STANDARDIZED CATCH RATES FOR SWORDFISH *(XIPHIAS GLADIUS)* FROM THE U.S. LONGLINE FLEET THROUGH 1992

SCRS/1993/104

Col.Vol.Sci.Pap. ICCAT, 42 (1) : 303-308 (1994)

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SUMMARY

Swordfish catch, size and effort data collected from the U.S. longline fleet operating over the wide geographical range of the western north Atlantic Ocean were used to develop age-specific indices of abundance of north Atlantic swordfish. Standardized catch rates were estimated using the General Linear Modeling approach.

RESUME

Les données de prise, taille et effort de l'espadon de la flottille palangrière des Etats-Unis qui a pêché dans un vaste secteur géographique de l'océan Atlantique nord, ont été utilisées pour élaborer des indices d'abondance spécifiques de l'âge de l'espadon de l'Atlantique nord. Les taux de capture standardisés ont été estimés en utilisant la méthode du Modèle linéaire généralisé.

RESUMEN

Se utilizaron los datos de captura, talla y esfuerzo de pez espada, recolectados de la flota de palangre de Estados Unidos que faena en una amplia escala geográfica en el Océano Atlántico norte central para desarrollar índices de abundancia específicos de la edad para el pez espada del Atlántico norte. Se estimaron tasas de captura estandarizadas utilizando el enfoque del Modelo Lineal Generalizado.

Introduction

Information on the relative abundance of swordfish age classes is necessary to tune age-sequenced analyses (VPA). Data collected from the US longline fleet has been previously used to develop standardized catch per unit effort (CPUE) indices of abundance. This report documents the analytical methods applied to the available US longline fleet data through 1991 and presents age-specific, standardized CPUE indices for use in tuning swordfish VPAs, updating the material presented in Scott *et.al.* (1993) Swordfish catch, size and effort data collected from the US longline fleet operating over a wide geographical range of the western north Atlantic Ocean were used to develop age-specific indicies of abundance of north Atlantic swordfish. Standardized catch rates were estimated using the General Linear Modeling (GLM) approach. Several methods for ageing the catch were incorporated in the present analysis.

Methods

Hoey and Bertolino (1988) described the available catch and effort data for swordfish from the US longline fishery. Hoey *et. al.* (1989), Scott and Bertolino (1991) and Scott *et. al.* (1992) described the GLM method of analysis employed for indexing swordfish abundance from those data. The present analysis is an application of the GLM techniques to updated catch and effort data (through 1991) from the US longline fleet. Age-specific indices of abundance (ages 1, 2, 3, 4, and 5^+ groupings) are developed after ageing the swordfish catch using the age slicing method applying the ICCAT Gompertz growth model for pooled sexes in the fashion described by Nelson *et. al.* (1990) and as used by the 1992 SCRS swordfish species group. Alternative methods could be employed, but the purpose of this paper is to present the abundance index information in a fashion that is consistent with previous studies and to allow some evaluation of the most recent catch rate data in view of recent regulatory measures.

For the present analysis, the analytical data base on US longline catch and effort for 1981 through 1992 was reviewed and updated based on fishermen's reports and/or interviews received since the previous update. A total of 4123 vessel trips, representing 123 different vessels from which at least two years catch and effort observations were available were used for analysis (Table 1). This represents an additional 603 observations compared to the 1992 analysis (Scott *et.al.* 1993). As described in Hoey *et.al.* (1989), Nelson *et.al.* (1990), Scott and Bertolino (1991), and Scott *et.al.* (1992, 1993), the available catch and effort data were cross classified by year, calendar quarter, area of fishing, size of set, proportion of total catch comprised of swordfish, operation style, and age class. Nominal CPUE values were calculated as fish caught per thousand hooks set. Average nominal values from the updated data set by year, age, and fishing area, are shown in Table 2.

Implementation of new US regulations, which are in conformity with the ICCAT recommendations for conservation of swordfish and limit the allowable landings of swordfish by US fishermen, resulted in changes in both the type of data obtained and the manner in which the US data are obtained for analysis. Three regulatory effects in particular, are of importance to the present analysis. The first is implementation of the ICCAT recommended minimum size of 25 kg whole weight. The second is implementation of additional reporting requirements wherein US fishermen are required to report both their daily fishing effort and the individual sizes for all swordfish landed. Prior to implementation of these regulations, reporting of fish sizes was voluntary and incomplete for many vessels. The third is a restriction on the total allowable harvest level by US fishermen in 1991 and 1992 (4,173 mt in 1991 and 4,561 mt in 1992).

Seven geographical areas of fishing were used for classification as defined in Hoey *et.al.* (1990), Scott and Bertolino (1991) and Scott *et.al.* (1992, 1993). The areas used for classification were: Caribbean (CAR), Gulf of Mexico (GOM), Florida east coast (FEC), South Atlantic Bight (SAB), mid-Atlantic Bight (MAB), New England coastal (NEC) and northeast distant waters (NED). Four set size classifiers were used: 1, <100 hooks/set; 2, 100-299 hooks/set; 3, 300-499 hooks/set; and 4, ≥ 500 hooks/set. Set size was assumed to control for changes in gear deployment hypothesized to affect CPUE. The levels used in classification approximated the quartiles in the data set. Four levels of the proportion swordfish in the total catch were used corresponding to the quartiles into which the proportion of swordfish fell (*i.e.* $\leq 25\%$, >25-$\leq 50\%$, >50-$\leq 75\%$, and $>75\%$). The percentage swordfish classifier was assumed to control for effects on swordfish CPUE through the diversification of the US longline fleet into a mixed species fishery and associated targeting on different species.

Nominal CPUE data were normalized through the natural log transform. Based on the results of Scott *et.al.* (1992) and the recommendation of the 1991 SCRS (SCRS Swordfish Assessment Group 1992), zero CPUE information was incorporated into the analysis by adding the zero CPUE effort uniformly across all other observations in the same analytical stratum. No specific classification variables were used which might control for regulatory effects.

Based on the 1991 SCRS recommendations (SCRS Swordfish Assessment Group, 1992), and those of Scott *et.al.* (1992) only models were fit to the data for which Least Square Means (LSM) for each year effect were estimable. In this analysis, due to the nature of the missing information, only main effect models resulted in estimable year effect LSMs. The final models fit to the CPUE data included main effects for year, calendar quarter, area, set size, operation style, and proportion swordfish. Standards were defined as the earliest year, and the highest classification level for all other main effects. Standardized residuals for each level of the year main effect were tested against a normal distribution null hypothesis using the Shapiro-Wilk statistic (Royston, 1982) and examined for trend.

Results and Discussion

Analysis of variance (ANOVA) results for the models fit to the CPUE data are shown in Tables 3 through 7. In all cases, the resulting F-statistic was highly significant. For the age-slicing method the main effect models fit explained between 40 and 56% of the variability in the observed data, depending on the age grouping modelled.

Indices of age-specific abundance, based on the yearly LSM estimates from the models fit are also presented in Tables 3 through 7 along with their 95% confidence regions (back transformed to arithmetic scale including the logrithmic bias correction). Graphically, these data are presented in Figures 1-5. As observed in prior GLM analyses of these data, the LSM estimates are sufficiently precise to allow discrimination of trend in the data for some ages.

The landed catch rates for fish smaller than the ICCAT minimum size (generally fish aged 2 or younger) were, in 1992, much reduced compared to levels estimated for years prior to the minimum size regulations. Actual catch rates are not estimable from these data, but observer data (SCRS/93/103) show that the actual catch rates are considerably higher than the landed catch rate data would indicate. For fish larger than the minimum size, the model estimated mean CPUE values for 1992 are higher

than the estimated levels for 1992. This result is significant at the 0.05 level for both the age 4 and age 5+ analyses. Although this result could be due to increases in abundance of ages 3-5+, it might also have resulted from an analytically uncontrolled effect on catchability for larger fish in response to regulations implemented in 1991.

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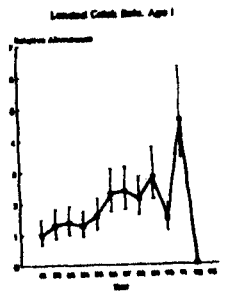

Figure 1. Standardized catch rates for age 1.

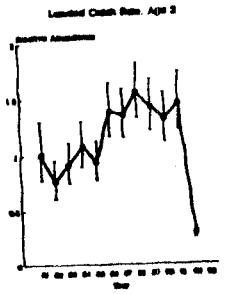

Fig 2. Standardized catch rates for age 2.

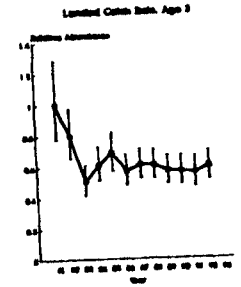

Fig 3. Standardized catch rates for age 3.

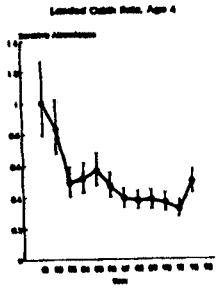

Figure 4. Standardized catch rates for age 4 swordfish using data through 1992 for the 1991 SCRS method of ageing. 95% confidence regions are indicated (bars).

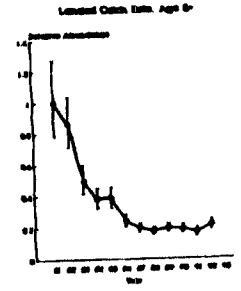

Figure 5. Standardized catch rates for age 5+ swordfish from data through 1992, using the 1991 SCRS method o ageing. 95% confidence regions are indicated (bars).

Table 1. Trip data with swordfish size, catch, and effort information available for analysis from the US longline fleet, 1981-1991.

	Year												
AREA	81	82	83	84	85	86	87	88	89	90	91	92	Total
CAR	0	0	0	0	10	39	88	150	63	49	59	51	517
GOM	0	1	7	5	36	39	75	64	78	58	48	81	492
FEC	26	28	26	76	60	100	278	361	208	136	181	250	1730
SAB	3	10	18	4	4	18	31	55	28	52	21	62	306
MAB	9	43	57	51	31	67	99	44	34	63	77	82	657
NEC	2	13	18	18	12	15	28	5	10	12	4	45	182
MED	3	6	9	13	19	18	27	41	30	23	26	32	247
Total	43	101	135	167	172	296	626	720	451	393	416	603	4123

Table 2. Nominal average swordfish CPUE (fish/1000 hooks) by area and age based on the SCRS 1991 ageing method from the US Longline fishery.

		Age				
AREA	YR	1	2	3	4	5+
CAR	85	2.41	3.80	10.06	9.08	9.06
CAR	86	4.29	11.12	13.79	12.79	8.87
CAR	87	5.22	7.86	9.72	6.32	5.97
CAR	88	4.32	10.31	9.58	4.68	4.25
CAR	89	2.12	7.35	9.79	6.13	6.10
CAR	90	2.16	6.23	7.05	4.62	4.92
CAR	91	2.87	8.24	9.92	5.84	6.22
CAR	92	0.01	1.11	4.92	5.64	7.25
GOM	82	4.91	8.60	3.69	1.23	6.14
GOM	83	7.25	13.67	9.24	5.45	5.44
GOM	84	9.05	18.73	6.65	3.25	3.35
GOM	85	5.46	5.66	3.84	1.72	1.75
GOM	86	5.84	2.84	0.96	0.56	0.39
GOM	87	1.06	2.34	0.97	0.32	0.59
GOM	88	2.91	4.15	2.03	1.23	1.09
GOM	89	6.43	7.88	3.52	1.53	2.24
GOM	90	3.62	6.68	3.54	1.49	1.81
GOM	91	2.08	2.55	1.98	1.20	0.93
GOM	92	0.01	0.77	2.32	1.15	1.06
FEC	81	6.23	8.19	8.16	4.48	12.21
FEC	82	1.64	6.85	10.02	7.43	14.30
FEC	83	3.80	4.49	7.32	3.52	7.11
FEC	84	5.17	8.10	5.41	2.67	4.63
FEC	85	3.28	5.71	6.33	3.03	5.61
FEC	86	11.74	9.41	4.50	1.91	2.45
FEC	87	8.53	10.54	5.76	2.14	2.68
FEC	88	6.57	11.18	6.33	2.36	2.60
FEC	89	7.34	10.01	5.48	2.11	3.08
FEC	90	7.30	11.07	5.67	2.02	2.43
FEC	91	5.58	10.96	6.23	2.30	2.79
FEC	92	0.09	3.25	7.83	3.52	3.52
SAB	81	12.36	42.39	33.62	5.73	15.17
SAB	82	10.78	18.03	9.10	5.18	10.22
SAB	83	16.08	18.24	7.44	2.33	9.74
SAB	84	4.51	10.24	6.11	2.97	3.76
SAB	85	20.10	18.61	10.14	3.06	4.43
SAB	86	27.11	20.58	5.11	1.18	1.11
SAB	87	23.90	33.87	8.63	2.29	1.42
SAB	88	10.73	20.04	8.53	2.76	1.59
SAB	89	8.72	15.18	4.78	1.20	1.09
SAB	90	7.47	16.94	6.41	1.55	1.85
SAB	91	2.55	16.23	6.18	2.06	1.46
SAB	92	0.00	4.28	14.61	4.90	1.96
MAB	81	6.75	13.57	18.53	7.97	14.98
MAB	82	16.44	8.02	6.85	4.62	12.66
MAB	83	9.88	10.15	4.12	2.37	5.31
MAB	84	5.26	7.19	4.44	2.35	3.76
MAB	85	13.51	6.85	4.85	2.62	5.21
MAB	86	8.37	10.63	4.39	1.78	2.47
MAB	87	5.98	6.26	3.87	1.80	2.23
MAB	88	5.01	5.39	2.78	1.31	1.50
MAB	89	4.13	4.11	2.31	1.30	1.34
MAB	90	4.12	3.96	2.03	0.99	1.55
MAB	91	4.72	4.05	2.68	1.19	2.54
MAB	92	0.03	0.49	1.22	0.63	0.93
NEC	81	2.44	3.49	2.57	1.76	2.69
NEC	82	7.63	4.02	6.71	5.42	6.37
NEC	83	3.83	4.89	2.49	2.39	4.43
NEC	84	2.29	6.57	6.67	4.83	7.60
NEC	85	5.59	7.24	7.80	4.57	5.25
NEC	86	4.66	9.13	5.03	3.40	3.18
NEC	87	5.26	5.30	4.33	2.14	2.83
NEC	88	0.92	5.36	3.04	1.73	1.40
NEC	89	10.06	8.58	3.44	1.85	2.30
NEC	90	3.87	6.11	4.11	1.65	1.78
NEC	91	2.11	7.96	8.85	5.41	5.48
NEC	92	0.00	0.42	1.62	0.64	1.04
MED	81	0.06	0.59	2.59	2.97	4.56
MED	82	0.17	2.08	6.35	5.67	6.21
MED	83	0.51	2.34	5.68	7.10	9.32
MED	84	1.44	8.38	12.46	9.88	11.26
MED	85	2.71	14.72	26.21	19.81	16.60
MED	86	3.82	12.51	11.82	9.62	9.48
MED	87	6.93	10.53	10.92	5.82	7.45
MED	88	5.10	21.55	13.45	6.88	5.91
MED	89	6.36	15.57	13.19	5.17	4.28
MED	90	2.27	15.65	14.77	6.63	4.28
MED	91	6.01	14.60	13.60	8.02	8.14
MED	92	0.01	2.65	9.94	7.12	5.99

Table 3. ANOVA results for US longline swordfish CPUE, age 1.

Dependent Variable: Log(age 1 catch/1000 Hooks)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	3086.42403681	96.45075115	113.19	0.0
Error	2620	2232.62186348	0.85214575		
Corrected Total	2652	5319.04590029			

R-Square	C.V.	Root MSE	T2CPU1 Mean
0.580259	74.85060	0.92311741	1.23327991

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	11	393.33526626	35.75775148	41.96	0.0001
QTR	3	1737.53420178	579.17806726	679.67	0.0
AREA	6	113.22516900	18.87086150	22.15	0.0001
OP	6	126.94775109	21.15795851	24.83	0.0001
SIZE	3	83.42565442	27.80855147	32.63	0.0001
TARG	3	235.61992656	78.53997552	92.17	0.0001

Pr > |T| HO: LSMEAN(year I)=LSMEAN(year J)

I/J	82	83	84	85	86	87	88	89	90	91	92
81	0.2347	0.0923	0.1885	0.0118	0.0001	0.0001	0.0001	0.0001	0.0201	0.0001	0.0001
82	.	0.5837	0.9724	0.1108	0.0001	0.0001	0.0001	0.0001	0.1931	0.0001	0.0001
83		.	0.5465	0.2333	0.0001	0.0001	0.0001	0.0001	0.4077	0.0001	0.0001
84			.	0.0551	0.0001	0.0001	0.0001	0.0001	0.1038	0.0001	0.0001
85				.	0.0001	0.0001	0.0009	0.0001	0.5691	0.0001	0.0001
86					.	0.6675	0.2690	0.0065	0.0001	0.0001	0.0001
87						.	0.0646	0.0070	0.0001	0.0001	0.0001
88							.	0.0001	0.0001	0.0001	0.0001
89								.	0.0001	0.0001	0.0001
90									.	0.0001	0.0001
91										.	0.0001

YR	LSMEAN	STDERR	U95%	CPUE	L95%
81	0.01299	0.20867	1.55854	1.03537	0.68782
82	0.25874	0.18287	1.88491	1.31713	0.92038
83	0.34019	0.16722	1.97767	1.42500	1.02678
84	0.26378	0.16231	1.81318	1.31910	0.95965
85	0.48809	0.15873	2.25196	1.64985	1.20873
86	0.86322	0.14912	3.21111	2.39729	1.78973
87	0.89365	0.14369	3.27268	2.46939	1.86327
88	0.78596	0.14364	2.93823	2.21726	1.67320
89	1.06818	0.14358	3.89587	2.94024	2.21902
90	0.43289	0.14752	2.08112	1.55857	1.16723
91	1.55395	0.15552	6.49397	4.78767	3.52971
92	-3.15487	0.31230	0.08258	0.04478	0.02428

Table 4. ANOVA results for US longline swordfish CPUE, age 2.

Dependent Variable: Log(age 2 catch/1000 Hooks)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	2938.43700737	91.82615648	164.96	0.0
Error	3485	1939.95233897	0.55665777		
Corrected Total	3517	4878.38934634			
	R-Square	C.V.	Root MSE		T2CPU2 Mean
	0.602338	42.68984	0.74609502		1.74771106

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	11	728.79485437	66.25407767	119.02	0.0001
QTR	3	109.37015563	36.45671854	65.49	0.0001
AREA	6	114.14669379	19.02444897	34.18	0.0001
OP	6	112.46005097	18.74334183	33.67	0.0001
SIZE	3	90.92869968	30.30956656	54.45	0.0001
TARG	3	497.06727090	165.68909030	297.65	0.0001

Pr > |T| HO: LSMEAN(year i)=LSMEAN(year j)

i/j	82	83	84	85	86	87	88	89	90	91	92
81	0.0811	0.5334	0.5885	0.6536	0.0163	0.0217	0.0007	0.0082	0.0404	0.0070	0.0001
82	.	0.1009	0.0010	0.0521	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
83		.	0.0651	0.7687	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
84			.	0.0963	0.0009	0.0008	0.0001	0.0001	0.0058	0.0002	0.0001
85				.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
86					.	0.6736	0.0282	0.6375	0.3990	0.4751	0.0001
87						.	0.0008	0.2911	0.5825	0.2274	0.0001
88							.	0.0491	0.0005	0.2459	0.0001
89								.	0.1414	0.7201	0.0001
90									.	0.1199	0.0001
91										.	0.0001

YR	LSMEAN	STDERR	U95%	CPUE	L95%
81	1.18797	0.13225	4.28849	3.30924	2.55359
82	0.92126	0.11509	3.16911	2.52914	2.01841
83	1.09813	0.10193	3.68074	3.01417	2.46831
84	1.26398	0.09624	4.29407	3.55590	2.94462
85	1.12480	0.09578	3.73264	3.09375	2.56421
86	1.51470	0.08779	5.42287	4.56560	3.84385
87	1.49166	0.08105	5.22684	4.45907	3.80409
88	1.63348	0.08098	6.02232	5.13848	4.38436
89	1.54221	0.08291	5.51874	4.69100	3.98741
90	1.46419	0.08456	5.12177	4.33953	3.67676
91	1.56461	0.09135	5.74217	4.80080	4.01376
92	-0.06651	0.08573	1.11093	0.93910	0.79384

Table 5. ANOVA results for US longline swordfish CPUE, age 3.

Dependent Variable: Log(age 3 catch/1000 Hooks)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	2117.58057772	66.17439305	144.37	0.0
Error	3513	1610.22670658	0.45836228		
Corrected Total	3545	3727.80728430			
	R-Square	C.V.	Root MSE		T2CPU3 Mean
	0.568050	44.37423	0.67702458		1.52571555

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	11	24.58655979	2.23514180	4.88	0.0001
QTR	3	52.02268000	17.34089333	37.83	0.0001
AREA	6	227.35511306	37.89251884	82.67	0.0001
OP	6	71.10391580	11.85065263	25.85	0.0001
SIZE	3	64.04838298	21.34946099	46.58	0.0001
TARG	3	415.12589194	138.37529731	301.89	0.0001

Pr > |T| HO: LSMEAN(year i)=LSMEAN(year j)

i/j	82	83	84	85	86	87	88	89	90	91	92
81	0.1040	0.0001	0.0001	0.0038	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
82	.	0.0001	0.0038	0.1044	0.0001	0.0013	0.0009	0.0001	0.0001	0.0001	0.0005
83		.	0.0241	0.0003	0.1091	0.0074	0.0106	0.0981	0.1211	0.2413	0.0227
84			.	0.1347	0.3596	0.9668	0.9241	0.3273	0.2916	0.2135	0.7235
85				.	0.0092	0.0690	0.0480	0.0052	0.0048	0.0045	0.0286
86					.	0.1922	0.2502	0.9894	0.8980	0.6654	0.4360
87						.	0.8262	0.1285	0.1145	0.0899	0.5506
88							.	0.1699	0.1528	0.1163	0.6825
89								.	0.8959	0.6362	0.3581
90									.	0.7288	0.3090
91										.	0.2230

YR	LSMEAN	STDERR	U95%	CPUE	L95%
81	1.85826	0.12909	8.32795	6.46622	5.02069
82	1.63591	0.10231	6.30706	5.16108	4.22333
83	1.18200	0.09661	3.95910	3.27615	2.71100
84	1.37024	0.09022	4.71683	3.95234	3.31175
85	1.48604	0.09044	5.29828	4.43767	3.71685
86	1.30573	0.08411	4.36721	3.70348	3.14062
87	1.37288	0.07779	4.61069	3.95868	3.39887
88	1.36419	0.07746	4.56768	3.92432	3.37158
89	1.30501	0.07890	4.31789	3.69921	3.16918
90	1.29849	0.08117	4.30976	3.67585	3.13518
91	1.27756	0.08698	4.27084	3.60146	3.03699
92	1.34724	0.07862	4.50155	3.85869	3.30763

Table 6. ANOVA results for US longline swordfish CPUE, age 4.

Dependent Variable: Log(age 4 catch/1000 Hooks)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	1752.39895788	54.76246743	116.26	0.0
Error	3023	1423.95475770	0.47104028		
Corrected Total	3055	3176.35371557			

R-Square	C.V.	Root MSE	T2CPU4 Mean
0.551701	78.72969	0.68632374	0.87174705

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	11	106.89241631	9.71749239	20.63	0.0001
QTR	3	178.61993047	59.53997682	126.40	0.0001
AREA	6	321.15004190	53.52500698	113.63	0.0001
OP	6	40.53291535	6.75548589	14.34	0.0001
SIZE	3	45.39958387	15.13319462	32.13	0.0001
TARG	3	214.10694878	71.36898293	151.51	0.0001

Pr > |T| HO: LSMEAN(year i) = LSMEAN(year j)

i/j	82	83	84	85	86	87	88	89	90	91	92
81	0.1948	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
82	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
83		.	0.5514	0.0834	0.6988	0.0053	0.0010	0.0025	0.0004	0.0001	0.8843
84			.	0.2116	0.2568	0.0001	0.0001	0.0001	0.0001	0.0001	0.5466
85				.	0.0116	0.0001	0.0001	0.0001	0.0001	0.0001	0.0344
86					.	0.0011	0.0001	0.0004	0.0001	0.0001	0.4508
87						.	0.3746	0.5585	0.1586	0.0010	0.0001
88							.	0.8390	0.4859	0.0065	0.0001
89								.	0.4155	0.0064	0.0001
90									.	0.0527	0.0001
91										.	0.0001

YR	LSMEAN	STDERR	U95%	CPUE	L95%
81	1.47756	0.12163	5.60328	4.41477	3.47835
82	1.29180	0.10606	4.50545	3.65984	2.97294
83	0.75696	0.09943	2.60332	2.14234	1.76299
84	0.81062	0.09279	2.70957	2.25900	1.88336
85	0.91344	0.09176	2.99665	2.50340	2.09133
86	0.72397	0.08502	2.44547	2.07008	1.75232
87	0.53879	0.07735	2.00049	1.71906	1.47723
88	0.50047	0.07698	1.92382	1.65439	1.42270
89	0.51006	0.07919	1.95115	1.67063	1.43044
90	0.46536	0.08180	1.87581	1.59793	1.36121
91	0.33764	0.08836	1.67319	1.40712	1.18336
92	0.76851	0.07836	2.52231	2.16319	1.85520

Table 7. ANOVA results for US longline swordfish CPUE, age 5+.

Dependent Variable: Log(age 5+ catch/1000 Hooks)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	1781.61547552	55.67548361	103.38	0.0
Error	3099	1668.98584790	0.53855626		
Corrected Total	3131	3450.60132342			

R-Square	C.V.	Root MSE	T2CP5P Mean
0.516320	73.83157	0.73386392	0.99397030

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	11	363.89883886	33.08171262	61.43	0.0001
QTR	3	260.02799201	86.67599734	160.94	0.0001
AREA	6	272.62149836	45.43691639	84.37	0.0001
OP	6	35.55842809	5.92640468	11.00	0.0001
SIZE	3	43.51032487	14.50344162	26.93	0.0001
TARG	3	179.35922122	59.78640707	111.01	0.0001

Pr > |T| HO: LSMEAN(year i)=LSMEAN(j)

i/j	82	83	84	85	86	87	88	89	90	91	92
81	0.2889	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
82	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
83		.	0.0029	0.0060	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
84			.	0.8119	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
85				.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
86					.	0.0010	0.0001	0.0014	0.0001	0.0001	0.0653
87						.	0.0256	0.9423	0.3321	0.0132	0.0955
88							.	0.0462	0.3460	0.3576	0.0001
89								.	0.3899	0.0184	0.0990
90									.	0.1194	0.0130
91										.	0.0002

YR	LSMEAN	STDERR	U95%	CPUE	L95%
81	2.29253	0.12492	12.7454	9.97752	7.81072
82	2.14361	0.09627	10.3494	8.56977	7.09617
83	1.59971	0.09340	5.9724	4.97325	4.14126
84	1.32774	0.08753	4.4957	3.78697	3.18997
85	1.34816	0.08712	4.5847	3.86499	3.25826
86	0.87691	0.08081	2.8251	2.41132	2.05812
87	0.67473	0.07119	2.2632	1.96848	1.71212
88	0.57145	0.07039	2.0378	1.77522	1.54645
89	0.67095	0.07390	2.2671	1.96144	1.69697
90	0.62148	0.07566	2.1655	1.86701	1.60970
91	0.51259	0.08461	1.9779	1.67560	1.41953
92	0.75975	0.07217	2.4690	2.14331	1.86061