

SWORDFISH CATCH AT SIZE AND CATCH AT AGE BY SEX FOR THE UNITED STATES

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SCRS/1996/150

Col.Vol.Sci.Pap. ICCAT, 46 (3) : 383-385 (1997)

SUMMARY

General additive model analyses were used to develop a model of swordfish sex ratio at size from U.S. and Venezuelan data. Significant effects were considered to be area, year, and area*year interaction; seasonal effects were not considered significant.

Predicted proportions of females by area, year and centimeter were used to convert the United States catch at size to catch at size by sex. In many cases, there were very few or no data for estimation, so substitutions of information from preceding and/or subsequent years were necessary. Because of the large number of area-year strata with little or no information before 1985, catch at size by sex was estimated only for 1985 and later.

Comparison of the calculated catches at age (*caa*) from undifferentiated catch at size (*cas*) with the *caa* from the sex-specific *cas* showed that with the sex-specific *caa* there were fewer fish in ages 2-4 (10-30% reductions) and substantially more fish at ages 0-1 and 6-10+ (20 to 280% increases).

RÉSUMÉ

Des analyses du modèle additif généralisé ont été utilisées pour élaborer un modèle de sex-ratio par taille pour l'espadon, à partir des données des Etats-Unis et du Venezuela. On a considéré que les effets significatifs étaient notamment la zone, l'année et les interactions zone-année. Les effets saisonniers n'ont pas été jugés importants.

Les proportions supposées de femelles par zone, année et centimètre ont été utilisées pour convertir la prise par taille des Etats-Unis en prise par taille par sexe. Dans de nombreux cas, on disposait de très peu, voire d'aucune donnée pour l'estimation et on a dû substituer les informations nécessaires par celles des années antérieures et/ou postérieures. Dans la mesure où l'on disposait de peu, voire d'aucune information avant 1985, la prise par taille par sexe n'a été estimée que pour les années 1985 et suivantes.

La comparaison entre les prises par âge calculées à partir des prises par âge non différenciées et les prises par âge par sexe calculées à partir des prises par âge par sexe non différenciées ont permis de conclure qu'avec la prise par âge par sexe calculée, les poissons des âges 2-4 sont moins nombreux (10 à 30% de moins) et que les poissons d'âges 0-1 et 6-10+ sont plus nombreux (20 à 280% de plus).

RESUMEN

Se usaron análisis del modelo general aditivo para desarrollar un modelo de proporción por sexo y por talla de pez espada basado en datos de Estados Unidos y Venezuela. Se consideró que los efectos importantes eran el área, año y la interacción año*área. No se consideraron importantes los efectos de temporada.

Para convertir la captura por talla de Estados Unidos en captura por talla por sexo, se usaron la proporciones previstas de hembras por área, año y centímetro. En muchos casos los datos eran escasos o nulos para hacer la estimación, por lo que fueron necesarias sustituciones o información de años precedentes y/o subsiguientes. Debido al gran número de estratos espacio-temporales con información escasa o nula de años previos a 1985, la captura por talla por sexo se estimó solo para el año 1985 y posteriores.

La comparación de las capturas por edad calculadas (*caa*) partiendo de captura por talla (*cas*) con la *caa* de la *cas* específica del sexo, mostró que con la *caa* específica del sexo había menos peces de edades 2-4 (reducciones del 10-30%) y muchos mas peces de edades 0-1 y 6-10+ (aumentos del 20 al 280%).

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Results

Swordfish sex at size data from the United States and Venezuela were examined for differences among area, year and season. Areas were defined as temperate, subtropical and tropical (Figure 1). The area east of 60°W between 13°N and 18°N was included in the subtropics (as did Turner et al 1996), because catches in that area have consisted of spawning or prespawning females which are found in the rest of the subtropics and generally not in the tropics. General additive model (GAM) analyses were used in analysis of the area, year and seasonal effects with length introduced as a covariate. For model development analyses were restricted to 1991-1995 when substantial numbers of observations were available for each area (Table 1). Area and yearly effects were considered to significantly affect the amount of variation explained by the model. Seasonal effects (both quarter and half year) were not considered significant. All two way interactions were examined and the area*year interaction was considered significant. Predicted proportions of females at length were estimated by area and year.

There were few or no observations in some area-year strata (Table 1). Predicted proportions female were sensitive to the available data, so to try to reduce the effects of small sample sizes predicted proportions from strata with fewer than 50 observations per year were not used. Because of the high proportion of strata with no observations prior to 1985, catch at size by sex was calculated only for 1985-1995.

For the temperate area the mean of the 1985 and 1989 predicted proportions female were substituted for 1986-1988. For the subtropics area the mean of the 1986 and 1991 proportions were used for 1987-1990. For the tropics the 1991 proportions were used for 1985-1990.

At small sizes the numbers of observations was also limited and the predicted proportions were sensitive to the observations. To reduce the effects of those small sample sizes the mean proportions by area from all years with more than 50 observations were used for conversion of the temperate catch at size below 90 cm, subtropical catch at size below 110 cm and tropical catch at size below 90 cm. A similar procedure was not used for larger sizes because the predicted proportions appeared relatively stable from year to year.

Calculated catch at age from the undifferentiated catch at size is shown in Table 2. The catch at age from the sex specific catch at size with recombined catches of males and females is shown in Table 3. The differences between those two catches at age (Table 4) indicate that the recombined caa has 10-30% fewer fish at ages 2-4 and 20% to 280% more fish at ages 0-1 and 6-10+. The sex specific catches at age are shown in Table 5.

Literature Cited

Turner, S.C., F. Arocha, and G.P. Scott. U.S. swordfish catch at age by sex. ICCAT, Col. Vol. Sci. Pap. 45(2): 373-378.

Table 1. Numbers of observations of sex at size from U.S. and Venezuelan sources from 1978-1995 available for conversion of catch at size to catch at size by sex.

year	Region			total
	temperate	subtropics	tropics	
78	23	57	0	80
79	3	143	0	146
80	57	237	0	294
81	14	93	0	107
82	0	0	0	0
83	1	3	0	4
84	171	7	0	178
85	207	74	0	281
86	0	94	41	135
87	0	0	0	0
88	0	0	0	0
89	202	0	0	202
90	1769	48	0	1817
91	1165	429	123	1717
92	413	732	968	2113
93	1205	2315	1024	4544
94	488	1442	523	2453
95	139	2072	250	2461
Total	5857	7746	2929	16532

Table 2. Calculated catch at age from original U.S. catch at size.

AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	3538	4976	4253	10307	4036	6676	6623	6095	7583	4916	4251
1	17866	21426	32423	30431	39078	21780	20469	14668	16199	17299	16963
2	24881	37415	40444	56717	54464	46084	32450	34910	31459	31556	36916
3	24102	27555	29604	35905	37043	32616	29285	24390	27009	24437	32002
4	14899	18319	15121	18566	18801	14248	14248	13260	12848	11810	15935
5	8021	8559	7611	8693	9433	8690	7034	6835	6633	5303	6981
6	4086	4073	3822	4072	4790	4302	3529	3415	3406	2532	3325
7	2358	2155	1968	2114	2450	2220	1733	1876	1746	1523	1772
8	1372	1130	1120	1120	1344	1226	928	914	899	767	938
9	861	763	649	753	846	737	566	549	553	472	588
10	2839	2410	2480	2393	2602	2303	1976	1854	1572	1408	1554
total	104822	128782	139496	171072	174888	143127	118841	108763	109907	102023	121224

Table 3. Calculated combined catch at age from U.S. catch at size by sex.

AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	10392	12912	14968	21209	15481	14640	12107	10794	12347	9061	7429
1	20321	28862	37516	42067	50350	31392	26635	19091	19296	20933	22556
2	18424	25808	29042	39411	38116	34390	25950	30071	28334	27859	33542
3	14603	17590	19054	22875	24074	22314	19875	16118	17699	16462	20623
4	10287	13459	11888	14258	14456	13675	11895	10517	10352	9881	12211
5	7192	8980	7909	9487	9718	9043	7605	7033	6811	5979	7729
6	4865	5751	5183	6217	6677	6040	4788	4792	4695	3806	5000
7	3599	4055	3590	4092	4468	3755	3216	3267	3169	2560	3378
8	2703	2609	2408	2715	2916	2448	1923	2072	2036	1605	2272
9	1941	1843	1700	1924	1968	1530	1188	1246	1271	1041	1405
10	10494	6912	6238	6816	6464	3879	3660	3762	3875	2837	5080
total	104822	128782	139496	171072	174888	143127	118841	108764	109907	102023	121224

Table 4. Relative (to single sex) and absolute differences (single sex - combined sex specific) in total U.S. catches at age calculated from aggregate catch at age and catch at age by sex.

age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	-1.94 -6954	-1.59 -7936	-2.52 -10715	-1.06 -10902	-2.84 -11445	-1.19 -7964	-0.83 -5484	-0.77 -4699	-0.63 -4764	-0.84 -4145	-0.75 -3178
1	-0.14 -2455	-0.35 -7436	-0.16 -5093	-0.38 -11636	-0.29 -11272	-0.44 -9612	-0.30 -6166	-0.30 -4423	-0.19 -3097	-0.21 -3634	-0.33 -5593
2	0.26 6457	0.31 11607	0.28 11402	0.31 17306	0.30 16148	0.25 11694	0.20 6500	0.14 4839	0.10 3125	0.12 3697	0.09 3374
3	0.39 9499	0.36 9965	0.36 10550	0.36 13030	0.35 12969	0.32 10282	0.32 9410	0.34 8272	0.34 9310	0.33 7975	0.36 11379
4	0.31 4612	0.27 4860	0.21 3233	0.23 4308	0.23 4345	0.17 2816	0.17 2353	0.21 2743	0.19 2496	0.16 1929	0.23 3724
5	0.10 829	-0.05 -421	-0.04 -298	-0.09 -794	-0.03 -285	-0.04 -353	-0.08 -571	-0.03 -198	-0.03 -198	-0.13 -676	-0.11 -748
6	-0.19 -779	-0.41 -1678	-0.36 -1361	-0.53 -2145	-0.39 -1887	-0.40 -1738	-0.36 -1259	-0.40 -1377	-0.38 -1289	-0.50 -1274	-0.50 -1675
7	-0.53 -1241	-0.88 -1900	-0.82 -1622	-0.94 -1978	-0.82 -2018	-0.69 -1535	-0.86 -1483	-0.74 -1391	-0.82 -1423	-0.68 -1037	-0.91 -1606
8	-0.97 -1331	-1.31 -1479	-1.15 -1288	-1.42 -1595	-1.17 -1572	-1.00 -1222	-1.07 -995	-1.27 -1158	-1.26 -1137	-1.09 -838	-1.42 -1334
9	-1.25 -1080	-1.42 -1080	-1.62 -1051	-1.56 -1171	-1.33 -1122	-1.08 -793	-1.10 -622	-1.27 -697	-1.30 -718	-1.21 -569	-1.39 -817
10	-2.70 -7655	-1.87 -4502	-1.52 -3758	-1.85 -4423	-1.48 -3862	-0.68 -1576	-0.85 -1684	-1.03 -1908	-1.47 -2303	-1.01 -1429	-2.27 -3526
total dif	2	0	-1	0	-1	-1	-1	3	2	-1	0

Table 5. U.S. catches at age by sex.

AGE	males										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	6110	6725	8658	11282	8870	8411	7067	6281	7159	5106	4128
1	11419	14814	18892	20944	25567	17240	13517	9758	9542	9938	11452
2	10734	12777	13744	18774	15967	14841	10150	13643	13040	11178	17795
3	8880	8446	9083	11512	10967	8761	7106	6839	7999	6132	11558
4	6346	6247	5822	7078	6459	4664	4321	4115	4541	3937	6887
5	4306	4307	3634	4851	4137	2701	2526	2567	2783	2281	4388
6	2727	2552	2115	2815	2526	1545	1346	1537	1620	1342	2557
7	1968	1768	1353	1889	1611	944	896	930	1040	747	1559
8	1460	1182	997	1231	1089	642	577	703	775	477	1079
9	1007	806	725	874	722	410	372	415	461	346	654
10	8358	4777	4071	4718	4122	1725	1806	2045	2438	1527	3663
total	63315	64400	69095	85967	83038	61885	49685	48833	51399	42912	65720

AGE	females										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	4282	6187	6310	9926	6610	6229	5039	4513	5189	3955	3301
1	8902	14048	18624	21124	24783	14153	13118	9333	9754	10995	11104
2	7691	13031	15299	20637	21350	19548	15799	16428	15294	16680	15747
3	5723	9144	9970	11363	13107	13574	12769	9279	9760	10330	9064
4	3941	7213	6066	7181	7997	9011	7574	6402	5812	6044	5324
5	2887	4673	4275	4636	5581	6342	5079	4467	4047	3698	3341
6	2138	3199	3067	3402	4151	4495	3441	3255	3075	2464	2443
7	1630	2287	2238	2203	2857	2811	2320	2337	2129	1812	1818
8	1243	1427	1411	1484	1827	1805	1346	1369	1261	1128	1193
9	934	1038	975	1051	1246	1120	815	831	810	694	751
10	2135	2135	2167	2098	2342	2154	1855	1717	1437	1310	1417
total	41507	64382	70401	85105	91851	81242	69156	59931	58508	59111	55504

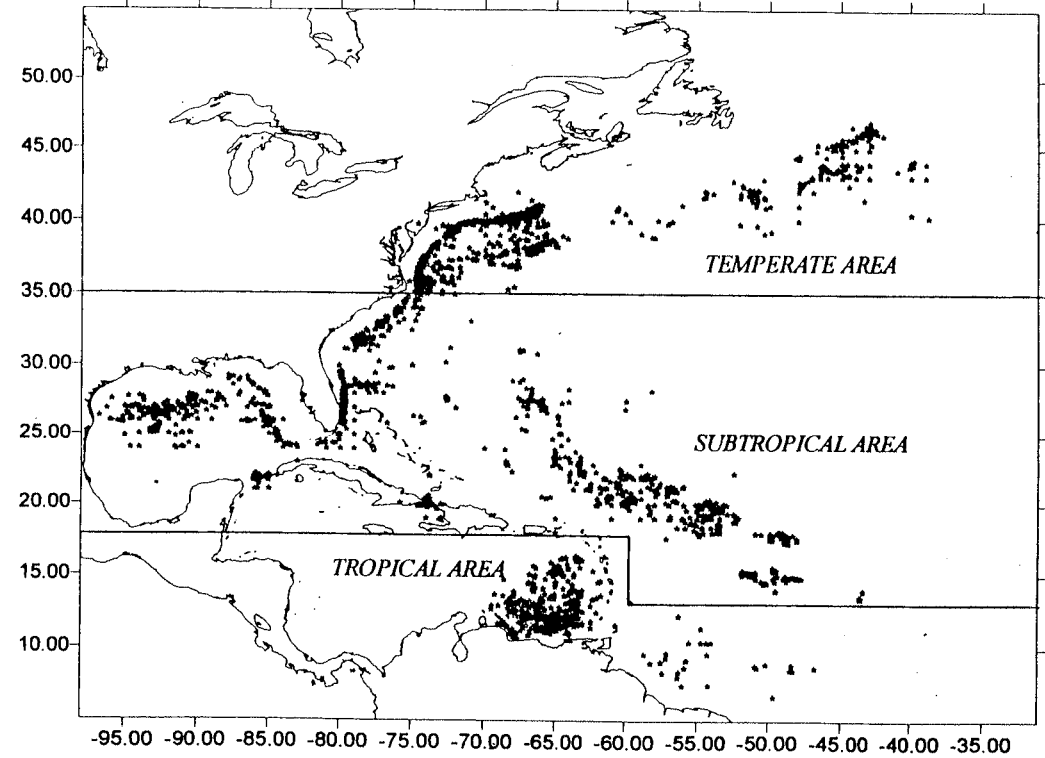


Figure 1. Areas used for swordfish sex at size data. Asterisks indicate collection locations.