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

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A fishery-independent survey of large and small coastal shark populations in coastal areas of the northeast Gulf of Mexico was conducted using longlines from 1993-2000. The survey was discontinued in 2001 due to lack of resources. Although field methods were standardized, some bias associated with factors such as spatial-temporal distributions could not be controlled. This bias could cause changes in catch rates not directly related to abundance. The present study attempts to standardize catch rates using a lognormal general linear model analysis. This error model has been used in a variety of studies attempting to standardize catch and effort data (Kimura, 1981; da Silva and Pereira, 1999; Punt et al., 2000).

Methods

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 m 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. 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 freshly baited gangion attached. Sharks captured using either method were measured to the nearest cm for lengths (precaudal, fork, total, and stretch total length) and data for sex and life history stage (neonate, young-of-the-year, juvenile, or adult) were recorded. Sharks that were in poor condition were sacrificed for life history studies and those in good condition were tagged with a 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 85 environmental meter and light transmission (cm) was determined using a secci disk. Further details can be found in Carlson and Brusher (1999).

Model design

The General Linear Model (GLM) was estimated using the PROC GLM procedure in SAS (SAS Inst., Inc.). The model used for the analysis was: LN (CPUE + 0.1) = $\mu + Y_i + A_j + M_k + \in$, where LN =natural logarithm, μ = intercept, Y_i = effect of year i (6 levels), A_j = effect of area j (2 levels), M_k = effect of month k (7 levels), and $\in$ = the error term. Nominal CPUE data were transformed by using a natural logarithm and adding a constant of 0.1 to each catch rate. The value of 0.1 was chosen over a value of 1 because the natural logarithm of 1 is 0.

Models were fit in a stepwise forward manner adding one independent variable and/or interactions at a time. The final model was chosen based on the overall level of significance and the % (model sum of squares/total sum of squares) explained of the variance of the model and each factor.

Results and Discussion

The final models chosen for factors affecting catch rates are given in Table 1. Depending on species, CPUE varied with year, month, area, and interactions between month and area, and area and year. Nominal and standardized catch rates are found in Table 2 and Figure 1.

Literature cited

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

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Kimura, D.K. 1981. Standardized measures of relative abundance based on modeling (c.p.u.e.), and application to Pacific ocean perch (*Sebastes alutus*). J. Const. Int. Explor. Mer. 39:211-218.

Punt, A.E., T.I. Walker, B.L. Taylor, and F. Pribac. 2000. Standardization of catch and effort data in a spatially-structured shark fishery. Fish. Res. 45:129-145.

Table 1. Results of the final model fit for sharks captured using longlines.

Dependent: Small Coastal

Source	DF	Sum of squares	Mean Square	F value	Pr>F
Model	20	154.048	7.702	6.07	<0.0001
Error	336	426.076	1.268		
Total	356	580.125			
Year	7	54.229	7.747	6.11	<0.0001
Area	1	23.071	23.071	18.19	<0.0001
Month	6	13.011	2.168	1.71	0.1178
Area*Month	6	46.537	7.756	6.12	<0.0001

Dependent: Atlantic sharpnose

Source	DF	Sum of squares	Mean Square	F value	Pr>F
Model	20	152.386	7.619	6.25	<0.0001
Error	336	409.514	1.218		
Total	356	561.900			
Year	7	58.231	8.318	6.83	<0.0001
Area	1	33.763	33.736	27.68	<0.0001
Month	6	8.902	1.483	1.22	0.2967
Area*Month	6	37.548	6.258	5.13	<0.0001

Dependent: Blacknose

Source	DF	Sum of squares	Mean Square	F value	Pr>F
Model	13	11.001	0.846	4.73	<0.0001
Error	343	61.428	0.179		
Total	356	72.430			
Year	7	5.422	0.774	4.33	0.0001
Month	6	3.711	0.618	3.45	0.0025

Dependent: Finetooth

Source	DF	Sum of squares	Mean Square	F value	Pr>F
Model	14	12.476	0.891	4.22	<0.0001
Error	342	72.201	0.211		
Total	356	84.678			
Year	7	3.661	0.523	2.48	0.017
Month	6	4.126	0.687	3.26	0.040
Area	1	3.81	3.810	18.05	<0.0001

Table 2. Nominal and standardized longline abundance indices (sharks/10 hook hrs) for all shark species. Coefficient of variation (CV) is calculated as the standard error/mean.

			Catch Rates					
SPECIES	**YEAR**	**N**	**Nominal**	**S.E.**	**CV**	**Standardized**	**S.E.**	**CV**
Small coastal	1993	13	0.212	0.060	0.285	0.517	0.262	0.507
	1994	66	0.385	0.075	0.196	0.235	0.128	0.544
	1995	43	0.361	0.108	0.298	0.343	0.166	0.483
	1996	69	1.074	0.135	0.126	1.073	0.098	0.092
	1997	60	0.637	0.109	0.172	0.594	0.110	0.185
	1998	29	0.325	0.127	0.392	0.439	0.166	0.378
	1999	42	1.192	0.196	0.165	1.170	0.136	0.116
	2000	35	0.706	0.146	0.207	0.534	0.158	0.296
Atlantic sharpnose	1993	13	0.159	0.062	0.386	0.481	0.248	0.516
	1994	66	0.288	0.061	0.213	0.136	0.120	0.882
	1995	43	0.339	0.107	0.315	0.301	0.157	0.520
	1996	69	0.951	0.136	0.143	0.951	0.093	0.098
	1997	60	0.563	0.104	0.185	0.531	0.104	0.196
	1998	29	0.260	0.101	0.387	0.380	0.157	0.413
	1999	42	1.140	0.195	0.171	1.160	0.129	0.111
	2000	35	0.601	0.142	0.235	0.445	0.150	0.337
Blacknose	1993	13	0.000	0.000	0.000	0.008	0.047	6.171
	1994	66	0.095	0.030	0.314	0.076	0.021	0.282
	1995	43	0.010	0.010	1.000	0.021	0.028	1.332
	1996	69	0.000	0.000	0.000	0.000	0.000	0.000
	1997	60	0.018	0.013	0.704	0.017	0.020	1.201
	1998	29	0.043	0.043	1.000	0.032	0.031	0.981
	1999	42	0.045	0.005	0.120	0.052	0.026	0.493
	2000	35	0.105	0.047	0.445	0.096	0.028	0.294
Finetooth	1993	13	0.045	0.026	0.577	0.014	0.056	3.924
	1994	66	0.000	0.000	0.000	0.046	0.028	0.610
	1995	43	0.016	0.016	1.000	0.012	0.034	2.759
	1996	69	0.123	0.039	0.314	0.123	0.022	0.182
	1997	60	0.056	0.033	0.589	0.057	0.024	0.425
	1998	29	0.022	0.022	1.000	0.006	0.037	6.800
	1999	42	0.039	0.028	0.718	0.010	0.031	2.972
	2000	35	0.000	0.000	0.000	0.000	0.000	0.000

Figure 1. Nominal and standardized longline indices of abundance. Each index has been divided by its mean.