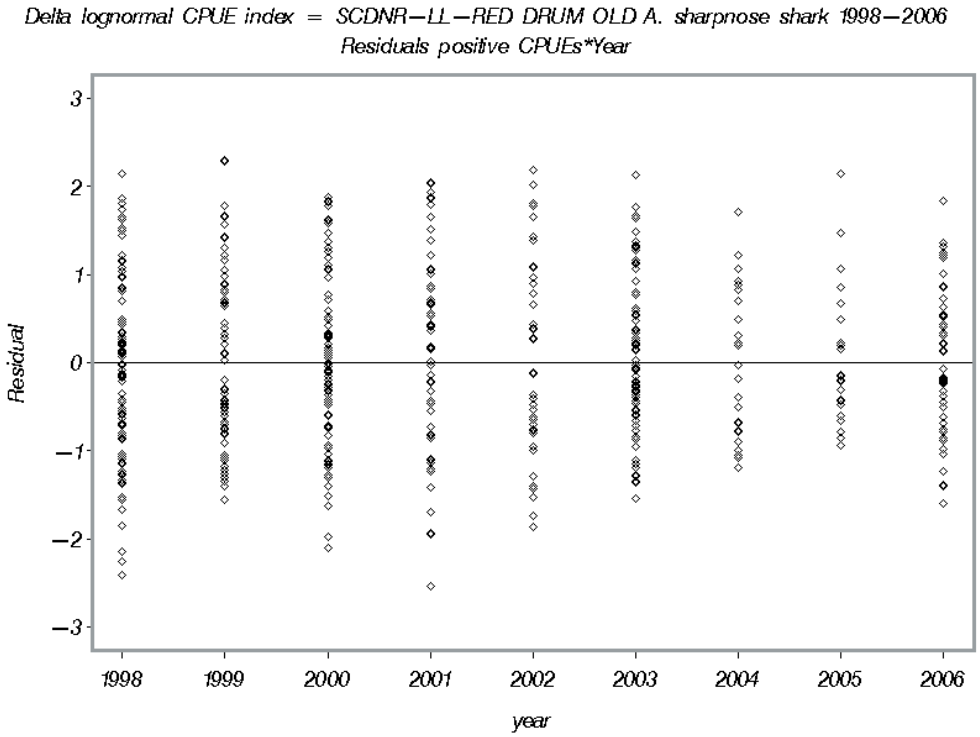
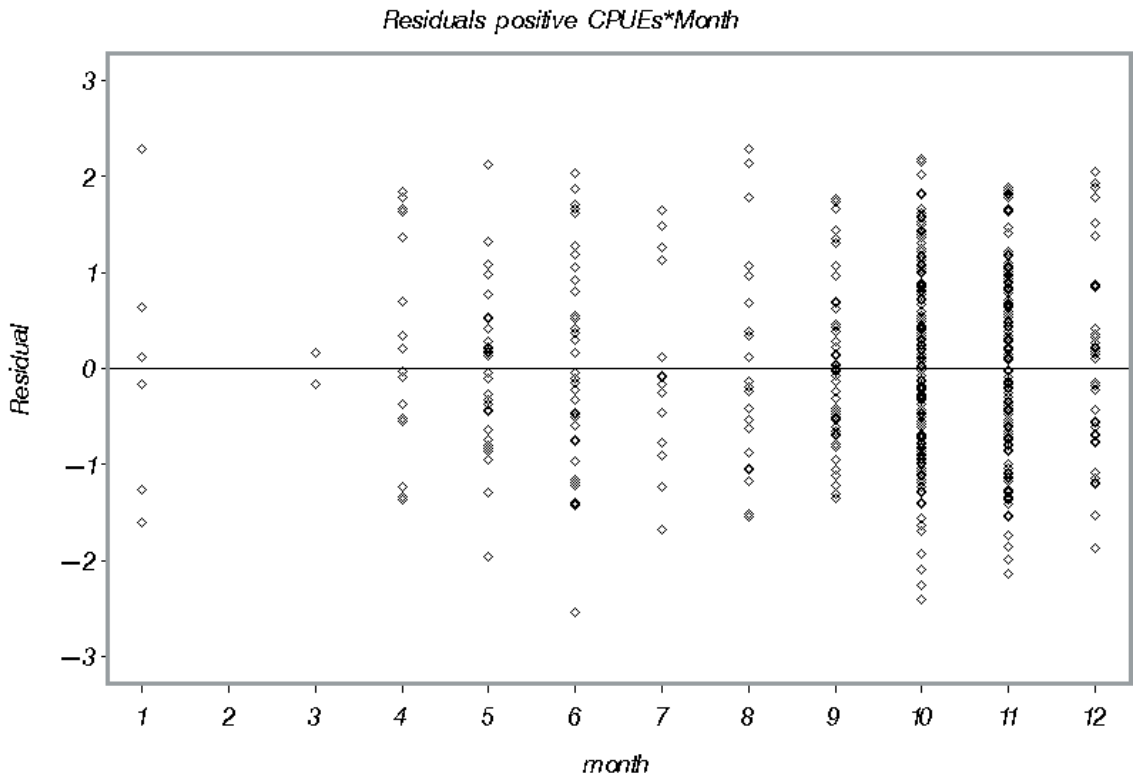


Figure 16b continued. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



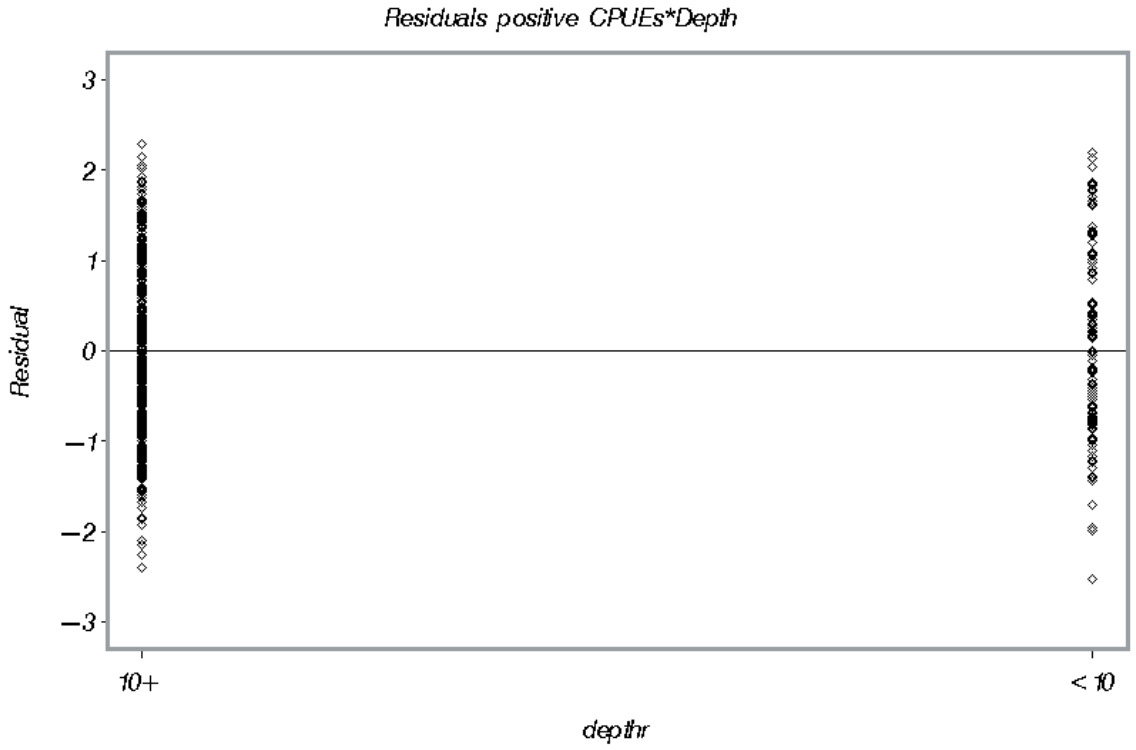


Figure 16b continued. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.

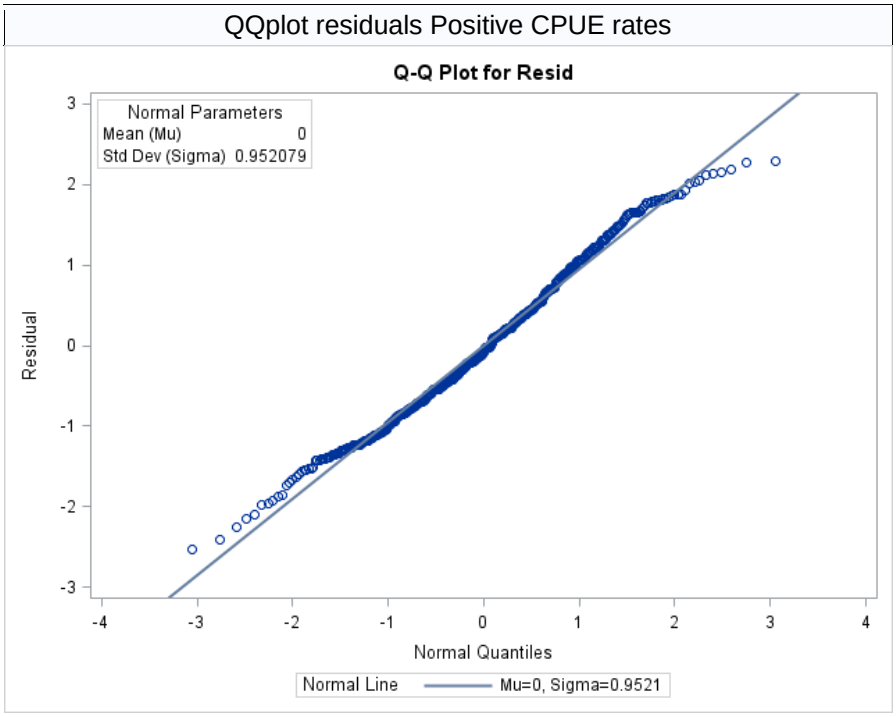


Figure 17. SCDNR-Red Drum-OLD age 1+ Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0)

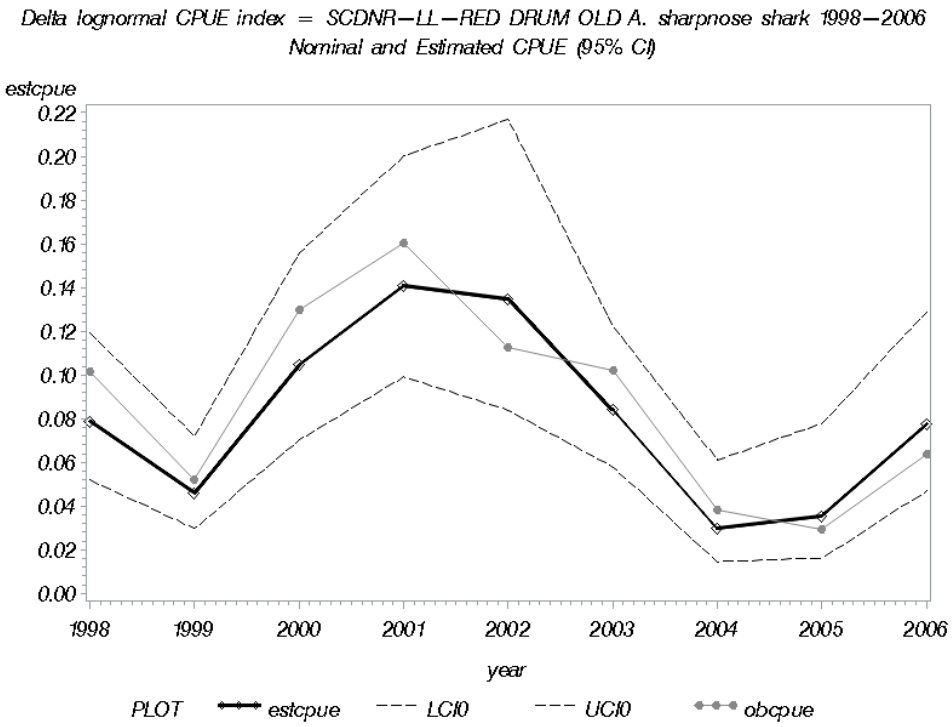


Figure 18. Fork lengths (cm) of Atlantic sharpnose sharks caught during the SCDNR red drum longline survey from 2007-2011.

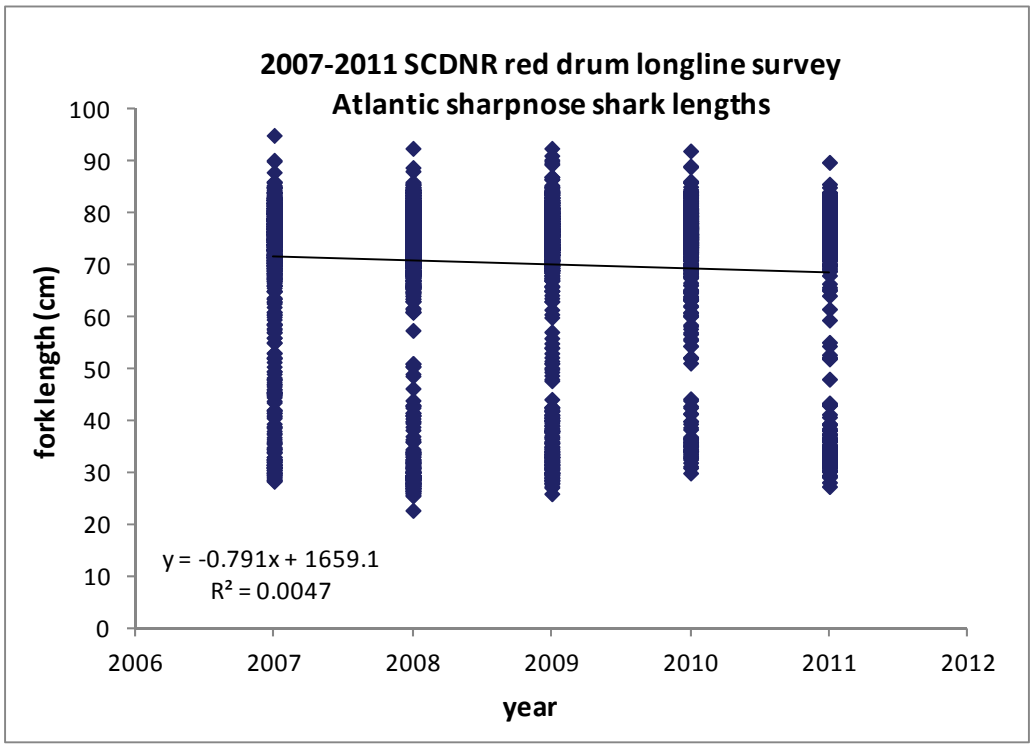


Figure 19a. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the binomial component.

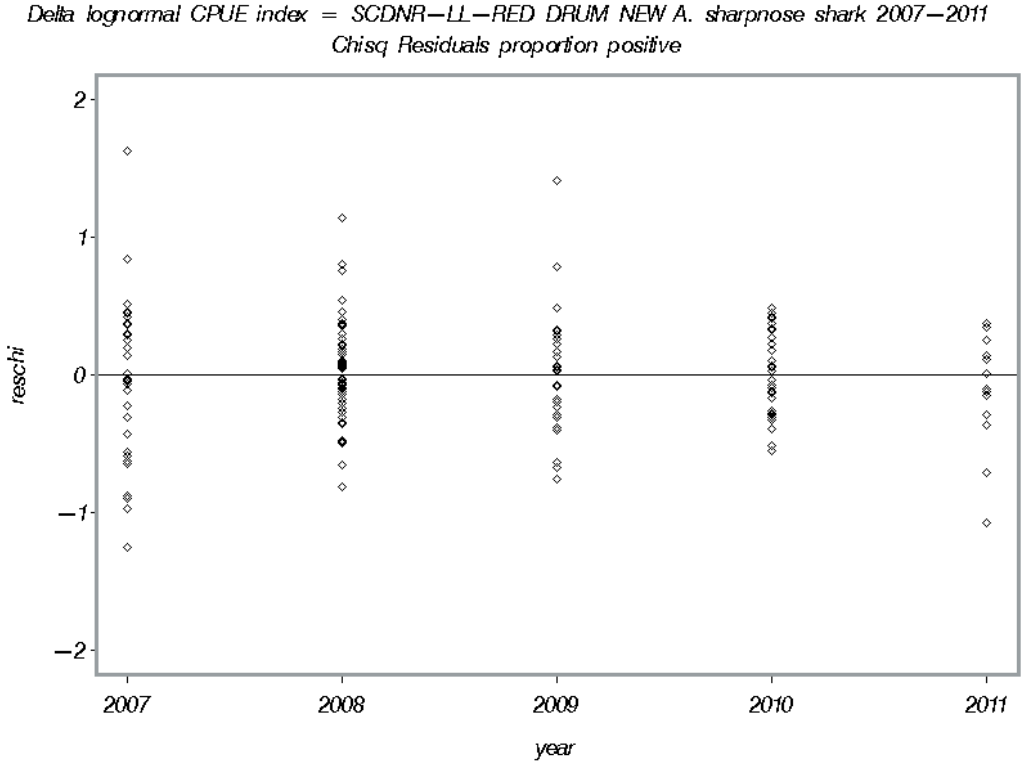
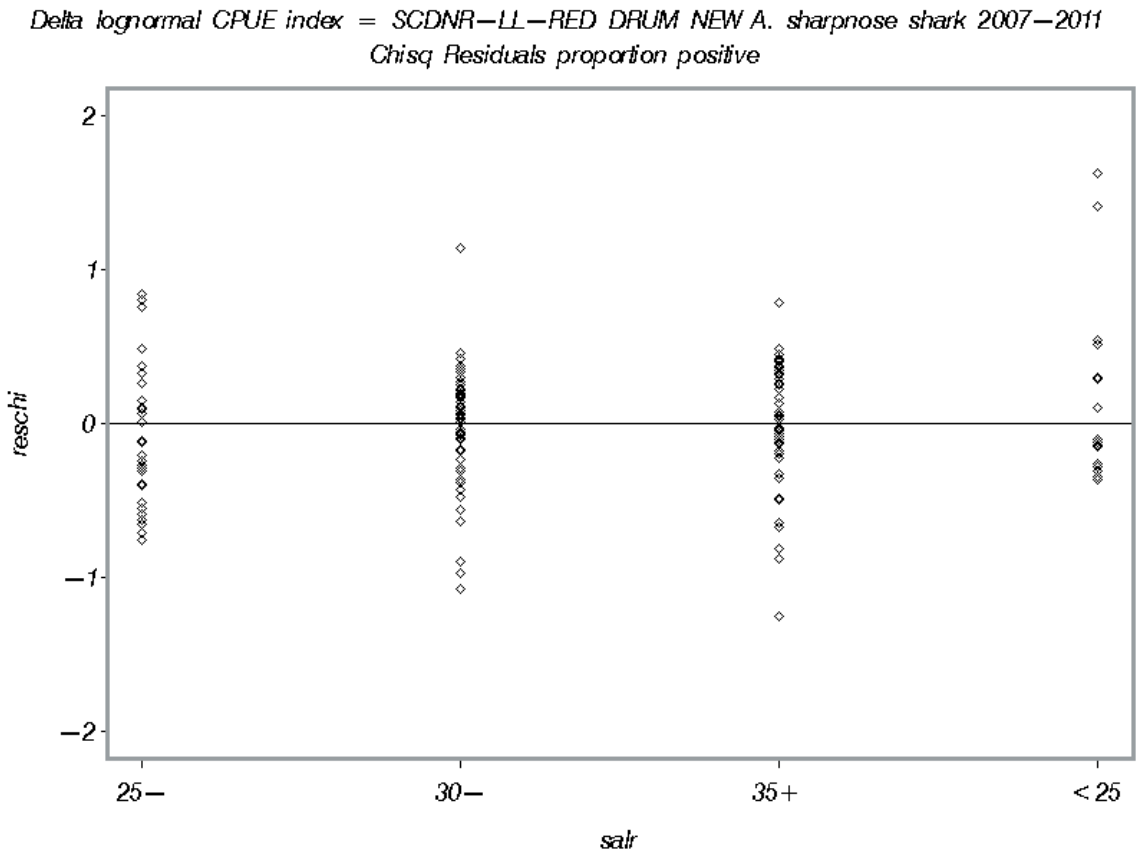


Figure 19a continued. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the binomial component.



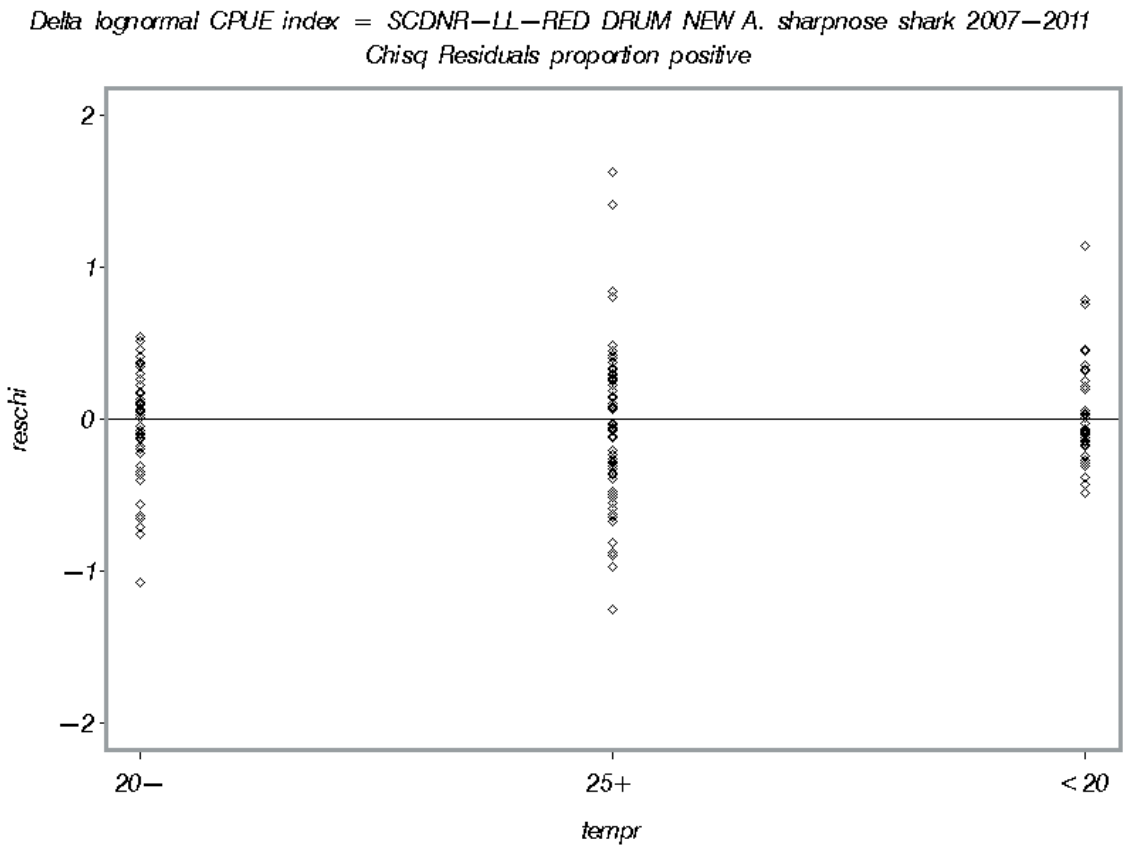
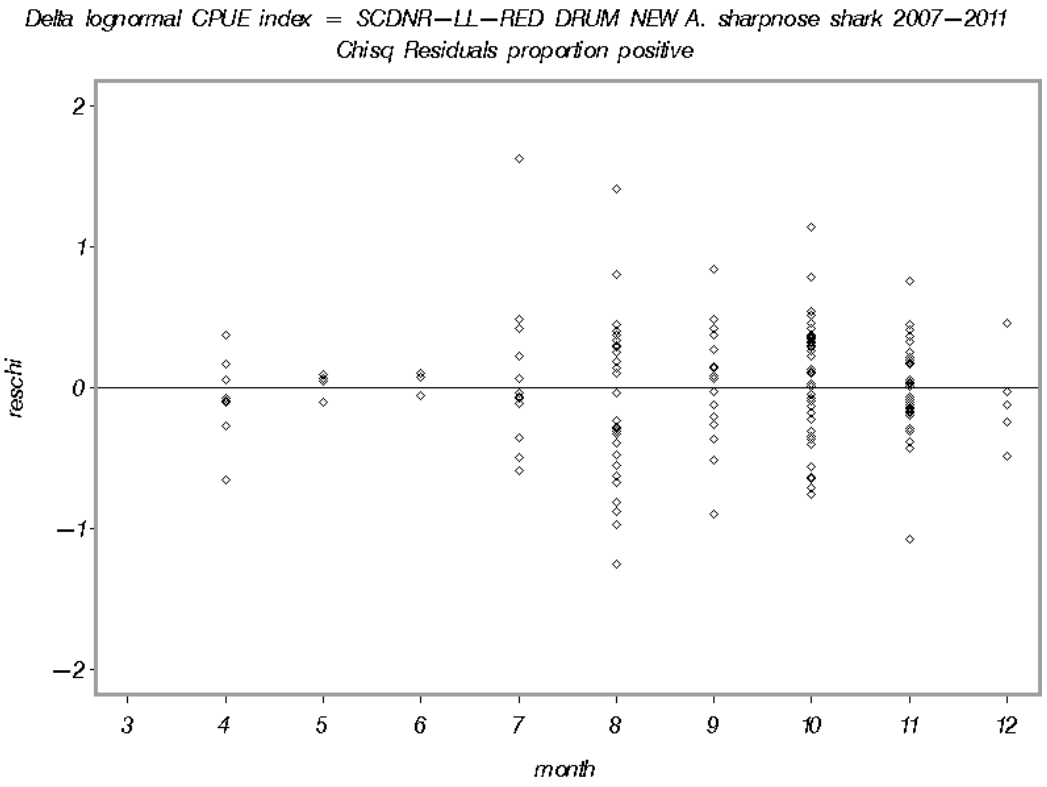


Figure 19a continued. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the binomial component.



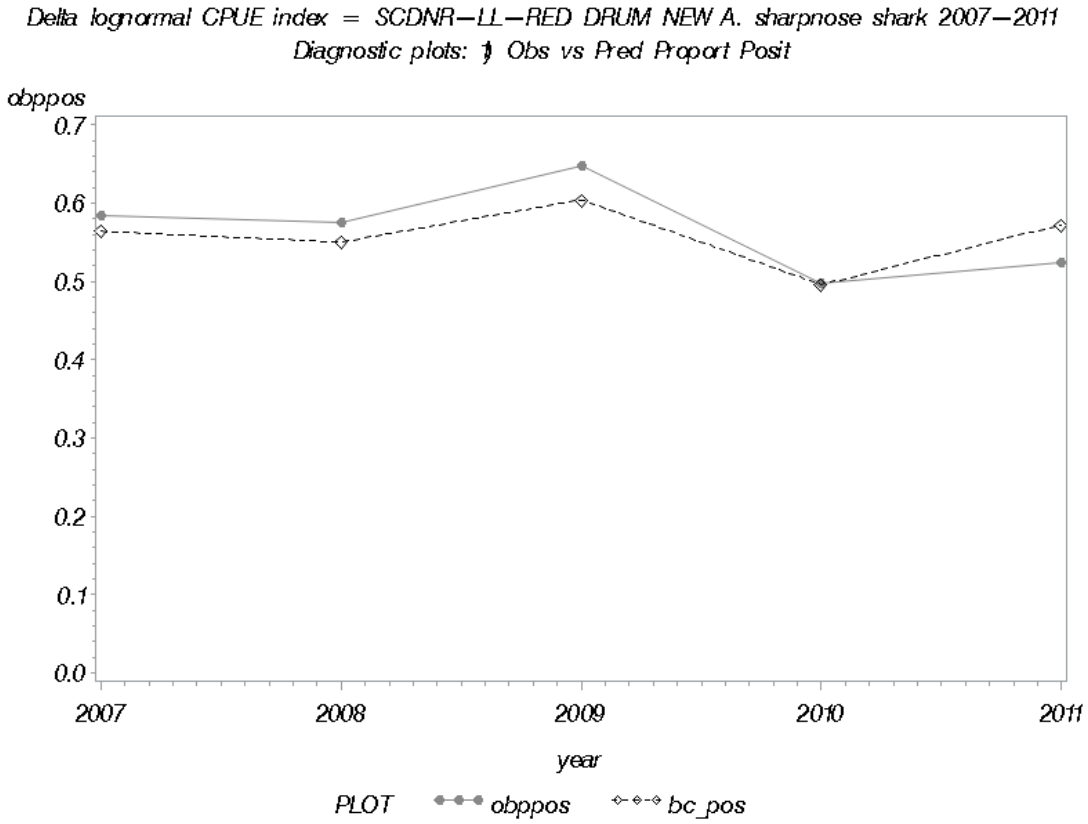
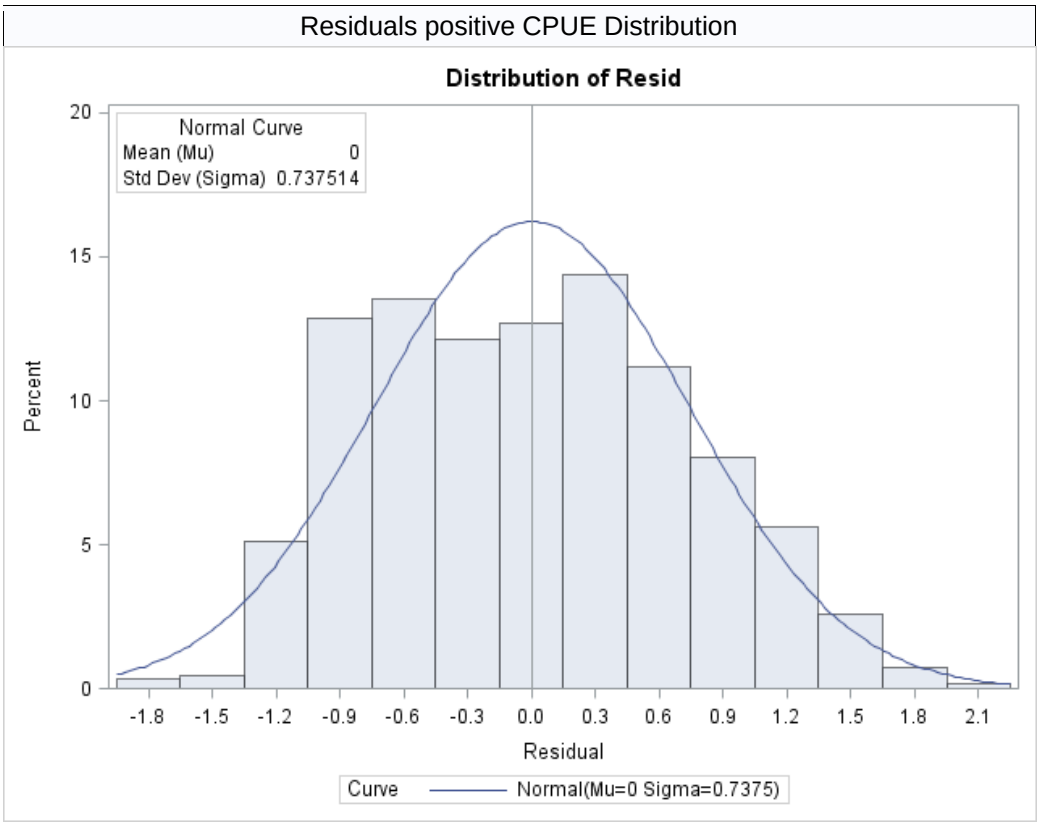


Figure 19b. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



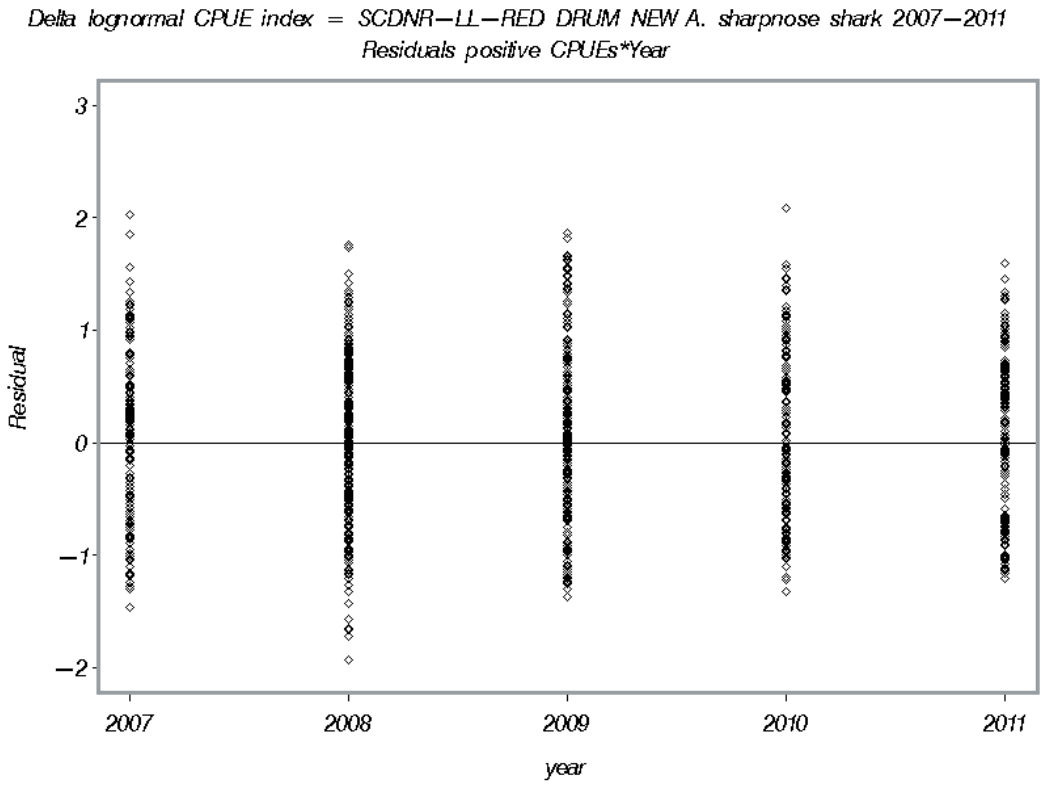
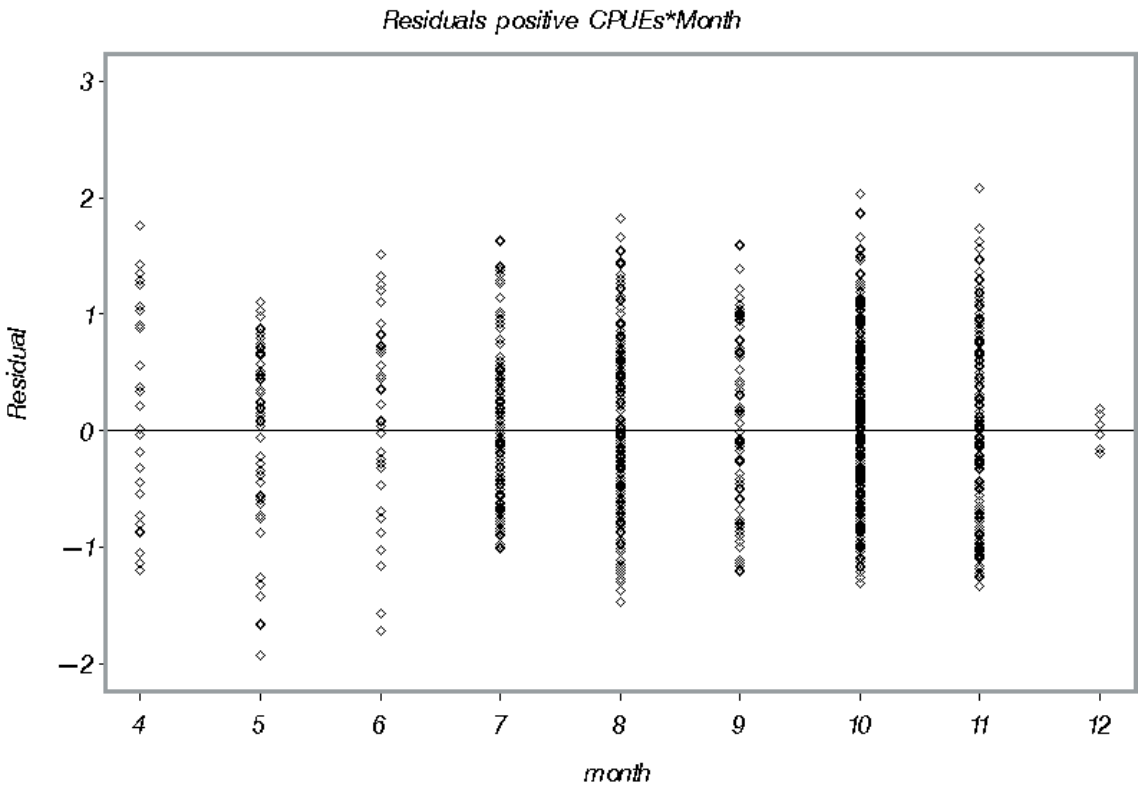


Figure 19b continued. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the lognormal component.



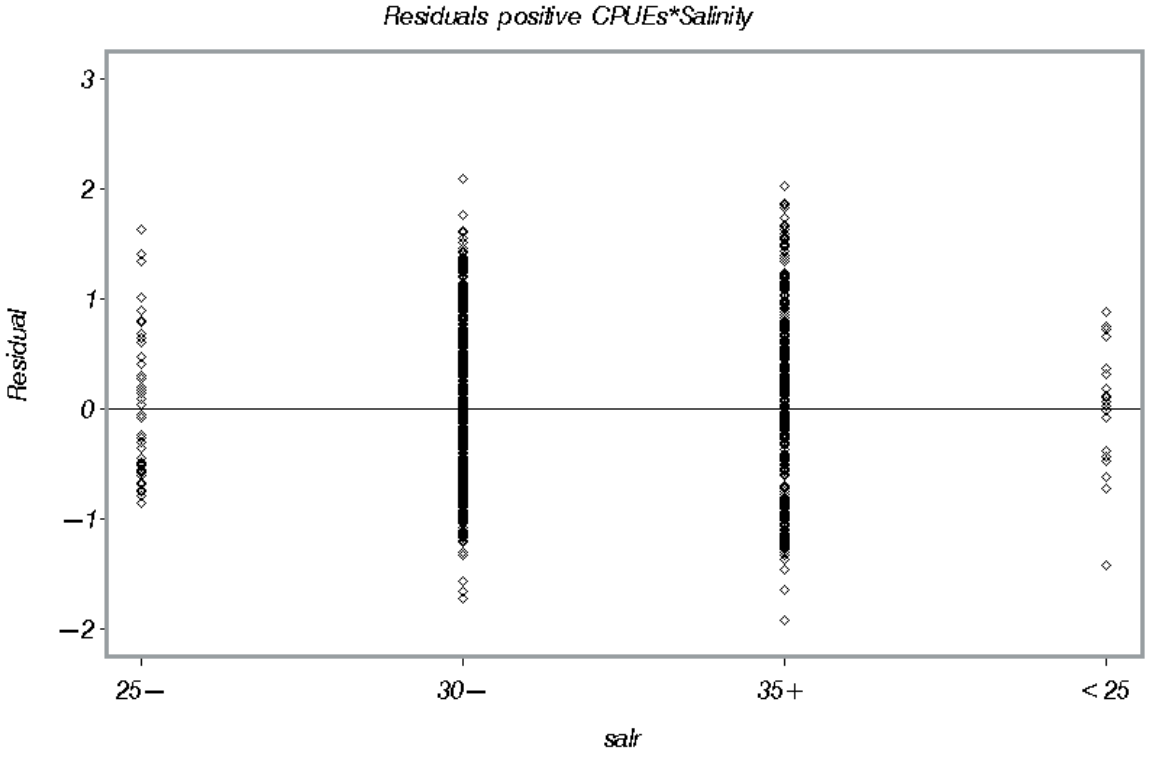


Figure 19b continued. SCDNR-Red Drum-NEW total Atlantic sharpnose shark model diagnostic plots for the lognormal component.

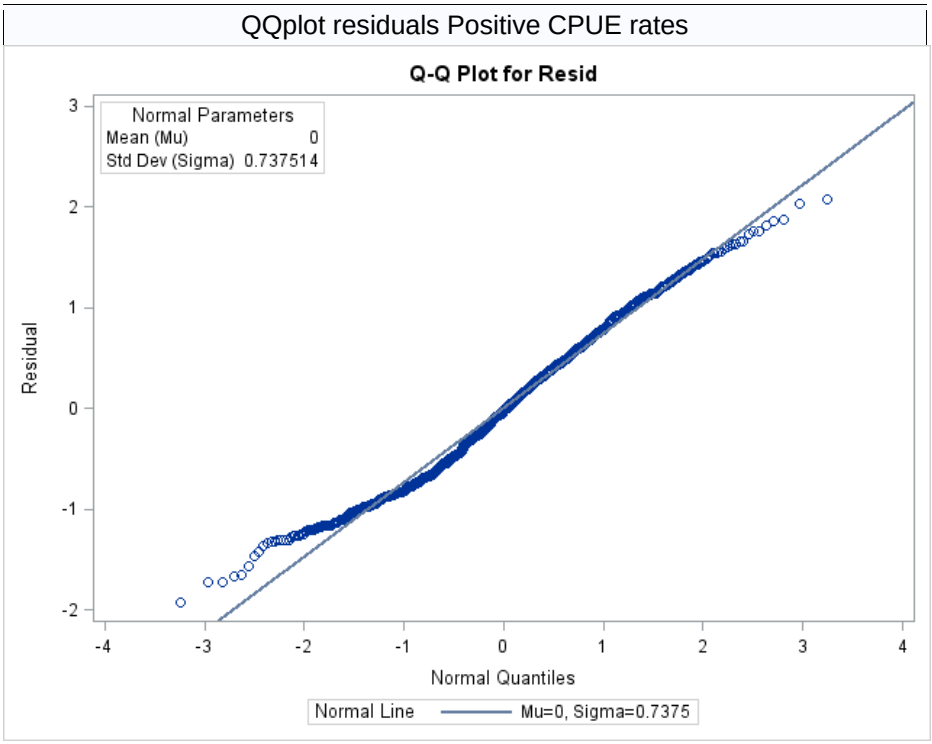


Figure 20. SCDNR-Red Drum-NEW total Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0)

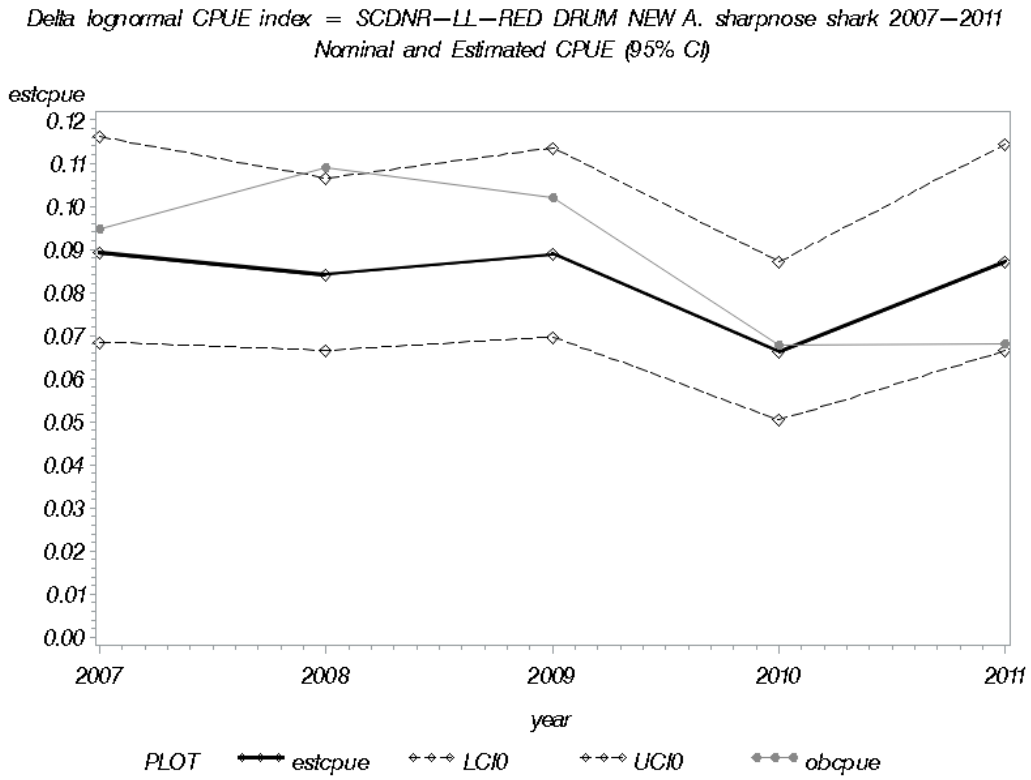
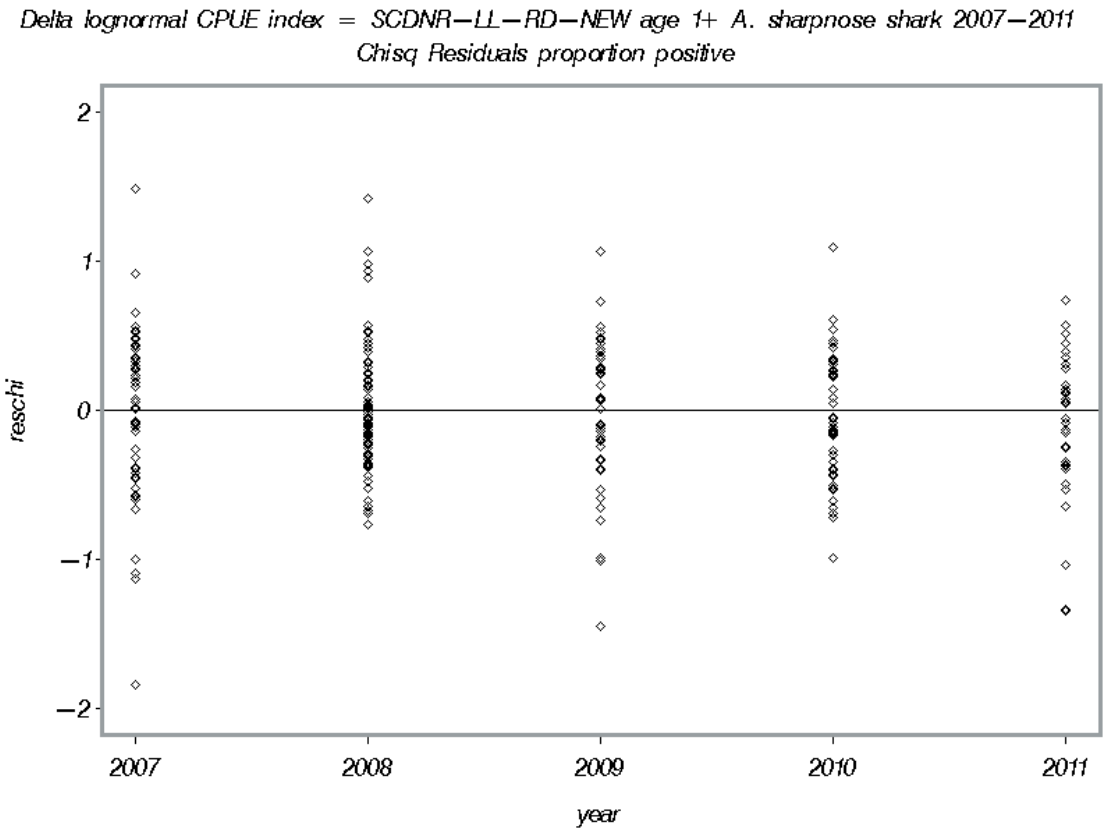


Figure 21a. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



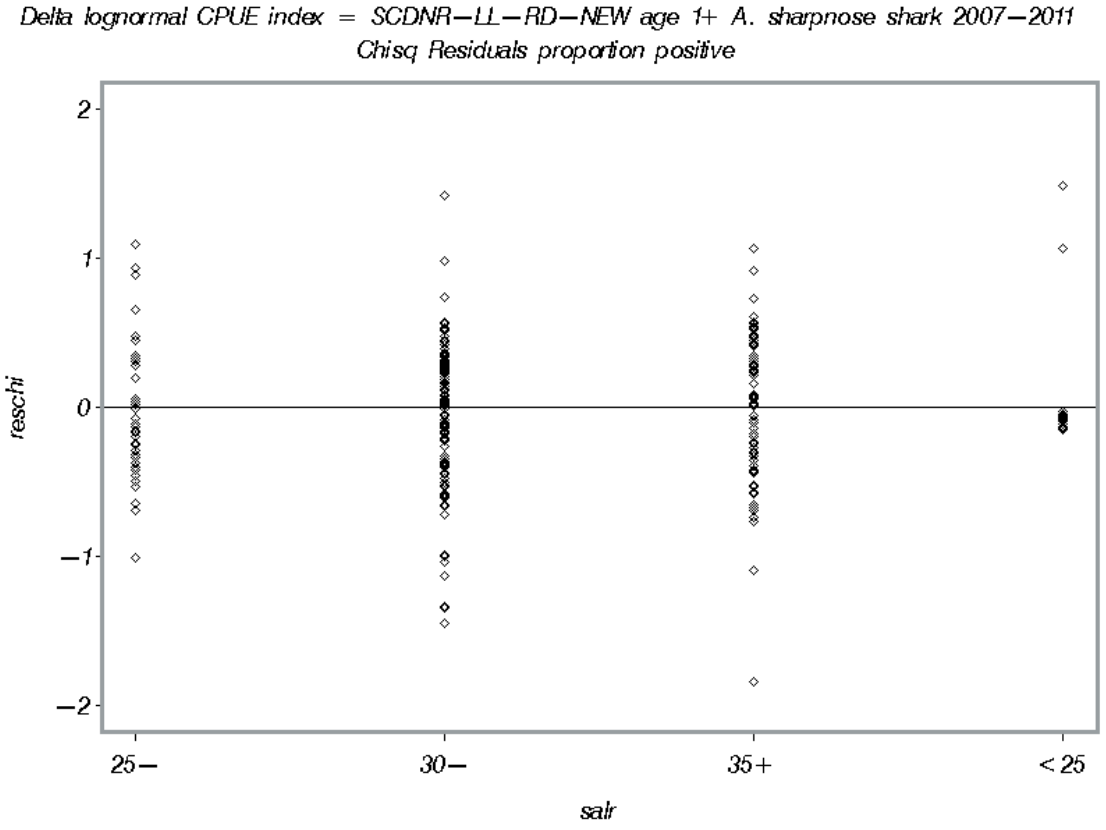
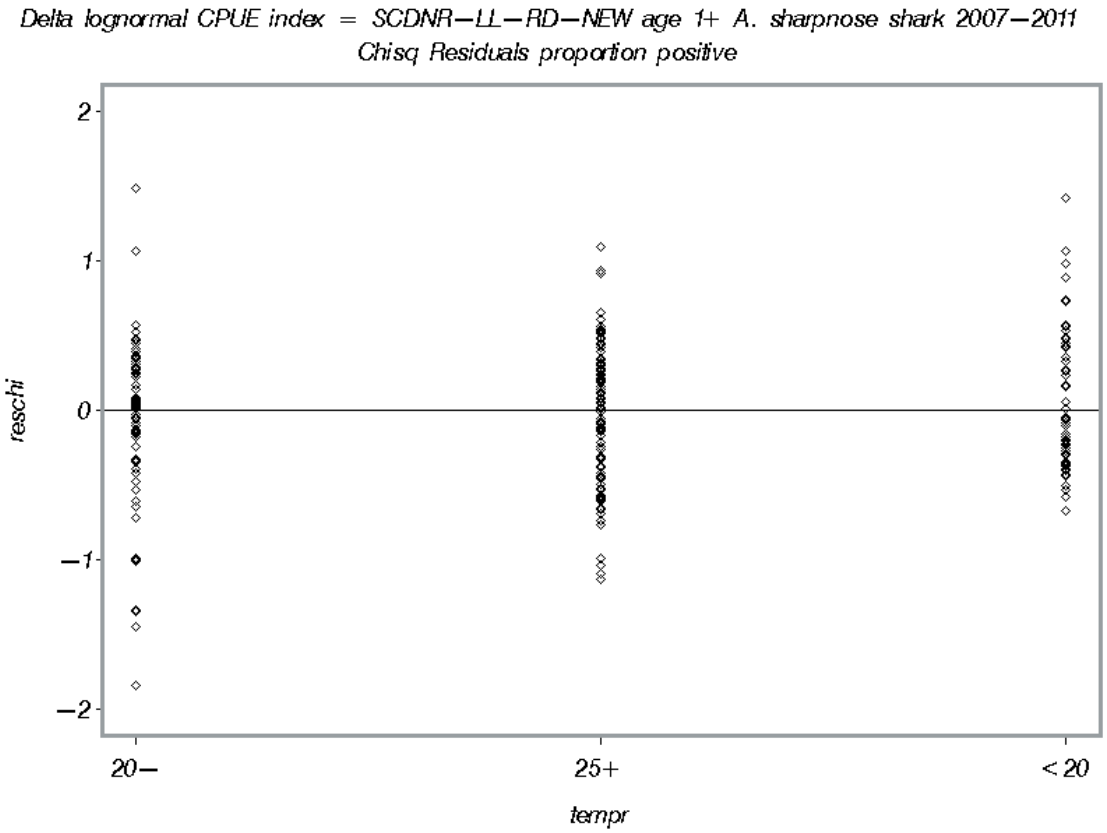


Figure 21a continued. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



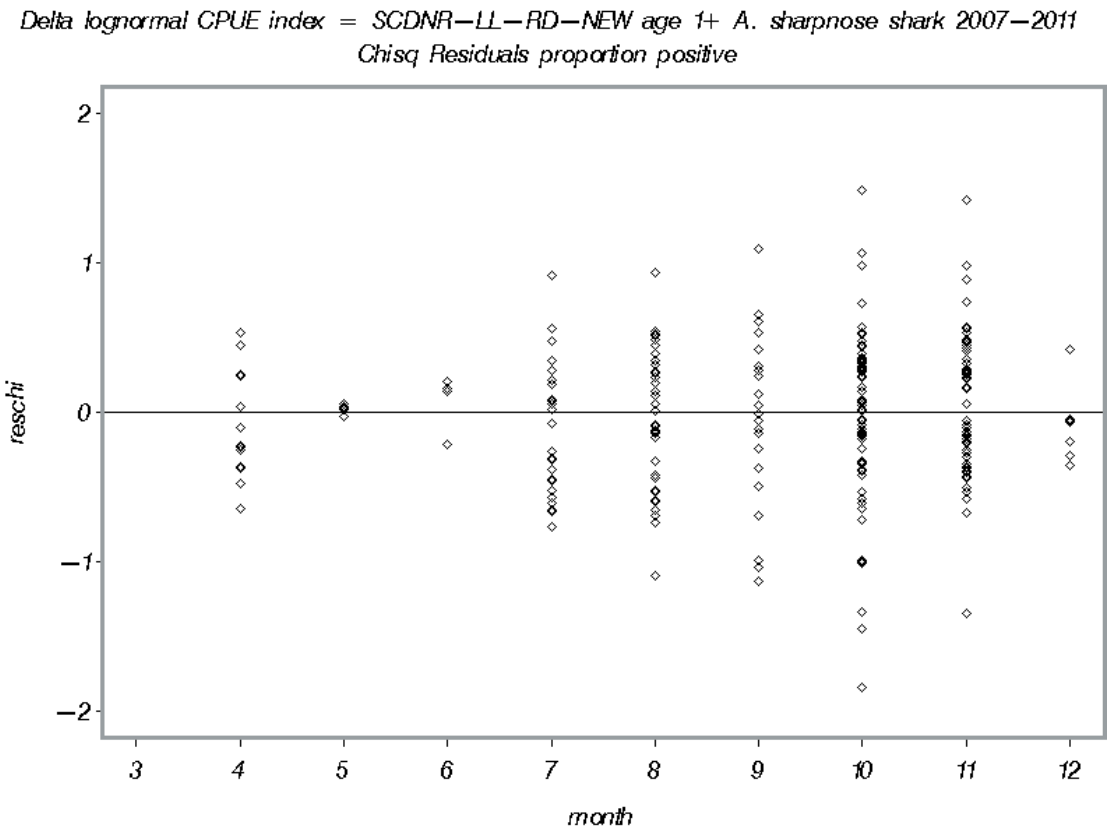
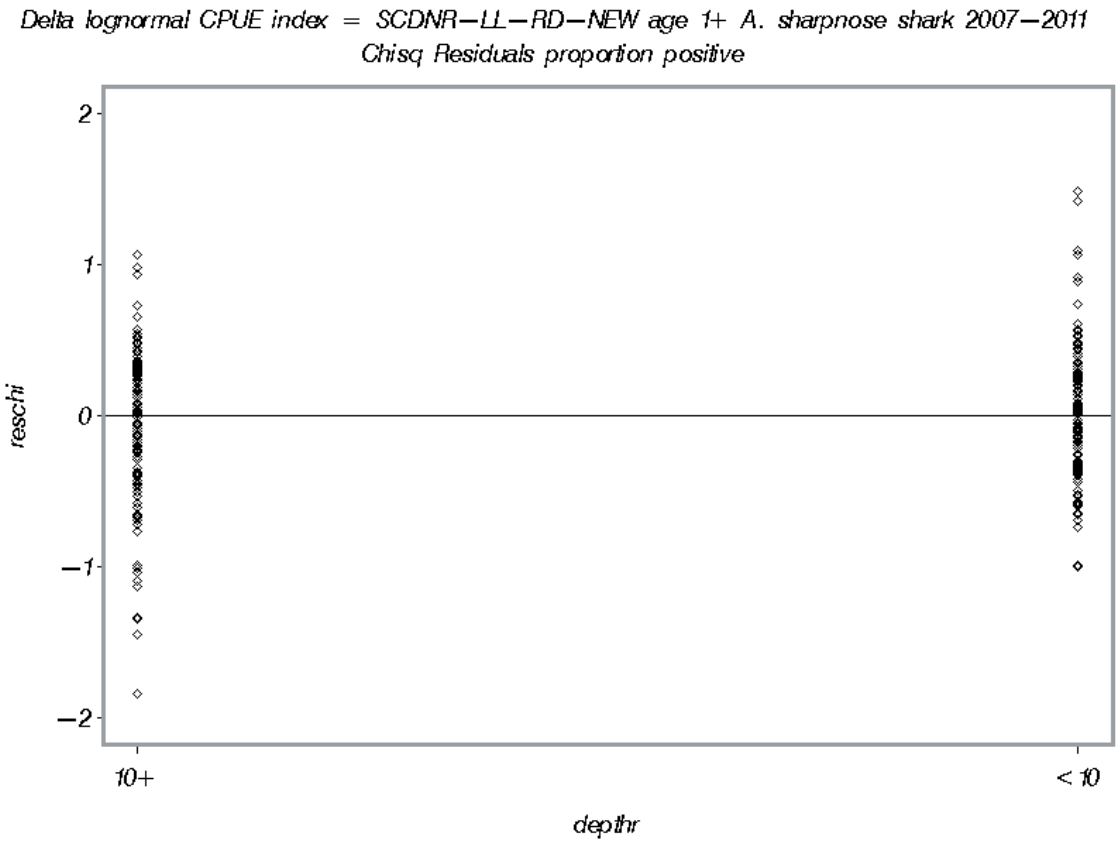


Figure 21a continued. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the binomial component.



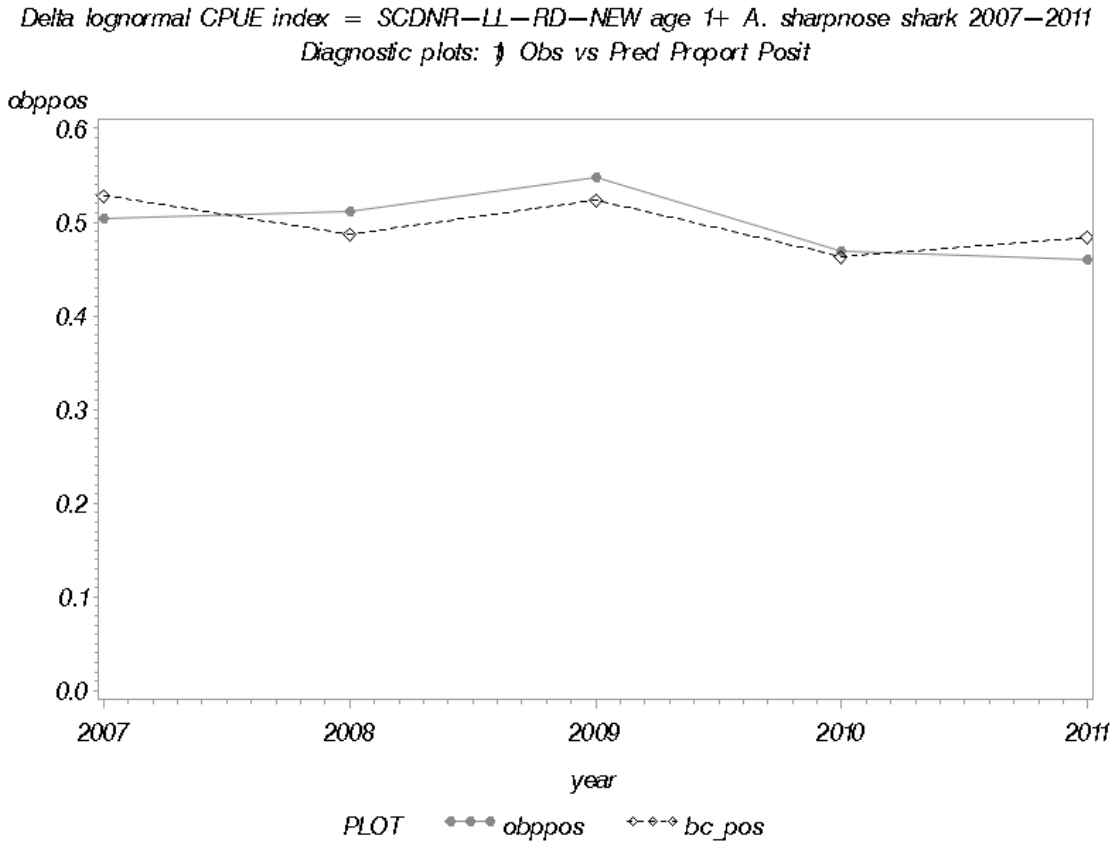
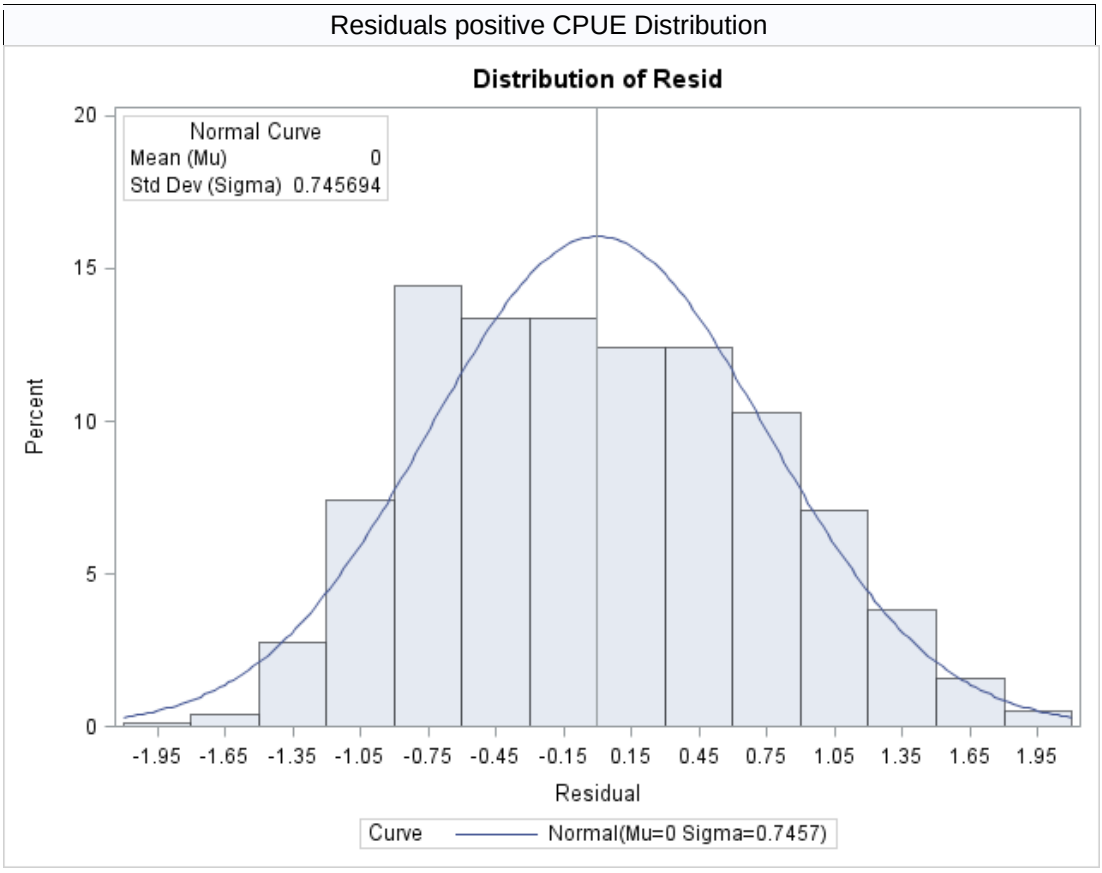


Figure 21b. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



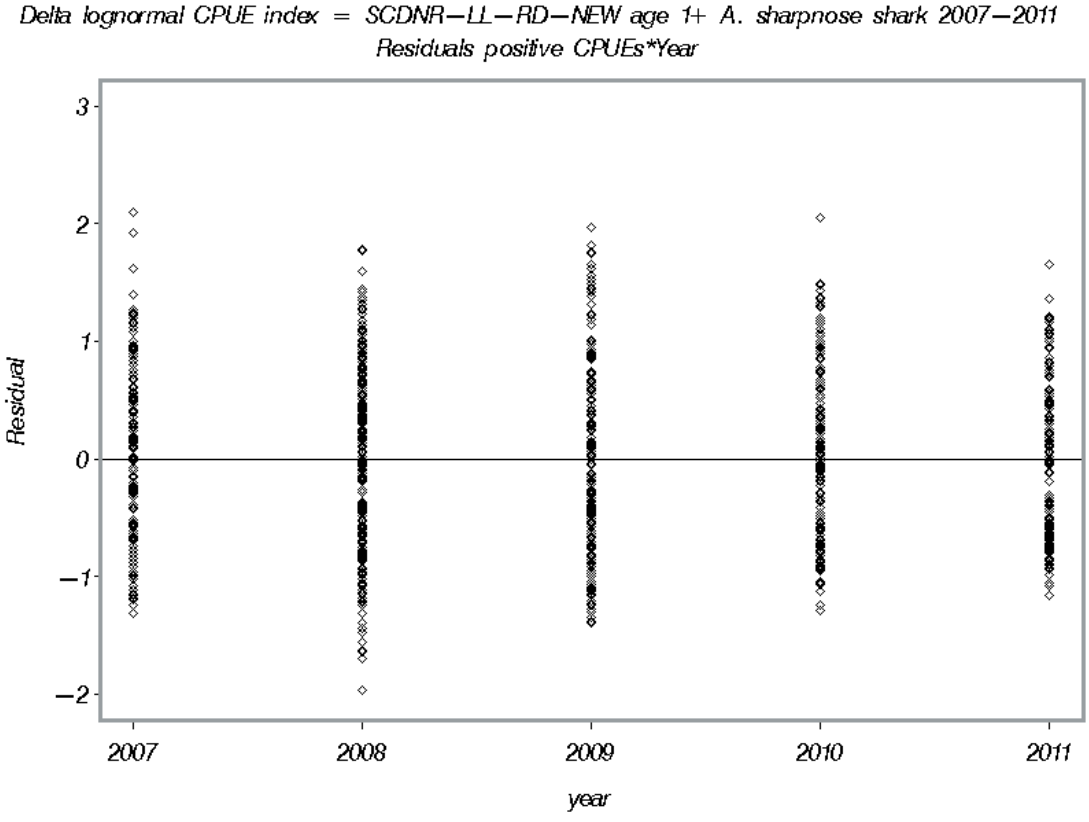
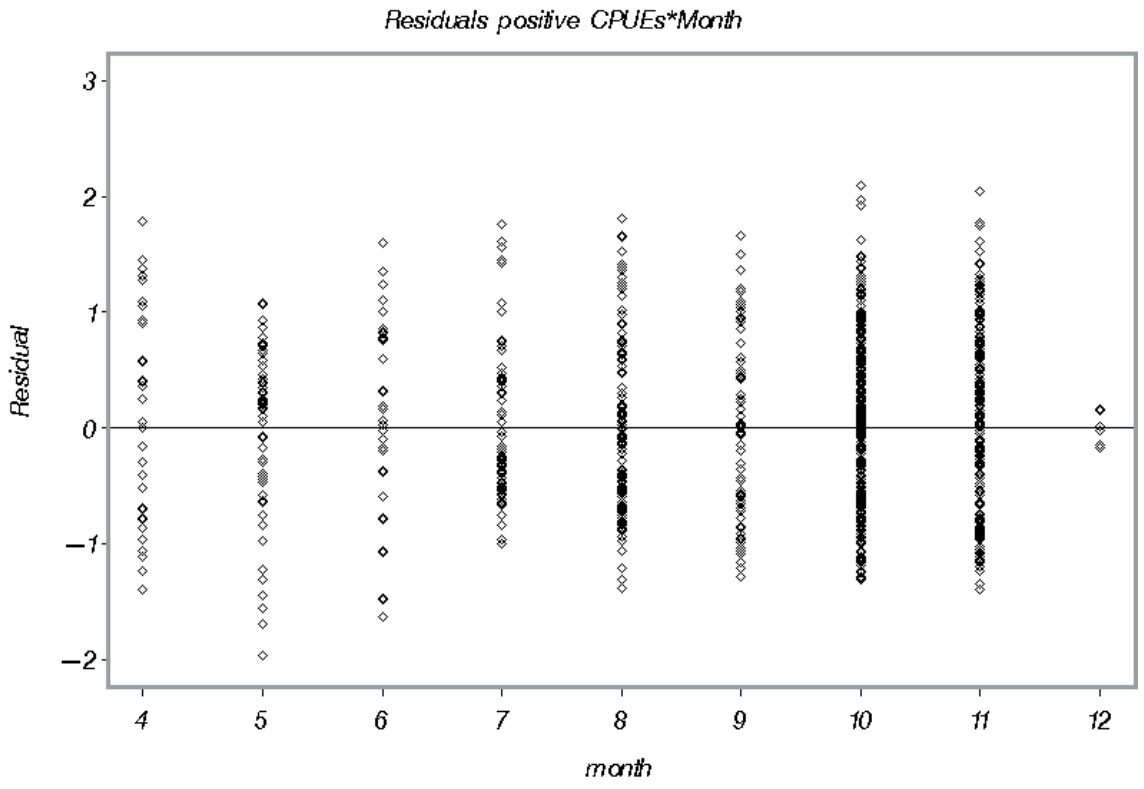


Figure 21b continued. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



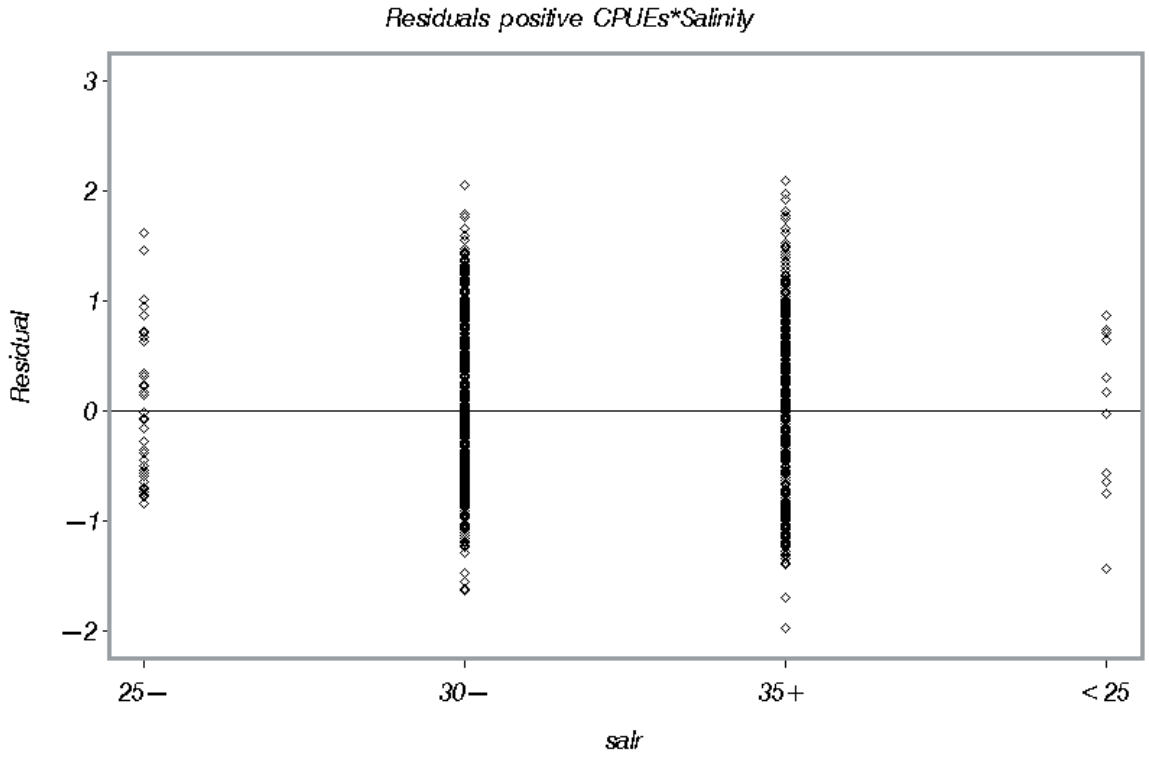
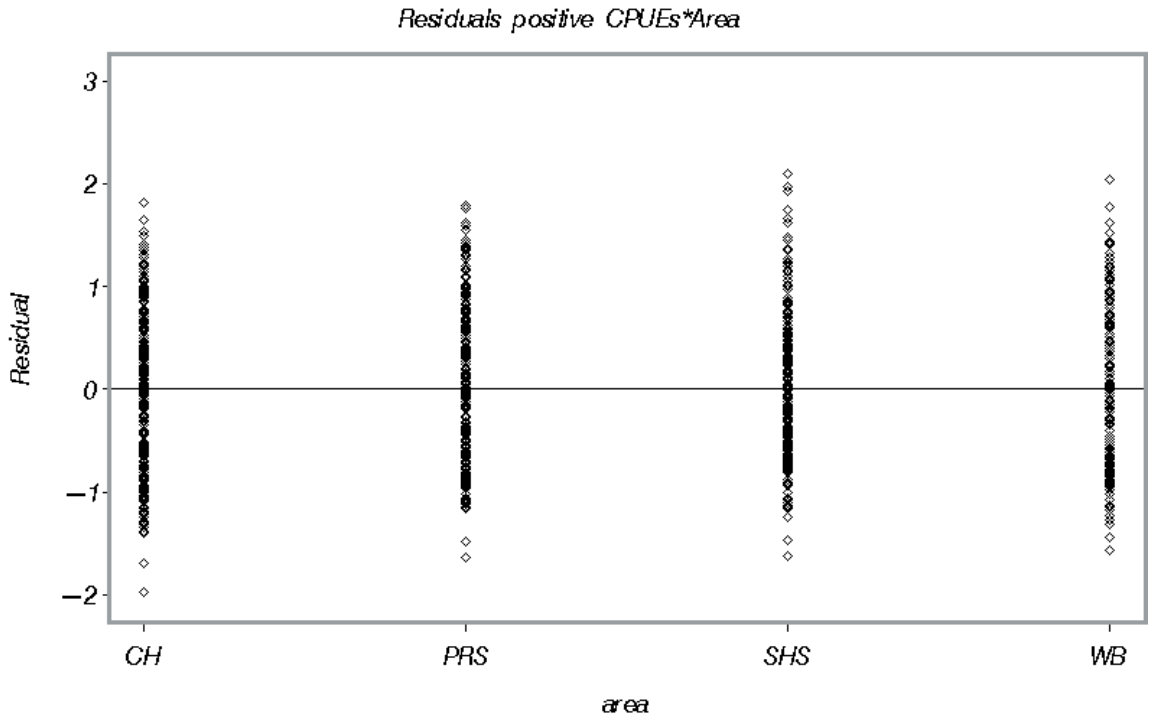


Figure 21b continued. SCDNR-Red Drum-NEW age 1+ Atlantic sharpnose shark model diagnostic plots for the lognormal component.



QQplot residuals Positive CPUE rates

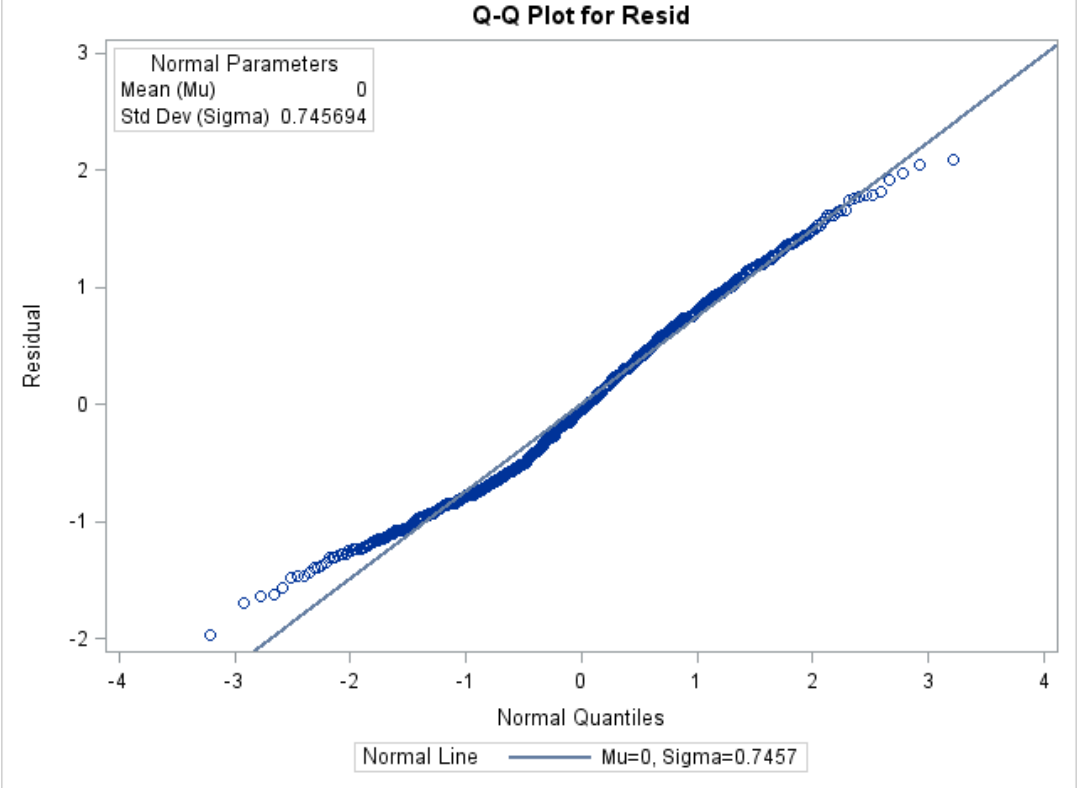
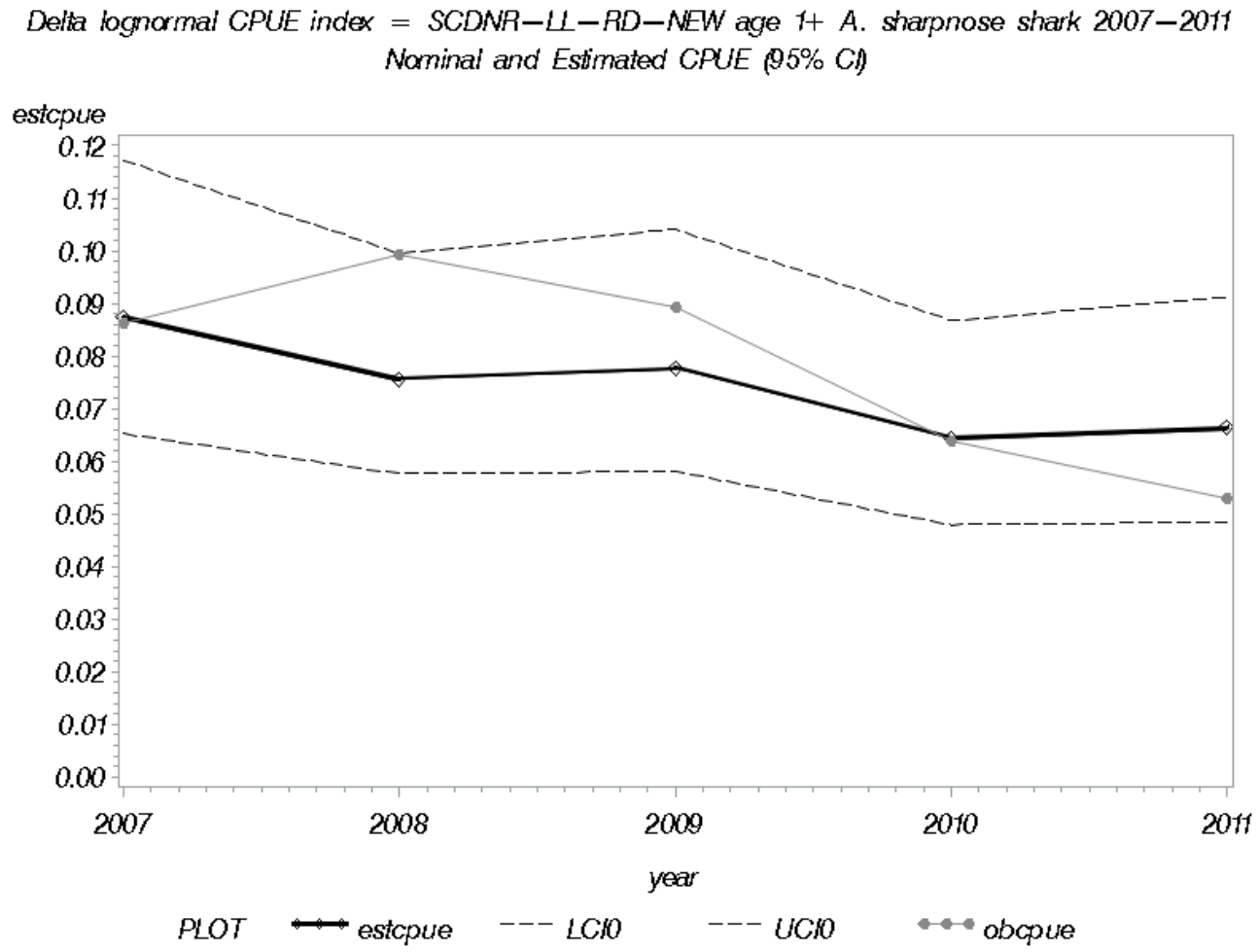


Figure 22. SCDNR-Red Drum-NEW total Atlantic sharpnose shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0)



Addendum to SEDAR34-WP-34 and 36
by C.T. McCandless, B.S. Frazier, and C.B. Belcher

After initial review of the SCDNR and GADNR red drum longline surveys it was requested to run the analyses on Atlantic sharpnose sharks combining the two surveys and compare results to the separate indices. The catch per unit effort in sharks per hook was modeled using the same methods as in SEDAR34-WP-34 and 36, using the following variables: year (2007 – 2011), month (April-December), depth (<10 m, 10+ m), salinity (<25 ppt, 25-29 ppt, 30-34 ppt, 35+ ppt), temperature (<20 degC, 20-24 degC, 25+ degC), and area (Winyah Bay, Charleston Harbor, St Helena Sound, Port Royal Sound, southern Georgia, and northern Florida). The results are presented here:

Table 1a. Results of the stepwise procedure for development of the combined red drum longline survey binomial catch rate model for age 1+ Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQ	PR>CHI
null	2288	3171.3250	1.3861				
month	2279	2851.3537	1.2511	9.7396	9.7396	319.97	<.0001
temp	2286	2946.9762	1.2891	6.9981		224.35	<.0001
year	2284	3161.0024	1.3209	4.7038		10.32	0.0353
sal	2285	3047.3289	1.3336	3.7876		124.00	<.0001
depth	2287	3162.9527	1.3343	3.7371		8.37	0.0038
area	2283	3085.3667	1.3515	2.4962		85.96	<.0001
survey	2287	3136.0132	1.3712	1.0750		35.31	<.0001
set	2270	3159.5019	1.3919	-0.4184		11.82	0.8562
month +							
sal	2276	2713.2817	1.1921	13.9961	4.2565	138.07	<.0001
area	2274	2732.3314	1.2016	13.3107	3.5712	119.02	<.0001
survey	2278	2781.4253	1.2210	11.9111	2.1716	69.93	<.0001
temp	2277	2809.2581	1.2338	10.9877	1.2481	42.10	<.0001
year	2275	2833.5239	1.2455	10.1436	0.4040	17.83	0.0013
depth	2278	2845.3093	1.2490	9.8911	0.1515	6.04	0.0140
month + sal +							
area	2271	2594.3633	1.1424	17.5817	3.5856	118.92	<.0001
survey	2275	2628.3282	1.1553	16.6510	2.6549	84.95	<.0001
temp	2274	2671.9930	1.1750	15.2298	1.2337	41.29	<.0001
year	2272	1686.6211	1.1825	14.6887	0.6926	26.66	<.0001
month + sal + area							
survey						0.00	.
temp	2269	2535.7828	1.1176	19.3709	1.7892	58.58	<.0001
year	2267	2573.4441	1.1352	18.1011	0.5194	20.92	0.0003

FINAL MODEL: month + year

AIC 98.4 **BIC** 132.6 **(-2) Res LL** 88.5

Type 3 Test of Fixed Effects

Fixed effect	month	year
Significance (Pr>Chi)	<.0001	0.0360
DF	8	4
CHI SQUARE	38.43	10.28

Table 1b. Results of the stepwise procedure for development of the combined red drum longline survey lognormal catch rate model for age 1+ Atlantic sharpnose sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model.

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQ	PR>CHI
null	1119	929.4294	0.8306				
month	1111	861.2449	0.7752	6.6699	6.6699	85.33	<.0001
sal	1116	889.8685	0.7974	3.9971		48.72	<.0001
area	1114	890.0372	0.7990	3.8045		48.50	<.0001
year	1115	910.7366	0.8168	1.6614		22.76	0.0001
depth	1118	927.6955	0.8298	0.0963		2.09	0.1481
survey	1118	920.4433	0.8233	0.8789		10.88	0.0010
temp	1117	920.7692	0.8243	0.7585		10.48	0.0053
set	1101	911.5231	0.8279	0.3251		21.79	0.2415
month +							
area	1106	796.2166	0.7199	13.3277	6.6578	87.93	<.0001
year	1107	849.7287	0.7676	7.5849	0.9150	15.08	0.0045
sal	1108	823.1681	0.8922	-7.4163		50.64	<.0001
month + area +							
year	1102	792.1946	0.7189	13.4481	0.1204	5.67	0.2250

FINAL MODEL: month + area + year

AIC 239.0 **BIC** 254.4 **(-2) Res LL** 225.0

Type 3 Test of Fixed Effects

Fixed effect	month	area	year
Significance (Pr>Chi)	<.0001	<.0001	0.2250
DF	8	5	4
CHI SQUARE	114.38	78.52	5.67

Table 2. Combined red drum longline survey age 1+ Atlantic sharpnose shark analysis number of model observations per year (obs n), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCI), the upper 95% confidence limit for the est cpue (UCI), and the coefficient of variation for the estimated cpue (CV).

year	n obs	obs pos	obs ppos	obs cpue	est cpue	LCI	UCI	CV
2007	429	220	0.5128	0.0462	0.0507	0.0410	0.0628	0.1068
2008	624	312	0.5000	0.0597	0.0445	0.0359	0.0552	0.1081
2009	398	205	0.5151	0.0540	0.0553	0.0438	0.0698	0.1166
2010	496	212	0.4274	0.0354	0.0353	0.0275	0.0453	0.1253
2011	420	198	0.4714	0.0400	0.0455	0.0358	0.0579	0.1206

Figure 1. Combined red drum longline survey age 1+ Atlantic sharpnose shark nominal (obcpue) and estimated (estcpue) indices with 95% confidence limits (LCI1), UCI1).