Col.Vol.Sci.Pap. ICCAT, 27 : 256-266 (1988)

REVIEW OF THE U.S. FISHERY FOR SWORDFISH, 1978 TO 1986

J. Hoey, A. Bertolino
Southeast Fisheries Center
75 Virginia Beach Drive, Miami, Florida, U.S.A.

SUMMARY

The U.S. swordfish fishery during the period 1978 to 1986 is reviewed. Annual and regional landings data are presented and discussed in light of changing areas of operation. Gear information is described. Size composition data is presented along with preliminary data on CPUE.

RESUME

Le présent document passe en revue la pêche américaine d'espadon de 1978 à 1986. Des données y sont présentées sur les débarquements annuels régionaux, et y sont examinées à la lumière du déplacement des lieux de pêche. Une information est fournie sur les engins. Des données sont présentées sur la composition de taille, ainsi que des données préliminaires sur la CPUE.

RESUMEN

Se examina la pesquería estadounidense de pez espada durante el periodo 1978-1986. Se presentan datos de desembarques regionales y anuales y se tratan de acuerdo con las zonas de operación, que van cambiando. Se presenta información sobre artes así como datos de composición por tallas junto con datos preliminares de CPUE.

INTRODUCTION

As a result of a successful legal challenge of the U.S. Food and Drug Administration (FDA) guideline on methyl mercury levels in fish, the FDA increased the standard from 0.5 ppm to 1.0 ppm in 1978. This allowed for the legal resumption of the U.S. swordfish fishery which had operated for much of the early 1970's in an 'underground' fashion avoiding most reporting requirements (Hoey and Casey - SCRS/87/48). Combined with the acceptance of extended jurisdiction laws in the late 1970's by the Bahamas, Canada, and Mexico, and innovative gear developments particularly in southern areas of the U.S. fishery, significant changes occured in gear and operating (time-area) practices employed by the U.S. swordfish fleet. These events in the late 1970's and early 1980's changed the nature of the longline fishery and continue to influence recent developments. Currently the U.S. fishery operates from the north coast of South America through the Gulf of Mexico and along the east coast of the U.S. to the Tail of the Grand Banks and east of the Flemish Cap. Total harvests over the past 6 years have averaged 4,700 MT live weight.

The purpose of this paper is to describe current operating practices and recent changes in the U.S. swordfish fishery between 1978 and 1986. A review of annual and regional landings and size composition data in light of gear and CPUE information will hopefully provide an adequate description of general trends. Improvements in the U.S. swordfish data base would not have been possible without the support and cooperation of commercial fishermen, processing industry representatives, and port sampling agents.

GEAR INFORMATION

Because gear modifications have influenced time-area harvesting practices between 1978 and 1986, a description of these changes provides important background information which contributes to understanding trends in annual and regional landings data. During the early and mid-1970's, the 'underground' fishery was primarily dominated by New England fishermen who used longline gear which was similar in construction to Japanese tuna and Norwegian shark longline gear. This traditional gear was developed in the early 1960's by U.S. and Canadian fishermen and it remained relatively unmodified until the mid-1970's. In general, the gear was a shallow rigged pelagic longline with branch lines 10m or less and float lines 15m or less. More detailed information on gear and operating practices employed in this fishery is described in the 1960 - 1977 review of the U.S. fishery (Hoey and Casey, SCRS/87/48). By the mid-1970's, a new fishery developed, primarily among fishermen in southern Florida. Interest in this fishery was undoubtedly stimulated by the seasonal passage of New England

longliners through the Florida Straits, into the Gulf of Mexico for the winter fishery. Many of the Florida fishermen experimented with Cuban creole drift line techniques (Guitart-Manday 1964), and recreational fishing practices especially the innovative use of chemical light sticks ("Cyalume" Light-Trademark of American Cyanamid), and carefully rigged baits. Berkeley, Irby, and Jolley (1981) reviewed these developments and provide detailed descriptions of the different gears. The major changes included a switch from tarred nylon mainlines and branch lines to monofilament construction of branch and float lines and later to complete monofilament mainlines, increased hook spacing, increased branch and float line lengths, the use of chemical light sticks in conjunction with each bait, and a switch from mackeral to squid bait. The modified "Florida" gear was shown to be two to three times as effective as the traditional gear in the Straits of Florida based on mean numbers per 100 hooks from logbook records (Berkeley et al, 1981). The use of this gear spread rapidly at first throughout the fishery south of Cape Hatteras (35 N). As the southern vessels extended their fishing range into the traditional New England grounds (1981-1982) gear experimentation continued so that by 1983 the modified gear was widely accepted and deployed in all areas by the U.S. fleet. The modified gear used in northern areas is often not rigged with the long dropper and branch lines, now common in southern regions, and the hook spacing is also shorter, especially in areas dominated by sharp thermal gradients. The U.S. fleet utilizes variable gear configurations and dimensions adopting specific patterns for specific areas. Over time, individual operators have also made changes in the amount of gear deployed in a single set with many vessel operators adding sections of gear as they have obtained larger vessels and more experienced crews, or reducing the number of hooks set as traditional gear is replaced with modified gear. Daily strategy decisions regarding the pattern of setting the gear, in terms of depth and surface temperature contours, influence the amount of gear set and the spacing within the gear. As in most pelagic longline fisheries, because of the amount of gear set and the soak time, only one set is made each day. For swordfish directed effort, the gear is set at dusk and hauled at dawn. In the last three years, competition and declining catch rates for swordfish within the U.S. EEZ coupled with dramatic increases in the value and demand for yellowfin and bigeye tuna, has led to fleet diversification with some operators concentrating on year-round tuna fisheries. This has led to additional gear and operating changes focusing on daytime tuna sets.

ANNUAL AND REGIONAL LANDINGS

Total annual landings are listed in Table 1 as dressed carcass weight (pounds) and live weight (pounds and metric tons). Landings rose from 3,684 MT in 1978 to 5,624 MT in 1980 and have remained between 4,529 and 5,086 MT during the past 6 years. Although longline landings have dominated the U.S. swordfish fishery since 1962, recent harpoon landings have declined from a three year average of 650 MT between 1978 and 1980 to less than 60 MT in 1984. More recent estimates of harpoon landings are considered unreliable although they are undoubtedly lower than 40 MT.

For the purpose of examining regional trends in U.S. landings, Table 2 provides landings in Metric tons live (round) weight and annual percentages for 5 geographical areas. The areas include the Caribbean, Gulf of Mexico, Southeast U.S. (Florida to South Carolina), Northeast U.S. (North Carolina to Maine), and Grand Banks region (30 W to 60 W longitude). Although U.S. fishermen had worked areas along the Scotian shelf in the 1960's and early 1970's, extended jurisdiction closed those areas within 200 miles of the Canadian coast. U.S. operations then moved to international waters at the Tail of the Grand Banks and Flemish Cap. Landings information indicates that the regional pattern in U.S. landings changed from a predominance of northern (N of 35 N) landings to a slight predominance of southern (S of 35 N) landings (56% to 58%) between 1980 and 1983. In the past two years landings have been almost equally split between northern and southern areas. Landings from the Caribbean and Grand Banks areas have taken on increased importance as the U.S. fleet has extended its range to the Northeast and Southeast. Increased landings from these international waters has resulted in a reduction in the proportion of landings attributed to the U.S. coastal areas (Table 2). The dramatic increase in Southeast U.S. landings from less than 1,000 MT in 1978 to consistent harvests exceeding 2,000 MT between 1980 and 1983, and the rapid increase in Caribbean landings highlights the dramatic effect the gear modifications, which allowed for successful commercial operations in southern waters, had on the recent history of the U.S. swordfish fishery.

Currently, landings are reported in every month in all areas with the exception of February and March in the northernmost regions. In general, peak landings for areas south of 35 N occur during winter and spring months, while landings north of 35 N peak in late summer and early fall. Between 1978 and 1986, landings within northern regions have expanded across months, so that more harvesting is occurring in spring and late fall months now than in earlier years. Landing patterns in the Gulf of Mexico in recent years appear to be influenced by the developing yellowfin tuna fishery. Swordfish landings are now increasing in months of high yellowfin abundance. Landings off the southeast U.S. appear to have shifted slightly to earlier months in the most recent years (1985-1986), especially to earlier months in the Caribbean region. A great deal of the expansion into the Caribbean can be attributed to the diversion of the southeast U.S. fleet into the more southerly latitudes in the last two years.

SIZE FREQUENCY SAMPLE

Based on cooperative work by Florida Sea Grant (Berkeley and Houde 1980, 1981), South Carolina Marine Resources Department personnel, NMFS personnel at the Southeast Fisheries Center, and support from the commercial sector, the available size frequency data for the U.S. swordfish fishery has been improved over the past 5 years. The size frequency data base records dressed (headed, gutted, tailed) carcass weights of individual fish as they are offloaded at the end of a trip. In addition to the individual weights, vessel, gear, port, date, fishing area, and when available trip effort totals (hooks and sets) are recorded for each trip sampled. Annual size frequency samples are described in Table 3 which lists the numbers of fish weighed as well as the total sampled dressed weight. The sample percentage of the total weight harvested is also indicated. In each of the past 5 years over 50,000 fish accounting for more than 50% of the total U.S. harvested weight have been sampled. Annual numbers sampled by 20 pound increments of dressed weight are listed in Table 4 and presented as annual size frequency histograms and cumulative frequency plots in Appendix 1. Table 5 summarizes the number of trips sampled for size frequency by year and area. Based on the large number of trips sampled and the large proportion of the total harvest weight accounted for by the annual sample, the annual size frequency histograms are representative of the size composition of the U.S. harvest. A more detailed analysis of area-time specific size frequencies is beyond the scope of this paper.

CATCH PER UNIT EFFORT

Catch per unit effort data from the U.S. swordfish fishery from 1978 thru 1986 must be standardized to account for the previously described gear changes. Area specific characteristics and changes adopted over time need to be evaluated. In this section, sources of CPUE data are described and mean CPUE values are provided by year and area. Mean CPUE values for all sizes combined should be interpreted with caution as they are undoubtedly influenced by the variability of U.S. gear configurations, changes over time, as well as variability in age-class strength and age (size) specific distribution patterns.

As previously mentioned, trip effort in total hooks fished and numbers of sets are occasionally reported with the size frequency data, collected as a result of interviews conducted by NMFS port samplers, or developed by comparing available logbook records to the size frequency data. In most cases trip effort data was assigned to the specific trip sampled. In the 1979 and 1980 Southeast U.S. sample, trip effort was assumed constant for a specific vessel-year combination based on interviews with captains. Because that fishery was dominated by small vessels making short 1 to 3 day trips, this was considered to be a reliable procedure for estimating trip effort (Berkeley and Houde 1981, Berkeley and Irby 1982). The trip effort data is associated with individual weights of swordfish landed from that trip. Catch rates can therefore be calculated in terms of numbers or weight for the total catch or for specific size categories. In comparison to the number of trips sampled for size frequency (Table 5), the number of trips with associated hook effort (Table 6a) or set effort (Table 7a) represent a reduced sample. Mean numbers per 1000 hooks and mean numbers per set are presented in Tables 6b and 7b respectively.

Logbook records voluntarily submitted to the senior author by a limited number of captains, and records from U.S. domestic observer trips on longline vessels provide a second source of CPUE data. This sample represents a limited number of vessels and captains (23), with several vessels represented by short time series. Total numbers of swordfish caught on a single set are recorded without associated size data. Mean CPUE's in either number per 1,000 hooks or number per set, were calculated by averaging individual set values (average of ratios - Rothschild and Yong 1970). The number of individual set records by area and year and associated mean CPUE values in number per 1,000 hooks and number per set are presented in Table 8. In light of the variable gear configurations used by the U.S. fleet, and the variable sizes of fish included in these individual set records, variability in hook and set based CPUE values is expected.

LITERATURE CITED

Berkeley, S.A. and E.D. Houde. 1980. Swordfish, Xiphias gladius, dynamics in the Straits of Florida. ICES C.M.1980/H:59, 11p.

Berkeley, S.A. and E.D. Houde. 1981. Population parameter estimates and catch-effort statistics in the broadbill swordfish (Xiphias gladius) fishery of the Florida Straits. ICES C.M.1981/H:35, 14p.

Berkeley, S.A., E.W. Irby, Jr., and J.W. Jolley, Jr. 1983. Florida's commercial swordfish fishery: Longline gear and methods. Univ. of Miami Sea Grant Program, Marine Advisory Bulletin. MAP 14, 23p.

Berkeley, S.A. and E.W. Irby, Jr. 1982. Analysis of catch, effort and landing data in the swordfish fishery of the Florida Straits. ICES C.M.1982/H:53, 12p.

Guitart-Manday, D. 1964. Biologia pesquera del Emperador o Pez de Espada, Xiphias gladius Linnaeus (Teleostome: Xiphiidae), en las aguas de Cuba. Poeyana, Series B, No.1, 37p.

Hoey, J.J. and J.G. Casey. 1987. Review of the U.S. Fishery for Swordfish, 1960 to 1977. SCRS/87/48

Rothschild, B.J. and M.Y. Yong. 1970. Apparent abundance, distribution and migrations of albacore, Thunnus alalunga, on the North Pacific longlining grounds. U.S. Fish Wildl. Serv., Spec. Sci. Rep.-Fish. No. 623, 37p.

TABLE 1. Annual U.S. landings in pounds dressed carcass weight and in pounds and metric tons live (round) weight.

YEAR	ANNUAL LANDINGS		
	DRESSED WEIGHT (LBS)	LIVE WEIGHT (LBS)	(MT)
1978	6,106,480	8,121,618	3,684
1979	7,654,873	10,180,981	4,618
1980	9,322,469	12,398,884	5,624
1981	7,506,809	9,984,056	4,529
1982	8,430,979	11,213,202	5,086
1983	7,957,652	10,583,677	4,801
1984	7,522,113	10,004,410	4,538
1985	7,654,322	10,180,248	4,618
1986	8,095,144	10,766,542	4,884

TABLE 2. Annual U.S. landings in metric tons live weight for five geographical regions in the North Atlantic. The regional percentage of annual total landings is listed.

	YEARS								
AREA	78	79	80	81	82	83	84	85	86
CARIBBEAN	0	0	0	0	0	0	25.4	394.7	1152.6
PERCENT(%)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.6)	(8.6)	(23.6)
GULF OF MEXICO	25.6	252.5	861.5	588.5	627.9	367	367.2	575	422.3
PERCENT(%)	(0.7)	(6.0)	(15.3)	(13.0)	(12.4)	(7.6)	(8.1)	(12.5)	(8.7)
SOUTHEAST U. S.	527.2	1817.9	2324.9	2021.1	2220.3	2071.2	1738.6	1500.5	902.6
PERCENT(%)	(14.3)	(39.4)	(41.3)	(44.6)	(43.7)	(43.1)	(38.3)	(32.5)	(18.5)
NORTHEAST U. S.	3063.6	1720.8	1913.6	1464.3	1604.3	1670.7	1460.6	889.2	1012.9
PERCENT(%)	(83.2)	(37.3)	(34.0)	(32.3)	(31.5)	(34.8)	(32.2)	(19.3)	(20.7)
GRAND BANKS	67.5	826.9	524	454.7	633.8	691.9	946.2	1258.3	1393.3
PERCENT(%)	(2.0)	(17.9)	(9.3)	(10.0)	(12.5)	(14.4)	(20.9)	(27.3)	(28.5)
TOTAL	3684	4618	5624	4529	5086	4801	4538	4618	4884

TABLE 3. Annual U.S. size frequency samples in numbers of swordfish weighed, total dressed weight sampled, and the weight percentage of total U.S. landings.

YEAR	U.S. SIZE FREQUENCY SAMPLE NUMBERS	DRESSED WEIGHT (LBS)	TOTAL LANDINGS %
1978	8,690	856,748	14
1979	32,035	3,078,686	40
1980	52,095	4,493,265	48
1981	35,587	3,345,725	45
1982	55,640	4,930,497	58
1983	54,801	4,624,911	58
1984	58,172	4,230,378	56
1985	69,455	5,163,044	67
1986	74,364	5,189,992	64

TABLE 4. Numbers of swordfish sampled by 20 pound increments of dressed (headed, gutted, tailed) weight from the U.S. fishery from 1978 to 1986.

	YEARS								
SIZE	1978	1979	1980	1981	1982	1983	1984	1985	1986
20	229	1525	3959	2278	4757	5597	5802	7781	7858
40	1105	6873	11267	6710	11055	13912	16349	16851	20010
60	1479	5453	9699	7126	9531	8835	11645	13071	13696
80	1512	4068	6609	4828	7859	6070	7033	9673	10797
100	1146	2986	4936	3105	5561	4422	4585	6374	7440
120	847	2320	3677	2385	3986	3416	3259	4327	4623
140	642	1852	2867	1863	3032	2820	2425	3056	2892
160	463	1437	2124	1423	2279	2158	1850	2173	1991
180	331	1180	1714	1252	1696	1703	1384	1523	1359
200	248	964	1258	985	1209	1312	1023	1131	909
220	183	713	959	751	985	1050	616	831	615
240	104	592	734	599	826	756	517	648	512
260	116	464	526	494	590	616	372	457	381
280	63	424	469	376	476	467	260	357	310
300	56	309	321	334	369	381	211	245	237
320	43	230	269	272	330	307	180	206	161
340	38	195	204	196	267	260	156	156	125
360	19	131	155	160	220	196	113	146	101
380	24	95	99	144	157	154	108	111	70
400	20	95	83	92	117	103	59	81	61
420	9	40	47	58	87	77	63	63	53
440	6	26	37	36	89	59	38	54	49
460	1	23	23	40	62	47	34	43	30
480	3	14	22	29	38	26	25	24	27
500	2	12	17	16	24	18	11	24	16
520		7	8	18	14	11	6	14	11
540	1	3	2	8	8	8	7	9	6
560		1	4	3	5	4	7	12	8
580		1	4		5	8	3	7	3
600			1	2	2		5	1	2
620					3	1		1	3
640				1		3		1	1
660				1		1	1	2	
680				1	1				
700							2		1
720							1		1
740						1			1
780									1
800								1	
880				1					

TABLE 5. Numbers of trips sampled for size frequency by area and year.

AREA	78	79	80	81	82	83	84	85	86
CARIBBEAN	-	-	-	-	-	-	4	61	219
GULF OF MEXICO	1	61	123	104	85	82	76	181	278
SOUTHEAST U.S.	88	1293	1552	1630	1736	1612	1296	1175	767
NORTHEAST U.S27	58	111	116	265	351	218	183	245	
GRAND BANKS	-	6	16	9	24	34	38	41	42

TABLE 6a. Numbers of sampled trips for size frequency and associated hook effort.

AREA	78	79	80	81	82	83	84	85	86
CARIBBEAN	-	-	-	-	-	-	-	11	19
GULF OF MEXICO	-	2	2	-	-	6	4	38	54
SOUTHEAST U.S.	-	744	1079	60	38	44	86	68	125
NORTHEAST U.S.	9	8	4	18	66	101	72	48	69
GRAND BANKS	-	2	5	3	6	15	18	22	18

TABLE 6b. Mean numbers per 1,000 hooks by area and year based on sampled trips with associated hook effort information.

MEAN CPUES(NUM/1000H) BY YEAR AND AREA

AREA \ YEAR	78	79	80	81	82	83	84	85	86
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	33.365	43.986
2	0.000	37.466	19.344	0.000	0.000	46.087	50.575	16.750	9.597
3	0.000	42.097	24.787	44.435	44.519	32.737	26.454	26.039	31.983
4	33.101	13.820	38.913	56.521	47.742	28.642	25.032	32.281	27.676
5	0.000	11.453	19.399	10.774	20.480	25.833	45.944	76.781	45.133

TABLE 7a. Numbers of sampled trips for size frequency and associated set effort.

AREA	78	79	80	81	82	83	84	85	86
CARIBBEAN	-	-	-	-	-	-	-	-	10
GULF OF MEXICO	-	2	2	-	-	6	1	21	54
SOUTHEAST U.S.	-	744	1079	60	38	44	85	66	125
NORTHEAST U.S.	9	8	4	18	66	97	69	39	68
GRAND BANKS	-	2	5	3	6	15	12	15	

TABLE 7b. Mean numbers caught per set by area and year for sampled trips with associated set effort information.

MEAN CPUES(NUM/SET) BY YEAR AND AREA

AREA \ YEAR	78	79	80	81	82	83	84	85	86
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.457
2	0.000	8.917	2.600	0.000	0.000	8.036	3.333	7.307	3.132
3	0.000	7.232	4.286	6.714	7.740	7.390	6.026	6.835	8.198
4	13.595	6.563	11.021	8.873	6.440	6.976	7.410	8.903	8.367
5	0.000	17.749	23.097	17.622	19.606	12.974	30.727	35.435	20.680

TABLE B. Numbers of individual set records by area and year with associated mean CPUE's based on numbers per 1,000 hooks and numbers per set.

NUMBERS OF SETS BY AREA AND YEAR FOR
THE CARIBBEAN, GULF, SE US, NE US, AND GRAND BANKS

AREA	78	79	80	81	82	83	84	85	86	TOTAL
1	0	0	0	0	0	2	0	0	64	66
2	9	27	87	4	0	14	26	123	27	317
3	38	66	131	174	143	172	307	293	61	1405
4	142	112	84	146	137	84	168	120	102	1095
5	17	31	65	80	348	437	27	14	0	1019

MEAN CPUE - NUMBER/1000 HOOKS

AREA	78	79	80	81	82	83	84	85	86
1	0.00	0.00	0.00	0.00	0.00	20.67	0.00	0.00	26.52
2	7.43	15.82	11.13	3.40	0.00	50.41	32.05	25.86	23.22
3	9.37	14.53	19.52	35.63	46.45	39.43	29.65	30.68	33.52
4	22.46	10.59	24.14	6.46	16.02	17.53	21.19	32.96	37.79
5	16.73	14.54	14.45	13.00	10.74	10.30	37.14	28.51	0.00

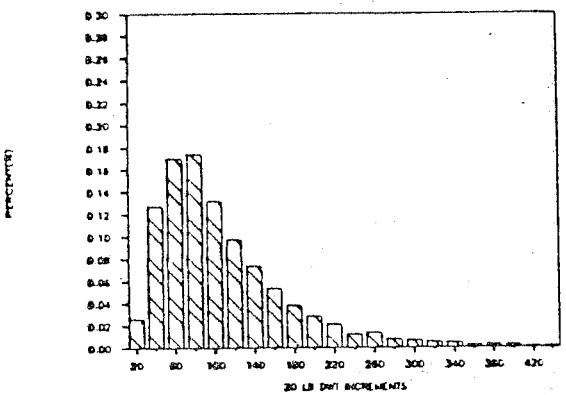
MEAN CPUE - NUMBER PER SET

AREA	78	79	80	81	82	83	84	85	86
1	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	8.67
2	3.00	23.52	11.13	2.75	0.00	8.71	7.42	6.55	5.52
3	4.76	6.73	6.37	5.81	8.48	7.69	6.95	6.13	8.69
4	22.81	7.19	7.99	6.30	5.88	4.27	5.20	8.67	11.70
5	32.12	26.16	22.55	22.31	13.57	14.20	23.19	32.00	0.00

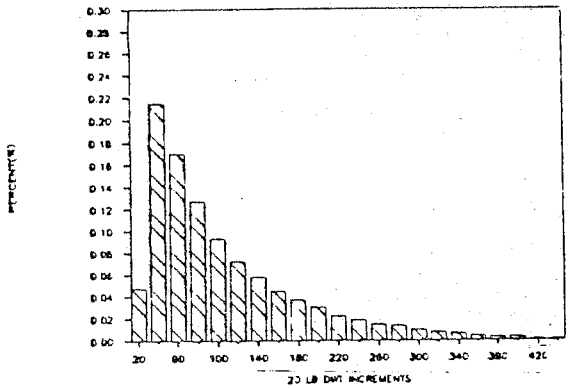
APPENDIX 1

Annual size frequency histograms and cumulative frequency plots for swordfish sampled from the U.S. fishery from 1978 to 1986

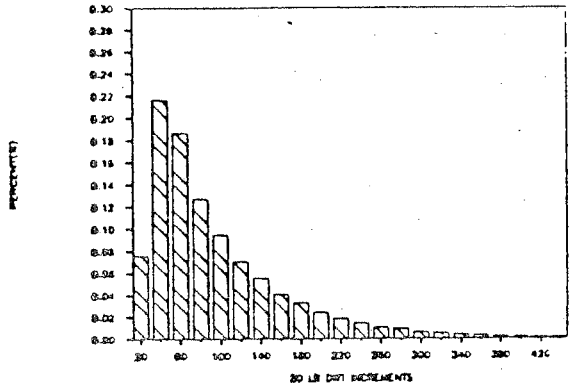
1978 U.S. SWORDFISH SIZE FREQUENCY



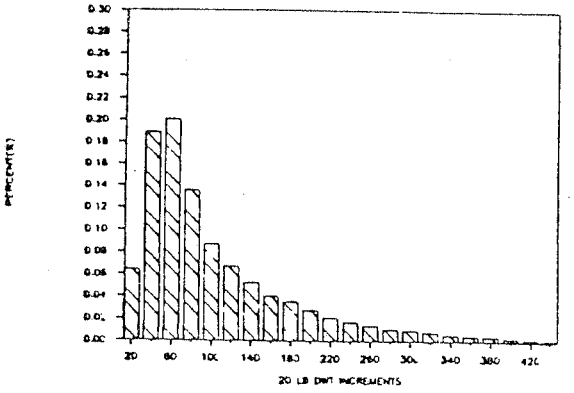
1979 U.S.SWORDFISH SIZE FREQUENCY



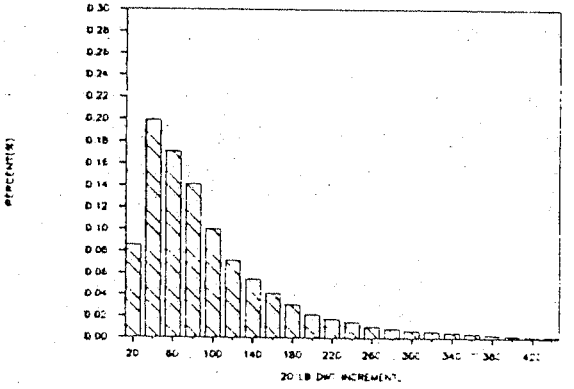
1980 U.S. SWORDFISH SIZE FREQUENCY



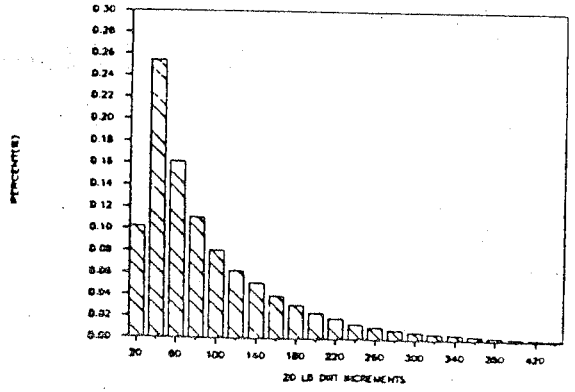
1981 U.S. SWORDFISH SIZE FREQUENCY



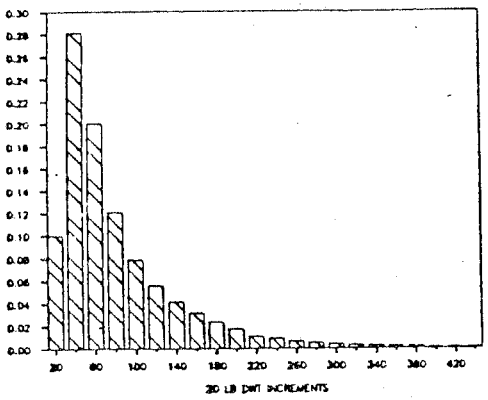
1982 U.S. SWORDFISH SIZE FREQUENCY



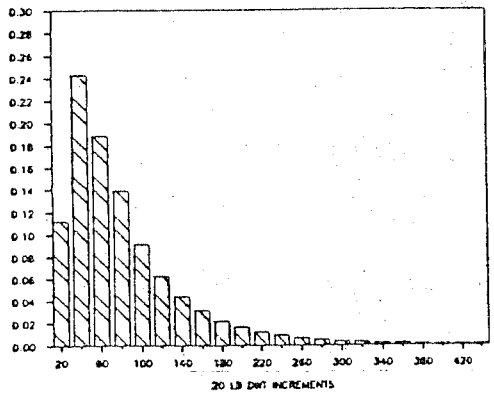
1983 U.S. SWORDFISH SIZE FREQUENCY



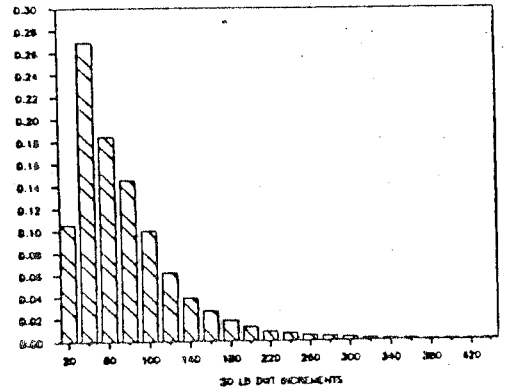
1984 U.S. SWORDFISH SIZE FREQUENCY



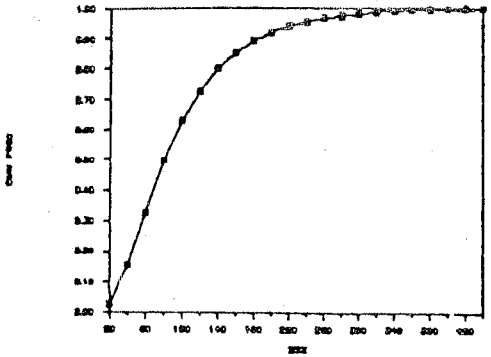
1985 U.S. SWORDFISH SIZE FREQUENCY



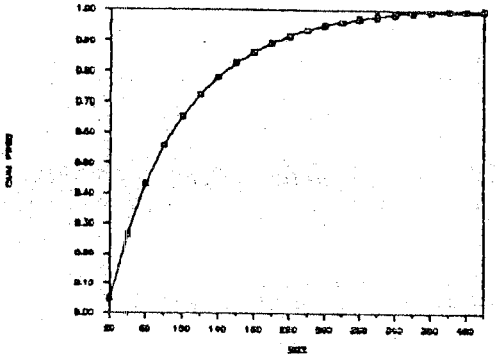
1986 U.S. SWORDFISH SIZE FREQUENCY



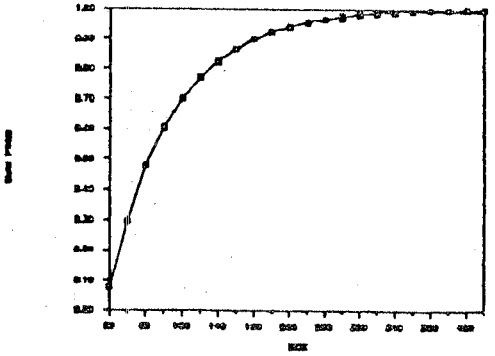
1978 U.S. CUMULATIVE FREQUENCY



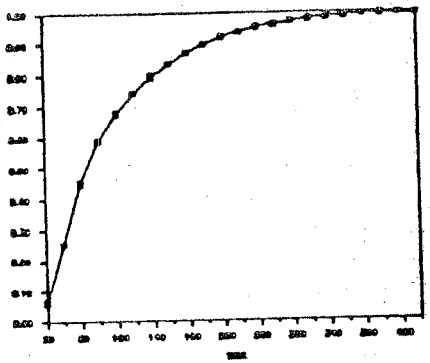
1979 U.S. CUMULATIVE FREQUENCY



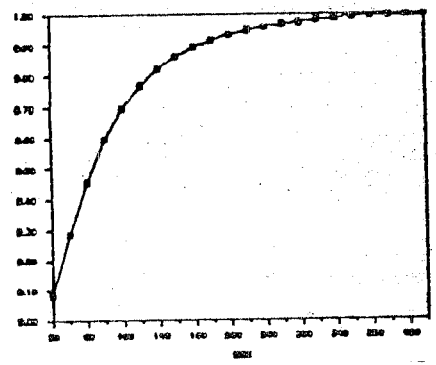
1980 U.S. CUMULATIVE FREQUENCY



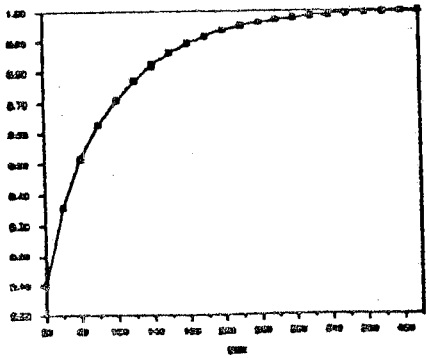
1981 U.S. CUMULATIVE FREQUENCY



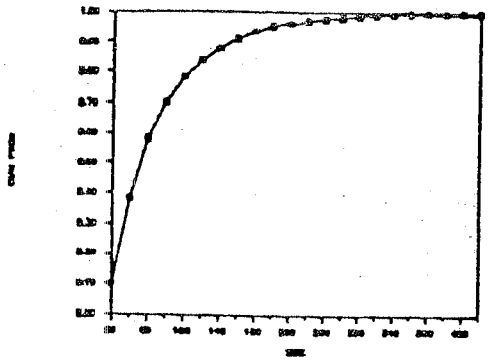
1982 U.S. CUMULATIVE FREQUENCY



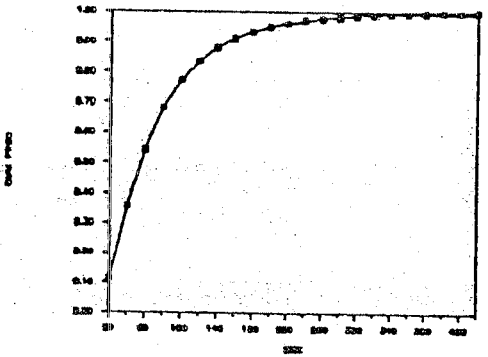
1983 U.S. CUMULATIVE FREQUENCY



1984 U.S. CUMULATIVE FREQUENCY



1985 U.S. CUMULATIVE FREQUENCY



1986 U.S. CUMULATIVE FREQUENCY