SCRS/1998/114 Col.Vol.Sci.Pap. ICCAT, 49 (1) : 449-456 (1999)

STANDARDIZED CATCH RATES FOR SWORDFISH *(XIPHIAS GLADIUS)* FROM THE U.S. LONGLINE FLEET THROUGH 1997

Jean Cramer and Angelo Bertolino[1]

SUMMARY

Swordfish size and effort data collected from the U.S. longline fleet operating over a 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 Generalized Linear Modeling approach.

RÉSUMÉ

Les données sur la taille et l'effort concernant l'espadon dans la flottille palangrière américaine pêchant dans une zone géographique étendue de la partie occidentale de l'Atlantique Nord ont servi à élaborer des indices spécifiques de l'âge de l'abondance en espadon dans l'Atlantique Nord. Le taux de capture standardisé a été estimé au moyen du modèle linéaire généralisé.

RESUMEN

Se utilizaron los datos de talla y esfuerzo de pez espada recolectados de la flota de palangre de Estados Unidos que opera en un amplio rango geográfico en el océano Atlántico oeste norte, para desarrollar índices de abundancia específicos de la edad para el pez espada del Atlántico norte. Se estimaron las tasas de captura estandarizadas utilizando el enfoque del Modelo Lineal Generalizado.

---

[1] U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, FL 33149, USA.

Introduction

Information on the relative abundance of swordfish is necessary to tune stock assessment models. Data collected from the US longline fleet has been previously used to develop standardized catch per unit effort (CPUE) indices of abundance for swordfish. This report documents the analytical methods applied to the available US longline fleet data through 1997 and presents age-specific, standardized CPUE indices for swordfish, updating the material presented in Scott *et.al.* (1992, 1993) and Scott and Bertolino(1994, 1995, 1996, 1997). 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 the indices of abundance presented herein. Standardized catch rates were estimated using the General Linear Modeling (GLM) approach.

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 (1991,1994,1995, 1996, 1997) and Scott *et. al.* (1992, 1993) 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 1997) from the US longline fleet. Age-specific indices of abundance (ages 1 through 8 and plus groups of 5^+ and 9^+) 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 1992-96 SCRS swordfish species groups. Sex-specific catch rate indices are not updated in this analysis as agreement within the SWO working group on the appropriate growth curves and sex-ratio at size has not yet been achieved.

In the present analysis, the analytical data base on US longline catch and effort for 1981 through 1997 was reviewed and updated based on fishermen's reports and/or interviews received since the previous update. A total of 6,973 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 approximately 8% increase in observations compared to the 1997 analysis (Scott and Bertolino 1997). As described in Hoey *et.al.* (1989), Nelson *et.al.* (1990), Scott and Bertolino (1991, 1994, 1995, 1996, 1997), 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, the indicated target for the trip (tuna, swordfish, or unknown), proportion of total landed catch in a trip comprised of the species of interest, 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 for swordfish by year, age, and fishing area, using the Gompertz growth equation for pooled sexes are shown in Table 2.

Implementation of 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 78.7 cm carcass length which was reduced to 73 cm in July of 1996. 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 landed harvest level by US fishermen since 1991.

Seven geographical areas of fishing were used for classification as defined in Hoey *et.al.* (1990), Scott and Bertolino (1991, 1994, 1995, 1996, 1997) and Scott *et.al.* (1992, 1993). The areas used for classification were: Caribbean (CAR, area 1), Gulf of Mexico (GOM, area 2), Florida east coast (FEC, area 3), South Atlantic Bight (SAB, area 4), mid-Atlantic Bight (MAB, area 5), New England coastal (NEC, area 6) and northeast distant waters (NED, or Grand Banks, area 7). For swordfish analyses, all areas were used. 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 landed catch in a trip were used corresponding to the quartiles into which the proportion of the species of interest fell (*i.e.* $\leq 25\%$, >25-$\leq 50\%$, >50-$\leq 75\%$, and $>75\%$). The proportion of catch 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. In addition, information collected via interviews with Captains or on logbooks at times indicated if the intended target for the trip was tunas or swordfish.

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 analyses by adding the zero CPUE effort uniformly across all other observations in the same analytical stratum.

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 of the species of interest. For the tuna analyses, trip target indicated was also used as a classifier and a variable AQUTR (area-quarter categories) was applied to allow for interactions between areas and calendar quarters. Standards were defined as the earliest year, and the highest classification level for all other main effects.

Results and Discussion

Analysis of variance (ANOVA) results for the models fit to the swordfish CPUE data are shown in Table 3. In all cases, the resulting F-statistic was highly significant. For the Gompertz age-slicing method the main effect models fit explained between 50 and 66% of the variability in the observed data, depending on the age groupings modeled.

Age-specific indices of swordfish abundance, based on the yearly LSM estimates from the models fit are also presented in Table 4 along with their 95% confidence regions (back transformed to arithmetic scale including a logarithmic bias correction) for the Gompertz ageing model (both sexes combined). 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. Graphically, these catch rate time-series are shown in Figure 1.

Because the landing and sale of swordfish smaller the minimum size was restricted from 1991-present, catch rates estimated from landings data are underestimates of the actual catch rates of small swordfish by the U.S. fleet. For this reason, estimates of standardized catch rates for fish aged 1 and 2 were only computed through 1990.

References

Hoey, J.J. and A. Bertolino. 1988. Review of the U.S. fishery for swordfish, 1978 to 1986. ICCAT - Col. Vol. Sci. Pap., Vol. XXVII:256-266.

Hoey, J. R. Conser, and E. Duffie. 1989. Catch per unit effort information from the U.S. swordfish fishery. ICCAT - Col. Vol. Sci. Pap., Vol. XXXIX:195-249.

Lo, N.C., L.D. Jacobson, and J.L. Squire. 1992. Inidces of relative abundance from fish spotter data based on delta-lognormal models. Can.J.Fish. Aquat.Sci. 49:2515-2526.

Nelson, W.R., B.E. Brown, R.J. Conser, J.J. Hoey, S. Nichols, J.E. Powers, M.P. Sissenwine, S.C. Turner, and D.S. Vaughn. 1990. Report of the NMFS swordfish stock assessment workshop (March 20-24, 1989). ICCAT - Col. Vol. Sci. Pap., Vol. XXXII(2):287-352.

Scott, G.P. and A. Bertolino. 1991. Standardized catch rates for swordfish (*Xiphias gladius*) from the U.S. longline fleet through 1990. ICCAT - Col. Vol. Sci. Pap., Vol. XXXV(2):397- 404.

Scott, G.P. and A. Bertolino. 1994. Standardized catch rates for swordfish (*Xiphias gladius*) from the U.S. longline fleet through 1993. ICCAT - Col. Vol. Sci. Pap., Vol. XLIV(3):166-173.

Scott, G.P. and A. Bertolino. 1995. Standardized catch rates for swordfish (*Xiphias gladius*) from the U.S. longline fleet through 1994. ICCAT - Col. Vol. Sci. Pap., Vol. XLV(2):368-272.

Scott, G.P. and A. Bertolino. 1996. Standardized catch rates for swordfish (*Xiphias gladius*) from the U.S. longline fleet through 1995. ICCAT - Col. Vol. Sci. Pap., Vol. XLVI (3):362-368.

Scott, G.P. and A. Bertolino. 1997. Standardized catch rates for swordfish (*Xiphias gladius*) from the U.S. longline fleet through 1996. ICCAT - Col. Vol. Sci. Pap., Vol.XLVIII(1):223-231.

Scott, G.P., V.R. Restrepo, and A.R. Bertolino. 1992. Standardized catch rates for swordfish (*Xiphias gladius*) from the US longline fleet through 1990. ICCAT - Coll. Vol. Sci. Pap.,Vol. XXXIX(2):554-571.

Scott, G.P., V.R. Restrepo, and A.R. Bertolino. 1993. Standardized catch rates for swordfish (*Xiphias gladius*) from the US longline fleet through 1991. ICCAT - Coll. Vol. Sci. Pap., Vol. XL(1):458-467.

SCRS Swordfish Assessment Group. 1992. Reference paper on 1991 swordfish stock assessments. ICCAT - Coll. Vol. Sci. Pap. XXXIX(2):397-476.

Turner, S.C. and G.P. Scott. 1992. Standardized catch rates of yellowfin tuna, Thunnus albacares, from the United States longline fishery in the Atlantic Ocean. ICCAT - Coll. Vol. Sci. Pap. XXXVIII:245-253

Table 1. Trip data with swordfish size, catch, and effort information available for analysis from the US longline fleet, 1981-1993.

	Year																	
AREA	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	TOTAL
CAR	0	0	0	0	10	39	88	150	63	49	45	51	72	95	82	84	45	873
GOM	0	1	7	5	33	39	75	65	78	58	64	81	58	56	60	75	56	811
FEC	26	28	26	76	48	100	278	361	208	136	206	250	208	265	222	276	283	2997
SAB	3	10	18	4	4	18	31	55	28	53	8	62	67	63	82	89	101	696
MAB	9	40	57	49	18	68	102	45	34	63	78	82	94	74	68	21	29	931
NEC	2	13	18	18	12	15	28	5	10	12	7	45	48	19	31	25	19	327
NED	3	6	9	13	19	18	27	41	31	23	19	32	30	24	18	12	13	338
TOTAL	43	98	135	165	144	297	629	722	452	394	427	603	577	596	563	582	546	6973

Table 2. Nominal average swordfish CPUE (fish/1000 hooks) by area and age based on the SCRS 1992 ageing method from the US Longline fishery.

		Age				
AREA	YR	1	2	3	4	5+
CAR	85	1.42	2.44	6.95	11.03	12.89
CAR	86	1.80	8.43	12.23	15.06	13.80
CAR	87	1.81	7.50	9.46	8.37	8.18
CAR	88	2.14	7.97	10.81	7.13	5.90
CAR	89	0.54	4.97	9.66	7.92	8.70
CAR	90	0.91	4.62	7.37	5.97	6.71
CAR	91	.	.	8.36	9.20	11.16
CAR	92	.	.	4.92	5.64	7.26
CAR	93	.	.	5.49	4.88	8.40
CAR	94	.	.	7.86	6.41	5.12
CAR	95	.	.	6.77	6.02	5.25
CAR	96	.	.	8.67	5.92	4.44
CAR	97	.	.	9.32	6.70	5.04
GOM	82	0.00	8.60	7.37	2.46	7.37
GOM	83	5.58	10.91	13.42	6.35	8.20
GOM	84	4.67	20.14	8.77	5.11	4.39
GOM	85	3.33	6.76	5.01	2.73	2.21
GOM	86	3.96	4.30	1.73	0.62	0.60
GOM	87	0.46	2.04	1.51	0.58	0.73
GOM	88	2.74	4.00	2.68	1.56	1.59
GOM	89	2.52	9.67	5.01	2.11	2.84
GOM	90	2.80	5.50	5.06	2.05	2.59
GOM	91	.	.	2.87	1.70	2.07
GOM	92	.	.	2.32	1.15	1.06
GOM	93	.	.	3.16	1.54	0.98
GOM	94	.	.	2.07	1.15	0.55
GOM	95	.	.	3.89	1.70	0.88
GOM	96	.	.	3.67	1.78	1.14
GOM	97	.	.	4.67	1.72	0.90
FEC	81	4.19	8.22	8.43	6.00	14.52
FEC	82	0.86	4.70	9.06	9.38	17.44
FEC	83	2.96	4.34	5.58	5.86	8.78
FEC	84	3.28	7.53	6.69	4.16	5.90
FEC	85	1.98	4.11	5.62	4.29	6.56
FEC	86	8.08	11.24	6.47	3.04	3.10
FEC	87	4.16	11.14	7.98	3.63	3.41
FEC	88	4.57	10.02	8.92	4.01	3.55
FEC	89	3.30	11.35	6.99	3.64	3.92
FEC	90	5.00	10.89	8.26	3.42	3.16
FEC	91	.	.	9.88	4.97	3.81
FEC	92	.	.	7.83	3.52	3.52
FEC	93	.	.	7.14	3.40	3.60
FEC	94	.	.	7.79	4.00	3.04
FEC	95	.	.	8.43	4.20	4.00
FEC	96	.	.	9.76	4.32	3.99
FEC	97	.	.	9.95	5.52	4.26
SAB	81	6.97	21.78	49.16	13.95	18.33
SAB	82	4.08	15.45	15.88	8.28	11.59
SAB	83	8.90	19.64	11.50	4.47	10.32
SAB	84	1.94	8.91	10.42	2.39	5.26
SAB	85	7.12	10.71	11.95	5.19	3.47
SAB	86	15.84	27.44	10.86	1.96	1.48
SAB	87	9.30	38.46	17.58	4.33	2.20
SAB	88	6.41	17.52	14.99	4.61	2.67
SAB	89	3.43	16.36	7.98	2.88	1.62
SAB	90	4.39	13.14	11.73	3.11	2.34
SAB	91	.	.	8.30	2.62	2.77
SAB	92	.	.	14.60	4.91	1.96
SAB	93	.	.	10.11	3.25	1.94
SAB	94	.	.	10.74	3.32	1.94
SAB	95	.	.	10.49	3.62	1.77
SAB	96	.	.	6.77	2.37	1.51
SAB	97	.	.	10.33	2.99	1.55
MAB	81	4.56	11.57	18.68	9.87	19.49
MAB	82	9.66	16.02	7.39	6.23	14.05
MAB	83	3.88	12.59	6.78	3.05	6.52
MAB	84	3.90	6.88	6.10	3.45	4.40
MAB	85	7.49	11.41	4.75	2.51	4.33
MAB	86	5.07	11.03	6.79	2.56	3.15
MAB	87	2.46	7.40	4.89	2.56	2.90
MAB	88	3.40	5.54	4.04	1.79	1.97
MAB	89	1.76	5.14	3.03	1.79	1.83
MAB	90	3.55	4.01	3.12	1.30	1.93
MAB	91	.	.	1.64	1.04	1.33
MAB	92	.	.	1.22	0.63	0.92
MAB	93	.	.	1.17	0.67	0.90
MAB	94	.	.	1.03	0.46	0.81
MAB	95	.	.	0.95	0.50	1.05
MAB	96	.	.	0.57	0.25	0.29
MAB	97	.	.	0.93	0.52	0.60
NEC	81	1.35	3.64	2.95	2.05	3.37
NEC	82	5.40	5.55	5.73	6.35	8.59
NEC	83	1.72	5.41	3.32	2.60	5.31
NEC	84	0.57	5.10	7.40	5.34	9.73
NEC	85	2.73	6.83	8.62	6.20	6.94
NEC	86	2.94	7.87	6.73	3.74	5.11
NEC	87	2.52	6.32	5.51	2.45	3.62
NEC	88	0.69	3.41	4.57	2.01	2.15
NEC	89	5.14	10.84	5.73	2.29	3.01
NEC	90	4.24	5.16	5.48	2.42	2.52
NEC	91	.	.	4.52	4.34	4.21
NEC	92	.	.	1.62	0.64	1.05
NEC	93	.	.	1.27	0.87	0.79
NEC	94	.	.	1.17	0.57	0.71
NEC	95	.	.	0.95	0.44	0.39
NEC	96	.	.	0.55	0.25	0.29
NEC	97	.	.	0.69	0.60	0.56
NED	81	0.02	0.27	1.46	3.28	5.74
NED	82	0.02	0.56	5.13	6.38	8.40
NED	83	0.08	1.62	3.89	7.18	12.21
NED	84	0.71	4.60	11.69	11.66	15.19
NED	85	1.53	8.03	23.81	23.82	24.14
NED	86	2.19	9.82	11.56	11.88	13.04
NED	87	3.20	9.83	11.87	7.90	9.74
NED	88	2.16	16.46	17.27	9.80	8.39
NED	89	2.54	12.08	16.40	7.86	6.15
NED	90	1.67	8.86	17.51	10.05	6.48
NED	91	.	.	13.56	9.61	7.36
NED	92	.	.	9.94	7.12	5.99
NED	93	.	.	11.26	6.69	5.23
NED	94	.	.	10.41	6.40	4.25
NED	95	.	.	10.23	4.90	3.37
NED	96	.	.	12.13	6.11	4.44
NED	97	.	.	8.27	5.98	4.49

Table 3. US LL swordfish CPUE ANOVA results, using distributed effort method.

GOMPERTZ AGEING, POOLED SEXES:

```
Dependent Variable: Ln(age 1/1000 hooks)
Source                 DF          Sum of Squares            Mean Square      F Value          Pr > F
Model                  30           2363.02778401            78.76759280        81.81          0.0001
Error                1719           1655.04008952             0.96279237
Corrected Total      1749           4018.06787353
                 R-Square                    C.V.               Root MSE                  T2CPU1 Mean
                 0.588101                111.3423             0.98121984                   0.88126386
Source                 DF             Type III SS            Mean Square      F Value          Pr > F
YR                      9             45.18955082             5.02106120         5.22          0.0001
QTR                     3           1595.83390662           531.94463554       552.50          0.0001
AREA                    6            106.30887077            17.71814513        18.40          0.0001
OP                      6            100.56529703            16.76088284        17.41          0.0001
SZST                    3             75.76043465            25.25347822        26.23          0.0001
TARG                    3             76.96333367            25.65444456        26.65          0.0001

Dependent Variable: Ln(age 2/1000 hooks)
Source                 DF          Sum of Squares            Mean Square      F Value          Pr > F
Model                  30           1865.66349925            62.18878331        94.52          0.0001
Error                2820           1855.49446223             0.65797676
Corrected Total      2850           3721.15796149
                 R-Square                    C.V.               Root MSE                  T2CPU2 Mean
                 0.501366                44.96371             0.81115767                   1.80402742
Source                 DF             Type III SS            Mean Square      F Value          Pr > F
YR                      9            108.68679414            12.07631046        18.35          0.0001
QTR                     3            421.69576481           140.56525494       213.63          0.0001
AREA                    6             96.88677373            16.14779562        24.54          0.0001
OP                      6            114.08638140            19.01439690        28.90          0.0001
SZST                    3             68.13427558            22.71142519        34.52          0.0001
TARG                    3            290.77718228            96.92572743       147.31          0.0001

Dependent Variable: Ln(age 3/1000 hooks)

Source                 DF          Sum of Squares            Mean Square      F Value          Pr > F
Model                  37           5347.19864779           144.51888237       305.83          0.0001
Error                5767           2725.15839796             0.47254351
Corrected Total      5804           8072.35704575
                 R-Square                    C.V.               Root MSE                  T2CPU3 Mean
                 0.662409                43.43725             0.68741800                   1.58255412
Source                 DF             Type III SS            Mean Square      F Value          Pr > F
YR                     16             63.21019990             3.95063749         8.36          0.0001
QTR                     3              9.88686298             3.29562099         6.97          0.0001
AREA                    6            297.91893427            49.65315571       105.08          0.0001
OP                      6             93.45068620            15.57511437        32.96          0.0001
SZST                    3            158.29611353            52.76537118       111.66          0.0001
TARG                    3            915.29269342           305.09756447       645.65          0.0001

Dependent Variable: Ln(age 4/1000 hooks)

Source                 DF          Sum of Squares            Mean Square      F Value          Pr > F
Model                  37           4261.99224529           115.18897960       251.40          0.0001
Error                5135           2352.83757799             0.45819622
Corrected Total      5172           6614.82982329
                 R-Square                    C.V.               Root MSE                  T2CPU4 Mean
                 0.644309                65.36083             0.67690193                   1.03563851
Source                 DF             Type III SS            Mean Square      F Value          Pr > F
YR                     16             76.80222243             4.80013890        10.48          0.0001
QTR                     3            279.35873197            93.11957732       203.23          0.0001
AREA                    6            466.88744486            77.81457414       169.83          0.0001
OP                      6             71.97160077            11.99526680        26.18          0.0001
SZST                    3             83.92027563            27.97342521        61.05          0.0001
TARG                    3            556.48165371           185.49388457       404.84          0.0001

Dependent Variable: Ln(age 5+/1000 hooks)

Source                 DF          Sum of Squares            Mean Square      F Value          Pr > F
Model                  37           4164.45355898           112.55279889       217.73          0.0001
Error                5112           2642.61280018             0.51694304
Corrected Total      5149           6807.06635916
                 R-Square                    C.V.               Root MSE                  T2CP5P Mean
                 0.611784                73.14107             0.71898751                   0.98301479
Source                 DF             Type III SS            Mean Square      F Value          Pr > F
YR                     16            368.20107766            23.01256735        44.52          0.0001
QTR                     3            324.38613941           108.12871314       209.17          0.0001
AREA                    6            445.36969713            74.22828286       143.59          0.0001
OP                      6             42.66891762             7.11148627        13.76          0.0001
SZST                    3             96.03923918            32.01307973        61.93          0.0001
TARG                    3            419.72180385           139.90726795       270.64          0.0001
```

Table 4. Annual, standardized age-specific CPUE from the distributed effort method for the Gompertz aged CPUE for pooled sexes, expressed relative (REL column) to the 1981 mean, with approximate upper and lower 95% confidence intervals (UREL and LREL).

Yr	LREL	REL	UREL
		Age 1	
81	0.58501	1.00000	1.70938
82	0.80597	1.28964	2.06356
83	0.77396	1.18181	1.80458
84	0.81427	1.23448	1.87155
85	1.00438	1.52502	2.31554
86	1.41440	2.06350	3.01050
87	1.14422	1.65502	2.39385
88	1.31485	1.90351	2.75571
89	1.21851	1.75632	2.53150
90	0.94980	1.38953	2.03282
		Age 2	
81	0.72701	1.00000	1.37550
82	0.61155	0.81406	1.08364
83	0.72291	0.93508	1.20951
84	0.78266	1.00286	1.28502
85	0.79792	1.02648	1.32050
86	1.25951	1.58556	1.99601
87	1.29994	1.61711	2.01167
88	1.36710	1.70113	2.11678
89	1.48093	1.84678	2.30300
90	1.08477	1.35833	1.70088
		Age 3	
81	0.78250	1.00000	1.27795
82	0.66069	0.80344	0.97704
83	0.56388	0.67276	0.80265
84	0.70924	0.83706	0.98791
85	0.75603	0.89717	1.06465
86	0.78333	0.90971	1.05648
87	0.85271	0.97791	1.12149
88	0.89257	1.02308	1.17266
89	0.79943	0.91998	1.05871
90	0.83145	0.96033	1.10918
91	0.86762	1.00292	1.15932
92	0.73362	0.84272	0.96804
93	0.64111	0.73592	0.84475
94	0.68433	0.78699	0.90504
95	0.74836	0.86086	0.99027
96	0.76139	0.89092	1.04250
97	0.73988	0.86631	1.01434
		Age 4	
81	0.78325	1.00000	1.27673
82	0.71552	0.88037	1.08322
83	0.45570	0.55180	0.66817
84	0.51181	0.61295	0.73407
85	0.57223	0.68806	0.82734
86	0.47392	0.55994	0.66157
87	0.45470	0.53005	0.61790
88	0.46345	0.53995	0.62908
89	0.42847	0.50057	0.58481
90	0.41853	0.49195	0.57826
91	0.51328	0.60305	0.70850
92	0.42308	0.49444	0.57784
93	0.38332	0.44798	0.52355
94	0.38548	0.45071	0.52697
95	0.42759	0.50003	0.58473
96	0.39979	0.47442	0.56299
97	0.49063	0.58208	0.69058

Yr	LREL	REL	UREL
		Age 5+	
81	0.78433	1.00000	1.27498
82	0.67141	0.82667	1.01784
83	0.39918	0.48359	0.58585
84	0.32874	0.39526	0.47525
85	0.34558	0.41698	0.50314
86	0.22873	0.27087	0.32077
87	0.19521	0.22782	0.26589
88	0.18235	0.21251	0.24765
89	0.20296	0.23779	0.27860
90	0.18793	0.22099	0.25987
91	0.22609	0.26586	0.31261
92	0.18375	0.21462	0.25068
93	0.17565	0.20527	0.23989
94	0.14707	0.17218	0.20158
95	0.16994	0.19908	0.23322
96	0.16007	0.19031	0.22625
97	0.16729	0.19902	0.23677
		Age 5	
81	0.77649	1.00000	1.28785
82	0.72122	0.90125	1.12622
83	0.37391	0.46096	0.56827
84	0.34333	0.41949	0.51255
85	0.43553	0.53164	0.64897
86	0.35205	0.42322	0.50878
87	0.27484	0.32596	0.38659
88	0.25289	0.29937	0.35439
89	0.27594	0.32819	0.39033
90	0.26471	0.31626	0.37785
91	0.31095	0.37164	0.44419
92	0.25837	0.30683	0.36439
93	0.25051	0.29783	0.35408
94	0.21438	0.25512	0.30360
95	0.24047	0.28671	0.34183
96	0.25132	0.30378	0.36719
97	0.25305	0.30649	0.37122
		Age 6	
81	0.74696	1.00000	1.33875
82	0.81302	1.04693	1.34814
83	0.52304	0.66388	0.84265
84	0.45598	0.57188	0.71725
85	0.48862	0.61568	0.77577
86	0.32527	0.40225	0.49747
87	0.26107	0.31780	0.38685
88	0.23646	0.28743	0.34938
89	0.26195	0.32029	0.39162
90	0.23188	0.28462	0.34935
91	0.30852	0.37837	0.46405
92	0.24902	0.30397	0.37105
93	0.25403	0.30973	0.37765
94	0.19356	0.23692	0.29000
95	0.20384	0.25016	0.30699
96	0.17961	0.22452	0.28065
97	0.19360	0.24332	0.30580

Yr	LREL	REL	UREL
		Age 7	
81	0.65980	1.00000	1.51560
82	0.45465	0.68380	1.02845
83	0.37572	0.55637	0.82387
84	0.31628	0.46337	0.67885
85	0.32564	0.47905	0.70473
86	0.21307	0.31021	0.45162
87	0.17530	0.25260	0.36397
88	0.15869	0.22834	0.32856
89	0.17076	0.24680	0.35671
90	0.17638	0.25544	0.36994
91	0.19869	0.28778	0.41681
92	0.17367	0.25092	0.36253
93	0.15308	0.22142	0.32027
94	0.14361	0.20803	0.30135
95	0.14422	0.20877	0.30220
96	0.11830	0.17356	0.25462
97	0.12578	0.18544	0.27339
		Age 8	
81	0.71372	1.00000	1.40111
82	0.68158	0.93190	1.27415
83	0.54304	0.73238	0.98774
84	0.34677	0.46375	0.62020
85	0.42263	0.56145	0.74587
86	0.24960	0.32927	0.43436
87	0.22904	0.29534	0.38082
88	0.19012	0.24466	0.31486
89	0.20026	0.25955	0.33639
90	0.21162	0.27666	0.36170
91	0.21131	0.27603	0.36057
92	0.22061	0.28618	0.37125
93	0.18576	0.24137	0.31363
94	0.16923	0.22002	0.28606
95	0.20570	0.26835	0.35008
96	0.14774	0.19727	0.26339
97	0.12319	0.17011	0.23492
		Age 9+	
81	0.61950	1.00000	1.61422
82	0.39828	0.60806	0.92833
83	0.34743	0.52666	0.79834
84	0.22888	0.34375	0.51626
85	0.22368	0.33728	0.50859
86	0.14541	0.21723	0.32453
87	0.12393	0.18295	0.27007
88	0.11769	0.17362	0.25613
89	0.11989	0.17664	0.26024
90	0.10266	0.15282	0.22748
91	0.11070	0.16483	0.24544
92	0.09568	0.14212	0.21108
93	0.08740	0.12973	0.19257
94	0.07719	0.11490	0.17102
95	0.08745	0.13019	0.19381
96	0.06785	0.10217	0.15386
97	0.05704	0.08683	0.13218

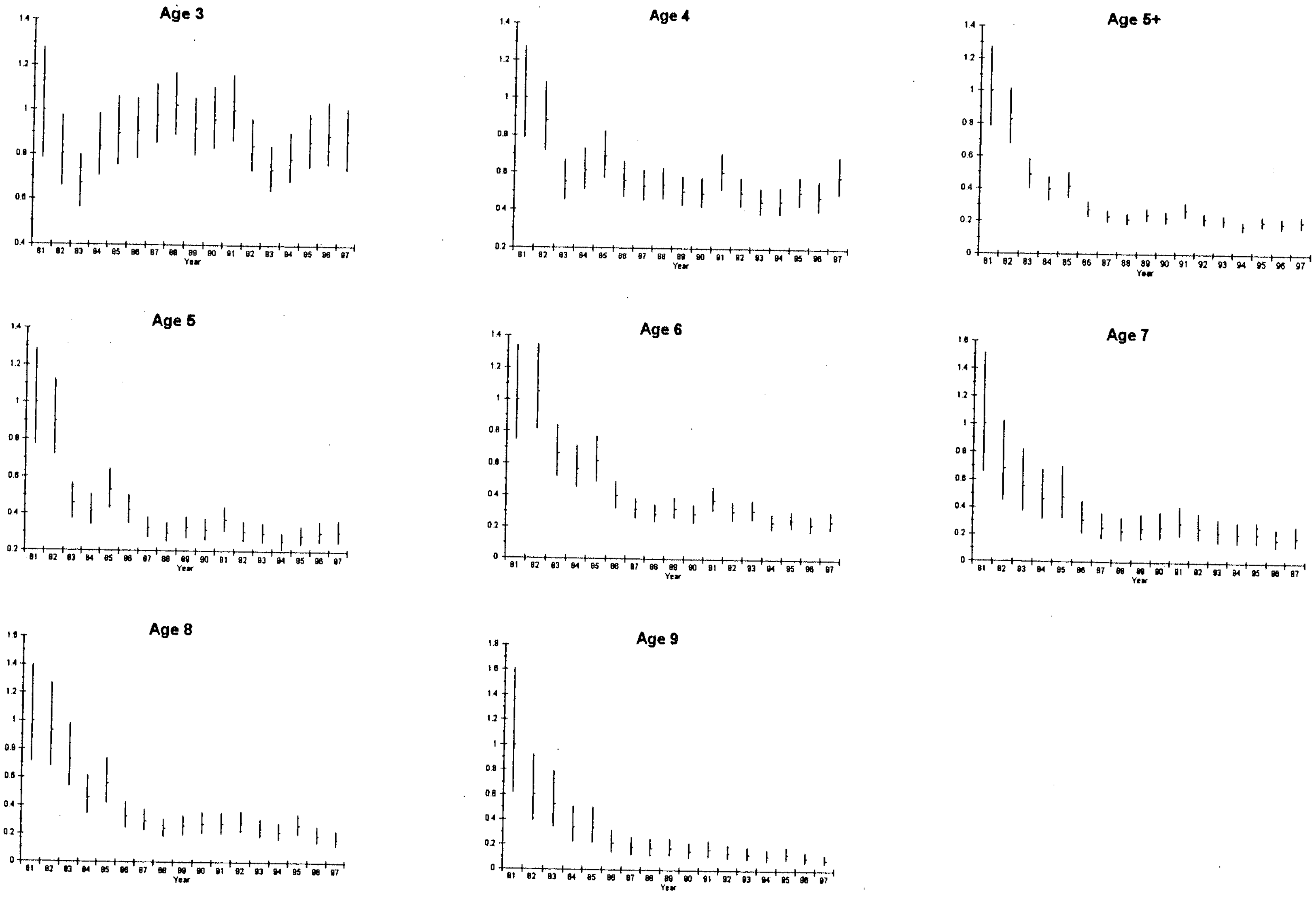

Figure 1. Swordfish age-specific relative abundance indices from the U.S. longline fishery.
Index time series is plotted relative to the 1981 estimated level.
Approximate 95% confidence intervals are shown.