Standardized recruitment index for blacktip sharks caught during the South Carolina Department of Natural Resource's Cooperative Atlantic States Shark Pupping and Nursery short-gillnet survey

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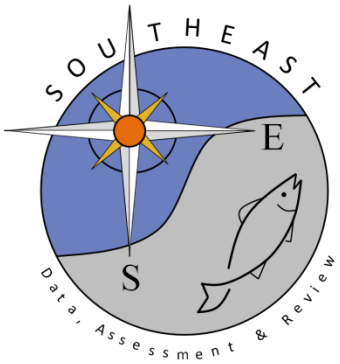
SEDAR65-DW10

11/25/19
Revised 12/10/19



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Please cite this document as:

Frazier, Bryan S. and Camilla T. McCandless. 2019. Standardized recruitment index for blacktip sharks caught during the South Carolina Department of Natural Resource's Cooperative Atlantic States Shark Pupping and Nursery short-gillnet survey. SEDAR65-DW10. SEDAR, North Charleston, SC. 8 pp.

SEDAR 65 DATA WORKSHOP DOCUMENT

Standardized recruitment index for blacktip sharks caught during the South Carolina Department of Natural Resources, Cooperative Atlantic States Shark Pupping and Nursery short-gillnet survey

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November 2019

Workshop Draft not to be cited without permission of authors

Summary

This document details blacktip shark catches from the South Carolina Department of Natural Resources (SCDNR), Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) short-gillnet survey (2006-2018). Catch per unit effort (CPUE) in number of sharks per net hour were used to examine the young-of-year (YOY) blacktip sharks trend in South Carolina estuaries for use as a recruitment index in the SEDAR 65 stock assessment. The CPUE was standardized using generalized linear models in a two-step delta-lognormal approach that models the proportion of positive catch with a binomial error distribution separately from the positive catch, which is modeled using a lognormal distribution. Nominal and standardized CPUE results from the COASTSPAN short-gillnet survey indicate a slight increasing trend overall in YOY blacktip shark relative abundance during the survey years with notable peaks in 2007 and 2012.

Introduction

In an effort to increase sampling effort in South Carolina's estuarine waters the South Carolina Department of Natural Resources (SCDNR) Marine Resources Division, in collaboration with the National Marine Fisheries Service's (NMFS) Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey added an additional survey gear (short gillnet) in 2006 to the established longline and gillnet methods that had been ongoing in several estuaries within South Carolina since 1998.

Methods

Sampling design

The use of short gillnets allowed concurrent sampling of adjacent shorelines using gillnets in already established COASTSPAN longline survey locations that had been sampled since 1998. These had been previously selected in the lower reaches of estuaries in depths which would facilitate the deployment and retrieval of hand deployed longlines (i.e. current velocity, tidal range, vessel traffic). All gillnet sampling occurred inside of inlets and sampling locations varied with regard to distance from nearshore waters. Sampling was conducted primarily from April through October with the majority of the effort occurring between May and September.

Sampling gear and data collection

The SC COASTSPAN short gillnet survey used an anchored gillnet, 3 m deep and constructed of #177 monofilament twine with a stretched mesh of 10.3 cm. This net was approximately 45 m in length. The shorter length (large gillnet survey was 230m) allowed for sampling in different environments (i.e. areas too small for the larger net). The net was set in <4 m of water adjacent to shorelines and inspected for catch at approximately 20-minute intervals to reduce mortality. Station location, water temperature, salinity, dissolved oxygen set and pickup time and time of day were recorded for each sex. The sex, fork length, total length, and umbilical scar condition of all sharks were recorded. Umbilical scar condition was recorded in six categories: "umbilical remains," "fresh open," "partially healed," "mostly healed," "well healed," and none. Sharks were then tagged with either a NMFS blue rototag or steel tipped dart tag (M-tag) and released.

Data Analysis

For the purposes of SEDAR 65, blacktip sharks larger than 660 mm FL (>1 yo animals) were excluded from analysis of the short-gillnet survey data (7 blacktips removed). Catch per unit effort (CPUE) in number of sharks per net hour was used to examine the relative abundance of young-of the-year (YOY) blacktip sharks. The CPUE was standardized using a delta-lognormal generalized linear model, which models the proportion of positive sets separately from the positive catch. After initial exploratory analyses, factors considered as potential influences on the catch were year (2006-2018), month (May-August), salinity (<20 ppt, 20-24.9 ppt, 25-29.9 ppt, 30+ ppt), tide (early flood, mid flood, late flood, high, early ebb, mid ebb, late ebb, low) and area (stations located in Bulls Bay and St Helena Sound). The proportion of sets with positive catch values was modeled assuming a binomial distribution with a logit link function and the positive catch sets were modeled assuming a lognormal distribution.

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

Results

A total of 233 YOY blacktip sharks were caught during the 637 gillnet sets from 2006 to 2018 included in these analyses for index development. The length frequency of all captured blacktips during the short-gillnet survey is displayed in Figure 1, with the majority (97%) of the catch as YOY. The proportion of sets with positive catch (at least one YOY blacktip shark caught) was 23%. The stepwise construction of each model and the resulting statistics are detailed in Table 1. Model diagnostic plots reveal that the model fit is acceptable (Figures 3 and 4). The resulting indices of abundance based on the year effect least square means, associated statistics and nominal indices are reported in Table 2 and are plotted by year in Figure 5. Nominal and standardized CPUE results from the COASTSPAN short-gillnet survey indicate a slight increasing trend overall in YOY blacktip shark relative abundance during the survey years with notable peaks in 2007 and 2012.

Table 1. Results of the stepwise procedure for development of the SCDNR COASTSPAN small gillnet catch rate model for blacktip sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQ	PR>CHI
null	224	344.2514	1.5368				
month	221	281.3119	1.2729	17.1720		62.94	<.0001
sal	221	334.7184	1.5146	1.4446		9.53	0.0230
year	212	322.2347	1.5200	1.0932		22.02	0.0373
area	220	338.3041	1.5377	-0.0586		5.95	0.2031
tide	222	342.1576	1.5413	-0.2928		2.09	0.3510
month +							
year	209	253.8286	1.2145	20.9721	3.8001	27.48	0.0066
sal	218	275.3322	1.2630	17.8162	0.6442	5.98	0.1126

FINAL MODEL: month + year

AIC 137.1 **BIC** 138.6 **(-2) Res LL** 135.1

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	month	year
DF	3	12
CHI SQUARE	25.00	12.25

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQ	PR>CHI
null	154	57.4488	0.3730				
month	151	50.3736	0.3336	10.5630		20.37	0.0001
area	150	54.5806	0.3639	2.4397		7.94	0.0939
tide	152	56.1132	0.3692	1.0188		3.65	0.1615
sal	152	56.4467	0.3714	0.4290		2.73	0.2557
year	142	53.8999	0.3796	-1.7694		9.88	0.6262
month +							
year	139	45.7578	0.3292	11.7426	13.5121	14.90	0.2472

FINAL MODEL: month + year

AIC 279.4 **BIC** 282.4 **(-2) Res LL** 277.4

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	month	year
DF	3	12
CHI SQUARE	24.73	14.02

Table 2. SCDNR COASTSPAN small gillnet blacktip shark analysis number of model observations per year (n obs), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per 100 hook hours (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCL), the upper 95% confidence limit for the est cpue (UCL), and the coefficient of variation for the estimated cpue (CV).

year	nobs	obs pos	obs ppos	obs cpue	est cpue	LCL	UCL	CV
2006	73	13	0.1781	0.4851	0.4978	0.2103	1.1783	0.4516
2007	24	6	0.2500	0.8916	1.4930	0.5625	3.9631	0.5187
2008	31	2	0.0645	0.1849	0.3010	0.0473	1.9142	1.1630
2009	12	2	0.1667	0.2152	0.3086	0.0506	1.8799	1.1235
2010	43	11	0.2558	0.5819	0.5651	0.2288	1.3956	0.4762
2011	62	11	0.1774	0.5671	0.6010	0.2396	1.5077	0.4853
2012	85	28	0.3294	1.1167	1.0683	0.6080	1.8772	0.2875
2013	64	13	0.2031	0.5878	0.8272	0.3655	1.8721	0.4261
2014	54	6	0.1111	0.2228	0.2497	0.0713	0.8750	0.6939
2015	73	13	0.1781	0.6338	0.5397	0.2253	1.2930	0.4586
2016	81	10	0.1235	0.3105	0.2959	0.1102	0.7950	0.5259
2017	86	16	0.1860	0.6251	0.6881	0.3150	1.5031	0.4061
2018	97	24	0.2474	0.9213	1.2167	0.6624	2.2347	0.3111

Figure 1. Length Frequency (mm fork length) of blacktip sharks captured in the South Carolina Department of Natural Resources Cooperative Atlantic States Shark Pupping and Nursery short-gillnet survey (n=240), seven animals were excluded from analysis (>660 mm animals considered 1 year old+).

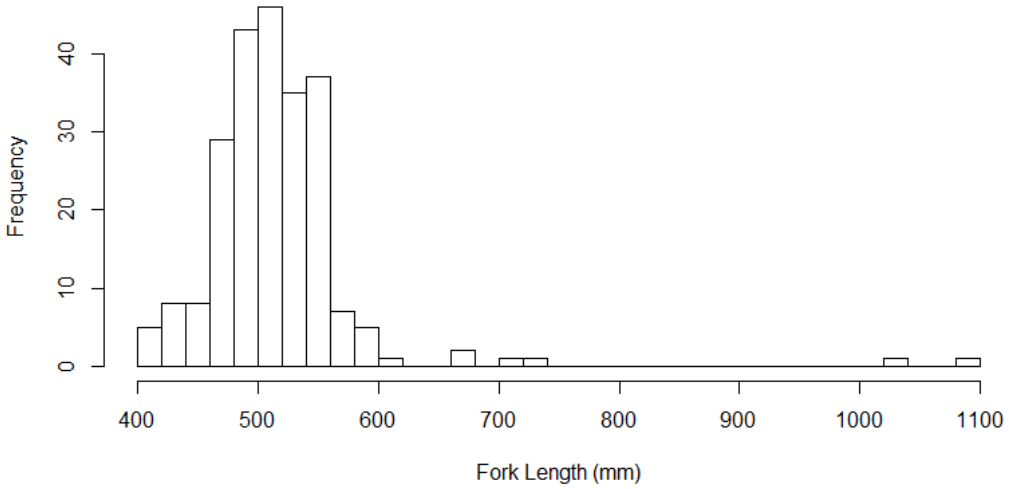


Figure 2. Model diagnostic plots for the binomial component.

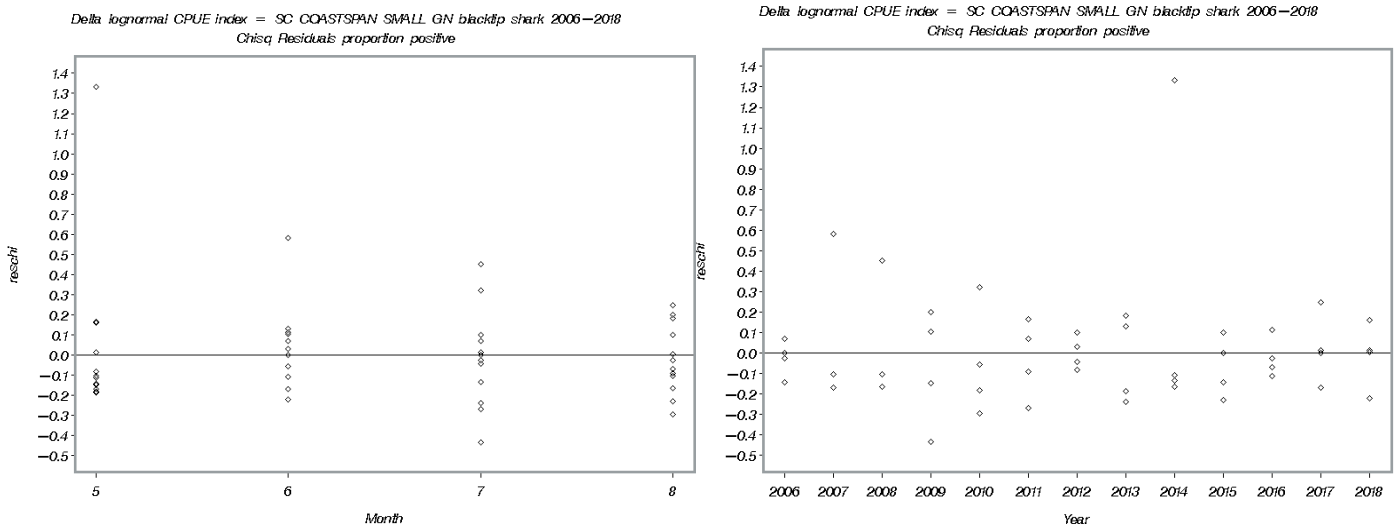
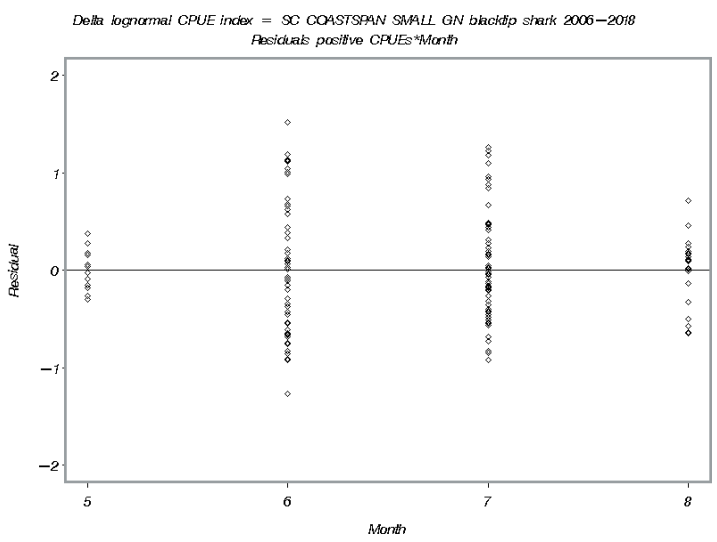
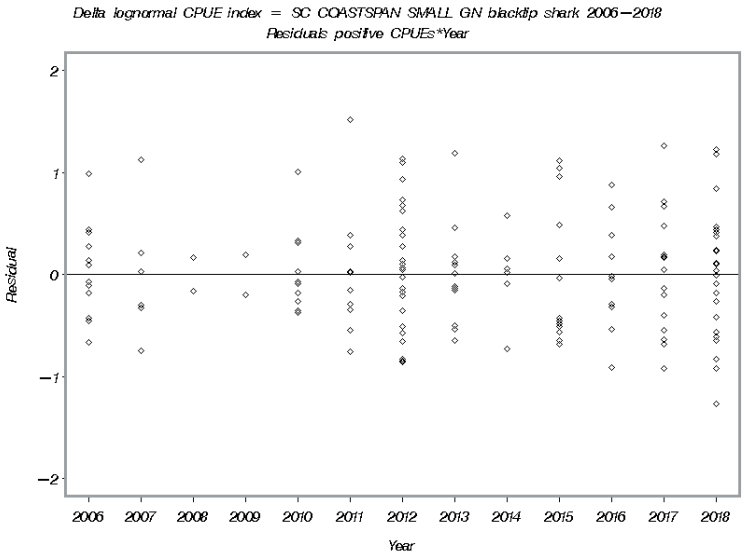
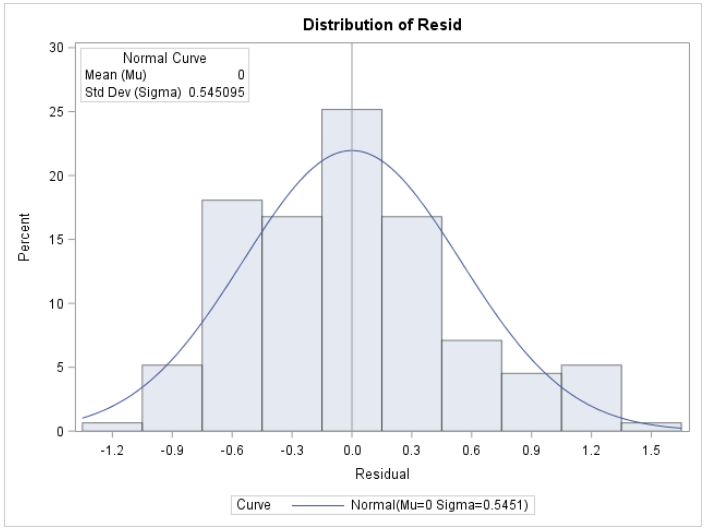


Figure 4. Model diagnostic plots for the lognormal component.







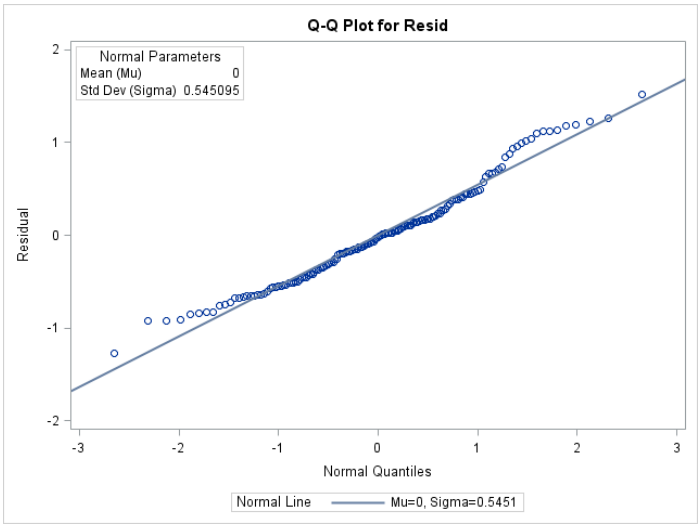


Figure 5. SCDNR COASTSPAN small gillnet blacktip shark nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCI0, UCI0).