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STANDARDIZED CATCH RATES OF BLACKTIP SHARKS (*CARCHARHINUS LIMBATUS*) COLLECTED DURING A GILLNET SURVEY IN MISSISSIPPI COASTAL WATERS, 1998-2011.

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Beginning in 1998, an ongoing monthly standardized gillnet survey has been conducted in Mississippi coastal waters from March to October each year. This fisheries independent dataset was developed to monitor the abundance and distribution of various elasmobranch and teleost species within Mississippi's coastal waters. As a result of 282 net sets and 924 hours of effort, 833 blacktip sharks were collected. Because the work was conducted in a known blacktip nursery area, blacktip shark catch was further divided into young-of-the-young (YOY, age-0) and juvenile catch. Due to the low occurrences of adults in the data, an abundance index was not produced. Standardized catch rates were estimated using a Generalized Linear Mixed modeling approach assuming a delta-lognormal error distribution and negative binomial regressions. Other than slight peaks in 2000 and 2005, standardized total blacktip catch rates remained stable across the time series. Both YOY and juvenile catch rates mimicked the total blacktip index.

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INTRODUCTION

Through the combined effort of the University of Mississippi and the University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL) a standardized gillnet survey within the waters of the Mississippi Sound has been conducted monthly from March to October, since 1998. The dataset began in 1998 in the north central GOM, with a three year study funded by NOAA's Marine Fisheries Initiative (MARFIN). The study focused on identifying and characterizing shark nursery grounds in Mississippi and Alabama waters and established a baseline for shark abundance in these areas (Parsons and Hoffmayer, 2005; Parsons and Hoffmayer, 2007). In 2001, the survey was partially continued (unfunded) in an effort to preserve some of the long-term monitoring of shark numbers. The following year (2002) no effort was put towards continuing the survey. Beginning in 2003, the gillnet survey was funded through combined efforts of the Gulfspan Program (NOAA) and the Mississippi Department of Marine Resources through the U.S. Fish and Wildlife Service (Sports Fish Restoration Act). The primary objective of this survey was to collect data on the seasonal abundance and distribution of local shark species in Mississippi waters. The funding for this survey has continued through 2012 and will most likely continue in the foreseeable future.

METHODOLOGY

Sampling Locations

From 1998 to 2011 sharks were collected at various sites along the Mississippi coast extending east to west from Petit Bois Island to St. Louis Bay. In general, collections were made from March to October with two to three locations sampled each month. Sampling was confined to the waters of the Mississippi Sound. Initially, sampling locations were selected such that a large geographical area and a range of environmental conditions could be covered. However, unless sampling was limited by conditions such as weather, sea state, and shrimp boat activity, we typically selected locations in close proximity to the barrier islands.

From 1998 to 2000 two locations were sampled each month, with one location (Horn Island) established as a long-term sampling location. During 2001, because no funding was available, the long-term Horn Island location was sampled monthly, along with a few other locations when available. With limited funding in 2003, only a few locations were sampled, primarily locations where previous sampling was conducted. From 2004 to 2009, two to three regions were sampled monthly, with waters around west Horn, west Cat, and southwest Round Islands as the three primary sampling regions. Each region was defined by a 3.8 x 2.8 km sampling area where monthly locations were randomly selected (Figure 1). In addition to the three primary sampling regions, sampling occurred in other areas, opportunistically. In 2010, the sampling protocol was modified to increase the number of monthly locations (7-8 per month), and new sampling regions were added to the Mississippi Sound sampling universe, including east Cat, east Ship, west Ship, Deer, east Horn, Sand, and Petit Bois Islands (Figure 1). To increase the number of sampling locations, the soak times were reduced from five to two hours.

Sampling Protocol

Sampling was conducted with a 152.4 x 3 m gillnet consisting of five 30.5 meter panels of 4.5, 5.1, 5.7, 6.4, and 7.0 cm square mesh. The net was typically fished between the hours of 0800 and 2000. Depending upon the rate of capture and the environmental conditions prevalent, the net was checked every 0.5 to 1.0 hour. Each time the net was checked, the time of day over which those sharks were captured was recorded. As expeditiously as possible, each shark captured was identified and measured (fork length, FL) and its sex and, when possible, maturity state recorded. Water temperature (°C), salinity (psu), and dissolved oxygen (mg/l) were measured at the water's surface and near the bottom at each sampling location. We also recorded depth (m), turbidity (cm), sea state (m) and used a GPS to record latitude and longitude.

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 young-of-year (YOY) when between 400 and 650 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). Detailed analysis of adult catch rates was not performed because of their small number of positive catches in the dataset (6.8%). Catch rates were standardized as catch per unit effort (CPUE) in sharks 100 m net $^{-1}$ hour $^{-1}$ for each size class of blacktip sharks and blacktip sharks as a whole. Length frequency distributions were constructed for blacktip sharks ranging from 380 to 1210+ mm 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 proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero 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

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

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:

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

where:

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

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, MONTH, LOCATION, DEPTH, SET TIME, EFFORT, MONTHLY RAINFALL (MONTHLY R), and PREVIOUS MONTH RAIN (PREV MON R), SURFACE (SUR) and BOTTOM (BOT) TEMPERATURE (TEMP), SALANITY (SAL), and DISSOLVED OXYGEN (DO) were examined for inclusion in the catch rate models. The factor MONTH includes the months that sampling was conducted from March to October. The Mississippi Sound was divided into two zones: east to west (1 and 2) which is represented by factor LOCATION. The factor SET TIME refers to the time of day the gillnet was first deployed at the sampling location. Since soak time changed throughout the duration of the survey, the hours the net soaked is represented by the factor EFFORT. The factors MONTHLY R and PREV MON R included the mean monthly rainfall (inches) in Mississippi's three coastal counties. The factors DEPTH, TEMP, SAL, and DO included values present in the data set. The factor YEAR included each year in the time series from 1998 to 2011, and was included in the model whether it explained the data or not, so that an annual catch rate series was produced.

RESULTS

From 1998 to 2011, 282 locations in Mississippi were sampled resulting in 924 hours of effort. During this time 833 blacktip sharks were collected (Figure 2). The total number of blacktip sharks captured ranged from 9 to 174 (Table 1). The blacktip shark catch consisted primarily of juvenile (n = 459) and YOY (n = 351), with relatively few adults (n = 23). Approximately 41% of the stations contained positive catches of blacktip sharks, with YOY, juvenile, and adult sharks occurring at 21.4, 29.3, and 6.8% of the stations, respectively. Due to the low occurrence of adults in the dataset, no further analysis was performed.

In the Mississippi gillnet survey, blacktip sharks ranged in size from 410 to 1,280 mm FL (mean: 663 ± 5.2 mm FL). The length frequency histogram (Figure 3) indicated that 93.5% of the sharks were between 400 and 900 mm FL. The nominal CPUE and number of stations with a positive catch for total, YOY, and juvenile blacktip are presented in Figures 4-6, 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, MONTH, DEPTH, EFFORT, TEMPSUR, TEMPBOT, SALSUR, and PREV MON R were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, LOCATION, TEMPBOT, MONTHLY R, and SET TIME. 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 1452.5 and 312.0, respectively. The AIC for the lognormal submodel increased slightly from model run #1 to #2, but steadily declined for each subsequent run when non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 7-9, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 10 and Table 3. Nominal and standardized blacktip catch rates remained relatively stable throughout the survey with slight peaks in abundance occurring in 2000, 2005, and 2007 (Figure 10).

YOY Blacktip Catch

For the YOY blacktip model, YEAR, MONTH, EFFORT, and TEMPSUR were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, MONTH, and SET TIME. 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 1343.6 and 138.5, respectively. The AIC for the lognormal submodel increased slightly when the LOCATION variable was removed; however, based upon the p-value (0.1515), it was determined that the slight increase was acceptable. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 11-13, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 14 and Table 5. The standardized YOY blacktip shark catch rates exhibited an increase from 1999 to 2001, but then remained stable from 2003 to 2011 (Figure 14). Nominal catch rates were relatively stable throughout the time series, with slight increases observed in 2000 and 2005 (Figure 14).

Juvenile Blacktip Catch

For the juvenile blacktip model, YEAR, MONTH, DEPTH, EFFORT, TEMPBOT, SALSUR, and PREV MON R were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, LOCATION, and TEMPBOT. 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 1441.9 and 213.3, respectively. The AIC for the lognormal submodel increased slightly from model run #6 to #7, but steadily declined for each subsequent run when non-significant variables were removed. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 13-15, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Figure 18 and Table 7. Both the nominal and standardized juvenile blacktip shark catch rates exhibited a peak in 2000, but then remained relatively stable throughout the rest of the time series (Figure 18).

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Table 1. Summary of the blacktip shark data used in these analyses collected during the Mississippi gillnet survey conducted between 1998 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
1998	15	36	36	416	1011	670	150
1999	16	27	27	504	846	675	100
2000	14	171	171	448	1084	660	120
2001	5	12	12	652	789	700	40
2002	0	0	0	-	-	-	-
2003	7	55	55	466	878	593	70
2004	12	30	30	498	1223	684	200
2005	13	138	138	451	1257	637	130
2006	24	48	48	410	1227	736	220
2007	19	91	91	43.5	1280	723	190
2008	22	72	72	430	880	580	110
2009	20	50	50	450	940	674	120
2010	59	78	78	420	1180	659	160
2011	56	25	25	529	1120	793	130

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
13	282	833	833	633

Table 2. Summary of the backward selection procedure for building delta-lognormal submodels for the total blacktip shark full index of relative abundance from 1998 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1470.6)*						*Lognormal Submodel Type 3 Tests (AIC 300.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	250	21.30	1.78	0.0461	0.0526	12	84	1.68	0.0870
location	1	250	0.12	0.12	0.7309	0.7311	1	84	3.40	0.0686
Month	7	250	19.94	2.85	0.0057	0.0071	7	84	0.67	0.6929
Depth	1	250	9.92	9.92	0.0016	0.0018	1	84	0.56	0.4555
*Effort__h_*	1	250	5.01	5.01	0.0253	0.0262	1	84	1.05	0.3073
Tempsur	1	250	3.77	3.77	0.0520	0.0532	1	84	1.89	0.1724
Tempbot	1	250	2.35	2.35	0.1255	0.1268	1	84	6.74	0.0111
Salsur	1	250	1.95	1.95	0.1629	0.1641	1	84	0.85	0.3597
Prev_Mon_R	1	250	4.21	4.21	0.0402	0.0412	1	84	3.61	0.0609
DObot	1	250	0.22	0.22	0.6423	0.6427	1	84	2.82	0.0967
Monthly_R	1	250	0.09	0.09	0.7636	0.7638	1	84	5.26	0.0243
DOsur	1	250	0.01	0.01	0.9149	0.9150	1	84	0.69	0.4092
Set_Time	1	250	0.01	0.01	0.9128	0.9129	1	84	2.74	0.1016
Salbot	1	250	0.00	0.00	0.9564	0.9564	1	84	1.90	0.1720

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1467.4)*						*Lognormal Submodel Type 3 Tests (AIC 335.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	251	21.86	1.82	0.0392	0.0452	12	91	1.55	0.1200
location	1	251	0.14	0.14	0.7115	0.7118	1	91	3.71	0.0571
Month	7	251	20.31	2.90	0.0049	0.0062			Dropped	
Depth	1	251	10.71	10.71	0.0011	0.0012	1	91	0.33	0.5648
*Effort__h_*	1	251	5.03	5.03	0.0249	0.0258	1	91	0.21	0.6465
Tempsur	1	251	4.86	4.86	0.0275	0.0284	1	91	1.58	0.2126
Tempbot	1	251	3.17	3.17	0.0749	0.0761	1	91	8.33	0.0049
Salsur	1	251	5.99	5.99	0.0144	0.0151	1	91	0.62	0.4327
Prev_Mon_R	1	251	4.30	4.30	0.0380	0.0390	1	91	2.48	0.1187
DObot	1	251	0.22	0.22	0.6387	0.6391	1	91	2.68	0.1048
Monthly_R	1	251	0.10	0.10	0.7574	0.7577	1	91	5.44	0.0219
DOsur	1	251	0.01	0.01	0.9105	0.9106	1	91	0.85	0.3588
Set_Time	1	251	0.01	0.01	0.9143	0.9144	1	91	2.93	0.0905
Salbot					Dropped		1	91	1.69	0.1966

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 1464.9)*						*Lognormal Submodel Type 3 Tests (AIC 333.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	252	22.87	1.91	0.0288	0.0341	12	92	1.56	0.1173
location	1	252	0.14	0.14	0.7078	0.7081	1	92	3.85	0.0529
Month	7	252	20.50	2.93	0.0046	0.0058			dropped	
Depth	1	252	10.78	10.78	0.0010	0.0012	1	92	0.37	0.5428
*Effort__h_*	1	252	5.04	5.04	0.0248	0.0257			dropped	
Tempsur	1	252	5.11	5.11	0.0238	0.0246	1	92	1.43	0.2351
Tempbot	1	252	3.17	3.17	0.0748	0.0760	1	92	8.20	0.0052
Salsur	1	252	6.01	6.01	0.0142	0.0149	1	92	0.55	0.4606
Prev_Mon_R	1	252	4.36	4.36	0.0369	0.0379	1	92	2.30	0.1326
DObot	1	252	0.22	0.22	0.6370	0.6374	1	92	2.70	0.1035
Monthly_R	1	252	0.09	0.09	0.7586	0.7588	1	92	5.29	0.0238
DOsur	1	252	0.02	0.02	0.8991	0.8992	1	92	0.81	0.3697
Set_Time					Dropped		1	92	3.67	0.0585
Salbot					Dropped		1	92	1.60	0.2096

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1461.8)*						*Lognormal Submodel Type 3 Tests (AIC 330.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	253	22.96	1.91	0.0280	0.0332	12	93	1.57	0.1152
location	1	253	0.14	0.14	0.7061	0.7064	1	93	4.30	0.0409
Month	7	253	20.81	2.97	0.0041	0.0052			Dropped	
Depth	1	253	11.30	11.30	0.0008	0.0009			Dropped	
*Effort__h_*	1	253	5.05	5.05	0.0246	0.0254			Dropped	
Tempsur	1	253	5.24	5.24	0.0221	0.0229	1	93	1.33	0.2512
Tempbot	1	253	3.30	3.30	0.0693	0.0705	1	93	8.25	0.0050
Salsur	1	253	6.23	6.23	0.0126	0.0132	1	93	0.49	0.4872
Prev_Mon_R	1	253	4.38	4.38	0.0363	0.0373	1	93	2.35	0.1289
DObot	1	253	0.29	0.29	0.5888	0.5893	1	93	2.38	0.1265
Monthly_R	1	253	0.10	0.10	0.7538	0.7540	1	93	5.40	0.0223
DOsur					Dropped		1	93	0.65	0.4231
Set_Time					Dropped		1	93	3.41	0.0681
Salbot					Dropped		1	93	1.28	0.2602

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1457.2)*						*Lognormal Submodel Type 3 Tests (AIC 326.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	254	23.78	1.98	0.0218	0.0263	12	94	1.74	0.0709
location	1	254	0.17	0.17	0.6791	0.6795	1	94	5.18	0.0251
Month	7	254	22.57	3.22	0.0020	0.0027			Dropped	
Depth	1	254	11.55	11.55	0.0007	0.0008			Dropped	
*Effort__h_*	1	254	5.06	5.06	0.0245	0.0253			Dropped	
Tempsur	1	254	5.30	5.30	0.0213	0.0221	1	94	0.85	0.3585
Tempbot	1	254	3.28	3.28	0.0702	0.0713	1	94	10.01	0.0021
Salsur	1	254	6.59	6.59	0.0102	0.0108			Dropped	
Prev_Mon_R	1	254	4.64	4.64	0.0313	0.0322	1	94	2.43	0.1224
DObot	1	254	0.29	0.29	0.5926	0.5931	1	94	2.87	0.0937
Monthly_R					Dropped		1	94	5.04	0.0271
DOsur					Dropped		1	94	0.80	0.3722
Set_Time					Dropped		1	94	3.83	0.0534
Salbot					Dropped		1	94	0.96	0.3306

Model Run #6	Binomial Submodel Type 3 Tests (AIC 1454.2)						Lognormal Submodel Type 3 Tests (AIC 324.9)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	255	24.13	2.01	0.0195	0.0238	12	95	1.68	0.0825
location					Dropped		1	95	5.10	0.0262
Month	1	255	11.58	11.58	0.0007	0.0008			Dropped	
Depth	1	255	5.26	5.26	0.0218	0.0226			Dropped	
*Effort__h_*	1	255	5.47	5.47	0.0194	0.0202			Dropped	
Tempsur	1	255	3.42	3.42	0.0646	0.0657	1	95	0.72	0.3983
Tempbot	1	255	7.93	7.93	0.0049	0.0052	1	95	9.22	0.0031
Salsur	1	255	4.70	4.70	0.0302	0.0311			Dropped	
Prev_Mon_R	1	255	0.29	0.29	0.5879	0.5884	1	95	2.56	0.1131
DObot	1	254	0.29	0.29	0.5926	0.5931	1	95	2.21	0.1401
Monthly_R					Dropped		1	95	4.52	0.0361
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	95	3.98	0.0490
Salbot					Dropped		1	95	0.92	0.3400

Model Run #7	Binomial Submodel Type 3 Tests (AIC 1452.5)						Lognormal Submodel Type 3 Tests (AIC 322.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	256	24.31	2.03	0.0185	0.0225	12	96	1.65	0.0911
location					Dropped		1	96	5.42	0.0220
Month	7	256	24.23	3.46	0.0010	0.0015			Dropped	
Depth	1	256	11.47	11.47	0.0007	0.0008			Dropped	
*Effort__h_*	1	256	5.57	5.57	0.0183	0.0190			Dropped	
Tempsur	1	256	5.19	5.19	0.0228	0.0236			Dropped	
Tempbot	1	256	3.68	3.68	0.0551	0.0562	1	96	19.12	<.0001
Salsur	1	256	7.77	7.77	0.0053	0.0057			Dropped	
Prev_Mon_R	1	256	4.50	4.50	0.0339	0.0348	1	96	2.34	0.1291
DObot					Dropped		1	96	1.85	0.1766
Monthly_R					Dropped		1	96	4.96	0.0283
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	96	3.42	0.0675
Salbot					Dropped		1	96	0.70	0.4064

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1452.5)*						*Lognormal Submodel Type 3 Tests (AIC 317.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	256	24.31	2.03	0.0185	0.0225	12	97	1.60	0.1053
location					Dropped		1	97	5.84	0.0176
Month	7	256	24.23	3.46	0.0010	0.0015			Dropped	
Depth	1	256	11.47	11.47	0.0007	0.0008			Dropped	
*Effort__h_*	1	256	5.57	5.57	0.0183	0.0190			Dropped	
Tempsur	1	256	5.19	5.19	0.0228	0.0236			Dropped	
Tempbot	1	256	3.68	3.68	0.0551	0.0562	1	97	18.58	<.0001
Salsur	1	256	7.77	7.77	0.0053	0.0057			Dropped	
Prev_Mon_R	1	256	4.50	4.50	0.0339	0.0348	1	97	1.76	0.1873
DObot					Dropped		1	97	2.31	0.1319
Monthly_R					Dropped		1	97	4.66	0.0334
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	97	3.44	0.0669
Salbot					Dropped				Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1452.5)*						*Lognormal Submodel Type 3 Tests (AIC 313.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	256	24.31	2.03	0.0185	0.0225	12	98	1.49	0.1398
location					Dropped		1	98	5.72	0.0186
Month	7	256	24.23	3.46	0.0010	0.0015			Dropped	
Depth	1	256	11.47	11.47	0.0007	0.0008			Dropped	
*Effort__h_*	1	256	5.57	5.57	0.0183	0.0190			Dropped	
Tempsur	1	256	5.19	5.19	0.0228	0.0236			Dropped	
Tempbot	1	256	3.68	3.68	0.0551	0.0562	1	98	17.30	<.0001
Salsur	1	256	7.77	7.77	0.0053	0.0057			Dropped	
Prev_Mon_R	1	256	4.50	4.50	0.0339	0.0348			Dropped	
DObot					Dropped		1	98	1.78	0.1855
Monthly_R					Dropped		1	98	3.77	0.0552
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	98	3.70	0.0572
Salbot					Dropped				Dropped	

Model Run #10	*Binomial Submodel Type 3 Tests (AIC 1452.5)*						*Lognormal Submodel Type 3 Tests (AIC 312.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	256	24.31	2.03	0.0185	0.0225	12	99	1.73	0.0709
location					Dropped		1	99	5.15	0.0254
Month	7	256	24.23	3.46	0.0010	0.0015			Dropped	
Depth	1	256	11.47	11.47	0.0007	0.0008			Dropped	
*Effort__h_*	1	256	5.57	5.57	0.0183	0.0190			Dropped	
Tempsur	1	256	5.19	5.19	0.0228	0.0236			Dropped	
Tempbot	1	256	3.68	3.68	0.0551	0.0562	1	99	21.02	<.0001
Salsur	1	256	7.77	7.77	0.0053	0.0057			Dropped	
Prev_Mon_R	1	256	4.50	4.50	0.0339	0.0348			Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped		1	99	2.94	0.0898
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	99	3.87	0.0518
Salbot					Dropped				Dropped	

Table 3. Indices for total blacktip shark catch rates from 1998 to 2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (numbers per 100 GN 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.

SurveyYear	Frequency	n	Lo Index	Scaled Index	CV	LCL	UCL
1998	0.53333	15	0.31763	0.75847	0.49491	0.29743	1.93419
1999	0.50000	16	0.20735	0.49513	0.51013	0.18923	1.29552
2000	0.92857	14	1.34005	3.19989	0.27302	1.87171	5.47057
2001	0.60000	5	0.25755	0.61499	0.87746	0.13569	2.78730
2003	0.42857	7	0.22808	0.54463	0.87122	0.12116	2.44823
2004	0.33333	12	0.14300	0.34148	0.80987	0.08251	1.41319
2005	0.61538	13	0.64684	1.54458	0.58474	0.52211	4.56940
2006	0.41667	24	0.13562	0.32384	0.61371	0.10453	1.00323
2007	0.78947	19	0.77604	1.85310	0.34041	0.95563	3.59344
2008	0.36364	22	0.49511	1.18227	0.52194	0.44298	3.15540
2009	0.45000	20	0.35789	0.85461	0.54507	0.30815	2.37013
2010	0.32203	59	0.40709	0.97209	0.42818	0.42789	2.20840
2011	0.14286	56	0.13188	0.31491	0.65464	0.09538	1.03974

Table 4. Summary of the backward selection procedure for building delta-lognormal submodels for the YOY blacktip shark full index of relative abundance from 1998 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1388.3)*						*Lognormal Submodel Type 3 Tests (AIC 160.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	223	14.46	1.20	0.2725	0.2809	12	31	1.70	0.1140
location	1	223	0.02	0.02	0.8839	0.8840	1	31	0.44	0.5117
Month	6	223	12.62	2.10	0.0496	0.0540	6	31	0.55	0.7631
Depth	1	223	0.80	0.80	0.3708	0.3718	1	31	1.08	0.3068
*Effort__h_*	1	223	5.76	5.76	0.0164	0.0172	1	31	0.58	0.4532
Tempsur	1	223	4.52	4.52	0.0334	0.0345	1	31	0.04	0.8424
Tempbot	1	223	0.08	0.08	0.7768	0.7770	1	31	0.02	0.9019
Salsur	1	223	0.62	0.62	0.4308	0.4316	1	31	0.26	0.6155
Prev_Mon_R	1	223	0.01	0.01	0.9108	0.9109	1	31	0.11	0.7416
DObot	1	223	0.13	0.13	0.7235	0.7239	1	31	0.06	0.8127
Monthly_R	1	223	0.12	0.12	0.7296	0.7299	1	31	0.04	0.8363
DOsur	1	223	1.12	1.12	0.2889	0.2901	1	31	0.62	0.4360
Set_Time	1	223	2.59	2.59	0.1074	0.1088	1	31	2.71	0.1097
Salbot	1	223	0.36	0.36	0.5508	0.5514	1	31	0.08	0.7765

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1384.8)*						*Lognormal Submodel Type 3 Tests (AIC 159.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	224	14.63	1.22	0.2622	0.2707	12	32	1.76	0.0993
location	1	224	0.02	0.02	0.8824	0.8826	1	32	0.45	0.5085
Month	6	224	12.68	2.11	0.0484	0.0528	6	32	0.59	0.7371
Depth	1	224	0.82	0.82	0.3647	0.3657	1	32	1.13	0.2967
*Effort__h_*	1	224	5.90	5.90	0.0151	0.0159	1	32	0.58	0.4512
Tempsur	1	224	4.54	4.54	0.0331	0.0341	1	32	0.03	0.8719
Tempbot	1	224	0.09	0.09	0.7659	0.7661			Dropped	
Salsur	1	224	0.64	0.64	0.4232	0.4240	1	32	0.25	0.6191
Prev_Mon_R					Dropped		1	32	0.10	0.7526
DObot	1	224	0.13	0.13	0.7208	0.7211	1	32	0.06	0.8023
Monthly_R	1	224	0.11	0.11	0.7432	0.7436	1	32	0.04	0.8480
DOsur	1	224	1.13	1.13	0.2877	0.2888	1	32	0.65	0.4255

Model Run #2	Binomial Submodel Type 3 Tests (AIC 1384.8)						Lognormal Submodel Type 3 Tests (AIC 159.3)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Set_Time	1	224	2.59	2.59	0.1072	0.1086	1	32	2.78	0.1050
Salbot	1	224	0.36	0.36	0.5495	0.5501	1	32	0.12	0.7283

Model Run #3	Binomial Submodel Type 3 Tests (AIC 1383.9)						Lognormal Submodel Type 3 Tests (AIC 156.8)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	225	14.96	1.25	0.2437	0.2525	12	33	1.84	0.0826
location					Dropped		1	33	0.47	0.4966
Month	6	225	12.77	2.13	0.0468	0.0511	6	33	1.32	0.2774
Depth	1	225	0.88	0.88	0.3477	0.3487	1	33	1.13	0.2950
*Effort__h_*	1	225	5.96	5.96	0.0147	0.0154	1	33	0.69	0.4129
Tempsur	1	225	4.56	4.56	0.0328	0.0338			Dropped	
Tempbot	1	225	0.11	0.11	0.7433	0.7436			Dropped	
Salsur	1	225	0.63	0.63	0.4257	0.4265	1	33	0.24	0.6307
Prev_Mon_R					Dropped		1	33	0.11	0.7378
DObot	1	225	0.12	0.12	0.7305	0.7308	1	33	0.05	0.8200
Monthly_R	1	225	0.10	0.10	0.7513	0.7516	1	33	0.04	0.8479
DOsur	1	225	1.12	1.12	0.2905	0.2916	1	33	0.70	0.4087
Set_Time	1	225	2.64	2.64	0.1045	0.1059	1	33	2.85	0.1008
Salbot	1	225	0.34	0.34	0.5611	0.5617	1	33	0.14	0.7148

Model Run #4	Binomial Submodel Type 3 Tests (AIC 1381.4)						Lognormal Submodel Type 3 Tests (AIC 153.4)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	226	14.90	1.24	0.2468	0.2555	12	34	2.08	0.0469
location					Dropped		1	34	0.51	0.4795
Month	6	226	12.76	2.13	0.0470	0.0513	6	34	1.43	0.2322
Depth	1	226	0.89	0.89	0.3453	0.3463	1	34	1.14	0.2931
*Effort__h_*	1	226	5.96	5.96	0.0146	0.0154	1	34	0.86	0.3605
Tempsur	1	226	4.58	4.58	0.0324	0.0335			Dropped	
Tempbot	1	226	0.09	0.09	0.7605	0.7607			Dropped	
Salsur	1	226	0.90	0.90	0.3415	0.3425	1	34	0.24	0.6306

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 1381.4)*						*Lognormal Submodel Type 3 Tests (AIC 153.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Prev_Mon_R					Dropped		1	34	0.09	0.7652
DObot	1	226	0.14	0.14	0.7047	0.7051	1	34	0.05	0.8237
Monthly_R					Dropped				Dropped	
DOsur	1	226	1.16	1.16	0.2811	0.2823	1	34	0.68	0.4141
Set_Time	1	226	2.77	2.77	0.0958	0.0971	1	34	3.04	0.0905
Salbot	1	226	0.42	0.42	0.5180	0.5187	1	34	0.23	0.6344

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 1380.4)*						*Lognormal Submodel Type 3 Tests (AIC 151.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	227	14.93	1.24	0.2455	0.2542	12	35	2.13	0.0405
location					Dropped		1	35	0.55	0.4618
Month	6	227	12.73	2.12	0.0475	0.0517	6	35	1.59	0.1804
Depth	1	227	0.95	0.95	0.3288	0.3298	1	35	1.29	0.2646
*Effort__h_*	1	227	5.99	5.99	0.0144	0.0151	1	35	0.83	0.3681
Tempsur	1	227	14.30	14.30	0.0002	0.0002			Dropped	
Tempbot					Dropped				Dropped	
Salsur	1	227	1.45	1.45	0.2278	0.2290	1	35	0.25	0.6231
Prev_Mon_R					Dropped		1	35	0.14	0.7112
DObot	1	227	0.13	0.13	0.7162	0.7166			Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	227	1.33	1.33	0.2485	0.2497	1	35	0.65	0.4253
Set_Time	1	227	2.77	2.77	0.0960	0.0974	1	35	3.67	0.0638
Salbot	1	227	0.83	0.83	0.3623	0.3633	1	35	0.21	0.6487

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1374.4)*						*Lognormal Submodel Type 3 Tests (AIC 148.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	228	15.02	1.25	0.2404	0.2491	12	36	2.17	0.0361
location					Dropped		1	36	0.61	0.4382
Month	6	228	13.23	2.20	0.0396	0.0436	6	36	2.18	0.0677
Depth	1	228	0.86	0.86	0.3532	0.3542	1	36	1.19	0.2820

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 1374.4)*						*Lognormal Submodel Type 3 Tests (AIC 148.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
*Effort__h_*	1	228	5.93	5.93	0.0149	0.0156	1	36	0.88	0.3539
Tempsur	1	228	14.48	14.48	0.0001	0.0002			Dropped	
Tempbot					Dropped				Dropped	
Salsur	1	228	1.35	1.35	0.2456	0.2468	1	36	0.30	0.5878
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	228	1.58	1.58	0.2081	0.2094	1	36	0.84	0.3650
Set_Time	1	228	2.69	2.69	0.1007	0.1021	1	36	3.61	0.0653
Salbot	1	228	0.72	0.72	0.3966	0.3975	1	36	0.13	0.7213

Model Run #7	*Binomial Submodel Type 3 Tests (AIC 1369.4)*						*Lognormal Submodel Type 3 Tests (AIC 144.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	229	14.88	1.24	0.2483	0.2568	12	37	2.22	0.0316
location					Dropped		1	37	0.83	0.3686
Month	6	229	13.19	2.20	0.0401	0.0441	6	37	2.30	0.0551
Depth	1	229	1.68	1.68	0.1944	0.1957	1	37	1.16	0.2880
*Effort__h_*	1	229	6.05	6.05	0.0139	0.0146	1	37	0.83	0.3671
Tempsur	1	229	13.97	13.97	0.0002	0.0002			Dropped	
Tempbot					Dropped				Dropped	
Salsur	1	229	0.65	0.65	0.4217	0.4225	1	37	0.96	0.3325
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	229	1.86	1.86	0.1722	0.1736	1	37	0.81	0.3735
Set_Time	1	229	2.66	2.66	0.1031	0.1045	1	37	3.79	0.0592
Salbot					Dropped				Dropped	

Model Run #8	*Binomial Submodel Type 3 Tests (AIC 1366.9)*						*Lognormal Submodel Type 3 Tests (AIC 143.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	230	14.31	1.19	0.2816	0.2895	12	38	2.17	0.0346
location					Dropped		1	38	1.44	0.2376
Month	6	230	13.85	2.31	0.0314	0.0349	6	38	2.22	0.0617
Depth	1	230	1.31	1.31	0.2517	0.2529	1	38	1.16	0.2876
*Effort__h_*	1	230	5.89	5.89	0.0152	0.0160	1	38	0.70	0.4075
Tempsur	1	230	13.32	13.32	0.0003	0.0003			Dropped	
Tempbot					Dropped				Dropped	
Salsur					Dropped		1	38	1.38	0.2476
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	230	2.92	2.92	0.0874	0.0888			Dropped	
Set_Time	1	230	2.45	2.45	0.1172	0.1185	1	38	3.82	0.0580
Salbot					Dropped				Dropped	

Model Run #9	*Binomial Submodel Type 3 Tests (AIC 1361.3)*						*Lognormal Submodel Type 3 Tests (AIC 142.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	231	14.03	1.17	0.2986	0.3061	12	39	2.49	0.0158
location					Dropped		1	39	1.89	0.1767
Month	6	231	13.55	2.26	0.0351	0.0388	6	39	2.17	0.0666
Depth					Dropped		1	39	1.24	0.2721
*Effort__h_*	1	231	5.68	5.68	0.0171	0.0179			Dropped	
Tempsur	1	231	12.82	12.82	0.0003	0.0004			Dropped	
Tempbot					Dropped				Dropped	
Salsur					Dropped		1	39	1.07	0.3067
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	231	2.98	2.98	0.0844	0.0857			Dropped	
Set_Time	1	231	2.20	2.20	0.1385	0.1398	1	39	6.29	0.0164
Salbot					Dropped				Dropped	

Model Run #10	Binomial Submodel Type 3 Tests (AIC 1352.0)						Lognormal Submodel Type 3 Tests (AIC 138.8)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	232	12.99	1.08	0.3701	0.3760	12	40	2.46	0.0165
location					Dropped		1	40	1.67	0.2032
Month	6	232	13.08	2.18	0.0418	0.0457	6	40	2.46	0.0408
Depth					Dropped		1	40	0.80	0.3779
*Effort__h_*	1	232	4.87	4.87	0.0273	0.0283			Dropped	
Tempsur	1	232	14.96	14.96	0.0001	0.0001			Dropped	
Tempbot					Dropped				Dropped	
Salsur					Dropped				Dropped	
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur	1	232	2.05	2.05	0.1522	0.1535			Dropped	
Set_Time					Dropped		1	40	5.64	0.0225
Salbot					Dropped				Dropped	

Model Run #11	Binomial Submodel Type 3 Tests (AIC 1343.6)						Lognormal Submodel Type 3 Tests (AIC 137.3)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	233	13.46	1.12	0.3366	0.3432	12	41	2.42	0.0175
location					Dropped		1	41	2.14	0.1515
Month	6	233	11.75	1.96	0.0677	0.0724	6	41	2.56	0.0336
Depth					Dropped				Dropped	
*Effort__h_*	1	233	4.52	4.52	0.0335	0.0345			Dropped	
Tempsur	1	233	14.23	14.23	0.0002	0.0002			Dropped	
Tempbot					Dropped				Dropped	
Salsur					Dropped				Dropped	
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	41	4.98	0.0312
Salbot					Dropped				Dropped	

Model Run #12	*Binomial Submodel Type 3 Tests (AIC 1343.6)*						*Lognormal Submodel Type 3 Tests (AIC 138.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	267	11.93	0.99	0.4514	0.4548	12	42	2.36	0.0200
location					Dropped				Dropped	
Month	6	233	11.75	1.96	0.0677	0.0724	6	42	2.73	0.0251
Depth					Dropped				Dropped	
*Effort__h_*	1	267	3.40	3.40	0.0651	0.0662			Dropped	
Tempsur	1	267	25.40	25.40	<.0001	<.0001			Dropped	
Tempbot					Dropped				Dropped	
Salsur					Dropped				Dropped	
Prev_Mon_R					Dropped				Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur					Dropped				Dropped	
Set_Time					Dropped		1	42	4.28	0.0447
Salbot					Dropped				Dropped	

Table 5. Indices of YOY blacktip shark catch rates from 1998-2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (number per 100 GN 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
1998	0.33333	15	0.06786	0.36239	0.99347	0.06909	1.9007
1999	0.25000	16	0.02677	0.14296	1.48270	0.01654	1.2354
2000	0.42857	14	0.33729	1.80110	0.68319	0.52235	6.2104
2001	0.40000	5	0.67327	3.59525	0.93710	0.73477	17.5917
2003	0.42857	7	0.08622	0.46041	1.28009	0.06421	3.3015
2004	0.33333	12	0.08865	0.47339	1.02190	0.08725	2.5686
2005	0.30769	13	0.12879	0.68772	0.96739	0.13536	3.4942
2006	0.20833	24	0.08320	0.44427	0.94078	0.09038	2.1839
2007	0.26316	19	0.19138	1.02196	0.78504	0.25561	4.0859
2008	0.31818	22	0.30802	1.64481	0.61133	0.53293	5.0764
2009	0.40000	20	0.22907	1.22322	0.59501	0.40674	3.6787
2010	0.13559	59	0.20878	1.11487	0.64309	0.34373	3.6160
2011	0.01786	56	0.00518	0.02765	5.31994	0.00070	1.0914

Table 6. Summary of the backward selection procedure for building delta-lognormal submodels for the juvenile blacktip shark full index of relative abundance from 1998 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 1470.4)*						*Lognormal Submodel Type 3 Tests (AIC 227.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	250	25.72	2.14	0.0118	0.0150	12	50	0.80	0.6475
Month	7	250	18.01	2.57	0.0119	0.0141	7	50	1.24	0.2991
location	1	250	0.06	0.06	0.8031	0.8033	1	50	2.65	0.1100
Depth	1	250	14.80	14.80	0.0001	0.0002	1	50	0.33	0.5675
*Effort__h_*	1	250	6.88	6.88	0.0087	0.0092	1	50	2.82	0.0992
Tempsur	1	250	0.51	0.51	0.4733	0.4739	1	50	0.33	0.5671
Tempbot	1	250	3.23	3.23	0.0725	0.0737	1	50	2.99	0.0898
Salsur	1	250	2.57	2.57	0.1086	0.1099	1	50	0.03	0.8623
Prev_Mon_R	1	250	2.69	2.69	0.1011	0.1024	1	50	1.62	0.2088
DObot	1	250	1.13	1.13	0.2884	0.2894	1	50	1.32	0.2557
Monthly_R	1	250	0.05	0.05	0.8270	0.8272	1	50	0.64	0.4264
DOsur	1	250	0.70	0.70	0.4013	0.4021	1	50	1.02	0.3178
Set_Time	1	250	0.31	0.31	0.5788	0.5793	1	50	0.31	0.5810
Salbot	1	250	0.00	0.00	0.9893	0.9893	1	50	0.09	0.7665

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 1467.4)*						*Lognormal Submodel Type 3 Tests (AIC 224.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	251	27.74	2.31	0.0060	0.0082	12	51	0.91	0.5429
Month	7	251	18.52	2.65	0.0098	0.0118	7	51	1.27	0.2844
location	1	251	0.07	0.07	0.7923	0.7925	1	51	2.94	0.0922
Depth	1	251	15.70	15.70	<.0001	<.0001	1	51	0.40	0.5292
*Effort__h_*	1	251	6.92	6.92	0.0085	0.0091	1	51	2.88	0.0960
Tempsur	1	251	0.64	0.64	0.4227	0.4234	1	51	0.34	0.5644
Tempbot	1	251	4.63	4.63	0.0314	0.0323	1	51	3.43	0.0698
Salsur	1	251	6.92	6.92	0.0085	0.0091			Dropped	
Prev_Mon_R	1	251	2.75	2.75	0.0972	0.0984	1	51	1.63	0.2068
DObot	1	251	1.19	1.19	0.2748	0.2758	1	51	1.39	0.2441
Monthly_R	1	251	0.05	0.05	0.8270	0.8272	1	51	0.63	0.4324

Model Run #2	Binomial Submodel Type 3 Tests (AIC 1467.4)						Lognormal Submodel Type 3 Tests (AIC 224.3)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
DOsur	1	251	0.71	0.71	0.4000	0.4008	1	51	1.12	0.2949
Set_Time	1	251	0.31	0.31	0.5772	0.5777	1	51	0.32	0.5721
Salbot					Dropped		1	51	0.07	0.7957

Model Run #3	Binomial Submodel Type 3 Tests (AIC 1463.0)						Lognormal Submodel Type 3 Tests (AIC 220.7)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	252	28.15	2.35	0.0053	0.0072	12	52	0.95	0.5052
Month	7	252	20.78	2.97	0.0041	0.0052	7	52	1.29	0.2760
location	1	252	0.06	0.06	0.8042	0.8044	1	52	3.30	0.0751
Depth	1	252	15.75	15.75	<.0001	<.0001	1	52	0.48	0.4914
*Effort__h_*	1	252	7.05	7.05	0.0079	0.0084	1	52	2.98	0.0902
Tempsur	1	252	0.64	0.64	0.4223	0.4231	1	52	0.28	0.5960
Tempbot	1	252	4.73	4.73	0.0297	0.0306	1	52	4.43	0.0401
Salsur	1	252	8.23	8.23	0.0041	0.0045			Dropped	
Prev_Mon_R	1	252	3.47	3.47	0.0626	0.0638	1	52	1.60	0.2109
DObot	1	252	1.18	1.18	0.2779	0.2790	1	52	1.53	0.2211
Monthly_R					Dropped		1	52	0.72	0.3998
DOsur	1	252	0.70	0.70	0.4016	0.4024	1	52	1.08	0.3031
Set_Time	1	252	0.32	0.32	0.5724	0.5729	1	52	0.30	0.5884
Salbot					Dropped				Dropped	

Model Run #4	Binomial Submodel Type 3 Tests (AIC 1462.3)						Lognormal Submodel Type 3 Tests (AIC 218.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	253	28.59	2.38	0.0045	0.0063	12	53	0.94	0.5116
Month	7	253	21.72	3.10	0.0028	0.0037	7	53	1.30	0.2698
location					Dropped		1	53	3.39	0.0711
Depth	1	253	15.75	15.75	<.0001	<.0001	1	53	0.49	0.4878
*Effort__h_*	1	253	7.12	7.12	0.0076	0.0081	1	53	2.80	0.0999
Tempsur	1	253	0.65	0.65	0.4211	0.4219			Dropped	
Tempbot	1	253	4.88	4.88	0.0272	0.0281	1	53	4.48	0.0391

Model Run #4	Binomial Submodel Type 3 Tests (AIC 1462.3)						Lognormal Submodel Type 3 Tests (AIC 218.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Salsur	1	253	9.07	9.07	0.0026	0.0029			Dropped	
Prev_Mon_R	1	253	3.47	3.47	0.0624	0.0636	1	53	1.46	0.2322
DObot	1	253	1.19	1.19	0.2761	0.2771	1	53	1.36	0.2490
Monthly_R					Dropped		1	53	0.66	0.4192
DOsur	1	253	0.71	0.71	0.3998	0.4006	1	53	0.96	0.3325
Set_Time	1	253	0.34	0.34	0.5577	0.5582	1	53	0.24	0.6227
Salbot					Dropped				Dropped	

Model Run #5	Binomial Submodel Type 3 Tests (AIC 1457.6)						Lognormal Submodel Type 3 Tests (AIC 215.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	254	30.32	2.53	0.0025	0.0037	12	54	1.10	0.3786
Month	7	254	21.83	3.12	0.0027	0.0036	7	54	1.30	0.2665
location					Dropped		1	54	3.65	0.0615
Depth	1	254	15.89	15.89	<.0001	<.0001	1	54	0.49	0.4857
*Effort__h_*	1	254	6.92	6.92	0.0085	0.0090	1	54	4.25	0.0442
Tempsur	1	254	0.90	0.90	0.3428	0.3437			Dropped	
Tempbot	1	254	4.71	4.71	0.0300	0.0309	1	54	4.38	0.0410
Salsur	1	254	8.83	8.83	0.0030	0.0032			Dropped	
Prev_Mon_R	1	254	3.63	3.63	0.0569	0.0580	1	54	1.93	0.1706
DObot	1	254	1.15	1.15	0.2839	0.2849	1	54	1.64	0.2064
Monthly_R					Dropped		1	54	1.09	0.3017
DOsur	1	254	0.77	0.77	0.3817	0.3825	1	54	1.12	0.2944
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #6	Binomial Submodel Type 3 Tests (AIC 1447.2)						Lognormal Submodel Type 3 Tests (AIC 213.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	255	30.20	2.52	0.0026	0.0038	12	55	1.10	0.3816
Month	7	255	21.81	3.12	0.0027	0.0036	7	55	1.28	0.2764
location					Dropped		1	55	3.72	0.0589

Model Run #6	Binomial Submodel Type 3 Tests (AIC 1447.2)						Lognormal Submodel Type 3 Tests (AIC 213.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Depth	1	255	17.57	17.57	<.0001	<.0001			Dropped	
*Effort__h_*	1	255	7.08	7.08	0.0078	0.0083	1	55	4.70	0.0345
Tempsur	1	255	1.11	1.11	0.2928	0.2938			Dropped	
Tempbot	1	255	4.21	4.21	0.0402	0.0412	1	55	3.94	0.0522
Salsur	1	255	8.25	8.25	0.0041	0.0044			Dropped	
Prev_Mon_R	1	255	3.29	3.29	0.0696	0.0708	1	55	2.36	0.1300
DObot	1	255	0.71	0.71	0.3986	0.3994	1	55	2.73	0.1040
Monthly_R					Dropped		1	55	1.22	0.2735
DOsur					Dropped		1	55	1.58	0.2142
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #7	Binomial Submodel Type 3 Tests (AIC 1441.9)						Lognormal Submodel Type 3 Tests (AIC 224.0)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	256	30.36	2.53	0.0025	0.0036	12	62	0.90	0.5543
Month	7	256	21.89	3.13	0.0027	0.0035			Dropped	
location					Dropped		1	62	4.61	0.0357
Depth	1	256	20.54	20.54	<.0001	<.0001			Dropped	
*Effort__h_*	1	256	6.86	6.86	0.0088	0.0094	1	62	2.13	0.1494
Tempsur	1	256	1.47	1.47	0.2255	0.2267			Dropped	
Tempbot	1	256	3.97	3.97	0.0464	0.0475	1	62	8.03	0.0062
Salsur	1	256	8.68	8.68	0.0032	0.0035			Dropped	
Prev_Mon_R	1	256	3.57	3.57	0.0589	0.0600	1	62	3.65	0.0608
DObot					Dropped		1	62	1.75	0.1912
Monthly_R					Dropped		1	62	1.85	0.1788
DOsur					Dropped		1	62	0.79	0.3779
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #8	Binomial Submodel Type 3 Tests (AIC 1441.9)						Lognormal Submodel Type 3 Tests (AIC 222.5)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	257	29.61	2.47	0.0032	0.0046	12	63	0.84	0.6055
Month	7	257	21.06	3.01	0.0037	0.0047			Dropped	
location					Dropped		1	63	5.03	0.0285
Depth	1	257	23.11	23.11	<.0001	<.0001			Dropped	
*Effort__h_*	1	257	6.22	6.22	0.0126	0.0133	1	63	1.65	0.2035
Tempsur					Dropped				Dropped	
Tempbot	1	257	13.50	13.50	0.0002	0.0003	1	63	7.41	0.0084
Salsur	1	257	7.68	7.68	0.0056	0.0060			Dropped	
Prev_Mon_R	1	257	3.47	3.47	0.0625	0.0636	1	63	3.52	0.0653
DObot					Dropped		1	63	1.20	0.2765
Monthly_R					Dropped		1	63	1.59	0.2125
DOsur					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #9	Binomial Submodel Type 3 Tests (AIC 1441.9)						Lognormal Submodel Type 3 Tests (AIC 220.5)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	258	28.19	2.35	0.0052	0.0071	12	64	0.86	0.5925
Month	7	258	18.98	2.71	0.0082	0.0099			Dropped	
location					Dropped		1	64	4.70	0.0339
Depth	1	258	22.42	22.42	<.0001	<.0001			Dropped	
*Effort__h_*	1	258	5.11	5.11	0.0238	0.0247	1	64	1.72	0.1939
Tempsur					Dropped				Dropped	
Tempbot	1	258	12.75	12.75	0.0004	0.0004	1	64	10.05	0.0023
Salsur	1	258	7.81	7.81	0.0052	0.0056			Dropped	
Prev_Mon_R	1	257	3.47	3.47	0.0625	0.0636	1	64	3.34	0.0723
DObot					Dropped				Dropped	
Monthly_R					Dropped		1	64	0.93	0.3376
DOsur					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #10	Binomial Submodel Type 3 Tests (AIC 1441.9)						Lognormal Submodel Type 3 Tests (AIC 216.9)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	258	28.19	2.35	0.0052	0.0071	12	65	0.79	0.6576
Month	7	258	18.98	2.71	0.0082	0.0099			Dropped	
location					Dropped		1	65	4.61	0.0356
Depth	1	258	22.42	22.42	<.0001	<.0001			Dropped	
*Effort__h_*	1	258	5.11	5.11	0.0238	0.0247	1	65	1.32	0.2546
Tempsur					Dropped				Dropped	
Tempbot	1	258	12.75	12.75	0.0004	0.0004	1	65	9.13	0.0036
Salsur	1	258	7.81	7.81	0.0052	0.0056			Dropped	
Prev_Mon_R	1	257	3.47	3.47	0.0625	0.0636	1	65	2.75	0.1022
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #11	Binomial Submodel Type 3 Tests (AIC 1441.9)						Lognormal Submodel Type 3 Tests (AIC 216.5)			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	258	28.19	2.35	0.0052	0.0071	12	66	0.72	0.7245
Month	7	258	18.98	2.71	0.0082	0.0099			Dropped	
location					Dropped		1	66	5.74	0.0194
Depth	1	258	22.42	22.42	<.0001	<.0001			Dropped	
*Effort__h_*	1	258	5.11	5.11	0.0238	0.0247			Dropped	
Tempsur					Dropped				Dropped	
Tempbot	1	258	12.75	12.75	0.0004	0.0004	1	66	9.08	0.0037
Salsur	1	258	7.81	7.81	0.0052	0.0056			Dropped	
Prev_Mon_R	1	257	3.47	3.47	0.0625	0.0636	1	66	1.96	0.1663
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Model Run #11	*Binomial Submodel Type 3 Tests (AIC 1441.9)*						*Lognormal Submodel Type 3 Tests (AIC 213.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	258	28.19	2.35	0.0052	0.0071	12	67	0.64	0.7967
Month	7	258	18.98	2.71	0.0082	0.0099			Dropped	
location					Dropped		1	67	6.09	0.0161
Depth	1	258	22.42	22.42	<.0001	<.0001			Dropped	
*Effort__h_*	1	258	5.11	5.11	0.0238	0.0247			Dropped	
Tempsur					Dropped				Dropped	
Tempbot	1	258	12.75	12.75	0.0004	0.0004	1	67	8.05	0.0060
Salsur	1	258	7.81	7.81	0.0052	0.0056			Dropped	
Prev_Mon_R	1	257	3.47	3.47	0.0625	0.0636			Dropped	
DObot					Dropped				Dropped	
Monthly_R					Dropped				Dropped	
DOsur					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Salbot					Dropped				Dropped	

Table 7. Indices of juvenile blacktip shark catch rates from 1998 to 2011 developed using the delta-lognormal model. The nominal frequency of occurrence, the number of samples (n), the Lo Index (number per 100 GN 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
1998	0.40000	15	0.23495	1.09858	0.70083	0.31031	3.88931
1999	0.37500	16	0.17376	0.81246	0.68854	0.23374	2.82402
2000	0.78571	14	1.11149	5.19713	0.31511	2.80875	9.61644
2001	0.40000	5	0.04573	0.21384	1.82687	0.01896	2.41112
2003	0.14286	7	0.03126	0.14618	2.66245	0.00811	2.63462
2004	0.25000	12	0.07357	0.34398	1.20511	0.05175	2.28654
2005	0.46154	13	0.24131	1.12833	0.81169	0.27196	4.68134
2006	0.20833	24	0.04088	0.19116	1.29434	0.02629	1.39007
2007	0.57895	19	0.27742	1.29717	0.62410	0.41194	4.08472
2008	0.13636	22	0.08121	0.37971	1.19124	0.05795	2.48784
2009	0.30000	20	0.10648	0.49788	0.88835	0.10830	2.28888
2010	0.23729	59	0.23066	1.07853	0.52936	0.39913	2.91436
2011	0.14286	56	0.13154	0.61506	0.71628	0.16980	2.22781

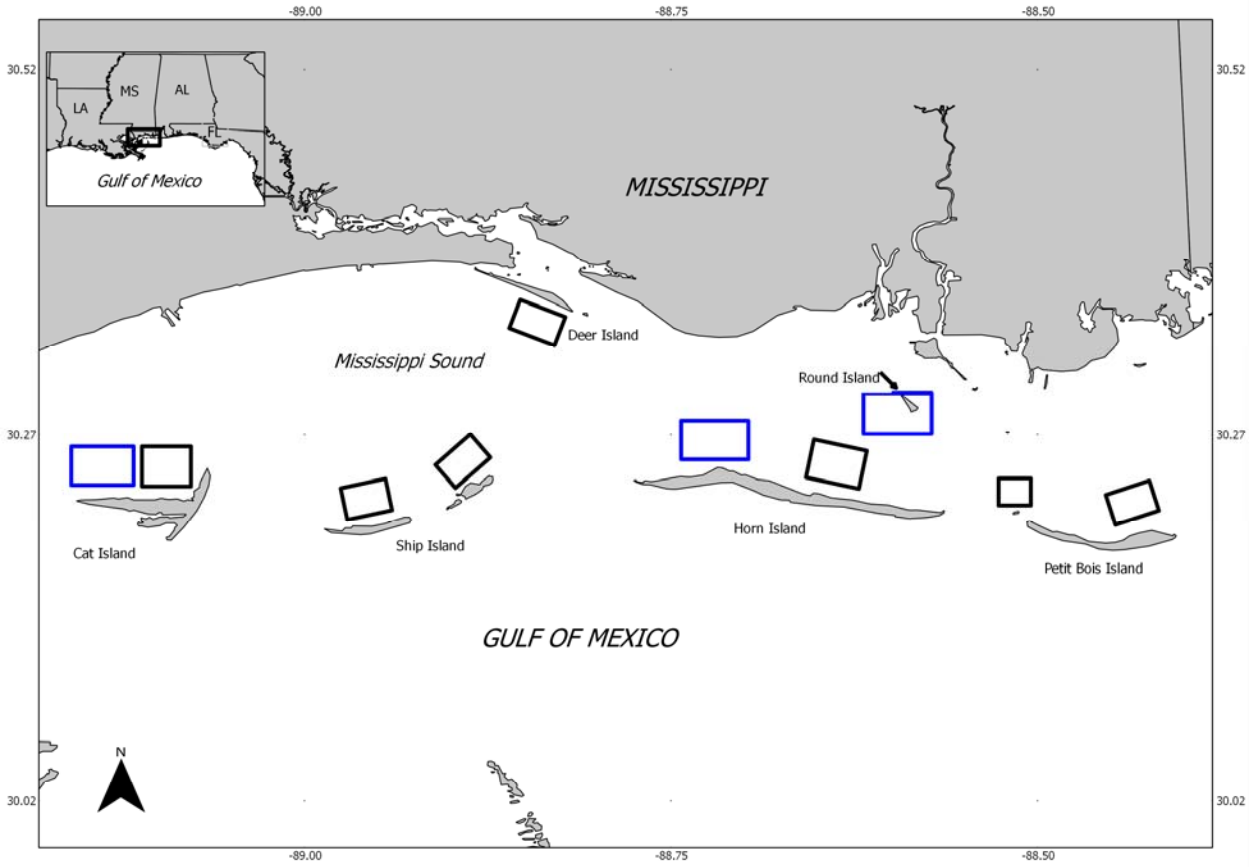


Figure 1. Sampling universe for the Mississippi gillnet survey from 1998-2011. Each rectangle represents a sampling region, from which randomly selected sampling locations were chosen. The blue rectangles represent the primary sampling regions that were sampled from 1998-2009, and the black rectangles represent the expanded sampling regions which were incorporated in 2010.

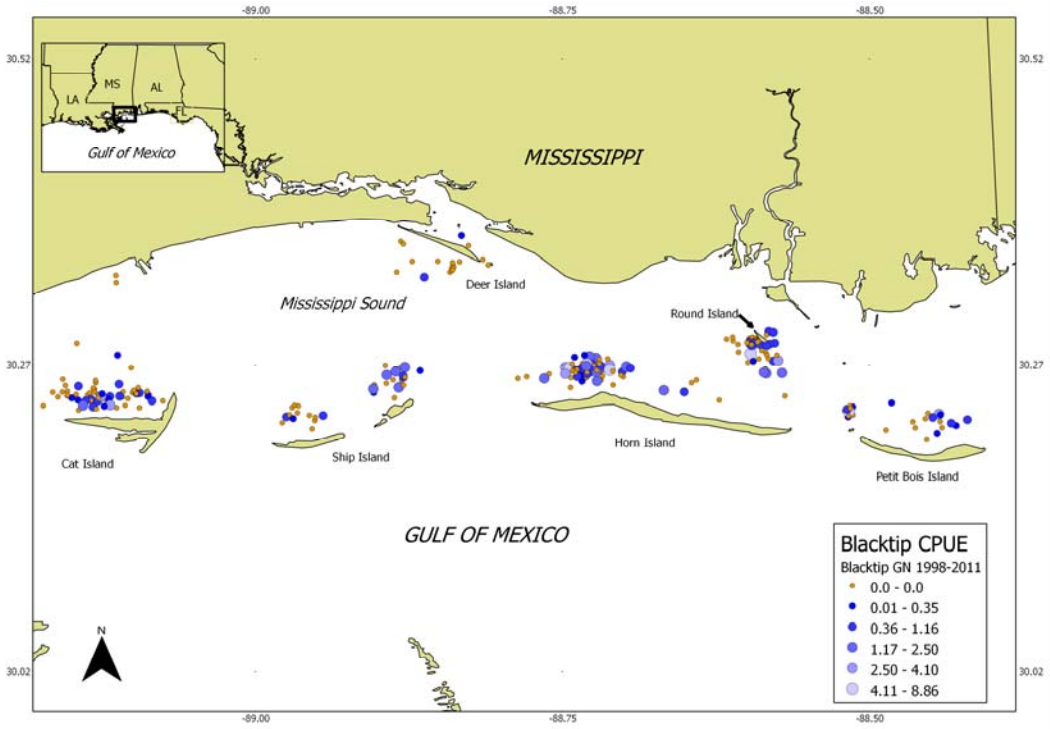


Figure 2. Stations sampled from 1998 to 2011 during the Mississippi gillnet survey with total blacktip shark CPUE presented.

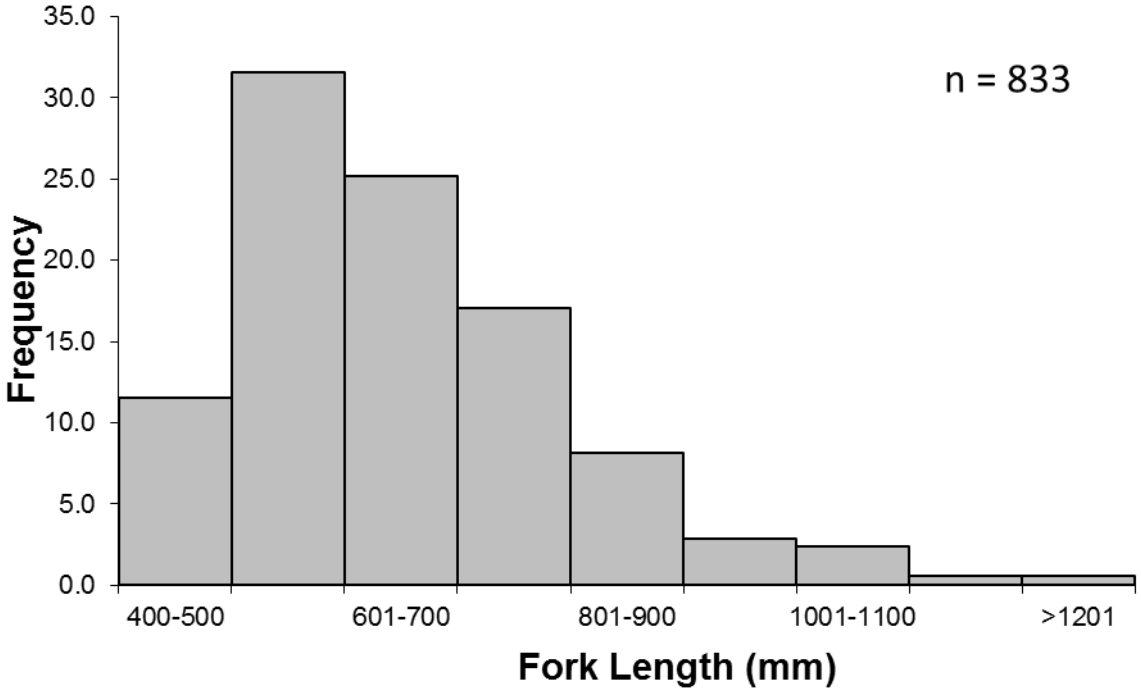


Figure 3. Length frequency distribution for blacktip sharks caught during the Mississippi gillnet survey from 1998-2011.

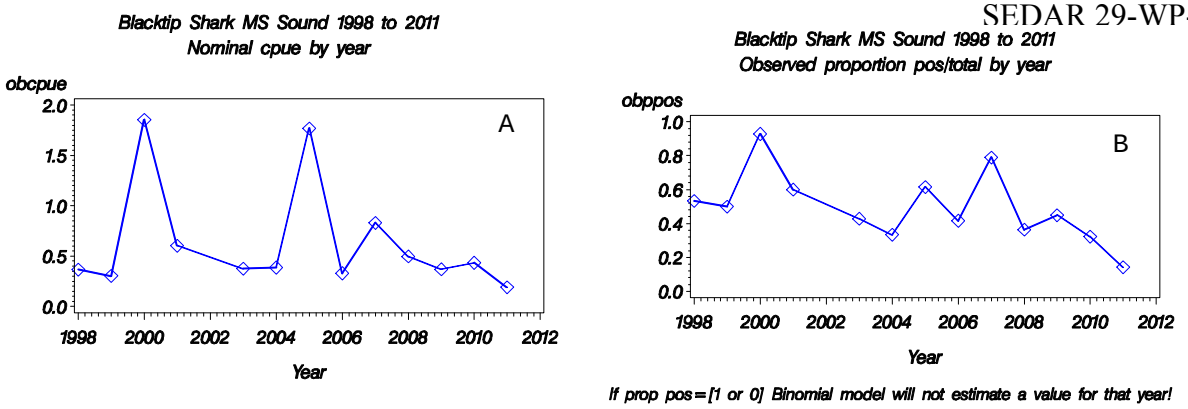


Figure 4. Annual trends for total blacktip sharks captured during Mississippi gillnet surveys from 1998 to 2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

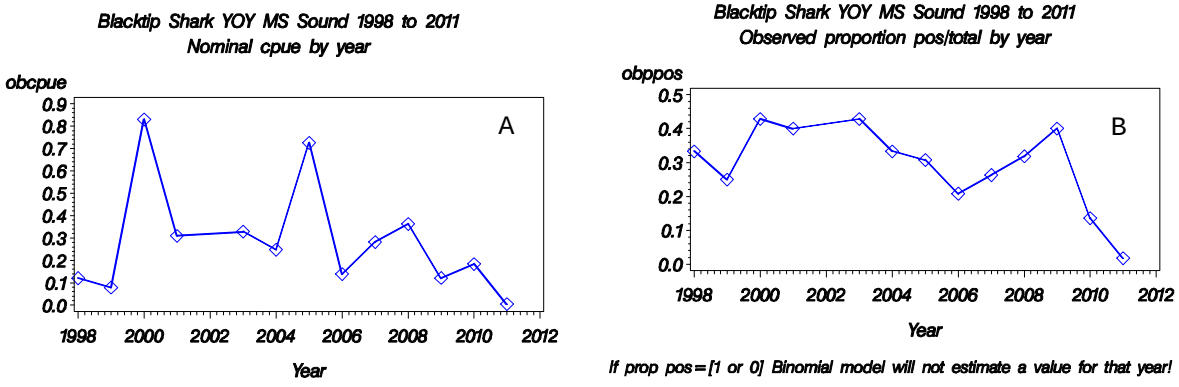


Figure 5. Annual trends for YOY blacktip sharks captured during Mississippi gillnet surveys from 1998 to 2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

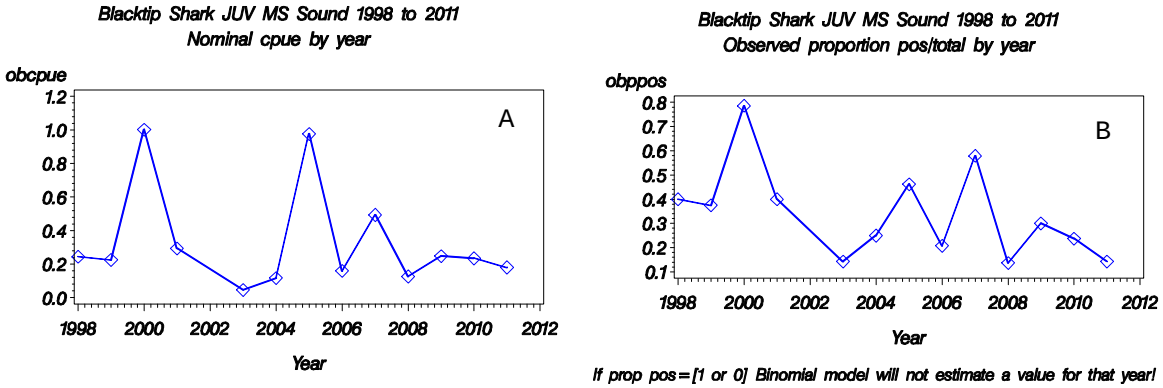


Figure 6. Annual trends for juvenile blacktip sharks captured during Mississippi gillnet surveys from 1998 to 2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

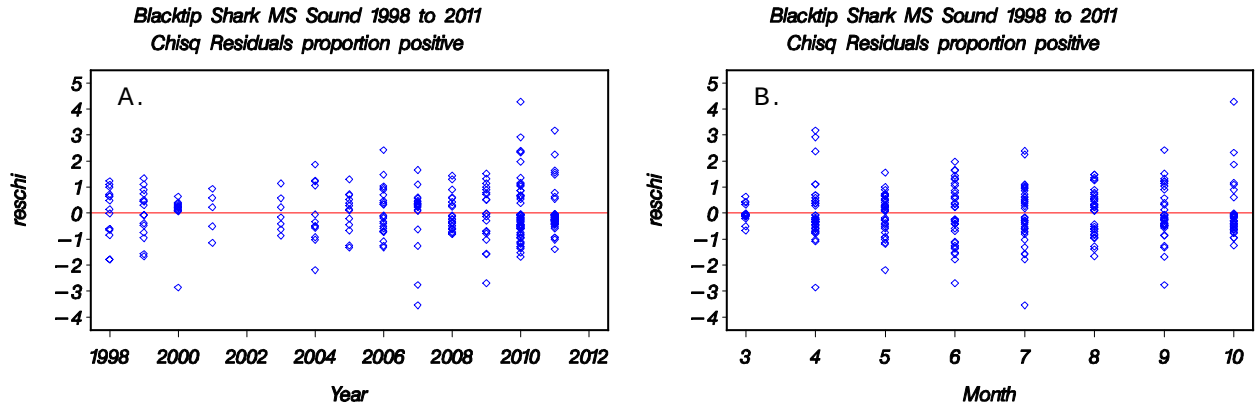


Figure 7. Diagnostic plots for the binomial component of the total blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month.

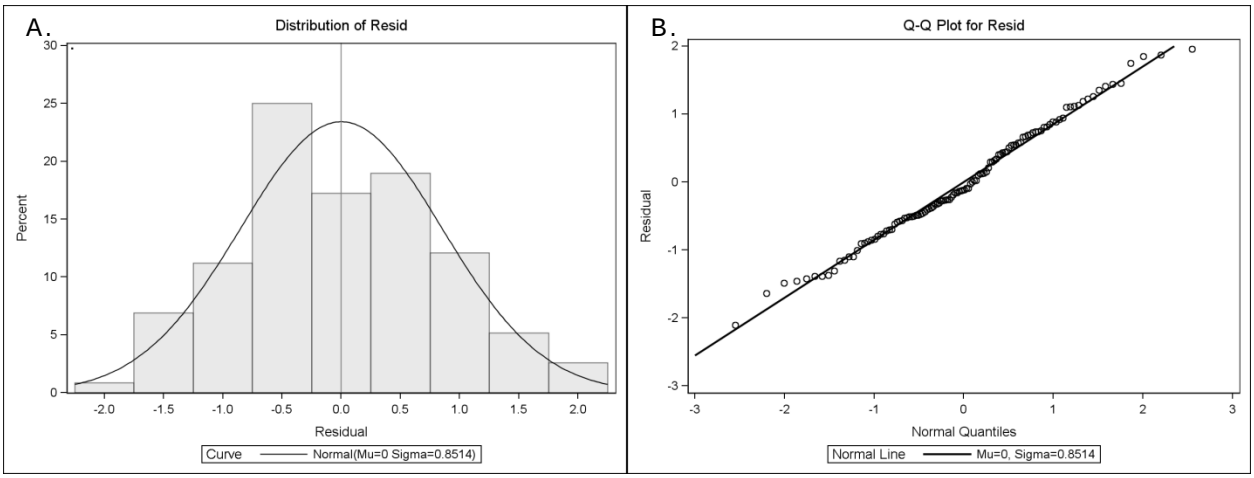


Figure 8. Diagnostic plots for the lognormal component of the total blacktip shark Mississippi gillnet survey model: **A.** the frequency distribution of log(CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

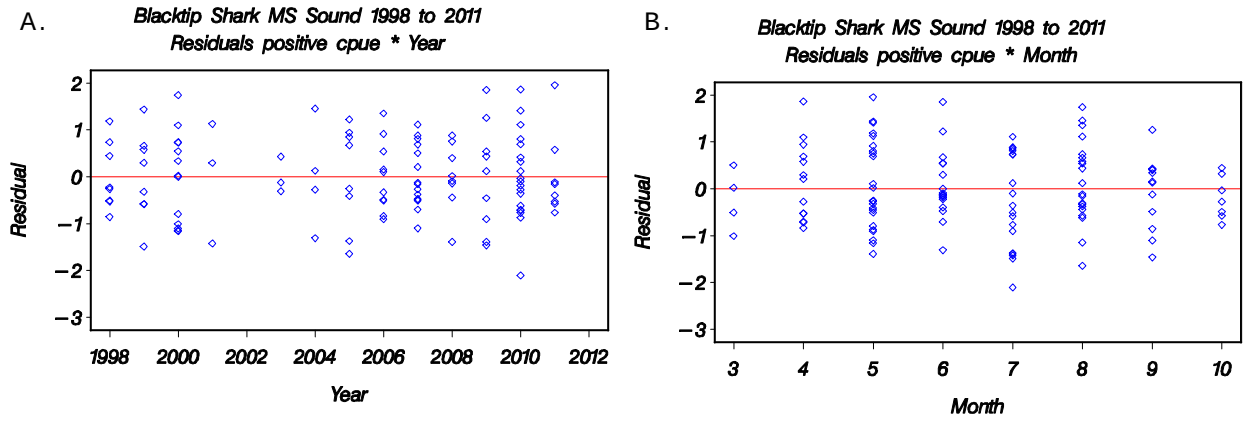


Figure 9. Diagnostic plots for the lognormal component of the total blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month.

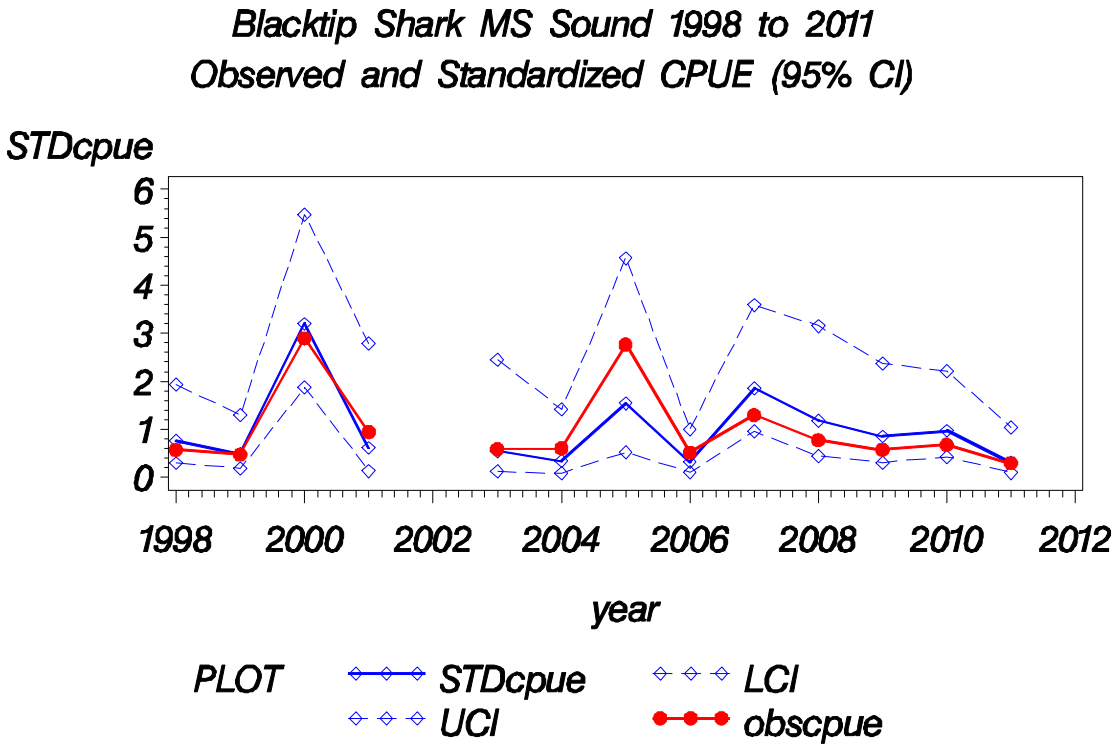


Figure 10. Observed and standardized CPUE for total blacktip shark catch in the Mississippi gillnet survey from 1998-2011.

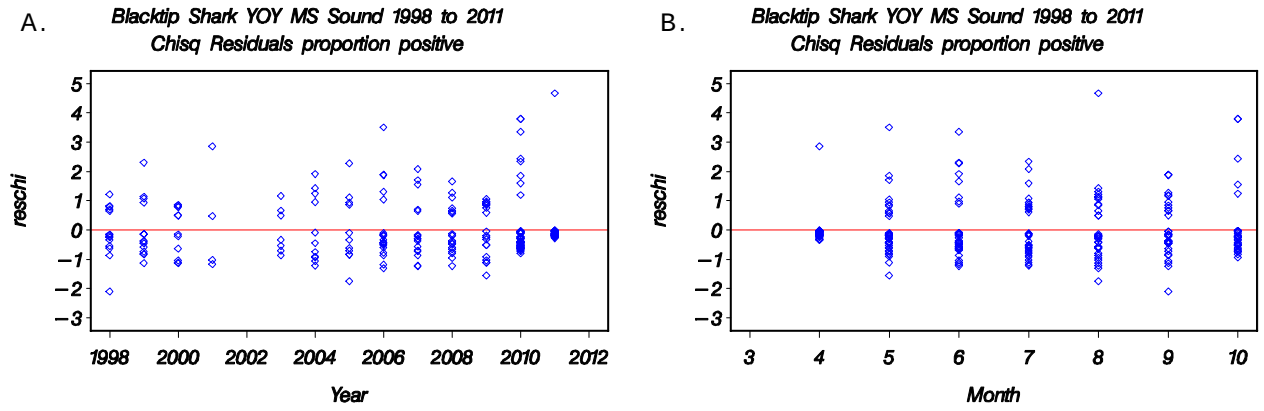


Figure 11. Diagnostic plots for the binomial component of the YOY blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by month.

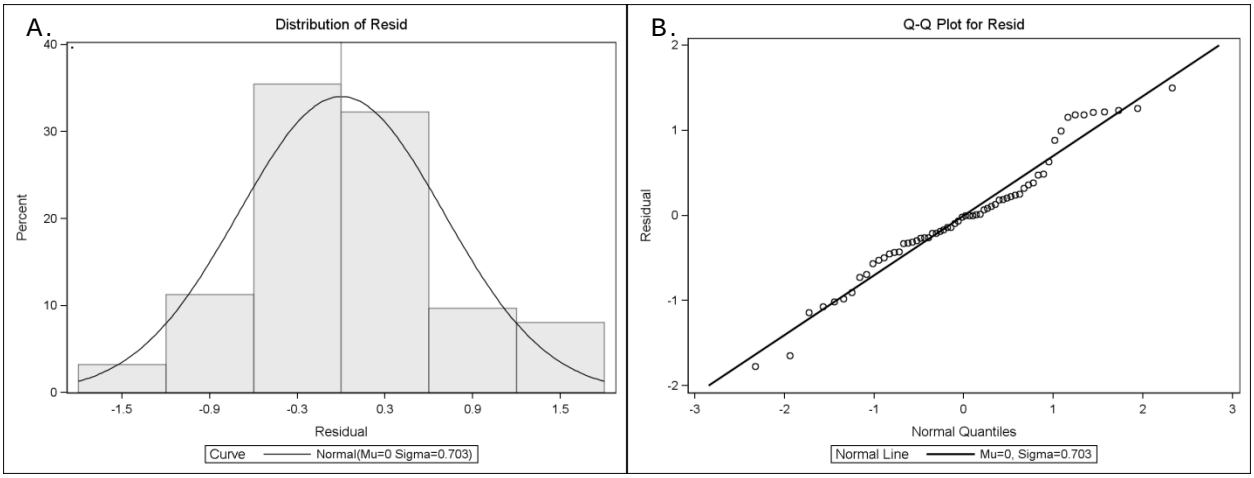


Figure 12. Diagnostic plots for the lognormal component of the YOY blacktip shark Mississippi gillnet survey model: **A.** the frequency distribution of log(CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

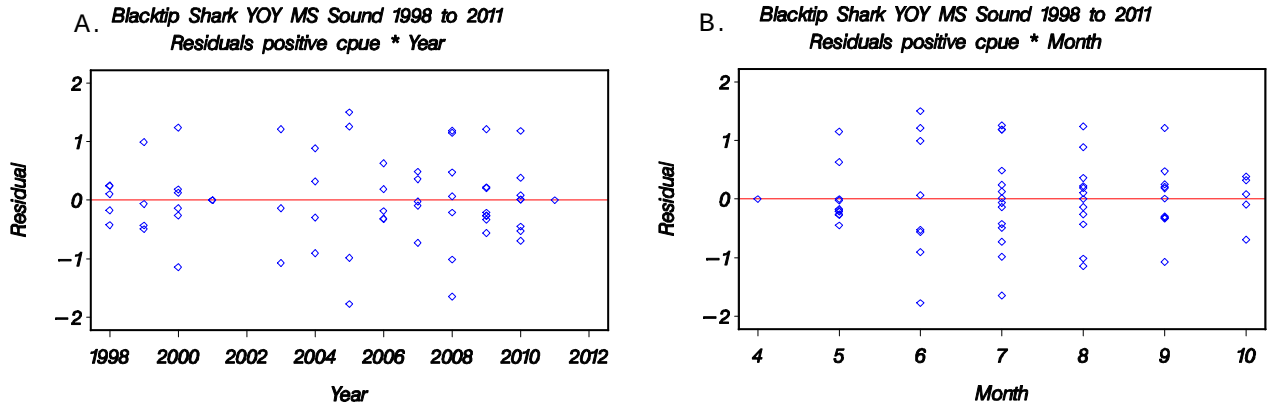


Figure13. Diagnostic plots for the lognormal component of the YOY blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by month.

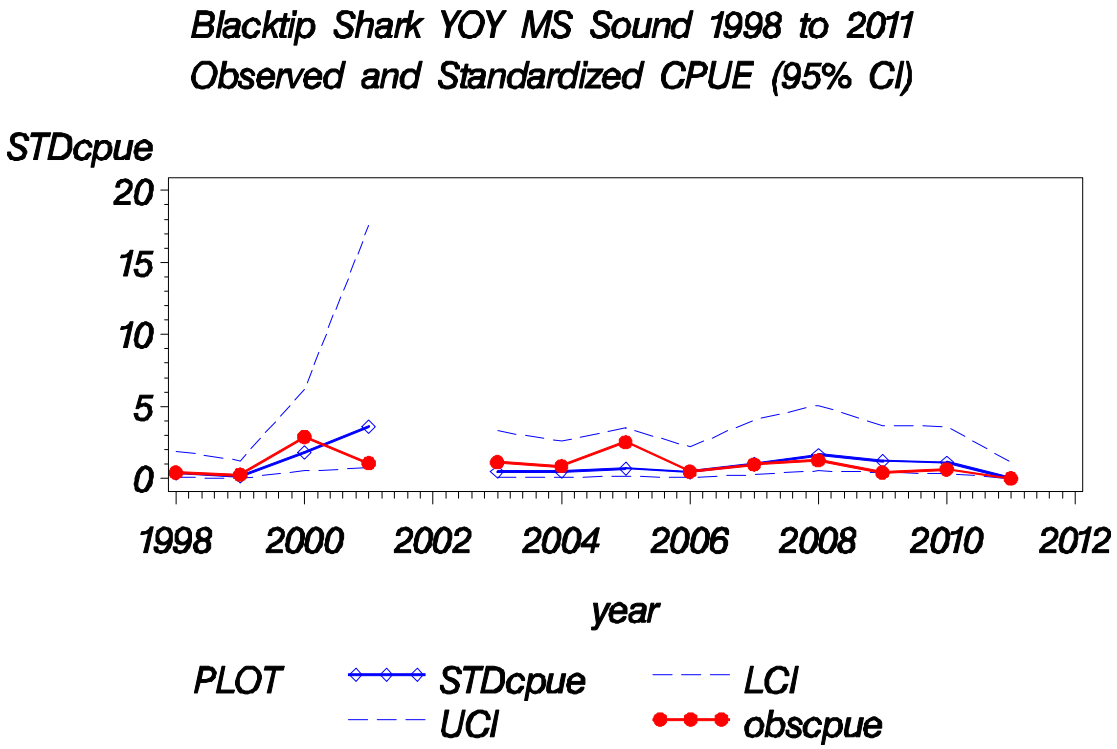


Figure 14. Observed and standardized CPUE for YOY blacktip shark catch in the Mississippi gillnet survey from 1998-2011.

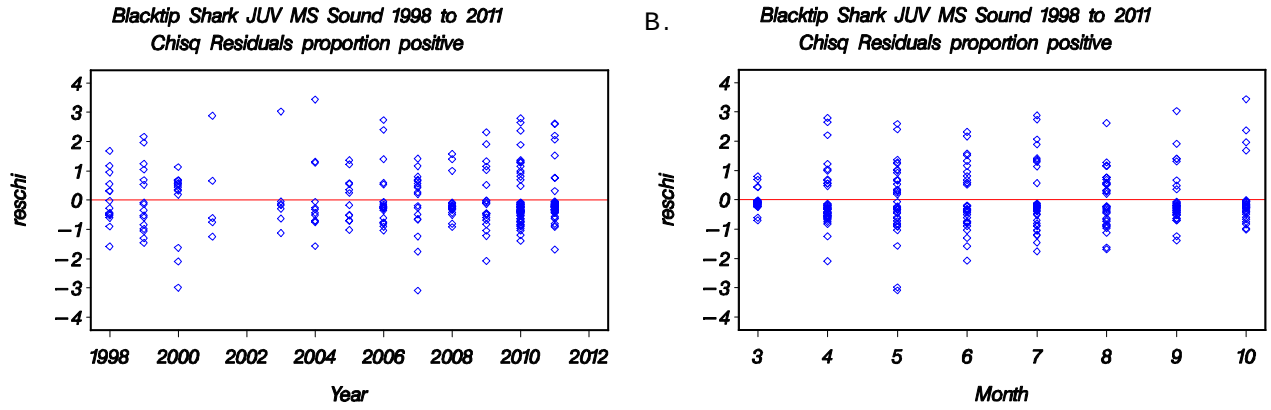


Figure 15. Diagnostic plots for the binomial component of the juvenile blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month.

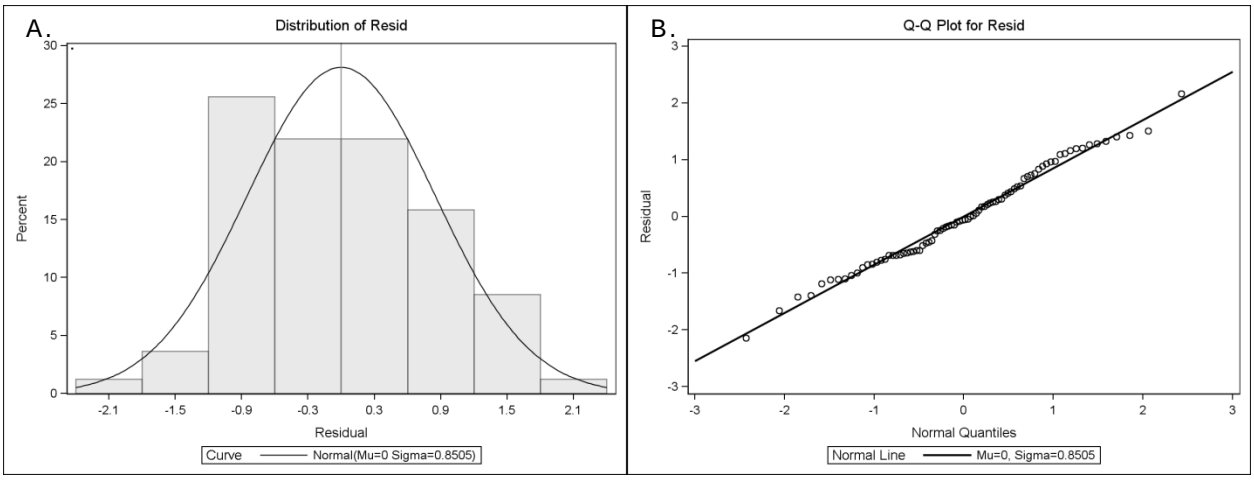


Figure 16. Diagnostic plots for the lognormal component of the juvenile blacktip shark Mississippi gillnet survey model: **A.** the frequency distribution of log(CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

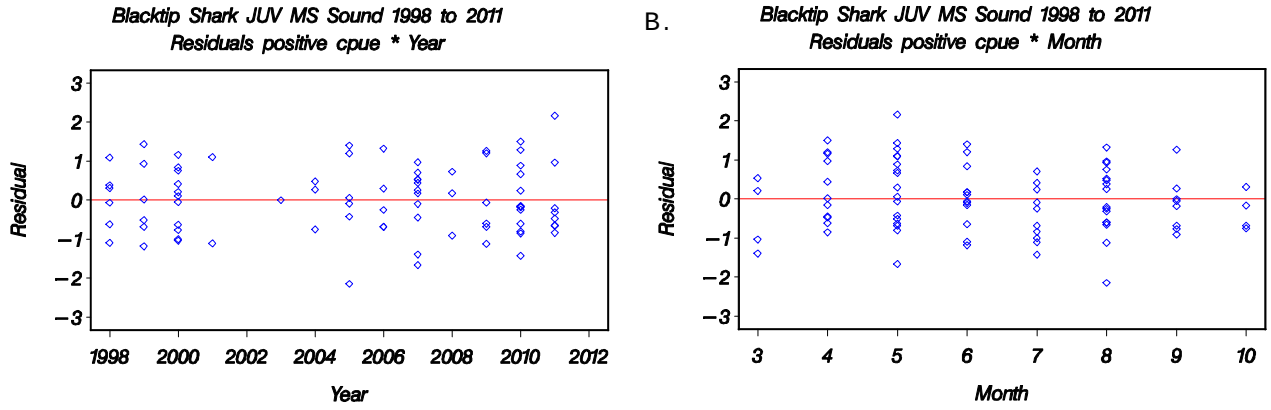


Figure17. Diagnostic plots for the lognormal component of the juvenile blacktip shark Mississippi gillnet survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month.

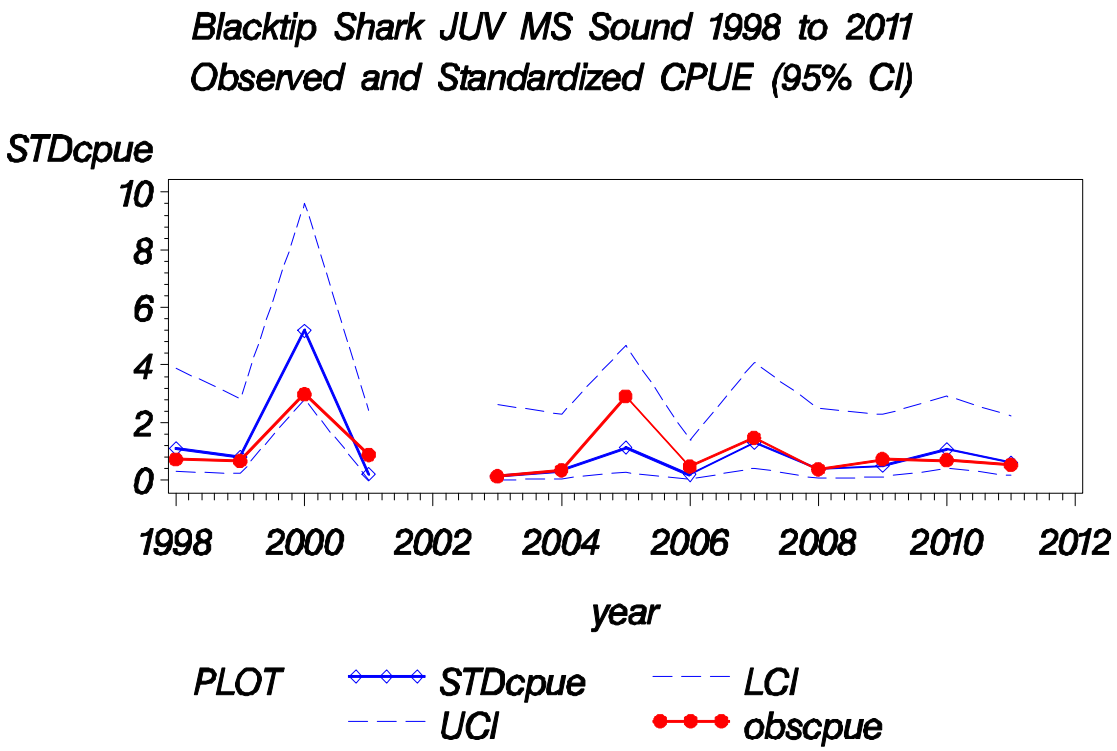
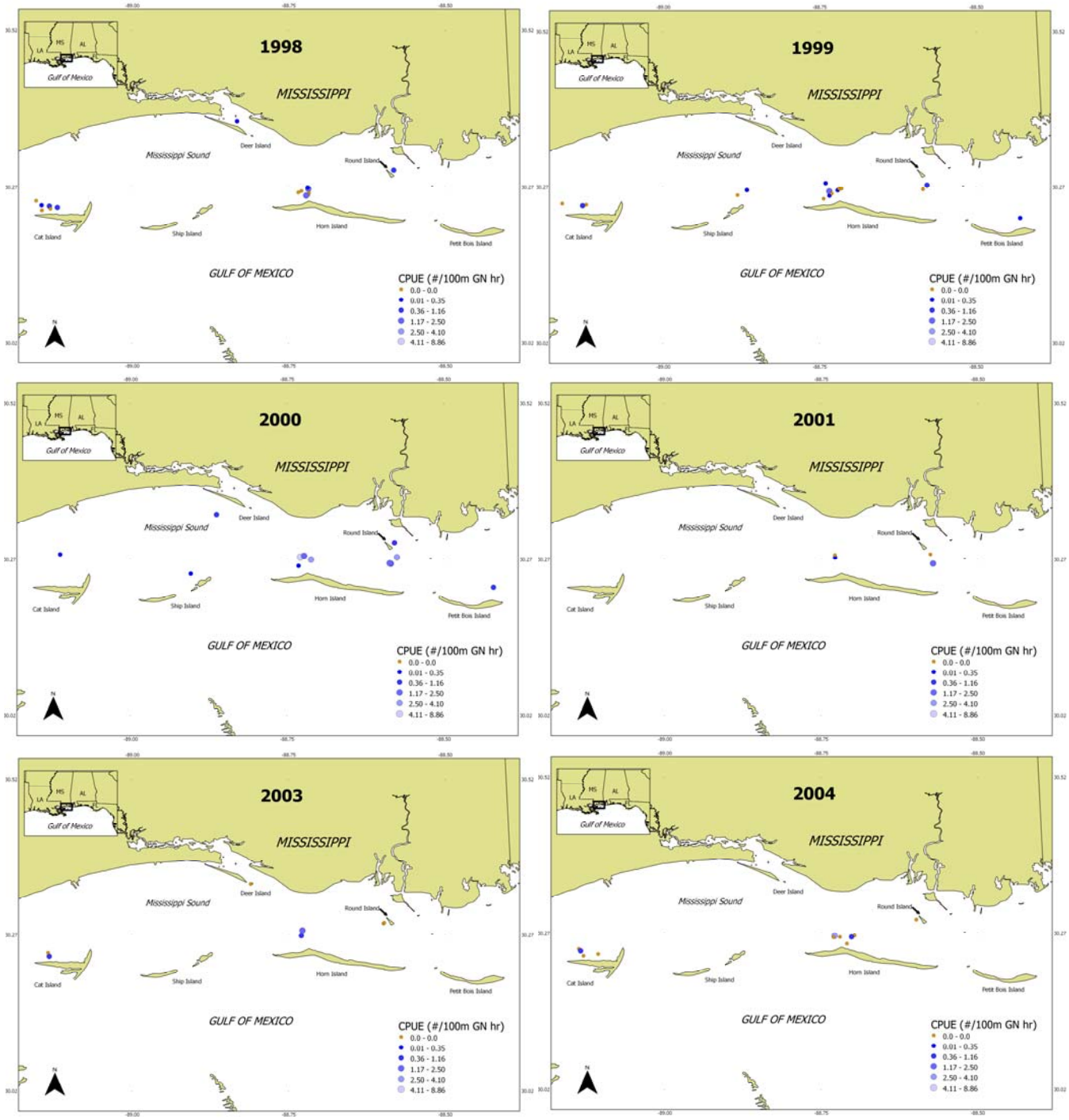


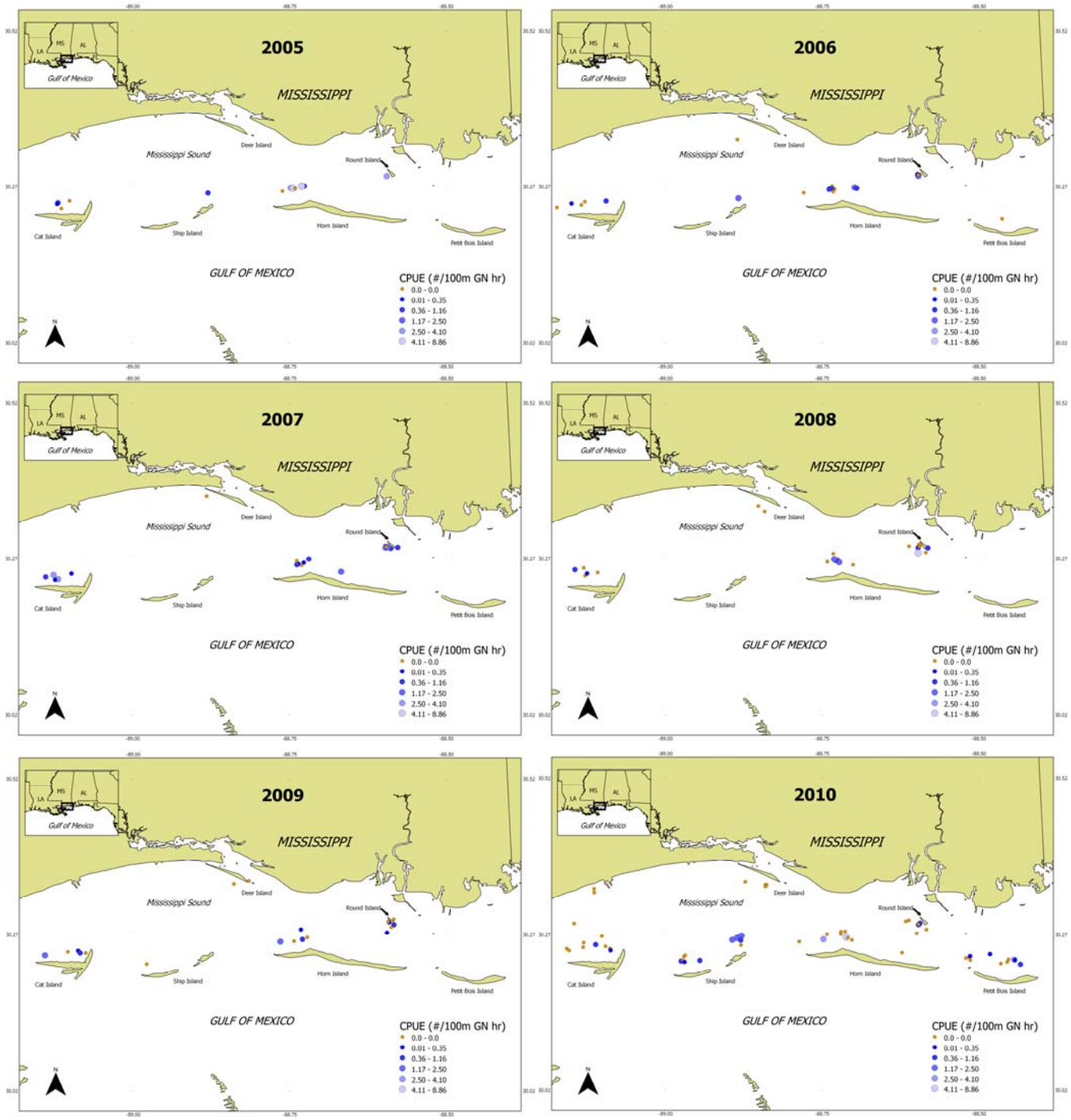
Figure 18. Observed and standardized CPUE for juvenile blacktip shark catch in the Mississippi gillnet survey from 1998-2011.

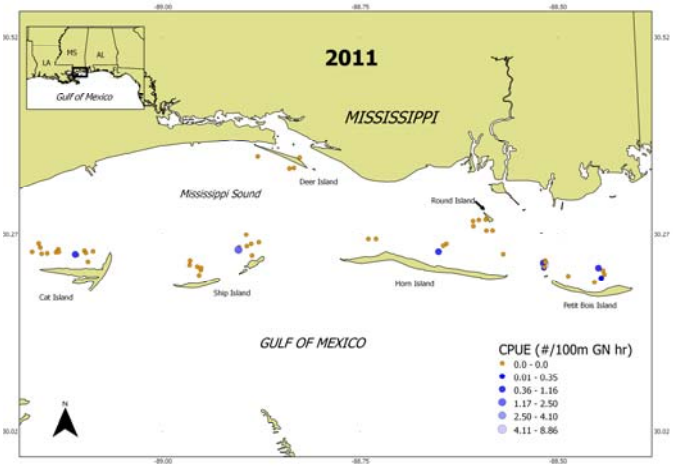
Appendix:

Annual Effort and Catch

Appendix Figure 1. Annual survey effort and catch of blacktip sharks from the Mississippi gill net survey from 1998-2011.




2005
2006
2007
2008
2009
2010
MISSISSIPPI
Gulf of Mexico
Mississippi Sound
GULF OF MEXICO
Deer Island
Round Island
Cat Island
Ship Island
Horn Island
Petit Bois Island
CPUE (#/100m GN hr)
0.0 - 0.0
0.01 - 0.35
0.36 - 1.16
1.17 - 2.50
2.50 - 4.10
4.11 - 8.86


2011
MISSISSIPPI
Gulf of Mexico
MS
AL
LA
Mississippi Sound
Deer Island
Round Island
Cat Island
Ship Island
Horn Island
Petit Bois Island
GULF OF MEXICO
CPUE (#/100m GN hr)
0.0 - 0.0
0.01 - 0.35
0.36 - 1.16
1.17 - 2.50
2.50 - 4.10
4.11 - 8.86
N