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

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INTRODUCTION

A fishery-independent survey of large and small coastal shark populations in coastal areas of the northeast Gulf of Mexico has been conducted using gillnets from 1996-2006. 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 small coastal species-aggregate, Atlantic sharpnose, blacknose, bonnethead and finetooth sharks. Additional catch rate series are also developed by life stage for each small coastal species.

MATERIAL AND METHODS

Field data collection

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. In 2005, an additional panel of net with 7.6 cm (3.0") mesh size was added to the sampling gear and the 20.3 cm mesh panel was removed.

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. 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. Mid-water 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

Several categorical variables were constructed for analysis of gillnet data:
"Year" (10 levels): 1996-2005
"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
"Gear" (2 levels):
Net 1=(mesh sizes 8.9– 14.0 cm and 20.3 cm)
Net 2=(mesh sizes 7.6-14.0 cm)

Because of the change in gear in 2005 (i.e. gillnet mesh) could affect CPUE, in 2006 a randomization technique was used to test the null hypothesis of no difference in mean CPUE between sharks captured with net 1 and those with net 2. Each net was independently randomly fished throughout the sampling strata in order to provide robust samples when introducing gear into the generalized linear model. Analysis was run for the time series through 2006 although standardized abundance indices are only reported through 2005.

The proportion of sets that caught sharks (when at least one shark was caught) was modeled assuming a binomial distribution with a logit link function. The positive catches were modeled assuming a poisson distribution with a log link function. 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 selecting the set of fixed factors and interactions for each error distribution, all interactions that included the factor year were treated as random interactions (Ortiz and Arocha, 2004). This process converted the basic models from generalized linear models into generalized linear mixed models. The final model determination was evaluated using the Akaike Information Criteria (AIC), and Schwarz's Bayesian Criterion (BIC). Models with smaller AIC and BIC values are preferred to those with larger values. These models were fit using a SAS macro, GLIMMIX (glmm800MaOB.sas: Russ Wolfinger, SAS Institute Inc.) and the MIXED procedure in SAS statistical computer software (PROC GLIMMIX). Relative indices of abundance were calculated as the product of the year effect least square means from the two independent models.

Results and Discussion

Gillnet

A total of 1001 gillnet sets have been made through out 4 areas since 1996 (Figure 1).

Atlantic sharpnose shark

For Atlantic sharpnose sharks, the percentage of sets with zero catch was 89.1% for all ages, 65.7% for adults, and 71.8% for juveniles. The stepwise construction of the models is summarized in Table 1. The standardized abundance index is shown in Figure 2. 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. Average sizes of sharks captured by life stage are reported in Table 3.

Blacknose sharks

For blacknose sharks, the percentage of sets with zero catch was 89.1% for all ages, 97.6% for adults, and 95.1% for juveniles. The stepwise construction of the models is summarized in Table 4. We were unable to

run the delta model for juvenile blacknose sharks. Initial runs resulted in the final Hessian not positive definite when year was introduced as a factor in the binomial model. Thus, a single generalized linear model was performed on the natural logarithm of catch per unit effort with the addition of a standard value (0.1) to account for zero values. The same factors were considered and criteria for elimination was utilized, as previously outlined. The standardized abundance index is shown in Figure 3. 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. Average sizes of sharks captured by life stage are reported in Table 6.

Bonnetheads

For bonnetheads, the percentage of sets with zero catch was 63.2% for all ages, 79.5% for adults, and 80.2% for juveniles. The stepwise construction of the models is summarized in Table 7. 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 8. Average sizes of sharks captured by life stage are reported in Table 9.

Finetooth shark

For finetooth, the percentage of sets with zero catch was 81.3% for all ages, 90.9% for adults, and 86.4% for juveniles. The stepwise construction of the models is summarized in Table 10. The standardized abundance index is shown in Figure 5. 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. Average sizes of sharks captured by life stage are reported in Table 12.

Small coastal aggregate

The percentage of sets with zero catch was 33.2% for the small coastal aggregate. We were unable to run the delta model because initial runs resulted in the final Hessian not positive definite when year was introduced as a factor in the binomial model. Thus, a single generalized linear model was performed on the natural logarithm of catch per unit effort with the addition of a standard value (0.1) to account for zero values. The same factors were considered and criteria for elimination was utilized, as previously outlined. The stepwise construction of the models is summarized in Table 13. The standardized abundance index is shown in Figure 6. 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 14.

Table 1. Analysis of deviance of explanatory variables for the binomial and Poisson generalized linear and mixed model formulations of the proportion of positive and positive catches for Atlantic sharpnose sharks for all life stages (A), adult (B), and juvenile (C). Final models selected are in bold.

(A) All Atlantic sharpnose shark

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	1387.056	1.387				
AREA	997	1158.049	1.162	16.259	16.259		
YEAR	990	1311.753	1.325	4.474		75.30	<.0001
SEASON	998	1364.926	1.368	1.398		22.13	<.0001
TIME	997	1370.389	1.375	0.904		16.67	0.0008
NET	999	1381.986	1.383	0.266		5.07	0.0243
SETDEPTH	999	1386.836	1.388	-0.084		0.22	0.6390
AREA +							
YEAR	987	1106.007	1.121	19.212	2.953	52.04	<.0001
SEASON	995	1131.762	1.137	17.995		26.29	<.0001
AREA + YEAR							
SEASON	985	1076.563	1.093	21.203	1.991	29.44	<.0001
FINAL GENMOD							
AREA+YEAR+SEASON							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR AREA SEASON	4736.4	4741.3	4734.4				
YEAR AREA SEASON YEAR*SEASON	4754.8	4757.8	4750.8				
YEAR+AREA+SEASON YEAR*AREA	**4716.9**	**4720.3**	**4712.9**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	487	4113.520	8.447				
YEAR	477	3253.576	6.821	19.247	19.247	859.94	<.0001
AREA	484	3665.007	7.572	10.351		448.51	<.0001
NET	486	3894.963	8.014	5.118		218.56	<.0001
TIME	484	3937.377	8.135	3.689		176.14	<.0001
SETDEPTH	486	4014.735	8.261	2.201		98.78	<.0001
SEASON	485	4110.188	8.475	-0.331		3.33	0.1890
YEAR +							
AREA	474	2916.201	6.152	27.163	7.915	337.37	<.0001
TIME	474	3176.083	6.701	20.672		77.49	<.0001
SETDEPTH	476	3206.401	6.736	20.251		47.17	<.0001
NET	476	3250.407	6.829	19.156		3.17	0.0750
YEAR + AREA							
TIME	471	2864.059	6.081	28.009	0.847	52.14	<.0001
SETDEPTH	473	2913.482	6.160	27.077		2.72	0.0992
FINAL GENMOD							
YEAR+AREA							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR AREA	1540.9	1545.1	1538.9				
YEAR+AREA YEAR*AREA	**1415.0**	**1493.6**	**1497.0**				

(B) Adult sharpnose shark

Proportion positive -Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	1286.850	1.287				
AREA	997	1105.566	1.109	13.829	13.829	181.28	<.0001
YEAR	990	1225.804	1.238	3.782		61.05	<.0001
SEASON	998	1267.140	1.270	1.334		19.71	<.0001
TIME	997	1276.126	1.280	0.535		10.72	0.0133
NET	999	1285.997	1.287	-0.034		0.85	0.3556
SETDEPTH	999	1286.719	1.288	-0.090		0.13	0.7167
AREA +							
YEAR	987	1061.735	1.076	16.407	2.578	43.83	<.0001
SEASON	995	1083.269	1.089	15.397		22.30	<.0001
AREA + YEAR							
SEASON	985	1037.085	1.053	18.182	1.775	24.65	<.0001
FINAL GENMOD							
YEAR + AREA +SEASON	985	1037.085	1.053	18.182	1.775	24.65	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR AREA SEASON	4897.0	4901.9	4895.0				
YEAR AREA SEASON YEAR*SEASON	4934.9	4937.9	4930.9				
YEAR+AREA+SEASON YEAR*AREA	**4893.2**	**4896.6**	**4889.2**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	342	1514.898	4.430				
YEAR	332	1045.542	3.149	28.904	28.904	469.36	<.0001
AREA	341	1296.976	3.803	14.134		217.92	<.0001
NET	339	1381.371	4.075	8.007		133.53	<.0001
TIME	339	1462.406	4.314	2.611		52.49	<.0001
SETDEPTH	340	1493.426	4.392	0.838		21.47	<.0001
SEASON	341	1512.201	4.435	-0.115		2.70	0.1005
YEAR +							
AREA	329	1010.730	3.072	30.644	1.740	34.81	<.0001
NET	331	1008.790	3.048	31.196		36.75	<.0001
TIME	329	1039.167	3.159	28.693		6.38	0.0947
YEAR + AREA							
NET	328	980.940	2.991	32.483	1.839	29.79	<.0001
FINAL GENMOD							
YEAR+AREA+NET	328	980.940	2.991	32.483	32.483	29.79	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+NET	1056.4	1060.2	1054.4				
YEAR+AREA+NET YEAR*AREA	**1031.5**	**1034.6**	**1027.5**				
YEAR+AREA+NET YEAR*NET	1056.4	1056.9	1054.4				

(C) Juvenile Atlantic sharpnose shark

Proportion positive -Binomial error distribution							
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQUARE	PR>CHI
NULL	1000	1190.327	1.190				
AREA	997	1045.456	1.049	11.906	11.906	144.87	<.0001
YEAR	990	1126.395	1.138	4.415		63.93	<.0001
TIME	997	1163.194	1.167	1.985		27.13	<.0001
NET	999	1181.355	1.183	0.654		8.97	0.0027
SEASON	998	1185.705	1.188	0.189		4.62	0.0992
SETDEPTH	999	1187.057	1.188	0.175		3.27	0.0706
AREA +							
YEAR	987	987.681	1.001	15.931	4.025	57.77	<.0001
TIME	994	1023.034	1.029	13.536		22.42	<.0001
NET	996	1036.791	1.041	12.549		8.67	0.0032
AREA + YEAR							
TIME	984	985.702	1.002	15.844	15.844	1.98	0.5767
NET	986	987.417	1.001	15.869	-0.063	0.26	0.6074
FINAL GENMOD							
YEAR + AREA							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR AREA	4836.9	4841.8	4834.9				
YEAR AREA YEAR*AREA	4801.5	4804.9	4797.5				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	281	1923.909	6.847				
AREA	278	1433.605	5.157	24.681	24.681	490.30	<.0001
YEAR	271	1524.203	5.624	17.852		399.71	<.0001
SETDEPTH	280	1805.137	6.447	5.838		118.77	<.0001
TIME	278	1799.290	6.472	5.468		124.62	<.0001
NET	280	1819.142	6.497	5.108		104.77	<.0001
SEASON	279	1899.161	6.807	0.579		24.75	<.0001
AREA +							
YEAR	268	1185.788	4.425	35.376	10.695	247.82	<.0001
NET	277	1372.513	4.955	27.630		61.09	<.0001
TIME	275	1366.561	4.969	27.420		67.04	<.0001
SETDEPTH	277	1417.353	5.117	25.266		16.25	<.0001
AREA +YEAR							
NET	267	1145.843	4.292	37.319	1.943	39.94	<.0001
TIME	265	1157.277	4.367	36.216		28.51	<.0001
SETDEPTH	267	1174.967	4.401	35.726		10.82	0.0010
AREA+YEAR+NET							
TIME	264	1124.821	4.261	37.770	0.451	21.02	0.0001
SETDEPTH	266	1139.153	4.283	37.451		6.69	0.0097
FINAL GENMOD							
YEAR+AREA+NET	267	1145.843	4.292	37.319	1.943	39.94	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				

YEAR+AREA+NET	834.4	838.0	832.4				
YEAR+AREA+NET YEAR*AREA	**820.0**	**823.1**	**816.0**				
YEAR+AREA+NET YEAR*NET	1193.7	1194.7	1189.7				

Table 2. The standardized index of abundance, and coefficients of variation (CV) for Atlantic sharpnose shark.

All Atlantic sharpnose sharks

YEAR	ABSOLUTE INDEX	CV
1996	1.066	0.357
1997	1.709	0.324
1998	1.230	0.401
1999	1.501	0.413
2000	1.169	0.465
2001	1.994	0.358
2002	1.992	0.332
2003	2.022	0.317
2004	1.128	0.388
2005	1.879	0.352
2006	5.209	0.281

Adult Atlantic sharpnose sharks

YEAR	ABSOLUTE INDEX	CV
1996	0.339	0.403
1997	0.679	0.296
1998	0.408	0.429
1999	0.361	0.518
2000	0.616	0.468
2001	0.706	0.382
2002	1.037	0.322
2003	1.091	0.287
2004	0.659	0.382

Juvenile Atlantic sharpnose sharks

YEAR	RELATIVE INDICES	CV
1996	1.166	0.356
1997	1.401	0.335
1998	1.039	0.43
1999	1.514	0.465
2000	0.852	0.505
2001	1.442	0.399
2002	1.036	0.405
2003	1.117	0.393
2004	0.667	0.449
2005	0.339	0.517

Table 3. Average sizes for juvenile and adult Atlantic sharpnose sharks collected during fishery independent sampling.

Year		Ave FL (cm)	Stdev
1996	**JUV**	57.5	6.4
	MAT	74.8	5.3
1997	**JUV**	53.0	7.9
	MAT	78.0	4.9
1998	**JUV**	55.1	5.9
	MAT	76.2	5.1
1999	**JUV**	54.9	5.7
	MAT	77.0	5.3
2000	**JUV**	68.5	11.5
	MAT	77.1	5.1
2001	**JUV**	53.8	5.3
	MAT	74.4	5.3
2002	**JUV**	53.0	6.0
	MAT	76.0	5.1
2003	**JUV**	56.1	5.8
	MAT	74.6	5.8
2004	**JUV**	50.6	6.1
	MAT	74.8	5.6
2005	**JUV**	51.0	6.7
	MAT	76.5	5.4

Table 4. Analysis of deviance of explanatory variables for the binomial and Poisson generalized linear and mixed model formulations of the proportion of positive and positive catches for blacknose sharks for all life stages (A), adult (B). The generalized linear model for juvenile (C) sharks was a log (CPUE+0.1). Final models selected are in bold.

(A) All blacknose shark

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	689.070	0.689				
YEAR	990	629.914	0.636	7.661	7.661	59.160	<.0001
AREA	997	636.697	0.639	7.323		52.370	<.0001
TIME	997	666.261	0.668	3.019		22.810	<.0001
SETDEPTH	999	669.439	0.670	2.752		19.630	<.0001
SEASON	998	671.984	0.673	2.284		17.090	0.0002
NET	999	672.664	0.673	2.283		16.410	<.0001
YEAR+							
AREA	987	554.6204	0.562	18.452	10.790	75.29	<.0001
SETDEPTH	989	603.03	0.610	11.513		26.88	<.0001
SEASON	988	608.9326	0.616	10.556		20.98	<.0001
TIME	987	626.3341	0.635	7.907		3.58	0.3105
NET	989	629.8049	0.637	7.584		0.11	0.7409
YEAR+AREA							
SEASON	985	532.075	0.540	21.608	3.156	22.550	<.0001
SETDEPTH	986	542.450	0.550	20.160		12.170	0.0005
YEAR+AREA+SEASON							
SETDEPTH	984	518.447	0.527	23.538		13.630	0.0002
FINAL GENMOD							
YEAR+AREA+ SEASON+SETDEPTH							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+ SEASON+SETDEPTH	6009.5	6014.4	6007.5				
YEAR+AREA+SEASON+ SETDEPTH YEAR*AREA	**5920.6**	**5923.9**	**5916.6**				
YEAR+AREA+SEASON+ SETDEPTH YEAR*SEASON	5979.2	5982.2	5975.2				
YEAR+AREA+SEASON+ SETDEPTH YEAR*SETDEPTH	6009.5	6010.5	6007.5				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	108	198.891	1.842				
YEAR	98	131.916	1.346	26.906	26.906	66.97	<.0001
TIME	105	168.247	1.602	12.990		30.64	<.0001
AREA	105	170.798	1.627	11.671		28.09	<.0001
NET	107	175.350	1.639	11.012		23.54	<.0001
SETDEPTH	107	183.306	1.713	6.974		15.58	<.0001
SEASON	106	194.819	1.838	0.199		4.07	0.1306
YEAR							
TIME	95	116.738	1.229	33.273	6.368	15.18	0.0017
SETDEPTH	97	123.255	1.271	31.001		8.66	0.0033
NET	97	131.915	1.360	26.153		0	0.9733
AREA	95	130.701	1.376	25.292		1.21	0.7494
FINAL GENMOD							
YEAR+TIME+SETDEPTH	94	103.103	1.097	40.440	7.166	13.63	0.0002
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+TIME+SETDEPTH	270.1	272.7	268.1				

YEAR+TIME+ SETDEPTH YEAR*TIME	270.1	271.2	268.1				
YEAR+TIME+ SETDEPTH YEAR*SETDEPTH	**270.1**	**270.7**	**268.1**				

(B) Adult blacknose shark

Proportion positive -Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	226.494	0.226				
YEAR	990	201.301	0.203	10.225	10.225	25.190	0.0050
AREA	997	212.711	0.213	5.803		13.780	0.0032
SEASON	998	217.426	0.218	3.811		9.070	0.0107
TIME	997	219.658	0.220	2.726		6.840	0.0773
SETDEPTH	999	223.531	0.224	1.209		2.960	0.0852
NET	999	225.006	0.225	0.557		1.490	0.2226
YEAR+							
AREA	987	184.9358	0.187	17.273	11.470		Negative of Hessian not positive definite
SEASON	988	190.5076	0.193	14.867		10.79	0.0045
YEAR							
SEASON	988	190.5076	0.193	14.867		10.79	0.0045
FINAL GENMOD							
YEAR+SEASON							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+SEASON	**5275.5**	**5280.1**	**5273.5**				
YEAR+SEASON YEAR*SEASON	11107.3	11110.3	11103.3				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	23	52.6861	2.291				
YEAR	16	16.741	1.046	54.324	54.324	35.95	<.0001
TIME	21	33.071	1.575	31.251		19.61	<.0001
AREA	21	33.724	1.606	29.895		18.96	<.0001
SETDEPTH	22	41.419	1.883	17.812		11.27	0.0008
NET	22	44.706	2.032	11.289		7.98	0.0047
SEASON	21	50.271	2.394	-4.504		2.41	0.2990
YEAR +							
SETDEPTH	15	14.939	0.996	56.524	2.200	1.80	0.1795
NET	16	16.741	1.046	54.324		-	-
AREA	14	14.742	1.053	54.032		2.00	0.3680
TIME	14	16.445	1.175	48.721		0.30	0.8626
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR	**49.2**	**50.0**	**47.2**				

(C) Juvenile blacknose shark

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	CHISQUARE	PR>CHI
NULL	1000	783.6143	0.784				
AREA	997	716.603	0.719	8.276	8.276	89.48	<.0001
SETDEPTH	999	772.933	0.774	1.264		13.74	0.0002
SEASON	998	773.984	0.776	1.031		12.38	0.0021
TIME	997	776.352	0.779	0.629		9.32	0.0253
NET	999	781.227	0.782	0.205		3.05	0.0805
YEAR	990	777.221	0.785	-0.186		8.20	0.609
AREA							
SEASON	995	705.735	0.709	9.486	1.209	15.30	0.0005
SETDEPTH	996	714.800	0.718	8.415		2.52	0.1123
FINAL GENMOD							
YEAR+SEASON+SETDEPTH	985	703.406	0.714	8.869	-0.617		
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+SEASON+SETDEPTH	2546.1	2551.0	2544.1				
YEAR+SEASON+ SETDEPTH YEAR*SEASION	2336.7	2340.1	2332.7				
YEAR+SEASON +SETDEPTH YEAR*SETDEPTH	**2435.6**	**2437.7**	**2431.6**				

Table 5. The standardized index of abundance, and coefficients of variation (CV) for blacknose shark.
All blacknose shark.

YEAR	ABSOLUTE INDEX	CV
1996	0.446	0.269
1997	0.161	0.710
1998	0.156	0.724
1999	0.308	0.833
2000	0.025	5.613
2001	0.157	0.971
2002	0.242	0.741
2003	0.216	0.759
2004	0.232	0.763
2005	0.118	1.159

Adult blacknose shark

YEAR	ABSOLUTE INDEX	CV
1996	0.446	0.269
1997	0.161	0.710
1998	0.156	0.724
1999	0.308	0.833
2000	0.025	5.613
2001	0.157	0.971
2002	0.242	0.741
2003	0.216	0.759
2004	0.232	0.763
2005	0.118	1.159

Juvenile blacknose shark

YEAR	ABSOLUTE INDEX	CV
1996	0.168	0.356
1997	0.082	0.351
1998	0.069	0.250
1999	0.086	0.268
2000	0.105	0.282
2001	0.114	0.289
2002	0.124	0.300
2003	0.117	0.296
2004	0.131	0.309
2005	0.119	0.294

Table 6. Average sizes for juvenile and adult blacknose sharks collected during fishery independent sampling.

Year		Ave FL (cm)	Stdev
1996	**JUV**	54.3	9.9
	MAT	99.1	9.9
1997	**JUV**	48.1	9.9
	MAT	86.8	5.5
1998	**JUV**	48.5	12.8
	MAT	93.4	4.2
1999	**JUV**	52.1	10.4
	MAT	NA	NA
2000	**JUV**	56.0	NA
	MAT	NA	NA
2001	**JUV**	55.4	10.6
	MAT	94.8	10.3
2002	**JUV**	61.0	1.4
	MAT	77.8	25.3
2003	**JUV**	63.9	12.8
	MAT	90.5	7.5
2004	**JUV**	61.5	12.0
	MAT	91.3	5.3
2005	**JUV**	NA	NA
	MAT	94.2	6.0

Table 7. Analysis of deviance of explanatory variables for the binomial and Poisson generalized linear and mixed model formulations of the proportion of positive and positive catches for bonnetheads for all life stages (A), adult (B), and juvenile (C). Final models selected are in bold.

(A) All bonnetheads

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	1316.6825	1.317				
AREA	997	1252.8931	1.257	4.558	4.558	63.79	<.0001
YEAR	990	1261.4327	1.274	3.228		55.25	<.0001
SEASON	999	1300.0847	1.301	1.162		16.60	<.0001
TIME	997	1302.2871	1.306	0.796		14.40	0.0024
NET	999	1311.8354	1.313	0.268		4.85	0.0277
SETDEPTH	998	1316.2858	1.319	-0.170		0.40	0.8201
AREA +							
YEAR	987	1210.1834	1.226	6.878	2.319	42.71	<.0001
SEASON	995	1252.6515	1.259	4.385		0.24	0.8862
FINAL GENMOD							
YEAR + AREA	987	1210.183	1.226	6.878	2.319	42.71	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR + AREA	4455.7	4460.6	4453.7				
YEAR + AREA YEAR*AREA	**4453.5**	**4456.8**	**4449.5**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	367	2407.6624	6.560				
YEAR	357	1988.408	5.570	15.100	15.100	419.25	<.0001
TIME	364	2219.643	6.098	7.049		188.02	<.0001
SETDEPTH	366	2299.210	6.282	4.244		108.45	<.0001
NET	366	2336.975	6.385	2.671		70.69	<.0001
AREA	364	2353.401	6.465	1.448		54.26	<.0001
SEASON	365	2394.807	6.561	-0.011		12.86	0.0016
YEAR +							
SETDEPTH	356	1963.042	5.514	15.948	0.848	25.37	<.0001
NET	356	1967.099	5.526	15.774		21.31	<.0001
TIME	354	1976.646	5.584	14.887		11.76	0.0082
AREA	354	1982.889	5.601	14.618		5.52	0.1375
FINAL GENMOD							
YEAR+SETDEPTH	356	1963.042	5.514	15.948	0.848	25.37	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+SETDEPTH	1301.8	1305.7	1299.8				
YEAR+SETDEPTH YEAR*SETDEPTH	**1293.6**	**1295.7**	**1289.6**				

(B) Adult bonnetheads

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	1014.9711	1.015				
AREA	997	926.353	0.929	8.456	8.456	88.62	<.0001
YEAR	990	943.3056	0.953	6.122		71.67	<.0001
NET	999	1000.4004	1.001	1.337		14.57	0.0001
TIME	997	1001.9598	1.005	0.985		13.01	0.0046
SEASON	998	1008.2684	1.010	0.461		6.70	0.035
SETDEPTH	999	1014.0239	1.015	-0.007		0.95	0.3304
AREA +							
YEAR	987	879.4741	0.891	12.209	3.752	46.88	<.0001
NET	996	917.6252	0.921	9.228		8.73	0.0031
AREA+YEAR							
NET	986	879.2737	0.892	12.140		0.20	0.6544
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR + AREA	4961.3	4966.2	4959.3				
YEAR + AREA YEAR*AREA	**4945.8**	**4949.2**	**4941.8**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	204	1301.8618	6.382				
YEAR	194	826.678	4.261	33.227	33.227	475.18	<.0001
TIME	201	979.261	4.872	23.657		322.60	<.0001
AREA	201	1161.842	5.780	9.423		140.02	<.0001
NET	203	1264.498	6.229	2.392		37.36	<.0001
SETDEPTH	203	1265.612	6.235	2.306		36.25	<.0001
SEASON	202	1282.721	6.350	0.495		19.14	<.0001
YEAR +							
AREA	191	755.101	3.953	38.051	4.823	71.58	<.0001
TIME	191	777.035	4.068	36.251		49.64	<.0001
NET	193	813.684	4.216	33.936		12.99	0.0003
SETDEPTH	193	826.281	4.281	32.913		0.40	0.5289
YEAR+AREA							
TIME	188	720.967	3.835	39.907	1.857	34.13	<.0001
NET	190	739.578	3.893	39.005		15.52	<.0001
YEAR+AREA+TIME							
NET	187	702.843	3.759	41.104	1.197	18.12	<.0001
FINAL GENMOD							
YEAR+AREA+TIME+NET							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+TIME+NET	696.5	699.7	694.5				
YEAR+AREA+TIME+ NET YEAR*AREA	**675.2**	**678.3**	**671.2**				
YEAR+AREA+TIME+NET YEAR*TIME	696.5	697.8	694.5				
YEAR+AREA+TIME+NET YEAR*NET	696.5	697.0	694.5				

(C) Juvenile bonnethead

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	995.676	0.996				
YEAR	990	913.358	0.923	7.341	7.341	82.32	<.0001
AREA	997	945.278	0.948	4.776		50.40	<.0001
NET	999	967.491	0.968	2.733		28.18	<.0001
TIME	997	968.090	0.971	2.478		27.59	<.0001
SETDEPTH	999	988.457	0.989	0.626		7.22	0.0072
SEASON	998	993.942	0.996	-0.026		1.73	0.4203
YEAR +							
AREA	987	855.766	0.867	12.920	5.579	57.59	<.0001
NET	989	912.796	0.923	7.304		0.56	0.4537
TIME	987	907.888	0.920	7.616		5.47	0.1405
FINAL GENMOD							
YEAR+AREA	987	855.766	0.867	12.920	5.579	57.59	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR + AREA	5100.8	5105.7	5098.8				
YEAR + AREA YEAR*AREA	**5031.7**	**5035.1**	**5027.7**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	197	993.825	5.045				
YEAR	187	814.147	4.354	13.699	13.699	179.68	<.0001
AREA	194	862.036	4.443	11.919		131.79	<.0001
SETDEPTH	196	872.047	4.449	11.806		121.78	<.0001
SEASON	195	869.531	4.459	11.609		124.29	<.0001
NET	196	957.715	4.886	3.142		36.11	<.0001
TIME	194	956.833	4.932	2.233		36.99	<.0001
YEAR +							
AREA	184	740.805	4.026	20.193	6.494	73.34	<.0001
SEASON	185	746.270	4.034	20.039		67.88	<.0001
SETDEPTH	186	764.523	4.110	18.523		49.62	<.0001
NET	186	806.398	4.335	14.060		7.75	0.0054
TIME	184	801.523	4.356	13.652		12.62	0.0055
YEAR+AREA							
SEASON	182	685.563	3.767	25.332	5.140	55.24	<.0001
SETDEPTH	183	715.834	3.912	22.462		24.97	<.0001
NET	183	735.650	4.020	20.315		5.15	0.0232
TIME	181	729.282	4.029	20.132		11.52	0.0092
YEAR+AREA+SEASON							
SETDEPTH	181	648.357	3.582	28.995	3.662	37.21	<.0001
NET	181	685.008	3.785	24.981		0.55	0.4563
TIME	179	677.965	3.788	24.922		7.60	0.0551
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+SEASON+ SETDEPTH	656.7	659.9	654.7				
YEAR+AREA+SEASON+ SETDEPTH YEAR*AREA	**618.4**	**621.5**	**614.4**				
YEAR+AREA+SEASON+ SETDEPTH YEAR*SEASON	626.5	629.4	622.5				
YEAR+AREA+SEASON+SETDEPTH YEAR*SETDEPTH	651.3	653.1	647.3				

Table 8. The standardized index of abundance, and coefficients of variation (CV) for bonnethead.

All bonnetheads

YEAR	ABSOLUTE INDEX	CV
1996	0.789	0.443
1997	0.900	0.551
1998	0.714	0.570
1999	1.249	0.526
2000	0.662	0.672
2001	1.176	0.480
2002	0.863	0.502
2003	2.218	0.448
2004	0.455	0.608
2005	0.589	0.577

Adult bonnetheads

YEAR	ABSOLUTE INDEX	CV
1996	0.563	0.483
1997	0.204	0.728
1998	0.165	0.814
1999	0.374	0.687
2000	0.046	2.407
2001	0.619	0.470
2002	0.504	0.452
2003	0.692	0.381
2004	0.296	0.557
2005	0.067	1.047

Juvenile bonnetheads

YEAR	ABSOLUTE INDEX	CV
1996	0.602	0.554
1997	0.827	0.575
1998	0.622	0.481
1999	0.710	0.598
2000	0.304	0.779
2001	0.390	0.617
2002	0.435	0.590
2003	0.292	0.624
2004	0.166	0.778
2005	0.046	1.536

Table 9. Average sizes for juvenile and adult bonnetheads collected during fishery independent sampling.

Year		Ave FL (cm)	Stdev
1996	**JUV**	59.9	7.2
	MAT	78.4	6.2
1997	**JUV**	55.0	6.2
	MAT	81.2	9.4
1998	**JUV**	60.4	7.0
	MAT	74.1	5.6
1999	**JUV**	52.1	12.2
	MAT	77.1	8.1
2000	**JUV**	50.0	6.5
	MAT	85.0	6.8
2001	**JUV**	58.0	10.5
	MAT	76.3	8.6
2002	**JUV**	55.5	9.2
	MAT	77.1	9.3
2003	**JUV**	52.4	9.0
	MAT	74.8	8.6
2004	**JUV**	59.4	6.0
	MAT	76.1	9.1
2005	**JUV**	45.3	2.1
	MAT	76.8	10.4

Table 10. Analysis of deviance of explanatory variables for the binomial and Poisson generalized linear and mixed model formulations of the proportion of positive and positive catches for finetooth sharks for all life stages (A), adult (B). Final models selected are in bold.

(A) All finetooth sharks

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	964.101	0.964				
AREA	997	713.943	0.716	25.724	25.724	250.16	<.0001
YEAR	990	885.7661	0.895	7.197		78.33	<.0001
TIME	997	952.5945	0.955	0.896		11.51	0.0093
NET	999	956.8598	0.958	0.652		7.24	0.0071
SEASON	998	959.2308	0.961	0.306		4.87	0.0876
SETDEPTH	999	964.0312	0.965	-0.093		0.07	0.7916
AREA +							
YEAR	987	667.695	0.676	29.832	4.108	46.25	<.0001
FINAL GENMOD							
YEAR + AREA	987	667.695	0.676	29.832	29.526	46.25	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR + AREA	5506.9	5511.8	5504.9				
YEAR + AREA YEAR*AREA	**5424.1**	**5427.4**	**5420.1**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	186	839.6848	4.514				
YEAR	176	639.396	3.633	19.526	19.526	200.29	<.0001
AREA	183	765.861	4.185	7.297		73.82	<.0001
TIME	183	792.153	4.329	4.114		47.53	<.0001
SEASON	184	815.384	4.431	1.839		24.30	<.0001
SETDEPTH	185	830.093	4.487	0.608		9.59	0.0020
NET	185	833.361	4.505	0.217		6.32	0.0119
YEAR +							
AREA	173	539.138	3.116	30.968	11.442	100.26	<.0001
SEASON	174	605.776	3.481	22.881		33.62	<.0001
TIME	173	635.504	3.673	18.629		3.89	0.2733
YEAR+AREA							
SEASON	171	498.866	2.917	35.377	4.409	40.27	<.0001
YEAR+AREA+SEASON	171	498.866	2.917	**35**	4.4093	40.27	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+SEASON	520.9	524.0	518.9				
YEAR+AREA+SEASON YEAR*AREA	**512.5**	**515.1**	**508.5**				
YEAR+AREA+SEASON YEAR*SEASON	512.2	515.0	508.2				

(B) Adult finetooth shark

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	609.8815	0.610				
AREA	997	469.746	0.471	22.746	22.746	140.14	<.0001
YEAR	990	562.287	0.568	6.873		47.59	<.0001
NET	999	603.311	0.604	0.978		6.57	0.0104
TIME	997	601.6371	0.603	1.055		8.24	0.0412
SEASON	998	609.8145	0.611	-0.189		0.07	0.9671
SETDEPTH	999	605.1436	0.606	0.678		4.74	0.0295
AREA+							
YEAR	987	445.2169	0.451	26.038	19.165	24.53	0.0063
NET	996	467.7253	0.470	23.001		2.02	0.1552
TIME							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR + AREA	**4921.8**	**4926.5**	**4919.8**				
YEAR + AREA YEAR*AREA	9062.6	9066.0	9058.6				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	90	165.6946	1.841				
YEAR	80	93.802	1.173	36.312	36.312	71.89	<.0001
NET	89	140.411	1.578	14.307		25.28	<.0001
TIME	88	146.736	1.667	9.429		18.96	<.0001
SEASON	88	161.571	1.836	0.273		4.12	0.1272
AREA	88	162.869	1.851	-0.529		2.83	0.2434
SETDEPTH	89	165.533	1.860	-1.025		0.16	0.6876
YEAR +							
NET	79	93.611	1.185	35.637	-0.675	0.19	0.6624
TIME	78	92.677	1.188	35.463		1.13	0.5697
FINAL GENMOD							
YEAR							
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR	**211.7**	**214.1**	**209.7**				

(C) Juvenile finetooth shark

Proportion positive- Binomial error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	795.563	0.796				
AREA	997	623.937	0.626	21.337	21.337	171.63	<.0001
YEAR	990	715.269	0.722	9.185		80.29	<.0001
TIME	997	781.561	0.784	1.464		14.00	0.0029
NET	999	784.575	0.785	1.282		10.99	0.0009
SEASON	998	787.891	0.789	0.766		7.67	0.0216
SETDEPTH	999	795.068	0.796	-0.038		0.50	0.4816
AREA+							
YEAR	987	569.474	0.577	27.476	6.139	54.46	<.0001
TIME	994	609.958	0.614	22.867		13.98	0.0029
NET	996	619.384	0.622	21.832		4.55	0.0329
AREA+YEAR							

TIME	984	569.439	0.579	27.259		0.04	0.9982
NET	986	569.419	0.578	27.409		0.05	0.81
FINAL GENMOD							
YEAR+AREA	987	569.474	0.577	27.476	6.139	54.46	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA	5737.8	5742.7	5735.8				
YEAR+AREA YEAR*AREA	**5722.9**	**5726.3**	**5718.9**				
Positive catches- Poisson error distribution							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	135	550.651	4.079				
YEAR	125	342.443	2.740	32.836	32.836	208.21	<.0001
AREA	132	501.196	3.797	6.912		49.45	<.0001
TIME	132	507.847	3.847	5.677		42.80	<.0001
SETDEPTH	134	524.841	3.917	3.976		25.81	<.0001
SEASON	133	541.233	4.069	0.232		9.42	0.0090
NET	134	545.554	4.071	0.186		5.10	0.0240
YEAR							
AREA	122	283.670	2.325	42.995	10.159	58.77	<.0001
TIME	122	341.825	2.802	31.309		0.62	0.8923
SETDEPTH	124	339.670	2.739	32.843		2.77	0.0959
FINAL GENMOD							
YEAR+AREA	122	283.670	2.325	42.995	10.159	58.77	<.0001
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA	367.8	370.6	365.8				
YEAR+AREA YEAR*AREA	**364.5**	**367.0**	**360.5**				

Table 11. The standardized index of abundance and coefficients of variation for finetooth shark.

All finetooth shark

YEAR	ABSOLUTE INDEX	CV
1996	0.47885	0.391
1997	1.36342	0.291
1998	0.05053	0.915
1999	0.84006	0.465
2000	0.25178	0.833
2001	0.5894	0.519
2002	0.45077	0.504
2003	1.14662	0.361
2004	0.44675	0.551
2005	0.65407	0.476

Adult finetooth shark

YEAR	ABSOLUTE INDEX	CV
1996	0.174	0.357
1997	0.173	0.396
1998	0.034	1.503
1999	0.200	0.525

2000	0.022	3.025
2001	0.123	0.614
2002	0.161	0.411
2003	0.188	0.378
2004	0.209	0.435
2005	0.219	0.524

Juvenile finetooth shark

YEAR	ABSOLUTE INDEX	CV
1996	0.377	0.420
1997	1.063	0.321
1998	0.017	1.358
1999	0.416	0.672
2000	0.208	0.920
2001	0.473	0.681
2002	0.235	0.704
2003	0.684	0.496
2004	0.178	0.779
2005	0.289	0.681

Table 12. Average sizes for juvenile and adult finetooth sharks collected during fishery independent sampling.

Year		Ave FL (cm)	Stdev
1996	**JUV**	69.5	12.3
	MAT	85.2	5.4
1997	**JUV**	62.3	10.2
	MAT	85.5	2.3
1998	**JUV**	68.8	16.9
	MAT	101.3	1.7
1999	**JUV**	86.0	12.2
	MAT	103.8	5.0
2000	**JUV**	85.5	10.4
	MAT	107.0	NA
2001	**JUV**	80.7	9.9
	MAT	105.0	6.3
2002	**JUV**	80.3	12.9
	MAT	104.4	4.2
2003	**JUV**	85.8	10.7
	MAT	104.7	6.3

2004	**JUV**	86.4	7.0
	MAT	103.1	7.0
2005	**JUV**	80.6	12.9
	MAT	101.8	6.2

Table 13. Analysis of deviance of explanatory variables for the generalized linear model log (CPUE+0.1) for the small coastal aggregate. Final models selected are in bold.

Lognormal (x+0.1)							
FACTOR	**DF**	**DEVIANCE**	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	1000	4525.722	4.526				
AREA	997	3555.412	3.566	21.203	21.203	241.550	<.0001
YEAR	990	3990.263	4.031	10.941		126.050	<.0001
TIME	997	4381.836	4.395	2.888		32.340	<.0001
SEASON	998	4446.738	4.456	1.548		17.620	0.0001
NET	999	4465.745	4.470	1.226		13.350	0.0003
SETDEPTH	999	4514.759	4.519	0.142		2.430	0.1192
AREA+							
YEAR	987	3233.373	3.276	27.615	6.411	95.040	<.0001
TIME	994	3463.526	3.484	23.008		26.21	<.0001
SEASON	995	3488.181	3.506	22.538		19.11	<.0001
NET	996	3531.662	3.546	21.651		6.71	0.0096
AREA+YEAR							
SEASON	985	3153.028	3.201	29.270	1.655	25.19	<.0001
TIME	984	3224.269	3.277	27.598		2.820	0.4198
NET	986	3233.290	3.279	27.543		0.03	0.8728
MIXED MODEL	**AIC**	**BIC**	**(-2) LOGLIKELIHOOD**				
YEAR+AREA+SEASON	4016.4	4021.2	4014.4				
YEAR+AREA+SEASON YEAR*AREA	4011.6	4015.0	4007.6				
YEAR+AREA+SEASON YEAR*SEASON	**4006.9**	**4009.9**	**4002.9**				

Table 14. The standardized index of abundance and coefficient of variation for the small coastal aggregate.

YEAR	**ABSOLUTE INDEX**	**CV**
1996	5.091	0.238
1997	14.715	0.144
1998	1.121	1.436
1999	1.174	1.253
2000	0.697	1.294
2001	1.327	0.732
2002	1.167	1.013
2003	1.454	0.531
2004	0.668	0.896
2005	0.611	0.645

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.

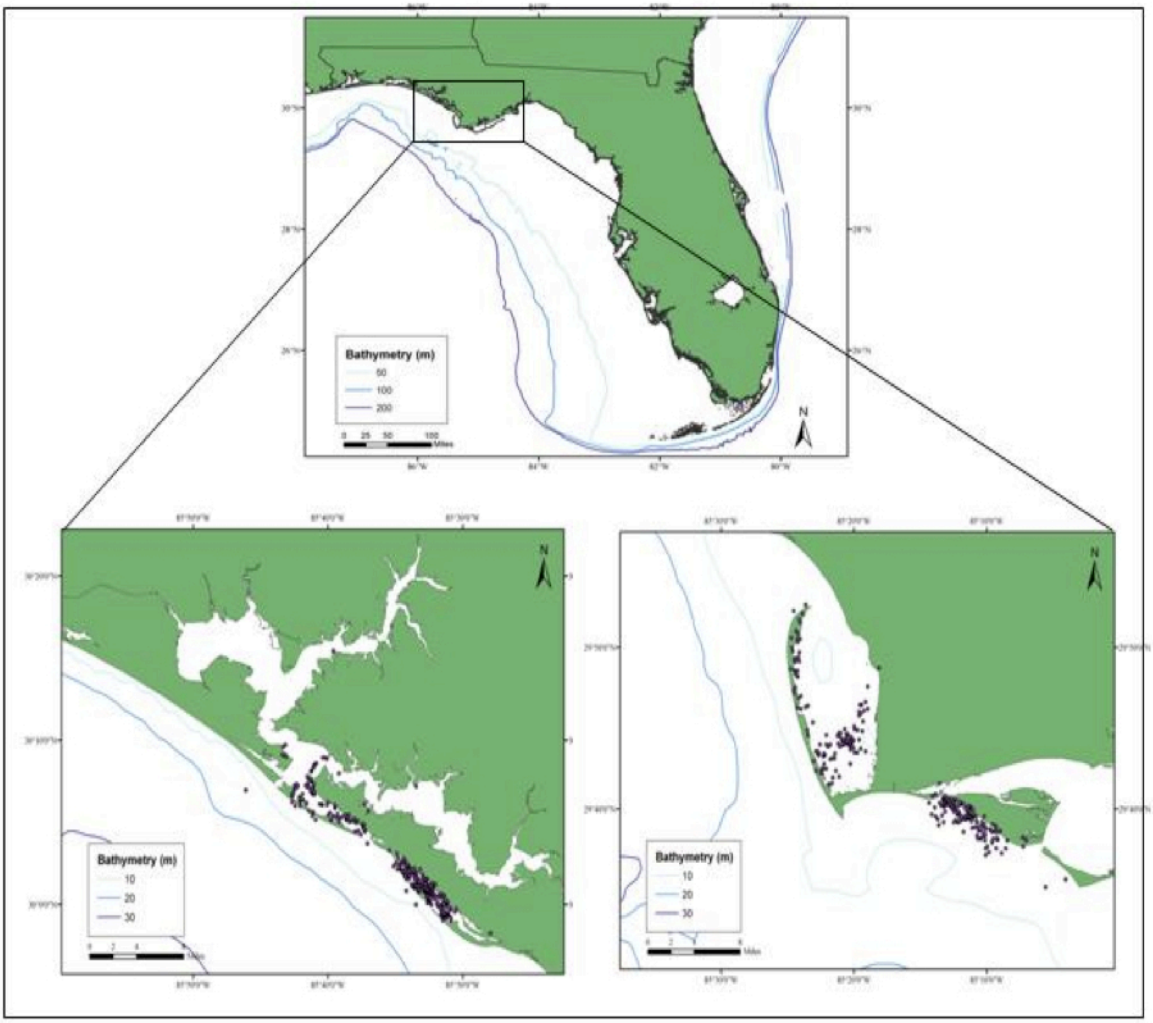
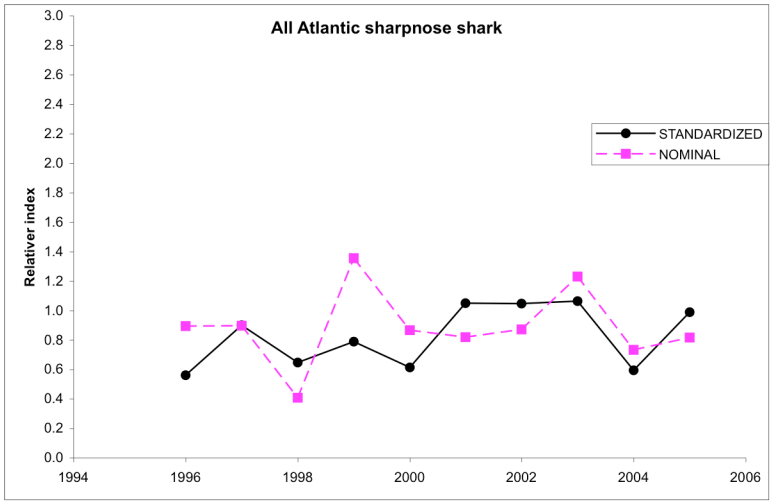
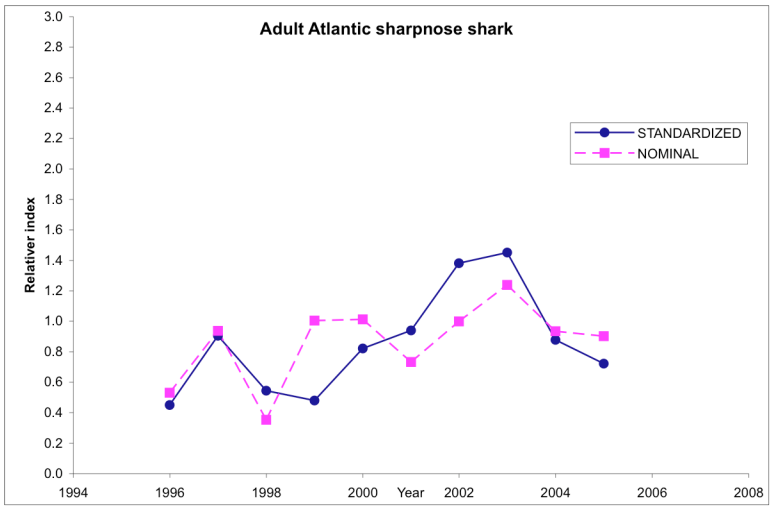


Figure 2. Nominal and standardized indices of abundance for Atlantic sharpnose shark. Each index has been divided by its mean.





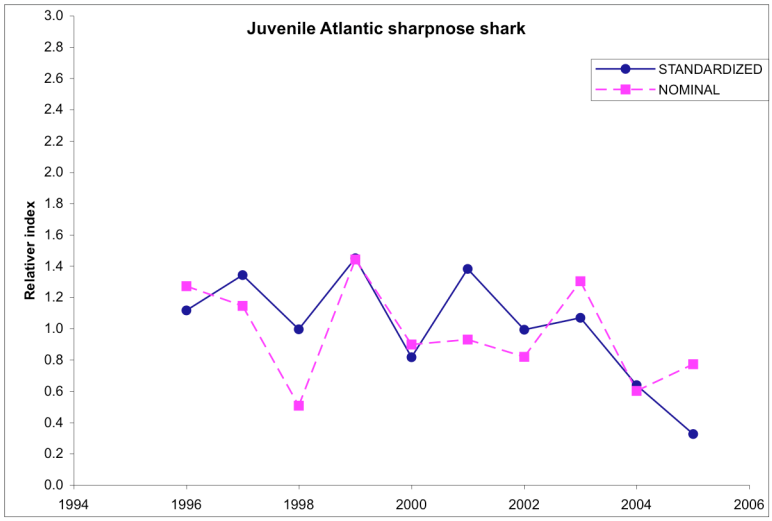
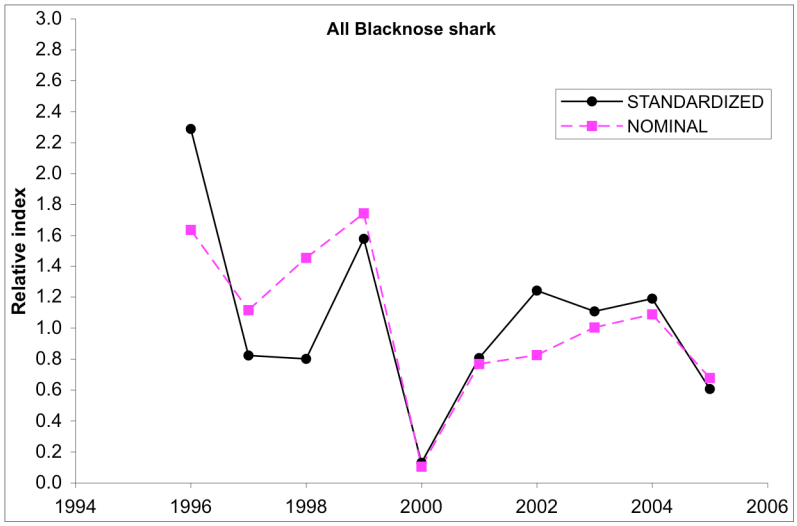
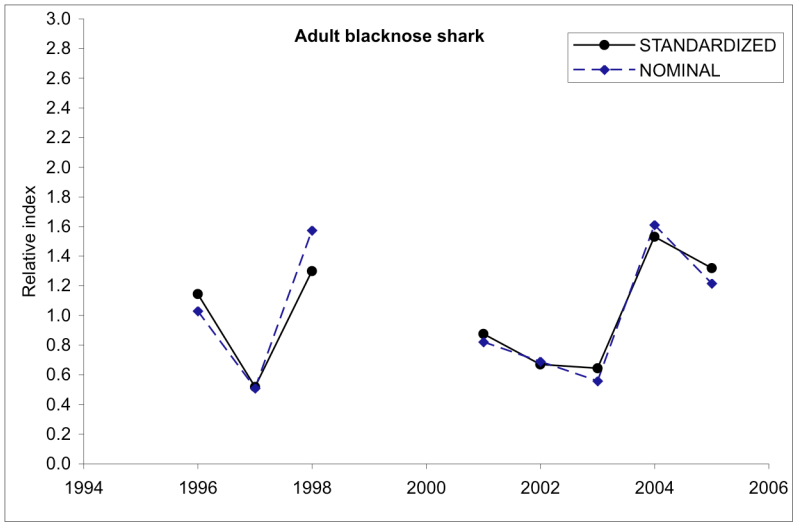


Figure 3. Nominal and standardized indices of abundance for blacknose shark. Each index has been divided by its mean.





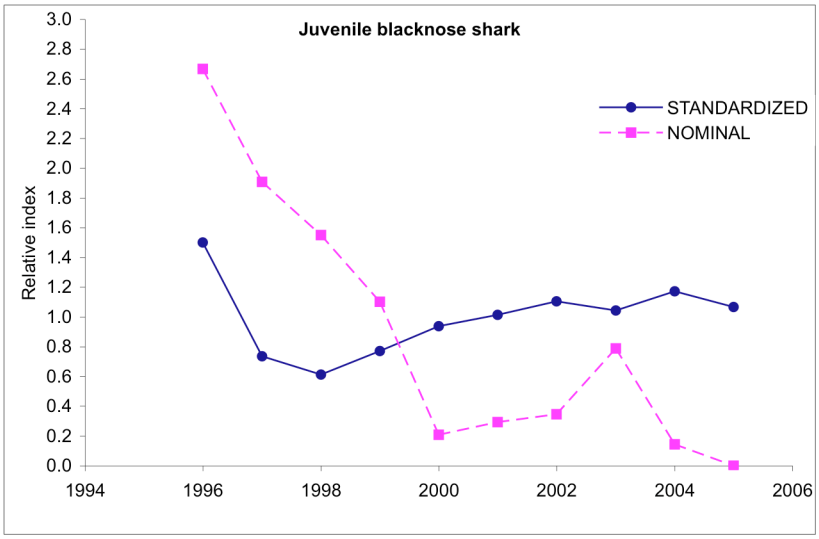
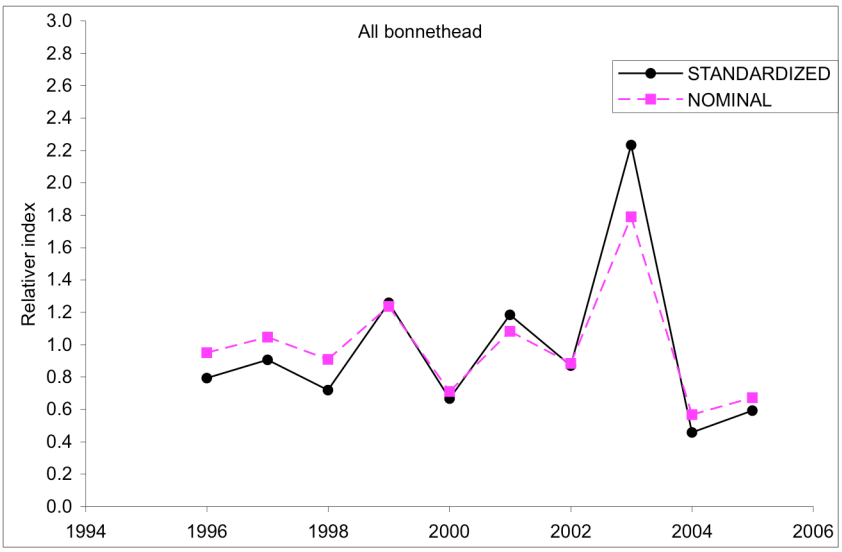
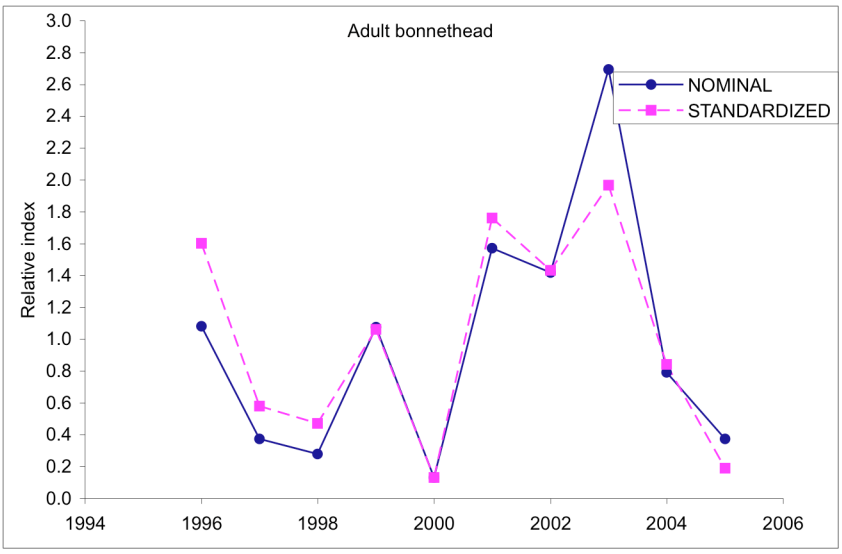


Figure 4. Nominal and standardized indices of abundance for bonnethead. Each index has been divided by its mean.





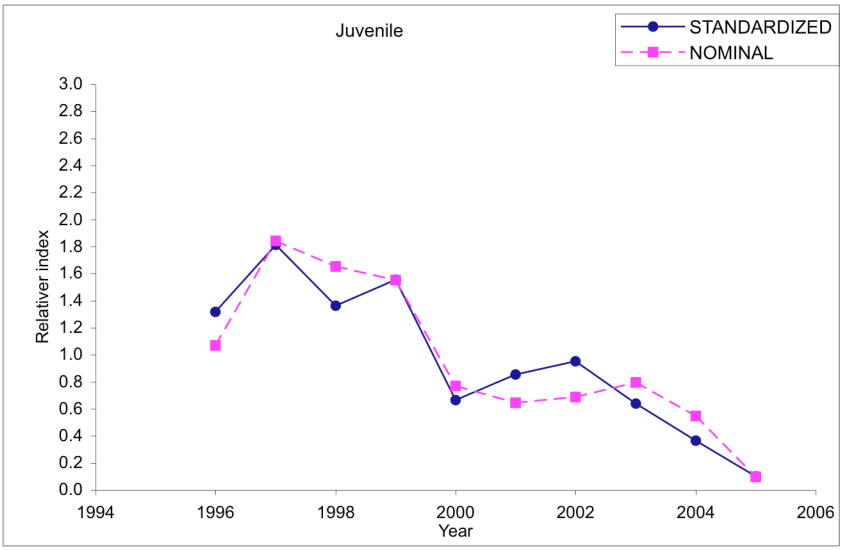
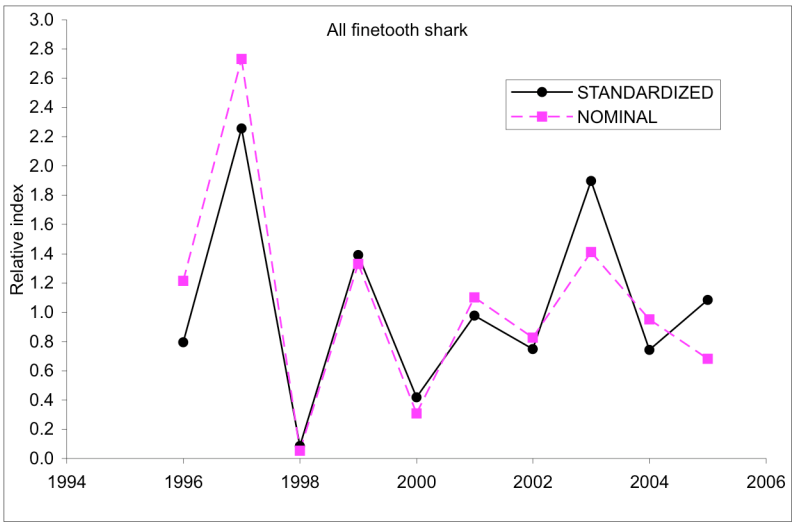
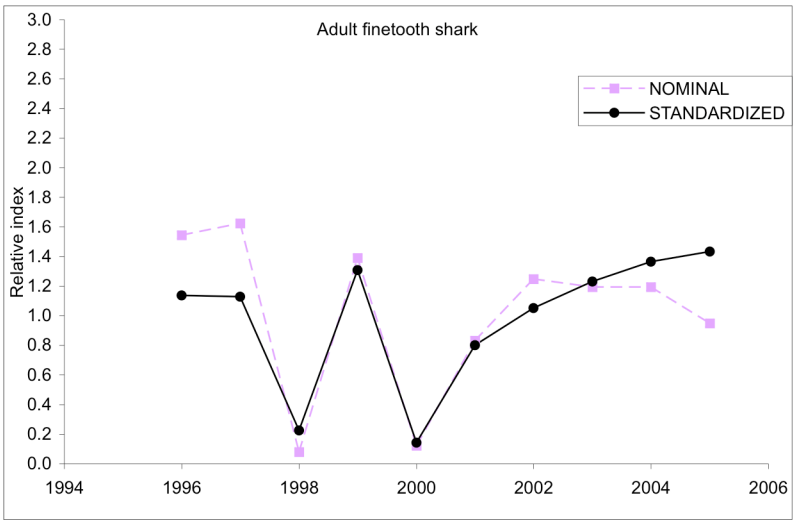


Figure 5. Nominal and standardized indices of abundance for finetooth shark. Each index has been divided by its mean.





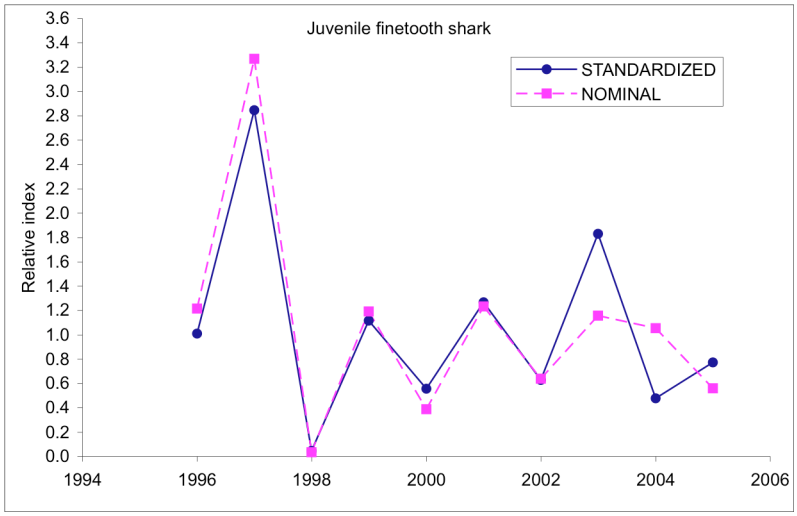


Figure 6. Nominal and standardized indices of abundance for the small coastal aggregate. Each index has been divided by its mean.