STANDARDIZED CATCH RATES OF LARGE COASTAL SHARKS FROM A FISHERY-INDEPENDENT SURVEY IN NORTHWEST FLORIDA

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INTRODUCTION

A fishery-independent survey of large and small coastal shark populations in coastal nursery areas of the northeast Gulf of Mexico has been conducted using gillnets from 1996-2004 and longlines from 1993-2000. Although field methods were standardized, some bias associated with factors such as spatial-temporal distributions could not be controlled which could cause changes in catch rates not directly related to abundance. The present study attempts to standardize catch rates using a modified two-step approach originally proposed by Lo et al. (1992). Catch rate series are developed for the large coastal species-aggregate, and blacktip shark, *Carcharhinus limbatus* from the longline survey. From the gillnet survey, catch rates are standardized for the large coastal species-aggregate, all blacktip sharks, and all sandbar sharks. Two additional catch rate series are also developed by age for the blacktip shark; young-of-the year (age 0+) and juvenile (age 1-5).

MATERIAL AND METHODS

Field data collection

Gillnets

A 186-m long gill net consisting of six different mesh size panels was utilized for sampling. Stretched mesh sizes (SM) ranged from 8.9 cm (3.5") to 14.0 cm (5.5") in steps of 1.27 cm (0.5"), with an additional size of 20.3 cm (8.0"). Panel depths when fishing were 3.1 m. Webbing for all panels, except for 20.3-cm, was of clear monofilament, double knotted and double selvaged. The 20.3-cm SM webbing was made of #28 multifilament nylon, single knotted, and double selvage. The nets when set were anchored at both ends.

Longline

The longline was constructed of a mainline made of two 152-m lengths of 425.8 kg-test monofilament line. Each 152-m length was connected by a 15.2-m length of 0.79-cm diameter braided polypropylene line so that the entire line when fished was 319.2 m long. Polyethylene floats made of 1.5-m lengths of 136-kg test monofilament line with a snap were attached to the mainline every 30.4 m. A standard longline consisted of 10-20 gangions placed at 15.2-m

intervals along the mainline. Gangions were 0.9 m long and composed of snaps, aluminum sleeves, hooks (Mustad #12/0, no 2888), and monofilament lines (136-kg test). Bait was either menhaden (*Brevoortia* spp.) or Atlantic mackerel (*Scomber scombrus*). The mainline, when set, was tethered to an anchor on each end with a 30.4-m, 0.79-cm polypropylene rope between the anchor and the end of the mainline. A buoy (3.6-m aluminum pole with 1.8-kg weight and 50.8-cm poly float), with a strobe light and flag extended 2.4 m above the float, was attached at each end of the mainline.

Survey design

Surveys were conducted monthly from April-October, occasionally March-November. The sampling gear was set at fixed stations or randomly set within each area based on depth strata and GPS location. For gillnets, the nets were checked and cleared of catch, or pulled and reset every 1.0-2.0 hr. For longlines, soak time ranged from 1.0-1.5 hr. Following each soak period, the longline was checked and all gangions that had caught sharks, been broken or damaged, or had damaged or lost baits, were removed from the mainline and a fresh-baited gangion attached. Sharks captured using either method were measured to the nearest cm for body lengths (precaudal, fork, total, and stretch total length) and data for sex and life history stage (neonate, young-of-the-year, juvenile, adult) were recorded. Sharks that were in poor condition were sacrificed for life history studies and those in good condition were tagged with a nylon-head dart tag and released. Environmental data were collected prior to sampling. Midwater temperature (°C), salinity (ppt), and dissolved oxygen (mg l⁻¹) was measured with a YSI Model 55 oxygen meter and light transmission (cm) was determined using a secci disk. Further details can be found in Carlson and Brusher (1999).

Index Development

Longline

Several categorical variables were constructed for analysis of longline data: "Year" (8 levels): 1993-2000 "Area" (2 levels): location of longline set (Figure 1). "SetBegin" (4 levels): Dawn=0401-1000 hrs Day=1001-1600 hrs Dusk=1601-2200 hrs Night=2201-0400 hrs "Season" (3 levels): Spring=Mar-May Summer=Jun-Aug Fall=Sep-Nov

Gillnet

Several categorical variables were constructed for analysis of gillnet data: "Year" (9 levels): 1996-2004 "Area" (4 levels): location of gillnet set (Figure 1).

"SetBegin" (4 levels):

Dawn=0401-1000 hrs Day=1001-1600 hrs

Dusk=1601-2200 hrs Night=2201-0400 hrs "Season" (3 levels): Spring=Mar-May Summer=Jun-Aug Fall=Sep-Nov "Setdepth" (2 levels): Shallow=less than 5 meters Deep=greater than 5 meters

The proportion of sets that caught any sharks (at least one shark was caught) was modeled assuming a binomial distribution with a logit link function. Positive catches were modeled assuming a poisson distribution with a log link. For longlines, an offset of the natural log of the number of hooks*soak time of the gear was used for the poisson model while for gillnets the offset was the natural log of the soak time of the net. Initially, a null model was run with no factors entered into the model. Models were then fit in a stepwise forward manner adding one independent variable. Each factor was ranked from greatest to least reduction in deviance per degree of freedom when compared to the null model. The factor with the greatest reduction in deviance was then incorporated into the model providing the effect was significant at p<0.05 based on a Chi-Square test, and the deviance per degree of freedom was reduced by at least 1% from the less complex model. The process was continued until no factors met the criterion for incorporation into the final model. Regardless of its level of significance, year was kept in all final models. After selection of the final model, the SAS GLIMMIX macro was run to allow fitting of the generalized linear mixed models using the SAS MIXED procedure (Wolfinger, SAS Inst., Inc.). The final mixed model calculates relative indices of abundance as the result of the year effect least square means from the combined binomial and poisson components using bias correction terms to calculate confidence intervals. Goodness-of-fit criteria for the final model included (-2) Residual Log Likelihood, Akaike's Information Criterion, and Schwarz's Bayesian Criterion. Relative indices of abundance were calculated as the product of the year effect least square means from the binomial and poisson models. The standard error of the combined index was estimated with the Delta Method (Lo et al. 1992). To facilitate visual comparison, a relative index and relative nominal index were calculated by dividing each value in the series by the mean value of the series.

RESULTS AND DISCUSSION

Longline 100

Large Coastal Sharks

A total of 348 longline sets were made from 1993-2000. The percentage of sets with zero catches was 64.4% for the large coastal aggregate. The stepwise construction of the binomial model of the probability of catching a large coastal shark and the poisson model on positive sets is in Table 1. The final binomial model was *Proportion positive sets*=Area + Year. Year was not significant in the final model but was kept in the glimmix model to allow for calculation of indices. The final poisson model was *Positive large coastal sets* =Year + Area. The frequency distribution of positive large coastal sets is in Figure 2 and the distribution of residuals by year is in Figure 3.

The standardized abundance index is shown in Figure 4. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 2.

Blacktip Sharks

For blacktip shark, the percentage of sets with zero catches was 76.1%. Most blacktip sharks caught on longlines were juveniles and the average size did not change considerable over the survey period (79 cm FL \pm 0.87 S.D.). The stepwise construction of the binomial model of the probability of catching a blacktip shark and the poisson model on positive sets is in Table 3. The final binomial model was *Proportion positive trips=Area + Year*. The final poisson model was *Positive blacktip shark sets=Year*. Year was not significant in the final binomial model but was kept in the glimmix model to allow for calculation of indices. The frequency distribution of Positive blacktip shark sets is in Figure 5 and the distribution of residuals by year is in Figure 6. The standardized abundance index is shown in Figure 7. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 2.

Gillnet

Large Coastal Sharks

A total of 712 gillnet sets were made from 1996-2004. The percentage of sets with zero catches was 57.1% for the large coastal aggregate. The stepwise construction of the binomial model of the probability of catching a large coastal shark and the poisson model on positive sets is in Table 4. The final binomial model was *Proportion positive sets=Area + Season + Year*. The final poisson model was *Positive large coastal sets =Area + Year + Season + Year*. The final poisson model was *Positive large coastal sets =Area + Year + Season*. The frequency distribution of positive large coastal sets is in Figure 8 and the distribution of residuals by year is in Figure 9. Although some interactions were significant (i.e. year*season), the increased number of degrees of freedom in the interaction precluded estimation of the least square means in the glimmix model. Thus, all final models were run without interactions.

The standardized abundance index is shown in Figure 10. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 5.

All Blacktip Sharks

For blacktip sharks regardless of age, the percentage of sets with zero catches was 67.1%. The stepwise construction of the binomial model of the probability of catching any blacktip shark and the poisson model on positive sets is in Table 6. The final binomial model was *Proportion positive trips=Area + Season + Year*. The final poisson model was *Positive blacktip shark sets= Setbegin + Area + Year Year* Setbegin*. The frequency distribution of positive blacktip shark sets is in Figure 11 and the distribution of residuals by year is in Figure 12. The standardized abundance index is shown in Figure 13. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 7.

Juvenile blacktip sharks

For juvenile blacktip sharks, the percentage of sets with zero catches was 72.1%. The average size of all juvenile blacktip sharks collected from 1996-2004 was 79.7 cm FL (\pm 12.5 S.D.). The stepwise construction of the binomial model of the probability of catching any blacktip shark and the poisson model on positive sets is in Table 8. The final binomial model was *Proportion positive trips=Area + Season + Year*. The final poisson model was *Positive blacktip shark sets= Setbegin + Area + Year Year* Setbegin*. The frequency distribution of positive juvenile blacktip shark sets is in Figure 14 and the distribution of residuals by year is in Figure 15. The standardized abundance index is shown in Figure 16. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 7.

Age 0 blacktip sharks

For age 0 blacktip sharks, the percentage of sets with zero catches was 72.1%. The average size of all age 0 blacktip sharks collected from 1996-2004 was 54.1 cm FL (\pm 5.4 S.D.). The stepwise construction of the binomial model of the probability of catching any blacktip shark and the poisson model on positive sets is in Table 9. The final binomial model was *Proportion positive trips=Area + Season + Year*. The final poisson model was *Positive blacktip shark sets= Year+ Area + Season*. The frequency distribution of positive age 0 blacktip shark sets is in Figure 17 and the distribution of residuals by year is in Figure 18. The standardized abundance index is shown in Figure 19. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 7.

Sandbar sharks

For all sandbar sharks, the percentage of sets with zero catches was 95.6%. The average size of all sandbar sharks collected from 1996-2004 was 79.1 cm FL (± 20.6 S.D.). The stepwise construction of the binomial model of the probability of catching any sandbar shark and the poisson model on positive sets is in Table 10. The final binomial model was *Proportion positive* trips=Area + Season + Year. The final poisson model was *Positive sandbar shark sets*= Year+ Area + Season. The frequency distribution of positive sandbar shark sets is in Figure 20 and the distribution of residuals by year is in Figure 21. The standardized abundance index is shown in Figure 22. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 11.

LITERATURE CITED

Carlson, J.K., Brusher, J.H., 1999. An index of abundance for coastal species of juvenile sharks from the northeast Gulf of Mexico. Mar. Fish. Rev. 61:37-45.

Lo, N.C., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49:2515:2526.

Table 1. Results of the stepwise procedure for development of the fishery independent longline catch rate model for the large coastal shark aggregate. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	347	453.286	1.306	702111	2221700	-226.643		
AREA	346	396.172	1.145	12.347	12.347	-198.086	57.110	<.0001
/EAR	340	437.114	1.286	1.582	12.047	-218.557	16.170	0.0236
	340		1.293					
TIME		444.932		0.987		-222.466	8.350	0.0392
SEASON	345	446.586	1.294	0.907		-223.293	6.700	0.0351
AREA +								
/EAR	339	388.474	1.146	12.276	-0.072	-194.237	7.7	0.36
FINAL MODEL: AREA + YEAR	339	388.474	1.146	12.276	-0.072	-194.237	7.7	0.36
Akaike's information criterion	1586.1							
Schwartz's Bayesian criterion	1589.9							
(-2) Res Log Likelihood	1584.1							
	Type 3	Tests of Fixed E	ffects					
Significance (Pr>Chi) of Type 3	AREA	YEAR						
est of fixed effects for each factor	<.0001	0.5147						
DF	1	7						
CHI SQUARE	41.47	6.220						
Positive catches-Poisson error distribution								
ACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%		CHISQUAR	E PR>CH
ACTOR	123	274.937	2.235			-120.663		
ACTOR				%DIFF 43.613	DELTA% 43.613			
FACTOR NULL /EAR	123	274.937	2.235			-120.663		<.000
FACTOR NULL /EAR \REA	123 116	274.937 146.206	2.235 1.260	43.613		-120.663 -56.297	128.73 60.5	<.0001 <.000
Positive catches-Poisson error distribution FACTOR NULL YEAR AREA TIME SEASON	123 116 122	274.937 146.206 214.434	2.235 1.260 1.758	43.613 21.367		-120.663 -56.297 -90.412	128.73 60.5 7.92	E PR>CH <.0001 <.000 0.0478 0.1241
FACTOR NULL YEAR AREA FIME	123 116 122 120	274.937 146.206 214.434 267.022	2.235 1.260 1.758 2.225	43.613 21.367 0.451		-120.663 -56.297 -90.412 -116.706	128.73 60.5 7.92	<.0001 <.000 0.0478
EACTOR JULL /EAR AREA 'IME SEASON /EAR +	123 116 122 120	274.937 146.206 214.434 267.022	2.235 1.260 1.758 2.225	43.613 21.367 0.451		-120.663 -56.297 -90.412 -116.706	128.73 60.5 7.92	<.000 <.000 0.0478 0.124
ACTOR NULL /EAR AREA TIME SEASON /EAR + AREA	123 116 122 120 121	274.937 146.206 214.434 267.022 270.763 134.749	2.235 1.260 1.758 2.225 2.238 1.172	43.613 21.367 0.451 -0.110 47.580	43.613 3.967	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569	128.73 60.5 7.92 4.17 11.46	<.000 <.000 0.0478 0.124 0.0007
ACTOR NULL YEAR AREA SEASON YEAR + AREA	123 116 122 120 121	274.937 146.206 214.434 267.022 270.763	2.235 1.260 1.758 2.225 2.238	43.613 21.367 0.451 -0.110	43.613	-120.663 -56.297 -90.412 -116.706 -118.576	128.73 60.5 7.92 4.17	<.0001 <.000 0.0478
FACTOR NULL YEAR AREA SEASON YEAR + AREA YEAR + AREA YEAR + AREA	123 116 122 120 121 115 115	274.937 146.206 214.434 267.022 270.763 134.749 134.749	2.235 1.260 1.758 2.225 2.238 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.580	43.613 3.967 3.967	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569	128.73 60.5 7.92 4.17 11.46 11.46	<.0001 <.000 0.0478 0.1241 0.0007
FACTOR NULL YEAR AREA SEASON YEAR + AREA YEAR + AREA YEAR + AREA YEAR * AREA YEAR * AREA	123 116 122 120 121 115 115 110	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.0478 0.124 0.0007 0.0007 0.3238
EACTOR NULL VEAR AREA FIME SEASON	123 116 122 120 121 115 115 110 115	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.0478 0.124 0.0007 0.0007 0.3238
ACTOR NULL YEAR AREA AREA YEAR + AREA YEAR + AREA YEAR * AREA FINAL MODEL: YEAR + AREA Akaike's information criterion	123 116 122 120 121 115 115 110 115 326.0	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323
ACTOR NULL YEAR AREA ITIME SEASON YEAR + AREA YEAR + AREA YEAR + AREA YEAR * AREA FINAL MODEL: YEAR + AREA Akaike's information criterion Schwartz's Bayesian criterion	123 116 122 120 121 115 115 110 115 326.0 330.7 326.0	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323
ACTOR NULL (EAR NREA SEASON (EAR + NREA (EAR + AREA (EAR * AREA (EAR * AREA SINAL MODEL: YEAR + AREA Akaike's information criterion Schwartz's Bayesian criterion -2) Res Log Likelihood	123 116 122 120 121 115 115 110 115 326.0 330.7 326.0	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926 134.7485	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323
ACTOR NULL (EAR NREA SEASON (EAR + NREA (EAR + AREA (EAR + AREA (EAR * ARE	123 116 122 120 121 115 115 110 115 326.0 330.7 326.0 Type YEAR	274.937 146.206 214.434 267.022 270.763 134.749 138.926 134.7485 134.7485 3 Tests of Fixed AREA	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323
FACTOR NULL (FAR AREA AREA SEASON (FAR + AREA (FAR + AREA (FAR + AREA (FAR * AREA (FAR * AREA FINAL MODEL: YEAR + AREA Akaike's information criterion Schwartz's Bayesian criterion -2) Res Log Likelihood Significance (Pr>Chi) of Type 3 est of fixed effects for each factor	123 116 122 120 121 115 115 110 115 326.0 330.7 326.0 Type YEAR <.0001	274.937 146.206 214.434 267.022 270.763 134.749 134.749 128.926 134.7485 3 Tests of Fixed AREA 0.0085	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323
ACTOR VULL YEAR AREA TIME SEASON YEAR + AREA YEAR + AREA YEAR + AREA YEAR * AREA FINAL MODEL: YEAR + AREA Akaike's information criterion Schwartz's Bayesian criterion	123 116 122 120 121 115 115 110 115 326.0 330.7 326.0 Type YEAR	274.937 146.206 214.434 267.022 270.763 134.749 138.926 134.7485 134.7485 3 Tests of Fixed AREA	2.235 1.260 1.758 2.225 2.238 1.172 1.172 1.172 1.172	43.613 21.367 0.451 -0.110 47.580 47.585	43.613 3.967 3.967 -0.015	-120.663 -56.297 -90.412 -116.706 -118.576 -50.569 -50.569 -47.657	128.73 60.5 7.92 4.17 11.46 11.46 5.82	<.000 <.000 0.047 0.124 0.000 0.000 0.323

Table 2. The relative standardized index of abundance from fishery independent longline catches, coefficients of variance (CV), and number of sets (N) for large coastal sharks and blacktip sharks, 1993-2000.

	La	rge coastal sha	rks Bla	cktip sharks	
YEAR	Ν	RELATIVE	CV	RELATIVE	CV
		INDICES		INDICES	
1993	9	0.816	0.73	0.768	1.288
1994	66	0.386	0.894	0.133	3.244
1995	38	1.272	0.61	1.018	1.244
1996	69	0.858	0.583	0.758	1.087
1997	60	0.926	0.539	1.299	0.704
1998	29	0.725	0.967	0.974	1.328
1999	42	1.174	0.564	1.136	1.011
2000	35	1.844	0.508	1.914	0.92

Table 3. Results of the stepwise procedure for development of the fishery independent longline catch rate model for blacktip sharks. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	347	382.349	1.102			-191.174		
AREA	346	340.008	0.983	10.817	10.817	-170.004	42.340	<.0001
/EAR	340	365.105	1.074	2.544		-182.552	17.240	0.0159
SEASON	345	377.450	1.094	0.709		-188.725	4.900	0.0864
TIME	344	378.058	1.099	0.260		-189.029	4.290	0.2318
AREA +								
	220	224 0207	0.000	10.000	0.495	167 470	E 07	0.6517
YEAR	339	334.9397	0.988	10.332	-0.485	-167.470	5.07	0.6517
FINAL MODEL: AREA + YEAR	339	334.9397	0.988	10.332	-0.485	-167.470	5.07	0.6517
Akaike's information criterion	1668.5							
Schwartz's Bayesian criterion	1672.3							
(-2) Res Log Likelihood	1666.5							
	Type 3	Tests of Fixed	Effects					
Significance (Pr>Chi) of Type 3								
est of fixed effects for each factor	<.0001	0.690						
DF	1	7						
CHI SQUARE	26.09	4.760						
Positive catches-Poisson error distribution FACTOR								
	DF 82	169.850	2 071	%DIFF	DELTA%	-100 143	CHISQUARE	PR>CH
NULL	82	169.850	2.071			-100.143		
NULL YEAR	82 75	169.850 66.525	2.071 0.887	57.177	DELTA% 57.177	-100.143 -48.480	103.32	<.0001
NULL YEAR AREA	82 75 81	169.850 66.525 128.611	2.071 0.887 1.588	57.177 23.345		-100.143 -48.480 -79.523	103.32 41.24	<.0001 <.000
NULL (EAR NREA TIME	82 75	169.850 66.525	2.071 0.887	57.177		-100.143 -48.480	103.32	<.0001 <.000 <.000
NULL YEAR AREA TIME SEASON	82 75 81 79	169.850 66.525 128.611 148.314	2.071 0.887 1.588 1.877	57.177 23.345 9.364		-100.143 -48.480 -79.523 -89.374	103.32 41.24 21.54	<.0001 <.000 <.000
NULL YEAR AREA TIME SEASON YEAR +	82 75 81 79	169.850 66.525 128.611 148.314	2.071 0.887 1.588 1.877	57.177 23.345 9.364		-100.143 -48.480 -79.523 -89.374	103.32 41.24 21.54	<.0001 <.000 <.000 0.0232
NULL /EAR REA FIME SEASON /EAR + FIME	82 75 81 79 80	169.850 66.525 128.611 148.314 162.321	2.071 0.887 1.588 1.877 2.029	57.177 23.345 9.364 2.044	57.177	-100.143 -48.480 -79.523 -89.374 -96.378	103.32 41.24 21.54 7.53	<.0001 <.000 <.000 0.0232 0.1069
NULL /EAR AREA SEASON /EAR + TIME AREA	82 75 81 79 80 72	169.850 66.525 128.611 148.314 162.321 60.4255	2.071 0.887 1.588 1.877 2.029 0.839	57.177 23.345 9.364 2.044 59.483	57.177	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430	103.32 41.24 21.54 7.53 6.1	<.0001 <.000 <.000 0.0232 0.1069 0.0666
NULL YEAR AREA FIME SEASON YEAR + FIME AREA SEASON	82 75 81 79 80 72 74	169.850 66.525 128.611 148.314 162.321 60.4255 63.160	2.071 0.887 1.588 1.877 2.029 0.839 0.854	57.177 23.345 9.364 2.044 59.483 58.794	57.177	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797	103.32 41.24 21.54 7.53 6.1 3.37	<.0001 <.0001 <.0001 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR	82 75 81 79 80 72 74 73	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.000 <.000 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion	82 75 81 79 80 72 74 73 75	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.0001 <.0001 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion	82 75 81 79 80 72 74 73 75 207.9	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.0001 <.0001 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion	82 75 81 79 80 72 74 73 75 207.9 210.2 205.9	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903 0.887	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.000 <.000 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion -2) Res Log Likelihood	82 75 81 79 80 72 74 73 75 207.9 210.2 205.9	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174 66.525	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903 0.887	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.000 <.000 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion -2) Res Log Likelihood Significance (Pr>Chi) of Type 3	82 75 81 79 80 72 74 73 75 207.9 210.2 205.9 Type	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174 66.525	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903 0.887	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.000 <.000 0.0232 0.1069 0.0666 0.7379
NULL YEAR AREA AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion (-2) Res Log Likelihood Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	82 75 81 79 80 72 74 73 75 207.9 210.2 205.9 Type YEAR <.0001	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174 66.525	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903 0.887	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	PR>CH <.0001 <.0001 0.0232 0.1069 0.0666 0.7379 <.0001
INFORMULL YEAR AREA TIME SEASON YEAR + TIME AREA SEASON FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion (-2) Res Log Likelihood Significance (Pr>Chi) of Type 3 test of fixed effects for each factor DF CHI SQUARE	82 75 81 79 80 72 74 73 75 207.9 210.2 205.9 Type YEAR	169.850 66.525 128.611 148.314 162.321 60.4255 63.160 65.9174 66.525	2.071 0.887 1.588 1.877 2.029 0.839 0.854 0.903 0.887	57.177 23.345 9.364 2.044 59.483 58.794 56.406	57.177 2.306	-100.143 -48.480 -79.523 -89.374 -96.378 -45.430 -46.797 -48.176	103.32 41.24 21.54 7.53 6.1 3.37 0.61	<.0001 <.0001 <.0001 0.0232 0.1069 0.0666 0.7379

Table 4. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for the large coastal shark aggregate. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution								
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	711	972.379	1.368			-486.189		
AREA	708	741.023	1.047	23.470	23.470	-370.512	231.360	<.0001
YEAR	703	911.459	1.297	5.198		-455.730	60.920	<.0001
SEASON	709	952.863	1.344	1.731		-476.432	19.520	<.0001
IME	708	957.115	1.352	1.153		-478.557	15.260	0.0016
SETDEPTH	710	966.411	1.361	0.474		-483.206	5.97	0.0146
AREA +								
SEASON	706	721.1693	1.021	25.309	1.839	-360.585	19.85	<.0001
IME	705	724.3675	1.027	24.872		-362.184	16.66	0.0008
'EAR	700	719.259	1.028	24.869		-359.630	21.76	0.0054
AREA + SEASON +								
/EAR	698	696.035	0.997	27.086	1.777	-348.018	25.130	0.0015
IME	703	704.8017	1.003	26.693		-352.401	16.37	0.001
AREA + SEASON + YEAR								
IME	695	687.386	0.989	27.681	0.595	-343.693	8.650	0.0343
AREA + SEASON + YEAR	698	696.035	0.997	27.086	1.777	-348.018	25.130	0.0015
AREA*SEASON	692	673.3444	0.973	28.852	1.765	-336.672	22.69	0.0009
REA*YEAR	678	650.0308	0.959	29.897		-325.015	Negative of H	lessian not positive d
	682	666,4462	0.977	28.548		-333.223	Nie wetting of I	lessian not positive d

YEAR

0.031

8.000

16.910

Akaike's information criterion

Schwartz's Bayesian criterion

Significance (Pr>Chi) of Type 3

test of fixed effects for each factor

(-2) Res Log Likelihood

DF

CHI SQUARE

3425.6

3430.1

3423.6

AREA

<.0001

3

136.33

Type 3 Tests of Fixed Effects

SEASON

<.0001

2

21.450

9

Table 4 (cont)

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	304	2369.678	7.795	702111	22217170	2516.616	0.10000.0.0	
AREA	301	1895.765	6.298	19.202	19.202	2753.573	473.91	<.0001
YEAR	296	1882.563	6.360	18.409		2760.174	487.12	<.0001
TIME	301	2090.596	6.946	10.898		2656.157	279.08	<.0001
SEASON	302	2163.348	7.163	8.102		2619.781	206.33	<.0001
SETDEPTH	303	2357.026	7.779	0.206		2522.942	12.65	0.0004
AREA +	_							
YEAR	293	1473.308	5.028	35.493	16.291	2964.801	422.46	<.0001
TIME	298	1676.946	5.627	27.808		2862.982	218.82	<.0001
SEASON	299	1737.589	5.811	25.448		2832.661	158.18	<.0001
AREA + YEAR +								
SEASON	291	1342.822	4.615	40.802	5.309	3030.044	130.49	<.0001
TIME	290	1440.987	4.969	36.255		2980.962	32.32	<.0001
AREA + YEAR + SEASON +	_							
TIME	288	1311.976	4.555	41.559	0.757	3045.467	30.85	<.0001
AREA + YEAR + SEASON	291	1342.822	4.615	40.802	5.309	3030.044	130.49	<.0001
YEAR*SEASON	276	906.475	3.284	57.866	17.065	3248.218	436.35	<.0001
AREA*SEASON	286	1320.924	4.619	40.749		3040.993	21.9	0.0005
AREA*YEAR	274	1269.177	4.632	40.577		3066.867	73.64	<.0001
FINAL MODEL: AREA + YEAR + SEASON								
Akaike's information criterion	896.9							
Schwartz's Bayesian criterion	900.5							
(-2) Res Log Likelihood	894.9							
	Type 3	Tests of Fixed	Effects					
Significance (Pr>Chi) of Type 3	AREA	YEAR	SEASON					
test of fixed effects for each factor	<.0001	<.0001	<.0001					
DF	3	8	2.000					
CHI SQUARE	53.6500	59.3900	21.680					

Table 5. The relative standardized index of abundance from fishery independent gillnet catches, coefficients of variance (CV), and number of sets (N) for large coastal sharks, 1996-2004.

YEAR	Ν	RELATIVE INDICES	CV
1996	26	0.511	0.241
1997	27	1.637	0.132
1998	68	0.607	0.310
1999	48	0.969	0.297
2000	54	0.811	0.326
2001	91	1.549	0.211
2002	130	0.936	0.201
2003	150	1.072	0.186
2004	117	0.908	0.220

Table 6. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for all blacktip sharks. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	711	901.705	1.268			-450.852		
AREA	708	724.381	1.023	19.325	19.325	-362.190	177.320	<.0001
YEAR	703	871.448	1.240	2.256		-435.724	30.260	0.0002
SEASON	709	889.820	1.255	1.040		-444.910	11.880	0.0026
SETDEPTH	710	896.375	1.263	0.451		-448.188	5.330	0.0210
ТІМЕ	708	895.277	1.265	0.292		-447.638	6.430	0.0925
AREA +	700	710 1100	4 000	00.407		050 050	40.07	
SEASON	706	712.1129	1.009	20.467	1.142	-356.056	12.27	0.0022
/EAR	700	715.252	1.022	19.431		-357.626	9.13	0.3315
AREA + SEASON +								
YEAR	698	699.7346	1.002	20.953	0.487	-349.867	12.38	0.1351
FINAL MODEL: AREA + SEASON + YEAR								
Akaike's information criterion	3405.9							
Schwartz's Bayesian criterion	3410.5							
(-2) Res Log Likelihood	3403.9							
	Type 3	Tests of Fixed E	Effects					
Significance (Pr>Chi) of Type 3	AREA	SEASON	YEAR					
est of fixed effects for each factor	<.0001	0.0007	0.1615					
DF	3	2	8					
CHI SQUARE	124.22	14.40	11.78					
Positive catches-Poisson error distribution						_		
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CH
	233	1154.614	4.955	44,000		911.009	170 74	000
TIME .	230	977.904	4.252	14.200	44 500	999.364	176.71	<.000
AREA	230	1007.900	4.382	11.568	11.568	984.366	146.71	<.0001
YEAR	225	1006.557	4.474	9.723		985.037	148.06	<.000
SEASON	231	1139.567	4.933	0.449		918.532	15.05	0.0005
SETDEPTH	232	1153.211	4.971	-0.309		911.710	1.4	0.2363
IME +								
AREA	227	857.950	3.780	23.730	9.530	1059.341	119.95	<.000
YEAR	222	939.666	4.233	14.584		1018.483	38.24	<.0001
IME + AREA +								
YEAR	219	825.608	3.770	23.924	0.194	1075.512	32.34	<.0001
ΓIME + AREA + YEAR								
YEAR*TIME	208	778.282	3.742	24.492	0.568	1099.175	47.33	<.0001
YEAR*AREA	202	787.513	3.899	21.327		1094.559	38.09	0.0024
FINAL MODEL: TIME + AREA + YEAR YEAR*T	ГІМЕ							
FINAL MODEL: TIME + AREA + YEAR YEAR*T Akaike's information criterion	ГІМЕ 703.0							
Akaike's information criterion								
	703.0							

	Type 3	lests of Fixed E	ffects
Significance (Pr>Chi) of Type 3	TIME	AREA	YEAR
test of fixed effects for each factor	0.3291	0.0002	0.5180
DF	3	3	8
CHI SQUARE	3.44	19.9900	5.38

Table 7. The relative standardized index of abundance from fishery independent gillnet catches, coefficients of variance (CV), and number of sets (n) for all blacktip sharks, juvenile blacktip sharks, and age-0 blacktip sharks, 1996-2004.

		ALL		JUVENILE		AGE 0	
		BLACKTIP		BLACKTIP		BLACKTIP	
		RELATIVE		RELATIVE		RELATIVE	
YEAR	Ν	INDICES	CV	INDICES	CV	INDICES	CV
1996	26	0.695	0.475	0.980	0.427	0.152	1.063
1997	27	1.397	0.287	1.513	0.279	0.782	0.397
1998	68	0.565	0.451	0.639	0.455	0.654	0.586
1999	49	1.209	0.359	1.068	0.412	2.101	0.388
2000	54	0.769	0.484	0.649	0.632	0.676	0.737
2001	91	1.583	0.286	1.408	0.312	2.130	0.350
2002	130	0.872	0.283	0.854	0.305	1.260	0.293
2003	150	0.909	0.283	0.790	0.318	1.012	0.334
2004	117	1.001	0.307	1.098	0.294	0.232	0.823

Table 8. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for juvenile blacktip sharks. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	711	843.685	1.187	/00111	DELIA	-421.842	OHIOGOANE	
REA	708	708.850	1.001	15.626	15.626	-354.425	134.830	<.0001
'EAR	703	812.648	1.156	2.583		-406.324	31.040	0.0001
EASON	709	832.116	1.174	1.093		-416.058	11.570	0.0031
ETDEPTH	710	835.351	1.177	0.848		-417.676	8.330	0.0039
IME	708	834.998	1.179	0.610		-417.499	8.690	0.0338
AREA +								
SEASON	706	696.6109	0.987	16.848	1.222	-348.305	12.24	0.0022
/EAR	700	695.4136	0.993	16.279		-347.707	13.44	0.0977
	700	033.4130	0.000	10.275		-341.101	13.44	0.0311
AREA + SEASON +								
'EAR	698	679.7895	0.974	17.925	1.078	-339.895	16.82	0.032
	000	010.1000	0.014	11.020	1.070	000.000	10.02	0.002
AREA + SEASON + YEAR								
′EAR*AREA	678	647.262	0.955	19.547	1.622	-323.631	Negative of H	essian not nos
′EAR*SEASON	682	654.216	0.959	19.160		-327.108	25.57	0.0603
REA*SEASON	692	673.155		18.022		-336.577		0.3559
IREA SEASON	092	075.155	0.973	10.022		-330.377	6.640	0.5559
INAL MODEL: AREA + SEASON + YEAR								
Akaike's information criterion	3469.1							
Schwartz's Bayesian criterion	3473.6							
-2) Res Log Likelihood	3467.1							
_,g		Tasta of Fixed F	<i>Kaata</i>					
	Type 3	Tests of Fixed E	YEAR					
ignificance (Pr>Chi) of Type 3								
	AREA	SEASON						
est of fixed effects for each factor	<.0001	0.0009	0.0496					
est of fixed effects for each factor DF								
Significance (Pr>Chi) of Type 3 lest of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution	<.0001 3	0.0009 2.000	0.0496 8.000					
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution ACTOR	<.0001 3 94.11 DF	0.0009 2.000 13.970 DEVIANCE	0.0496 8.000 15.530 DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution FACTOR IULL	<.0001 3 94.11 DF 198	0.0009 2.000 13.970 DEVIANCE 920.743	0.0496 8.000 15.530 DEVIANCE/DF 4.650			582.723		
est of fixed effects for each factor PF CHI SQUARE Positive catches-Poisson error distribution FACTOR IULL	<.0001 3 94.11 DF	0.0009 2.000 13.970 DEVIANCE	0.0496 8.000 15.530 DEVIANCE/DF	%DIFF 15.186	DELTA% 15.186			PR>CHI <.0001
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME	<.0001 3 94.11 DF 198	0.0009 2.000 13.970 DEVIANCE 920.743	0.0496 8.000 15.530 DEVIANCE/DF 4.650			582.723	151.66	
est of fixed effects for each factor F HI SQUARE Positive catches-Poisson error distribution ACTOR IULL IME (EAR	<.0001 3 94.11 DF 198 195	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200	15.186 9.679		582.723 658.553 644.084	151.66 122.72	<.0001 <.0001
est of fixed effects for each factor F HI SQUARE Positive catches-Poisson error distribution ACTOR IULL IME EAR IREA	<.0001 3 94.11 DF 198 195 190 195	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441	15.186 9.679 4.494		582.723 658.553 644.084 610.075	151.66 122.72 54.7	<.0001 <.0001 <.0001
est of fixed effects for each factor OF CHI SQUARE Positive catches-Poisson error distribution CACTOR ULL ULL TIME ZEA SEASON	<.0001 3 94.11 198 195 190 195 196	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660	15.186 9.679 4.494 -0.200		582.723 658.553 644.084 610.075 586.463	151.66 122.72 54.7 7.48	<.0001 <.0001 <.0001 0.0237
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR AULL TIME VEAR AREA SEASON	<.0001 3 94.11 DF 198 195 190 195	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441	15.186 9.679 4.494		582.723 658.553 644.084 610.075	151.66 122.72 54.7 7.48	<.0001 <.0001 <.0001
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution ACTOR VILL TIME /EAR REA SEASON SETDEPTH	<.0001 3 94.11 198 195 190 195 196	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660	15.186 9.679 4.494 -0.200		582.723 658.553 644.084 610.075 586.463	151.66 122.72 54.7 7.48	<.0001 <.0001 <.0001 0.0237
est of fixed effects for each factor F HI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME (EAR REA SEASON SETDEPTH IME +	<.0001 3 94.11 198 195 190 195 196 197	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664	15.186 9.679 4.494 -0.200 -0.294	15.186	582.723 658.553 644.084 610.075 586.463 583.703	151.66 122.72 54.7 7.48 1.96	<.0001 <.0001 <.0001 0.0237 0.1616
est of fixed effects for each factor oF HI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME (EAR JREA SEASON SETDEPTH IME + JREA	<.0001 3 94.11 198 195 190 195 196	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660	15.186 9.679 4.494 -0.200		582.723 658.553 644.084 610.075 586.463	151.66 122.72 54.7 7.48 1.96 38.23	<.0001 <.0001 <.0001 0.0237
est of fixed effects for each factor oF HI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME (EAR JREA SEASON SETDEPTH IME + JREA	<.0001 3 94.11 198 195 190 195 196 197 192	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807	15.186 9.679 4.494 -0.200 -0.294 18.143	15.186	582.723 658.553 644.084 610.075 586.463 583.703 677.670	151.66 122.72 54.7 7.48 1.96 38.23	<.0001 <.0001 <.0001 0.0237 0.1616 <.0001
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME TEAR TEAR SEASON SETDEPTH IME + IREA TEAR IME + AREA +	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494	15.186 2.957	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320	151.66 122.72 54.7 7.48 1.96 38.23 25.53	<.0001 <.0001 <.0001 0.0237 0.1616 <.0001 0.0013
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution ACTOR JULL IME TEAR TEAR SEASON SETDEPTH IME + IREA TEAR IME + AREA +	<.0001 3 94.11 198 195 190 195 196 197 192	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807	15.186 9.679 4.494 -0.200 -0.294 18.143	15.186	582.723 658.553 644.084 610.075 586.463 583.703 677.670	151.66 122.72 54.7 7.48 1.96 38.23 25.53	<.0001 <.0001 <.0001 0.0237 0.1616 <.0001
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution ACTOR NULL TIME (EAR REA SEASON SETDEPTH TIME + AREA (EAR TIME + AREA + (EAR	<.0001 3 94.11 DF 198 195 196 197 192 187 184	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.976	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49	<.0001 <.0001 <.0001 0.0237 0.1616 <.0001 0.0013
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME YEAR VEAR VEAR VEAR VEAR Y	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002	15.186 2.957	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46	<.0001 <.0001 0.0237 0.1616 <.0001 0.0013 0.0028 <.0001
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME ZEAR AREA SEASON SETDEPTH TIME + AREA YEAR TIME + AREA + YEAR AREA YEAR AREA YEAR AREA YEAR AREA YEAR YE	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 3.870	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00037 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME ZEAR AREA SEASON SETDEPTH TIME + AREA YEAR TIME + AREA + YEAR AREA YEAR AREA YEAR AREA YEAR AREA YEAR YE	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 0.0237 0.1616 <.0001 0.0013 0.0028 <.0001
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME YEAR VEAR VEAR VEAR VEAR Y	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 3.870	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME (ZAR AREA SEASON SETDEPTH TIME + AREA YEAR TIME + AREA + (ZAR AREA TIME + (ZAR AREA AREA AREA AREA TIME + AREA AREA TIME + AREA AREA TIME + AREA TIME + AR	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 3.870	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor SF SHI SQUARE Positive catches-Poisson error distribution ACTOR JULL TIME (EAR REA SEASON SETDEPTH TIME + REA REA (EAR TIME + AREA + (EAR TIME + AREA + (EAR TIME / (EAR*TIME (EAR*TIME (EAR*AREA STALE - AREA + YEAR AREA*TIME Waike's information criterion	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 3.870	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME VEAR VEAR SEASON SETDEPTH TIME + AREA VEAR TIME + AREA + VEAR AREA TIME + AREA + VEAR AREA TIME + AREA + VEAR TIME + AREA + VEAR AREA TIME + AREA + VEAR TIME + AREA + VEAR TIME + AREA + VEAR TIME + AREA TIME + AR	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167 603.2	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 3.870	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution FACTOR VULL TIME YEAR VEAR VEAR VEAR VEAR VEAR TIME + AREA YEAR TIME + AREA YEAR TIME + AREA + YEAR YEAR TIME + AREA + YEAR YEAR TIME + AREA + YEAR	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167 603.2 606.3 601.2	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.870 4.006	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor F CHI SQUARE Positive catches-Poisson error distribution ACTOR UULL IME EAR EAR EAR EAR EAR IME + AREA + EAR IME +	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167 603.2 606.3 601.2	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 913.262 918.783 730.850 743.549 707.360 653.897 673.299 668.929	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.870 4.006	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 <.0001 0.0237 0.1616 <.0001 0.0013 0.0028 <.0001 0.0002
est of fixed effects for each factor PECHI SQUARE Positive catches-Poisson error distribution FACTOR VIUL TIME TATA TATA TATA TATA TATA TATA TATA TIME + AREA TATA TIME + AREA TATA TIME + AREA TIME + AREA TIM	<.0001 3 94.11 DF 198 195 190 195 196 197 192 187 184 178 174 167 603.2 606.3 601.2 Type	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 918.783 730.850 743.549 707.360 653.897 673.299 668.929 668.929	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 4.006	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028
est of fixed effects for each factor DF CHI SQUARE Positive catches-Poisson error distribution ACTOR NULL TIME (EAR REA SEASON SETDEPTH TIME + REA (EAR TIME + AREA + (EAR TIME + AREA + (EAR TIME + AREA + (EAR)	<.0001 3 94.11 198 195 190 195 196 197 192 187 184 178 174 167 603.2 606.3 601.2 Type TIME	0.0009 2.000 13.970 DEVIANCE 920.743 769.083 798.021 866.039 918.783 730.850 743.549 707.360 653.897 673.299 668.929 668.929	0.0496 8.000 15.530 DEVIANCE/DF 4.650 3.944 4.200 4.441 4.660 4.664 3.807 3.976 3.844 3.674 3.870 4.006	15.186 9.679 4.494 -0.200 -0.294 18.143 14.494 17.330 21.002 16.788	15.186 2.957 -0.814	582.723 658.553 644.084 610.075 586.463 583.703 677.670 671.320 689.415 716.146 706.445	151.66 122.72 54.7 7.48 1.96 38.23 25.53 23.49 53.46 34.06 34.06	<.0001 <.0001 .00237 0.1616 <.0001 0.0013 0.0028 <.0001 0.00028

Table 9. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for age 0 blacktip sharks. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution			DE1/14110=/2=	*/ DI==	BE1 - 14		0.00000000	BF A 177	
ACTOR	DF		DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI	-
JLL	711	492.098	0.692			-246.049			
REA	708	372.114	0.526	24.062	24.062	-186.057	119.980	<.0001	
ASON	709	470.878	0.664	4.042		-235.439	21.220	<.0001	
AR	703	473.594	0.674	2.665		-236.797	18.500	0.0177	
ME	708	490.064	0.692	-0.009		-245.032	2.030	0.5654	
ETDEPTH	710								
IDEPTH	710	491.488	0.692	-0.017		-245.744	0.610	0.4346	
EA +									
ASON	706	353.1638	0.500	27.725	3.663	-176.582	18.95	<.0001	
EAR	700	360.9913	0.516	25.490	0.000	-180.496	11.12	0.1948	
	700	500.3315	0.010	23.430		-100.430	11.12	0.1340	
REA + SEASON +									
AR	698	339.9495	0.487	29.632	1.907	-169.975	13.21	0.1047	
NAL MODEL: AREA + SEASON + YEAR									
aike's information criterion									
hwartz's Bayesian criterion									
?) Res Log Likelihood									
	Type 3 T	ests of Fixed Eff	ects						
gnificance (Pr>Chi) of Type 3	AREA	SEASON	YEAR						
at of fixed effects for each factor	<.0001	<.0001	0.05						
	2	2.000	8.000						
II SQUARE	72.01	18.780	15.330						
I SQUARE	72.01	10.700	13.330						
ositive catches-Poisson error distribution									
CTOR	DF	DEVIANCE	DEVIANCE/DI	= %DI	IFF DE	LTA%	L CH	ISQUARE	PR>
	77	212.082	2.754	,,,_			-63.525		
		212.002	2.754				-05.525		<.0
10	00	05 074	4 000		10 4	0.010	E 474		
	69	95.374	1.382	49.8		9.816	-5.171	116.71	
	69 75	95.374 179.857	1.382 2.398	49.8 12.9			-5.171 -47.413	116.71 32.22	
ASON					933				<.00
ASON IE	75 74	179.857 179.533	2.398 2.426	12.9 11.9	933 916		-47.413 -47.251	32.22 32.55	<.00 <.00
ASON IE EA	75 74 75	179.857 179.533 191.905	2.398 2.426 2.559	12.9 11.9 7.1	933 916 01		-47.413 -47.251 -53.437	32.22 32.55 20.18	<.00 <.00 <.00
ASON ME IEA	75 74	179.857 179.533	2.398 2.426	12.9 11.9	933 916 01		-47.413 -47.251	32.22 32.55	<.00 <.00 <.00
ASON /E EA TDEPTH	75 74 75	179.857 179.533 191.905	2.398 2.426 2.559	12.9 11.9 7.1	933 916 01		-47.413 -47.251 -53.437	32.22 32.55 20.18	<.00 <.00 <.00
ASON Æ EA TDEPTH AR +	75 74 75 76	179.857 179.533 191.905 212.056	2.398 2.426 2.559 2.790	12.9 11.9 7.1 -1.3	933 916 01 904		-47.413 -47.251 -53.437 -63.512	32.22 32.55 20.18 0.03	<.00 <.00 <.00
ASON NE EA TDEPTH AR + EA	75 74 75 76 67	179.857 179.533 191.905 212.056 88.610	2.398 2.426 2.559 2.790 1.323	12.9 11.9 7.1 -1.3 51.9	933 916 01 804 983 2		-47.413 -47.251 -53.437 -63.512 -1.789	32.22 32.55 20.18 0.03 6.76	<.00 <.00 <.00 0.87
ASON ME EA TDEPTH AR + EA ASON	75 74 75 76 67 67	179.857 179.533 191.905 212.056 88.610 89.972	2.398 2.426 2.559 2.790 1.323 1.343	12.6 11.9 7.1 -1.3 51.9 51.2	933 916 01 904 983 2 245		-47.413 -47.251 -53.437 -63.512 -1.789 -2.470	32.22 32.55 20.18 0.03 6.76 5.4	<.00 <.00 <.00 0.87
ASON /E EA TDEPTH EA ASON	75 74 75 76 67	179.857 179.533 191.905 212.056 88.610	2.398 2.426 2.559 2.790 1.323	12.9 11.9 7.1 -1.3 51.9	933 916 01 904 983 2 245		-47.413 -47.251 -53.437 -63.512 -1.789	32.22 32.55 20.18 0.03 6.76	<.00 <.00 <.00 0.87 0.03
ASON IE EA TDEPTH AR + EA ASON IE	75 74 75 76 67 67	179.857 179.533 191.905 212.056 88.610 89.972	2.398 2.426 2.559 2.790 1.323 1.343	12.6 11.9 7.1 -1.3 51.9 51.2	933 916 01 904 983 2 245		-47.413 -47.251 -53.437 -63.512 -1.789 -2.470	32.22 32.55 20.18 0.03 6.76 5.4	<.00 <.00 <.00 0.87 0.03
ASON ME TEA TDEPTH AR + EA ASON ME AR + AREA +	75 74 75 76 67 67	179.857 179.533 191.905 212.056 88.610 89.972	2.398 2.426 2.559 2.790 1.323 1.343	12.6 11.9 7.1 -1.3 51.9 51.2	933 916 01 904 983 2 245 119		-47.413 -47.251 -53.437 -63.512 -1.789 -2.470	32.22 32.55 20.18 0.03 6.76 5.4	<.00 <.00 <.00 0.87 0.03 0.04 0.78
ASON ME REA RTDEPTH REA RASON ME EAR + AREA + RASON	75 74 75 76 67 67 66 65	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.9 11.9 7.1 -1.3 51.9 51.2 48.1 54.2	933 916 01 904 983 2 245 119 230 2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67	<.00 <.00 <.00 0.87 0.03 0.03 0.78
ASON ME EA ITDEPTH EA EA ASON ME EAR + AREA + ASON	75 74 75 76 67 66 65 57	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON ME REA ETDEPTH EAR + REA ASON ME EAR + AREA + EASON EAR* AREA EAR* AREA	75 74 75 76 67 67 66 65	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.9 11.9 7.1 -1.3 51.9 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON ME REA ETDEPTH EAR + REA EASON ME EAR + AREA + ASON EAR* AREA AR* SEASON NAL MODEL: YEAR + AREA + SEASON	75 74 75 76 67 66 65 57 57	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.8 0.00 0.7 0.00 0.7 0.03
EASON ME REA ETDEPTH EAR + REA EASON ME EAR + AREA + EASON EAR* AREA EAR* AREA EAR* SEASON NAL MODEL: YEAR + AREA + SEASON	75 74 75 76 67 66 65 57	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.8 0.00 0.7 0.00 0.7 0.03
EASON ME REA ETDEPTH EAR + REA EASON ME EAR + AREA + EASON EAR* AREA EAR* SEASON NAL MODEL: YEAR + AREA + SEASON NAL MODEL: YEAR + AREA + SEASON	75 74 75 76 67 66 65 57 57	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON //E EA TDEPTH AR + EA ASON //E AR + AREA + ASON AR* AREA AR* SEASON IAL MODEL: YEAR + AREA + SEASON IAL MODEL: YEAR + creater + season IAL MODEL + creater + season IA	75 74 75 76 67 66 65 57 57 57	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.8 0.00 0.7 0.00 0.7 0.03
ASON ME ERA TIDEPTH RAR + REA ASON ME EAR + AREA + ASON ART AREA ART AREA ART SEASON NAL MODEL: YEAR + AREA + SEASON aike's information criterion hwartz's Bayesian criterion hwartz's Bayesian criterion	75 74 75 76 67 66 65 57 57 180.3 182.5 178.3	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261 1.328 1.379	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON ME IEA TDEPTH MAR + IEA ASON ME AR + AREA + ASON AR* AREA AR* SEASON NAL MODEL: YEAR + AREA + SEASON aike's information criterion hwartz's Bayesian criterion) Res Log Likelihood	75 74 75 76 67 66 65 57 57 180.3 182.5 178.3	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261 1.328 1.379	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON ME IEA TDEPTH IAR + IEA ASON ME IAR + AREA + ASON AR* AREA AR* SEASON VAL MODEL: YEAR + AREA + SEASON VAL MODEL: YEAR + AREA + SEASON VAL MODEL: YEAR + CONTRACTOR Newartz's Bayesian criterion hwartz's Bayesian criterion hwartz's Bayesian criterion hwartz's Bayesian criterion hwartz's Bayesian criterion	75 74 75 76 67 66 65 57 57 180.3 182.5 178.3 Typ YEAF	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261 1.328 1.379	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
ASON ME REA ETDEPTH EAR + REA EAR + REA EAR + ASON ME EAR + AREA + ASON EAR * AREA EAR *	75 74 75 76 67 66 65 57 57 180.3 182.5 178.3 182.5 178.3 Typ YEAR <.000	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585 • 3 Tests of Fixe • AREA 1 0.0180	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261 1.328 1.379 d Effects SEASON 0.0356	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	<.00 <.00 <.00 0.87 0.03 0.06 0.78
EAR EASON ME REA ETDEPTH EAR + REA EASON ME EAR + AREA + EASON EAR * AREA EAR* AREA EAR* SEASON NAL MODEL: YEAR + AREA + SEASON NAL MODEL: YEAR + AREA + SEASON Kaike's information criterion chwartz's Bayesian criterion Chwartz's Bayesian criterion Chwartz's Bayesian criterion Solution Chwartz's Bayesian criterion Chwartz's Bayesian criterion Solution Chwartz's Bayesian criterion Chwartz's Chwartz's	75 74 75 76 67 66 65 57 57 180.3 182.5 178.3 Typ YEAF	179.857 179.533 191.905 212.056 88.610 89.972 94.311 81.941 75.686 78.585 8 • 3 Tests of Fixe AREA 1 0.0180 2	2.398 2.426 2.559 2.790 1.323 1.343 1.429 1.261 1.328 1.379	12.5 11.5 7.1 -1.3 51.5 51.2 48.1 54.2	333 316 01 004 3083 2 245 119 230 2 791 -2	2.167	-47.413 -47.251 -53.437 -63.512 -1.789 -2.470 -4.640 1.545 4.673	32.22 32.55 20.18 0.03 6.76 5.4 1.060 6.67 6.26	0.03 0.061 0.91

Table 10. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for juvenile sandbar sharks. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood

Proportion positive-Binomial error distribution FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI	
NULL	711	254.944	0.359			-127.472			
AREA	708	188.622	0.266	25.701	25.701	-94.311	66.320	<.0001	
/EAR	703	224.604	0.319	10.898		-112.302	30.340	0.0002	
TIME	708	242.005	0.342	4.673		-121.003	12.940	0.0048	
SETDEPTH	710	251.656	0.354	1.151		-125.828	3.290	0.0698	
SEASON	709	253.784	0.358	0.174		-126.892	1.160	0.5600	
AREA + YEAR	700	162.6653	0.232	35.193	9.492	-81.333	25.96	0.0011	
TIME	705	174.4811	0.247	30.979		-87.241		Hessian not positive of	definite.
AREA + YEAR									
AREA * YEAR	680	157.1029	0.231	35.568	0.375	-78.551	Negative of	Hessian not positive of	definite.
FINAL MODEL: AREA + YEAR									
Akaike's information criterion	2834.3								
Schwartz's Bayesian criterion	2838.4								
(-2) Res Log Likelihood	2832.3								
		3 Tests of Fixed	Effects						
Significance (Pr>Chi) of Type 3	AREA	YEAR							
test of fixed effects for each factor	<.0001	<.0001							
DF	1	8							
CHI SQUARE	32.76	45.000							
Positive catches-Poisson error distribution									
FACTOR			/IANCE DEVIA	NCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
FACTOR				NCE/DF .705	%DIFF	DELTA%	L -14.471	CHISQUARE	PR>CHI
FACTOR NULL		30 8	1.149 2	.705	%DIFF 68.447	DELTA% 68.447		CHISQUARE 62.37	PR>CHI <.0001
FACTOR NULL YEAR		30 8 22 1	1.149 2 8.777 0	.705 .854	68.447		-14.471 16.714	62.37	<.0001
FACTOR NULL YEAR TIME		30 8 22 1 28 4	1.14928.77703.8241	.705 .854 .565	68.447 42.138		-14.471 16.714 4.191	62.37 37.32	<.0001 <.0001
FACTOR NULL YEAR TIME SETDEPTH		30 8 22 1 28 4 29 4	1.149 2 8.777 0 3.824 1 7.704 1	.705 .854 .565 .645	68.447 42.138 39.187		-14.471 16.714 4.191 2.251	62.37 37.32 33.44	<.0001 <.0001 <.0001
FACTOR NULL YEAR TIME SETDEPTH AREA		30 8 22 1 28 4 29 4 29 7	1.149 2 8.777 0 3.824 1 7.704 1 3.353 2	.705 .854 .565 .645 .529	68.447 42.138 39.187 6.489		-14.471 16.714 4.191 2.251 -10.574	62.37 37.32 33.44 7.8	<.0001 <.0001 <.0001 0.0052
FACTOR NULL YEAR TIME SETDEPTH AREA		30 8 22 1 28 4 29 4 29 7	1.149 2 8.777 0 3.824 1 7.704 1 3.353 2	.705 .854 .565 .645	68.447 42.138 39.187		-14.471 16.714 4.191 2.251	62.37 37.32 33.44	<.0001 <.0001 <.0001
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR +		30 8 22 1 28 4 29 4 29 7 28 7	1.149 2 8.777 0 3.824 1 7.704 1 3.353 2 7.958 2	705 .854 .565 .645 .529 .784	68.447 42.138 39.187 6.489 -2.930	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876	62.37 37.32 33.44 7.8 3.19	<.0001 <.0001 <.0001 0.0052 0.2029
FACTOR NULL YEAR SETDEPTH AREA SEASON YEAR + TIME		30 8 22 1 28 4 29 4 29 7 28 7 20 1	1.149 2 8.777 0 3.824 1 7.704 1 3.353 2 7.958 2 6.614 0	.705 .854 .565 .645 .529 .784	68.447 42.138 39.187 6.489 -2.930 69.289		-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796	62.37 37.32 33.44 7.8 3.19 2.16	<.0001 <.0001 <.00052 0.2029 0.3391
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH		30 8 22 1 28 4 29 4 29 7 28 7 20 1	1.149 2 8.777 0 3.824 1 7.704 1 3.353 2 7.958 2 6.614 0	705 .854 .565 .645 .529 .784	68.447 42.138 39.187 6.489 -2.930	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876	62.37 37.32 33.44 7.8 3.19	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH		30 8 22 1 28 4 29 4 29 7 28 7 28 7 20 1 21 1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784	68.447 42.138 39.187 6.489 -2.930 69.289	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796	62.37 37.32 33.44 7.8 3.19 2.16	<.0001 <.0001 0.0052 0.2029 0.3391
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA		30 8 22 1 28 4 29 4 29 7 28 7 28 7 20 1 21 1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
Positive catches-Poisson error distribution FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion		30 8 22 1 28 4 29 4 29 7 28 7 28 7 20 1 21 1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR		30 8 22 1 28 4 29 4 29 7 28 7 28 7 20 1 21 1 21 1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion		30 8 22 1 28 4 29 4 29 7 28 7 20 1 21 1 21 1 56.1 56.1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion		30 8 22 1 28 4 29 4 29 7 28 7 20 1 21 1 21 1 56.1 57.2 54.1 54.1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion (-2) Res Log Likelihood		30 8 22 1 28 4 29 4 29 7 28 7 20 1 21 1 21 1 56.1 57.2 54.1 54.1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0 3.7761 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion Schwartz's Bayesian criterion (-2) Res Log Likelihood Significance (Pr>Chi) of Type 3		30 8 22 1 28 4 29 4 29 7 28 7 20 1 21 1 21 1 56.1 57.2 54.1 54.1	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0 3.7761 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835
FACTOR NULL YEAR TIME SETDEPTH AREA SEASON YEAR + TIME SETDEPTH AREA FINAL MODEL: YEAR Akaike's information criterion		30 8 22 1 28 4 29 4 29 4 29 4 29 4 29 4 20 1 21 1 56.1 56.1 57.2 54.1 Type 3 Tests TIME TIME	1.149 2 8.777 0 3.824 1 3.353 2 7.958 2 6.614 0 8.286 0 3.7761 0	.705 .854 .565 .645 .529 .784 .831 .871	68.447 42.138 39.187 6.489 -2.930 69.289 67.808	68.447	-14.471 16.714 4.191 2.251 -10.574 -12.876 17.796 16.960	62.37 37.32 33.44 7.8 3.19 2.16 0.49	<.0001 <.0001 <.0001 0.0052 0.2029 0.3391 0.4835

YEAR	Ν	RELATIVE INDICES	CV
1996	26	0.485	0.653
1997	27	1.167	0.563
1998	68	3.424	0.456
1999	49	0.459	2.283
2000	54	0.769	1.603
2001	91	1.075	0.808
2002	130	0.388	1.137
2003	150	0.76	0.721
2004	117	0.472	1.441

Table 11. The relative standardized index of abundance from fishery independent gillnet catches, coefficients of variance (CV), and number of sets (N) for all sandbar sharks, 1996-2004.

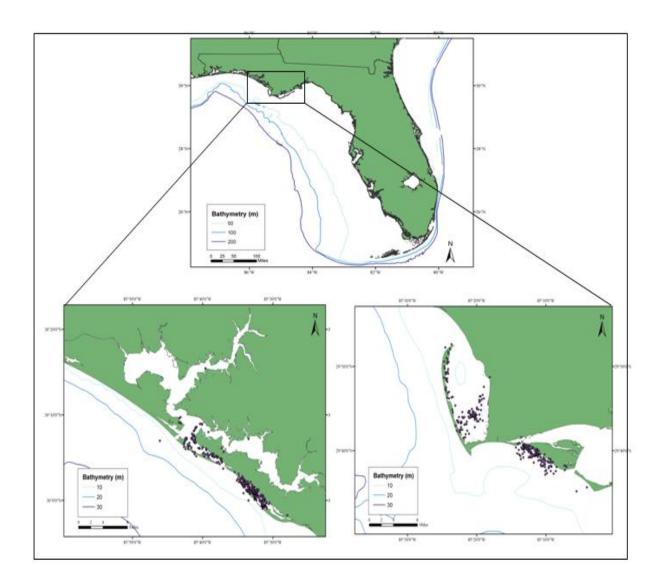


Figure 1. Location of study site in northwest Florida near latitude 30° 00' N and longitude 85° 35' W. Locations of sets of fishing gear are represented by dots.

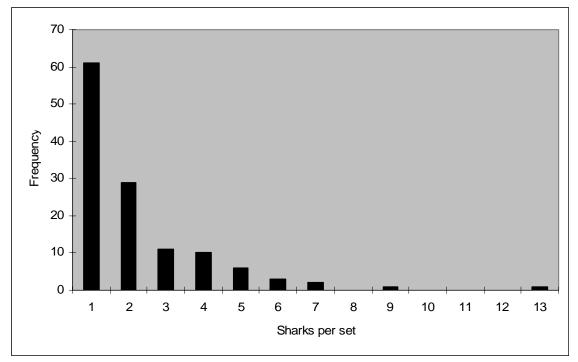


Figure 2. Frequency distribution of positive sets for the large coastal shark aggregate caught using longlines.

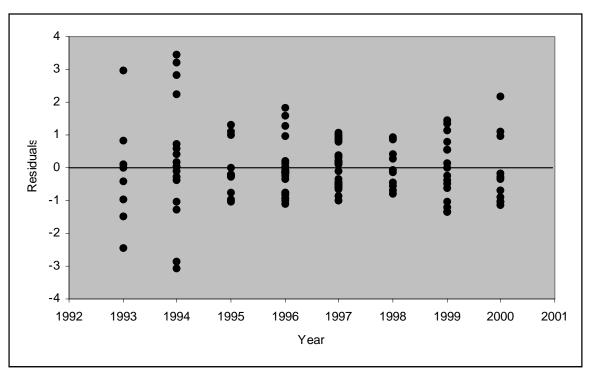


Figure 3. Residuals for the poisson model on positive catch rates by year for the large coastal shark aggregate caught using longlines.

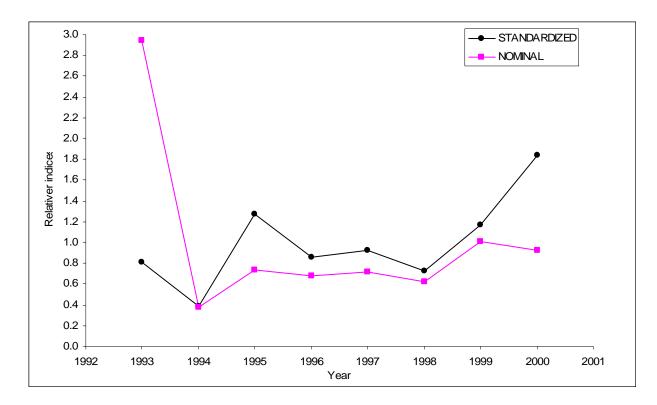


Figure 4. Standardized and nominal relative abundance trends for the large coastal shark aggregate caught using longlines.

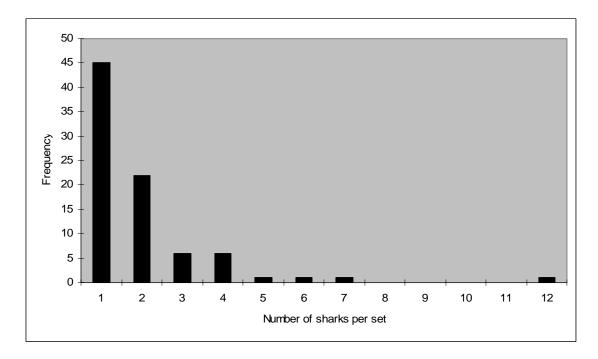


Figure 5. Frequency distribution of positive sets for blacktip sharks caught using longlines.

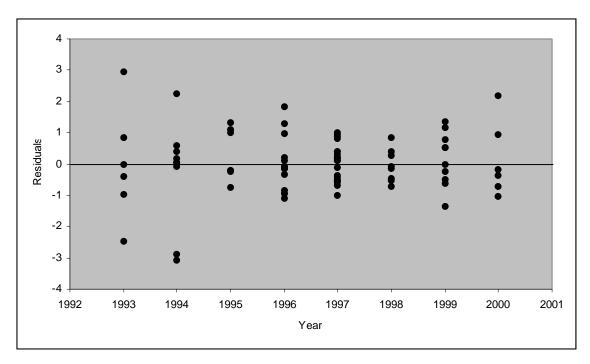


Figure 6. Residuals for the poisson model on positive catch rates by year for blacktip sharks caught using longlines.

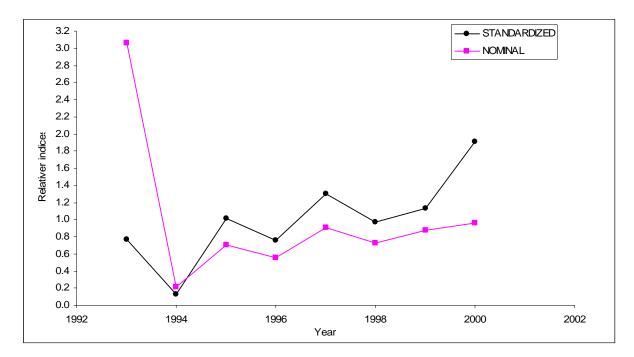


Figure 7. Standardized and nominal relative abundance trends for blacktip sharks caught using longlines.

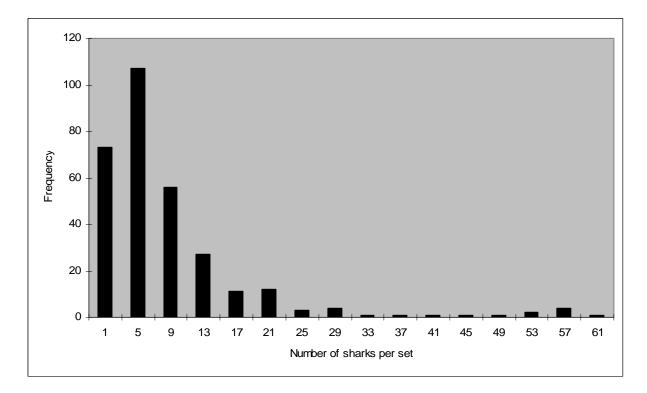


Figure 8. Frequency distribution of positive sets for the large coastal shark aggregate caught using gillnets.

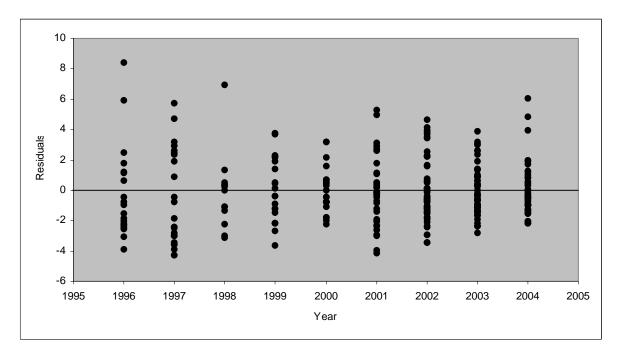


Figure 9. Residuals for the poisson model on positive catch rates by year for the large coastal shark aggregate caught using gillnets.

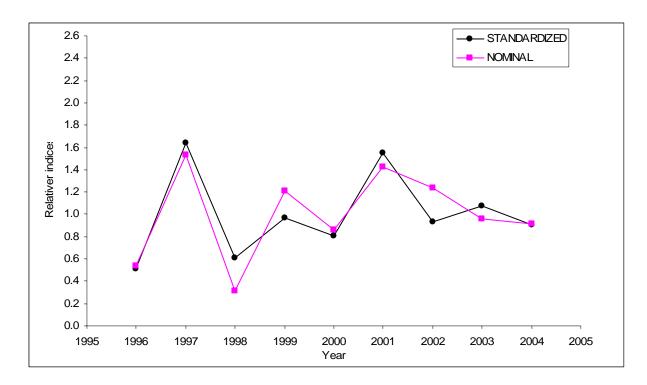


Figure 10. Standardized and nominal relative abundance trends for large coastal sharks caught using gillnets.

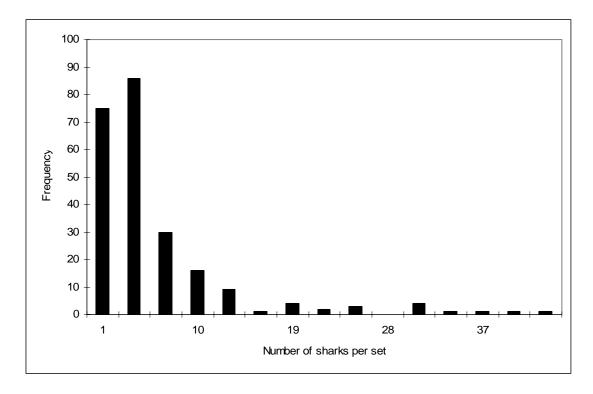


Figure 11. Frequency distribution of positive sets for all blacktip sharks caught using gillnets.

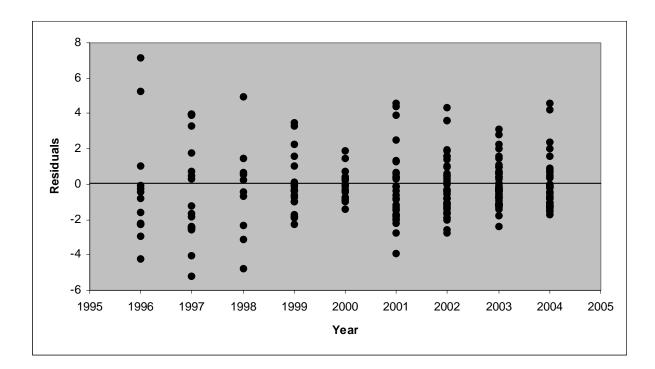


Figure 12. Residuals for the poisson model on positive catch rates by year for all blacktip sharks caught using gillnets.

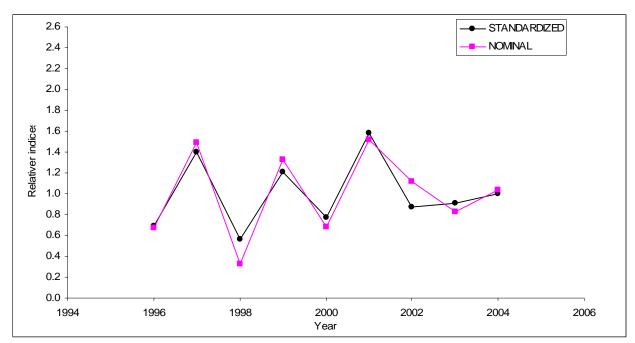


Figure 13. Standardized and nominal relative abundance trends for all blacktip sharks caught using gillnets.

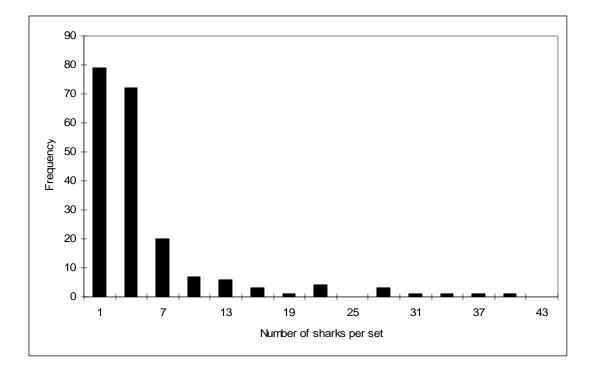


Figure 14. Frequency distribution of positive sets for juvenile blacktip sharks caught using gillnets.

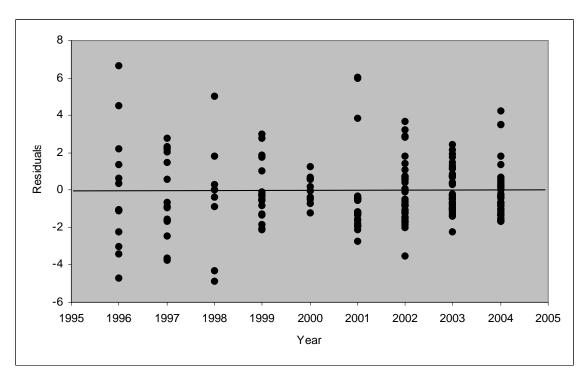


Figure 15. Residuals for the poisson model on positive catch rates by year for juvenile blacktip sharks caught using gillnets.

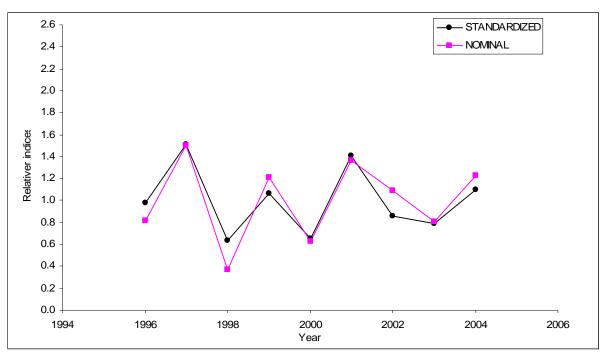


Figure 16. Standardized and nominal relative abundance trends for juvenile blacktip sharks caught using gillnets.

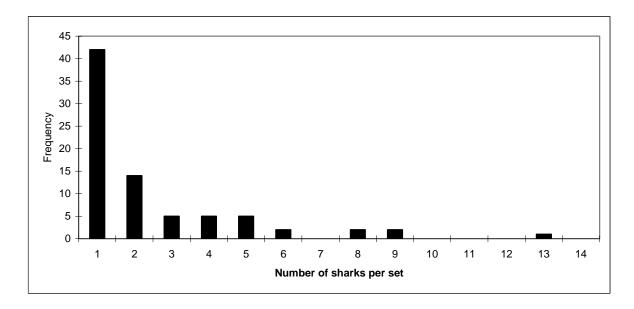


Figure 17. Frequency distribution of positive sets for age 0 blacktip sharks caught using gillnets.

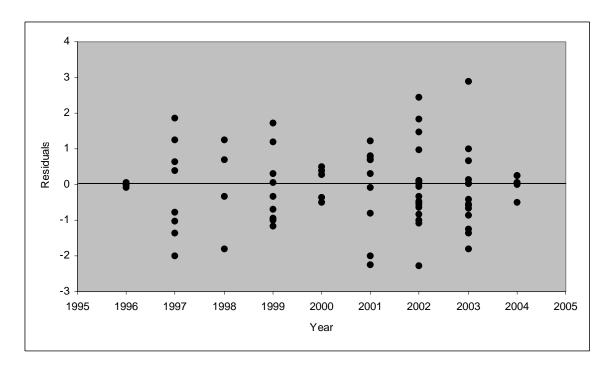


Figure 18. Residuals for the poisson model on positive catch rates by year for age 0 blacktip sharks caught using gillnets.

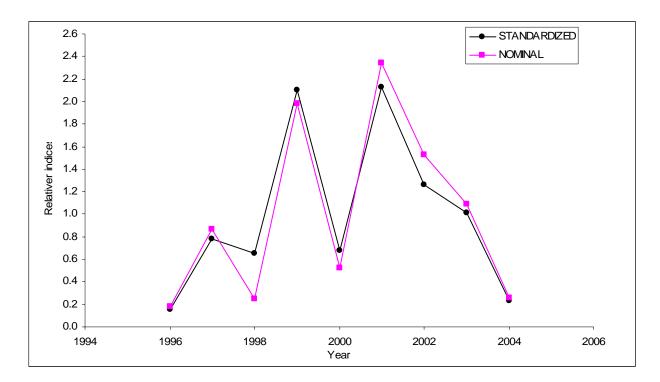


Figure 19. Standardized and nominal relative abundance trends for age 0 blacktip sharks caught using gillnets.

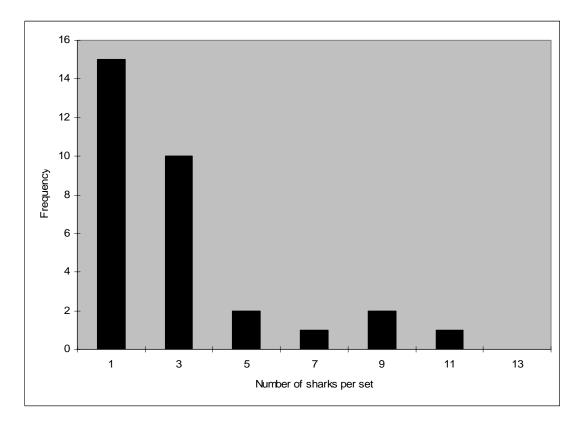


Figure 20. Frequency distribution of positive sets for sandbar sharks caught using gillnets.

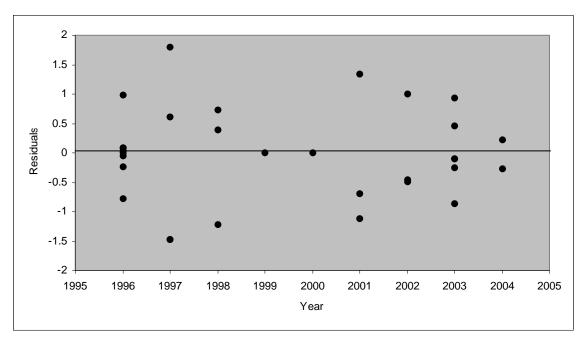


Figure 21. Residuals for the poisson model on positive catch rates by year for sandbar sharks caught using gillnets.

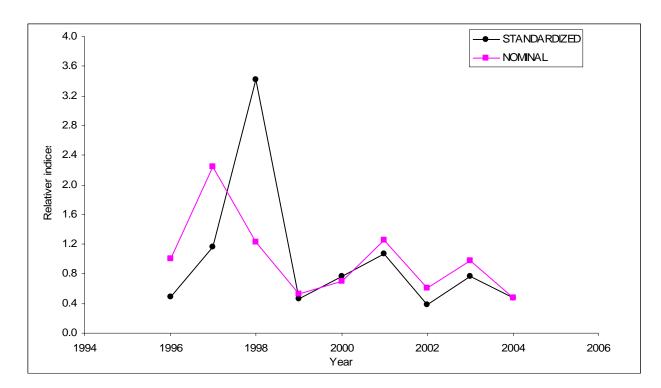


Figure 22. Standardized and nominal relative abundance trends for sandbar sharks caught using gillnets.

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APPENDIX TO LCS05/06-DW-12 (STANDARDIZED CATCH RATES OF LARGE COASTAL SHARKS FROM A FISHERY-INDEPENDENT SURVEY IN NORTHWEST FLORIDA)

Introduction

Based on discussion at the 2005 Shark SEDAR Data workshop, the present appendix to document LCS05/06-DW-12 attempts to standardize catch rates for the large coastal species-aggregate minus prohibited species minus blacktip shark minus sandbar shark. All analysis followed standardization procedures outline in LCS05/06-DW-12. No other series were attempted to be modeled because of low sample size. In addition, because of the small sample size associated with the juvenile sandbar shark series and the GLM model overcompensating in some years, the catch rate group suggested presenting this time series as a nominal series only.

Results

<u>Gillnet</u>

Large coastal species-aggregate (minus prohibited species minus blacktip shark minus sandbar shark)

The percentage of sets with zero catches was 71.3% for this group. The stepwise constructions of the models are in Table 1a. The final binomial model was *Proportion positive sets=Area + Season + Time + Year*. The final poisson model was *Positive large coastal sets = Year + Season + Setdepth*. First order interactions were run but found not to be significant. The standardized abundance index is shown in Figure 1a. To allow for visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 2a.

Sandbar sharks

The nominal series for juvenile sandbar shark is in Table 3a.

Table 1a. Results of the stepwise procedure for development of the fishery independent gillnet catch rate model for the large coastal shark aggregate minus prohibited species minus blacktip shark minus sandbar shark. %DIFF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

Proportion positive-Binomial error distribution								
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	711	852.981	1.200			-426.490		
AREA	708	684.694	0.967	19.389	19.389	-342.347	168.290	<.0001
YEAR	703	808.497	1.150	4.137		-404.248	44.48	<.0001
SEASON	709	821.550	1.159	3.413		-410.775	31.430	<.0001
ГIME	708	831.966	1.175	2.050		-415.983	21.010	0.0001
SETDEPTH	710	849.040	1.196	0.322		-424.520	3.940	0.0471
AREA +								
SEASON	706	654.9893	0.928	22.668	3.279	-327.495	29.7	<.0001
IME	705	660.7737	0.937	21.874		-330.387	23.92	<.0001
YEAR	700	666.564	0.952	20.627		-333.282	18.13	0.0203
AREA + SEASON +								
ГIМЕ	703	631.046	0.898	25.177	2.509	-315.523	23.940	<.0001
'EAR	698	633.888	0.908	24.301		-316.944	21.1	0.0069
AREA + SEASON + TIME								
/EAR	695	621.782	0.895	25.427	0.250	-310.891	9.260	0.3205
AREA + SEASON + TIME + YEAR								
AREA*SEASON	689	612.9436	0.890	25.847		-306.472	8.84	0.1829
REA*TIME	687	604.3879	0.880	26.669		-302,194	Negative of	Hessian not positive
AREA*YEAR	675	584,7926	0.866	27.785		-292.396	Negative of	Hessian not positive
SEASON*TIME	689	611.7257	0.888	25.994		-305.863	10.06	0.1223
IME*YEAR	680	603.7493	0.888	25.992		-301.875		Hessian not positive
FINAL MODEL: AREA + SEASON + TIME + YEAR								
Akaike's information criterion	3709.8							
Schwartz's Bayesian criterion	3714.3							
-2) Res Log Likelihood	3707.8							

Table 1a continued.

Positive catches-Poisson error distribution								
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	203	1128.792	5.561			555.772		
YEAR	195	729.427	3.741	32.729	32.729	755.454	399.36	<.0001
SEASON	201	1006.763	5.009	9.923		616.786	122.03	<.0001
TIME	200	1013.320	5.067	8.883		613.508	115.47	<.0001
SETDEPTH	202	1034.408	5.121	7.908		602.964	94.38	<.0001
AREA	200	1057.049	5.285	4.951		591.644	71.74	<.0001
YEAR +								
SEASON	193	631.635	3.273	41.144	8.415	804.350	97.79	<.0001
AREA	192	678.319	3.533	36.465		781.008	51.11	<.0001
SETDEPTH	194	725.960	3.742	32.703		757.188	3.47	0.0626
TIME	192	718.487	3.742	32.702		760.924	10.94	0.0121
YEAR + SEASON								
SETDEPTH	190	588.323	3.096	44.314	3.170	826.006	43.31	<.0001
AREA	190	621.9818	3.274	41.128		809.1769	9.65	0.0218
TIME	192	628.692	3.274	41.113		805.822	2.94	0.0862
YEAR + SEASON + SETDEPTH +								
AREA	189	580.5045	3.071	44.764	0.449	829.9155	48.19	<.0001
TIME	189	619.670	3.279	41.037		810.333	9.02	0.0290
YEAR + SEASON + SETDEPTH								
YEAR*SEASON	177	565.3409	3.194	42.559	-2.204	837.4974	63.35	<.0001
YEAR*SETDEPTH	185	597.417	3.229	41.925		821.459	31.27	<.0001
SEASON*SETDEPTH	190.0	628.5294	3.308	40.509		805.903	0.16	0.9218
FINAL MODEL: YEAR + SEASON + SETDEPTH								
Akaike's information criterion	588.9							
Schwartz's Bayesian criterion	592.2							
(-2) Res Log Likelihood	586.9							

Table 2a. The relative standardized index of abundance from fishery independent gillnet catches, coefficients of variance (CV), and number of sets (N) for the large coastal shark aggregate minus prohibited species minus blacktip shark minus sandbar shark, 1996-2004

YEAR	RELATIVE INDICES	LCL	UCL	CV	Ν
1996	0.328	-0.014	0.67	0.532	26
1997	1.197	0.558	1.836	0.272	27
1998	0.521	0.016	1.027	0.494	68
1999	0.973	0.09	1.856	0.463	48
2000	1.112	0.215	2.008	0.411	54
2001	1.682	0.662	2.703	0.309	91
2002	1.129	0.51	1.748	0.28	130
2003	1.022	0.47	1.574	0.276	150
2004	1.034	0.399	1.67	0.314	117

YEAR	RELATIVE	S.D.
1996	1.00	0.06
1997	2.25	0.24
1998	1.22	0.21
1999	0.53	0.12
2000	0.69	0.18
2001	1.25	0.3
2002	0.61	0.16
2003	0.97	0.19
2004	0.47	0.12

Table 3a. The nominal index (# sharks/net/hr) of abundance from fishery independent gillnets catches and standard deviation (S.D.) for the sandbar shark, 1996-2004.

Figure 1A. Standardized and nominal relative abundance trends for the large coastal shark aggregate minus prohibited species minus blacktip shark minus sandbar shark using gillnets.

