

**STANDARDIZED CATCH RATES FOR MAKO
(UNCLASSIFIED *ISURUS SP.*) AND BLUE (*PRIONACE GLAUCA*)
SHARKS IN THE VIRGINIA-MASSACHUSETTS (UNITED STATES)
ROD AND REEL FISHERY DURING 1986-2005**

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SUMMARY

Abundance indices for unclassified mako (Isurus sp.) and blue (Prionace glauca) sharks off the coast of the United States from Virginia through Massachusetts were developed using data obtained during interviews of rod and reel anglers in 1986-2005. Subsets of the data were analyzed to assess effects of factors such as month, area fished, boat type (private or charter), interview type (dockside or phone) and fishing method on catch per unit effort. Standardized catch rates were estimated through generalized linear models by applying delta-Poisson error distribution assumptions. A stepwise approach was used to quantify the relative importance of the main factors explaining the variance in catch rates

RÉSUMÉ

Les indices d'abondance de l'Isurus sp. non classifié et du requin peau bleue (Prionace glauca) que l'on trouve au large des côtes des Etats-Unis, depuis la Virginie jusqu'au Massachusetts, ont été mis au point à l'aide des données obtenues des entretiens réalisés auprès des pêcheurs à la ligne entre 1986 et 2005. Des sous-ensembles de données ont été analysés afin d'évaluer les effets des facteurs, tels que le mois, la zone de pêche, le type de navire (privé ou affrété), le type d'entretien (au quai ou par téléphone) et le mode de pêche sur la capture par unité d'effort. Les taux de capture standardisés ont été estimés par le biais de modèles linéaires généralisés en appliquant des postulats de distribution d'erreur delta-Poisson. Une approche pas-à-pas a été employée pour quantifier l'importance relative des principaux facteurs qui expliquaient la variance dans les taux de capture.

RESUMEN

Se desarrollaron los índices de abundancia del marrajo (Isurus sp.) y la tintorera (Prionace glauca) en las aguas situadas frente a la costa de Estados Unidos desde Virginia hasta Massachusetts utilizando los datos obtenidos mediante las entrevistas a los pescadores con caña y carrete en 1986-2005. Se analizaron los subconjuntos de datos para evaluar los efectos en la captura por unidad de esfuerzo de factores como mes, zona pescada, tipo de buque (privado o fletado), tipo de entrevista (en el muelle o telefónica) y método de pesca. Se estimaron las tasas de captura estandarizadas mediante modelos lineales generalizados aplicando supuestos de distribución de error delta-Poisson. Se utilizó un enfoque gradual para cuantificar la importancia relativa de los principales factores que explican la varianza en las tasas de captura.

KEYWORDS

*Catch/effort, abundance, sport fishing, fishery surveys, multivariate analyses,
stock assessments, catch rate standardization, generalized linear model,
shark fisheries, pelagic fisheries*

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1. Introduction

Data from the United States National Marine Fisheries Service's Large Pelagic Survey have typically been used to develop abundance indices for a variety of species, including bluefin tuna (Brown SCRS/2006/084), sharks (Brown 2000), and bigeye and yellowfin tuna (Brown 1999, Brown 2004). This paper describes the development of indices of abundance for blue sharks (*Prionace glauca*) and mako sharks (unclassified *Isurus sp.*) for the period 1986-2005.

2. Material and methods

The Large Pelagic Survey (LPS) collects data on the catch and effort of individual fishing trips through interviews with fishermen at the dock and in some years has collected such information over the telephone. Information collected usually includes date, landing area, boat type (charter or private), fishing area, number of anglers fishing, number of lines in the water, hours fished, type of fishing (primarily trolling or chumming), fishing target, sea surface temperature (SST) and catch.

Fishing areas were defined for this analysis at two levels of detail based upon landing location, STATE and REGION. The states included (from south to north along the mid-Atlantic coast of the United States) Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts. Considering that fishing trips in this fishery are generally of short duration (less than one day, some of two-three days), the landing state can be expected to provide a reasonable proxy for fishing area. The REGIONS were defined based upon state; they were the southern area (SOUTH) from Virginia through New Jersey and the northern area (NORTH) from New York through Massachusetts. These definitions are consistent with definitions for previous shark catch per unit effort (CPUE) standardization analyses for this fishery (Brown 2000).

Observations were limited to those on which anglers indicated that they were targeting sharks and were employing the chumming fishing method exclusively. These restrictions are consistent with restrictions imposed for previous shark catch per unit effort (CPUE) standardization analyses for this fishery (Brown 2000). Trips targeting other species categories (such as tunas) were not included because they were thought to be adding noise rather than information.

Factors which were considered as possible influences on catch rates included YEAR, MONTH, REGION, BOATTYPE, sea surface temperature (TEMP), STATE, tournament participation (TOURNAMENT, Y=yes and N=no) and interview type (dockside/telephone recall or DOCKRECL). Fishing effort was defined as hours fished as has been done in analyses for small bluefin tuna (Turner and Brown 1998).

The Lo method (Lo *et al.* 1992) was used to develop standardized indices; with that method separate analyses are conducted of the positive catch rates and the proportions of the observed trips which were successful. The error distribution for the proportion positive analysis was assumed to be binomial; for the positive catch rate analyses a Poisson error distribution was assumed, fitting the number of yellowfin tuna per trip with the natural log of the fishing hours as the offset term.

A stepwise approach was used to quantify the relative importance of the main factors explaining the variance in catch rates. That is, first the Null model was run, in which no factors were entered in the model. These results reflect the distribution of the nominal data. Each potential factor was then tested one at a time. The results were then ranked from greatest to least reduction in deviance per degree of freedom when compared to the Null model. The factor which resulted in the greatest reduction in deviance per degree of freedom was then incorporated into the model, provided two conditions were met: 1) the effect of the factor was determined to be significant at least the 5% level based upon a Chi-Square test, and 2) the deviance per degree of freedom was reduced by at least 1% from the less complex model. This process was repeated, adding factors one at a time at each step, until no factor met the criteria for incorporation into the final model.

The relative indices of abundance by year are determined based upon the standardized year effects. The product of the standardized proportion positives and the standardized positive catch rates was used to calculate overall standardized catch rates.

3. Results and discussion

3.1 Blue shark

The stepwise construction of the model is shown in **Table 1** for the proportion positive analysis and in **Table 2** for the positive catch rate analysis. The final model for the proportion positive analysis includes the factors STATE, YEAR, and TEMP*TEMP (the polynomial effect of sea surface temperature). For the positive catch rate analysis, the final model includes the factors YEAR, STATE, MONTH, and STATE*MONTH.

The results of the relative abundance analyses for blue sharks in the Virginia - Massachusetts rod and reel fishery (1986-2005) are shown in **Table 3** (proportion positive) and in **Table 4** (positive catch trips). The final models and index trend are shown in **Table 5** and **Figure 1**.

3.2 Mako shark

The stepwise construction of the model is shown in **Table 6** for the proportion positive analysis and in **Table 7** for the positive catch rate analysis. The final model for the proportion positive analysis includes the factors YEAR and STATE. For the positive catch rate analysis, the final model includes the factors YEAR, STATE, MONTH, STATE*MONTH, TOURNAMENT, STATE*TOURNAMENT, BOATTYPE and STATE*BOATTYPE.

The results of the relative abundance analyses for blue sharks in the Virginia - Massachusetts rod and reel fishery (1986-2002) are shown in **Table 8** (proportion positive) and in **Table 9** (positive catch trips). The final models and index trend are shown in **Table 10** and **Figure 2**.

Although the LPS data did not record the species of mako shark for most of its history, the longfin mako, *Isurus paucus*, is generally not found in the waters typically fished by this fishery, preferring the waters of the Gulf Stream further offshore. It is expected that most or all of the catch recorded in the LPS is of shortfin mako, *Isurus oxyrinchus*. This is supported by the fact that, since LPS interviewers began recording the species of mako shark in 1999 (rather than coding as UNCLASSIFIED MAKO), over 97% of the mako sharks caught have been identified as shortfin mako sharks. Therefore, it may be reasonable to consider the results of this analysis as applying to shortfin mako sharks.

References

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Table 1. Results of the stepwise procedure to develop the proportion positive catch rate model for blue sharks (*Prionace glauca*).

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*****
                          There are no explanatory factors in the base model.
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		8309	11328.3	1.3634		-5664.2	
STATE	8302	10203.4	1.2290	9.85	-5101.7	1124.95	0.00000
REGION	8308	10325.4	1.2428	8.84	-5162.7	1002.95	0.00000
YEAR	8290	10548.2	1.2724	6.67	-5274.1	780.17	0.00000
TEMP*TEMP	8308	11028.8	1.3275	2.63	-5514.4	299.56	0.00000
TEMP	8308	11061.2	1.3314	2.35	-5530.6	267.10	0.00000
BOATTYPE	8308	11206.8	1.3489	1.06	-5603.4	121.56	0.00000
DOCKRECL	8308	11266.5	1.3561	0.53	-5633.3	61.82	0.00000
MONTH	8306	11313.7	1.3621	0.09	-5656.8	14.66	0.00213
TOURNAMENT	8308	11321.7	1.3627	0.05	-5660.8	6.63	0.01004

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                          The explanatory factors in the base model are: STATE
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		8302	10203.4	1.2290		-5101.7	
YEAR	8283	9516.2	1.1489	6.52	-4758.1	687.15	0.00000
TEMP*TEMP	8301	10000.7	1.2048	1.97	-5000.3	202.69	0.00000
MONTH	8299	10007.4	1.2059	1.88	-5003.7	195.93	0.00000
TEMP	8301	10027.5	1.2080	1.71	-5013.7	175.91	0.00000
BOATTYPE	8301	10105.2	1.2173	0.95	-5052.6	98.19	0.00000
DOCKRECL	8301	10145.9	1.2223	0.55	-5073.0	57.44	0.00000
TOURNAMENT	8301	10166.0	1.2247	0.35	-5083.0	37.41	0.00000
REGION	8302	10203.4	1.2290	0.00	-5101.7	0.00	.

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*****
                          The explanatory factors in the base model are: STATE YEAR
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		8283	9516.2	1.1489		-4758.1	
TEMP*TEMP	8282	9217.0	1.1129	3.13	-4608.5	299.24	0.00000
TEMP	8282	9221.8	1.1135	3.08	-4610.9	294.45	0.00000
MONTH	8280	9262.9	1.1187	2.63	-4631.5	253.29	0.00000
TOURNAMENT	8282	9480.9	1.1448	0.36	-4740.5	35.28	0.00000
BOATTYPE	8282	9485.2	1.1453	0.31	-4742.6	31.06	0.00000
REGION	8283	9516.2	1.1489	0.00	-4758.1	0.00	.
DOCKRECL	8282	9515.6	1.1489	-0.01	-4757.8	0.66	0.41711

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                          The explanatory factors in the base model are: STATE YEAR TEMP*TEMP
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		8282	9217.0	1.1129		-4608.5	
MONTH	8279	9148.5	1.1050	0.71	-4574.3	68.43	0.00000
BOATTYPE	8281	9187.3	1.1094	0.31	-4593.7	29.65	0.00000
TOURNAMENT	8281	9207.4	1.1119	0.09	-4603.7	9.60	0.00194
TEMP	8281	9215.7	1.1129	0.00	-4607.8	1.31	0.25306
REGION	8282	9217.0	1.1129	0.00	-4608.5	0.00	.
DOCKRECL	8281	9216.8	1.1130	-0.01	-4608.4	0.17	0.68413

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                          The explanatory factors in the base model are: STATE YEAR TEMP*TEMP
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		6767	7364.3	1.0883		-3682.2	
BOATTYPE	6766	7309.0	1.0802	0.74	-3654.5	55.37	0.00000
REGION	6767	7364.3	1.0883	0.00	-3682.2	0.00	.
TOURNAMENT	6766	7363.5	1.0883	-0.00	-3681.8	0.80	0.37204
DOCKRECL	6766	7363.9	1.0884	-0.01	-3681.9	0.45	0.50371
TEMP	6766	7364.0	1.0884	-0.01	-3682.0	0.34	0.55889

FINAL MODEL: SUCCESS=STATE+YEAR+TEMP*TEMP (the polynomial effect of seas surface temperature)% REDUCTION; percent difference in deviance/df between the newly included factor and the previous factor entered into the model; LOGLIKE: log likelihood; CHISQ: Pearson Chi-square statistic; PROBCHISQ: significance level of the Chi-square statistic.

Table 2. Results of the stepwise procedure to develop the positive catch rate model for blue sharks (*Prionace glauca*).

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*****
                          There are no explanatory factors in the base model.
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	3524	17487.7	4.9625		10256.6		
YEAR	3505	16050.4	4.5793	7.72	10975.3	1437.33	0.00000
STATE	3517	16282.3	4.6296	6.71	10859.4	1205.43	0.00000
REGION	3523	16763.1	4.7582	4.12	10618.9	724.57	0.00000
TEMP*TEMP	3523	17177.0	4.8757	1.75	10412.0	310.68	0.00000
TEMP	3523	17218.7	4.8875	1.51	10391.2	269.03	0.00000
BOATTYPE	3523	17282.5	4.9056	1.15	10359.3	205.26	0.00000
TOURNAMENT	3523	17287.8	4.9071	1.12	10356.6	199.90	0.00000
MONTH	3521	17338.2	4.9242	0.77	10331.4	149.48	0.00000
DOCKRECL	3523	17389.1	4.9359	0.54	10305.9	98.58	0.00000

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                          The explanatory factors in the base model are: YEAR
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	3505	16050.4	4.5793		10975.3		
STATE	3498	14881.1	4.2542	7.10	11560.0	1169.33	0.00000
REGION	3504	15285.4	4.3623	4.74	11357.8	765.00	0.00000
TEMP*TEMP	3504	15639.5	4.4633	2.53	11180.7	410.88	0.00000
TEMP	3504	15651.6	4.4668	2.46	11174.7	398.73	0.00000
BOATTYPE	3504	15860.2	4.5263	1.16	11070.4	190.13	0.00000
DOCKRECL	3504	15880.2	4.5320	1.03	11060.4	170.21	0.00000
MONTH	3502	15905.2	4.5417	0.82	11047.9	145.22	0.00000
TOURNAMENT	3504	15978.2	4.5600	0.42	11011.4	72.21	0.00000

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                          The explanatory factors in the base model are: YEAR STATE
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	3498	14881.1	4.2542		11560.0		
MONTH	3495	14162.1	4.0521	4.75	11919.4	718.91	0.00000
TEMP*TEMP	3497	14470.3	4.1379	2.73	11765.3	410.73	0.00000
TEMP	3497	14484.5	4.1420	2.64	11758.3	396.59	0.00000
DOCKRECL	3497	14716.7	4.2084	1.08	11642.1	164.32	0.00000
BOATTYPE	3497	14738.7	4.2147	0.93	11631.2	142.39	0.00000
TOURNAMENT	3497	14863.5	4.2504	0.09	11568.7	17.54	0.00003
REGION	3498	14881.1	4.2542	0.00	11560.0	0.00	.

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                          The explanatory factors in the base model are: YEAR STATE MONTH
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	3495	14162.1	4.0521		11919.4		
DOCKRECL	3494	14024.4	4.0138	0.94	11988.3	137.76	0.00000
BOATTYPE	3494	14043.5	4.0193	0.81	11978.7	118.60	0.00000
TOURNAMENT	3494	14046.4	4.0201	0.79	11977.3	115.75	0.00000
TEMP*TEMP	3494	14110.1	4.0384	0.34	11945.4	52.01	0.00000
TEMP	3494	14112.4	4.0390	0.32	11944.3	49.71	0.00000
REGION	3495	14162.1	4.0521	0.00	11919.4	0.00	.

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                          The explanatory factors in the base model are: YEAR STATE MONTH
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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		3495	14162.1	4.0521		11919.4	
STATE*MONTH	3478	13832.1	3.9770	1.85	12084.4	330.00	0.00000
MONTH*TEMP	3491	13921.3	3.9878	1.59	12039.8	240.82	0.00000
STATE*TOURNAMENT	3487	13923.5	3.9930	1.46	12038.8	238.65	0.00000
STATE*DOCKRECL	3487	13927.4	3.9941	1.43	12036.8	234.72	0.00000
MONTH*BOATTYPE	3491	13945.3	3.9946	1.42	12027.9	216.87	0.00000
MONTH*TOURNAMENT	3491	14004.8	4.0117	1.00	11998.1	157.31	0.00000
STATE*BOATTYPE	3487	13991.3	4.0124	0.98	12004.9	170.87	0.00000
STATE*TEMP*TEMP	3487	14012.5	4.0185	0.83	11994.3	149.66	0.00000
STATE*TEMP	3487	14015.2	4.0193	0.81	11992.9	146.97	0.00000

FINAL MODEL: Blue Sharks (Kept+Released) = YEAR+STATE+MONTH+STATE*MONTH
 %REDUCTION: percent difference in deviance/df between the newly included factor and the previous factor entered into the model; LOGLIKE: log likelihood;
 CHISQ: Pearson Chi-square statistic; PROBCHISQ: significance level of the Chi-square statistic.

Note: The complete process of acceptance/rejection of two-way interaction effects is not shown.

Table 3. Results of the blue shark (*Prionace glauca*) analysis (1986-2002). Lo method with binomial error assumption for proportion positives.

Class		Level s	Val ues																			
STATE		8	CT	DE	MA	MD	NJ	NY	RI	VA												
YEAR		20	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
			Number of Observations Read										8310									
			Number of Observations Used										8310									
			Number of Observations Not Used										0									
			Parameter Search																			
CovP1		1.0169	Variance		1.0169	Res Log Li ke		-2	Res Log Li ke		38286.3054											
			Fit Statistics																			
			-2 Res Log Likelihood			38286.3																
			AIC (smaller is better)			38288.3																
			AICC (smaller is better)			38288.3																
			BIC (smaller is better)			38295.3																
			Information Criteria																			
Neg2LogLi ke		38286.3	Parms	1	AIC	38288.3	AICC	38288.3	HQIC	38290.7	BIC	38295.3	CAIC	38296.3								
Solution for Fixed Effects																						
Effect	STATE	YEAR	Estimate	Standard Error	DF	t Value	Pr > t	Al pha	Lower	Upper												
Intercept			0.7156	0.5077	8282	1.41	0.1587	0.05	-0.2797	1.7108												
STATE	CT		3.2934	0.4902	8282	6.72	<.0001	0.05	2.3325	4.2543												
STATE	DE		1.2406	0.4856	8282	2.55	0.0106	0.05	0.2887	2.1924												
STATE	MA		3.0296	0.4820	8282	6.29	<.0001	0.05	2.0847	3.9745												
STATE	MD		0.6698	0.4654	8282	1.44	0.1501	0.05	-0.2424	1.5820												
STATE	NJ		1.3378	0.4606	8282	2.90	0.0037	0.05	0.4350	2.2406												
STATE	NY		2.4975	0.4587	8282	5.44	<.0001	0.05	1.5984	3.3967												
STATE	RI		3.1457	0.4648	8282	6.77	<.0001	0.05	2.2345	4.0569												
STATE	VA		0																			
YEAR		1986	-0.4932	0.1512	8282	-3.26	0.0011	0.05	-0.7897	-0.1968												
YEAR		1987	-1.0913	0.1470	8282	-7.42	<.0001	0.05	-1.3795	-0.8032												
YEAR		1988	-0.2017	0.1542	8282	-1.31	0.1908	0.05	-0.5039	0.1005												
YEAR		1989	-0.4381	0.1472	8282	-2.98	0.0029	0.05	-0.7266	-0.1496												
YEAR		1990	-0.4608	0.1380	8282	-3.34	0.0008	0.05	-0.7313	-0.1904												
YEAR		1991	-0.3174	0.1369	8282	-2.32	0.0205	0.05	-0.5858	-0.04900												
YEAR		1992	0.1771	0.1357	8282	1.31	0.1918	0.05	-0.08886	0.4432												
YEAR		1993	-1.4767	0.1844	8282	-8.01	<.0001	0.05	-1.8380	-1.1153												
YEAR		1994	0.3448	0.1654	8282	2.08	0.0372	0.05	0.02049	0.6691												
YEAR		1995	0.06352	0.1605	8282	0.40	0.6923	0.05	-0.2512	0.3782												
YEAR		1996	1.6674	0.2253	8282	7.40	<.0001	0.05	1.2258	2.1091												
YEAR		1997	0.7467	0.1733	8282	4.31	<.0001	0.05	0.4070	1.0864												
YEAR		1998	0.5954	0.2298	8282	2.59	0.0096	0.05	0.1450	1.0458												
YEAR		1999	0.4568	0.2351	8282	1.94	0.0520	0.05	-0.00404	0.9177												
YEAR		2000	1.0570	0.1950	8282	5.42	<.0001	0.05	0.6748	1.4392												
YEAR		2001	0.4328	0.2234	8282	1.94	0.0527	0.05	-0.00510	0.8707												
YEAR		2002	0.4561	0.2028	8282	2.25	0.0246	0.05	0.05846	0.8537												
YEAR		2003	1.2405	0.1449	8282	8.56	<.0001	0.05	0.9564	1.5246												
YEAR		2004	1.0355	0.1460	8282	7.09	<.0001	0.05	0.7492	1.3218												
YEAR		2005	0																			
TEMP*TEMP			-0.00071	0.000044	8282	-16.20	<.0001	0.05	-0.00079	-0.00062												
Type 3 Tests of Fixed Effects																						
Effect	Num DF	Den DF	Chi-Square	F Value	Pr > Chi Sq	Pr > F																
STATE	7	8282	812.64	116.09	<.0001	<.0001																
YEAR	19	8282	680.52	35.82	<.0001	<.0001																
TEMP*TEMP	1	8282	262.42	262.42	<.0001	<.0001																
				Deviance	9216.9790																	
				Scaled Deviance	9063.8190																	
				Pearson Chi-Square	8421.9488																	
				Scaled Pearson Chi-Square	8282.0000																	
				Extra-Dispersion Scale	1.0169																	

Table 4. Results of the blue shark (*Prionace glauca*) analysis (1986-2002). Lo method with Poisson error assumption for positive catch trips.

Class	Level s	Val ues																					
		YEAR	20	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
STATE	8	CT	DE	MA	MD	NJ	NY	RI	VA														
MONTH	4	6	7	8	9																		
		Number of Observations Read											3525										
		Number of Observations Used											3525										
		Number of Observations Not Used											0										
CovP1		Variance											5.5279										
5.5279		5.5279																					
		Res Log Like											-2 Res Log Like										
		-5459.4914											10918.9827										
												Fit Statistics											
												-2 Res Log Likelihood		10919.0									
												AIC (smaller is better)		10921.0									
												AIC (smaller is better)		10921.0									
												BIC (smaller is better)		10927.1									
Solution for Fixed Effects																							
Standard																							
Effect	STATE	YEAR	MONTH	Estimate	Error	DF	t Value	Pr > t	Alpha	Lower	Upper												
Intercept				-2.7572	1.6961	3478	-1.63	0.1041	0.05	-6.0826	0.5682												
YEAR		1986		-0.05180	0.1370	3478	-0.38	0.7054	0.05	-0.3204	0.2168												
YEAR		1987		0.01622	0.1342	3478	0.12	0.9038	0.05	-0.2468	0.2793												
YEAR		1988		-0.02958	0.1273	3478	-0.23	0.8162	0.05	-0.2791	0.2200												
YEAR		1989		-0.08441	0.1304	3478	-0.65	0.5175	0.05	-0.3401	0.1713												
YEAR		1990		-0.1132	0.1318	3478	-0.86	0.3905	0.05	-0.3716	0.1452												
YEAR		1991		0.2472	0.1143	3478	2.16	0.0307	0.05	0.02303	0.4713												
YEAR		1992		0.2169	0.1110	3478	1.95	0.0508	0.05	-0.00076	0.4345												
YEAR		1993		0.2616	0.1187	3478	2.20	0.0276	0.05	0.02893	0.4942												
YEAR		1994		0.2720	0.1247	3478	2.18	0.0292	0.05	0.02751	0.5165												
YEAR		1995		0.6643	0.1113	3478	5.97	< .0001	0.05	0.4460	0.8825												
YEAR		1996		1.0101	0.1165	3478	8.67	< .0001	0.05	0.7816	1.2385												
YEAR		1997		0.7106	0.1183	3478	6.00	< .0001	0.05	0.4786	0.9426												
YEAR		1998		0.3998	0.1709	3478	2.34	0.0194	0.05	0.06477	0.7348												
YEAR		1999		0.3339	0.1644	3478	2.03	0.0424	0.05	0.01151	0.6562												
YEAR		2000		0.2115	0.1331	3478	1.59	0.1120	0.05	-0.04937	0.4724												
YEAR		2001		-0.1439	0.2132	3478	-0.68	0.4997	0.05	-0.5619	0.2741												
YEAR		2002		-0.1796	0.1750	3478	-1.03	0.3049	0.05	-0.5226	0.1635												
YEAR		2003		0.3499	0.1081	3478	3.24	0.0012	0.05	0.1379	0.5619												
YEAR		2004		0.2197	0.1093	3478	2.01	0.0445	0.05	0.005387	0.4340												
YEAR		2005		0																			
STATE	CT			2.4044	1.7209	3478	1.40	0.1625	0.05	-0.9697	5.7785												
STATE	DE			2.0655	1.7204	3478	1.20	0.2300	0.05	-1.3075	5.4385												
STATE	MA			1.7672	1.7148	3478	1.03	0.3028	0.05	-1.5949	5.1293												
STATE	MD			0.8490	2.1719	3478	0.39	0.6959	0.05	-3.4093	5.1072												
STATE	NJ			1.1763	1.9115	3478	0.62	0.5383	0.05	-2.5714	4.9239												
STATE	NY			2.3804	1.6967	3478	1.40	0.1607	0.05	-0.9463	5.7070												
STATE	RI			1.6639	1.6665	3478	1.00	0.3181	0.05	-1.6035	4.9313												
STATE	VA			0																			
MONTH		6		1.2019	1.8661	3478	0.64	0.5196	0.05	-2.4569	4.8606												
MONTH		7		0.7539	0.3139	3478	2.40	0.0164	0.05	0.1385	1.3693												
MONTH		8		0.4449	0.3317	3478	1.34	0.1799	0.05	-0.2054	1.0951												
MONTH		9		0																			
STATE*MONTH	CT	6		-0.7448	1.8923	3478	-0.39	0.6939	0.05	-4.4550	2.9655												
STATE*MONTH	CT	7		-0.8062	0.4551	3478	-1.77	0.0766	0.05	-1.6985	0.08615												
STATE*MONTH	CT	8		-0.7800	0.5514	3478	-1.41	0.1573	0.05	-1.8611	0.3012												
STATE*MONTH	CT	9		0																			
STATE*MONTH	DE	6		-1.1402	1.8940	3478	-0.60	0.5472	0.05	-4.8536	2.5732												
STATE*MONTH	DE	7		-1.1503	0.6811	3478	-1.69	0.0913	0.05	-2.4856	0.1851												
STATE*MONTH	DE	8		0																			
STATE*MONTH	DE	9		-1.5693	2.3231	3478	-0.68	0.4994	0.05	-6.1241	2.9855												
STATE*MONTH	MA	6		0.2089	0.4198	3478	0.50	0.6187	0.05	-0.6141	1.0319												
STATE*MONTH	MA	7		0.03015	0.4441	3478	0.07	0.9459	0.05	-0.8405	0.9008												
STATE*MONTH	MA	8		0																			
STATE*MONTH	MA	9		0																			
STATE*MONTH	MD	6		-0.3375	2.3102	3478	-0.15	0.8839	0.05	-4.8669	4.1920												
STATE*MONTH	MD	7		-0.5666	1.8237	3478	-0.31	0.7560	0.05	-4.1422	3.0090												
STATE*MONTH	MD	8		0																			
STATE*MONTH	MD	9		0																			
STATE*MONTH	NJ	6		-0.5415	2.0669	3478	-0.26	0.7933	0.05	-4.5939	3.5109												
STATE*MONTH	NJ	7		-0.2373	0.9610	3478	-0.25	0.8050	0.05	-2.1215	1.6469												
STATE*MONTH	NJ	8		-0.3007	1.1179	3478	-0.27	0.7879	0.05	-2.4925	1.8910												
STATE*MONTH	NJ	9		0																			
STATE*MONTH	NY	6		-1.1758	1.8684	3478	-0.63	0.5292	0.05	-4.8391	2.4875												
STATE*MONTH	NY	7		-1.0542	0.3288	3478	-3.21	0.0014	0.05	-1.6989	-0.4094												
STATE*MONTH	NY	8		-1.0157	0.3527	3478	-2.88	0.0040	0.05	-1.7071	-0.3242												
STATE*MONTH	NY	9		0																			
STATE*MONTH	RI	6		0.2121	1.8416	3478	0.12	0.9083	0.05	-3.3987	3.8228												
STATE*MONTH	RI	7		0																			
STATE*MONTH	RI	8		0																			
STATE*MONTH	RI	9		0																			
STATE*MONTH	VA	6		0																			
STATE*MONTH	VA	7		0																			

Table 4 (cont.). Results of the blue shark (*Prionace glauca*) analysis (1986-2002). Lo method with Poisson error assumption for positive catch trips.

Type 3 Tests of Fixed Effects						
Effect	Num DF	Den DF	Chi-Square	F Value	Pr > Chi Sq	Pr > F
YEAR	19	3478	253.47	13.34	<.0001	<.0001
STATE	7	3478	17.85	2.55	0.0127	0.0128
MONTH	3	3478	2.19	0.73	0.5334	0.5335
STATE*MONTH	17	3478	54.13	3.18	<.0001	<.0001
Deviance				13832.1477		
Scaled Deviance				2502.2434		
Pearson Chi-Square				19226.0313		
Scaled Pearson Chi-Square				3478.0000		
Extra-Dispersion Scale				5.5279		

Table 5. Relative Abundance Indices for BLUE SHARKS Proportion Positive err. dist: binomial, Positive err. dist: Poisson.

<i>Year</i>	<i>Index</i>	<i>LCI</i>	<i>UCI</i>	<i>CV</i>
1986	0.447	0.297	0.597	0.172
1987	0.306	0.192	0.420	0.190
1988	0.553	0.395	0.710	0.145
1989	0.449	0.312	0.586	0.156
1990	0.430	0.303	0.556	0.150
1991	0.677	0.533	0.822	0.109
1992	0.879	0.727	1.032	0.089
1993	0.284	0.162	0.407	0.220
1994	1.012	0.769	1.254	0.122
1995	1.293	1.028	1.558	0.104
1996	3.291	2.729	3.852	0.087
1997	1.870	1.499	2.241	0.101
1998	1.288	0.809	1.768	0.190
1999	1.135	0.706	1.564	0.193
2000	1.266	0.962	1.570	0.122
2001	0.696	0.348	1.043	0.255
2002	0.679	0.405	0.953	0.206
2003	1.536	1.324	1.748	0.070
2004	1.268	1.079	1.457	0.076
2005	0.642	0.470	0.815	0.137

Table 6. Results of the stepwise procedure to develop the proportion positive catch rate model for mako sharks (*Isurus sp.*).

 There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		9703	11295.8	1.1642		-5647.9	
YEAR	9684	11044.7	1.1405	2.03	-5522.4	251.08	0.00000
STATE	9696	11121.4	1.1470	1.47	-5560.7	174.43	0.00000
REGION	9702	11230.0	1.1575	0.57	-5615.0	65.81	0.00000
DOCKRECL	9702	11241.8	1.1587	0.47	-5620.9	53.98	0.00000
TEMP*TEMP	9702	11261.4	1.1607	0.29	-5630.7	34.33	0.00000
TEMP	9702	11264.8	1.1611	0.26	-5632.4	31.02	0.00000
MONTH	9700	11291.8	1.1641	0.00	-5645.9	3.95	0.26735
TOURNAMENT	9702	11294.4	1.1641	0.00	-5647.2	1.38	0.24041
BOATTYPE	9702	11295.6	1.1643	-0.01	-5647.8	0.17	0.68442

 The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		9684	11044.7	1.1405		-5522.4	
STATE	9677	10904.0	1.1268	1.20	-5452.0	140.72	0.00000
REGION	9683	10974.5	1.1334	0.63	-5487.3	70.19	0.00000
TEMP*TEMP	9683	11012.0	1.1373	0.29	-5506.0	32.68	0.00000
DOCKRECL	9683	11013.0	1.1374	0.28	-5506.5	31.67	0.00000
TEMP	9683	11013.7	1.1374	0.27	-5506.8	31.04	0.00000
MONTH	9681	11037.4	1.1401	0.03	-5518.7	7.28	0.06343
BOATTYPE	9683	11043.0	1.1405	0.00	-5521.5	1.68	0.19510
TOURNAMENT	9683	11044.5	1.1406	-0.01	-5522.3	0.16	0.69357

 The explanatory factors in the base model are: YEAR STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE		9677	10904.0	1.1268		-5452.0	
DOCKRECL	9676	10870.5	1.1234	0.30	-5435.2	33.51	0.00000
TEMP*TEMP	9676	10876.6	1.1241	0.24	-5438.3	27.40	0.00000
TEMP	9676	10876.7	1.1241	0.24	-5438.3	27.33	0.00000
MONTH	9674	10877.0	1.1244	0.22	-5438.5	26.93	0.00001
BOATTYPE	9676	10902.1	1.1267	0.01	-5451.0	1.90	0.16790
REGION	9677	10904.0	1.1268	0.00	-5452.0	0.00	.
TOURNAMENT	9676	10904.0	1.1269	-0.01	-5452.0	0.02	0.87927

FINAL MODEL: SUCCESS= YEAR + STATE %REDUCTION: percent difference in deviance/df between the newly included factor and the previous factor entered into the model; LOGLIKE: log likelihood; CHISQ: Pearson Chi-square statistic; PROBCHISQ: significance level of the Chi-square statistic.

Table 7. Results of the stepwise procedure to develop the positive catch rate model for mako sharks (*Isurus* sp).

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*****
                          There are no explanatory factors in the base model.
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2607	1756.8	0.6739		-2459.0		
YEAR	2588	1683.0	0.6503	3.50	-2422.1	73.81	0.00000
STATE	2600	1693.9	0.6515	3.32	-2427.5	62.92	0.00000
MONTH	2604	1740.5	0.6684	0.81	-2450.9	16.26	0.00100
BOATTYPE	2606	1746.4	0.6701	0.55	-2453.8	10.40	0.00126
TOURNAMENT	2606	1754.8	0.6734	0.07	-2458.0	1.95	0.16226
DOCKRECL	2606	1755.7	0.6737	0.02	-2458.5	1.10	0.29357
REGION	2606	1756.0	0.6738	0.01	-2458.6	0.80	0.37236

```

*****
                          The explanatory factors in the base model are: YEAR
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2588	1683.0	0.6503		-2422.1		
STATE	2581	1638.8	0.6349	2.36	-2400.0	44.19	0.00000
MONTH	2585	1664.0	0.6437	1.01	-2412.6	18.99	0.00028
TOURNAMENT	2587	1678.9	0.6490	0.20	-2420.1	4.05	0.04416
BOATTYPE	2587	1679.1	0.6491	0.19	-2420.2	3.88	0.04889
DOCKRECL	2587	1682.3	0.6503	0.00	-2421.8	0.68	0.40794
REGION	2587	1682.6	0.6504	-0.02	-2421.9	0.35	0.55555

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*****
                          The explanatory factors in the base model are: YEAR STATE
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2581	1638.8	0.6349		-2400.0		
MONTH	2578	1624.8	0.6303	0.74	-2393.0	13.95	0.00297
TOURNAMENT	2580	1634.1	0.6334	0.25	-2397.7	4.68	0.03048
BOATTYPE	2580	1636.2	0.6342	0.12	-2398.7	2.56	0.10982
REGION	2581	1638.8	0.6349	0.00	-2400.0	0.00	.
DOCKRECL	2580	1638.5	0.6351	-0.02	-2399.9	0.30	0.58165

```

*****
                          The explanatory factors in the base model are: YEAR STATE MONTH STATE*MONTH
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2561	1568.3	0.6124		-2364.7		
STATE*TOURNAMENT	2553	1534.0	0.6009	1.88	-2347.6	34.25	0.00004
STATE*BOATTYPE	2553	1543.9	0.6047	1.25	-2352.6	24.39	0.00197
STATE*DOCKRECL	2553	1544.5	0.6050	1.21	-2352.9	23.77	0.00250
STATE*TEMP	2553	1546.3	0.6057	1.10	-2353.7	22.03	0.00487
STATE*(TEMP*TEMP)	2553	1546.3	0.6057	1.10	-2353.7	22.03	0.00487
MONTH*TEMP	2557	1563.6	0.6115	0.14	-2362.4	4.67	0.32271

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*****
                          The explanatory factors in the base model are: YEAR STATE MONTH STATE*MONTH TOURNAMENT
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2560	1564.9	0.6113		-2363.1		
STATE*TOURNAMENT	2553	1534.0	0.6009	1.70	-2347.6	30.88	0.00007
STATE*BOATTYPE	2552	1540.2	0.6035	1.27	-2350.7	24.70	0.00175
STATE*DOCKRECL	2552	1542.2	0.6043	1.14	-2351.7	22.69	0.00379
STATE*TEMP	2552	1542.9	0.6046	1.09	-2352.1	21.96	0.00498
STATE*(TEMP*TEMP)	2552	1542.9	0.6046	1.09	-2352.1	21.96	0.00498
MONTH*TEMP	2556	1560.2	0.6104	0.14	-2360.7	4.66	0.32382

```

*****
                          The explanatory factors in the base model are: YEAR STATE MONTH STATE*MONTH TOURNAMENT STATE*TOURNAMENT
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2553	1534.0	0.6009		-2347.6		
STATE*BOATTYPE	2545	1510.4	0.5935	1.23	-2335.8	23.60	0.00267
STATE*TEMP	2545	1516.8	0.5960	0.81	-2339.0	17.24	0.02774
STATE*(TEMP*TEMP)	2545	1516.8	0.5960	0.81	-2339.0	17.24	0.02774
STATE*DOCKRECL	2545	1525.1	0.5992	0.27	-2343.1	8.97	0.34492
MONTH*TEMP	2549	1530.0	0.6002	0.11	-2345.6	4.02	0.40386

```

*****
                          The explanatory factors in the base model are: YEAR STATE MONTH STATE*MONTH TOURNAMENT STATE*TOURNAMENT BOATTYPE
*****

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FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2552	1533.1	0.6008		-2347.2		
STATE*BOATTYPE	2545	1510.4	0.5935	1.21	-2335.8	22.72	0.00191
STATE*TEMP	2544	1515.9	0.5959	0.81	-2338.6	17.26	0.02755
STATE*(TEMP*TEMP)	2544	1515.9	0.5959	0.81	-2338.6	17.26	0.02755
STATE*DOCKRECL	2544	1523.9	0.5990	0.29	-2342.6	9.26	0.32076
MONTH*TEMP	2548	1529.1	0.6001	0.11	-2345.2	4.05	0.39981

FINAL MODEL: Mako Sharks (Kept+Released)
 =YEAR+STATE+MONTH+STATE*MONTH+TOURNAMENT+STATE*TOURNAMENT+BOATTYPE+STATE*BOATTYPE
 %REDUCTION: percent difference in deviance/df between the newly included factor and the previous factor entered into the model; LOGLIKE: log likelihood; CHISQ: Pearson Chi-square statistic; PROBCHISQ: significance level of the Chi-square statistic.

Table 8. Results of the mako shark (*Isurus sp*) analysis (1986-2002). Lo method with binomial error assumption for proportion positives.

Class	Level s	Values								
YEAR	20	1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005								
STATE	8	CT DE MA MD NJ NY RI VA								
Number of Observations Read							9704			
Number of Observations Used							9704			
Number of Observations Not Used							0			
CovP1	Variance	Res Log Like		-2 Res Log Like						
1.0045	1.0045	-22023.4591		44046.9182						
		-2 Res Log Likelihood		44046.9						
		AIC (smaller is better)		44048.9						
		AICC (smaller is better)		44048.9						
		BIC (smaller is better)		44056.1						
		Information Criteria								
Neg2LogLike	Parms	AIC	AICC	HQIC	BIC	CAIC				
44046.9	1	44048.9	44048.9	44051.4	44056.1	44057.1				
Solution for Fixed Effects										
Standard										
Effect	STATE	YEAR	Estimate	Error	DF	t Value	Pr > t	Alpha	Lower	Upper
Intercept			-1.2331	0.2844	9677	-4.34	<.0001	0.05	-1.7905	-0.6757
YEAR		1986	0.4700	0.1311	9677	3.58	0.0003	0.05	0.2129	0.7270
YEAR		1987	0.06010	0.1335	9677	0.45	0.6525	0.05	-0.2015	0.3217
YEAR		1988	-0.2812	0.1725	9677	-1.63	0.1032	0.05	-0.6194	0.05699
YEAR		1989	-0.2535	0.1444	9677	-1.76	0.0792	0.05	-0.5366	0.02957
YEAR		1990	-0.2616	0.1385	9677	-1.89	0.0589	0.05	-0.5331	0.009867
YEAR		1991	-0.1962	0.1398	9677	-1.40	0.1607	0.05	-0.4703	0.07796
YEAR		1992	-0.01148	0.1409	9677	-0.08	0.9351	0.05	-0.2877	0.2648
YEAR		1993	0.07226	0.1618	9677	0.45	0.6552	0.05	-0.2449	0.3894
YEAR		1994	0.05614	0.1684	9677	0.33	0.7389	0.05	-0.2740	0.3863
YEAR		1995	0.2868	0.1580	9677	1.81	0.0697	0.05	-0.02305	0.5966
YEAR		1996	0.2694	0.1968	9677	1.37	0.1711	0.05	-0.1164	0.6551
YEAR		1997	0.2089	0.1705	9677	1.22	0.2206	0.05	-0.1254	0.5432
YEAR		1998	0.6616	0.2108	9677	3.14	0.0017	0.05	0.2484	1.0749
YEAR		1999	0.9418	0.2199	9677	4.28	<.0001	0.05	0.5107	1.3728
YEAR		2000	0.3901	0.1850	9677	2.11	0.0350	0.05	0.02754	0.7527
YEAR		2001	0.4656	0.2071	9677	2.25	0.0246	0.05	0.05966	0.8715
YEAR		2002	0.6419	0.1986	9677	3.23	0.0012	0.05	0.2525	1.0313
YEAR		2003	0.3032	0.1441	9677	2.10	0.0354	0.05	0.02077	0.5857
YEAR		2004	0.9385	0.1411	9677	6.65	<.0001	0.05	0.6619	1.2151
YEAR		2005	0							
STATE	CT		-0.3085	0.3193	9677	-0.97	0.3340	0.05	-0.9343	0.3174
STATE	DE		0.1286	0.2897	9677	0.44	0.6572	0.05	-0.4393	0.6965
STATE	MA		-0.5224	0.3031	9677	-1.72	0.0849	0.05	-1.1166	0.07182
STATE	MD		0.4818	0.2686	9677	1.79	0.0730	0.05	-0.04484	1.0084
STATE	NJ		0.2581	0.2651	9677	0.97	0.3303	0.05	-0.2616	0.7778
STATE	NY		0.03270	0.2635	9677	0.12	0.9013	0.05	-0.4839	0.5493
STATE	RI		-0.6628	0.2785	9677	-2.38	0.0173	0.05	-1.2087	-0.1170
STATE	VA		0							
Type 3 Tests of Fixed Effects										
Effect	Num	Den	Chi-Square	F Value	Pr > Chi Sq	Pr > F				
YEAR	19	9677	216.27	11.38	<.0001	<.0001				
STATE	7	9677	129.46	18.49	<.0001	<.0001				
Deviance				10903.9786						
Scaled Deviance				10855.6039						
Pearson Chi-Square				9720.1226						
Scaled Pearson Chi-Square				9677.0000						
Extra-Dispersion Scale				1.0045						

Table 9. Results of the mako shark (*Isurus sp*) analysis (1986-2002). Lo method with Poisson error assumption for positive catch trips.

Class	Level s	Val ues	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
STATE		8	CT	DE	MA	MD	NJ	NY	RI	VA													
MONTH		4	6	7	8	9																	
tournament		2	N	Y																			
BOATYPE		2	CHARTER	PRI	VATE																		
			Number of Observations Read																	2608			
			Number of Observations Used																	2608			
			Number of Observations Not Used																	0			
CovP1	Variance		Res Log Li ke																	-2			
0.9862	0.9862		-3324.9958																	6649.9916			
Fit Statistics																							
-2 Res Log Likelihood																							6650.0
AIC (smaller is better)																							6652.0
AICC (smaller is better)																							6652.0
BIC (smaller is better)																							6657.8
Solution for Fixed Effects																							
Effect	STATE	tournament	YEAR	MONTH	BOATYPE	Estimate	Error	DF	t Value	Pr > t	Al pha	Lower	Upper										
Intercept						-3.0829	1.1130	2545	-2.77	0.0056	0.05	-5.2653	-0.9004										
YEAR			1986			-0.1505	0.09698	2545	-1.55	0.1209	0.05	-0.3406	0.03970										
YEAR			1987			0.001752	0.09921	2545	0.02	0.9859	0.05	-0.1928	0.1963										
YEAR			1988			-0.3163	0.1440	2545	-2.20	0.0281	0.05	-0.5986	-0.03399										
YEAR			1989			-0.1304	0.1119	2545	-1.17	0.2441	0.05	-0.3499	0.08907										
YEAR			1990			-0.1144	0.1049	2545	-1.09	0.2756	0.05	-0.3200	0.09130										
YEAR			1991			-0.1891	0.1077	2545	-1.76	0.0793	0.05	-0.4002	0.02211										
YEAR			1992			-0.1495	0.1062	2545	-1.41	0.1593	0.05	-0.3578	0.05876										
YEAR			1993			-0.04421	0.1143	2545	-0.39	0.6990	0.05	-0.2684	0.1799										
YEAR			1994			-0.1284	0.1246	2545	-1.03	0.3028	0.05	-0.3728	0.1159										
YEAR			1995			0.1598	0.1082	2545	1.48	0.1397	0.05	-0.05230	0.3719										
YEAR			1996			-0.1773	0.1447	2545	-1.23	0.2205	0.05	-0.4610	0.1064										
YEAR			1997			-0.02736	0.1259	2545	-0.22	0.8279	0.05	-0.2742	0.2195										
YEAR			1998			0.06197	0.1388	2545	0.45	0.6552	0.05	-0.2101	0.3341										
YEAR			1999			0.2922	0.1309	2545	2.23	0.0257	0.05	0.03541	0.5489										
YEAR			2000			0.08163	0.1254	2545	0.65	0.5152	0.05	-0.1643	0.3276										
YEAR			2001			0.1404	0.1357	2545	1.03	0.3008	0.05	-0.1257	0.4065										
YEAR			2002			0.1980	0.1320	2545	1.50	0.1336	0.05	-0.06077	0.4569										
YEAR			2003			-0.01000	0.1043	2545	-0.10	0.9237	0.05	-0.2145	0.1945										
YEAR			2004			0.1724	0.09458	2545	1.82	0.0685	0.05	-0.01311	0.3578										
YEAR			2005			0	0	2545	0	1.0000	0.05												
STATE	CT					0.5509	1.2822	2545	0.43	0.6675	0.05	-1.9635	3.0652										
STATE	DE					3.5805	1.2064	2545	2.97	0.0030	0.05	-1.2150	5.9461										
STATE	MA					1.5145	1.1953	2545	1.27	0.2052	0.05	-0.8293	3.8583										
STATE	MD					1.2799	1.2215	2545	1.05	0.2948	0.05	-1.1154	3.6752										
STATE	NJ					1.4718	1.1398	2545	1.29	0.1967	0.05	-0.7633	3.7068										
STATE	NY					1.3924	1.1167	2545	1.25	0.2126	0.05	-0.7974	3.5821										
STATE	RI					1.4841	1.1671	2545	1.27	0.2036	0.05	-0.8045	3.7727										
STATE	VA					0	0	2545	0	1.0000	0.05												
MONTH				6		0.8951	1.0395	2545	0.86	0.3893	0.05	-1.1433	2.9334										
MONTH				7		0.6344	1.1016	2545	0.58	0.5647	0.05	-1.5256	2.7945										
MONTH				8		0.04166	0.3543	2545	0.12	0.9064	0.05	-0.6530	0.7363										
MONTH				9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	CT			6		-0.7897	1.1960	2545	-0.66	0.5092	0.05	-3.1350	1.5556										
STATE*MONTH	CT			7		-0.5145	1.2121	2545	-0.42	0.6713	0.05	-2.8914	1.8624										
STATE*MONTH	CT			8		0.4794	0.6905	2545	0.69	0.4875	0.05	-0.8746	1.8334										
STATE*MONTH	CT			9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	DE			6		-2.3436	1.1259	2545	-2.08	0.0375	0.05	-4.5514	-0.1358										
STATE*MONTH	DE			7		-1.9635	1.2173	2545	-1.61	0.1069	0.05	-4.3505	0.4236										
STATE*MONTH	DE			8		0	0	2545	0	1.0000	0.05												
STATE*MONTH	MA			7		-1.2722	1.1734	2545	-1.08	0.2784	0.05	-3.5732	1.0288										
STATE*MONTH	MA			8		0	0	2545	0	1.0000	0.05												
STATE*MONTH	MD			6		-0.6098	1.1545	2545	-0.53	0.5974	0.05	-2.8736	1.6539										
STATE*MONTH	MD			7		-0.3029	1.2193	2545	-0.25	0.8038	0.05	-2.6938	2.0880										
STATE*MONTH	MD			8		0.2947	0.8410	2545	0.35	0.7260	0.05	-1.3543	1.9438										
STATE*MONTH	MD			9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	NJ			6		-0.8024	1.0716	2545	-0.75	0.4540	0.05	-2.9038	1.2989										
STATE*MONTH	NJ			7		-0.5254	1.1328	2545	-0.46	0.6428	0.05	-2.7468	1.6960										
STATE*MONTH	NJ			8		-0.07745	0.4848	2545	-0.16	0.8731	0.05	-1.0280	0.8731										
STATE*MONTH	NJ			9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	NY			6		-0.7301	1.0475	2545	-0.70	0.4859	0.05	-2.7841	1.3239										
STATE*MONTH	NY			7		-0.5553	1.1085	2545	-0.50	0.6164	0.05	-2.7289	1.6183										
STATE*MONTH	NY			8		0.08854	0.3733	2545	0.24	0.8125	0.05	-0.6435	0.8206										
STATE*MONTH	NY			9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	RI			6		-0.8155	1.1096	2545	-0.73	0.4624	0.05	-2.9912	1.3602										
STATE*MONTH	RI			7		-0.5026	1.1503	2545	-0.44	0.6622	0.05	-2.7581	1.7529										
STATE*MONTH	RI			8		0	0	2545	0	1.0000	0.05												
STATE*MONTH	RI			9		0	0	2545	0	1.0000	0.05												
STATE*MONTH	VA			6		0	0	2545	0	1.0000	0.05												
STATE*MONTH	VA			7		0	0	2545	0	1.0000	0.05												

Table 9 (cont.). Results of the mako shark (*Isurus sp*) analysis (1986-2002). Lo method with Poisson error assumption for positive catch trips.

Effect	STATE	tournament	YEAR	MONTH	BOATTYPE	Standard Estimate	Error	DF	t Value	Pr > t	Alpha	Lower
Upper												
STATE*MONTH	VA			9		0						
tournament		N				0.7292	0.4898	2545	1.49	0.1367	0.05	-0.2313
1.6897												
tournament		Y				0						
STATE*tournament	CT	N				-0.04009	0.6853	2545	-0.06	0.9534	0.05	-1.3839
1.3038												
STATE*tournament	CT	Y				0						
STATE*tournament	DE	N				-1.2622	0.5246	2545	-2.41	0.0162	0.05	-2.2908
0.2335												
STATE*tournament	DE	Y				0						
STATE*tournament	MA	N				0.08973	0.5277	2545	0.17	0.8650	0.05	-0.9451
1.1245												
STATE*tournament	MA	Y				0						
STATE*tournament	MD	N				-0.6321	0.4979	2545	-1.27	0.2044	0.05	-1.6086
0.3443												
STATE*tournament	MD	Y				0						
STATE*tournament	NJ	N				-0.7094	0.4939	2545	-1.44	0.1510	0.05	-1.6778
0.2590												
STATE*tournament	NJ	Y				0						
STATE*tournament	NY	N				-0.6275	0.4934	2545	-1.27	0.2036	0.05	-1.5950
0.3400												
STATE*tournament	NY	Y				0						
STATE*tournament	RI	N				-0.8020	0.5277	2545	-1.52	0.1287	0.05	-1.8368
0.2327												
STATE*tournament	RI	Y				0						
STATE*tournament	VA	N				0						
STATE*tournament	VA	Y				0						
BOATTYPE												
1.2424					CHARTER	0.5561	0.3500	2545	1.59	0.1122	0.05	-0.1302
BOATTYPE												
STATE*BOATTYPE	CT				PRI VATE	0						
0.4361					CHARTER	-0.5123	0.4837	2545	-1.06	0.2896	0.05	-1.4608
STATE*BOATTYPE	CT				PRI VATE	0						
STATE*BOATTYPE	DE				CHARTER	-0.7622	0.3859	2545	-1.97	0.0484	0.05	-1.5189
0.00543												
STATE*BOATTYPE	DE				PRI VATE	0						
STATE*BOATTYPE	MA				CHARTER	0.2214	0.4027	2545	0.55	0.5826	0.05	-0.5683
1.0111												
STATE*BOATTYPE	MA				PRI VATE	0						
STATE*BOATTYPE	MD				CHARTER	-0.5867	0.3592	2545	-1.63	0.1025	0.05	-1.2910
0.1176												
STATE*BOATTYPE	MD				PRI VATE	0						
STATE*BOATTYPE	NJ				CHARTER	-0.6040	0.3549	2545	-1.70	0.0889	0.05	-1.2999
0.09183												
STATE*BOATTYPE	NJ				PRI VATE	0						
STATE*BOATTYPE	NY				CHARTER	-0.4866	0.3537	2545	-1.38	0.1690	0.05	-1.1802
0.2069												
STATE*BOATTYPE	NY				PRI VATE	0						
STATE*BOATTYPE	RI				CHARTER	-0.4934	0.3882	2545	-1.27	0.2039	0.05	-1.2547
0.2679												
STATE*BOATTYPE	RI				PRI VATE	0						
STATE*BOATTYPE	VA				CHARTER	0						
STATE*BOATTYPE	VA				PRI VATE	0						

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	Chi-Square	F Value	Pr > Chi Sq	Pr > F
YEAR	19	2545	66.26	3.49	<.0001	<.0001
STATE	7	2545	31.94	4.56	<.0001	<.0001
MONTH	3	2545	6.98	2.33	0.0725	0.0728
STATE*MONTH	17	2545	47.06	2.77	0.0001	0.0001
tournament	1	2545	5.65	5.65	0.0174	0.0175
STATE*tournament	7	2545	30.46	4.35	<.0001	<.0001
BOATTYPE	1	2545	4.33	4.33	0.0375	0.0376
STATE*BOATTYPE	7	2545	21.10	3.01	0.0036	0.0037

Deviance 1510.4262
 Scaled Deviance 1531.6285
 Pearson Chi-Square 2509.7695
 Scaled Pearson Chi-Square 2545.0000
 Extra-Dispersion Scale 0.9862

Table 10. Relative Abundance Indices for mako sharks, Proportion Positive err. dist: binomial
Positive err. dist: Poisson.

<i>Year</i>	<i>Index</i>	<i>LCI</i>	<i>UCI</i>	<i>CV</i>
1986	0.964	0.671	1.257	0.155
1987	0.842	0.535	1.148	0.186
1988	0.470	0.017	0.923	0.492
1989	0.579	0.242	0.916	0.297
1990	0.584	0.287	0.881	0.259
1991	0.571	0.267	0.875	0.271
1992	0.686	0.358	1.013	0.244
1993	0.811	0.356	1.266	0.286
1994	0.737	0.248	1.225	0.338
1995	1.161	0.661	1.661	0.220
1996	0.819	0.171	1.467	0.404
1997	0.911	0.353	1.470	0.313
1998	1.347	0.515	2.179	0.315
1999	1.995	1.002	2.988	0.254
2000	1.153	0.491	1.814	0.293
2001	1.286	0.471	2.100	0.323
2002	1.525	0.691	2.358	0.279
2003	0.991	0.585	1.397	0.209
2004	1.767	1.328	2.205	0.127
2005	0.803	0.353	1.253	0.286

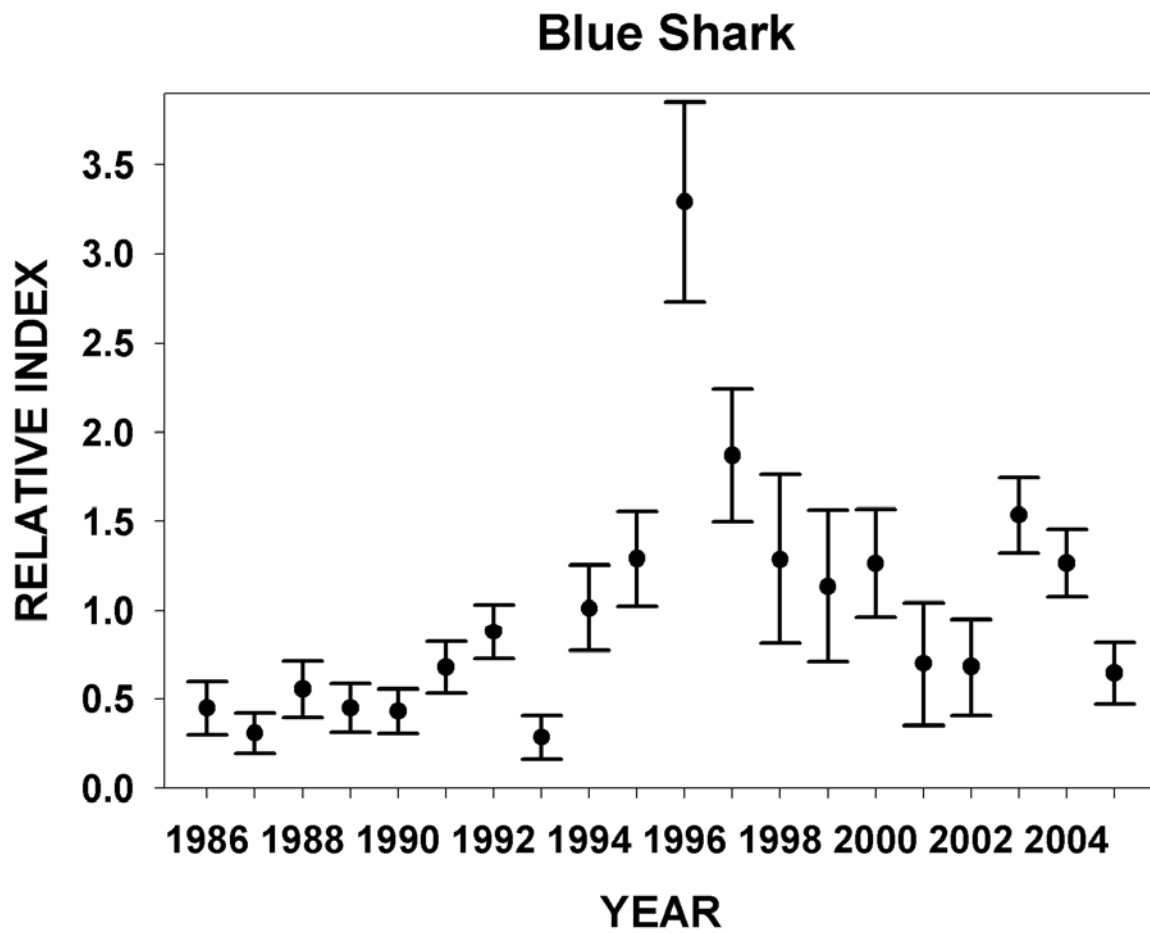


Figure 1. Relative abundance indices for BLUE SHARKS with approximate 95% confidence intervals. (Proportion Positive error distribution: binomial; Positive error distribution: Poisson).
 Model = STATE+YEAR+TEMP*TEMP (for proportion positive)
 Model = YEAR+STATE+MONTH+ STATE*MONTH (for positive catches)

Mako Shark

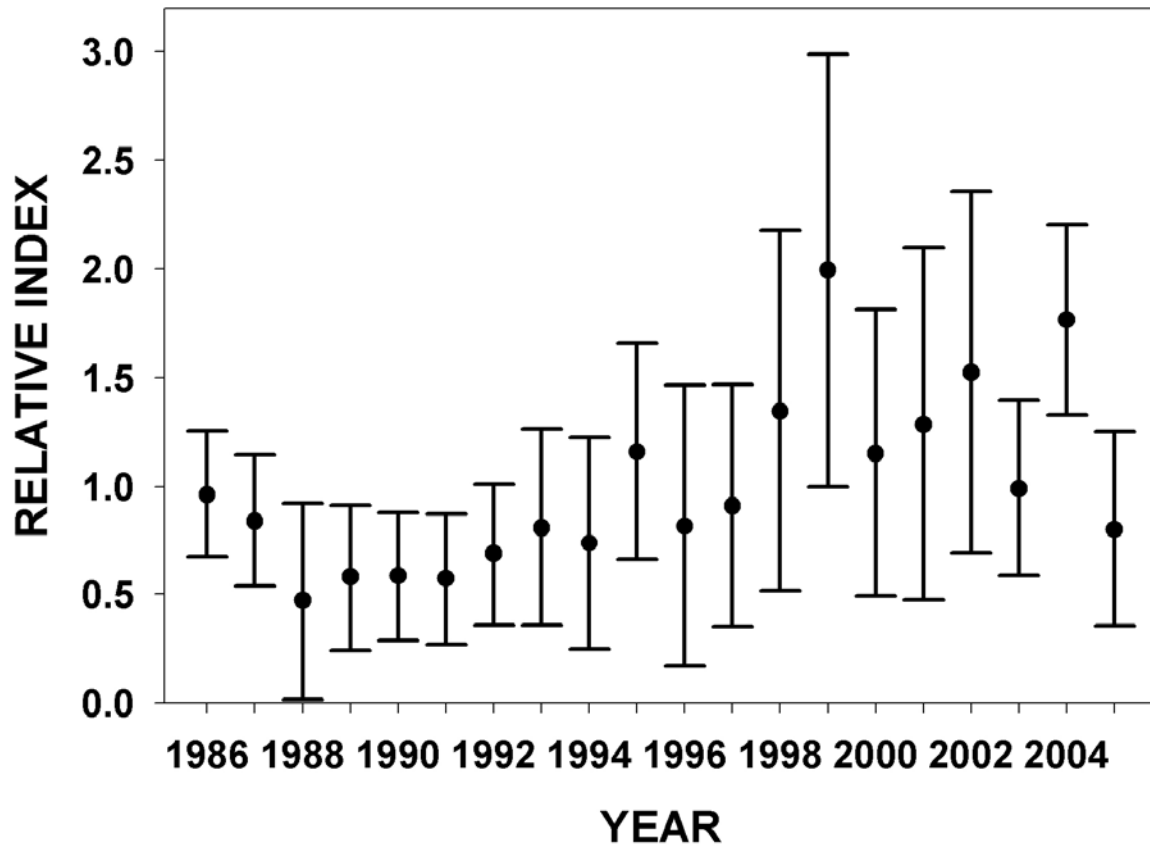


Figure 2. Relative abundance indices for MAKO SHARKS with approximate 95% confidence intervals. (Proportion Positive error distribution: binomial; Positive error distribution: Poisson).

Model = **YEAR+STATE** (for proportion positive)

Model = **YEAR+STATE+MONTH+STATE*MONTH+TOURNAMENT+STATE*TOURNAMENT+BOATTYPE+STATE*BOATTYPE** (for positive catches)