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STANDARDIZED CATCH RATES OF FOUR SHARK SPECIES IN THE VIRGINIA-MASSACHUSETTS (U.S.) ROD AND REEL FISHERY

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SUMMARY

Abundance indices for several shark species off the coast of the United States from Virginia through Massachusetts were developed using data obtained during interviews of anglers in 1986-1993. Subsets of the data were analyzed to assess effects of month, area fished, boat type (private or charter), and interview type (dockside or phone) on catch per unit effort. Standardized catch rates were developed using general linear models for unclassified mako *(Isurus sp.)*, sandbar *(Carcharhinus plumbeus)*, dusky *(Carcharhinus obscurus)*, and blue *(Prionace glauca)* sharks. The nominal catch rate trend is presented for unclassified hammerhead *(Sphyrna sp.)* sharks.

RÉSUMÉ

Des indices d'abondance ont été élaborés pour plusieurs espèces de requins au large de la côte des Etats-Unis, de la Virginie au Massachusetts, en utilisant les données collectées lors d'enquêtes auprès de pêcheurs à la ligne réalisées en 1986-1993. Les sous-jeux des données ont été analysés afin d'évaluer l'influence du mois, de la zone de pêche, du type de bateau (privé ou affrété) et du type d'enquête (à quai ou par téléphone) sur la capture par unité d'effort. On a élaboré des taux de capture standardisés en utilisant Des modèles linéaires généraux pour les requins-taupes (*Isurus sp.*), les requins gris (*Carcharhinus plumbeus*), les requins sombres (*Carcharhinus obscurus*) et les requins bleus (*Prionace glauca*) non classés. Pour les requins-marteaux non classés (*Sphyrna sp.*), la tendance du taux de capture nominal est présentée.

RESUMEN

Se desarrollaron índices de abundancia para varias especies de tiburones frente a la costa de Estados Unidos, desde Virginia hasta Massachusetts, empleando datos obtenidos en entrevistas a pescadores deportivos en 1986-1993. Se analizaron subconjuntos de datos para evaluar los efectos de mes, zona explotada, tipo de barco (particular o alquilado) y tipo de entrevista (a pie de muelle o por teléfono) sobre captura por unidad de esfuerzo. Se desarrollaron tasas de captura estandarizadas utilizando modelos lineales generalizados para el tiburón maco (*Isurus* sp.), tiburón de Milbert (*Carcharhinus plumbeus*), tiburón arenero (*Carcharhinus obscurus*) y tintorera (*Prionace glauca*). Se presenta la tendencia de la tasa de captura nominal para tiburones martillo sin clasificar (*Sphyrna* sp.).

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Catch per unit effort (CPUE) data on rod and reel (RR) and handline (HL) fisheries off the coast of the United States from Virginia through Massachusetts were collected between 1980 and 1993. Fishermen were interviewed as they returned to the dock and by phone to determine if the trip was directed at large pelagic game fish (sharks, tunas, billfishes). Interviewers recorded the number of fish caught and the methods employed for each trip.

Each trip interview record includes data on: target species, date, boat type, fishing method and state. For this analysis data were restricted to only those trips which targeted sharks and which employed the chumming method. The analysis was also limited to months May through September. Nominal catch rates within these restrictions appeared to be higher than those outside. Observed effort was concentrated during June and July (86% of observations) and in New Jersey - New York (74%). About one-third of observations were of charter boat trips; interviews were evenly split between phone and dockside.

The variation in factors such as area fished, time of year, and boat type (private/charter) make it inappropriate to compare nominal CPUE across years. A general linear model (GLM) approach (Draper and Smith 1966) was used to develop standardized indices of abundance for unclassified mako (*Isurus sp.*), sandbar (*Carcharhimus plumbeus*), dusky (*Carcharhinus obscurus*), blue (*Prionace glauca*) and unclassified hammerhead (*Sphyrna sp.*) sharks in the RR fishery during 1986-1993 (the available time period for which shark targeted effort was covered). The variables chosen for analysis were year, month, boat type, interview type (phone/dockside), state, and region. Region was defined by grouping trips from Virginia - New Jersey into a "**SOUTH**" region and trips from New York - Massachusetts into a "**NORTH**" region. Nominal catch rates appeared to be similar within these groupings for some species. The Lo method for GLM analysis (Lo *et al.* 1992) was employed using the logged catch per trip (X100) as the CPUE value. This method models the proportion of positive (successful) trips and the catch rate of positive trips separately and then combines the results to yield an index value.

Factors were iteratively removed from the models unless each contributed significantly to the model at the 5% level. The exception to this was the month factor in the model predicting proportion positive for mako sharks. Month was only significant at the 15% level, but was retained because two factors were necessary in order to calculate the indices and confidence limits. There were insufficient observations of trips catching hammerhead sharks to permit the estimation of reliable indices and confidence limits for those species. The final models for each species are shown in Table 1.

The nominal CPUE and standardized catch rates are shown in Table 2. Also shown are the relative catch rate indices, calculated by dividing each nominal (or standardized) catch rate by the annual mean nominal (or standardized catch rate) for each species. These relative trends are shown in Figures 1 - 4.

The increase in relative catch rates of blue sharks (Figure 4) in recent years raised the concern that there may be increased directed effort toward blue sharks which was not detected by criteria defined in the analysis (shark target, chumming method). The temporal-spatial distribution of nominal effort and catch rate levels were examined for any evidence that effort was shifting offshore. However, there was no evidence of such a trend nor of any clear correlation between distance offshore and blue shark catch rates. Another concern was the unavailablity of data from New Jersey in 1988. However, any effect should have been accounted for by the models.

Literature Cited

Draper, N.R., and H. Smith. 1966. Applied Regression Analysis. John Riley and Sons, Inc., New York, 407 p.

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.

SPECIES (common name)	SIGNIFICANT FACTORS	
	PROPORTION OF TRIPS SUCCESSFUL =:	CATCH PER 100 SUCCESSFUL TRIPS =:
MAKO	YEAR + MONTH (MONTH significant at 15% level)	YEAR + STATE
SANDBAR	YEAR + STATE	YEAR + MONTH + INTERVIEW TYPE
DUSKY	YEAR + MONTH + REGION + INTERVIEW TYPE	YEAR + BOAT TYPE + MONTH + INTERVIEW TYPE
BLUE	YEAR + MONTH + REGION	YEAR + MONTH + REGION + INTERVIEW TYPE

TABLE 2. Nominal and GLM standardized catch per 100 trips (with upper [UCL] and lower [LCL] confidence limits defined +/- two standard errors for the standardized CPUE).

YEAR	TRIPS WITH CATCH	NOMINAL CPUE	STAND. CPUE	UCL	LCL	TRIPS WITH CATCH	NOMINAL CPUE	STAND. CPUE	UCL	LCL
	MAKO					SANDBAR				
1986	369	48.70	40.92	56.04	25.80	119	21.06	16.20	30.26	2.14
1987	273	36.52	26.83	40.97	12.69	67	11.07	15.40	25.98	4.82
1988	71	15.57	11.31	22.67	-0.05	59	21.32	29.83	43.69	15.97
1989	160	24.50	18.07	30.65	5.49	170	33.04	26.12	37.40	14.84
1990	201	26.21	20.78	33.72	7.84	87	11.92	8.15	16.67	-0.37
1991	193	26.48	33.60	47.64	19.56	67	15.98	8.42	19.40	-2.56
1992	188	30.82	32.09	46.37	17.81	66	12.50	14.80	24.96	4.64
1993	101	42.73	32.43	49.75	15.11	7	2.31	2.48	10.38	-5.42
	DUSKY					BLUE				
1986	169	32.04	30.62	41.32	19.92	255	87.13	75.26	109.10	41.42
1987	155	27.34	25.72	36.88	14.56	207	74.74	43.89	76.79	10.99
1988	26	8.96	12.60	23.46	1.74	228	187.42	91.15	134.51	47.79
1989	91	17.57	24.19	34.79	13.59	224	103.96	48.16	78.04	18.28
1990	105	16.65	12.20	23.00	1.40	245	73.48	54.52	86.62	22.42
1991	85	17.54	23.29	33.41	13.17	295	162.46	113.86	158.84	68.88
1992	28	5.57	6.15	14.73	-2.43	386	234.65	141.59	194.05	89.13
1993	37	16.63	11.78	23.00	0.56	196	247.11	129.37	187.39	71.35
	HAMMERHEAD					TOTAL OBS. TRIPS (shark target, chumming, with and without catch)				
1986	50	5.49				1002				
1987	34	3.41				1057				
1988	4	0.85				469				
1989	24	3.34				808				
1990	23	2.47	NOT ESTIMATED			973	NOT APPLICABLE			
1991	46	6.03				895				
1992	17	2.10				808				
1993	3	0.69				433				

TABLE 3. Relative nominal and GLM standardized catch per 100 trips (with upper [UCL] and lower [LCL] confidence limits defined +/- two standard errors for the relative standardized CPUE).

YEAR	RELATIVE VALUES (yearly value/mean value across years)							
	NOMINAL CPUE	STAND. CPUE	UCL	LCL	NOMINAL CPUE	STAND. CPUE	UCL	LCL
	MAKO				SANDBAR			
1986	1.55	1.52	2.08	0.96	1.30	1.07	1.99	0.14
1987	1.16	0.99	1.52	0.47	0.69	1.01	1.71	0.32
1988	0.50	0.42	0.84	-0.00	1.32	1.97	2.88	1.05
1989	0.78	0.67	1.14	0.20	2.05	1.72	2.46	0.98
1990	0.83	0.77	1.25	0.29	0.74	0.54	1.10	-0.02
1991	0.84	1.24	1.76	0.72	0.99	0.55	1.28	-0.17
1992	0.98	1.19	1.72	0.66	0.77	0.98	1.64	0.31
1993	1.36	1.20	1.84	0.56	0.14	0.16	0.68	-0.36
	DUSKY				BLUE			
1986	1.80	1.67	2.26	1.09	0.60	0.86	1.25	0.47
1987	1.54	1.40	2.01	0.79	0.51	0.50	0.88	0.13
1988	0.50	0.69	1.28	0.09	1.28	1.04	1.54	0.55
1989	0.99	1.32	1.90	0.74	0.71	0.55	0.89	0.21
1990	0.94	0.67	1.26	0.08	0.50	0.63	0.99	0.26
1991	0.99	1.27	1.82	0.72	1.11	1.31	1.82	0.79
1992	0.31	0.34	0.80	-0.13	1.60	1.62	2.22	1.02
1993	0.93	0.64	1.26	0.03	1.69	1.48	2.15	0.82

Figure 1. Relative nominal and GLM standardized (+/- two standard errors) catch per 100 trips for mako sharks. The relative values are obtained by dividing each yearly value by the mean value across years.

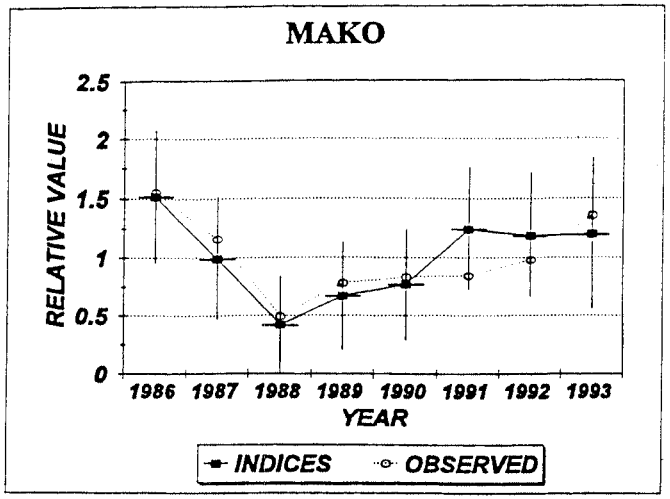

Figure 2. Relative nominal and GLM standardized (+/- two standard errors) catch per 100 trips for sandbar sharks. The relative values are obtained by dividing each yearly value by the mean value across years.

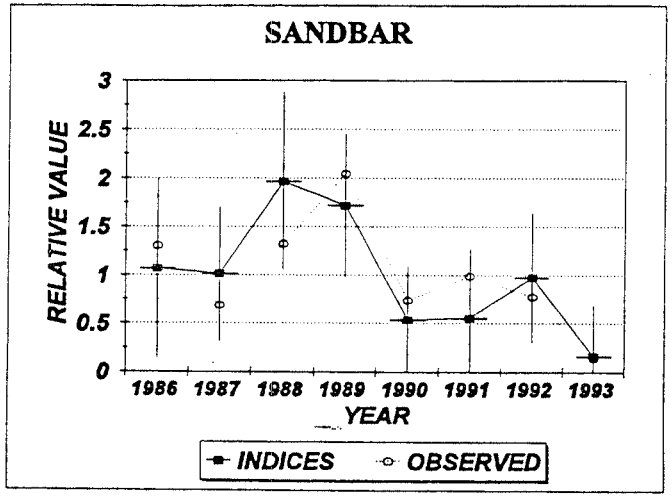

Figure 3. Relative nominal and GLM standardized (+/- two standard errors) catch per 100 trips for dusky sharks. The relative values are obtained by dividing each yearly value by the mean value across years.

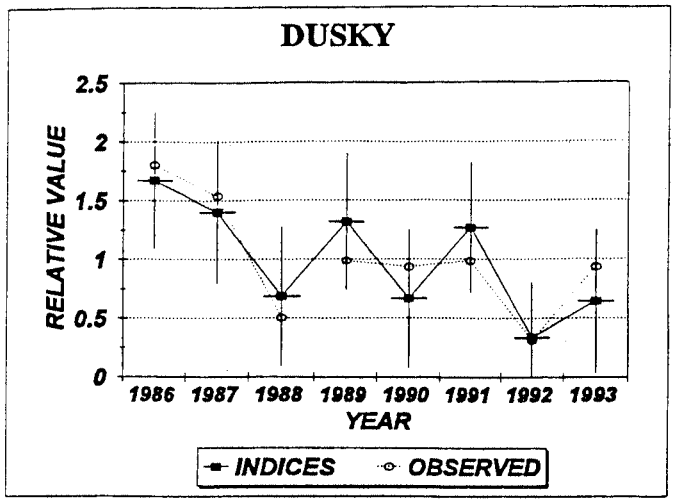

Figure 4. Relative nominal and GLM standardized (+/- two standard errors) catch per 100 trips for blue sharks. The relative values are obtained by dividing each yearly value by the mean value across years.