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The Directed Shark Drift Gillnet Fishery: Characterization of the Large Coastal Shark Catch and Standardization of Catch Rates from Observer Data.

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Introduction

The shark drift gillnet fishery developed off the east coast of Florida and Georgia in the late 1980's. Historically, a number of the involved vessels in this fishery strike netted and drift netted for king mackerel, *Scomberomorus cavalla*, Spanish mackerel, *S. maculatus*, bluefish, *Pomotomus saltatrix*, and occasionally for sharks, from November through March. As this fishery developed, some fishers drift gillnetted for sharks from October through April before and after the mackerel seasons (Schaefer et al. 1989). By 1987, many fishers were drift gillnetting for king mackerel during April-September to compensate for their reduction in quotas in their winter fisheries. However, as the king mackerel drift gillnet fishery was further restricted in about 1990, more fishers began drift gillnetting for sharks during all times of the year.

<u>I. Fishery description</u>

Vessels, fishing gear, and fishing techniques has been previously described in Trent et al. (1997). Generally, shark driftnet vessels operate between 4.8 and 14.4 km from shore in areas north of Key West, FL (~24° 37-24° 58' N) and between West Palm Beach, FL (~26° 46'N) to Altamaha Sound, GA (~31° 45' N) (Figure 1). Vessels fish gillnets (both multi and monofilament) ranging in length from 547.2-2,736 m; depths from 9.1-13.7 m and stretched mesh sizes from 12.7-25.4 cm (Trent et al. 1997; Carlson et al. 2005 and references therein). Nets are normally set in a straight line off the stern at night, allowed to drift at the surface for a period of time and then hauled onto the vessel when the catch is adequate. The number of drift gillnet vessels has decreased from about 12 in 1990 to about 6, depending on the market value of sharks and the level of activity in other fisheries.

Shark drift gillnet fisheries are multi-specific and land up to 14 different species of sharks. Depending on season and area, large coastal species (primarily blacktip, *Carcharhinus limbatus*) are targeted. Because this fishery targets large coastal sharks, information on catch is necessary for assessment. Data for this fishery was summarized for large coastal species for 1993-1995 and 1998-2004 from that reported in Trent et al. (1997) and Carlson et al. (2005 and references therein).

Information on this fishery was collected utilizing on-board NMFS-approved contract observers. The observer normally left port with the vessel between 1500-1700 hrs; depending on distance to the fishing grounds. Trips are normally 1-3 days in duration. For each set and haul of the net observers recorded: beginning and ending times of setting and hauling; estimated length of net set; latitude and longitude coordinates; and water depth. During haulback, the observer remained about 3-8 m forward of the net reel in an unobstructed view and recorded species, numbers and estimated lengths (±30 cm) of sharks and other species caught as they were suspended in the net just after passing over the power roller.

Estimation of average size

It is difficult to correctly measure all shark catches because generally observers have additional duties while onboard fishing vessels. However, when the haulback is complete observers sometimes have the opportunity to measure sharks when the vessel is returning to port. The average size (cm FL) of blacktip sharks harvested is reported in Table 1. Weights (in kg) were estimated from these lengths using length-weight relationships provided in Carlson (unpublished data).

Table 1. Average size of blacktip sharks caught by year.

Year	Ave size (cm FL)	Std. Dev.	Ave size (kg)	Std. Dev.	Percentage measured of the catch
2000	105.2	2.9	7.8	0.6	1.3
2001	124.8	2.1	12.6	0.5	1.2
2002	112.5	1.6	10.2	0.4	5.2
2003	133.3	17.8	15.2	5.0	5.6
2004	121.9	25.8	12.4	6.7	2.7

II. Gillnet selectivity

Introduction

Gillnets have been and are widely used for the harvest of fish species. Because gillnets are highly selective for certain size fish, knowledge of the size selection of gillnets is necessary to effectively regulate their use and for population assessment (Regier and Robson 1966; Hamley 1975). Moreover, an understanding of the selective patterns of the fishing gear can aid in recommendations to maximize or minimize the catch on certain sizes and species and is an essential part of any age structured stock assessment using commercial data collected in gillnets. Despite the importance of gillnet selectivity in fisheries assessment and management, there are no selectivity models available for blacktip sharks. Objectives for this section were to develop selectivity parameters for the blacktip shark using data derived from a fishery-independent gillnet assessment of shark populations (Carlson and Brusher 1999).

Methods

Data necessary for calculation of mesh selectivity were obtained from gillnets used in a fishery-independent survey (Carlson and Brusher 1999). Sharks were collected with a 186-m long gill net consisting of panels of six different mesh sizes. Stretched mesh sizes ranged from 8.9 cm

(3.5") to 14.0 cm (5.5") in steps of 1.3 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 stretched mesh webbing was made of #28 multifilament nylon, single-knotted, and double-selvaged. Mesh selectivities were estimated following the method of Kirkwood and Walker (1986). This method fits a gamma distribution to length data for each mesh size using the log-likelihood function:

$$L=\sum_{i=1}^{I}\sum_{j=1}^{J} [n_{ij} \ln (\mu_j S_{ij})-\mu_j S_{ij}]$$

where n_{ij} =the number of sharks of length class j caught in mesh size i,

$$\mu_j=\sum_{i=1}^{I} n_{ij}/\sum_{t=11}^{I} S_{ij}$$

and s_{ij} is the relative selectivity of a shark in length class j caught in mesh size i. Selectivity is modeled as a function of shark length class (l_j) and the parameters α and β describe the probability density function of the gamma distribution for mesh size i:

$$S_{ij}=(l_j/ \alpha_i \beta_i)^{\alpha i} \exp(\alpha_i-l_j/\beta_i).$$

The values of α and β were calculated from the mesh size(m_i), a scaling parameter (θ_1) to relate mode of the gamma distribution (α, β) to mesh size, and the variance (θ_2) as

$$\alpha_i \beta_i=\theta_1 m_i$$

and

$$\beta_i=-0.5(\theta_1 m_i -(\theta_i^2 m_i^2+4\theta_2)^{0.5}).$$

The assumptions of the model (Kirkwood and Walker 1986) are (1) the shape of the selectivity curve is represented by a gamma distribution; (2) the length at maximum selectivity for panel j of mesh size i is proportional to the mesh size; (3) sampling occurs across the whole population; (4) the variance is constant for each mesh size; (5) catches within each length class are independent observations from a Poisson distribution; and (6) all mesh sizes have equal fishing power. The values of θ_1 and θ_2 were obtained by minimizing the negative log-likelihood function.

Results and Discussion

The relative selectivity for the six mesh sizes is depicted in Figure 2. The blacktip shark exhibited a relatively narrow selection curve. Peak selectivities increased from 550 mm FL for the 8.9 cm and 10.2 cm mesh panel to 850 mm FL for 14.0 cm mesh in 100 mm increments per mesh panel. Selectivity was highest at 1150 mm FL for mesh panel 20.3 cm.

The θ_1 values for blacktip shark were 145.5. The value calculated for θ_2, a value which describes the variances of sizes by mesh, were 136787.

III. Catch rate standardization

Introduction

Catch and effort data from many different fisheries have been used to derive indices of abundance. However, the use of commercial fishing catch data requires standardization to correct for factors unrelated to abundance (Hilborn and Walters 1992). Based on discussion at the 2005 Shark SEDAR workshop, the present study attempts to standardize catch rates for the large coastal species-aggregate, large coastal species-aggregate minus prohibited species, large coastal species-aggregate minus prohibited species minus blacktip shark minus sandbar shark, and a species-specific catch rate for blacktip sharks in the Atlantic Ocean. All analysis is restricted to observed sets made off the US southeast Atlantic Ocean. Sets made in the Gulf of Mexico because of the low sample size were excluded from the analysis. Standardization of all catch rates was attempted using a modified two-step approach originally proposed by Lo et al. (1992).

Methods

A combined data set was developed based on observer programs from Trent el al. (1997) and Carlson et al. (2005 and references therein). Catch rates were standardized in a two-part generalized linear model analysis using the PROC GENMOD procedure in SAS (SAS Inst., Inc.). For the purposes of analysis, several categorical variables were constructed:

- "Year" (10 levels)= 1993-1995, 1998-2004
- "Area" (4 levels)=location of net set (Figure 1).
    - South Florida=South of 27°51' N Latitude
    - Central Florida=27°51' N to 30°00' N Latitude
    - N. Florida/Georgia=North of 30°00' N Latitude
- "SetBegin" (4 levels)
    - Dawn=0401-1000 hrs
    - Day=1001-1600 hrs
    - Dusk=1601-2200 hrs
    - Night=2201-0400 hrs
- "Season" (4 levels): corresponds to the level of observer coverage as it pertains to the right whale calving season and the large coastal shark season.
    - Rightwhale1=Jan-Mar
    - Nonrightwhale1=Apr-Jun
    - Nonrightwhale2=Jul-Sep
    - Rightwhale2=Oct-Dec
- "Meshsize" (3 levels): corresponds to the principal mesh size used in the fishing gear.
    - Small mesh=4"-6" stretched mesh
    - Medium mesh=7"-9" stretched mesh
    - Large mesh=>10" stretched mesh.

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. The positive catches were modeled assuming a lognormal distribution with a normal link function. Positive catches were modeled using a dependent variable of catch per unit effort (CPUE):

$$\mathrm{CPUE} = \mathrm{LN}\left(\frac{\text{sharks kept} + \text{sharks released alive} + \text{sharks discarded dead}}{(\text{net length} \times \text{net depth} \times \text{soak time})}\right)$$

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 lognormal 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 lognormal 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

<u>Large coastal aggregate</u>

For all combined years, the percentage of sets with zero catches was 13.9% for the large coastal aggregate. The stepwise construction of the models is summarized in Table 2. The final binomial model was *Proportion positive trips=Area + Season + Year.* The final lognormal model was *ln(CPUE) =Area + Year + Setbegin + Meshsize.* Year was not significant in the final binomial model but was kept in the glimmix model to allow for calculation of indices. Although some interactions were significant (i.e. year*area), the lower number of degrees of freedom in the interaction precluded estimation of the least square means in the glimminx model. Thus, all final models were run without interactions. The delta-lognormal 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 3.

<u>Atlantic Ocean blacktip shark</u>

For blacktip shark, the percentage of sets with zero catches was 20.8%. The stepwise construction of the models is summarized in Table 4. The final binomial model was *Proportion positive trips=Area + Season + Year.* The final lognormal model was *ln(CPUE) =Area + Year +*

Meshsize.. Although some interactions were significant (i.e. year*area), the lower number of degrees of freedom in the interaction precluded estimation of the least square means in the glimminx model. Thus, all final models were run without interactions.
The delta-lognormal 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 5.

Large coastal aggregate (minus prohibited species)
No analysis was run for this series as only 2 sets have been observed with prohibited species.

Large coastal aggregate (minus prohibited species minus sandbar and blacktip shark)
For this series, the percentage of sets with zero catches was 36.6%. The stepwise construction of the models is summarized in Table 6. The final binomial model was *Proportion positive trips= Setbegin + Year.* The final lognormal model was *ln(CPUE) =Area + Year.* Year was not significant in the final binomial model but was kept in the glimmix model to allow for calculation of indices. The delta-lognormal 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 7.

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Table 2. Results of the stepwise procedure for development of the 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	335	271.990	0.812			-135.995		
AREA	333	240.483	0.722	11.053	11.053	-120.242	31.510	<.0001
MESHSIZE	333	251.194	0.754	7.091		-125.597	20.800	<.0001
YEAR	326	251.191	0.771	5.098		-125.595	20.800	0.0136
SEASON	332	259.701	0.782	3.655		-129.851	12.290	0.0065
SETBEGIN	332	266.269	0.802	1.219		-133.135	5.720	0.1260
AREA +								
SEASON	330	221.455	0.671	17.346	6.293	-110.727	19.030	0.0003
YEAR	324	221.295	0.683	15.876		-110.648	19.190	0.0236
MESHSIZE	331	236.536	0.715	11.984		-118.268	3.950	0.1390
AREA + SEASON +								
YEAR	321	208.656	0.650	19.940	2.593	-104.328	12.800	0.1719
AREA + SEASON + YEAR								
AREA*SEASON	318	204.3485	0.643	20.853	0.913	-102.174	Negative of Hessian not posi	
AREA*YEAR	309	194.2882	0.629	22.557		-97.144	Negative of Hessian not posi	
SEASON*YEAR	318	204.3485	0.643	20.853		-102.174	Negative of Hessian not posi	
FINAL MODEL: AREA + SEASON + YEAR								
Akaike's information criterion	1889.6							
Schwartz's Bayesian criterion	1893.3							
(-2) Res Log Likelihood	1887.6							

Positive catches-lognormal error distribution

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	288	1397.581	4.853			-637.816		
AREA	286	1114.994	3.899	19.662	19.662	-605.174	65.28	<.0001
MESHSIZE	286	1143.829	3.999	17.584		-608.863	57.90	<.0001
YEAR	279	1208.686	4.332	10.726		-616.833	41.97	<.0001
SETBEGIN	285	1322.166	4.639	4.400		-629.800	16.03	0.0011
SEASON	285	1379.705	4.841	0.240		-635.955	3.72	0.2933
AREA +								
YEAR	277	959.634	3.464	28.609	8.948	-583.491	43.37	<.0001
MESHSIZE	284	1035.554	3.646	24.860		-594.494	21.36	<.0001
SETBEGIN	283	1055.166	3.729	23.167		-597.205	15.94	0.0012
AREA + YEAR +								
SETBEGIN	274	924.856	3.375	30.443	1.834	-578.157	10.67	0.0137
MESHSIZE	275	934.518	3.398	29.972		-579.659	7.66	0.0217
AREA + YEAR + SETBEGIN +								
MESHSIZE	272	898.435	3.303	31.934	1.490	-573.969	8.38	0.0152
FINAL MODEL: AREA + YEAR + SETBEGIN + MESHSIZE								
Akaike's information criterion	1149.6							
Schwartz's Bayesian criterion	1153.2							
(-2) Res Log Likelihood	1147.6							

Table 3. The relative standardized index of abundance, and lower (LCL) and upper (UCL) 95% confidence limits associated with the relative abundance index for large coastal sharks, 1993-1995 and 1998-2004.

YEAR	RELATIVE INDICES	UCL	LCL
1993	0.338	1.019	-0.342
1994	1.050	1.322	0.778
1995	0.299	0.756	-0.157
1996			
1997			
1998	1.088	1.466	0.71
1999	1.336	1.543	1.129
2000	1.239	1.416	1.063
2001	1.179	1.34	1.019
2002	1.077	1.322	0.832
2003	1.112	1.439	0.785
2004	1.281	1.488	1.075

Table 4. Results of the stepwise procedure for development of the catch rate model for blacktip 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	335	343.8893	1.0265			-171.9447		
AREA	333	299.3860	0.8991	12.4183	12.4183	-149.6930	44.5	<.0001
MESHSIZE	333	312.0891	0.9372	8.7022		-156.0445	31.8	<.0001
YEAR	326	316.0702	0.9695	5.5521		-158.0351	27.82	0.0010
SEASON	332	332.0270	1.0001	2.5770		-166.0135	11.86	0.0079
SETBEGIN	332	342.6471	1.0321	-0.5391		-171.3235	1.24	0.7429
AREA +								
SEASON	330	277.0207	0.8395	18.2243	5.8060	-138.5104	22.37	<.0001
YEAR	324	275.9763	0.8518	17.0239		-137.9881	23.41	0.0053
MESHSIZE	331	293.4285	0.8865	13.6424		-146.7143	5.96	0.0509
AREA + SEASON +								
YEAR	321	262.3149	0.8172	20.3943	2.1700	-131.1574	14.71	0.0993
MESHSIZE	328	276.5576	0.8432	17.8632		-138.2788	0.46	0.7933
FINAL MODEL: AREA + SEASON + YEAR								
Akaike's information criterion	1774.9							
Schwartz's Bayesian criterion	1778.6							
(-2) Res Log Likelihood	1772.9							

Table 4. continued.

Positive catches-lognormal error distribution								
FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	265	1382.6840	5.2177			-596.6596		
AREA	263	1122.1529	4.2667	18.2253	18.2253	-568.8922	55.53	<.0001
MESHSIZE	263	1149.1231	4.3693	16.2598		-572.0510	49.22	<.0001
YEAR	256	1193.9423	4.6638	10.6147		-577.1398	39.04	<.0001
SETBEGIN	262	1332.7275	5.0867	2.5093		-591.7654	9.79	0.0205
SEASON	262	1353.0783	5.1644	1.0207		-593.7809	5.76	0.1240
AREA +								
YEAR	254	946.1670	3.7251	28.6068	10.3815	-546.2044	45.38	<.0001
MESHSIZE	261	1056.8836	4.0494	22.3914		-560.9223	15.94	0.0003
SETBEGIN	260	1081.7326	4.1605	20.2612		-564.0131	9.76	0.0207
AREA + YEAR +								
MESHSIZE	252	924.9147	3.6703	29.6565	1.0497	-543.1829	6.04	0.0487
SETBEGIN	251	931.8379	3.7125	28.8476		-544.1748	4.06	0.2551
FINAL MODEL: AREA + YEAR + MESHSIZE								
Akaike's information criterion	1087.5							
Schwartz's Bayesian criterion	1091.0							
(-2) Res Log Likelihood	1085.5							

Table 5. The relative standardized index of abundance, and lower (LCL) and upper (UCL) 95% confidence limits associated with the relative abundance index for blacktip sharks, 1993-1995 and 1998-2004.

YEAR	RELATIVE INDICES	UCL	LCL
1993	0.455	1.247	-0.337
1994	0.955	1.281	0.630
1995	0.419	0.978	-0.140
1996			
1997			
1998	1.286	1.700	0.872
1999	1.384	1.604	1.163
2000	1.286	1.458	1.114
2001	1.001	1.193	0.809
2002	0.982	1.260	0.704
2003	1.029	1.405	0.652
2004	1.204	1.493	0.915

Table 6. Results of the stepwise procedure for development of the catch rate model for the large coastal aggregate (minus prohibited species minus sandbar and blacktip 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	335	441.391	1.318			-220.695		
SETBEGIN	332	431.916	1.301	1.262	1.262	-215.958	9.480	0.0236
MESHSIZE	333	433.327	1.301	1.237		-216.664	8.060	0.0177
AREA	333	434.371	1.304	0.999		-217.186	7.020	0.0299
SEASON	332	433.254	1.305	0.957		-216.627	8.140	0.0433
YEAR	326	434.536	1.333	-1.165		-217.268	6.850	0.6522
SETBEGIN +								
MESHSIZE	330	426.903	1.294	1.817	0.554	-213.451	5.010	0.0816
YEAR	323	424.757	1.315	0.193		-212.378	7.160	0.6206
SETBEGIN + YEAR	323	424.757	1.315	0.193		-212.378	7.160	0.6206

FINAL MODEL: SETBEGIN + YEAR

Akaike's information criterion	1460.9
Schwartz's Bayesian criterion	1466.7
(-2) Res Log Likelihood	1460.9

Positive catches-lognormal error distribution

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQUARE	PR>CHI
NULL	212	513.541	2.422			-395.958		
AREA	210	390.987	1.862	23.139	23.139	-366.920	58.08	<.0001
YEAR	203	395.009	1.946	19.671		-368.010	55.90	<.0001
SEASON	209	447.217	2.140	11.665		-381.230	29.46	<.0001
MESHSIZE	210	473.420	2.254	6.935		-387.294	17.33	0.0002
SETBEGIN	209	500.830	2.396	1.075		-393.289	5.34	0.1486
AREA +								
YEAR	201	321.461	1.599	33.977	10.838	-346.068	41.70	<.0001
MESHSIZE	208	375.115	1.803	25.551		-362.507	8.83	0.0121
SEASON	207	378.866	1.830	24.443		-363.566	6.71	0.0818
AREA + YEAR +								
MESHSIZE	199	318.460	1.600	33.936	-0.041	-345.069	2.00	0.3683
AREA + YEAR	201	321.461	1.599	33.977	10.838	-346.068	41.70	<.0001

FINAL MODEL: AREA + YEAR

Akaike's information criterion	700.0
Schwartz's Bayesian criterion	703.3
(-2) Res Log Likelihood	698.0

Table 7. The relative standardized index of abundance, and lower (LCL) and upper (UCL) 95% confidence limits associated with the relative abundance index for the large coastal aggregate (minus prohibited species minus sandbar and blacktip shark), 1993-1995 and 1998-2004.

YEAR	RELATIVE INDICES	UCL	LCL
1993	0.754	1.561	-0.053
1994	0.918	1.188	0.648
1995	0.537	1.056	0.017
1996			
1997			
1998	1.037	1.584	0.49
1999	1.203	1.454	0.952
2000	1.246	1.477	1.016
2001	1.167	1.367	0.967
2002	1.092	1.352	0.832
2003	0.953	1.33	0.575
2004	1.094	1.396	0.792

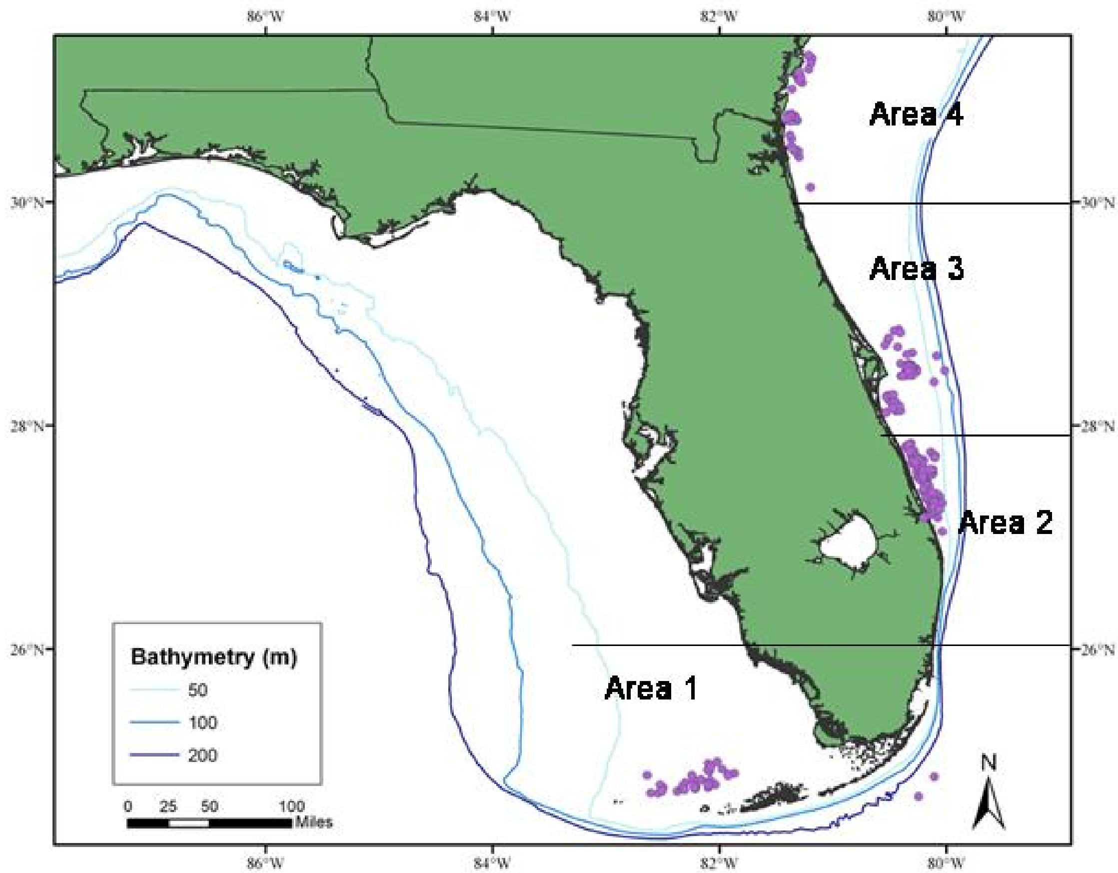

Figure 1. Distribution of fishing effort in the directed shark gillnet fishery 1993-1995 and 1998-2004. Fishing areas defined for GLM analysis are area 1: Florida Keys; area 2: South Florida; area 3: Central Florida; area 4: North Florida/Georgia. Sets made in area 1 were eliminated from the catch rate analysis.

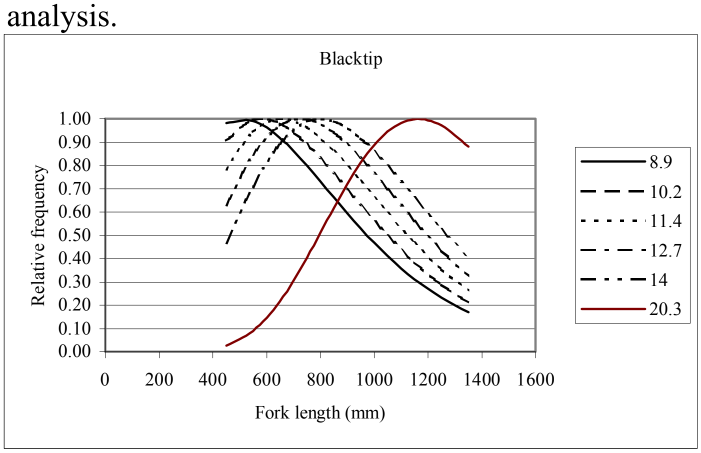

Figure 2. Estimated relative selectivities by mesh size panel as a function of shark fork length for the blacktip shark.

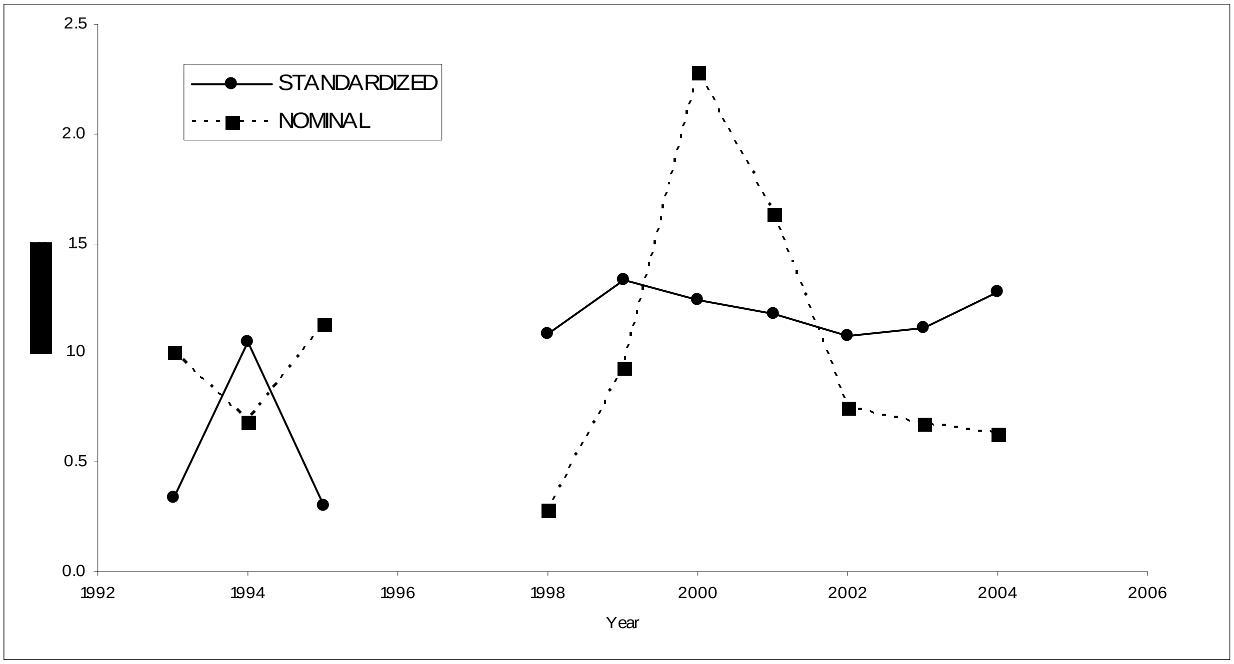

Figure 3. Standardized and nominal relative abundance trends for large coastal sharks, 1993-1995 and 1998-2004.

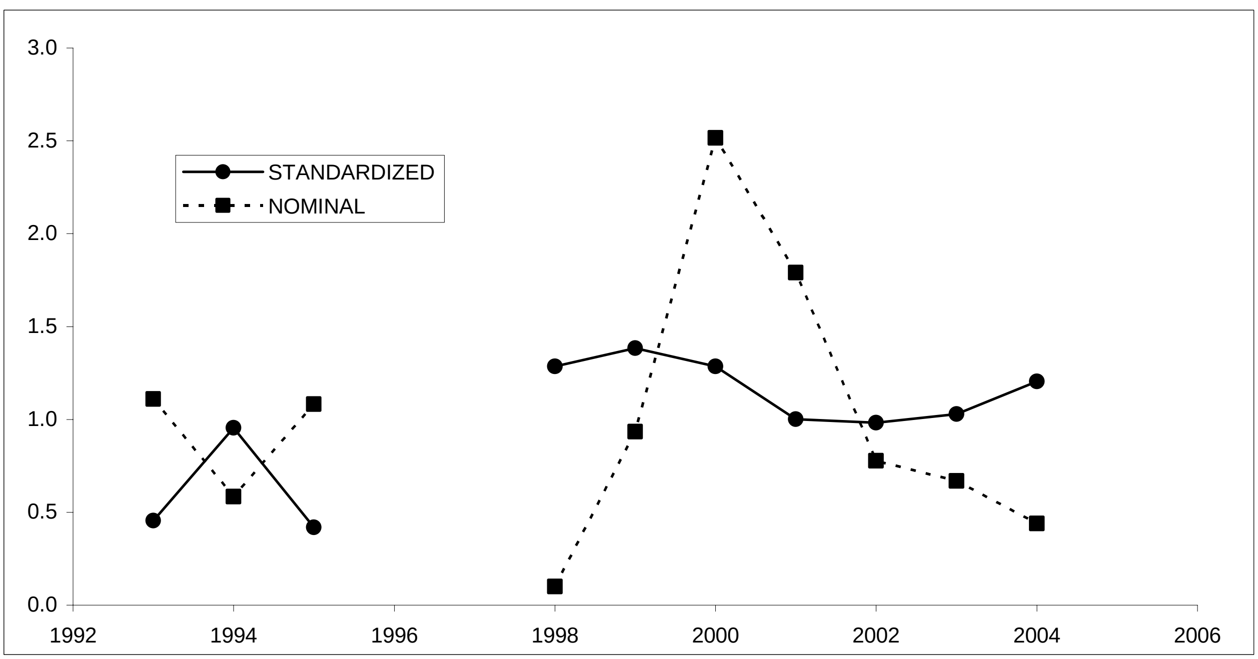

Figure 4. Standardized and nominal relative abundance trends for blacktip sharks, 1993-1995 and 1998-2004.

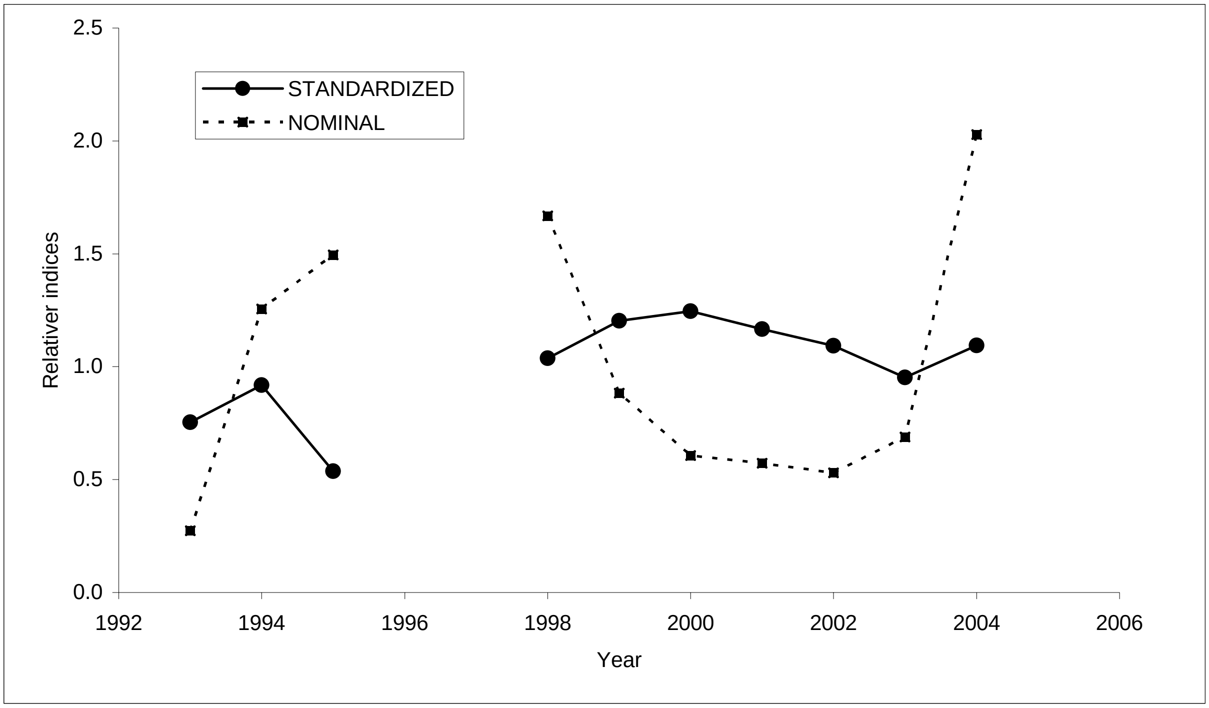

Figure 5. Standardized and nominal relative abundance trends for the large coastal aggregate (minus prohibited species minus sandbar and blacktip shark), 1993-1995 and 1998-2004.