Canadian Atlantic Fisheries

Scientific Advisory Committee

CAFSAC
Research Document 81/15

STATUS & ASSESSMENT OF NORTHWEST ATLANTIC SWORDFISH STOCKS

P. C. F. Hurley and T. D. Iles
Marine Fish Division
Department of Fisheries and Oceans
Biological Station
St. Andrews, N. B. EOG 2XO
Canada

Abstract

A lack of both biological and statistical data for this species and its fisheries in the northwest Atlantic preclude any formal assessment procedures at present. Catch statistics collected from the Canadian fishery in 1979 and 1980, when compared to pre-closure data, indicate there has only been a partial recovery of the stock(s) exploited by this fishery. Preliminary analysis of swordfish by-catch data from the Japanese tuna longline fishery suggests that, while catch rates in the northwest Atlantic did improve during the period of reduced Canadian and American effort in the early 1970's, this trend was reversed in 1975 and catch rates have subsequently returned to almost the same levels experienced in 1970.

Résumé

Par suite du manque de données, tant biologiques que statistiques, sur l'espadon et son exploitation dans l'Atlantique nord-ouest, il est impossible d'en faire une évaluation formelle. Quand on compare les statistiques de prises des pêcheurs canadiens en 1979 et 1980 avec celles d'avant la fermeture, on constate qu'il n'y a eu qu'un rétablissement partiel du stock (ou des stocks) exploité par la pêche. Une analyse préliminaire des prises fortuites d'espadons dans la pêche au thon des palangriers japonais donne à penser que, bien que les taux de capture dans l'Atlantique nord-ouest aient accusé une augmentation pendant la période d'effort réduit de la part des pêcheurs américains et canadiens au début des années 1970, cette tendance a été renversée en 1975, et les taux de capture sont retombés à peu près aux mêmes niveaux que ceux de 1970.

Introduction

The biological and statistical problems that have to be dealt with before a formal assessment of this species is possible are formidable, and can be briefly reviewed. Swordfish otoliths, unlike those of most teleosts, are minute and difficult to find. No accepted method of ageing is yet available from these or from analysis of any other hard parts. Swordfish are dressed at sea so that neither length nor sex can be determined from landings and conversion factors to derive round weight and length from dressed weight have to be established by sampling from commercial vessels. These should take into account seasonal variations which are likely to be large. There is a significant, but until now, undefined in detail sexual dimorphism in the growth of swordfish, with females attaining significantly larger sizes, which makes the sexing of individuals important in estimating growth parameters. As sex ratio varies widely in different areas and gear types, this raises problems both in monitoring sex ratios and in the methodology of assessment itself.

Hurley and Iles (1980) drew attention to the recent development of fisheries in the northwest Atlantic and to changes in existing ones. American fisheries in the New England area, off the southeastern Atlantic states and in the Gulf of Mexico have continued and probably intensified in 1980. Data on the size of the fisheries and the biological make-up of the catch, particularly in relation to size and sex, are not available.

The Japanese tuna longline fishery prosecuted throughout the Atlantic takes swordfish as a by-catch. From 1978, Japanese vessels fishing in the U.S.A. FCZ were required to release all swordfish caught as by-catch in the tuna fishery and the reported swordfish catches declined rapidly, particularly in the Gulf of Mexico area. It was estimated that 44.2% of the swordfish released were alive when released (Kikawa and Honma 1980), although the long-term survival rate is unknown.

No catch data for the Canadian fishery is available for the period 1971-1978. The total Canadian 1979 catch was estimated after discussion with fishery officers and fishermen. There was no monitoring of the fishery during the season and the only detailed information available comes from log book coverage and the results of three sampling trips on commercial vessels by observers. The log books, which recorded set by set estimates of numbers caught and total weight, accounted for approximately 22% of the total catch. The sampling trips resulted in length (flank length) measurements and estimated dressed weights on some 300 fish.

The virtual lack of any meaningful fisheries data compounds the problems of ageing and sizing the catch to a degree that precludes any formal assessment procedures.

Stock Structure of Atlantic Swordfish

The swordfish is distributed world-wide in all tropical, subtropical and temperate seas from about latitude 45°N to 45°S. In the Atlantic, swordfish occur on both the west and east sides and also in the Mediterranean and Black Seas and the Sea of Marmara. The Canadian fishery is contiguous with and overlaps the U.S. fishery that extends south into the Gulf of Mexico and with areas where swordfish are caught as by-catch by Japanese tuna longliners.

As with any widespread species, the question of the stock structure is important in determining the degree to which "locally" applied fishing effort determined changes in resource abundance. There is no commonly accepted, simple or obvious hypothesis for stock structure in swordfish, and the evidence from different sources tends to be inconsistent, incomplete or contradictory.

Two areas of larval concentrations have been identified, one in the Mediterranean and the other in the Caribbean. A third has been suggested off the northwest coast of Africa. Spawning periods associated with these larval concentrations tend to be drawn out but there is considerable confusion in reports from different authors which make it difficult to decide the degree to which spawning is seasonal. The known facts do suggest that separate stocks may occur but the information is not conclusive.

Morphometric and meristic analysis and information on the occurrence of parasites is not yet available, but both these fields of study were covered by the 1980 Canadian research survey. Material is currently being examined.

The distribution of catch and catch-per-unit-effort data for the Japanese longline fleet, in which swordfish is caught as an incidental species, does include data of some value. The data have been subject to preliminary analysis for the period 1970-1978, inclusive, and are given in Figures 1 to 3, plotted by 5° squares. (See Table 1 for explanation of Figures 1-3). This does not demonstrate clear evidence for spatial segregation of catches that might indicate stock differentiation; however, the data have been pooled over a 9-yr period. Monthly analysis is planned to determine whether seasonal migrations obscure stock boundaries.

No trans-Atlantic tag returns have been reported and, until recently, there were no tags returned at any distance from the point of tagging. This may reflect the relatively narrow range of distribution of the Canadian and American fleets over the period that tags were being reported. A more recent return does indicate much longer migrational routes.

While the stock question does remain open, the fact that marked changes in both mean fish size (weight) and in catch-per-unit-effort have occurred in areas subject to fishing effort, indicates at the very least that the fishing effect is much greater than the migration effect in determining resource abundance even over a wide area of the northwest Atlantic. Further anlaysis will concentrate on these aspects of the available data base. The objective is to determine the current status in relation to the trends established in the 1960's and, if possible, to indicate the trend direction.

Japanese Longline Trends

Data are published each year in the Fisheries Agency of Japan Annual Report of Effort and Catch Statistics on Japanese Tuna Longline Fishery giving the catch in numbers of each species by 5° squares for all ocean areas of the world for their tuna longline fleet. Total effort for each square is also given. Swordfish is not a species for which there is a directed fishery, so that catches and catch rates may be relatively unbiased as an indicator of distribution and abundance. Figure 4 shows the relationship between effort and catch-per-unit-effort for the northwest Atlantic. The correlation coefficient of +0.04 confirms that the fishery is not a directed one.

Table 2 gives the results of the analysis of four separate areas within each of which data for 5° squares was combined. Systematic increases in size composition from south to north are indicated for swordfish and this suggested the latitudinal separation of areas followed in Table 2. Figure 5 shows trend lines for each area separately and the weighted mean for all areas. The most marked trend is shown in the Georges Bank and Scotian Shelf area, an area which accounts for much of the "traditional" Canadian effort. The U.S. jurisdictional changes forbidding the retention of swordfish by foreign vessels from 1978 affects the 1978 estimates for the Gulf of Mexico particularly.

Figure 6 gives the weighted mean for the whole area depicted as a 3-yr moving average. The data suggest that there was an increase in swordfish numbers in the early 1970's, but the trend has been reversed since about 1975. This is understandable if it is assumed that there was a significant and unreported fishery re-initiated at this time despite the 1971 ban, and that the rate of increase in effort during the mid-1970's was high enough to halt and reverse the expected stock recuperation. This conclusion can be tested, in general terms, by reference to data obtained on the Canadian fisheries in 1979 and 1980.

The Canadian Fisheries 1979-80

The total 1980 swordfish catch was estimated to be 1884.8 MT round weight. A vessel-by-vessel and trip-by-trip estimate of longline catches indicated a total longline catch of 1793.6 MT while sales slips indicated 91.2 MT were taken by harpoon (both directed and incidental) and as incidental catches on other gear types. Total longline effort was estimated to be 1.69×10^6 hooks based upon longline effort reported in logbooks scaled by a ratio of reported longline catch to estimated total catch.

A monthly breakdown of catch, effort, catch-per-unit-effort and mean weight data from both 1979 and 1980 logbooks is presented in Table 3. Total weights and mean weights are based upon daily estimated dressed weights.

A breakdown of catch rate and mean weight by 5° square is presented in Table 4. Data for 1963-69 are from Beckett (1971). No clear trend is obvious in the data except that mean weight values tend to correspond to mid- to late-60's values.

Annual totals of catch-per-unit-effort and mean weight for 1979 and 1980 are plotted in Figures 7,8, & 9, together with data referring to the preclosure fishery. Mean dressed weights and CPUE data expressed as weight for the period 1962 to 1970 are taken from data reported by Caddy (1976). The CPUE estimates expressed as numbers, which is more directly comparable with the Japanese longline data, were calculated from data presented by Beckett (1971). All three figures indicate that the appropriate measure is at a slightly higher level in 1979 and 1980 than in 1970. All three show a downward trend from 1979 to 1980, although it is not possible at this stage to indicate whether this is a significant one. Even so, the data are consistent with the information from the Japanese longline data. It is concluded that there is no evidence of a resource recovery and that the current trend is towards a declining resource base. There is every need for concern considering the existence of new, unreported and apparently uncontrolled fisheries in the southern part of the range in the northwest Atlantic.

Literature Cited

Beckett, J. S. 1971. Canadian swordfish longline fishery. ICCAT SCRS 71/36: 7 p.

Caddy, J. F. 1976. A review of some factors relevant to management of swordfish fisheries in the northwest Atlantic. Fish. Mar. Serv. Res. Dev. Tech. Rep. 633: 36 p.

Hurley, P. C. F., and T. D. Iles. 1980. A review of the Canadian swordfish fishery. CAFSAC Res. Doc. 80/81: 20 p.

Kikawa, S., and M. Honma. 1981. Overall fishing effort and catch with a comment on the status of stock for the swordfish, *Xiphias gladius*, in the Atlantic ocean. ICCAT Col. Vol. Sci. Pap. XV (2): 381-386.

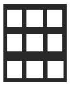
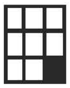
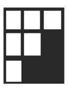
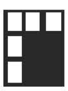
	Fig. 1 Effort (Hooks $x10^{-3}$)	Fig. 2 # of Swordfish	Fig. 3 CPUE
	0	0	0
	1-100	1-100	.01-.10
	101-500	101-500	.11-.25
	501-1000	501-1000	.26-.50
	1001-2000	1001-2000	.51-.75
	2001-5000	2001-5000	.76-1.0
	5001-10000	5001-10000	1.1-2.50
	10001-15000	10001-15000	2.51-5.0
	15001-20000	15001-20000	5.01-10.00
	20001 +	20001 +	10.01-15.00

Table 1. Legend to Figures 1, 2 and 3.

AREA		JAPANESE ATLANTIC LONGLINE FISHERY								
		1970	1971	1972	1973	1974	1975	1976	1977	1978
GULF OF MEXICO	Catch (No's)	550	1369	496	427	515	1443	1402	1415	79 (1)
	Effort (Hooksx10^{-5})	17.53	28.29	13.22	12.45	13.15	41.42	46.38	44.65	30.88
	CPUE (No's/Hooksx10^{-3})	0.314	0.484	0.375	0.343	0.392	0.348	0.302	0.317	
FLORIDA	Catch	57	57	12	0	18	72	80	2	5
	Effort	2.88	2.64	0.36	0.03	0.25	1.58	0.80	0.02	0.11
	CPUE	0.198	0.216	0.330		0.72	0.46	1.00	1.00	0.45
LONG ISLAND	Catch	815	4253	1702	2326	495	409	991	1889	784
	Effort	13.37	65.86	27.33	42.05	16.95	11.04	31.19	23.39	29.92
	CPUE	0.610	0.645	0.616	0.553	0.292	0.371	0.318	0.810	0.262
GEORGES BANK & SCOTIAN SHELF	Catch	191	2776	1029	2754	5084	3342	4151	3572	3058
	Effort	4.45	39.53	9.47	18.59	28.40	18.28	35.63	27.66	30.04
	CPUE	0.429	0.702	1.087	1.481	1.790	1.828	1.165	1.291	0.895
TOTAL (ALL AREAS)	Catch	1613	8455	3239	5507	6112	5266	6624	6878	3926
	Effort	38.23	136.32	50.38	73.12	58.75	72.32	113.90	95.72	90.95
	CPUE	0.422	0.620	0.642	0.753	1.040	0.723	0.582	0.719	0.432 (2)

(1) Fish not allowed to be landed by Japanese fleet under U.S.A. regulations from 1978 on.

(2) Unadjusted for (1). CPUE estimated at 0.492 if Gulf of Mexico average for period is used, and 0.536 if Gulf of Mexico figure omitted.

Table 2. Analysis of Japanese tuna longline fishery statistics by area, 1970-78.

Table 3. Canadian swordfish longline fishery data by month as reported in logbooks for 1979 and 1980.

	EFFORT			CATCH			CPUE	
1979 Month	# of vessels	# of days	1000's of hooks	# of fish	mt. est. drssd wt.	mean wt.	mt/ 1000 hooks	# of fish /1000 hooks
July	10	88	95.2	975	53.92	55.3	0.566	10.24
August	15	175	206.9	2626	173.88	66.2	0.840	12.69
Sept.	17	179	196.2	3528	201.54	57.1	1.027	17.98
Oct.	8	43	42.2	520	28.57	54.9	0.677	12.32
TOTAL	20	485	540.5	7649	457.91	60.6	0.887	14.16
1980								
June	4	28	24.2	300	16.43	54.8	0.680	12.42
July	15	147	148.5	1625	96.56	59.4	0.650	10.95
August	22	216	265.2	3742	217.17	58.0	0.819	14.11
Sept.	21	179	207.3	3079	178.89	58.1	0.863	14.86
Oct.	10	75	101.9	1704	102.56	60.2	1.007	16.73
TOTAL	39	645	747.0	10450	611.60	58.6	0.819	13.99

Table 4. Catch rate and annual mean dressed weight trends by 5° squares for the Canadian swordfish longline fishery.

Lat.	40		45		40		40		40		40	
Long.	45		50		50		55		60		65	
	A	B	A	B	A	B	A	B	A	B	A	B
1963	4.24	96	0.96	95	3.45	91	2.66	96	1.40	80	3.59	62
1964	—	—	1.13	71	1.21	92	0.88	85	2.14	63	1.49	62
1965	0.99	73	—	—	0.76	82	0.60	106	0.68	67	1.07	65
1966	1.69	62	1.16	44	0.83	78	0.70	70	0.84	66	1.07	64
1967	1.09	60	0.62	18	1.50	54	1.11	64	1.01	52	1.56	51
1968	1.23	48	--	--	0.76	60	0.77	55	0.92	51	1.30	44
1969	1.76	50	--	--	0.71	69	0.59	53	0.80	50	0.97	49
1979	0.94	57	1.07	67	0.91	74	1.11	72	1.33	57	1.94	51
1980	—	--	0.35	76	1.38	65	1.49	64	1.30	51	1.50	53

A - Catch rate (number of fish) per 100 hooks

B - Mean fish size (estimated dressed weight in kg)

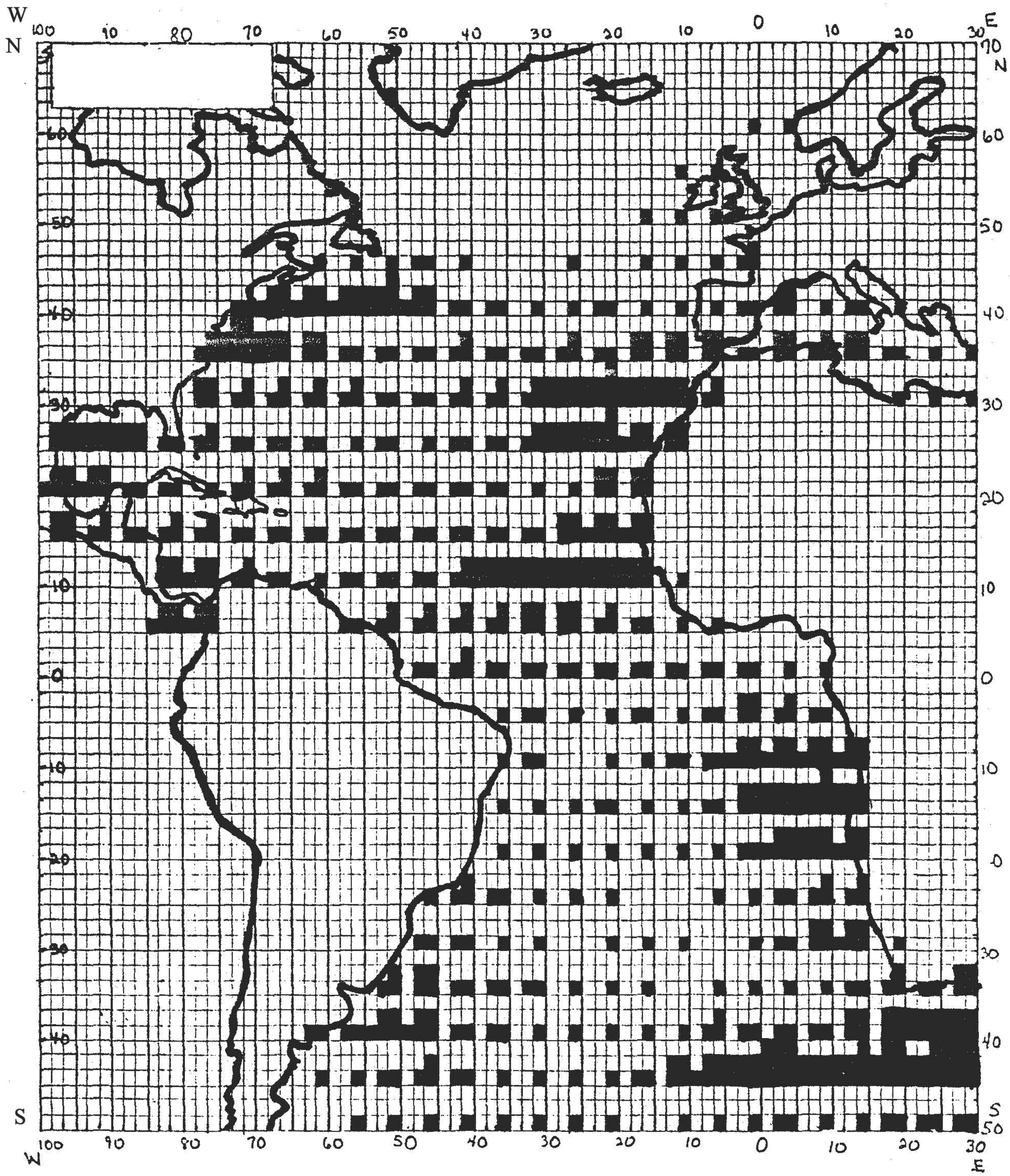


Figure 1. Distribution of fishing effort of the Japanese tuna longline fishery, 1970-78 inclusive (see Table 1 for legend).

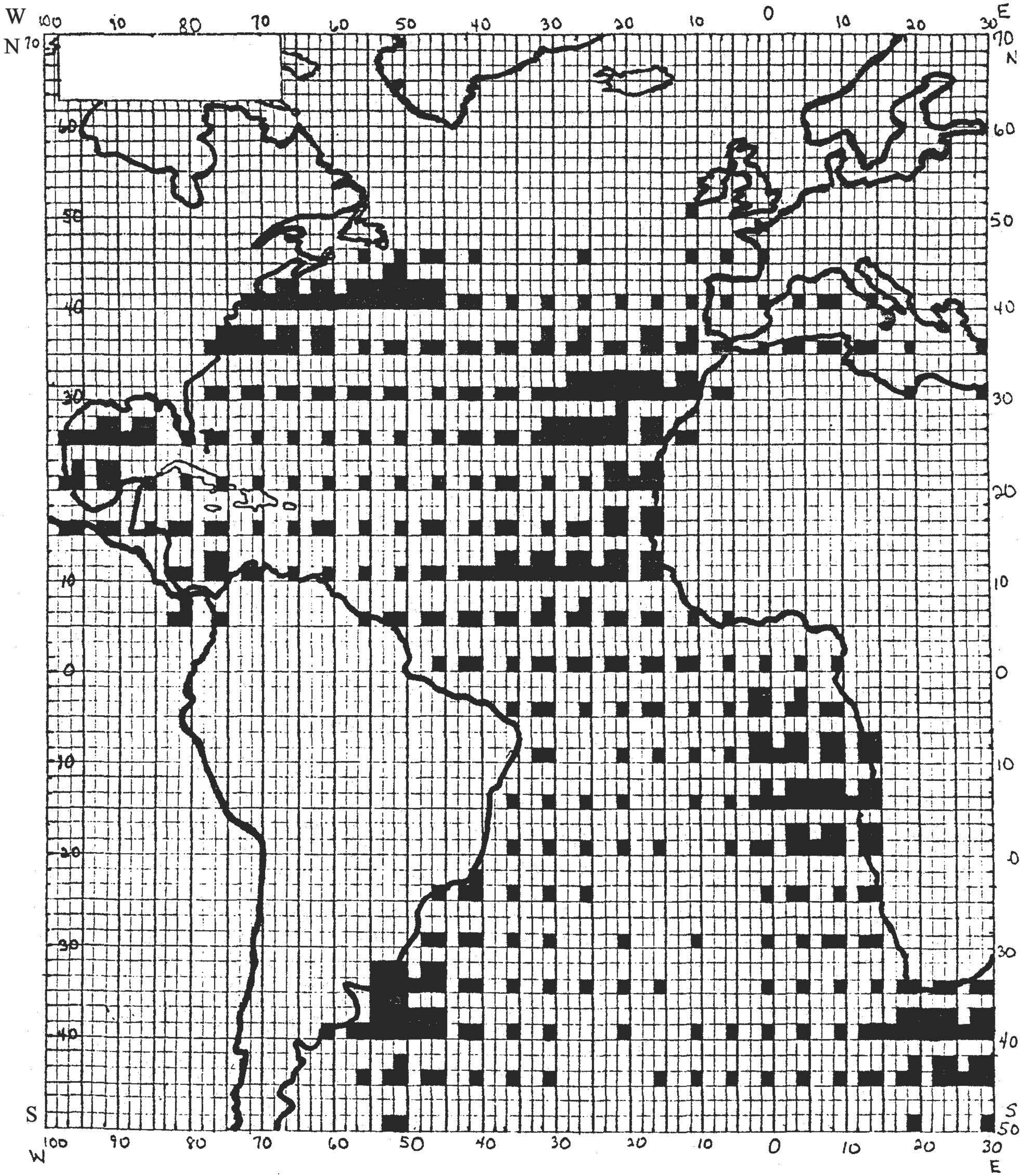


Figure 2. Distribution of swordfish catch of the Japanese tuna longline fishery, 1970-78 inclusive (see Table 1 for legend).

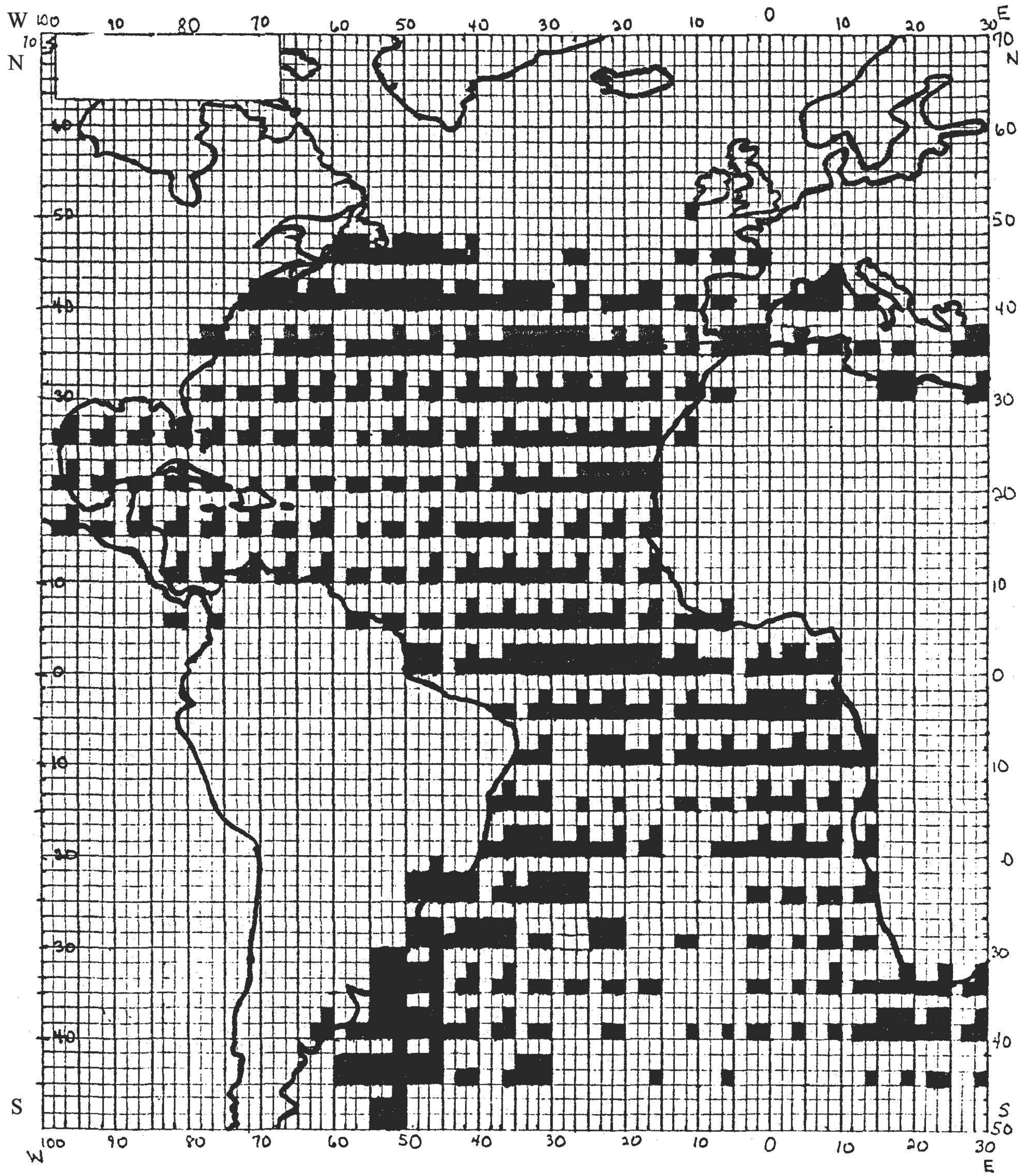


Figure 3. Distribution of swordfish catch-per-unit effort of the Japanese tuna longline fishery, 1970-78 inclusive (see Table 1 for legend)

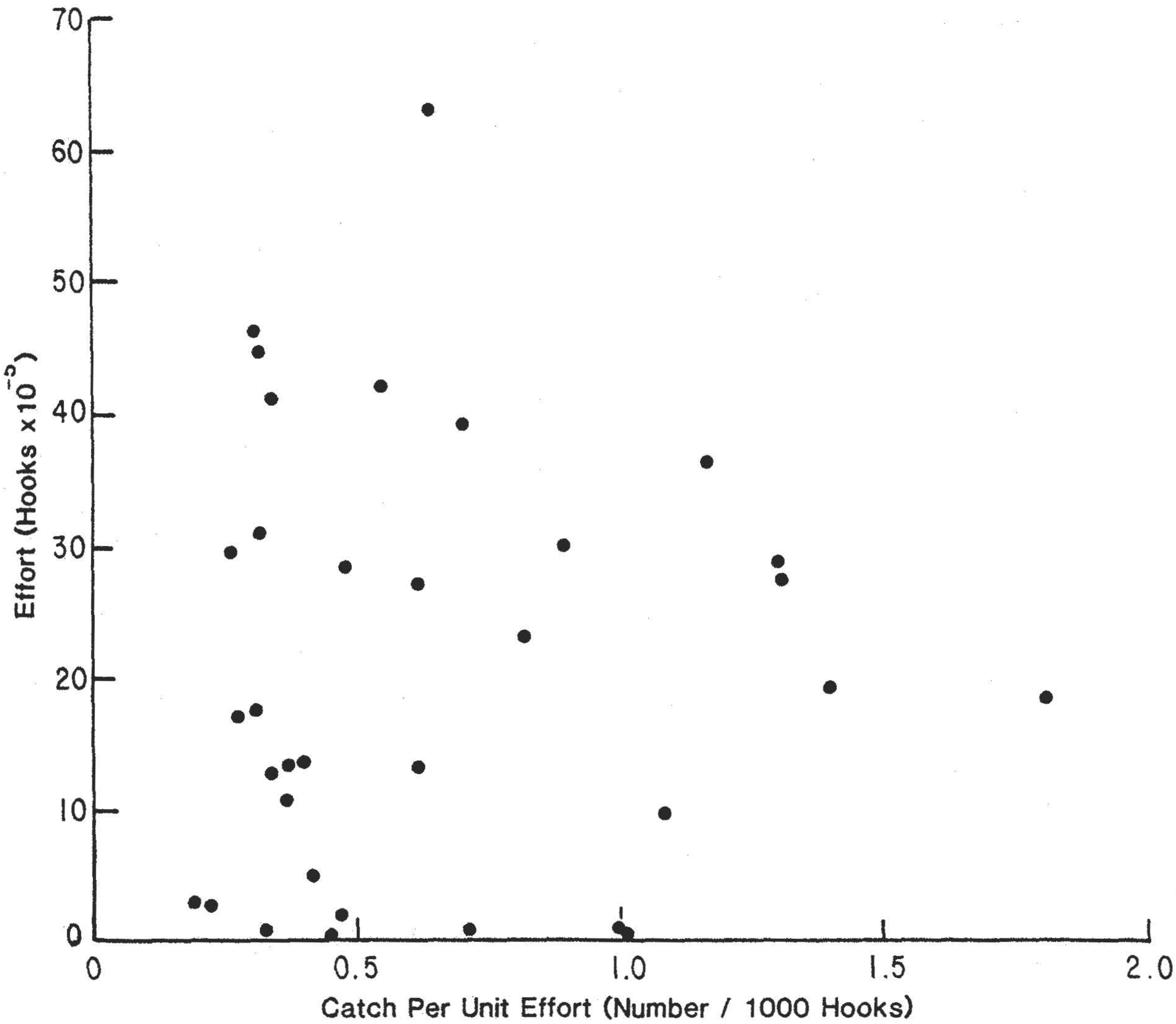


Figure 4. Relationship between effort and swordfish catch-per-unit effort of the Japanese tuna longline fishery.

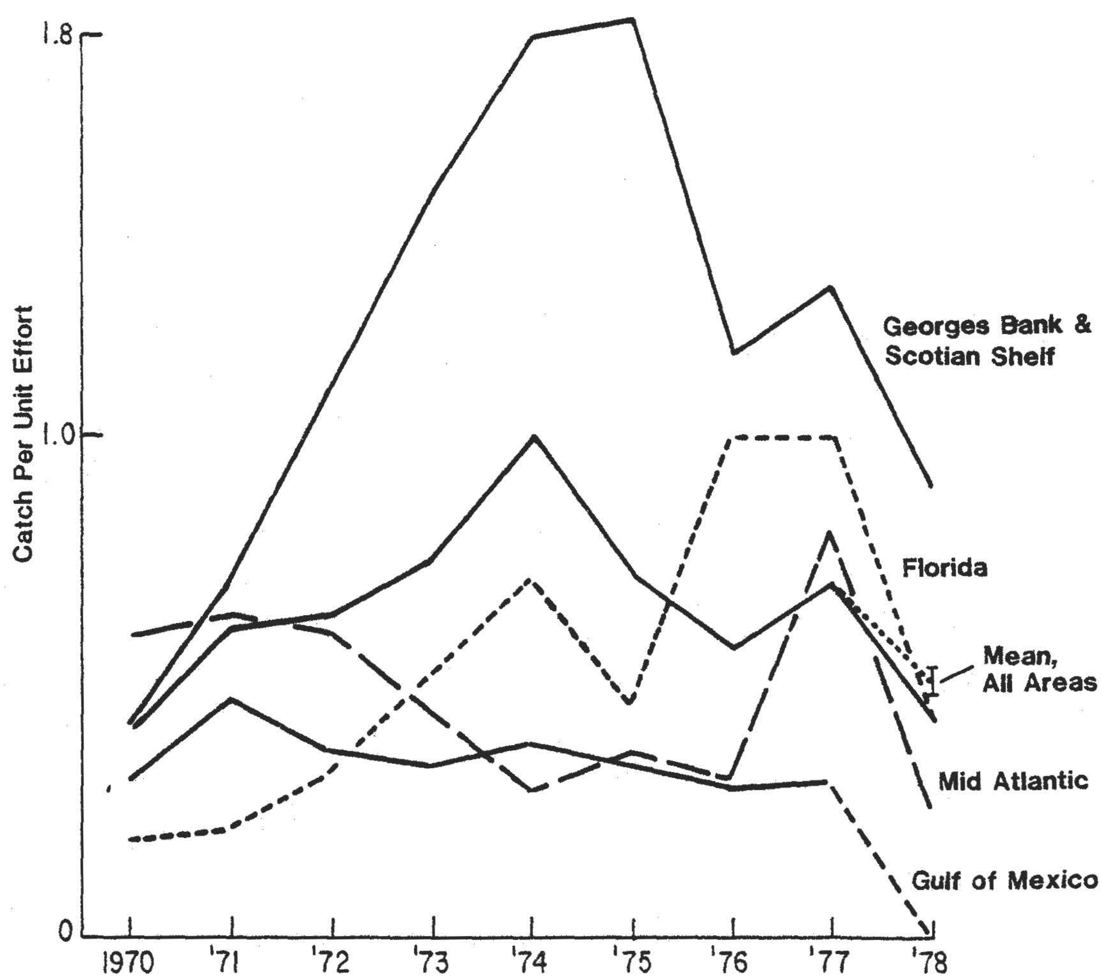


Figure 5. Swordfish catch-per-unit effort trends by area for the Japanese tuna longline fishery, 1970-78.

Figure 6. Swordfish catch-per-unit effort trend for the Japanese tuna longline fishery, 1970-78 (3-year moving average of all areas examined).

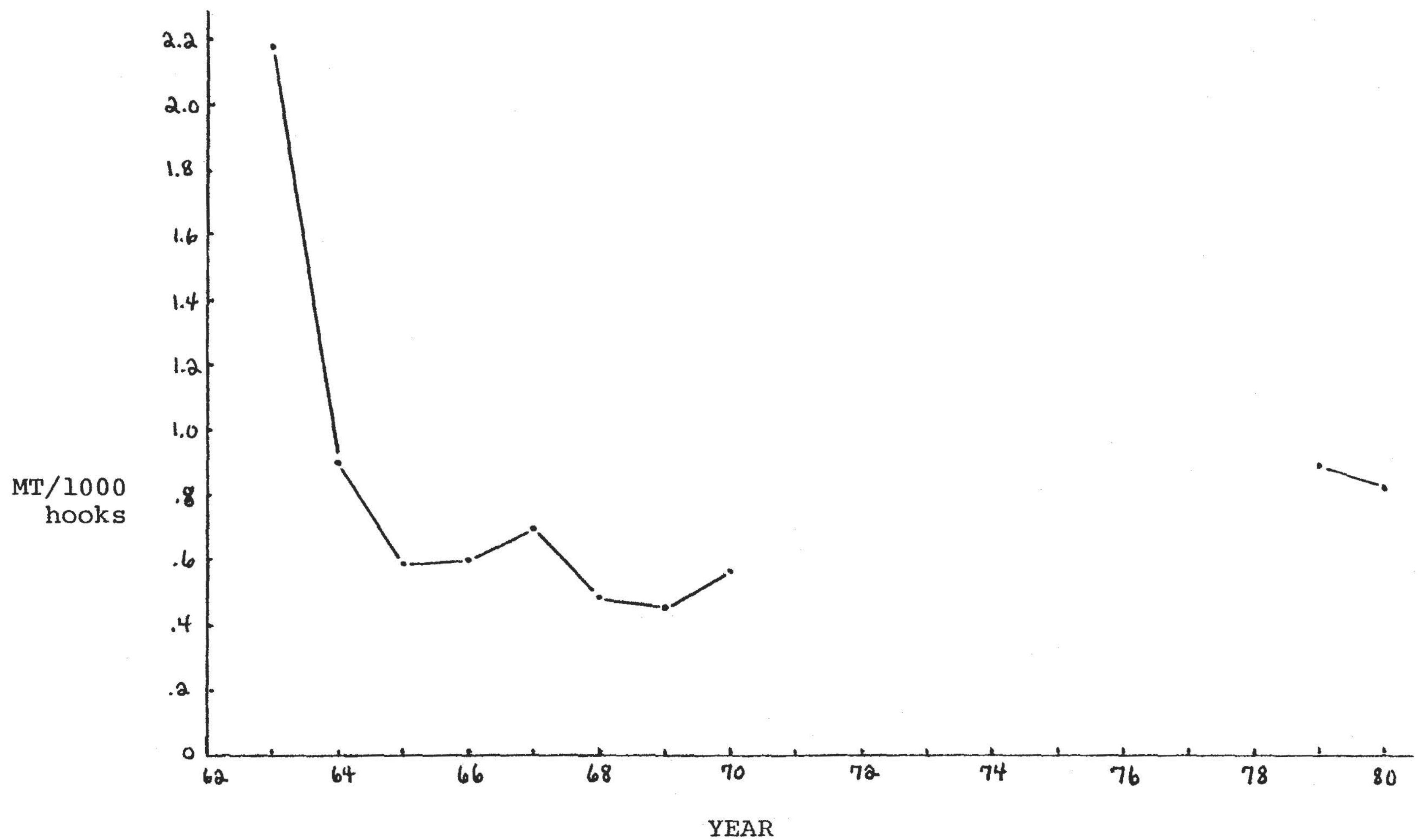


Figure 7. Catch-per-unit effort trend of Canadian swordfish longline fishery (catch expressed as weight).

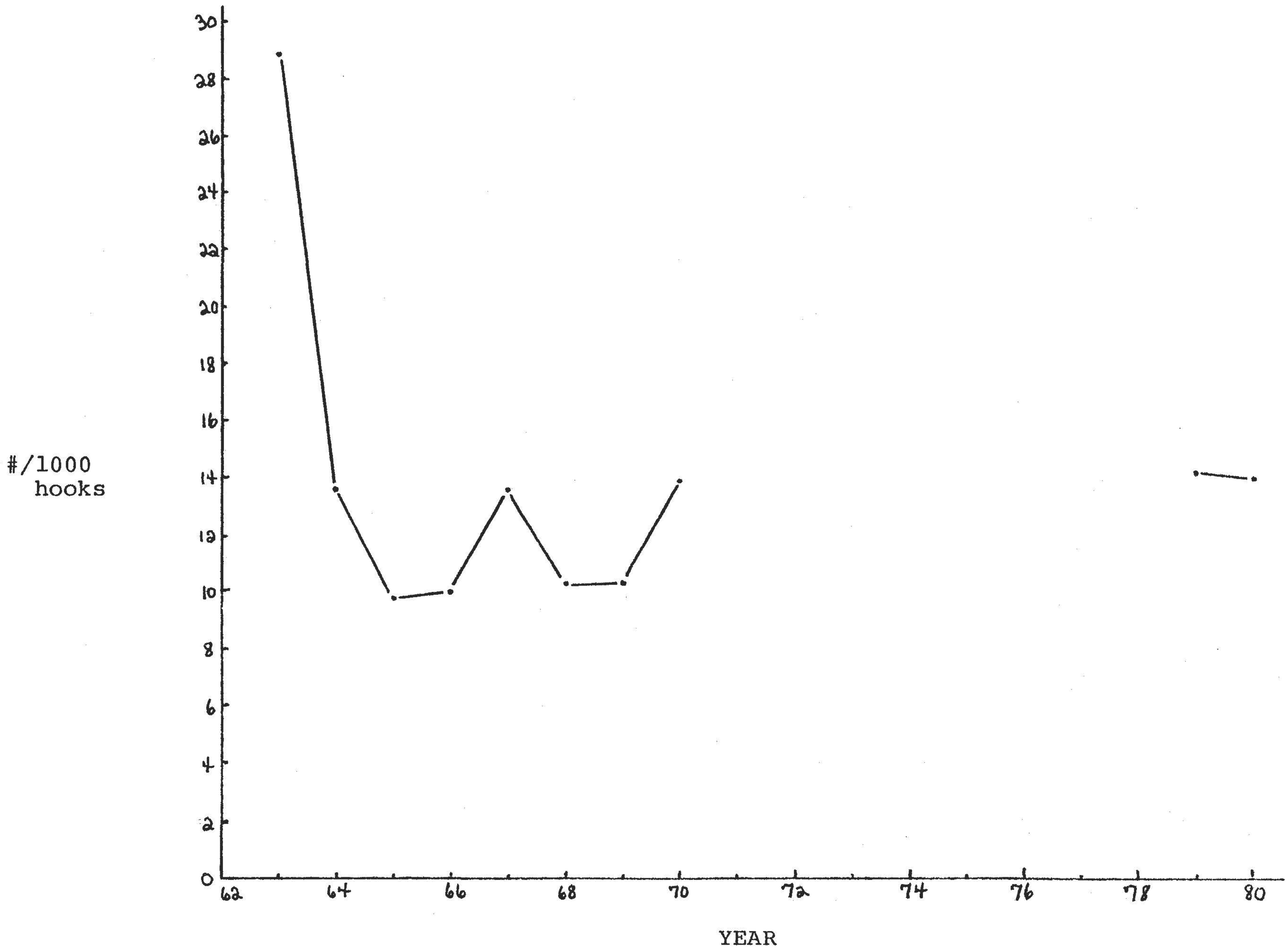


Figure 8. Catch-per-unit effort trend of Canadian swordfish longline fishery (catch expressed as numbers of fish).

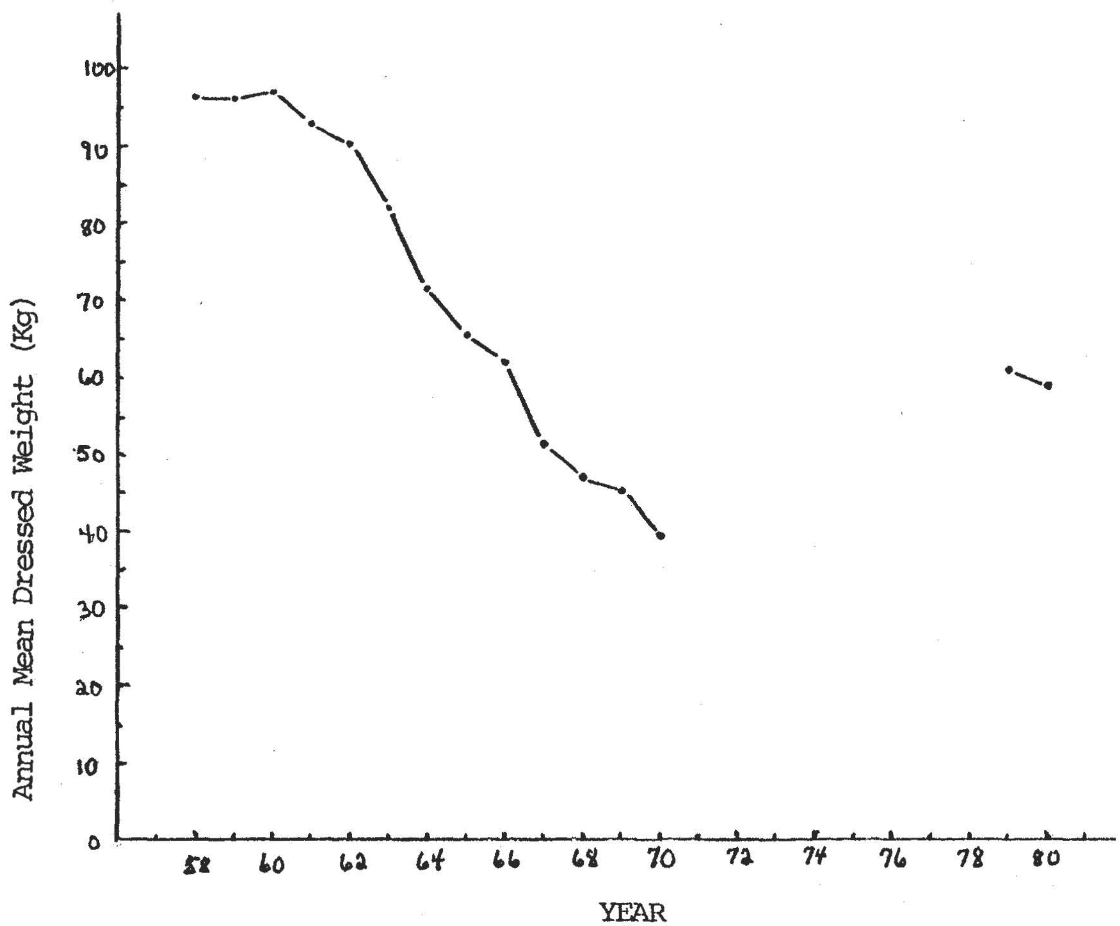


Figure 9. Trend of annual mean dressed weight of Canadian swordfish fishery.