Col.Vol.Sci.Pap. ICCAT, 27 : 267-282 (1988)

REVIEW OF THE U.S. FISHERY FOR SWORDFISH, 1960 TO 1977

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SUMMARY

The U.S. swordfish fishery during the period 1960 to 1977 is reviewed. Landings, areas of operation, gear information, and CPUE data are presented. U.S. size frequency data is presented and compared to Canadian size frequency data from the 1960's.

RESUME

Le présent document passe en revue la pêche américaine d'espadon de 1960 à 1977. Il indique les débarquements, les zones d'opération, une description des engins et les données de CPUE. Les données américaines de fréquence de taille y sont présentées et comparées aux données canadiennes de fréquence de taille des années soixante.

RESUMEN

Se examina la pesquería estadounidense de pez espada durante el periodo 1960-1977. Se presentan datos sobre desembarques, zonas de operación, artes y CPUE. Se facilitan también datos estadounidenses de frecuencias de talla que se comparan con los datos canadienses de la misma naturaleza, correspondientes a la década de los años 60.

INTRODUCTION

In the early 1960's, incidental catches of swordfish by research vessels and by Norwegian and Japanese longliners prompted U.S. and Canadian fishermen to use pelagic longline gear for swordfish (Beckett 1971). From 1960 to 1970, the U.S. and Canadian fleets shared a common history as the seasonal harpoon fishery developed into a year round longline fishery. The switch to longline gear allowed for expanded operations in area and time. Similar gear and operating (time-area) strategies were developed, and longlining rapidly replaced harpoon gear as the dominant fishing method in the western North Atlantic. Reported landings for Canada, the United States, and Japan from the western North Atlantic increased from 2,800 MT (live) in 1960 (harpoon only) to 8,800 MT in 1963, and then stabilized at approximately 5,000 MT through 1971 (Caddy 1976). By the end of the 1960's a year-round fishery had developed which exploited most one degree squares along the edge of the continental shelf and the north wall of the Gulf Stream from Cape Hatteras, N.C. to the Tail of the Grand Banks and the Flemish Cap (46 N and 45 W). The Canadian fleet dominated this fishery, accounting for over 90% of the total harvest in the late 1960's. In early 1970, swordfish in the Gulf of Mexico were commercially exploited for the first time. During that same year, the U.S. Food and Drug Administration (FDA) instituted regulations prohibiting the interstate transportation and importation of swordfish which contained mercury in excess of 0.5 ppm. Although this regulation substantially reduced both U.S. and Canadian effort, an "underground" fishery soon emerged which avoided reporting landings and effort statistics. These regulations were legally challenged by the U.S. commercial industry and the FDA revised the standard from 0.5 ppm to 1.0 ppm in 1978 which allowed for the legal resumption of the U.S. fishery. The Canadian government revised their mercury regulations in 1979.

The purpose of this paper is to review available information from the U.S. swordfish fishery in the 1960's and 1970's. Information on the U.S. fishery in the 1960's is relatively limited primarily because it was significantly smaller than the Canadian fishery. Extensive size frequency data is available from the Canadian fishery in the 1960's (Beckett and Tibbo 1968, Beckett 1971, Caddy 1976) and this data is compared to the U.S. data. In the 1970's, due to the mercury restrictions, data is extremely limited from both fisheries. A review of the available data from the 1970's can provide insight into the response of the swordfish population to the effort reduction produced by the mercury restrictions. Data from the U.S. fishery from 1978 to 1986 are reviewed by Hoey and Bertolino (SCRS/87/47).

GEAR INFORMATION

The pelagic longline gear used by the U.S. and Canadian fleets to harvest swordfish was essentially bottom longline gear modified along the lines of pelagic gear used by the Japanese for tunas and the Norwegians for sharks. Gear dimensions and additional information can be found in Wilson and Bartlett (1967), Ruhle (1969), and Berkeley et al. (1981). In general, the gear was rigged relatively shallow with branch lines usually less than 10 meters in length and float lines less than 15 meters. The mainline was heavy multi-strand nylon line with a diameter of about 4mm (1/4 or 3/8 inch). Branch lines were also multi-strand nylon of a slightly smaller diameter with a short monofilament leader. Mustad shark hooks of either the 3/0 or 3-1/2/0 size were usually used with mackerel bait. Hooks were spaced 15 to 30 meters apart with anywhere from 5 to 10 hooks between floats and from several hundred to two thousand hooks set in a single night. The fishing strategy emphasized carefully tracking sea surface temperature patterns and water movements while covering large areas in search of sharp thermal boundaries and high concentrations of swordfish (Ruhle 1969).

ANNUAL AND REGIONAL LANDINGS

Total annual U.S. landings in pounds and metric tons live weight from 1962 through 1977 are listed in Table 1. As previously mentioned, the U.S. landings during the 1960's represent a small percentage of the total western North Atlantic harvests summarized by Caddy (1976). The gradual but steady increase in landings from 1971 through 1977 document the resurgence of the U.S. fishery during the period influenced by mercury restrictions. Because of the mercury restrictions, these landings estimates should be viewed with caution. It is important to note however, that the regulations were most effectively enforced on imports and not on inter-state transportation within the U.S. Estimated landings of 2,300 metric tons in 1975 and 1976, from a fishery that was subject to irregular enforcement, may in fact be reasonable values especially when viewed in terms of landings during the 1960's by the U.S. fleet.

Regional landings in metric tons (Table 2) for the 1960's and 1970's emphasize the concentration of the fishery in the northeast region of the U.S. Exploratory work in the Gulf of Mexico in 1969 attracted more substantial effort in 1970, while the first reported landings for the southeast occur in 1976. Although the accuracy of annual regional values for the 1970's is suspect, it would seem unlikely that the unreported southeast landings prior to the late 1970's exceeded 300 metric tons. In the northeast region, the seasonal pattern described by Beckett (1971) for the Canadian longline fleet applies to the U.S fleet as well. Vessels fished off Cape Hatteras in the winter and early spring and then moved along the edge of the continental shelf to Georges Bank in May and June. Effort progressed to the northeast along the Scotian shelf and the Grand Banks during the summer and fall months and then moved offshore as the water cooled over the continental shelf. The values for the U.S. harvest attributed to the Grand Banks region (30 W to 60 W longitude) based on reported landings by ICNAF statistical zones, document the longstanding importance of this region to the U.S. fleet and emphasize the close relationship that existed between the U.S. and Canadian fisheries.

SIZE FREQUENCY SAMPLE

The available U.S. size frequency data base for the 1960's and 1970's records individual dressed (headed, gutted, tailed) carcass weights with vessel, gear, port, date, fishing area, and associated trip effort information, when available, for each trip sampled. Because of the limited sample from the early 1960's, samples from 1962 and 1963 are combined as are samples from 1964 and 1965. No size frequency data is available from the U.S. fleet between 1966 and 1969 and between 1971 and 1973. Data from 1970 was collected by the Bureau of Commercial Fisheries and reflects almost a complete sample of the total harvest in the first year of commercial exploitation of the Gulf of Mexico.

Numbers sampled from the U.S. fleet by 20 pound increments of dressed weight are listed in Table 3 for combined 1962-1963 and 1964-1965 samples and annual samples for 1970, and 1974 to 1977. The data are presented as size frequency histograms in Appendix 1. These annual U.S. samples can be compared to Canadian size frequency data expanded to annual Canadian landings for 1959 through 1969 (Caddy 1977). Table 1 from that report is duplicated in Appendix 2 with annual size frequency histograms and cumulative frequency plots for 1960 through 1969. Two features in that Table need to be verified: (1) 1968 values for the 60-79 and 80-99 pound categories appear inordinately low, (2) 1969 values for all size categories appear to be an order of magnitude too high for a 4,800 MT harvest.

The combined 1962-1963 U.S. sample represents only November and December trips from Georges Bank. Samples from those months contain a greater proportion of small fish than the comparable 1962 or 1963 total annual Canadian size frequencies. The 1964-1965 combined U.S. sample reflects trips from May through September and it is very similar to the appropriate Canadian size frequencies. A comparison of Canadian size frequency histograms from the 1960's with the U.S. size frequencies from the more recent years (1974-1977 Appendix 1 - 1978-1986 Appendix 1 SCRS/87/47) provides perspective on size changes over almost three decades in the western North Atlantic. Size frequencies from the late 1960's do not appear to be significantly different from those of the late 1970's, while size frequencies from the

1980's have shifted toward smaller fish.

CATCH PER UNIT EFFORT

Catch per unit effort data from the U.S. swordfish fishery from the 1960's and 1970's through 1977, generally reflect stable gear configurations and standard operating (time-area) practices. Voluntarily submitted logbook records comprise the major source of available data. Total numbers of swordfish caught on each set are recorded without associated size data. Mean CPUE's in number per 1,000 hooks and number per set were calculated by averaging individual set values (average of ratios - Rothschild and Yong 1970). Numbers of individual set records by year and area and associated mean CPUE's in numbers per 1,000 hooks and number per set are presented in Table 4a (1961-1969) and 4b (1970-1977). Frequency histograms of mean CPUE values (number per 100 hooks) by year from 1962 to 1977 are presented in Appendix 3. Changes in these distribution patterns, with increased skewness and reduced frequencies of CPUE's greater than 3 fish per 100 hooks, correlate well with landings trends previously discussed. Hoey (1986) analyzed CPUE trends in this data from 1974 through 1982.

LITERATURE CITED

Beckett, J.S. and S.N. Tibbo. 1968. Recent changes in size composition of Canadian Atlantic swordfish catches. ICNAF redbook 1968 part III - Res. Doc.68/69, 62-66.

Beckett, J.S. 1971. Canadian swordfish longline fishery. ICCAT Col. Vol. Sci. Pap., (SCRS-1971) 71/36, 7p.

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.

Caddy, J.F. 1976. A review of some factors relevant to management of swordfish fisheries in the northwest Atlantic. Can. Fish. Mar. Serv. Tech. Rep. No. 633, 36p.

Caddy, J.F. 1977. Some approaches to elucidation of the dynamics of swordfish (Xiphias gladius) populations. Can. Fish. Mar. Serv. Tech. Rep. No. 1439, 10p.

Hoey, J.J. 1986. CPUE trends from set records of United States directed swordfish effort. Working paper 86/9. Swordfish Assessment Workshop, Miami Florida - April 1986: 11p.

Hoey, J.J. and A.R. Bertolino. 1987. Review of the U.S. Fishery for Swordfish, 1978 to 1986. SCRS/87/47.

Ruhle, P. 1969. Long-lining for swordfish. New England Marine Resources Information Program. Pub. 4, July 1969, 8p.

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.

Wilson, P.C. and M. Bartlett. 1967. Inventory of U.S. exploratory longline fishing effort and catch rates for tunas and swordfish in the Northwestern Atlantic, 1957-1965. U.S. Fish Wildl. Serv., Spec. Sci. Rep.-Fish. No. 543, 52p.

TABLE 1. Annual U.S. landings in pounds and Metric tons live (round) weight from 1962 to 1977.

YEAR	LIVE (ROUND) WEIGHT POUNDS	METRIC TONS
1962	994,414	451.1
1963	2,931,775	1,330.1
1964	3,217,642	1,460.0
1965	2,842,302	1,289.3
1966	1,438,399	653.0
1967	1,111,665	504.2
1968	626,721	284.3
1969	400,760	181.8
1970	650,680	295.2
1971	83,594	38.0
1972	575,641	261.1
1973	951,170	431.4
1974	3,800,407	1,724.0
1975	5,208,248	2,262.0
1976	5,134,063	2,329.0
1977	3,521,928	1,598.0

TABLE 2. Annual U.S. landings in Metric tons live weight for the swordfish fishery from 1962 through 1977 by five geographical areas in the North Atlantic. Regional percentage of total annual landings is listed.

	YEARS							
AREA	62	63	64	65	66	67	68	69
GULF OF MEXICO	0	0	0	0	0	0	0	0.7
PERCENT(%)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.4)
NORTHEAST U. S.	451	1330	1434	1262.4	634.2	504	274.2	181.1
PERCENT(%)	(100)	(100)	(98.2)	(98.9)	(97.1)	(100)	(96.5)	(99.5)
GRAND BANKS	0	0	25.4	26.8	18.8	0	10.2	0
PERCENT(%)	(0.0)	(0.0)	(1.7)	(2.1)	(2.8)	(0.0)	(3.5)	(0.0)
TOTAL	451	1330	1460	1289	653	504	284	182

	YEARS							
AREA	70	71	72	73	74	75	76	77
GULF OF MEXICO	156.6	0.6	0	6.5	22.6	59.4	177.5	1.1
PERCENT(%)	(53.1)	(1.4)	(0.0)	(1.5)	(1.3)	(2.5)	(7.6)	(0.1)
SOUTHEAST U. S.	0	0	0	0	0	0	118.9	88.5
PERCENT(%)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(5.1)	(5.5)
NORTHEAST U. S.	138.6	37.4	261	346.3	861.2	1484.9	1385	1269.5
PERCENT(%)	(47.0)	(98.4)	(100)	(80.3)	(50)	(62.8)	(59.5)	(79.4)
GRAND BANKS	0	0	0	78.6	840.1	818.1	647.3	238.4
PERCENT(%)	(0.0)	(0.0)	(0.0)	(18.3)	(48.7)	(34.6)	(27.8)	(15.9)
TOTAL	295	38	261	431	1724	2363	2329	1598

TABLE 3. Numbers of swordfish sampled by 20 pound increments of dressed (headed, gutted, tailed) weight from the U.S. fishery from 1962 to 1977.

	YEARS						
SIZE	62-63	64-65	1970	1974	1975	1976	1977
20	8	1	42	47	69	67	120
40	60	25	376	133	212	354	350
60	116	68	462	83	222	308	384
80	104	95	338	72	203	243	359
100	101	152	266	71	166	159	254
120	79	163	269	50	131	157	211
140	62	130	259	34	100	115	166
160	60	115	212	24	77	91	114
180	42	121	152	8	55	63	62
200	25	85	93	14	45	39	58
220	23	86	58	12	43	21	32
240	20	71	32	6	15	21	26
260	12	44	24	2	12	21	20
280	10	38	11		10	5	12
300	8	32	8	4	5	5	7
320	5	14	5	1	3	6	5
340	1	6		2	1	4	3
360	1	4			1	3	6
380		5					1
400		1		1			3
420							
440							
460							
480		1					
500							
520							
540							
560							
580							
600							

TABLE 4. 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	61	62	63	64	65	66	67	68	69	TOTAL
2	0	0	0	0	0	0	0	8	12	20
3	0	0	2	7	7	5	0	0	0	21
4	9	54	151	330	130	99	5	62	0	840
5	0	0	4	1	5	11	0	5	0	26

MEAN CPUE - NUMBER/1000 HOOKS

AREA	61	62	63	64	65	66	67	68	69
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.89	7.12
3	0.00	0.00	0.00	6.12	11.01	0.67	0.00	0.00	0.00
4	8.81	32.44	27.63	14.62	11.25	6.83	2.33	9.34	0.00
5	0.00	0.00	5.95	0.00	1.33	7.13	0.00	4.69	0.00

MEAN CPUE - NUMBER PER SET

AREA	61	62	63	64	65	66	67	68	69
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.38	3.08
3	0.00	0.00	0.00	4.00	7.71	1.00	0.00	0.00	0.00
4	1.44	15.37	17.48	11.04	11.13	9.19	1.20	13.18	0.00
5	0.00	0.00	1.75	0.00	0.80	10.27	0.00	5.60	0.00

AREA	70	71	72	73	74	75	76	77	TOTAL
1	0	0	0	0	0	0	5	0	5
2	212	10	0	6	66	71	27	15	407
3	0	0	0	0	1	15	57	63	136
4	25	0	0	24	79	142	92	67	429
5	0	0	0	10	19	46	27	24	126

MEAN CPUE - NUMBER/1000 HOOKS

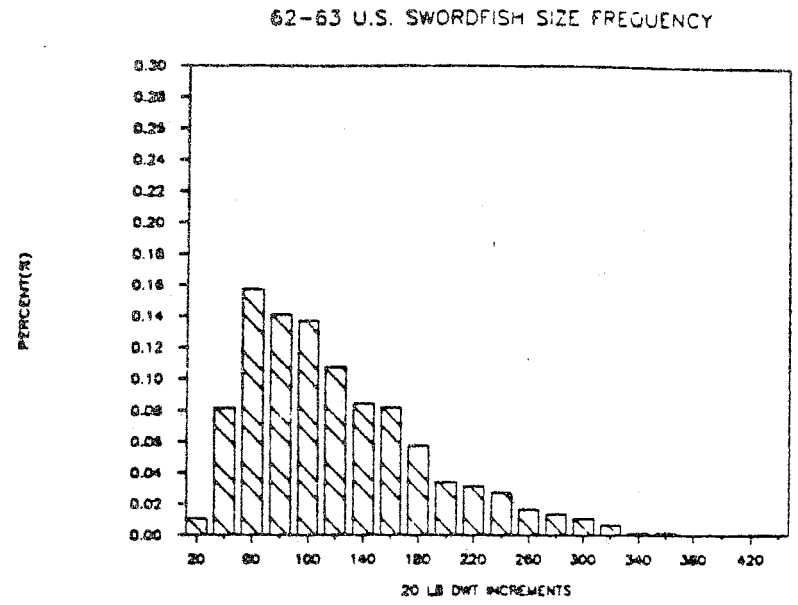
AREA	70	71	72	73	74	75	76	77
1	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00
2	15.02	10.75	0.00	10.77	18.24	5.72	5.42	4.31
3	0.00	0.00	0.00	0.00	1.01	16.35	9.37	12.88
4	18.54	0.00	0.00	28.19	15.99	11.37	10.54	27.04
5	0.00	0.00	0.00	33.39	32.68	17.32	9.39	10.82

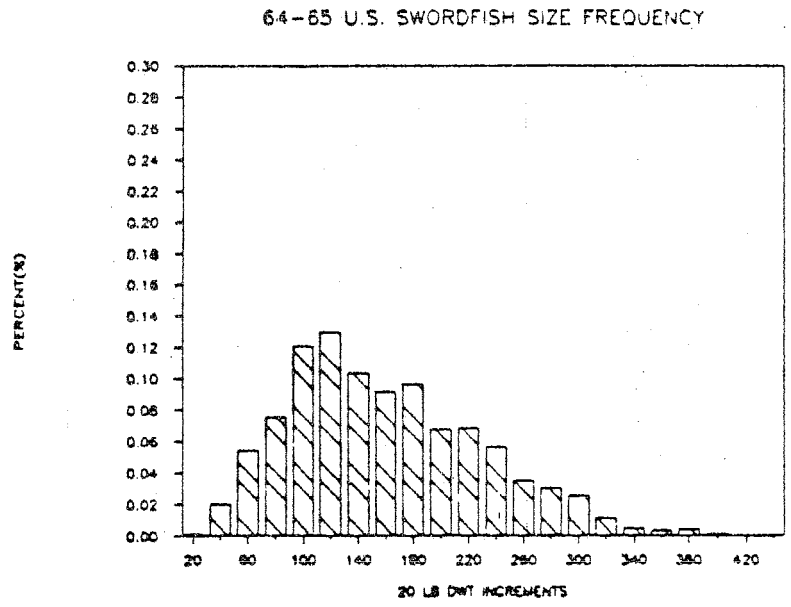
MEAN CPUE - NUMBER PER SET

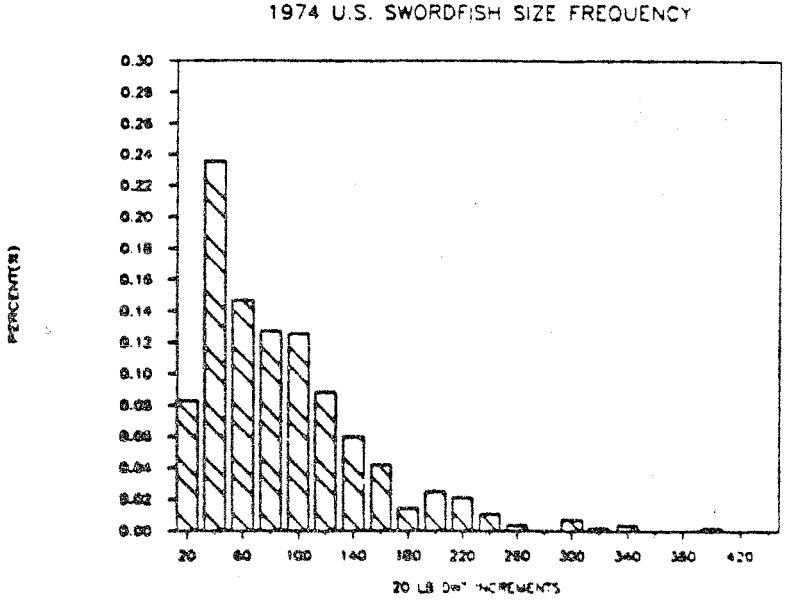
AREA	70	71	72	73	74	75	76	77
1	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00
2	16.31	12.80	0.00	10.33	24.82	5.36	3.59	2.40
3	0.00	0.00	0.00	0.00	1.00	11.33	9.21	6.94
4	24.40	0.00	0.00	40.21	17.97	10.08	10.75	20.90
5	0.00	0.00	0.00	56.30	63.11	24.57	17.22	19.29

APPENDIX 1

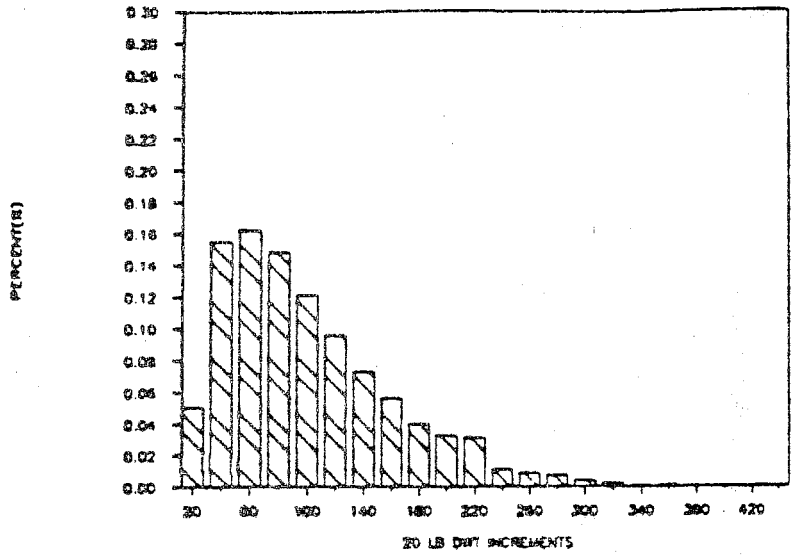
Annual size frequency histograms for swordfish sampled from the U.S. fishery from 1962 to 1977.



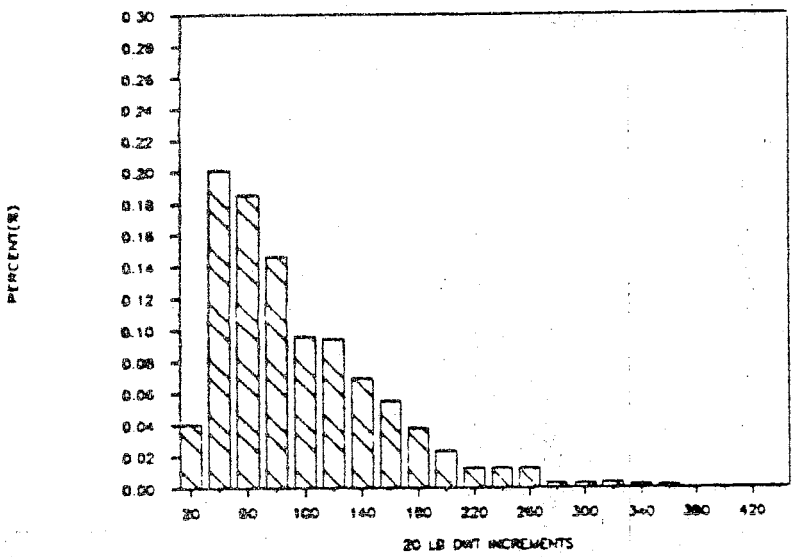




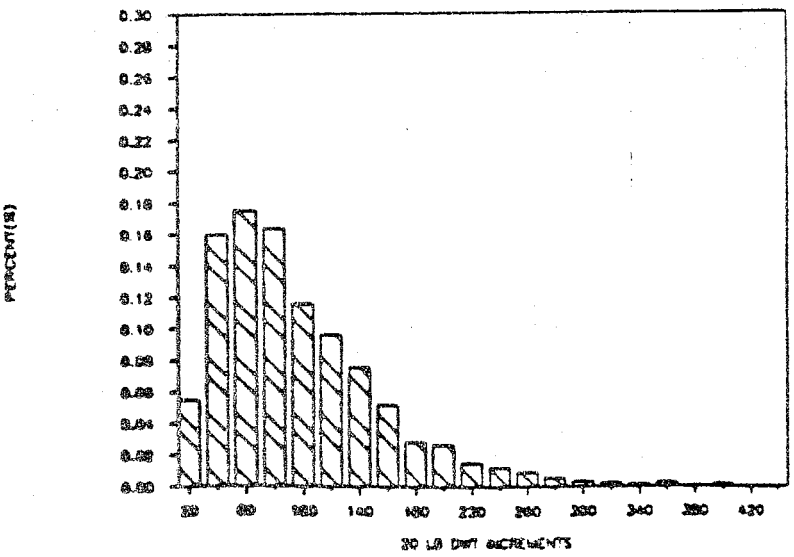
1975 U.S. SWORDFISH SIZE FREQUENCY

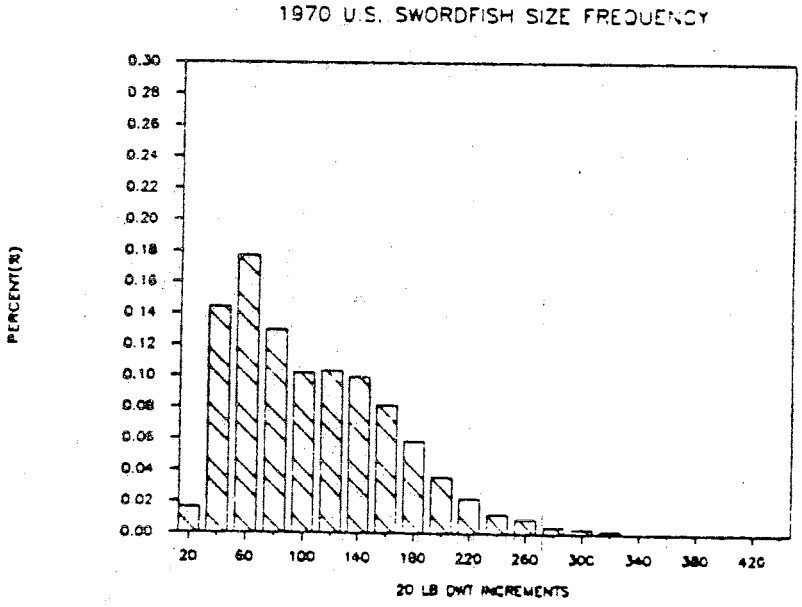


1976 U.S. SWORDFISH SIZE FREQUENCY



1977 U.S. SWORDFISH SIZE FREQUENCY




1970 U.S. SWORDFISH SIZE FREQUENCY
PERCENT(%)
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
20
60
100
140
180
220
260
300
340
380
420
20 LB DWT INCREMENTS

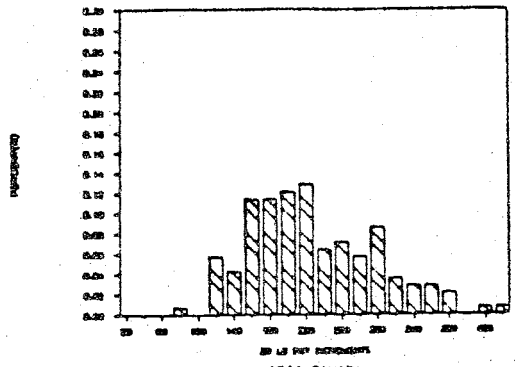
APPENDIX 2

Annual size frequency histograms and cumulative frequency plots for estimated numbers caught by dressed weight category from the Canadian swordfish fishery from 1960 to 1969. Estimated numbers by 20 pound increments presented by Caddy (1977) in Table 1.

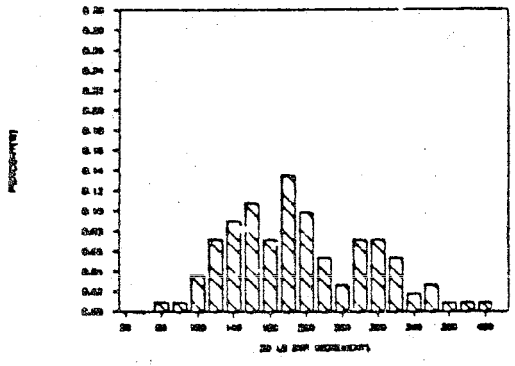
Table 1. Estimated numbers by dressed weight category of Canadian swordfish annual landings, 1959-69 incl., based on total landed weight + port samples of commercial catch.

Dressed wt (lb)	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
<20					36	140	467	346	617	3403	20198
20-39					805	2131	2555	1963	4003	9556	113879
40-59	48		134		2930	6513	3809	2997	7757	9512	80509
60-79	478	126	134	128	3652	6551	6007	4355	9445	11114	90724
80-99	1621		537	352	4340	8517	6383	4917	9496	11820	91955
100-119	3235	1008	1073	1121	5055	8366	6689	5622	8306	9093	74009
120-139	4758	756	1341	2149	6389	7351	5823	6031	6455	9527	55936
140-159	5279	2016	1609	2421	7232	6839	4929	5488	5064	4435	39456
160-179	5217	2016	1074	2680	7900	6739	3840	4337	3818	2946	30124
180-199	4803	2142	2014	2437	7509	6263	3345	3482	3018	2267	24157
200-219	3234	2268	1476	1648	5729	4767	2478	2602	1828	1646	16599
220-239	2527	1134	805	1520	4531	3887	2206	2071	1535	1162	11193
240-259	1954	1260	402	1328	3745	2996	1585	1582	1016	829	9558
260-279	1145	1008	1072	612	2701	2198	1242	1315	736	693	7003
280-299	621	1512	1073	512	1923	1732	1108	947	652	450	5016
300-319	336	630	804	352	1446	1053	689	695	495	292	4062
320-339	479	504	268	272	1153	782	463	425	296	248	2419
340-359	240	504	402	176	770	430	340	289	265	206	1652
360-379	143	378	134	96	750	402	254	238	236	185	1770
380-399	288		134	48	586	230	222	99	188	80	944
400-419	96	126	134	16	345	82	137	89	131	58	1239
420-439	96	126		48	190	81	139	64	148	47	531
440-459			134	48	193	82	70	49	108	30	413
460-479	48	126		16	73		30	20	58	52	295
480-499			134	16	45		69	20	34	6	295
500-519					45		20	4	52	23	236
520-539				16	9		20	4	57	12	177
540+	48				36		20	24	75	12	236

1960 CANADA



1961 CANADA



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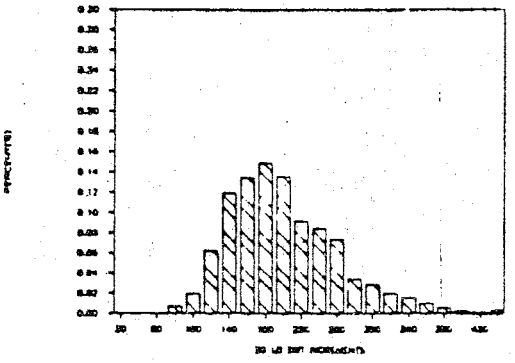

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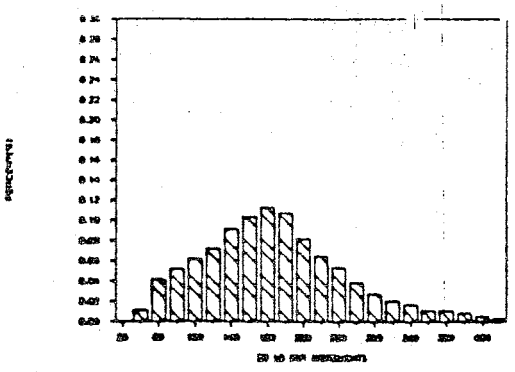
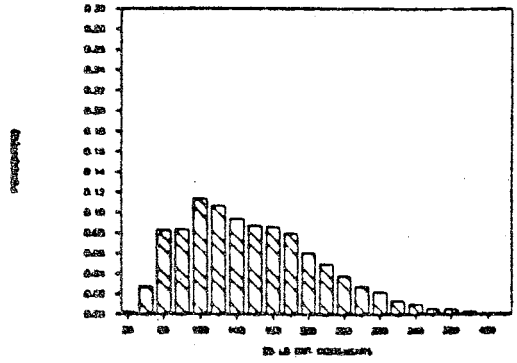


1964 CANADA



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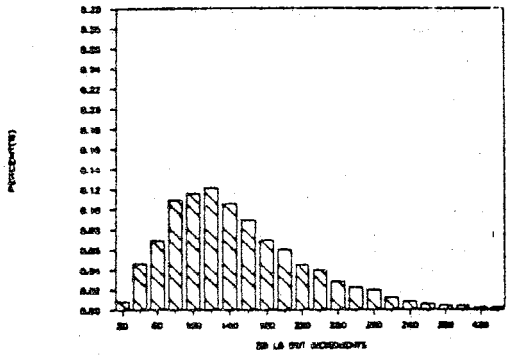

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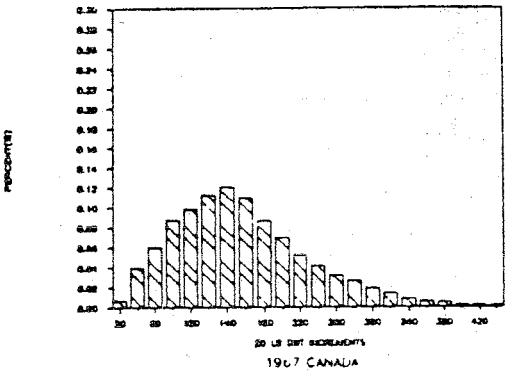

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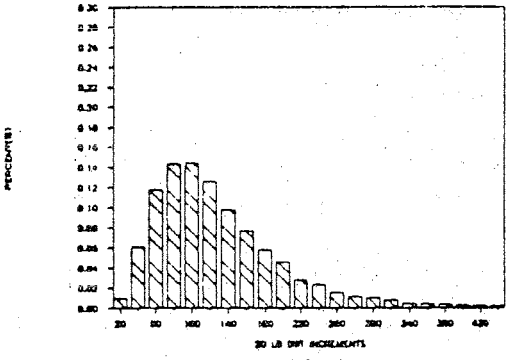

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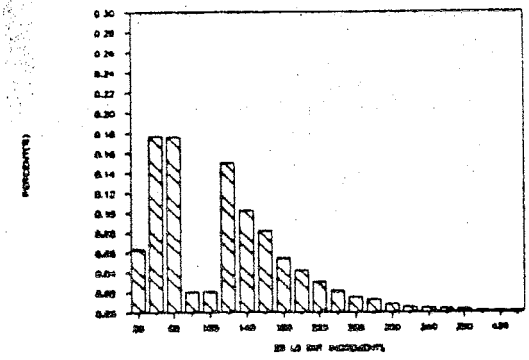

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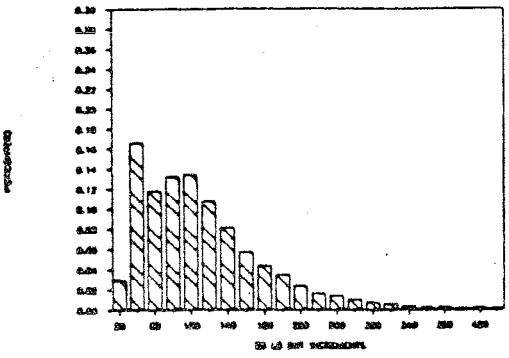
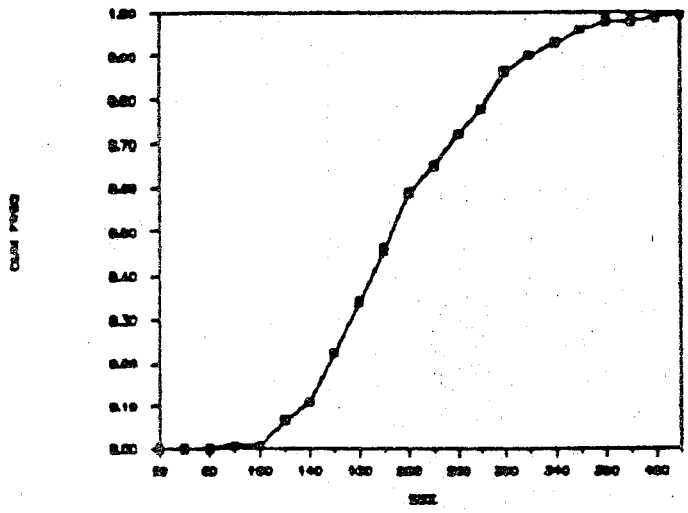


1960 CANADA CUMULATIVE FREQUENCY



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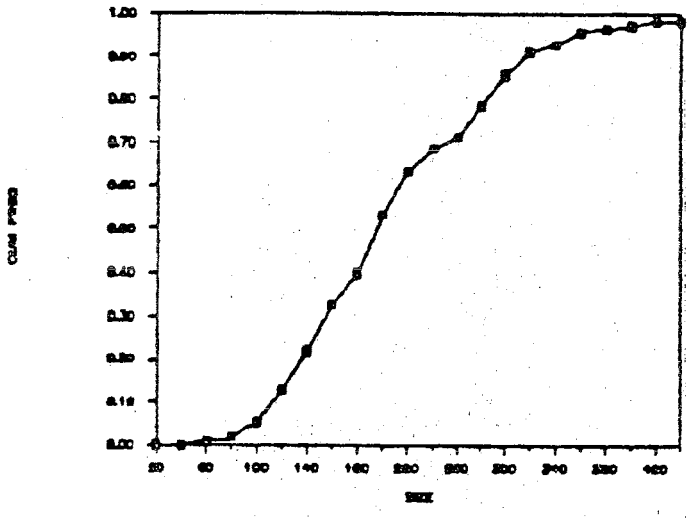

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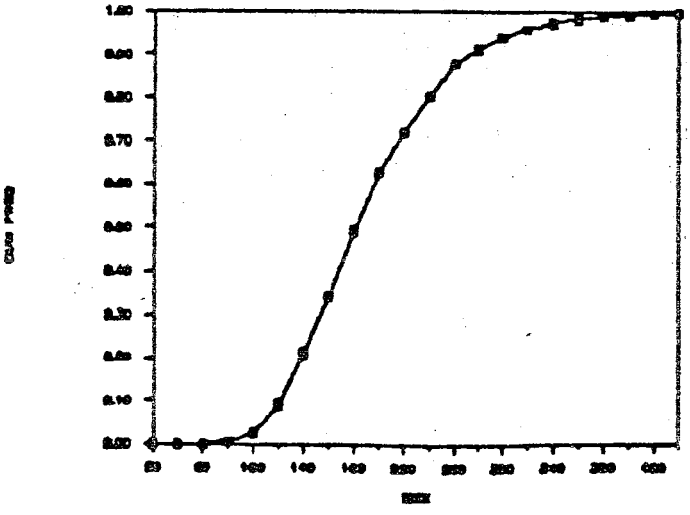

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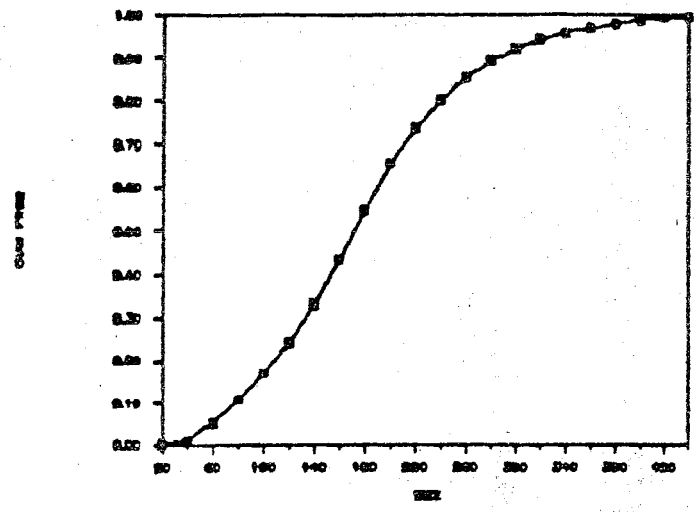

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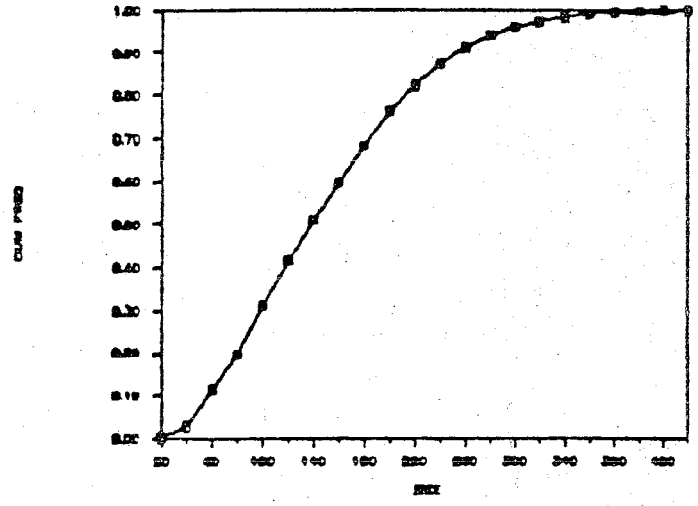

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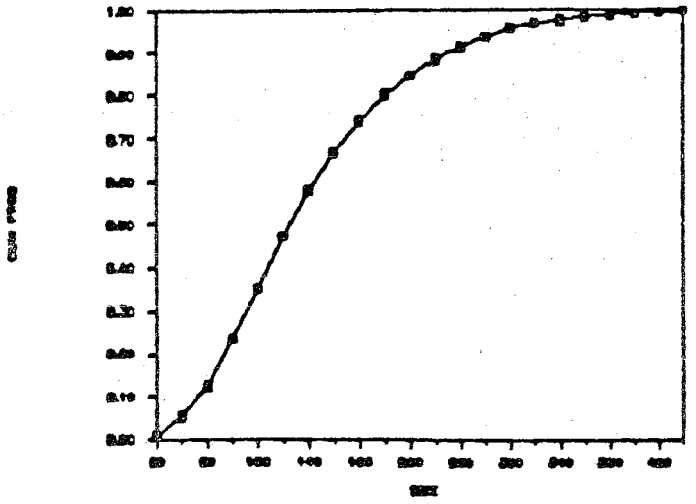

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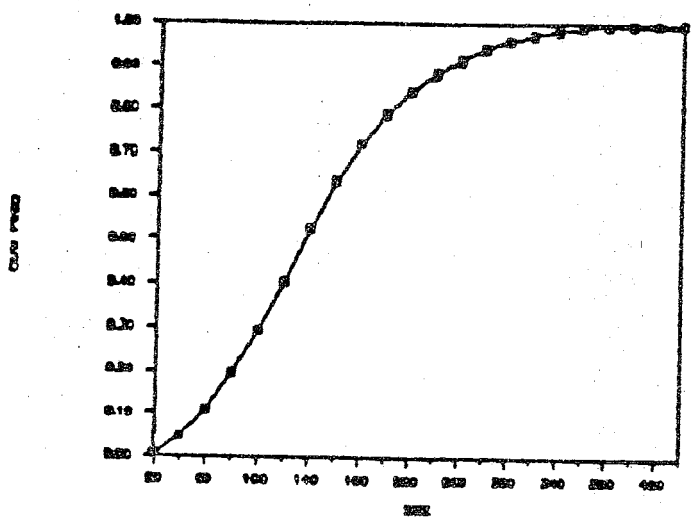

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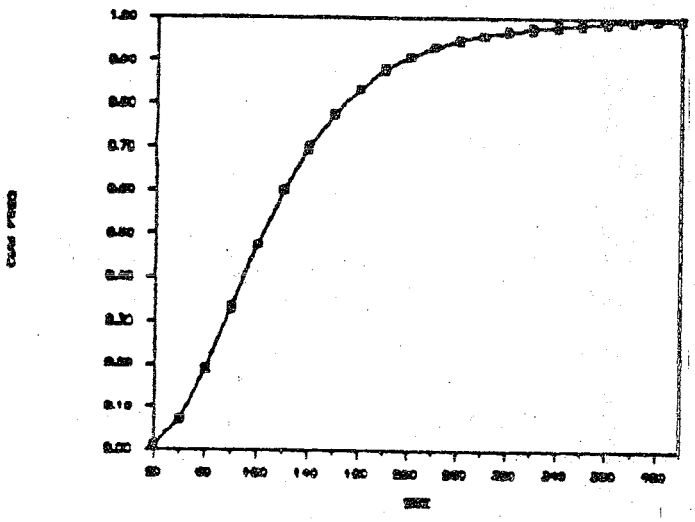

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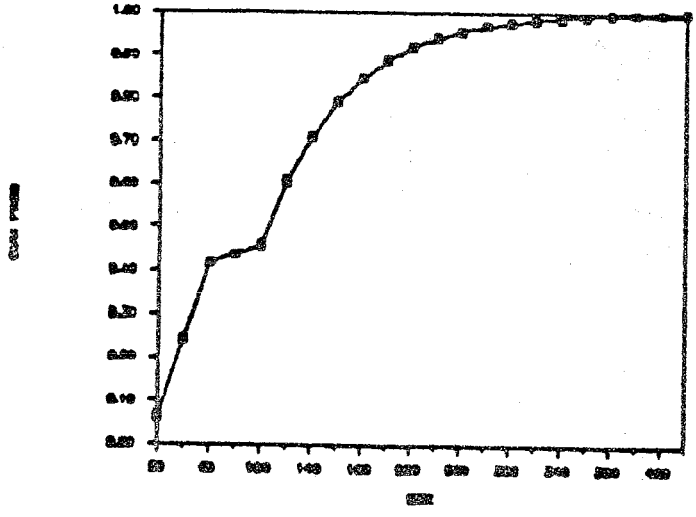

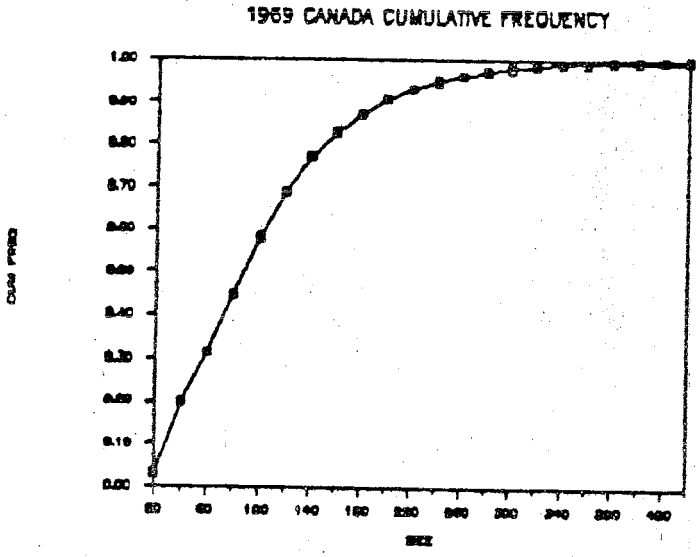
1969 CANADA CUMULATIVE FREQUENCY
CUM FREQ
SIZE

APPENDIX 3

Frequency histograms of mean CPUE values (number per 100 hooks) from single set records from the U.S. swordfish fishery from 1962 to 1977.