Standardized catch rates of blacktip sharks (*Carcharhinus limbatus*) collected during a SEAMAP bottom longline survey in Mississippi/Louisiana coastal waters from 2008 to 2011.

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STANDARDIZED CATCH RATES OF BLACKTIP SHARKS (*CARCHARHINUS LIMBATUS*) COLLECTED DURING A SEAMAP BOTTOM LONGLINE SURVEY IN MISSISSIPPI/LOUISIANA COASTAL WATERS FROM 2008 TO 2011.

Jill M. Hendon[1], Eric R. Hoffmayer[2], and Adam G. Pollack[2]

In late 2007, a fisheries independent bottom longline survey began in Mississippi and Louisiana coastal waters to monitor the abundance and distribution of various elasmobranch and teleost species. The standardized sampling was conducted monthly (March through October) each year. This survey was initiated to complement the National Oceanographic and Atmospheric Administration, Mississippi Laboratory's offshore monitoring; therefore, methodologies for this project were are identical to NOAA's. As a result, from 2008 through 2011, of 282 sets and 490 hours of effort, 647 blacktip sharks were collected. Because the work was conducted in a known blacktip nursery area, blacktip shark catch was further divided, when possible, into young-of-the-young (YOY, age-0, n=74), juvenile (n=432), and adult (n=88) catch. Data from 2007 was not included in this analysis as it was not a full year's data set. Standardized catch rates were estimated using a Generalized Linear Mixed modeling approach assuming a delta-lognormal error distribution and negative binomial regression. Overall, standardized abundance indices of blacktip sharks have remained relatively stable throughout the survey, except for 2011, which has shown a slight decline for all stages.

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INTRODUCTION

The University of Southern Mississippi Gulf Coast Research Laboratory developed a fisheries independent bottom longline survey in late 2007 to monitor the abundance and distribution of coastal shark and teleost species in Mississippi coastal waters as well as the Chandeleur Sound off of Louisiana. This is a Southeast Area Monitoring and Assessment Program (SEAMAP) funded project and complements NOAA Mississippi Laboratory's offshore survey. Sampling was conducted in September and October of 2007, and then monthly (March to October) from 2008 through 2011. The funding for this survey has continued through 2012 and will most likely continue in the foreseeable future.

METHODOLOGY

Sampling Locations

The inshore bottom longline survey design includes three sampling regions: Mississippi Sound (30.31-30.24N, 88.40-89.15W), South of Mississippi Barrier Islands (30.22-30.14N, 88.40-89.15W), and Northern Chandeleur Sound (30.31-30.24N, 88.40-89.15W). The Mississippi Sound and South of Mississippi Barrier Islands regions were sub-divided into six equal areas (Figure 1, Areas 1-6). Each month (March through October) one sampling site was randomly selected, without replacement, within each area. The Northern Chandeleur Sound sampling region was considered one area (Figure 1, Area 7) and three sampling sites were randomly selected, without replacement, in this area monthly. This resulted in a total of nine stations sampled each month.

Sampling Protocol

The sampling protocol and equipment follows the procedures established by the NOAA Fisheries Mississippi Laboratories bottom longline survey (Grace and Henwood 1997). The longline gear consisted of a 1.6 km (426 kg test) monofilament mainline and 100, 3.66 m gangions (332 kg test monofilament) outfitted with #15/0 circle hooks and baited with *Scomber scombrus*. A hydraulic longline reel was used for setting and retrieving the mainline. Radar high-flyers with bullet buoys were used to mark the longline end points. The mainline was weighted down at either end as well as at the midpoint. The longline fished for one hour from the time of last high-flier deployment to the time of first high-flier retrieval. During the soak time, the environmental data was collected at the midpoint of the set (surface/mid/bottom measurements for temperature (°C), salinity (psu), and dissolved oxygen (mg/l); turbidity). Water depth (m) and latitude and longitude were also recorded at each station. All sharks landed were identified, measured [precaudal length (PCL), fork length (FL), stretched total length (STL)], weighed, and sex identified. Effort for the sampling was calculated from the time of first highflier deployment to the time of last highflier retrieval.

Analysis

For the purpose of analysis, blacktip sharks were divided into size classes based on estimates of their growth rates and size at maturity. Blacktip sharks were designated as young-of-the-year (YOY) when between 380 and 659 mm fork length (FL), juvenile when between 660 and 1034 mm FL (male) and between 660 and 1173 mm FL (female), and adult when >1035 mm FL (male) and >1174 mm FL (female) (Carlson et al. 2006). Catch rates were standardized as catch per unit effort (CPUE) (# sharks

/ 100 hook * hours). Length frequency distributions were constructed for blacktip sharks ranging from 433 to 1480 mm FL using 100 mm increments.

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for blacktip sharks (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al*. 2000). The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes the proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the non-zero abundance data (Lo *et al*. 1992).

The delta-lognormal index of relative abundance (I_y) as described by Lo *et al*. (1992) was estimated as:

(1) $I_y = c_y p_y$,

where c_y is the estimate of mean CPUE for positive catches only for year y, and p_y is the estimate of mean probability of occurrence during year y. Both c_y and p_y were estimated using generalized linear models. Data used to estimate abundance for positive catches (c) and probability of occurrence (p) were assumed to have a lognormal distribution and a binomial distribution, respectively, and modeled using the following equations:

(2) $\ln(c) = X\beta + \varepsilon$

and

(3) $p = \frac{e^{\mathbf{X\beta}+\varepsilon}}{1+e^{\mathbf{X\beta}+\varepsilon}}$,

respectively, where c is a vector of the positive catch data, p is a vector of the presence/absence data, X is the design matrix for main effects, β is the parameter vector for main effects, and ε is a vector of independent normally distributed errors with expectation zero and variance σ^2. Therefore, c_y and p_y were estimated as least-squares means for each year along with their corresponding standard errors, SE(c_y) and SE(p_y), respectively. From these estimates, I_y was calculated, as in equation (1), and its variance calculated as:

(4) $V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c, p)$,

where:

(5) $\mathrm{Cov}(c, p) \approx \rho_{c,p}\left[\mathrm{SE}(c_y)\mathrm{SE}(p_y)\right]$,

and $\rho_{c,p}$ denotes correlation of c and p among years.

The submodels of the delta-lognormal model were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.10$. Binomial submodel performance was evaluated using AIC, while the performance of the lognormal submodel was evaluated based on analyses of residual scatter and QQ plots in addition to AIC.

For all indices developed, the factors YEAR, AREA or REGION, MONTH, DEPTH, SET, Temperature at the surface (TEMPSUR) and bottom (TEMPBOT), salinity at the surface (SALSUR) and bottom (SALBOT), dissolved oxygen at the surface (DOSUR) and bottom (DOBOT), rainfall for the previous month (PREV_MONTH_RAIN), and rainfall for the current month (MONTH_RAIN), were examined for inclusion in the catch rate models. The factor MONTH includes the months that sampling was conducted (March to October). The study area was divided into 3 regions and 7 areas (See Figure 1). The factor AREA was used for all indices except YOY when the factor REGION was used. The factor SET refers to the time of day the longline was deployed at the sampling location. The factors PREV_MONTH_RAIN and MONTH_RAIN included the mean monthly rainfall (inches) in Mississippi's three coastal counties. The factors for DEPTH, temperature, salinity, and dissolved oxygen included values present in the data set. The factor YEAR included each year in the time series (2008 to 2011), and was forced into the submodels regardless of significance.

RESULTS

From 2008 to 2011, 282 sites were sampled resulting in 490 hours of effort (Figure 2). During this time 647 blacktip sharks were caught, of which we have full measurement data from 594. The total number of blacktip sharks captured each year ranged from 61 to 221 sharks (Table 1). The blacktip shark catch consisted primarily of juveniles (n = 432) with relatively few YOY (n = 74) and adults (n = 88) present. Approximately 47% of the stations sampled contained positive catches of blacktip sharks, with YOY, juvenile, and adult sharks occurring at 12.1, 37.6, and 15.6% of the stations, respectively.

Blacktip sharks ranged in size from 433 to 1480 mm FL (mean: 832.1 ± 193.4 mm FL). The length frequency histogram (Figure 3) indicated that 74.2% of the sharks were between 600 and 1100 mm FL. The nominal CPUE and number of stations with a positive catch for total and juvenile blacktip are presented in Figures 4-7, which indicated annual variation in nominal CPUE, with varying proportion of positive catches over the years.

Total Blacktip Catch

For the total blacktip model, YEAR, AREA, MONTH, DEPTH, DOSUR, and MONTH_RAIN were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, SET, TEMPBOT, DOSUR, and DOBOT. Table 2 summarizes the backward selection procedure used to select the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 1427.7 and 331.2, respectively. The AIC for the binomial submodel increased from model run #4 to #5 when factor TEMPSUR was removed ($p = 0.2082$); however the AIC dropped thereafter. The AIC for the lognormal submodel increased slightly from model run #6 to #7 when factor MONTH was removed ($p = 0.4377$); however, the AIC went back down for runs #8 and 9 after other non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 8-10, and indicated that the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 11 and Table 3. Nominal and standardized blacktip catch rates remained relatively stable through 2010 and declined in 2011 (Figure 11).

YOY Blacktip Catch

For the YOY blacktip model, YEAR, MONTH, REGION, and SALBOT were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, DEPTH, SET, TEMPBOT, and SALSUR. Table 4 summarizes the backward selection procedure used to select the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 1166.1 and 73.6, respectively. The AIC for the binomial submodel increased from model runs #2 to #4 when factors DOSUR ($p = 0.5307$) and SAL SUR ($p = 0.5863$) were removed; however, the AIC went down thereafter. The AIC for the lognormal submodel increased slightly from model runs #2 to #3 when factor MONTH was removed ($p = 0.5800$) and again between runs #7 and #8 when REGION ($p = 0.3178$) was removed; however, the AIC went back down for runs # 9 and 10 after other non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 12-14, and indicated that the distribution of the residuals is approximately normal (Figure 13). Annual abundance indices are presented in Figure 15 and Table 5. Nominal and standardized YOY blacktip catch rates remained relatively stable throughout the survey (Figure 15).

Juvenile Blacktip Catch

For the juvenile blacktip model, YEAR, AREA, DEPTH, DOSUR, and MONTH_RAIN were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, MONTH, AREA, TEMPBOT, DOSUR and DOBOT. Table 6 summarizes the backward selection procedure used to select the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 1186.6 and 264.4, respectively. The AIC for the binomial submodel increased slightly from model run #2 to #3 when factor DOBOT was removed ($p = 0.8156$); however, the AIC went back down for subsequent runs after other non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 16-18, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 19 and Table 7. Both the nominal and standardized juvenile blacktip shark catch rates remained relatively stable through 2010 with a slight decline in 2011 (Figure 19).

Adult Blacktip Catch

For the adult blacktip model, YEAR, MONTH, AREA, DEPTH, TEMPSUR, TEMPBOT, and MONTH_RAIN were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, AREA, and TEMPSUR. Table 8 summarizes the backward selection procedure used to select the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 1574.0 and 68.8, respectively. The AIC for the binomial submodel increased from model runs #1 to #3 when factors DOBOT ($p = 0.9780$) and SET ($p = 0.8237$) were removed; however the AIC declined thereafter. The AIC for the lognormal submodel increased slightly from model run #8 to #9 when factor MONTH was removed ($p = 0.2393$); however, the AIC continued to decline for runs #10 and 11 after other non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 20-22, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 23 and Table 9. Both the nominal and standardized juvenile blacktip shark catch rates remained relatively stable through 2010 with a slight decline in 2011 (Figure 23).

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Table 1. Summary of the blacktip shark data used in these analyses collected during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008 and 2011.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation
2008	68	145	139	446	1363	856.0	198.0
2009	71	220	204	433	1480	789.0	167.0
2010	72	221	196	462	1466	856.6	208.6
2011	71	61	55	536	1470	845.8	195.3

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
4	282	647	594	832.1

Table 2. Summary of the backward selection procedure for building delta-lognormal submodels for the total blacktip shark full index of relative abundance from 2008 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1466.2)*						*Lognormal Submodel Type 3 Tests (AIC 357.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	255	8.68	2.89	0.0339	0.0359	3	105	1.10	0.3534
AREA	6	255	18.16	3.03	0.0059	0.0071	6	105	0.57	0.7565
MONTH	7	255	13.33	1.90	0.0645	0.0693	7	105	0.53	0.8101
DEPTH	1	255	3.32	3.32	0.0682	0.0694	1	105	0.42	0.5189
SET	1	255	0.68	0.68	0.4101	0.4109	1	105	1.94	0.1663
TEMPSUR	1	255	1.66	1.66	0.1975	0.1987	1	105	0.01	0.9336
TEMPBOT	1	255	4.44	4.44	0.0350	0.0360	1	105	11.74	0.0009
SALSUR	1	255	3.68	3.68	0.0552	0.0563	1	105	0.42	0.5167
SALBOT	1	255	3.02	3.02	0.0823	0.0835	1	105	0.22	0.6391
DOSUR	1	255	5.08	5.08	0.0242	0.0250	1	105	6.34	0.0133
DOBOT	1	255	0.21	0.21	0.6432	0.6436	1	105	3.69	0.0574
PREV_MONTH_RAIN	1	255	0.00	0.00	0.9866	0.9866	1	105	1.11	0.2948
MONTH_RAIN	1	255	3.99	3.99	0.0458	0.0469	1	105	0.08	0.7754

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1462.8)*						*Lognormal Submodel Type 3 Tests (AIC 353.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	256	9.45	3.15	0.0239	0.0256	3	106	1.13	0.3387
AREA	6	256	18.46	3.08	0.0052	0.0063	6	106	0.57	0.7529
MONTH	7	256	14.59	2.08	0.0416	0.0457	7	106	0.66	0.7039
DEPTH	1	256	3.35	3.35	0.0674	0.0685	1	106	0.42	0.5202
SET	1	256	0.68	0.68	0.4085	0.4093	1	106	2.18	0.1424
TEMPSUR	1	256	1.69	1.69	0.1932	0.1944			Dropped	
TEMPBOT	1	256	4.47	4.47	0.0346	0.0356	1	106	17.60	<.0001
SALSUR	1	256	3.69	3.69	0.0548	0.0559	1	106	0.42	0.5176
SALBOT	1	256	3.09	3.09	0.0788	0.0800	1	106	0.23	0.6299
DOSUR	1	256	5.32	5.32	0.0211	0.0219	1	106	6.43	0.0127
DOBOT	1	256	0.22	0.22	0.6380	0.6384	1	106	4.39	0.0386
PREV_MONTH_RAIN					Dropped		1	106	1.11	0.2940
MONTH_RAIN	1	256	5.27	5.27	0.0217	0.0225	1	106	0.08	0.7772

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 1457.4)*						*Lognormal Submodel Type 3 Tests (AIC 348.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	257	9.53	3.18	0.0230	0.0247	3	107	1.14	0.3354
AREA	6	257	18.60	3.10	0.0049	0.0060	6	107	0.58	0.7462
MONTH	7	257	15.29	2.18	0.0324	0.0360	7	107	0.79	0.5997
DEPTH	1	257	3.34	3.34	0.0677	0.0689	1	107	0.50	0.4791
SET	1	257	0.90	0.90	0.3441	0.3450	1	107	2.16	0.1442
TEMPSUR	1	257	2.27	2.27	0.1317	0.1329			Dropped	
TEMPBOT	1	257	4.56	4.56	0.0328	0.0338	1	107	17.68	<.0001
SALSUR	1	257	3.89	3.89	0.0486	0.0496	1	107	0.49	0.4838
SALBOT	1	257	3.15	3.15	0.0760	0.0772	1	107	0.24	0.6226
DOSUR	1	257	5.18	5.18	0.0228	0.0237	1	107	6.54	0.0120
DOBOT					Dropped		1	107	4.34	0.0395
PREV_MONTH_RAIN					Dropped		1	107	1.33	0.2514
MONTH_RAIN	1	257	5.57	5.57	0.0183	0.0190			Dropped	

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1443.4)*						*Lognormal Submodel Type 3 Tests (AIC 347.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	258	9.45	3.15	0.0238	0.0255	3	113	1.12	0.3454
AREA	6	258	18.44	3.07	0.0052	0.0064			Dropped	
MONTH	7	258	15.45	2.21	0.0307	0.0341	7	113	0.84	0.5570
DEPTH	1	258	3.48	3.48	0.0621	0.0633	1	113	0.33	0.5643
SET					Dropped		1	113	2.87	0.0929
TEMPSUR	1	258	1.59	1.59	0.2070	0.2082			Dropped	
TEMPBOT	1	258	4.12	4.12	0.0424	0.0435	1	113	19.39	<.0001
SALSUR	1	258	3.36	3.36	0.0670	0.0681	1	113	0.78	0.3788
SALBOT	1	258	2.81	2.81	0.0939	0.0951	1	113	0.04	0.8454
DOSUR	1	258	4.50	4.50	0.0340	0.0349	1	113	4.94	0.0282
DOBOT					Dropped		1	113	5.73	0.0183
PREV_MONTH_RAIN					Dropped		1	113	1.75	0.1882
MONTH_RAIN	1	258	5.55	5.55	0.0185	0.0192			Dropped	

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1448.7)*						*Lognormal Submodel Type 3 Tests (AIC 343.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	259	9.74	3.25	0.0209	0.0225	3	114	1.18	0.3207
AREA	6	259	16.96	2.83	0.0094	0.0111			Dropped	
MONTH	7	259	14.40	2.06	0.0446	0.0487	7	114	0.99	0.4430
DEPTH	1	259	2.42	2.42	0.1200	0.1213	1	114	0.54	0.4654
SET					Dropped		1	114	2.87	0.0932
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	259	2.53	2.53	0.1114	0.1127	1	114	27.46	<.0001
SALSUR	1	259	1.98	1.98	0.1592	0.1604	1	114	1.21	0.2737
SALBOT	1	259	1.64	1.64	0.2004	0.2015			Dropped	
DOSUR	1	259	4.74	4.74	0.0294	0.0303	1	114	4.96	0.0279
DOBOT					Dropped		1	114	11.10	0.0012
PREV_MONTH_RAIN					Dropped		1	114	1.78	0.1844
MONTH_RAIN	1	259	5.11	5.11	0.0238	0.0246			Dropped	

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1440.8)*						*Lognormal Submodel Type 3 Tests (AIC 338.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	260	9.41	3.14	0.0243	0.0260	3	115	1.11	0.3470
AREA	6	260	17.72	2.95	0.0070	0.0083			Dropped	
MONTH	7	260	13.55	1.94	0.0598	0.0644	7	115	1.00	0.4377
DEPTH	1	260	5.76	5.76	0.0164	0.0171			Dropped	
SET					Dropped		1	115	2.85	0.0941
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	260	1.22	1.22	0.2699	0.2710	1	115	27.50	<.0001
SALSUR	1	260	1.03	1.03	0.3091	0.3100	1	115	2.47	0.1186
SALBOT					Dropped				Dropped	
DOSUR	1	260	4.74	4.74	0.0295	0.0304	1	115	5.18	0.0247
DOBOT					Dropped		1	115	12.91	0.0005
PREV_MONTH_RAIN					Dropped		1	115	1.47	0.2280
MONTH_RAIN	1	260	5.03	5.03	0.0250	0.0258			Dropped	

Model Run #7	*Binomial Submodel Type 3 Tests (AIC 1437.6)*						*Lognormal Submodel Type 3 Tests (AIC 341.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	261	9.20	3.07	0.0267	0.0285	3	122	2.19	0.0925
AREA	6	261	17.08	2.85	0.0090	0.0106			Dropped	
MONTH	7	261	13.31	1.90	0.0650	0.0697			Dropped	
DEPTH	1	261	5.45	5.45	0.0196	0.0204			Dropped	
SET					Dropped		1	122	2.88	0.0924
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	261	1.69	1.69	0.1933	0.1945	1	122	29.98	<.0001
SALSUR					Dropped		1	122	0.39	0.5318
SALBOT					Dropped				Dropped	
DOSUR	1	261	3.98	3.98	0.0461	0.0472	1	122	3.93	0.0496
DOBOT					Dropped		1	122	13.74	0.0003
PREV_MONTH_RAIN					Dropped		1	122	2.29	0.1332
MONTH_RAIN	1	261	5.12	5.12	0.0237	0.0245			Dropped	

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1427.7)*						*Lognormal Submodel Type 3 Tests (AIC 335.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	262	10.67	3.56	0.0136	0.0149	3	123	2.10	0.1036
AREA	6	262	16.48	2.75	0.0114	0.0132			Dropped	
MONTH	7	262	22.21	3.17	0.0023	0.0031			Dropped	
DEPTH	1	262	4.33	4.33	0.0374	0.0384			Dropped	
SET					Dropped		1	123	2.86	0.0932
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	123	31.33	<.0001
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR	1	262	4.88	4.88	0.0272	0.0280	1	123	3.65	0.0583
DOBOT					Dropped		1	123	13.47	0.0004
PREV_MONTH_RAIN					Dropped		1	123	2.37	0.1265
MONTH_RAIN	1	262	5.79	5.79	0.0161	0.0168			Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1427.7)*						*Lognormal Submodel Type 3 Tests (AIC 331.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	262	10.67	3.56	0.0136	0.0149	3	124	2.20	0.0910
AREA	6	262	16.48	2.75	0.0114	0.0132			Dropped	
MONTH	7	262	22.21	3.17	0.0023	0.0031			Dropped	
DEPTH	1	262	4.33	4.33	0.0374	0.0384			Dropped	
SET					Dropped		1	124	3.66	0.0580
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	124	29.70	<.0001
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR	1	262	4.88	4.88	0.0272	0.0280	1	124	6.37	0.0129
DOBOT					Dropped		1	124	12.44	0.0006
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	262	5.79	5.79	0.0161	0.0168			Dropped	

Table 3. Indices for total blacktip shark catch rates from 2008 to 2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (numbers per 100 hook per hour), the Lo indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	*Frequency*	*n*	*Lo Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2008	0.52941	68	0.79308	0.98427	0.28535	0.56247	1.72238
2009	0.39437	71	0.92083	1.14281	0.35358	0.57525	2.27036
2010	0.61111	72	1.18451	1.47007	0.22547	0.94172	2.29485
2011	0.33803	71	0.32460	0.40285	0.36746	0.19771	0.82085

Table 4. Summary of the backward selection procedure for building delta-lognormal submodels for YOY blacktip shark full index of relative abundance from 2008 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1242.5)*						*Lognormal Submodel Type 3 Tests (AIC 79.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	191	4.32	1.44	0.2291	0.2326	3	13	0.21	0.8855
MONTH	5	191	11.20	2.24	0.0476	0.0520	5	13	0.73	0.6163
REGION	2	191	6.29	3.14	0.0431	0.0453	2	13	0.63	0.5481
DEPTH	1	191	0.08	0.08	0.7713	0.7716	1	13	3.49	0.0842
SET	1	191	2.03	2.03	0.1543	0.1559	1	13	0.88	0.3656
TEMPSUR	1	191	0.79	0.79	0.3755	0.3766	1	13	0.34	0.5724
TEMPBOT	1	191	1.62	1.62	0.2032	0.2047	1	13	0.59	0.4579
SALSUR	1	191	0.59	0.59	0.4440	0.4449	1	13	1.44	0.2518
SALBOT	1	191	0.32	0.32	0.5703	0.5710	1	13	0.59	0.4552
DOSUR	1	191	0.36	0.36	0.5474	0.5481	1	13	0.02	0.8792
DOBOT	1	191	0.52	0.52	0.4715	0.4724	1	13	3.12	0.1010
PREV_MONTH_RAIN	1	191	0.76	0.76	0.3838	0.3849	1	13	0.35	0.5637
MONTH_RAIN	1	191	0.44	0.44	0.5081	0.5089	1	13	0.35	0.5648

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1232.7)*						*Lognormal Submodel Type 3 Tests (AIC 78.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	192	4.55	1.52	0.2082	0.2119	3	14	0.28	0.8398
MONTH	5	192	11.84	2.37	0.0370	0.0410	5	14	0.78	0.5800
REGION	2	192	6.94	3.47	0.0311	0.0331	2	14	0.85	0.4471
DEPTH					Dropped		1	14	3.98	0.0658
SET	1	192	2.12	2.12	0.1458	0.1475	1	14	1.35	0.2655
TEMPSUR	1	192	0.90	0.90	0.3436	0.3448	1	14	0.36	0.5560
TEMPBOT	1	192	1.67	1.67	0.1958	0.1973	1	14	0.61	0.4495
SALSUR	1	192	0.59	0.59	0.4422	0.4431	1	14	1.72	0.2112
SALBOT	1	192	0.52	0.52	0.4709	0.4718	1	14	0.64	0.4385
DOSUR	1	192	0.39	0.39	0.5300	0.5307			Dropped	
DOBOT	1	192	0.55	0.55	0.4568	0.4577	1	14	4.27	0.0579
PREV_MONTH_RAIN	1	192	0.78	0.78	0.3766	0.3777	1	14	0.36	0.5595
MONTH_RAIN	1	192	0.46	0.46	0.4997	0.5005	1	14	0.35	0.5624

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 1238.7)*						*Lognormal Submodel Type 3 Tests (AIC 87.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	193	4.43	1.48	0.2186	0.2222	3	19	1.11	0.3698
MONTH	5	193	11.59	2.32	0.0408	0.0449			Dropped	
REGION	2	193	6.52	3.26	0.0384	0.0406	2	19	1.08	0.3585
DEPTH					Dropped		1	19	4.00	0.0601
SET	1	193	1.70	1.70	0.1926	0.1942	1	19	2.67	0.1188
TEMPSUR	1	193	0.80	0.80	0.3704	0.3715	1	19	0.91	0.3511
TEMPBOT	1	193	1.67	1.67	0.1963	0.1978	1	19	2.92	0.1036
SALSUR	1	193	0.30	0.30	0.5856	0.5863	1	19	1.15	0.2961
SALBOT	1	193	0.66	0.66	0.4172	0.4182	1	19	0.18	0.6790
DOSUR					Dropped				Dropped	
DOBOT	1	193	0.93	0.93	0.3341	0.3353	1	19	4.25	0.0532
PREV_MONTH_RAIN	1	193	0.64	0.64	0.4219	0.4229	1	19	0.51	0.4821
MONTH_RAIN	1	193	0.43	0.43	0.5132	0.5140	1	19	1.14	0.2981

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1242.9)*						*Lognormal Submodel Type 3 Tests (AIC 84.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	194	4.67	1.56	0.1976	0.2013	3	20	1.61	0.2176
MONTH	5	194	11.46	2.29	0.0431	0.0473			Dropped	
REGION	2	194	6.31	3.15	0.0427	0.0449	2	20	1.38	0.2739
DEPTH					Dropped		1	20	3.99	0.0595
SET	1	194	1.98	1.98	0.1597	0.1613	1	20	3.66	0.0702
TEMPSUR	1	194	0.67	0.67	0.4148	0.4158	1	20	1.69	0.2085
TEMPBOT	1	194	1.38	1.38	0.2399	0.2414	1	20	5.42	0.0305
SALSUR					Dropped		1	20	9.32	0.0063
SALBOT	1	194	3.84	3.84	0.0500	0.0515			Dropped	
DOSUR					Dropped				Dropped	
DOBOT	1	194	2.20	2.20	0.1379	0.1395	1	20	4.55	0.0456
PREV_MONTH_RAIN	1	194	0.63	0.63	0.4281	0.4291	1	20	0.43	0.5194
MONTH_RAIN	1	194	0.31	0.31	0.5800	0.5807	1	20	1.27	0.2734

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1233.3)*						*Lognormal Submodel Type 3 Tests (AIC 79.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	195	4.84	1.61	0.1836	0.1873	3	21	1.67	0.2043
MONTH	5	195	11.90	2.38	0.0362	0.0401			Dropped	
REGION	2	195	6.47	3.24	0.0393	0.0414	2	21	1.46	0.2551
DEPTH					Dropped		1	21	3.80	0.0648
SET	1	195	1.98	1.98	0.1592	0.1608	1	21	3.70	0.0682
TEMPSUR	1	195	0.82	0.82	0.3662	0.3673	1	21	1.67	0.2108
TEMPBOT	1	195	1.37	1.37	0.2423	0.2437	1	21	5.13	0.0342
SALSUR					Dropped		1	21	9.23	0.0063
SALBOT	1	195	3.68	3.68	0.0552	0.0567			Dropped	
DOSUR					Dropped				Dropped	
DOBOT	1	195	2.01	2.01	0.1564	0.1580	1	21	4.39	0.0484
PREV_MONTH_RAIN	1	195	0.35	0.35	0.5569	0.5576			Dropped	
MONTH_RAIN					Dropped		1	21	0.87	0.3623

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1221.1)*						*Lognormal Submodel Type 3 Tests (AIC 75.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	196	5.02	1.67	0.1704	0.1741	3	22	1.83	0.1716
MONTH	5	196	12.81	2.56	0.0253	0.0285			Dropped	
REGION	2	196	6.99	3.49	0.0304	0.0323	2	22	1.79	0.1909
DEPTH					Dropped		1	22	3.76	0.0653
SET	1	196	2.06	2.06	0.1512	0.1528	1	22	4.97	0.0364
TEMPSUR	1	196	1.06	1.06	0.3024	0.3037	1	22	1.56	0.2250
TEMPBOT	1	196	1.40	1.40	0.2372	0.2386	1	22	4.41	0.0474
SALSUR					Dropped		1	22	10.52	0.0037
SALBOT	1	196	3.59	3.59	0.0580	0.0595			Dropped	
DOSUR					Dropped				Dropped	
DOBOT	1	196	1.84	1.84	0.1755	0.1770	1	22	4.64	0.0424
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN					Dropped				Dropped	

Model Run #7	*Binomial Submodel Type 3 Tests (AIC 1206.7)*						*Lognormal Submodel Type 3 Tests (AIC 74.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	197	5.08	1.69	0.1659	0.1696	3	23	2.03	0.1379
MONTH	5	197	17.41	3.48	0.0038	0.0049			Dropped	
REGION	2	197	6.09	3.04	0.0476	0.0499	2	23	1.21	0.3178
DEPTH					Dropped		1	23	2.76	0.1099
SET	1	197	1.19	1.19	0.2763	0.2776	1	23	4.98	0.0356
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	197	0.45	0.45	0.5010	0.5017	1	23	4.44	0.0462
SALSUR					Dropped		1	23	9.36	0.0055
SALBOT	1	197	3.27	3.27	0.0704	0.0719			Dropped	
DOSUR					Dropped				Dropped	
DOBOT	1	197	0.89	0.89	0.3458	0.3469	1	23	3.01	0.0960
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN					Dropped				Dropped	

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1188.5)*						*Lognormal Submodel Type 3 Tests (AIC 75.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	198	6.50	2.17	0.0898	0.0934	3	25	2.34	0.0974
MONTH	5	198	19.10	3.82	0.0018	0.0025			Dropped	
REGION	2	198	6.05	3.03	0.0485	0.0507			Dropped	
DEPTH					Dropped		1	25	4.32	0.0481
SET	1	198	1.52	1.52	0.2183	0.2197	1	25	8.12	0.0087
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	25	3.29	0.0819
SALSUR					Dropped		1	25	8.33	0.0079
SALBOT	1	198	7.70	7.70	0.0055	0.0060			Dropped	
DOSUR					Dropped				Dropped	
DOBOT	1	198	1.32	1.32	0.2513	0.2527	1	25	2.35	0.1378
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN					Dropped				Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1173.9)*						*Lognormal Submodel Type 3 Tests (AIC 73.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	199	6.85	2.28	0.0769	0.0803	3	26	3.16	0.0416
MONTH	5	199	20.14	4.03	0.0012	0.0017			Dropped	
REGION	2	199	6.24	3.12	0.0441	0.0462			Dropped	
DEPTH					Dropped		1	26	4.97	0.0346
SET	1	199	1.59	1.59	0.2071	0.2086	1	26	6.42	0.0176
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	26	5.14	0.0320
SALSUR					Dropped		1	26	7.09	0.0131
SALBOT	1	199	6.96	6.96	0.0083	0.0090			Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped				Dropped	
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN					Dropped				Dropped	

Model Run #10	*Binomial Submodel Type 3 Tests (AIC 1166.1)*						*Lognormal Submodel Type 3 Tests (AIC 73.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	200	6.52	2.17	0.0889	0.0924	3	26	3.16	0.0416
MONTH	5	200	19.24	3.85	0.0017	0.0024			Dropped	
REGION	2	200	5.69	2.85	0.0580	0.0604			Dropped	
DEPTH					Dropped		1	26	4.97	0.0346
SET					Dropped		1	26	6.42	0.0176
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	26	5.14	0.0320
SALSUR					Dropped		1	26	7.09	0.0131
SALBOT	1	200	6.10	6.10	0.0135	0.0143			Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped				Dropped	
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN					Dropped				Dropped	

Table 5. Indices of YOY blacktip shark catch rates from 2008-2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (number per 100 hook per hour), the Lo indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	n	Lo Index	Scaled Index	CV	LCL	UCL
2008	0.12500	48	0.05187	0.48134	1.00725	0.09027	2.56670
2009	0.18519	54	0.18770	1.74185	0.57859	0.59466	5.10213
2010	0.24074	54	0.15760	1.46248	0.51554	0.55387	3.86165
2011	0.08929	56	0.03387	0.31433	1.30826	0.04265	2.31688

Table 6. Summary of the backward selection procedure for building delta-lognormal submodels for the juvenile blacktip shark full index of relative abundance from 2008 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1254.4)*						*Lognormal Submodel Type 3 Tests (AIC 291.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	128	2.07	0.68	0.5575	0.5631	3	80	0.95	0.4201
MONTH	6	188	4.28	0.71	0.6384	0.6400	6	80	1.25	0.2917
AREA	6	173	24.83	4.14	0.0004	0.0007	6	80	1.96	0.0817
DEPTH	1	154	3.58	3.58	0.0585	0.0603	1	80	0.79	0.3764
SET	1	175	0.20	0.20	0.6549	0.6555	1	80	0.28	0.5974
TEMPSUR	1	188	1.95	1.95	0.1626	0.1642	1	80	0.00	0.9685
TEMPBOT	1	175	4.10	4.10	0.0429	0.0444	1	80	11.58	0.0010
SALSUR	1	198	1.46	1.46	0.2269	0.2283	1	80	1.42	0.2365
SALBOT	1	175	2.94	2.94	0.0864	0.0882	1	80	0.00	0.9641
DOSUR	1	187	3.07	3.07	0.0799	0.0815	1	80	8.45	0.0047
DOBOT	1	166	0.06	0.06	0.8046	0.8049	1	80	4.53	0.0364
PREV_MONTH_RAIN	1	209	0.01	0.01	0.9039	0.9041	1	80	0.43	0.5151
MONTH_RAIN	1	198	5.35	5.35	0.0207	0.0218	1	80	0.00	0.9944

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1250.7)*						*Lognormal Submodel Type 3 Tests (AIC 286.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	128	2.17	0.72	0.5383	0.5442	3	81	0.97	0.4096
MONTH	6	178	5.41	0.90	0.4922	0.4958	6	81	1.30	0.2652
AREA	6	175	24.88	4.15	0.0004	0.0006	6	81	2.00	0.0751
DEPTH	1	155	3.55	3.55	0.0596	0.0614	1	81	0.85	0.3602
SET	1	178	0.21	0.21	0.6484	0.6490	1	81	0.30	0.5834
TEMPSUR	1	190	1.97	1.97	0.1609	0.1625	1	81	0.00	0.9653
TEMPBOT	1	177	4.09	4.09	0.0431	0.0446	1	81	11.78	0.0009
SALSUR	1	197	1.43	1.43	0.2321	0.2336	1	81	1.46	0.2303
SALBOT	1	178	2.99	2.99	0.0837	0.0854	1	81	0.00	0.9701
DOSUR	1	187	3.10	3.10	0.0781	0.0797	1	81	8.75	0.0041
DOBOT	1	169	0.05	0.05	0.8154	0.8156	1	81	4.57	0.0356
PREV_MONTH_RAIN					Dropped		1	81	0.72	0.3998
MONTH_RAIN	1	206	7.88	7.88	0.0050	0.0055			Dropped	

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 1256.3)*						*Lognormal Submodel Type 3 Tests (AIC 281.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	127	2.10	0.69	0.5519	0.5577	3	82	1.00	0.3985
MONTH	6	176	5.35	0.89	0.4995	0.5031	6	82	1.60	0.1563
AREA	6	169	26.03	4.34	0.0002	0.0004	6	82	2.09	0.0628
DEPTH	1	151	3.81	3.81	0.0509	0.0527	1	82	0.97	0.3283
SET	1	172	0.33	0.33	0.5635	0.5643	1	82	0.32	0.5748
TEMPSUR	1	188	2.01	2.01	0.1562	0.1579	1	82	0.00	0.9648
TEMPBOT	1	172	4.08	4.08	0.0434	0.0449	1	82	17.01	<.0001
SALSUR	1	200	2.25	2.25	0.1339	0.1355	1	82	1.72	0.1933
SALBOT	1	180	4.11	4.11	0.0427	0.0442			Dropped	
DOSUR	1	172	3.36	3.36	0.0668	0.0685	1	82	8.87	0.0038
DOBOT					Dropped		1	82	6.56	0.0123
PREV_MONTH_RAIN					Dropped		1	82	0.74	0.3911
MONTH_RAIN	1	205	7.70	7.70	0.0055	0.0060			Dropped	

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1237.8)*						*Lognormal Submodel Type 3 Tests (AIC 278.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	129	2.41	0.79	0.4924	0.4989	3	83	1.03	0.3839
MONTH	6	183	5.66	0.94	0.4626	0.4666	6	83	2.10	0.0621
AREA	6	179	27.00	4.50	0.0001	0.0003	6	83	2.14	0.0573
DEPTH	1	161	3.60	3.60	0.0578	0.0596	1	83	1.00	0.3196
SET					Dropped		1	83	0.35	0.5543
TEMPSUR	1	185	3.07	3.07	0.0796	0.0812			Dropped	
TEMPBOT	1	180	4.71	4.71	0.0300	0.0313	1	83	27.97	<.0001
SALSUR	1	201	2.75	2.75	0.0973	0.0988	1	83	1.77	0.1873
SALBOT	1	188	4.62	4.62	0.0315	0.0328			Dropped	
DOSUR	1	191	4.58	4.58	0.0324	0.0336	1	83	9.03	0.0035
DOBOT					Dropped		1	83	8.77	0.0040
PREV_MONTH_RAIN					Dropped		1	83	0.75	0.3877
MONTH_RAIN	1	203	8.27	8.27	0.0040	0.0045			Dropped	

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1213.8)*						*Lognormal Submodel Type 3 Tests (AIC 274.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	126	3.46	1.14	0.3262	0.3353	3	84	0.98	0.4052
MONTH					Dropped		6	84	2.23	0.0483
AREA	6	193	26.55	4.42	0.0002	0.0003	6	84	2.18	0.0528
DEPTH	1	161	3.82	3.82	0.0506	0.0523	1	84	1.27	0.2627
SET					Dropped				Dropped	
TEMPSUR	1	195	1.67	1.67	0.1956	0.1971			Dropped	
TEMPBOT	1	182	3.80	3.80	0.0511	0.0527	1	84	28.34	<.0001
SALSUR	1	181	2.92	2.92	0.0876	0.0893	1	84	2.02	0.1586
SALBOT	1	189	3.43	3.43	0.0640	0.0656			Dropped	
DOSUR	1	192	4.80	4.80	0.0285	0.0297	1	84	8.99	0.0036
DOBOT					Dropped		1	84	10.15	0.0020
PREV_MONTH_RAIN					Dropped		1	84	0.95	0.3325
MONTH_RAIN	1	167	7.09	7.09	0.0078	0.0085			Dropped	

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1209.6)*						*Lognormal Submodel Type 3 Tests (AIC 269.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	126	3.57	1.18	0.3117	0.3209	3	85	1.06	0.3706
MONTH					Dropped		6	85	2.33	0.0394
AREA	6	192	26.05	4.34	0.0002	0.0004	6	85	2.30	0.0418
DEPTH	1	160	3.48	3.48	0.0621	0.0639	1	85	1.91	0.1709
SET					Dropped				Dropped	
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	222	3.13	3.13	0.0767	0.0781	1	85	27.54	<.0001
SALSUR	1	208	1.82	1.82	0.1770	0.1784	1	85	2.98	0.0878
SALBOT	1	196	2.20	2.20	0.1377	0.1393			Dropped	
DOSUR	1	186	5.92	5.92	0.0150	0.0159	1	85	11.81	0.0009
DOBOT					Dropped		1	85	9.61	0.0026
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	179	6.76	6.76	0.0093	0.0101			Dropped	

Model Run #7	*Binomial Submodel Type 3 Tests (AIC 1194.0)*						*Lognormal Submodel Type 3 Tests (AIC 267.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	128	4.02	1.33	0.2595	0.2688	3	86	1.23	0.3044
MONTH					Dropped		6	86	2.50	0.0283
AREA	6	205	25.28	4.21	0.0003	0.0005	6	86	1.98	0.0768
DEPTH	1	175	3.76	3.76	0.0524	0.0540			Dropped	
SET					Dropped				Dropped	
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	220	1.77	1.77	0.1840	0.1853	1	86	33.24	<.0001
SALSUR					Dropped		1	86	2.11	0.1504
SALBOT	1	175	0.73	0.73	0.3937	0.3949			Dropped	
DOSUR	1	201	4.70	4.70	0.0301	0.0313	1	86	10.38	0.0018
DOBOT					Dropped		1	86	7.49	0.0075
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	165	6.67	6.67	0.0098	0.0107			Dropped	

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1190.8)*						*Lognormal Submodel Type 3 Tests (AIC 264.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	127	3.78	1.25	0.2862	0.2956	3	87	1.47	0.2290
MONTH					Dropped		6	87	2.10	0.0614
AREA	6	205	26.67	4.44	0.0002	0.0003	6	87	2.41	0.0336
DEPTH	1	186	6.58	6.58	0.0103	0.0111			Dropped	
SET					Dropped				Dropped	
TEMPSUR					Dropped				Dropped	
TEMPBOT	1	220	1.72	1.72	0.1896	0.1910	1	87	30.78	<.0001
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR	1	205	5.31	5.31	0.0212	0.0222	1	87	8.70	0.0041
DOBOT					Dropped		1	87	5.51	0.0212
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	168	7.24	7.24	0.0071	0.0078			Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1186.6)*						*Lognormal Submodel Type 3 Tests (AIC 264.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	129	4.21	1.39	0.2396	0.2490	3	87	1.47	0.2290
MONTH					Dropped		6	87	2.10	0.0614
AREA	6	211	25.34	4.22	0.0003	0.0005	6	87	2.41	0.0336
DEPTH	1	192	5.27	5.27	0.0217	0.0228			Dropped	
SET					Dropped				Dropped	
TEMPSUR					Dropped				Dropped	
TEMPBOT					Dropped		1	87	30.78	<.0001
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR	1	222	6.70	6.70	0.0096	0.0103	1	87	8.70	0.0041
DOBOT					Dropped		1	87	5.51	0.0212
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	159	11.24	11.24	0.0008	0.0010			Dropped	

Table 7. Indices of juvenile blacktip shark catch rates from 2008-2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (number per 100 hook per hour), the Lo indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	n	Lo Index	Scaled Index	CV	LCL	UCL
2008	0.50000	58	0.54427	0.83909	0.30763	0.45986	1.53107
2009	0.38095	63	0.94413	1.45553	0.33067	0.76423	2.77216
2010	0.53968	63	0.75072	1.15737	0.29237	0.65270	2.05225
2011	0.30645	62	0.35546	0.54801	0.34489	0.28028	1.07147

Table 8. Summary of the backward selection procedure for building delta-lognormal submodels for the adult blacktip shark full index of relative abundance from 2008 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1673.1)*						*Lognormal Submodel Type 3 Tests (AIC 89.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	158	3.93	1.30	0.2687	0.2757	3	17	1.28	0.3115
MONTH	7	195	15.81	2.25	0.0269	0.0316	7	17	1.25	0.3288
AREA	6	191	16.29	2.71	0.0123	0.0150	6	17	2.67	0.0519
DEPTH	1	181	11.13	11.13	0.0009	0.0010	1	17	0.74	0.4026
SET	1	197	0.05	0.05	0.8248	0.8250	1	17	2.93	0.1053
TEMPSUR	1	210	6.51	6.51	0.0108	0.0115	1	17	9.44	0.0069
TEMPBOT	1	196	7.48	7.48	0.0062	0.0068	1	17	1.22	0.2838
SALSUR	1	217	1.85	1.85	0.1742	0.1756	1	17	0.25	0.6255
SALBOT	1	224	0.04	0.04	0.8324	0.8326	1	17	2.24	0.1528
DOSUR	1	182	2.40	2.40	0.1211	0.1228	1	17	1.98	0.1775
DOBOT	1	190	0.00	0.00	0.9780	0.9780	1	17	5.01	0.0389
PREV_MONTH_RAIN	1	238	0.45	0.45	0.5037	0.5044	1	17	1.12	0.3045
MONTH_RAIN	1	221	3.98	3.98	0.0460	0.0472	1	17	0.13	0.7218

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1677.8)*						*Lognormal Submodel Type 3 Tests (AIC 85.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	158	3.95	1.31	0.2670	0.2740	3	18	1.86	0.1724
MONTH	7	194	16.00	2.28	0.0251	0.0297	7	18	1.33	0.2920
AREA	6	190	16.57	2.76	0.0110	0.0135	6	18	2.78	0.0429
DEPTH	1	180	11.31	11.31	0.0008	0.0009	1	18	1.07	0.3146
SET	1	201	0.05	0.05	0.8235	0.8237	1	18	3.41	0.0813
TEMPSUR	1	214	7.00	7.00	0.0081	0.0087	1	18	10.41	0.0047
TEMPBOT	1	194	7.60	7.60	0.0058	0.0064	1	18	1.54	0.2313
SALSUR	1	214	2.63	2.63	0.1052	0.1066	1	18	0.18	0.6741
SALBOT	1	213	0.05	0.05	0.8182	0.8184	1	18	2.37	0.1414
DOSUR	1	188	2.52	2.52	0.1127	0.1144	1	18	2.20	0.1555
DOBOT					Dropped		1	18	5.14	0.0359
PREV_MONTH_RAIN	1	236	0.48	0.48	0.4888	0.4894	1	18	1.12	0.3046
MONTH_RAIN	1	220	4.09	4.09	0.0431	0.0443			Dropped	

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 1710.4)*						*Lognormal Submodel Type 3 Tests (AIC 81.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	159	3.79	1.26	0.2848	0.2916	3	19	2.00	0.1476
MONTH	7	186	16.67	2.38	0.0197	0.0239	7	19	1.62	0.1900
AREA	6	184	17.41	2.90	0.0079	0.0100	6	19	2.92	0.0343
DEPTH	1	171	12.11	12.11	0.0005	0.0006	1	19	1.16	0.2940
SET					Dropped		1	19	3.38	0.0818
TEMPSUR	1	205	7.35	7.35	0.0067	0.0073	1	19	10.71	0.0040
TEMPBOT	1	185	7.88	7.88	0.0050	0.0055	1	19	2.14	0.1599
SALSUR	1	203	2.97	2.97	0.0848	0.0863			Dropped	
SALBOT	1	203	0.04	0.04	0.8451	0.8453	1	19	2.49	0.1314
DOSUR	1	183	2.85	2.85	0.0913	0.0930	1	19	2.66	0.1193
DOBOT					Dropped		1	19	5.84	0.0259
PREV_MONTH_RAIN	1	231	0.62	0.62	0.4304	0.4312	1	19	1.45	0.2429
MONTH_RAIN	1	206	4.38	4.38	0.0364	0.0376			Dropped	

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1674.9)*						*Lognormal Submodel Type 3 Tests (AIC 79.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	158	4.20	1.39	0.2408	0.2479	3	20	1.60	0.2202
MONTH	7	192	16.22	2.31	0.0231	0.0276	7	20	1.44	0.2436
AREA	6	193	17.25	2.87	0.0084	0.0105	6	20	3.35	0.0188
DEPTH	1	187	13.14	13.14	0.0003	0.0004			Dropped	
SET					Dropped		1	20	2.65	0.1190
TEMPSUR	1	211	7.47	7.47	0.0063	0.0068	1	20	9.49	0.0059
TEMPBOT	1	202	11.07	11.07	0.0009	0.0010	1	20	1.79	0.1955
SALSUR	1	201	2.95	2.95	0.0861	0.0877			Dropped	
SALBOT					Dropped		1	20	1.32	0.2650
DOSUR	1	191	2.75	2.75	0.0973	0.0989	1	20	1.83	0.1912
DOBOT					Dropped		1	20	4.67	0.0430
PREV_MONTH_RAIN	1	233	0.56	0.56	0.4523	0.4531	1	20	0.59	0.4502
MONTH_RAIN	1	213	4.14	4.14	0.0419	0.0431			Dropped	

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1659.6)*						*Lognormal Submodel Type 3 Tests (AIC 75.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	150	4.01	1.33	0.2600	0.2678	3	21	1.45	0.2573
MONTH	7	190	22.74	3.24	0.0019	0.0028	7	21	1.66	0.1727
AREA	6	197	16.44	2.74	0.0116	0.0141	6	21	3.40	0.0168
DEPTH	1	193	12.68	12.68	0.0004	0.0005			Dropped	
SET					Dropped		1	21	2.47	0.1309
TEMPSUR	1	200	9.21	9.21	0.0024	0.0027	1	21	11.69	0.0026
TEMPBOT	1	208	10.64	10.64	0.0011	0.0013	1	21	2.12	0.1603
SALSUR	1	206	2.51	2.51	0.1133	0.1149			Dropped	
SALBOT					Dropped		1	21	1.02	0.3231
DOSUR	1	195	2.09	2.09	0.1486	0.1502	1	21	1.30	0.2674
DOBOT					Dropped		1	21	4.38	0.0486
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	217	5.28	5.28	0.0215	0.0225			Dropped	

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1586.9)*						*Lognormal Submodel Type 3 Tests (AIC 72.7)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	151	4.36	1.44	0.2254	0.2332	3	22	1.40	0.2689
MONTH	7	208	20.60	2.94	0.0044	0.0059	7	22	1.53	0.2090
AREA	6	214	11.81	1.97	0.0664	0.0716	6	22	3.22	0.0199
DEPTH	1	211	10.84	10.84	0.0010	0.0012			Dropped	
SET					Dropped		1	22	1.62	0.2162
TEMPSUR	1	217	8.72	8.72	0.0031	0.0035	1	22	11.23	0.0029
TEMPBOT	1	221	10.14	10.14	0.0014	0.0017	1	22	5.57	0.0275
SALSUR	1	222	0.69	0.69	0.4052	0.4061			Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped		1	22	0.55	0.4667
DOBOT					Dropped		1	22	3.36	0.0804
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	222	4.33	4.33	0.0374	0.0385			Dropped	

Model Run #7	*Binomial Submodel Type 3 Tests (AIC 1574.0)*						*Lognormal Submodel Type 3 Tests (AIC 70.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	147	4.49	1.48	0.2135	0.2217	3	23	1.57	0.2236
MONTH	7	212	20.54	2.93	0.0045	0.0060	7	23	1.55	0.2014
AREA	6	211	10.93	1.82	0.0904	0.0961	6	23	3.22	0.0191
DEPTH	1	213	10.43	10.43	0.0012	0.0014			Dropped	
SET					Dropped		1	23	1.18	0.2884
TEMPSUR	1	225	7.91	7.91	0.0049	0.0053	1	23	13.13	0.0014
TEMPBOT	1	215	9.77	9.77	0.0018	0.0020	1	23	7.06	0.0141
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped		1	23	3.64	0.0691
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	219	4.07	4.07	0.0436	0.0448			Dropped	

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1574.0)*						*Lognormal Submodel Type 3 Tests (AIC 67.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	147	4.49	1.48	0.2135	0.2217	3	24	2.04	0.1356
MONTH	7	212	20.54	2.93	0.0045	0.0060	7	24	1.43	0.2393
AREA	6	211	10.93	1.82	0.0904	0.0961	6	24	3.04	0.0235
DEPTH	1	213	10.43	10.43	0.0012	0.0014			Dropped	
SET					Dropped				Dropped	
TEMPSUR	1	225	7.91	7.91	0.0049	0.0053	1	24	11.96	0.0020
TEMPBOT	1	215	9.77	9.77	0.0018	0.0020	1	24	6.12	0.0209
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped		1	24	3.33	0.0805
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	219	4.07	4.07	0.0436	0.0448			Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1574.0)*						*Lognormal Submodel Type 3 Tests (AIC 75.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	147	4.49	1.48	0.2135	0.2217	3	31	1.63	0.2036
MONTH	7	212	20.54	2.93	0.0045	0.0060			Dropped	
AREA	6	211	10.93	1.82	0.0904	0.0961	6	31	2.54	0.0407
DEPTH	1	213	10.43	10.43	0.0012	0.0014			Dropped	
SET					Dropped				Dropped	
TEMPSUR	1	225	7.91	7.91	0.0049	0.0053	1	31	2.66	0.1130
TEMPBOT	1	215	9.77	9.77	0.0018	0.0020	1	31	1.01	0.3218
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped		1	31	0.22	0.6444
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	219	4.07	4.07	0.0436	0.0448			Dropped	

Model Run #10	*Binomial Submodel Type 3 Tests (AIC 1574.0)*						*Lognormal Submodel Type 3 Tests (AIC 72.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	147	4.49	1.48	0.2135	0.2217	3	32	1.60	0.2096
MONTH	7	212	20.54	2.93	0.0045	0.0060			Dropped	
AREA	6	211	10.93	1.82	0.0904	0.0961	6	32	2.60	0.0365
DEPTH	1	213	10.43	10.43	0.0012	0.0014			Dropped	
SET					Dropped				Dropped	
TEMPSUR	1	225	7.91	7.91	0.0049	0.0053	1	32	4.49	0.0420
TEMPBOT	1	215	9.77	9.77	0.0018	0.0020	1	32	0.92	0.3443
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped				Dropped	
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	219	4.07	4.07	0.0436	0.0448			Dropped	

Model Run #11	*Binomial Submodel Type 3 Tests (AIC 1574.0)*						*Lognormal Submodel Type 3 Tests (AIC 68.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	3	147	4.49	1.48	0.2135	0.2217	3	33	1.46	0.2433
MONTH	7	212	20.54	2.93	0.0045	0.0060			Dropped	
AREA	6	211	10.93	1.82	0.0904	0.0961	6	33	2.46	0.0444
DEPTH	1	213	10.43	10.43	0.0012	0.0014			Dropped	
SET					Dropped				Dropped	
TEMPSUR	1	225	7.91	7.91	0.0049	0.0053	1	33	3.78	0.0604
TEMPBOT	1	215	9.77	9.77	0.0018	0.0020			Dropped	
SALSUR					Dropped				Dropped	
SALBOT					Dropped				Dropped	
DOSUR					Dropped				Dropped	
DOBOT					Dropped				Dropped	
PREV_MONTH_RAIN					Dropped				Dropped	
MONTH_RAIN	1	219	4.07	4.07	0.0436	0.0448			Dropped	

Table 9. Indices of adult blacktip shark catch rates from 2008-2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (number per 100 hook per hour), the Lo indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	n	Lo Index	Scaled Index	CV	LCL	UCL
2008	0.25000	68	0.087911	1.43301	0.60661	0.46778	4.38986
2009	0.12676	71	0.061413	1.00107	0.78393	0.25077	3.99621
2010	0.18056	72	0.075282	1.22714	0.63335	0.38411	3.92044
2011	0.07042	71	0.020784	0.33879	1.53877	0.03739	3.06944

Figure 1. Sampling universe for the Mississippi/Louisiana SEAMAP bottom longline survey. The three regions sampled were the Mississippi Sound (Areas 1-3), South of the Mississippi Barrier Islands (Areas 4-6), and the Northern Chandeleur Sound (Area 7). Sampling locations were randomly selected from each Area monthly (March to October).

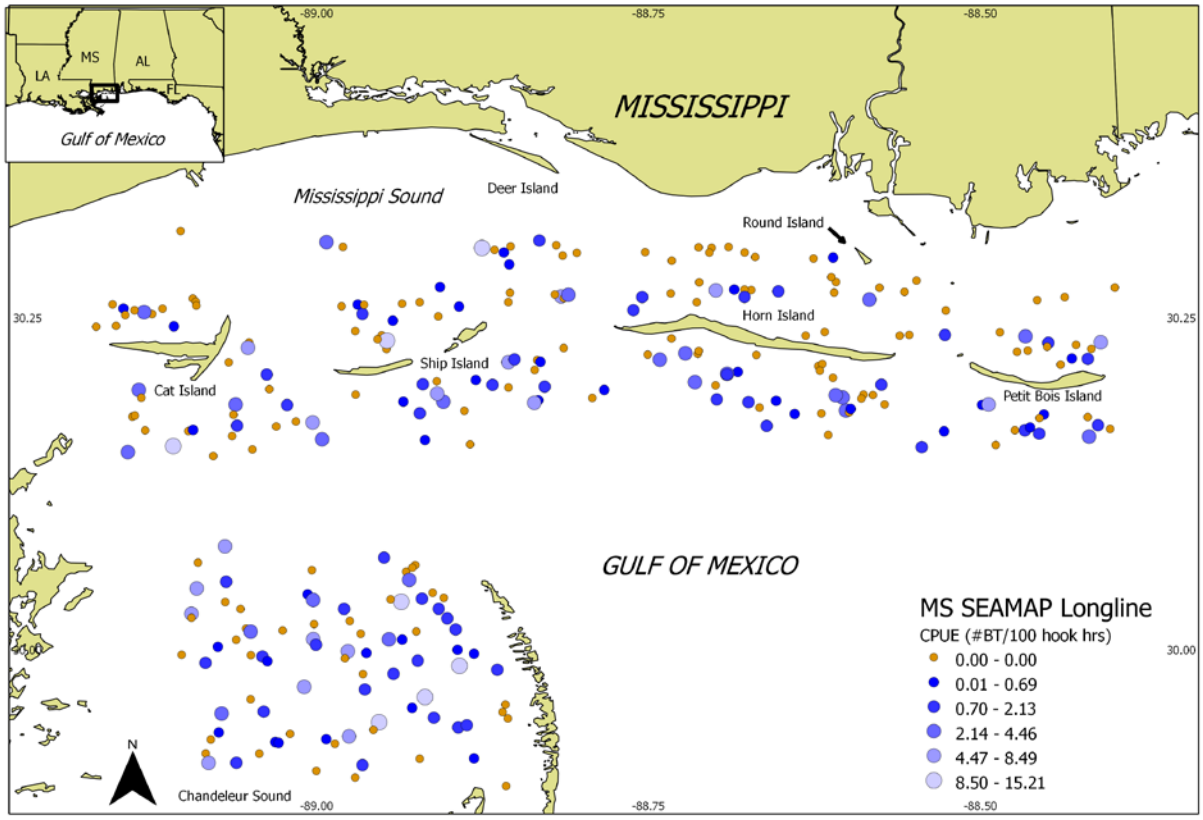

Figure 2. Stations sampled from 2008 to 2011 during the Mississippi/Louisiana SEAMAP bottom longline survey with total blacktip shark CPUE presented.

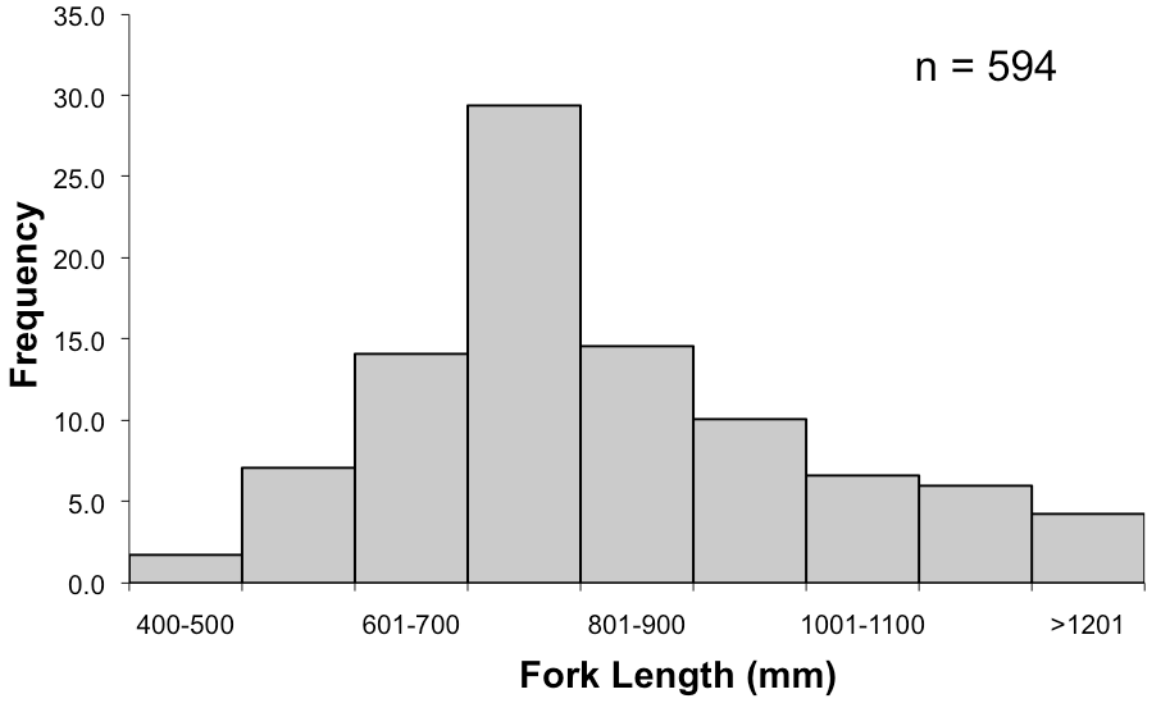

Figure 3. Length frequency distribution for blacktip sharks caught during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.

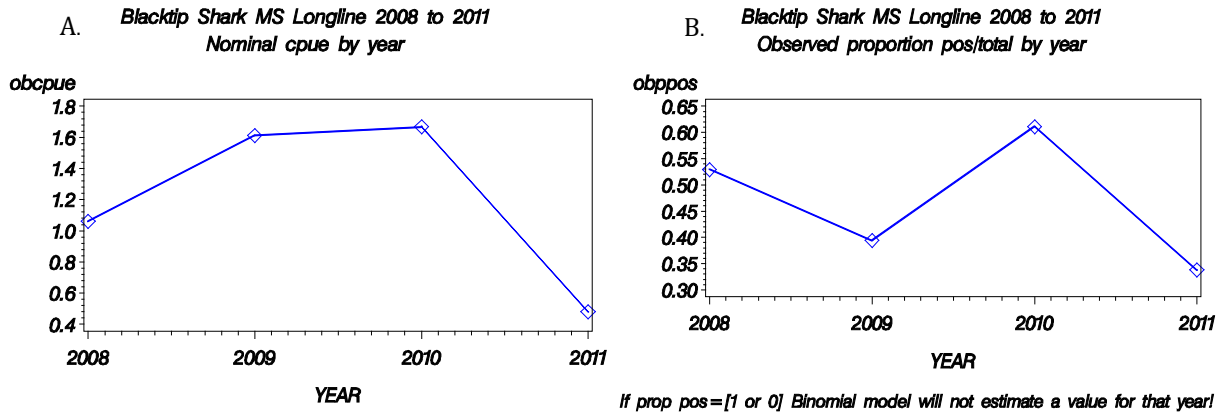

Figure 4. Annual trends for blacktip sharks (all) captured during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011, in **A.** nominal CPUE and **B.** proportion of positive stations.

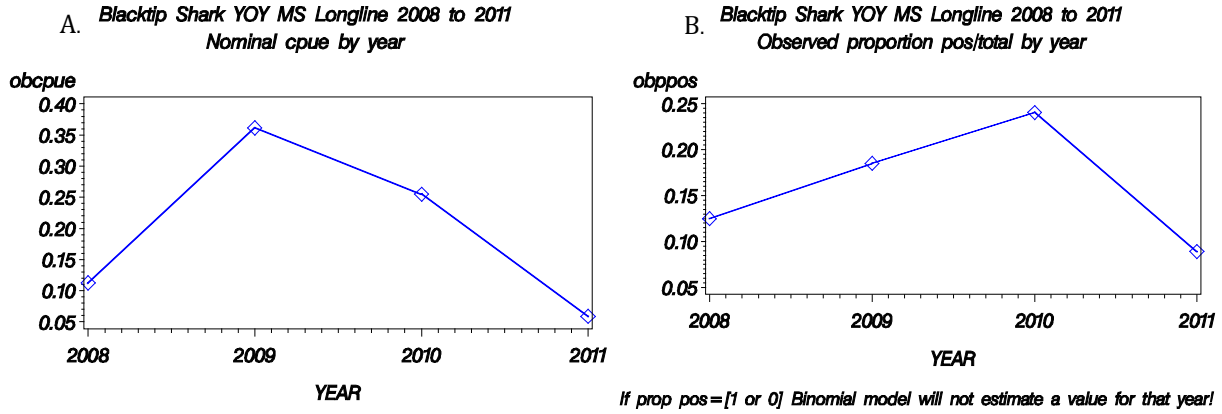

Figure 5. Annual trends for YOY blacktip sharks captured during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

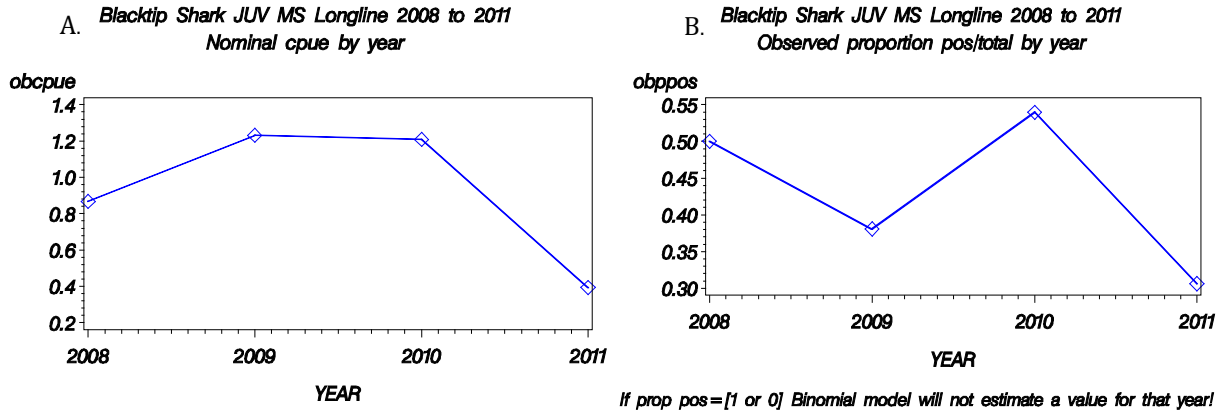

Figure 6. Annual trends for juvenile blacktip sharks captured during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

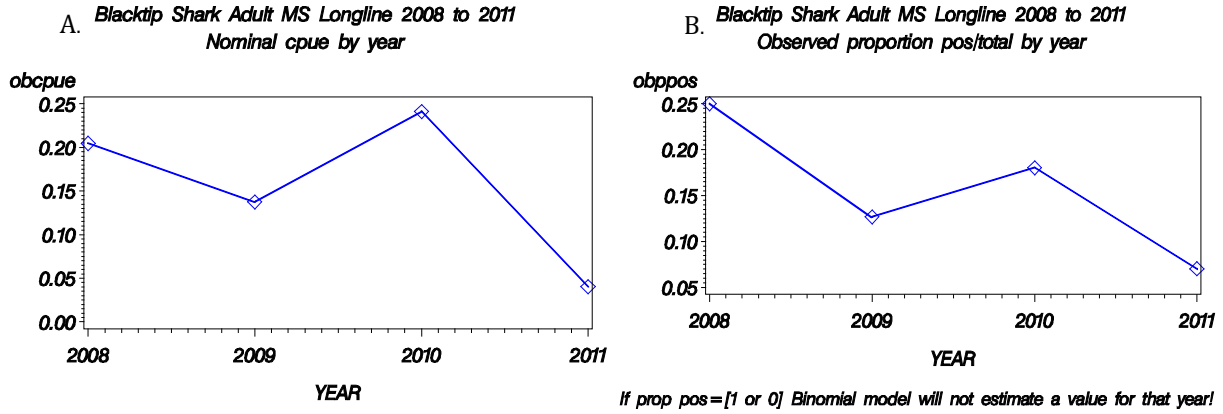

Figure 7. Annual trends for adult blacktip sharks captured during the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

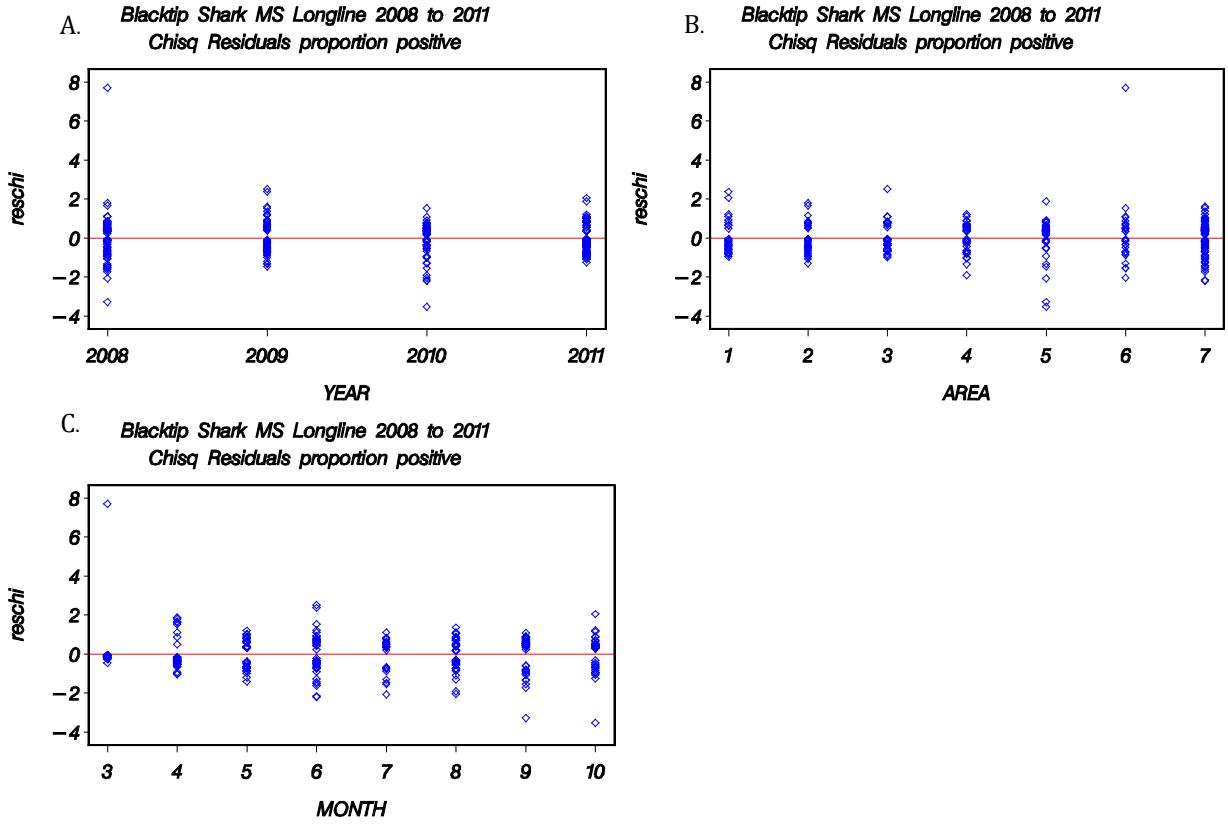

Figure 8. Diagnostic plots for the binomial component of all the blacktip sharks caught from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on the proportion of positive stations by: **A.** YEAR **B.** AREA and **C.** MONTH.

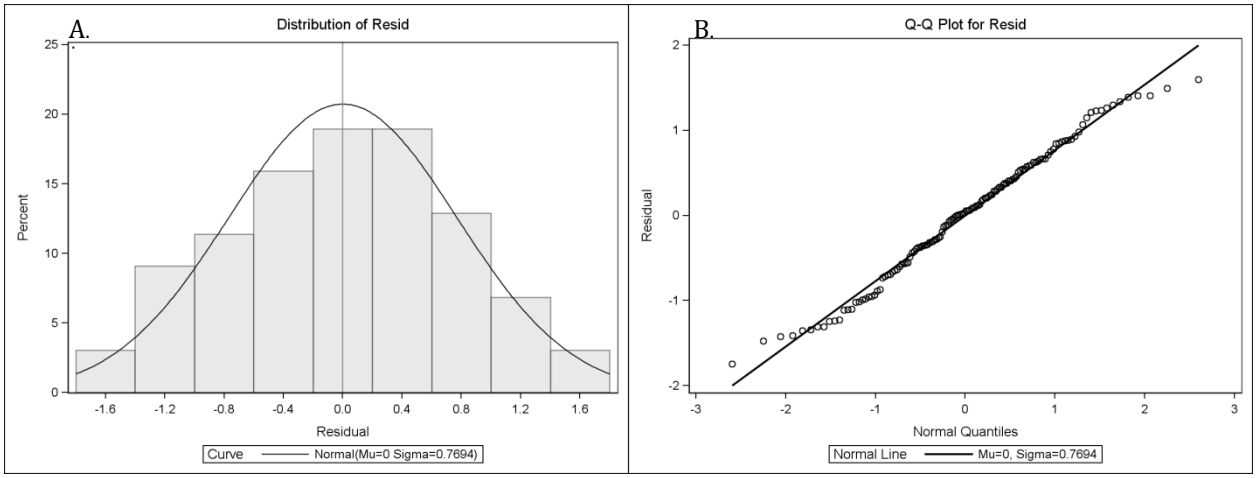

Figure 9. Diagnostic plots for the lognormal component of all blacktip sharks caught from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

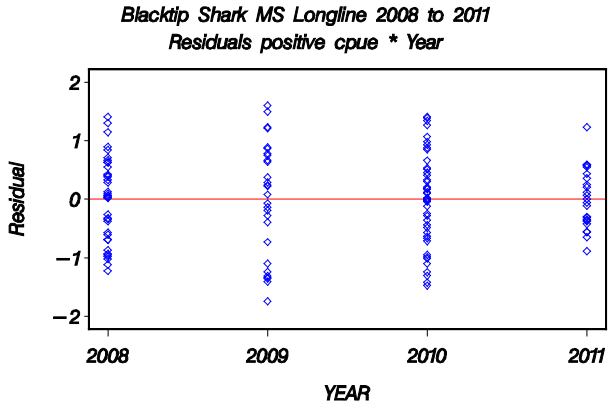

Figure 10. Diagnostic plots for the lognormal component of all blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on positive CPUE by YEAR.

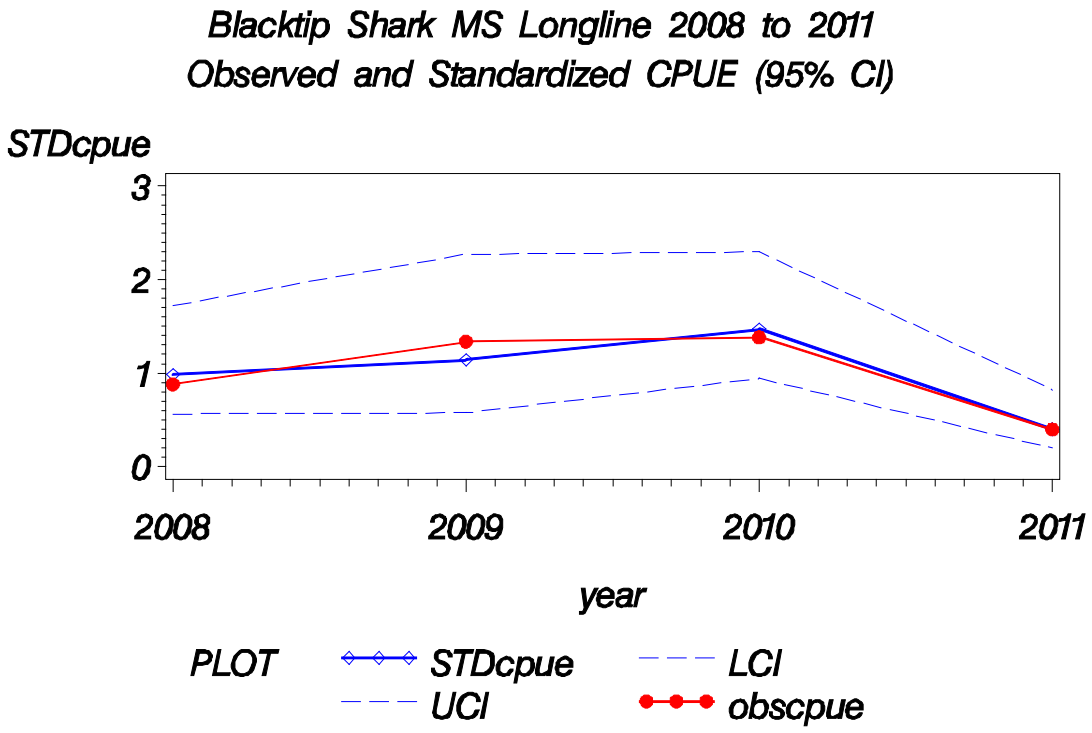

Figure 11. Observed and standardized CPUE for all blacktip sharks caught in the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.

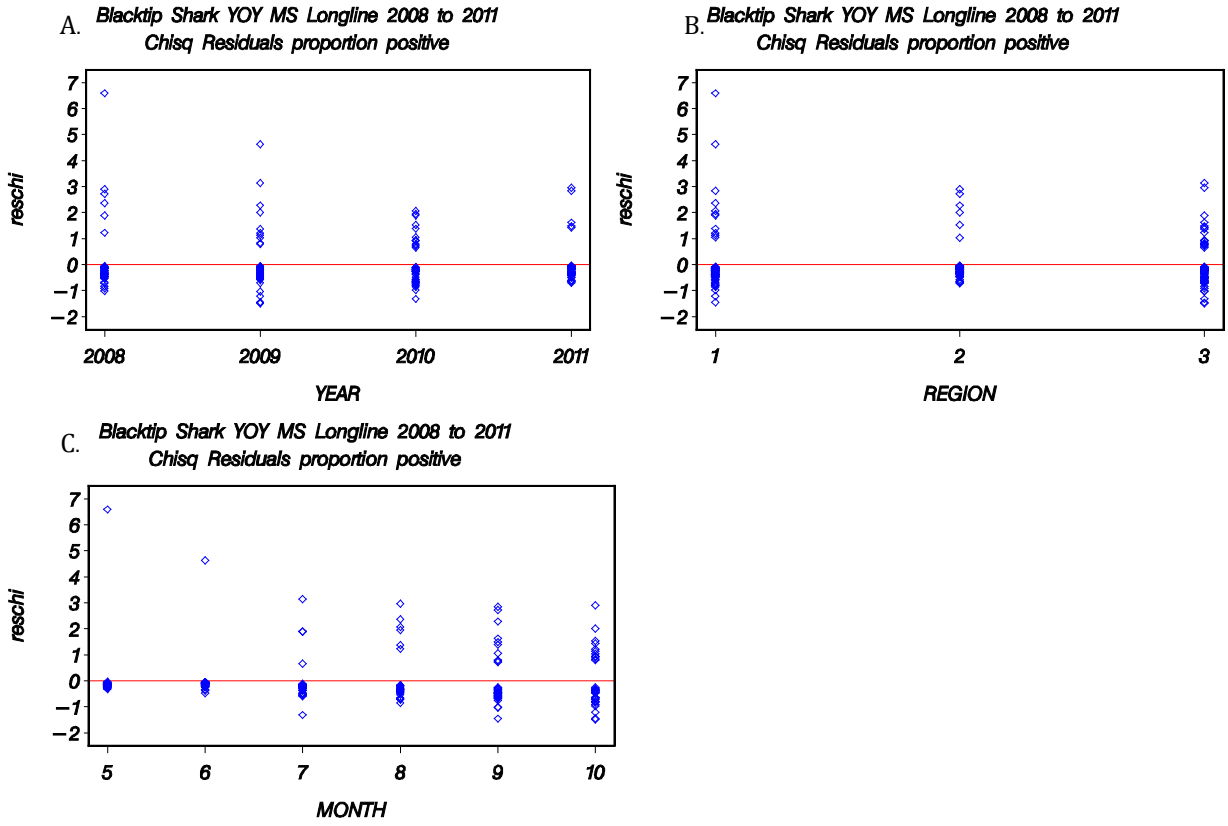

Figure 12. Diagnostic plots for the binomial component of YOY blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on the proportion of positive stations by: **A.** YEAR, **B.** REGION, and **C.** MONTH.

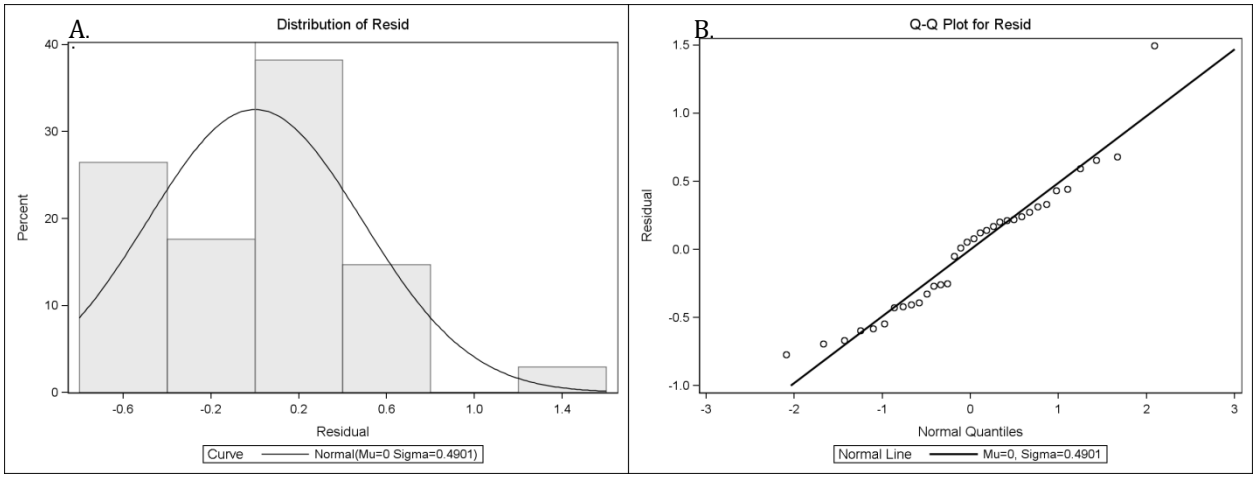

Figure 13. Diagnostic plots for the lognormal component of the YOY blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

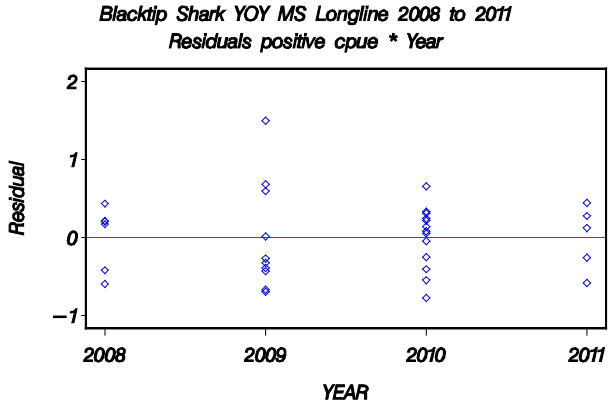

Figure 14. Diagnostic plots for the lognormal component of YOY blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on positive CPUE by YEAR.

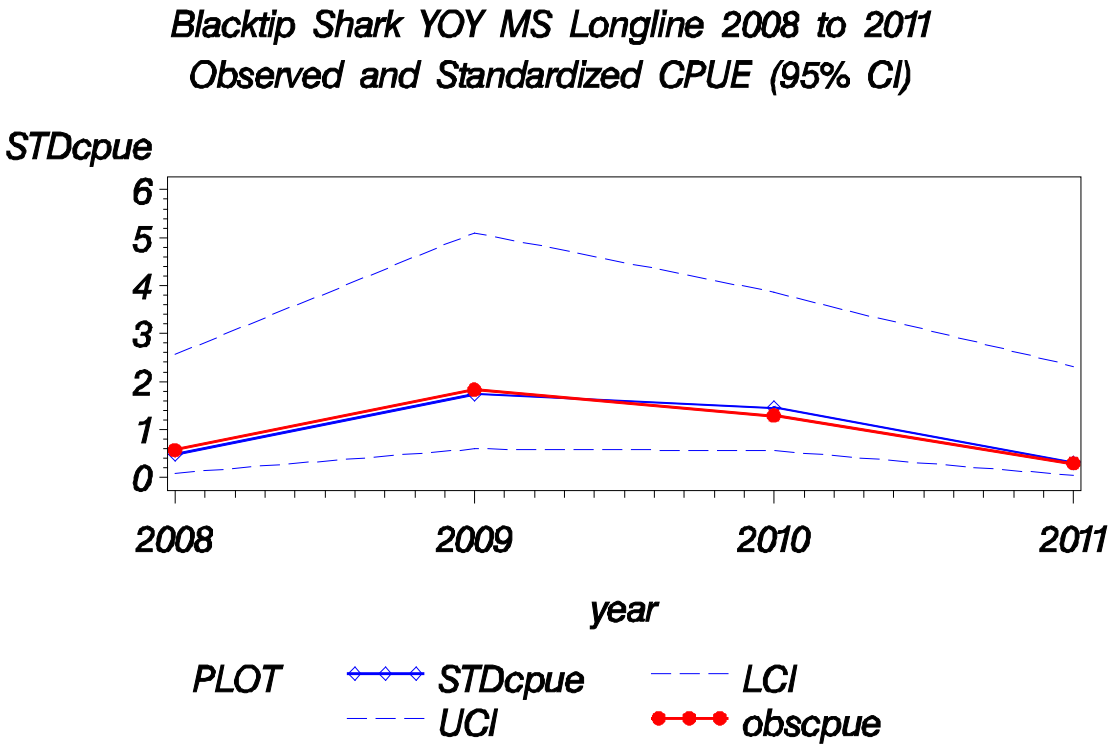

Figure 15. Observed and standardized CPUE for YOY blacktip sharks caught in the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.

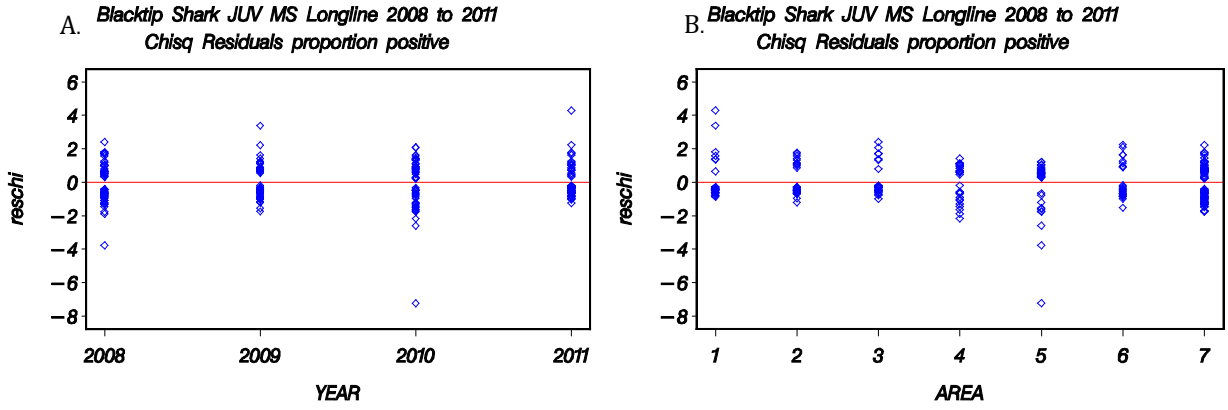

Figure 16. Diagnostic plots for the binomial component of juvenile blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline survey (2008-2011). The Chi-Square residuals on the proportion of positive stations by: **A.** YEAR, and **B.** AREA.

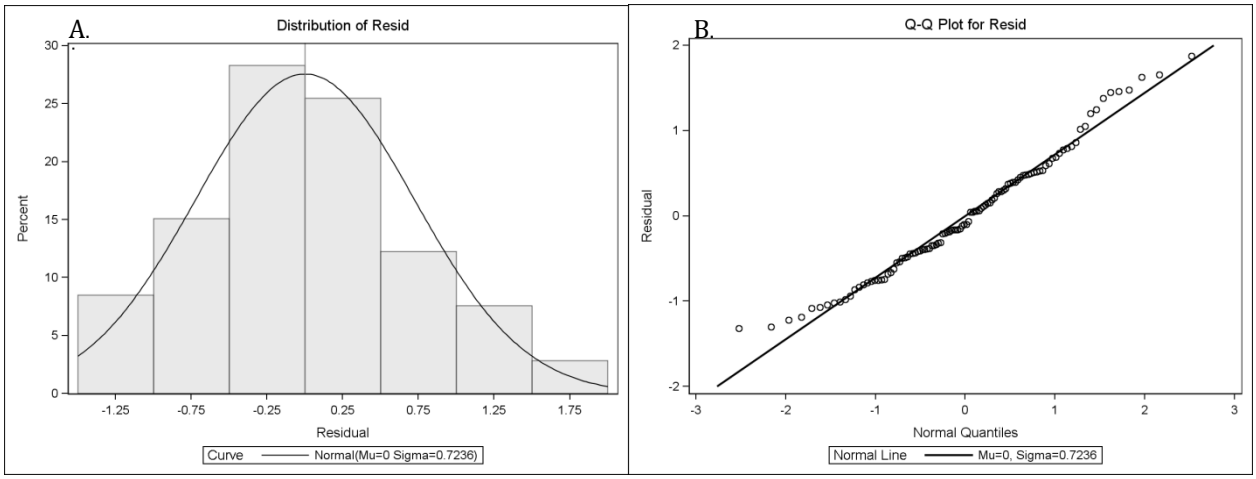

Figure 17. Diagnostic plots for the lognormal component of juvenile blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

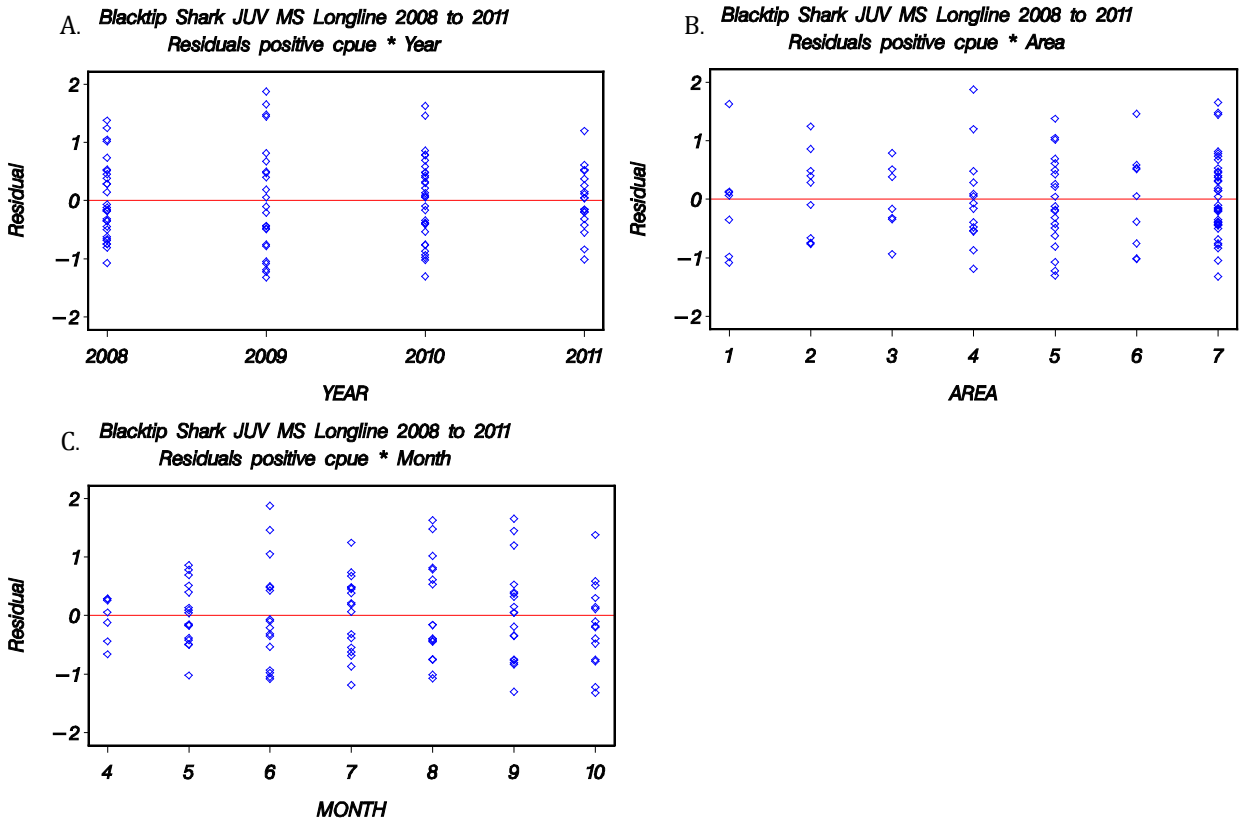

Figure 18. Diagnostic plots for the lognormal component of the juvenile blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on positive CPUE by: **A.** YEAR, **B.** AREA, and **C.** MONTH.

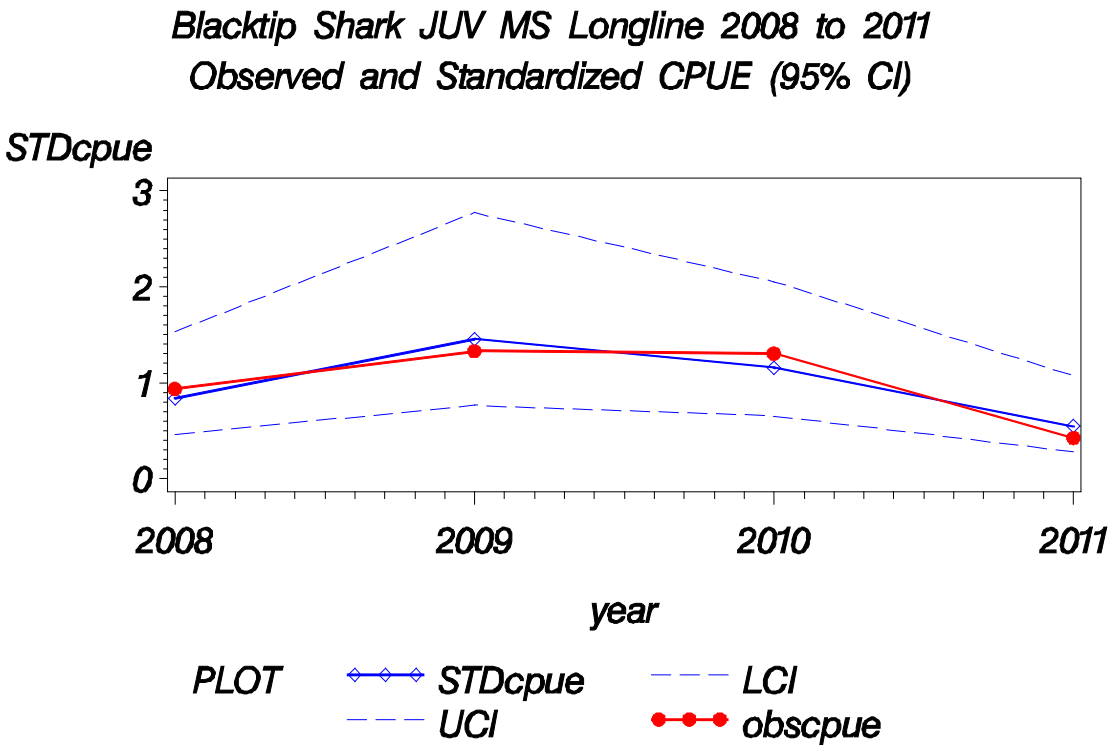

Figure 19. Observed and standardized CPUE for juvenile blacktip sharks caught in the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.

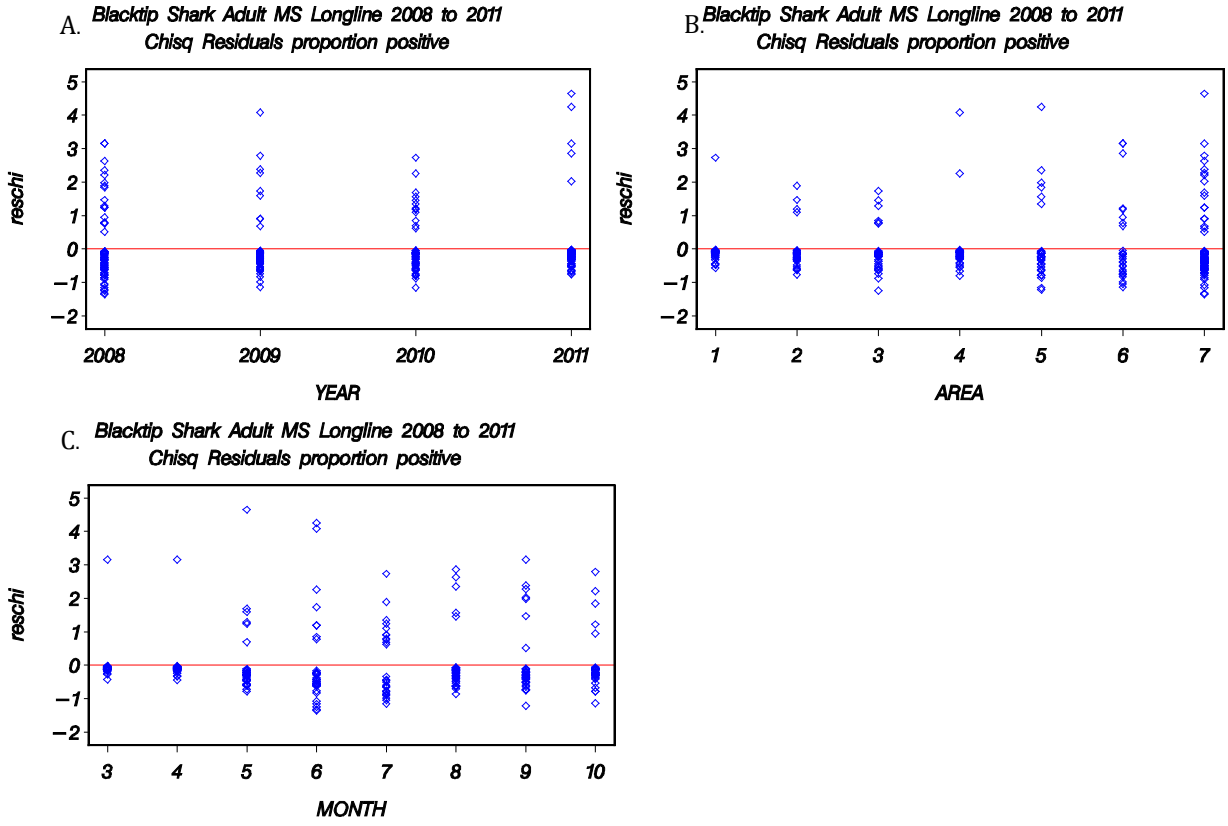

Figure 20. Diagnostic plots for the binomial component of adult blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model. The Chi-Square residuals on the proportion of positive stations by: **A.** YEAR, **B.** AREA, and **C.** MONTH.

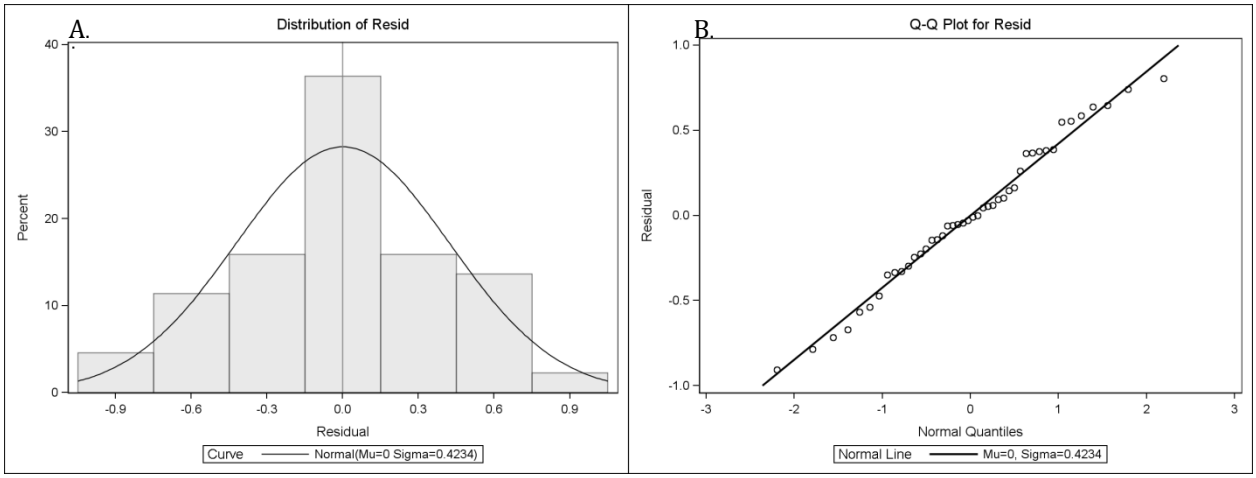

Figure 21. Diagnostic plots for the lognormal component of adult blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

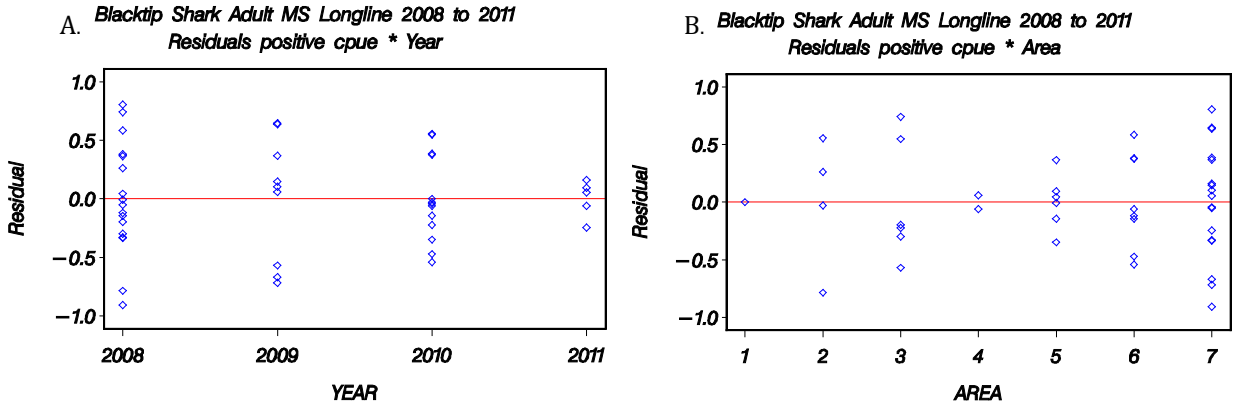

Figure 22. Diagnostic plots for the lognormal component of adult blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline (2008-2011) survey model: **A.** the Chi-Square residuals on positive CPUE by: **A.** YEAR, and **B.** AREA.

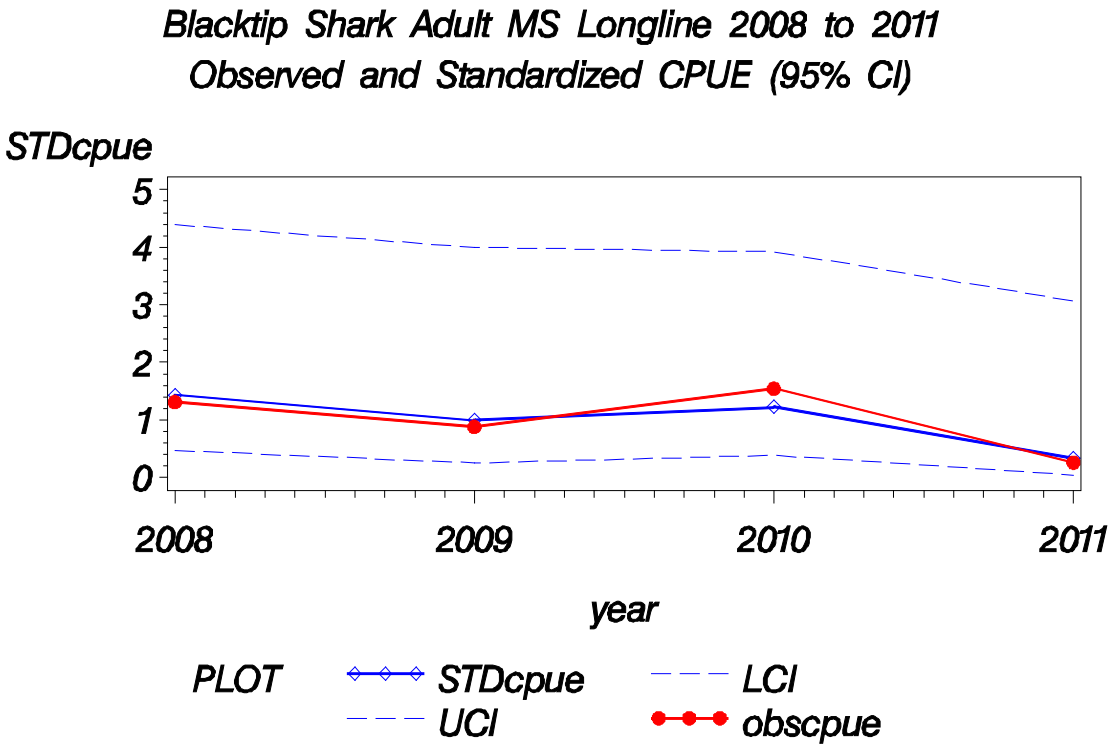

Figure 23. Observed and standardized CPUE for adult blacktip sharks caught in the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.

Appendix:

Annual Effort and Catch

Appendix Figure 1. Annual survey effort and catch of blacktip sharks from the Mississippi/Louisiana SEAMAP bottom longline survey from 2008-2011.