Standardized catch rates of Atlantic sharpnose sharks (Rhizoprionodon terraenovae) collected during bottom longline surveys in Mississippi, Louisiana, Alabama, and Texas coastal waters, 2004-2011

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SEDAR34-WP-11

Submitted: 10 June 2013

Addendum Added: 8 July 2013

Please cite this document as:

Hoffmayer, E., A. Pollack, J. Hendon, M. Drymon, and M. Grace. 2013. Standardized catch rates of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) collected during bottom longline surveys in Mississippi, Louisiana, Alabama, and Texas coastal waters, 2004-2011. SEDAR34-WP-11. SEDAR, North Charleston, SC. 23 pp.

STANDARDIZED CATCH RATES OF ATLANTIC SHARPNOSE SHARKS (*RHIZOPRIONODON TERRAENOVAE*) COLLECTED DURING BOTTOM LONGLINE SURVEYS IN MISSISSIPPI, LOUISIANA, ALABAMA, AND TEXAS COASTAL WATERS FROM 2004 TO 2011.

Eric Hoffmayer[1], Adam Pollack[1], Jill Hendon[2], Marcus Drymon[3] and Mark Grace[1]

In 2004, a monthly bottom longline survey was established in Mississippi's inshore coastal waters. In 2006, Alabama also initiated a bottom longline survey in their coastal waters. Then in 2008 the Southeast Area Monitoring and Assessment Program implemented a standardized bottom longline survey in the state waters of Alabama (incorporated with the 2006 survey), Mississippi/Louisiana and Texas. The four separate bottom longline data sets were combined to describe Atlantic sharpnose shark catch data along the coastal waters of the northern Gulf of Mexico. The data for the combined index included sampling from 2004 to 2011, and resulted in 1114 bottom longline sets, and 3,895 Atlantic sharpnose shark encounters. Standardized catch rates were estimated using a generalized linear mixed modeling approach assuming a delta-lognormal error distribution. Nominal and standardized Atlantic sharpnose shark catch rates remained relatively stable throughout the survey period.

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INTRODUCTION

Fishery-independent inshore bottom longline surveys of coastal shark populations have taken place in the northcentral Gulf of Mexico since 2004. The University of Southern Mississippi Gulf Coast Research Laboratory developed an inshore bottom longline survey in 2004 to examine the distribution and abundance of juvenile sharks within Mississippi's coastal waters. Then in 2006 the Dauphin Island Sea Laboratory also initiated a shark bottom longline survey. In 2008, the National Marine Fisheries Service (NMFS) Southeast Area Monitor and Assessment Program (SEAMAP) developed a coastal bottom longline survey in Alabama (combined with the 2006 survey), Mississippi/Louisiana, and Texas state waters. The SEAMAP state partners that conduct this survey work include Dauphin Island Sea Laboratory, Gulf Coast Research Laboratory, and Texas Parks and Wildlife Department. Data from all surveys were combined in an attempt to provide a combined single relative index of abundance for Atlantic sharpnose sharks for the northern Gulf of Mexico.

METHODOLOGY

Mississippi Inshore Survey

The Mississippi Inshore Survey began in 2004. Twelve 10.6 km block grids were identified within the Mississippi Sound (MS state waters only) and a random stratified block design was used to select stations. One station from each grid was selected monthly (March to October). Sampling was conducted with a 152.4 m bottom longline that consisted of 50 1.0 m gangions (2.0 mm monofilament) outfitted with #12/0 circle hooks, and baited with menhaden (*Brevoortia patronus*). The longline was typically fished between the hours of 0800 and 2000, and was allowed to soak for one hour prior to retrieval. For additional details see SEDAR29-WP-14.

Alabama Survey

Bottom longline sampling for the Alabama nearshore survey began in May 2006 and employed a random stratified block design. Blocks were established both in the Mississippi Sound/Mobile Bay and waters south of Dauphin Island. Each month (January to December), stations were randomly selected within the blocks, and effort was allocated across three depth strata (0-5m, 5-10m, and 10-20m). 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 1.8 km (426 kg test) monofilament mainline and 100, 3.7 m gangions (332 kg test monofilament) outfitted with #15/0 circle hooks and baited with Atlantic mackerel (*Scomber scombrus*). The longline fished for one hour from the time of last high-flier deployment to the time of first high-flier retrieval. For additional details see SEDAR29-WP-11.

Mississippi/Louisiana Survey

Bottom longline sampling in the Mississippi/Louisiana nearshore waters began in 2008 and employed a random stratified block design with effort within each block allocated across three depth strata (0-5m, 5-10m, and 10-20m). The study area was broken into three regions: Mississippi Sound, South of barrier islands, and Chandeleur Sound. Each month from March to

October, three stations were sampled from each region. 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 1.8 km (426 kg test) monofilament mainline and 100, 3.7 m gangions (332 kg test monofilament) outfitted with #15/0 circle hooks and baited with Atlantic mackerel, (*Scomber scombrus*). The longline fished for one hour from the time of last high-flier deployment to the time of first high-flier retrieval. For additional details see SEDAR29-WP-15.

Texas Survey

The bottom longline sampling began in 2008 and employed a random stratified block design with effort within each block allocated across three depth strata (0-5m, 5-10m, and 10-20m). The study area was broken into two regions: Corpus Christi and Galvaston Bay. Sampling typically occurred every other month from March to October, with two stations sampled from each region. 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 1.8 km (426 kg test) monofilament mainline and 100, 3.7 m gangions (332 kg test monofilament) outfitted with #15/0 circle hooks and baited with Atlantic mackerel, (*Scomber scombrus*). The longline fished for one hour from the time of last high-flier deployment to the time of first high-flier retrieval.

Combined Survey Modifications

The study area for the Mississippi inshore, Alabama, Mississippi/Louisiana, and Texas surveys was approximately 468, 1,092, 1,242, and 1,440 km^2, respectively. Due to the spatial overlap in three of the four surveys, the LA/MS/AL study area was divided into eleven 26 x 6 km blocks (blocks 1-6, 8-12), and one 17 x 18 km block (Chandeleur Sound; block 7) (Figure 1). Two 45 x 16 km areas (blocks 13-14) were established outside of Galveston and Corpus Christi Bays in Texas coastal waters (Figure 2). Each station sampled by the individual surveys was defined as being within one of these 14 blocks. Soak time was calculated differently between the four surveys. However, as all four surveys allowed the gear to fish for one hour prior to retrieval, one hour was chosen to use as the soak time in the combined index.

The factors YEAR, MONTH, BLOCK, GEAR, DEPTH, SET TIME, MONTHLY RAINFALL (MONTHLY R), and PREVIOUS MONTH RAINFALL (PREV MON R) were examined for inclusion in the catch rate models. The factor MONTH includes the months that sampling was conducted. The northern Gulf of Mexico (Alabama, Mississippi, Louisiana, and Texas) was divided into 14 blocks (Figure 1), which is represented by the factor BLOCK. The factor GEAR refers to the 1.6 km standard bottom longline gear (BLL) used by Alabama, Mississippi, and Texas, and the 152 m bottom longline gear (HL) used by the inshore Mississippi survey. The factor SET TIME refers to the time of day the bottom longline was first deployed at the sampling location. The factors MONTHLY R and PREV MON R included the mean monthly and previous monthly rainfall (inches) within the state's coastal counties. Rainfall data was obtained through NOAA's regional climate center website (http://www.ncdc.noaa.gov/customer-support/partnerships/regional-climate-centers). The factor YEAR included each year in the time series from 2004 to 2011, and was included in the model whether it explained the data or not, so that an annual catch rate series was produced.

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for Atlantic sharpnose sharks (Lo *et al*. 1992). The main advantage of using this method is the 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) $$p = \frac{e^{X\beta+\varepsilon}}{1+e^{X\beta+\varepsilon}},$$

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.

Data Filtering

The initial model run with all the data included did converge. After examining all the different factors in the model, it was evident that the monthly distribution of the sampling was responsible. Ninety-five percent of the sampling effort occurred from March to October each year, with approximately 5% (62 stations) of the sampling effort occurring from November to February (Table 1). In addition, this winter effort only occurred off Alabama. Once this winter effort was removed from the data set, the model was able to converge.

RESULTS

From 2004 to 2011, 1,114 sites were sampled resulting in the catch of 3,895 Atlantic sharpnose sharks (Figures 3 and 4). The number of sites sampled varied across surveys with Alabama (452) having the highest number, followed by Mississippi inshore (323), Mississippi/Louisiana (281), and Texas (58). The total number of Atlantic sharpnose sharks captured each year ranged from 65 to 865 sharks (Table 2). Approximately 54% of the stations sampled contained positive catches of Atlantic sharpnose sharks, with Mississippi/Louisiana (64.8%) having the highest positive catch sites, followed by Texas (56.9%), Mississippi inshore (55.4%) and Alabama (45.0%).

Atlantic sharpnose sharks ranged in size from 360 to 963 mm FL (mean: 675.5 ± 1.8 mm FL). The length frequency histogram (Figure 5) indicated that 82.0% of the sharks were between 500 and 800 mm FL. Two peaks were prominent in the data set: one between 500-550 mm FL and the other between 600-800 mm FL (Figure 5). The nominal CPUE and number of stations with a positive catch for Atlantic sharpnose sharks are presented in Figure 6, which indicated annual variation in nominal CPUE, with varying proportion of positive catches over the years.

Atlantic sharpnose shark Catch

For the Atlantic sharpnose shark model YEAR, MONTH, BLOCK, GEAR and MONTHLY R were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, MONTH and BLOCK. Table 3 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 4747.1 and 1629.5, respectively. 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 4. Nominal and standardized Atlantic sharpnose shark catch rates remained relatively stable throughout the survey period (Figure 10).

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Table 1. Monthly distribution of sampling effort for each survey included in the combined northern Gulf of Mexico inshore bottom longline index.

	Month											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Alabama BLL	4	11	31	33	44	54	68	51	57	52	34	13
Mississippi/Louisiana BLL	0	0	36	34	35	36	29	38	37	36	0	0
Texas BLL	0	0	6	0	6	9	13	7	17	0	0	0
Mississippi HL	0	0	29	45	56	44	47	39	37	26	0	0
Total	**4**	**11**	**102**	**112**	**141**	**143**	**157**	**135**	**148**	**114**	**34**	**13**

Table 2. Summary of the Atlantic sharpnose shark data used in these analyses collected during the Mississippi bottom longline survey conducted between 2004 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
2004	46	119	114	360	912	704	99
2005	27	65	65	510	840	710	82
2006	127	277	272	431	940	693	117
2007	173	351	351	435	958	690	120
2008	219	778	759	420	924	664	102
2009	159	720	692	420	963	666	111
2010	184	865	799	421	950	684	100
2011	179	720	684	420	931	664	111
Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured			Overall Mean Fork Length (mm)	
8	1114	3895	3755			676	

Table 3. Summary of the backward selection procedure for building delta-lognormal submodels for the Atlantic sharpnose shark full index of relative abundance from 2004 to 2011.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 4789.0)*						*Lognormal Submodel Type 3 Tests (AIC 1666.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	289	10.44	1.47	0.1650	0.1767	7	552	0.41	0.8972
Month	7	967	54.13	7.73	<.0001	<.0001	7	552	3.49	0.0011
Block	13	888	98.38	7.56	<.0001	<.0001	13	552	4.97	<.0001
Gear	1	764	11.36	11.36	0.0007	0.0008	1	552	1.52	0.2185
Depth	1	919	1.00	1.00	0.3170	0.3172	1	552	0.02	0.8814
Set_Time	1	969	1.72	1.72	0.1892	0.1895	1	552	2.74	0.0983
Monthly_R	1	789	8.93	8.93	0.0028	0.0029	1	552	1.73	0.1895
Prev_Mon_R	1	783	1.69	1.69	0.1932	0.1936	1	552	3.59	0.0586

Model Run #2	*Binomial Submodel Type 3 Tests (AIC 4782.1)*						*Lognormal Submodel Type 3 Tests (AIC 1660.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	288	9.71	1.37	0.2054	0.2179	7	553	0.42	0.8912
Month	7	969	54.36	7.76	<.0001	<.0001	7	553	3.52	0.0011
Block	13	881	97.77	7.51	<.0001	<.0001	13	553	5.40	<.0001
Gear	1	767	11.57	11.57	0.0007	0.0007	1	553	1.50	0.2217
Depth					Dropped				Dropped	
Set_Time	1	968	1.80	1.80	0.1791	0.1795	1	553	2.75	0.0980
Monthly_R	1	796	8.77	8.77	0.0031	0.0032	1	553	1.74	0.1873
Prev_Mon_R	1	788	1.63	1.63	0.2020	0.2024	1	553	3.60	0.0581

Model Run #3	*Binomial Submodel Type 3 Tests (AIC 4771.0)*						*Lognormal Submodel Type 3 Tests (AIC 1659.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	277	10.57	1.49	0.1587	0.1710	7	554	0.49	0.8449
Month	7	984	56.14	8.02	<.0001	<.0001	7	554	3.42	0.0014
Block	13	879	97.08	7.46	<.0001	<.0001	13	554	5.87	<.0001
Gear	1	768	11.76	11.76	0.0006	0.0006			Dropped	
Depth					Dropped				Dropped	
Set_Time	1	969	1.68	1.68	0.1944	0.1948	1	554	2.45	0.1182
Monthly_R	1	811	7.25	7.25	0.0071	0.0072	1	554	1.75	0.1860
Prev_Mon_R					Dropped		1	554	3.86	0.0498

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 4747.1)*						*Lognormal Submodel Type 3 Tests (AIC 1654.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	272	9.27	1.31	0.2338	0.2474	7	555	0.41	0.8993
Month	7	985	56.39	8.05	<.0001	<.0001	7	555	3.21	0.0024
Block	13	880	96.82	7.44	<.0001	<.0001	13	555	5.88	<.0001
Gear	1	759	10.83	10.83	0.0010	0.0010			Dropped	
Depth					Dropped				Dropped	
Set_Time					Dropped		1	555	2.23	0.1358
Monthly_R	1	824	7.29	7.29	0.0069	0.0071			Dropped	
Prev_Mon_R					Dropped		1	555	2.48	0.1155

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 4747.1)*						*Lognormal Submodel Type 3 Tests (AIC1634.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	272	9.27	1.31	0.2338	0.2474	7	556	0.45	0.8684
Month	7	985	56.39	8.05	<.0001	<.0001	7	556	3.18	0.0026
Block	13	880	96.82	7.44	<.0001	<.0001	13	556	5.72	<.0001
Gear	1	759	10.83	10.83	0.0010	0.0010			Dropped	
Depth					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Monthly_R	1	824	7.29	7.29	0.0069	0.0071			Dropped	
Prev_Mon_R					Dropped		1	556	2.15	0.1433

Model Run #6	*Binomial Submodel Type 3 Tests (AIC 4747.1)*						*Lognormal Submodel Type 3 Tests (AIC 1629.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	7	272	9.27	1.31	0.2338	0.2474	7	557	0.45	0.8690
Month	7	985	56.39	8.05	<.0001	<.0001	7	557	2.83	0.0066
Block	13	880	96.82	7.44	<.0001	<.0001	13	557	5.80	<.0001
Gear	1	759	10.83	10.83	0.0010	0.0010			Dropped	
Depth					Dropped				Dropped	
Set_Time					Dropped				Dropped	
Monthly_R	1	824	7.29	7.29	0.0069	0.0071			Dropped	
Prev_Mon_R					Dropped				Dropped	

Table 4. Indices for Atlantic sharpnose shark catch rates from 2004 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	*NominalFrequency*	*N*	*LoIndex*	*ScaledLoIndex*	*CV*	*LCL*	*UCL*
2004	0.56522	46	4.05914	1.12944	0.20077	0.75893	1.68084
2005	0.70370	27	4.10993	1.14357	0.18872	0.78665	1.66245
2006	0.50000	112	3.14712	0.87567	0.13500	0.66929	1.14570
2007	0.53896	154	3.13573	0.87250	0.11358	0.69572	1.09421
2008	0.54902	204	3.68926	1.02652	0.12315	0.80316	1.31199
2009	0.55484	155	3.56933	0.99315	0.13758	0.75521	1.30605
2010	0.63842	177	3.62161	1.00770	0.11218	0.80575	1.26027
2011	0.50847	177	3.41944	0.95144	0.13005	0.73434	1.23274

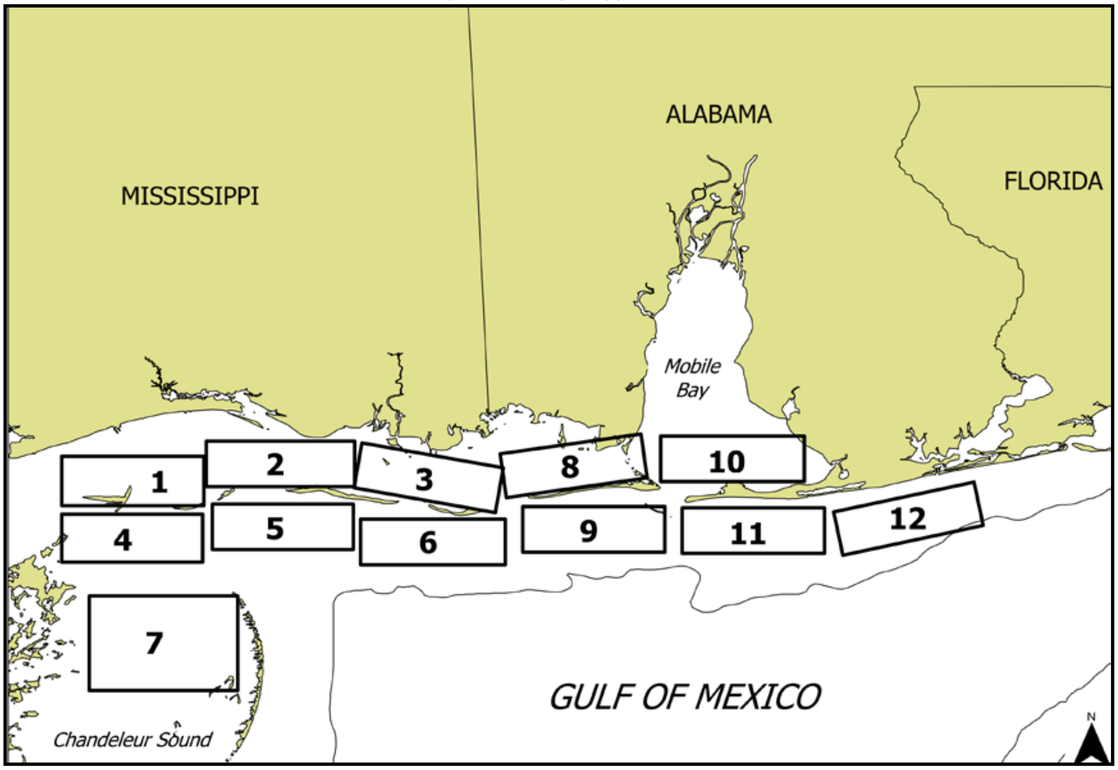


Figure 1. Sampling universe for the combined Louisiana/Mississippi/Alabama bottom longline index. The study area was divided into 12 blocks: 11 blocks (1-6 and 8-12) were the same size (156 km^2), and one block (7) was larger (306 km^2). Monthly sampling sites were randomly selected within each of the blocks.

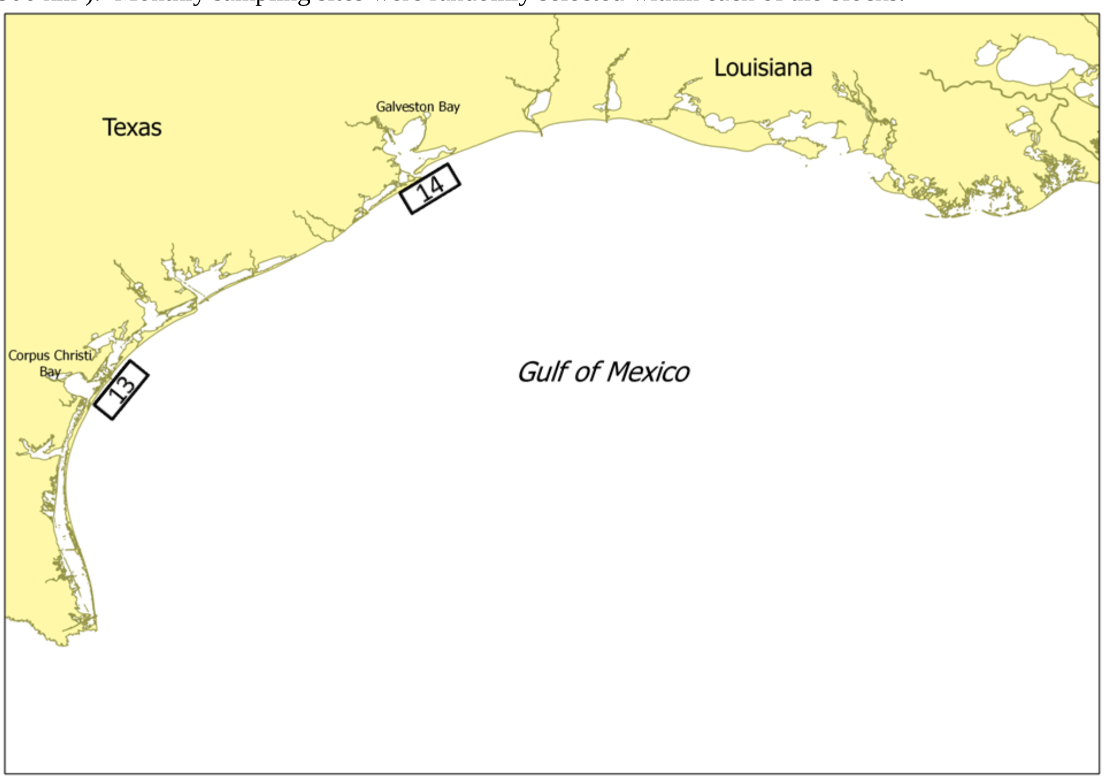


Figure 2. Sampling universe for Texas bottom longline index. The study area consisted of two 720 km^2 blocks. Sampling sites were randomly selected within each of the blocks.

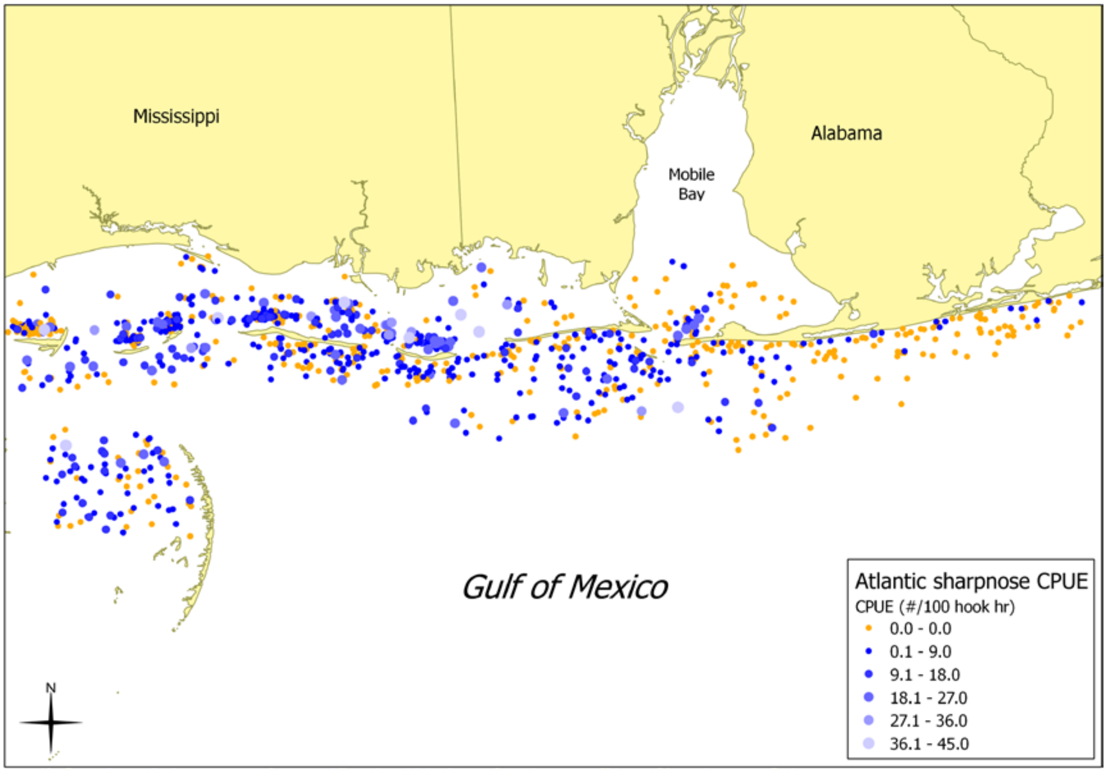


Figure 3. Stations sampled using bottom longline gear from 2004 to 2011 in Mississippi, Alabama, and Louisiana coastal waters with total Atlantic sharpnose shark CPUE presented.

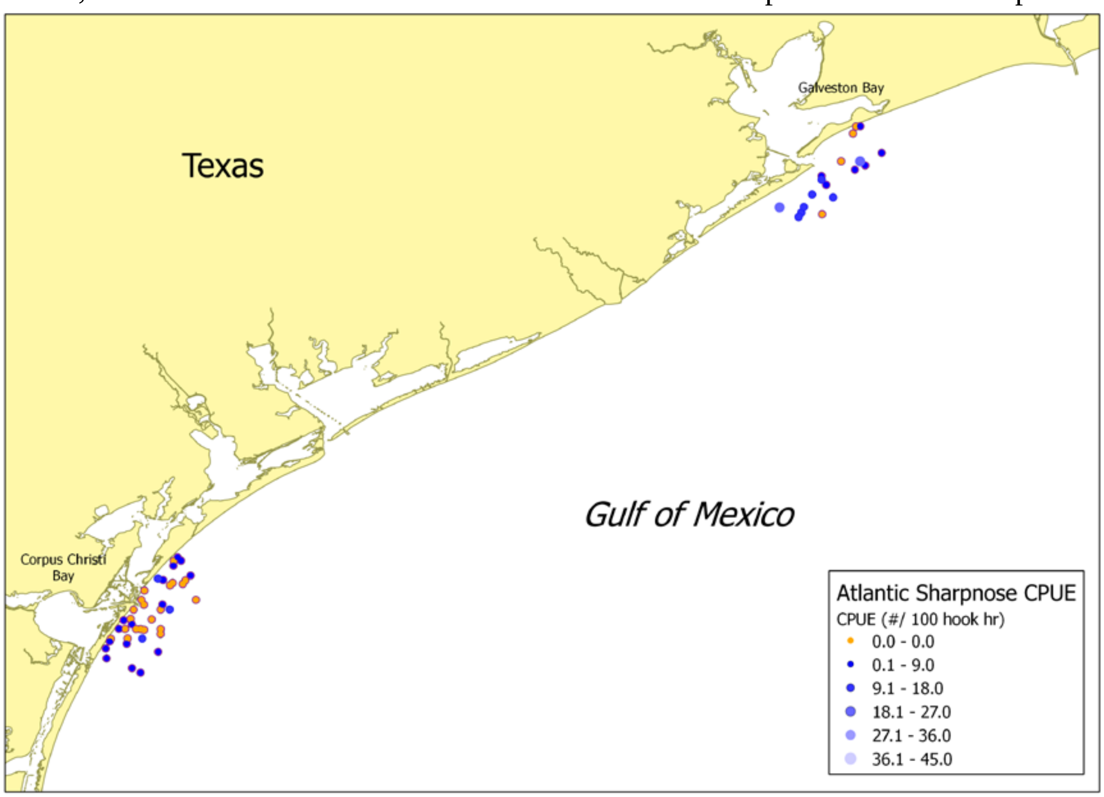


Figure 4. Stations sampled using bottom longline gear from 2008 to 2011 in Texas coastal waters with total Atlantic sharpnose shark CPUE presented.

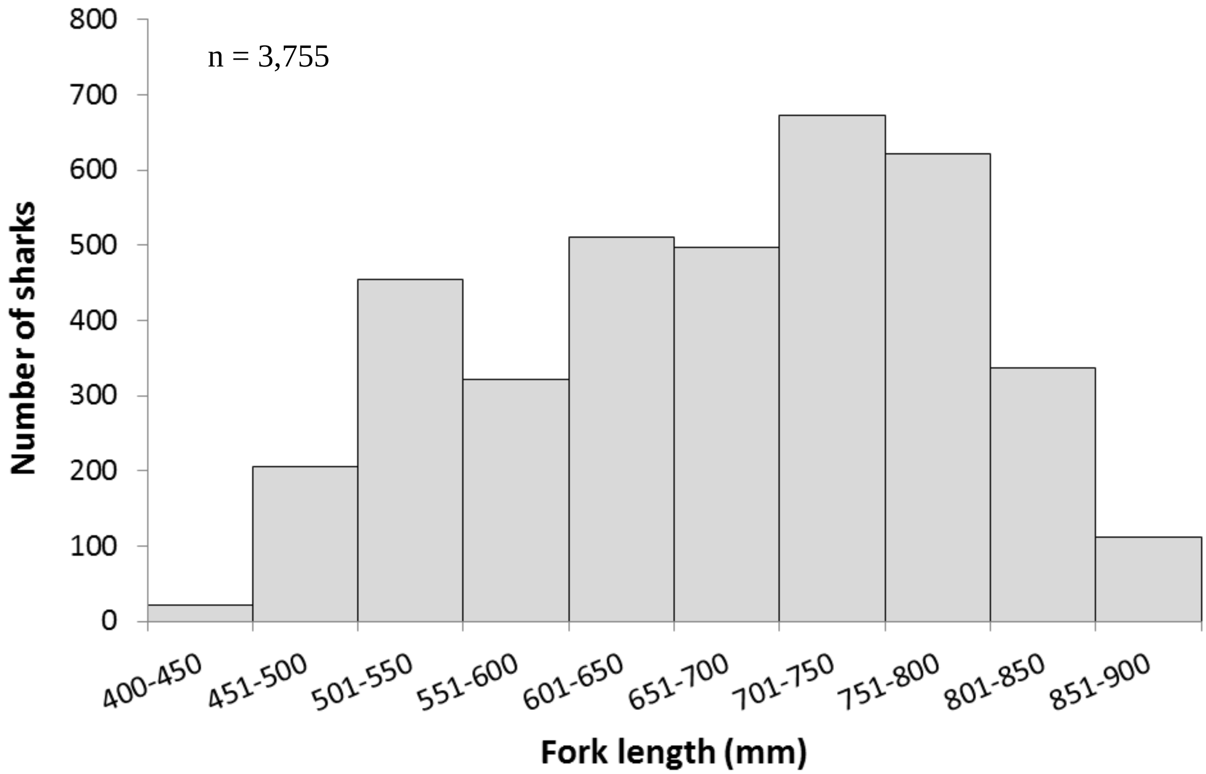


Figure 5. Length frequency distribution for all Atlantic sharpnose sharks captured in Mississippi, Alabama, Louisiana, and Texas.

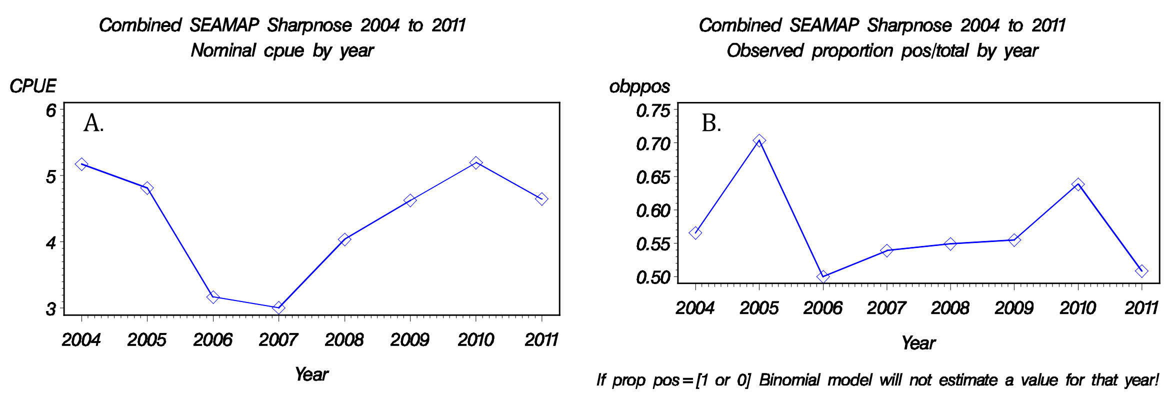


Figure 6. Annual trends for Atlantic sharpnose sharks captured during the combined northern Gulf of Mexico bottom longline survey from 2004 to 2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

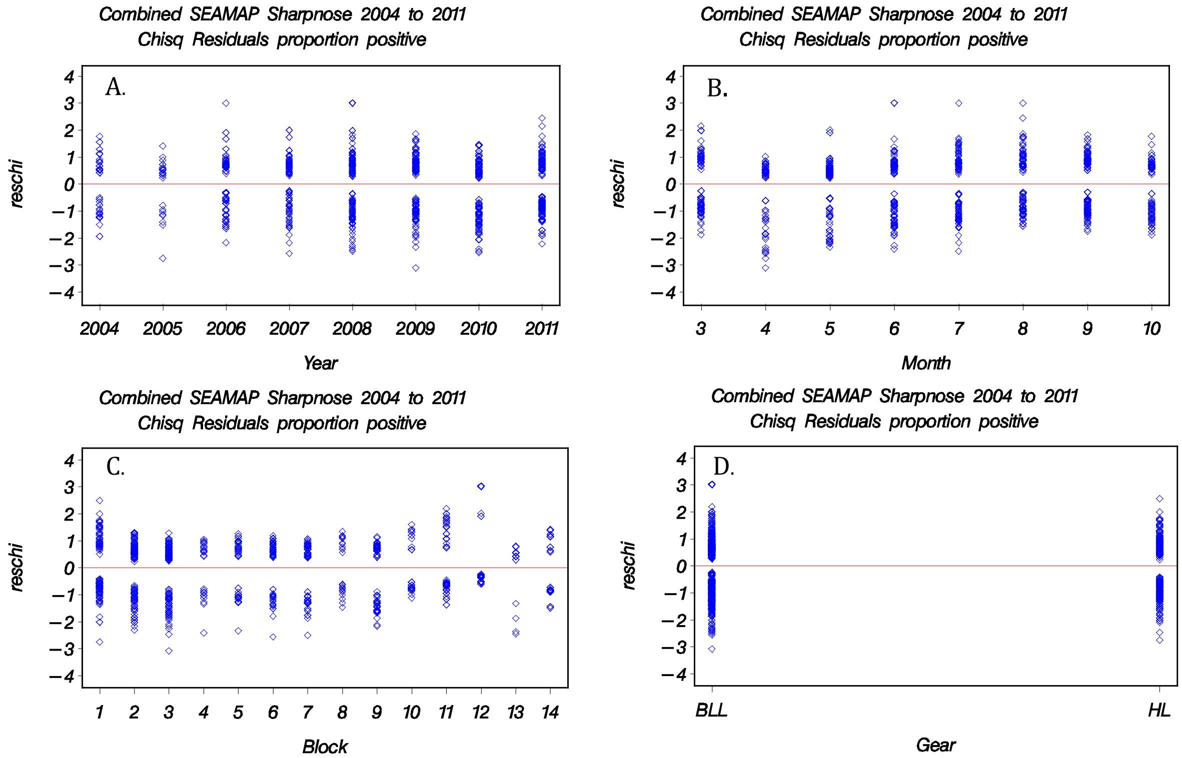


Figure 7. Diagnostic plots for the binomial component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month, **C.** the Chi-Square residuals by block, **D.** the Chi-Square residuals by gear type.

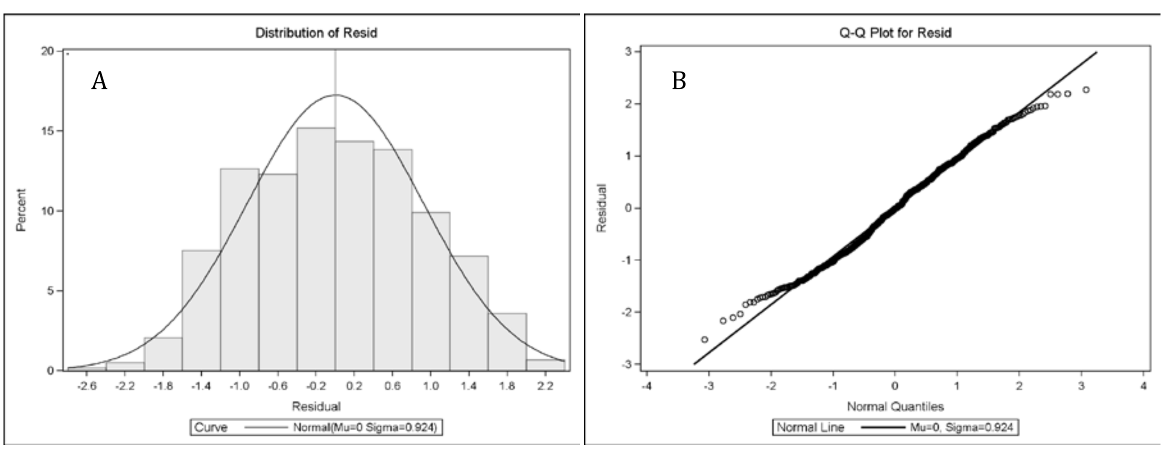


Figure 8. Diagnostic plots for the lognormal component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

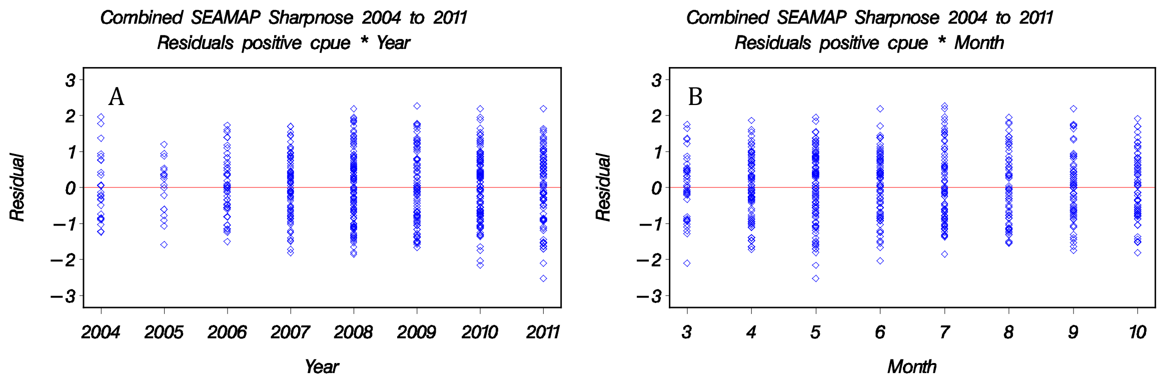


Figure 9. Diagnostic plots for the lognormal component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by month.

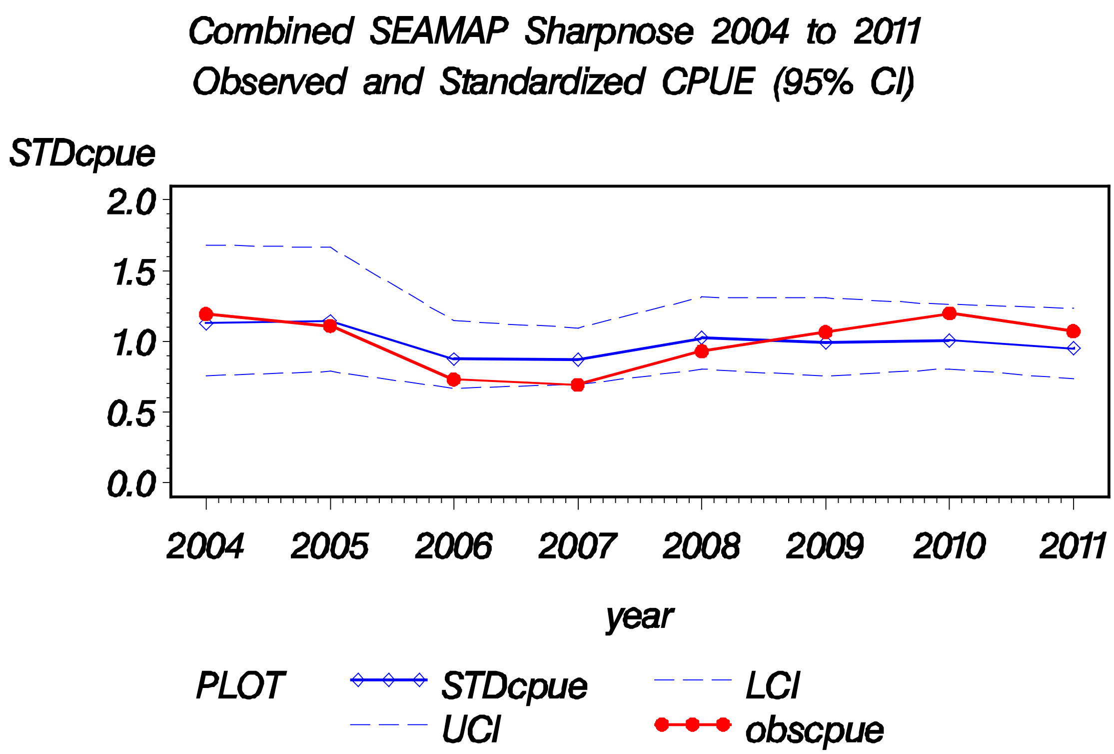
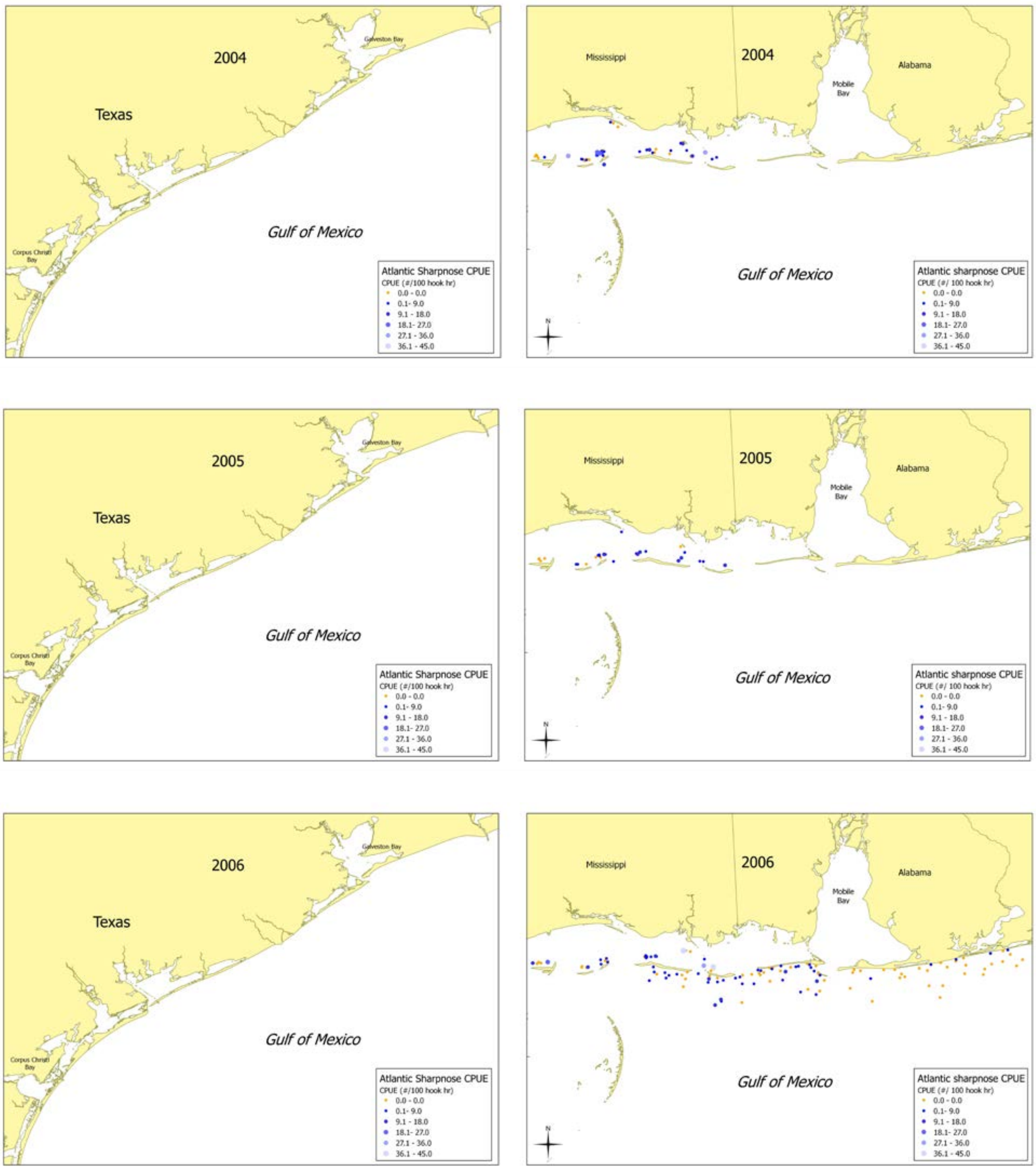


Figure 10. Observed and standardized CPUE for Atlantic sharpnose shark catch in the combined northern Gulf of Mexico bottom longline survey from 2004-2011.

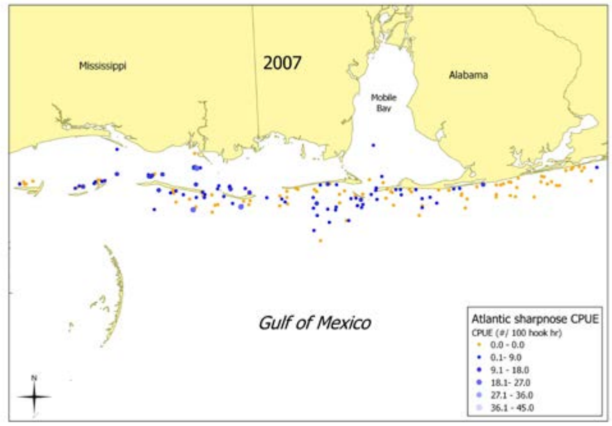
Appendix:

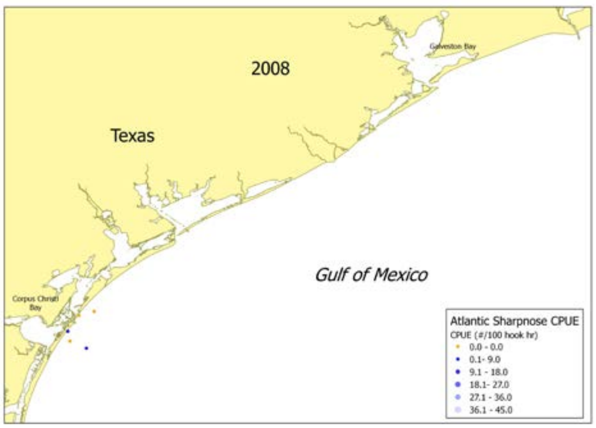
Annual Effort and Catch

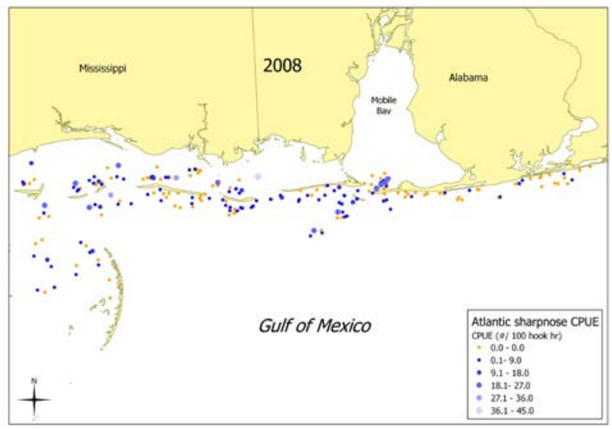
Appendix Figure 1. Annual survey effort and catch of Atlantic sharpnose sharks from the combined northern Gulf of Mexico inshore bottom longline survey from 2004-2011.

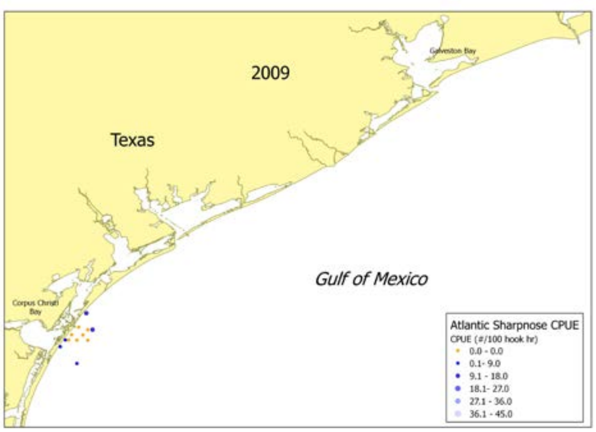


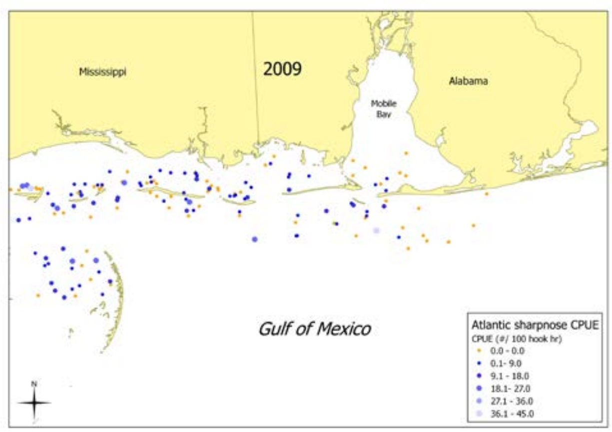

Galveston Bay
2007
Texas
Gulf of Mexico
Corpus Christi Bay
Atlantic Sharpnose CPUE
CPUE (#/100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0

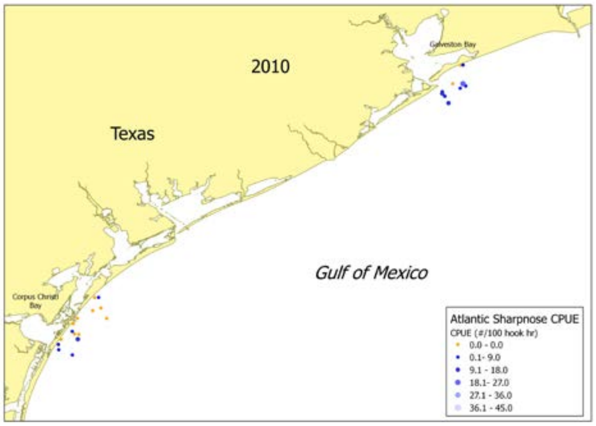

Mississippi
2007
Mobile Bay
Alabama
Gulf of Mexico
N
Atlantic sharpnose CPUE
CPUE (#/ 100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0

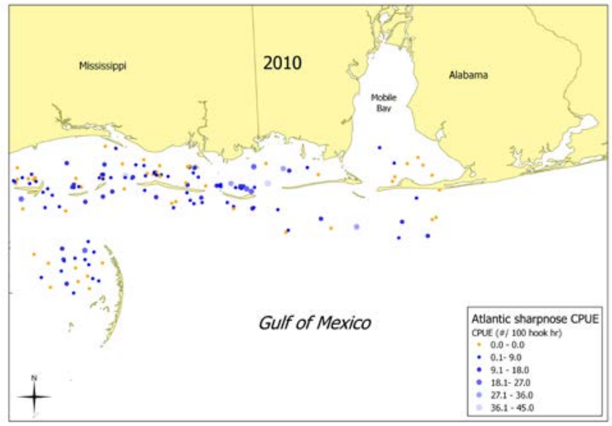

Galveston Bay
2008
Texas
Gulf of Mexico
Corpus Christi Bay
Atlantic Sharpnose CPUE
CPUE (#/100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0

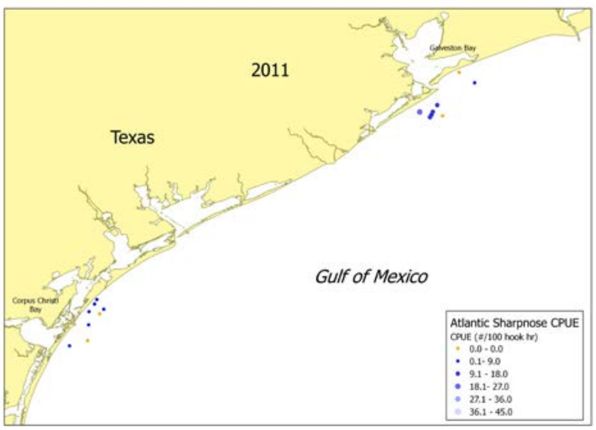

Mississippi
2008
Mobile Bay
Alabama
Gulf of Mexico
N
Atlantic sharpnose CPUE
CPUE (#/ 100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0

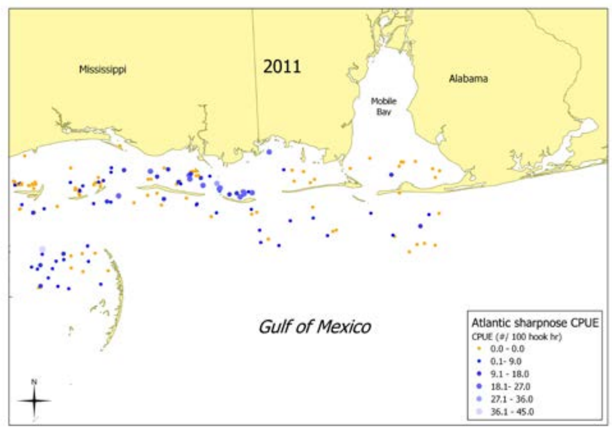

Galveston Bay
2009
Texas
Gulf of Mexico
Corpus Christi Bay
Atlantic Sharpnose CPUE
CPUE (#/100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0


Mississippi
2009
Mobile Bay
Alabama
Gulf of Mexico
N
Atlantic sharpnose CPUE
CPUE (#/ 100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0


2010
Texas
Galveston Bay
Corpus Christi Bay
Gulf of Mexico
Atlantic Sharpnose CPUE
CPUE (#/100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0


Mississippi
2010
Alabama
Mobile Bay
Gulf of Mexico
N
Atlantic sharpnose CPUE
CPUE (#/ 100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0


2011
Texas
Galveston Bay
Corpus Christi Bay
Gulf of Mexico
Atlantic Sharpnose CPUE
CPUE (#/100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0


Mississippi
2011
Alabama
Mobile Bay
Gulf of Mexico
N
Atlantic sharpnose CPUE
CPUE (#/ 100 hook hr)
0.0 - 0.0
0.1- 9.0
9.1 - 18.0
18.1- 27.0
27.1 - 36.0
36.1 - 45.0

<u>SEDAR 34-WP-11 Addendum.</u> The changes to document 11 as a result of plenary discussions at the SEDAR 34 data workshop are discussed below.

Issue #1 – The inclusion of the Texas SEAMAP bottom longline data set

This document combines several small-scale bottom longline data sets from the northern Gulf of Mexico into a single spatiotemporally broader index. Three of the four indices formed a continuous area from Chandeleur Sound, LA to the Alabama/Florida border; however, the Texas data set was disjunct from the others. In addition, the Texas data set only included 58 stations over fours, representing 5.2% of the stations in the combined index. As a result, it was suggested during plenary that we removed the Texas data set from the combined index due to the small sample size and disconnected nature of the data set.

In response to the suggestions of the group, the Texas data set was removed from the analysis.

Issue #2 – The potential influence of environmental variables when developing the standardized index

Within the combined bottom longline data set, 98 Alabama stations did not include any environmental data (e.g. temperature, salinity, and dissolved oxygen). Due to the large number of stations missing environmental data, we initially analyzed the entire data set without the use of the environmental data; however, it was suggested during plenary that we rerun the analysis with and without the inclusion of the environmental data to determine their potential influence on the index. After examining the results of both analyses, the group preferred the analysis without the environmental data, which included the entire data set (minus the Texas data).

In response to the suggestions of the group, the entire data set minus the Texas data was reanalyzed and the updated results are below.

RESULTS

From 2004 to 2011, 1,056 sites were sampled resulting in the catch of 3,666 Atlantic sharpnose sharks. The number of sites sampled varied across surveys with Alabama (452) having the highest number, followed by Mississippi inshore (323), and Mississippi/Louisiana (281). Approximately 54% of the stations sampled contained positive catches of Atlantic sharpnose sharks, with Mississippi/Louisiana (64.8%) having the highest positive catch sites, followed by Mississippi inshore (55.4%) and Alabama (45.0%). The nominal CPUE and number of stations with a positive catch for Atlantic sharpnose sharks are presented in Figure 6, which indicated annual variation in nominal CPUE, with varying proportion of positive catches over the years.

Atlantic sharpnose shark Catch

For the Atlantic sharpnose shark model YEAR, MONTH, BLOCK, GEAR and MONTHLY R were retained in the binomial submodel. The variables retained in the lognormal submodel were YEAR, MONTH and BLOCK. The AIC for the binomial and lognormal submodels were 4503.0 and 1539.0, respectively. 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 4. Nominal and standardized Atlantic sharpnose shark catch rates remained relatively stable throughout the survey period (Figure 10).

Table 4. Indices for Atlantic sharpnose shark catch rates from 2004 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	*NominalFrequency*	*N*	*LoIndex*	*ScaledLoIndex*	*CV*	*LCL*	*UCL*
2004	0.56522	46	3.98854	1.15135	0.21142	0.75784	1.74920
2005	0.70370	27	3.99983	1.15461	0.20316	0.77225	1.72630
2006	0.50000	112	3.08506	0.89055	0.14009	0.67386	1.17693
2007	0.53896	154	3.03976	0.87747	0.11809	0.69345	1.11034
2008	0.55276	199	3.57377	1.03162	0.13092	0.79486	1.33892
2009	0.56643	143	3.27442	0.94521	0.14742	0.70497	1.26733
2010	0.65132	152	3.66112	1.05684	0.12191	0.82892	1.34743
2011	0.48447	161	3.09124	0.89233	0.14620	0.66713	1.19357

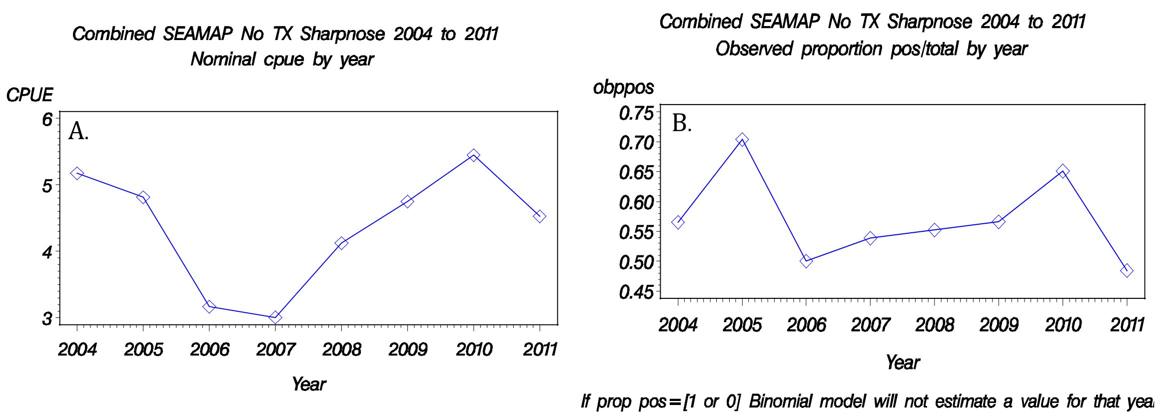


Figure 6. Annual trends for Atlantic sharpnose sharks captured during the combined northern Gulf of Mexico bottom longline survey from 2004 to 2011 in **A.** nominal CPUE and **B.** proportion of positive stations.

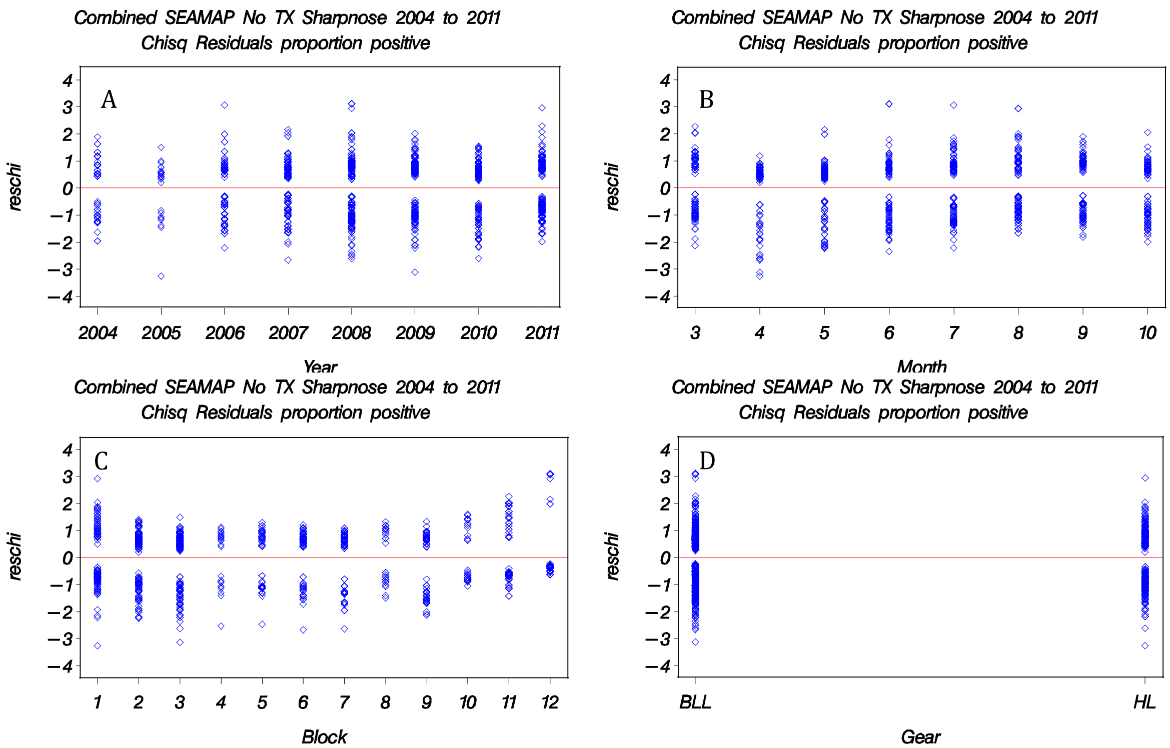


Figure 7. Diagnostic plots for the binomial component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by month, **C.** the Chi-Square residuals by block, **D.** the Chi-Square residuals by gear type.

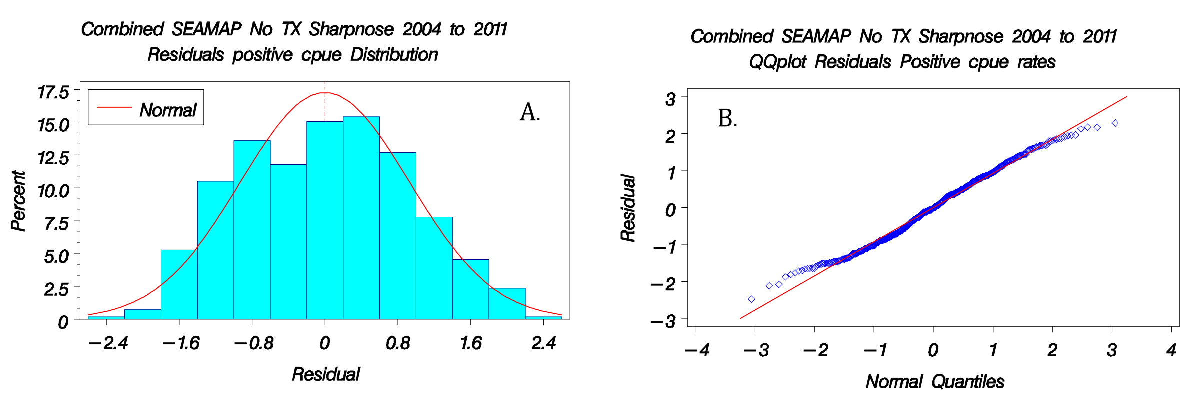


Figure 8. Diagnostic plots for the lognormal component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

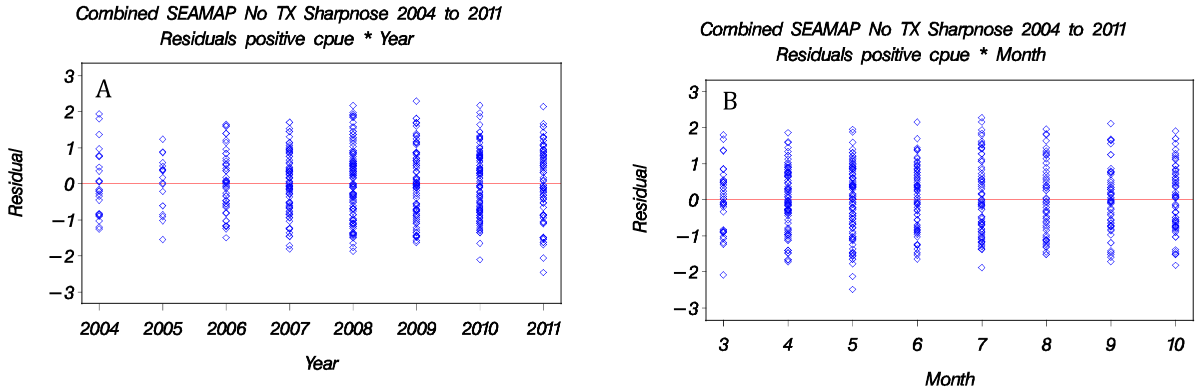


Figure 9. Diagnostic plots for the lognormal component of the Atlantic sharpnose shark combined northern Gulf of Mexico bottom longline survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by month.

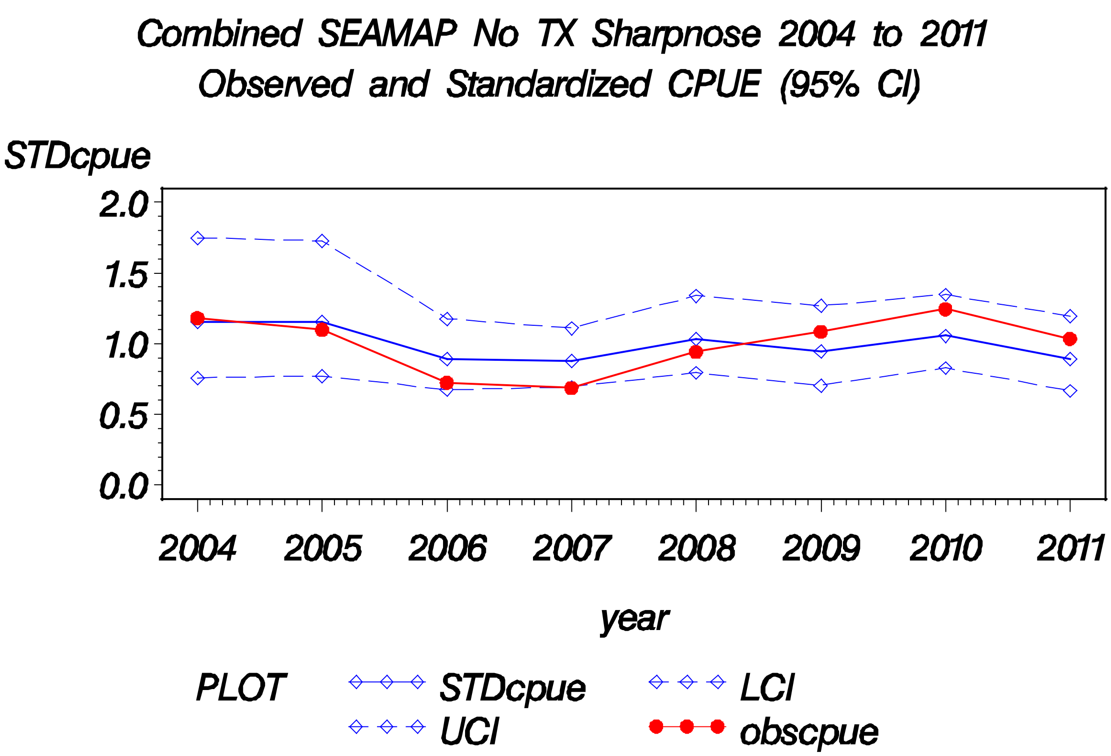


Figure 10. Observed and standardized CPUE for Atlantic sharpnose shark catch in the combined northern Gulf of Mexico bottom longline survey from 2004-2011.