A REVIEW OF THE STOCK STATUS OF THE ATLANTIC MARLINS

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SUMMARY

The stock status of blue marlin and white marlin was reviewed on the basis of the newly revised billfish data base following our previous method. In the Atlantic-wide and the separate North and South Atlantic stock structure hypotheses, it appeared that the blue marlin stock was reduced considerably in 1967 and since then was at a very low level up to 1979. Effective fishing intensity, on the other hand, reduced notably in 1978 and 1979 into the range of f_{opt} or below. The decreasing white marlin stock was also suggested in both hypotheses, although MSY and f_{opt} were not available for this species. In the Atlantic-wide and the North Atlantic stock hypotheses, effective fishing intensity, it appeared, was in a steadily decreasing trend with the 1979 estimate near the lower limit of its range since 1963.

RESUME

L'état des stocks de makaire bleu et de makaire blanc a été examiné, en partant de la base de données des poissons porte-épée récemment révisée, et suivant la méthode utilisée antérieurement. En considérant l'ensemble de l'Atlantique, et selon l'hypothèse de stocks séparés nord et sud, il semble que le stock de makaire bleu ait considérablement diminué en 1967, atteignant alors un niveau très faible qu'il a conservé jusqu'en 1979. D'autre part, l'intensité de pêche effective a considérablement diminué en 1978 et 1979, se situant dans la gamme du f_{opt} ou en-dessous. Une baisse du stock de makaire blanc a également été suggérée par les deux hypothèses, bien que la PME et le f_{opt} de cette espèce ne soient pas disponibles. Selon les hypothèses d'un stock de l'Atlantique entier et d'un stock nord-atlantique, l'intensité de pêche effective semble montrer une forte tendance à la baisse, les estimations de 1979 approchant de la limite la plus basse de la gamme de valeurs enregistrées depuis 1963.

RESUMEN

Se examinó la situación del stock de la aguja azul y aguja blanca, partiendo de la nueva base de datos sobre marlines, que fueron nuevamente revisados, siguiendo el método anteriormente aplicado. En las hipótesis de las estructuras del stock para el total del Atlántico, y de los dos stocks separados al Norte y Sur, aparece que el stock de aguja azul sufrió una considerable merma en 1967, manteniendose a un nivel muy bajo hasta 1979. Por otra parte, la intensidad efectiva de pesca se redujo notablemente entre 1978 y 1979, hasta alcanzar el nivel f_{opt} ó inferior. Asimismo, se señaló en ambas hipótesis la disminución del stock de aguja blanca, aunque el RMS y el f_{opt} no estaban disponibles para estas especies. La intensidad efectiva de pesca, tanto para la hipótesis de un stock del total del Atlántico, como la que supone dos stocks al Norte y al Sur, mostraban una tendencia decreciente constante; las estimaciones para 1979 se encuentran próximas al límite de su nivel más bajo desde 1963.

Introduction

The ICCAT billfish statistics have long suffered from a number of deficiencies. The intersessional billfish workshop, Miami, June 1981, made a thorough revision and correction of the billfish data base on the basic agreement. Except sailfish-spearfish group, the corrected data included catches by countries and gears from 1956 to 1979 broken down into species and allocated into the North and South Atlantic. Using these revised all Atlantic catches and Japanese data, we reviewed the trends in Japanese fishery and the recent condition of the stocks of white marlin and blue marlin under two stock structure hypothese, the separate North and South Atlantic stocks and single Atlantic-wide stock.

Method

The method we followed is basically the same as that by Farber and Conser (1981). Estimation of effective fishing intensity from the basic Japanese longline data is by the Honma's (1974) procedure and the same as that in our previous report (1979). As the standard years for calculation, the period 1965-1975 was used on the monthly basis. Conser (1980) discussed a choice of the standard years period and showed that it was not very sensitive to the trends in resultant indices of abundance. Suzuki and Kikawa (1981 ms) suggested that it might affect sometimes largely the result in relation to the choice of the time stratum used (in practical monthly or quarterly). Checking what choice is the most adequate as the standard years period is important but it is not intended in this report. Effective fishing intensity by the Japanese longline fishery was raised to total estimates using ratio of all Atlantic catch to Japanese catch. This raising factor has in recent years steadily increased in inverse proportion to the decreasing rate of Japanese catch resulting in more unreliability in total estimates. This is especially true of the South Atlantic stock hypothesis, where the raising factor is as large as 10 to 60 or 70 after 1971 for both white and blue marlins. The Japanese 1976 catch in the South Atlantic is of an all-time low, which makes the total estimates the most uncertain.

The PRODFIT was used to apply data sets to the generalized production model under the three hypotheses on significant age groups fished. The correction of the billfish data base is so deep and extensive that available total catch data allocated into North and South Atlantic differ in many cases considerably from previous estimates (Kikawa and Honma 1979, 1980; Conser 1980; Conser and Beardsley 1978; Farber and Conser 1981).

Additional Japanese catch

This segment of billfish catch is the catch made within the U.S. Fishery Conservation Zone that was all returned to sea. Table 1 shows the quarterly number of fish caught from the published statistical reports plus number of fish hooked on longline and returned to sea within this zone. The latter catch, based on quarterly reports from longline vessels, is broken down into fish "dead" and "alive" at the time of return. Although nearly half of fish returned is recorded "dead", the actual mortality of fish returned is between the total number and the number of "dead" fish. In this report, therefore, the maximum catch including all fish returned was treated as resultant catch from the Japanese fishery in 1978 and 1979.

Trends in catch, effort and CPUE for Japanese fishery

Blue marlin

Fig.1 shows the change in blue marlin catch in the Japanese fishery in the North, South and all Atlantic. Catch by all other countries is also shown in the figure. Figs.2 and 3 indicate changes in effective number of hooks and CPUE (fish per 100 effective hooks) obtained under the two stock structure hypotheses.

North Atlantic: Blue marlin catch has changed drastically throughout the history. The latest peek in catch occurred in 1975, followed by the trend down to 100 mt in 1979, the lowest ever. Catch changed as effective fishing effort changed, the 1979 effort being the lowest after the 1960's. Change in CPUE is also drastic. It fell down to the very low level as early as in 1966 and to the lowest in 1977-1978, although a little upward in 1979.

South Atlantic: Catch plummeted in 1967 and continued to fall until 1972 after which it was almost negligible compared with earlier catches. Very few effective fishing effort remained after 1974 but it turned a little upward in 1979. As in the North Atlantic, CPUE fell down to the very low level in 1966.

Atlantic-wide: From this point of view, CPUE in the recent three years average is evidently at the lowest, which is about 69 percent of the 10 years average after 1970 and about 24 percent of the average in the 1960's.

White marlin

Figs.4-6 show changes in catch, effective number of hooks and CPUE for white marlin by Japanese fishery. Catch by all other countries is shown in Fig.1. Underlying stock hypotheses are the same as blue marlin.

North Atlantic: Catch was at a very low level of around 100 mt in recent three years after it plummeted in 1977. Effective fishing effort during this period was considerably low due to the change in fishing targets, the 1979 effort being the lowest. Very low effective fishing effort apparently results in the recent drop in catch except in 1977. After 1977, CPUE turned upward, however, it is in the decreasing trend when seen throughout the 1970's.

South Atlantic: Effective fishing effort was virtually removed from this area after 1974 and catch became almost negligible compared with earlier catches. CPUE nearly leveled off during the 1970's with a large fluctuation, although at a much lower level than in the 1960's.

Atlantic-wide: The decreasing trend in CPUE since the early 1960's is the most evident. The recent three years average in CPUE is about 70 percent of the previous 10 years average and about 40 percent of the average in the 1960's.

Condition of stocks

Tables 2 and 3 show the data sets of newly revised total catch and estimated total effective fishing intensity for blue and white marlins over the perid 1956-1979 for each of the two stock structure hypotheses.

Blue marlin

Two data sets, 1956-1979 and 1964-1979, with different hypotheses of 4-6 significant age groups fished as in Farber and Conser (1981) were used for the production model analysis. Generally, the 1956-1979 data set give a better fit to the model for the single Atlantic-wide stock and the separate South Atlantic stock, while the 1964-1979 data set fits better to the separate North Atlantic stock. Table 4 shows the PRODFIT parameter estimates for the 1956-1979 data set. Figs.7-9 indicate the catch/effective fishing intensity plots for the separate North Atlantic, South Atlantic and the single Atlantic-wide stock, respectively. No yield curves fitted are shown in the figures.

North Atlantic: According to Table 4, MSY is 2100-2600 mt and corresponding f_{opt} is 370×10^3- 510×10^3 hooks/5°sq. Fig.7 indicates that many of the plots are in the over-fishing side since 1962 when the fishery covered nearly the stock area. Effective fishing intensity was once reduced in the latter half of the 1960's and again increased into the over-fishing side from 1971 to 1977. The resultant catch rapidly and steadily decreased and fell to the lowest level from 1976 afterward. The level of effective fishing intensity in 1978 and 1979 was reduced within the f_{opt} range or below.

South Atlantic: MSY is suggested to be 1900-2500 mt and corresponding f_{opt} to be 450×10^3- 650×10^3 hooks/5°sq. As in the North Atlantic stock, a considerable drop in catch from 1964 to 1967 is evident (Fig.8). After 1967, there was little change in catch with the very wide change in effective fishing intensity. In 1978 and 1979, effective fishing intensity was reduced to below the f_{opt} range.

Atlantic-wide: Under this hypothesis, MSY is estimated as 4200-5000 mt and the corresponding f_{opt} as 350×10^3- 480×10^3 hooks/5°sq. Plots in Fig.9 behave as done in the separate North Atlantic stock hypothesis. Effective fishing intensity in 1963-1965 and in 1971-1977 are in the over-fishing side. It was also reduced in 1978 and 1979 within the f_{opt} range or below.

In either case above, the blue marlin stock, it appears, decreased till 1967 and was at a considerable low level up to 1979. On the other hand, effective fishing intensity was greatly reduced in 1978 and 1979 into the f_{opt} range or below. With this level of fishing intensity, therefore, a close monitoring for the stock is necessary for the time being until the better assessment on the biological basis is worked out.

White marlin

The data set, 1956-1979, under the different hypotheses of 3-5 significant age groups fished was tried to apply to the model. However, the PRODFIT parameter estimates were not available, since the starting values were incompatible with the model in the majority of underlying hypotheses. This suggests that there is almost no correlation between indices of abundance(U) and effective fishing intensity. A great care, therefore, must be paid to the validity of indices of abundance so far as the data set employed is concerned. Figs.10-12 show the catch/effective fishing intensity

plots for white marlin.

North Atlantic: Effective fishing intensity ranged roughly from 300 x 10^3 to 650 x 10^3 hooks/5°sq. over the period after 1962. The 1964 estimate far beyond the upper limit of this range is of an only exception. The 1979 estimate is in the vicinity of its lower limit (Fig.10).

South Atlantic: Effective fishing intensity changed very widely from year to year. The 1964 estimate is also the largest in the past. It is relatively low in 1979 (Fig.11).

Atlantic-wide: Catch/fishing intensity plots behave as done in the North Atlantic stock hypothesis. Effective fishing intensity ranged from 300 x 10^3 to 650 x 10^3 hooks/5°sq. over the period after 1962, except the largest in 1964. However, during most of this period, it changed only from 300 x 10^3 to 500 x 10^3 hooks/5°sq. With this relatively small change in effective fishing intensity, the stock level seems to have been decreased. The 1979 estimate of effective fishing intensity is in the vicinity of the lower limit of its range.

The decreasing white marlin stock in recent years seems to be evident not only in the Atlantic-wide stock but in the separate North and South Atlantic stock hypothesis. This is also suggested by the CPUE trend in the Japanese fishery, where catch and effort have more validity but much less coverage in stock areas. In the North Atlantic, a downward trend in CPUE especially in the latter half of the 1970's is noted. however, the decreasing trend in white marlin stock thus suggested does not seem to be more serious than in blue marlin for which the apparent decrease since as early as 1966 is suggested (Figs.3 and 7). In any event, the method of obtaining total fishing intensity by simply raising estimates from Japanese data should be re-examined when the billfish data base is more improved.

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Table 1 1978 and 1979 Japanese and All atlantic catch and fishing intensity estimates of white marlin and blue marlin.

Fish species	Proposed stock	Year	Japan									All countries					
			C (in number)			C (MT)			f			C (MT)			f		
			a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
White marlin	North Atlantic	1978	1300	3175	4944	27	66	103	88	56	88	426	466	502	1388	395	429
		1979	1758	3168	4493	42	76	107	67	48	67	479	513	545	764	324	341
	South Atlantic	1978	328			14			8			484			277		
		1979	367			15			10			511			341		
	Whole Atlantic	1978	1628	3503	5272	41	80	117	53	36	53	910	949	990	1176	427	448
		1979	2125	5293	4860	57	91	122	42	31	42	990	1024	1075	729	349	370
Blue marlin	North Atlantic	1978	396	599	816	54	82	111	52	38	52	847	875	905	816	405	424
		1979	661	818	1061	68	103	109	45	43	45	775	810	823	513	338	340
	South Atlantic	1978	151			15			9			513			308		
		1979	557			66			33			485			242		
	Whole Atlantic	1978	547	750	967	69	97	126	36	28	36	1360	1388	1424	710	401	407
		1979	1218	1375	1618	134	169	175	41	40	41	1260	1295	1358	386	307	318

Note: C Catch
f Effective fishing intensity (1000 hooks/5°sq.)
a Excluding fish returned to sea within U.S. Fishery Conservation Zone.
b Including reported catch of "dead" fish at time of return to sea.
c Including reported total catch of fish returned to sea, irrespective of "dead" or "alive".

Table 2 Annual catch and fishing intensity estimates of blue marlin by Japanese and all Atlantic fisheries, 1956-1979.

1. North Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	7	7	+	+	23.33
1957	91	91	5	5	18.20
1958	240	240	47	47	5.11
1959	231	231	76	76	3.04
1960	581	684	74	87	7.86
1961	379	647	40	68	9.51
1962	3223	3446	300	321	10.74
1963	4759	5138	513	554	9.27
1964	4434	4806	789	852	5.64
1965	3330	3680	599	665	5.53
1966	1677	2033	310	375	5.42
1967	485	1167	130	313	3.73
1968	474	1338	124	350	3.82
1969	658	1595	190	460	3.47
1970	758	1839	216	525	3.50
1971	1223	2111	494	855	2.47
1972	335	1313	165	647	2.03
1973	229	1615	100	705	2.29
1974	267	1731	100	648	2.67
1975	551	1924	262	914	2.11
1976	260	1243	156	746	1.67
1977	118	1171	76	754	1.55
1978	111	905	52	424	2.13
1979	109	823	45	340	2.42

2. South Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	32	32	2	2	16.00
1957	673	673	64	64	10.52
1958	532	532	81	81	6.57
1959	610	610	218	218	2.80
1960	2131	2131	298	298	7.15
1961	3389	3430	362	366	9.37
1962	3821	3856	767	775	4.98
1963	3841	3896	800	808	4.82
1964	3156	3201	865	874	3.66
1965	2421	2473	739	754	3.28
1966	1693	1819	505	540	3.37
1967	588	1067	257	465	2.29
1968	472	1090	175	404	2.70
1969	302	1490	157	774	1.93
1970	247	1019	104	430	2.37
1971	172	1086	87	549	1.98
1972	85	1060	49	611	1.73
1973	117	1565	51	682	2.29
1974	17	1101	8	518	2.13
1975	57	1106	31	601	1.84
1976	4	946	4	946	1.00
1977	17	886	11	573	1.55
1978	15	519	9	311	1.67
1979	66	535	33	267	2.00

3. Whole Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	39	39	1	1	39.00
1957	764	764	27	27	28.30
1958	772	772	59	59	13.08
1959	841	841	128	128	6.57
1960	2712	2815	156	162	17.38
1961	3768	4077	158	171	23.84
1962	7044	7302	471	490	14.90
1963	8600	9034	618	649	13.92
1964	7590	8007	817	858	9.33
1965	5751	6153	650	696	8.84
1966	3370	3852	381	434	8.88
1967	1073	2234	176	366	6.10
1968	946	2428	143	368	6.60
1969	960	3085	178	571	5.40
1970	1005	2858	175	497	5.75
1971	1395	3197	345	790	4.05
1972	420	2373	122	689	3.44
1973	346	3180	82	753	4.22
1974	284	2832	66	658	4.30
1975	608	3030	178	886	3.42
1976	264	2189	101	837	2.62
1977	135	2057	52	792	2.60
1978	126	1424	36	407	3.50
1979	175	1358	41	318	4.27

Notes:

C_1 Catch by Japanese longline fishery.

C_2 Catch by all Atlantic fisheries.

f_1 Effective fishing intensity by Japanese longline fishery (1000 hooks per 5° sq.).

f_2 Effective fishing intensity by all Atlantic fisheries (1000 hooks per 5° sq.).

U C_2/f_2

* Maximum catch including fish returned to sea within U.S. Fishery Conservation Zone.

Table 3 Annual catch and fishing intensity estimates of white marlin by Japanese and all Atlantic fisheries, 1956-1979.

1. North Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	4	4	+	+	20.00
1957	25	25	3	3	8.33
1958	62	62	42	42	1.48
1959	16	16	98	98	0.16
1960	25	85	43	146	0.58
1961	30	101	22	74	1.36
1962	271	376	165	229	1.64
1963	754	912	350	423	2.16
1964	1493	1690	849	959	1.76
1965	1913	2124	497	552	3.85
1966	1417	1787	396	499	3.58
1967	174	578	124	412	1.40
1968	273	681	115	286	2.38
1969	451	1190	136	359	3.31
1970	419	1036	201	496	2.09
1971	915	1535	377	633	2.42
1972	339	1198	170	600	2.00
1973	328	990	126	381	2.60
1974	381	1211	120	382	3.17
1975	404	1084	222	595	1.82
1976	540	1047	181	351	2.98
1977	80	499	87	543	0.92
1978	*103	*502	88	429	1.17
1979	*107	*545	67	341	1.60

2. South Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	15	15	1	1	15.00
1957	135	135	17	17	7.94
1958	99	99	23	23	4.30
1959	96	96	139	139	0.69
1960	228	228	189	189	1.21
1961	662	722	183	199	3.63
1962	1644	1683	633	656	2.57
1963	1664	1700	421	429	3.96
1964	2002	2041	1026	1047	1.95
1965	2718	2779	750	765	3.63
1966	1585	1714	474	512	3.35
1967	494	838	245	417	2.01
1968	815	1355	309	513	2.64
1969	392	1042	162	431	2.42
1970	284	1049	217	801	1.31
1971	65	711	29	318	2.24
1972	101	1133	61	684	1.66
1973	27	789	17	497	1.59
1974	9	536	2	119	4.50
1975	14	486	16	555	0.88
1976	3	763	20	509	1.50
1977	26	459	8	141	3.25
1978	14	488	8	279	1.75
1979	15	530	10	353	1.50

3. Whole Atlantic stock

Year	C_1	C_2	f_1	f_2	U
1956	19	19	+	+	31.67
1957	160	160	9	9	17.78
1958	161	161	34	34	4.74
1959	112	112	116	116	0.97
1960	253	313	106	131	2.39
1961	692	823	92	109	7.55
1962	1915	2059	368	397	5.19
1963	2418	2612	381	411	6.36
1964	3495	3731	926	991	3.76
1965	4631	4903	607	643	7.63
1966	3002	3501	430	503	6.96
1967	668	1416	176	373	3.80
1968	1088	2036	200	374	5.44
1969	843	2232	147	390	5.72
1970	703	2085	208	618	3.37
1971	980	2246	226	518	4.34
1972	440	2331	123	652	3.58
1973	355	1779	79	396	4.49
1974	390	1747	69	309	5.65
1975	418	1570	133	500	3.14
1976	543	1810	103	343	5.28
1977	106	958	53	479	2.00
1978	*117	*990	53	448	2.21
1979	*122	*1075	42	370	2.91

Table 4 Estimated production model parameters for blue marlin with the assumption of three significant age groups fished.

Proposed stock	K	m	r^2	f_{opt}	MSY
North Atlantic	4	0.0	0.58	∞	2627
		1.0	0.62	513	2270
		2.0	0.66	477	2530
	5	0.0	-	-	-
		1.0	0.74	422	2202
		2.0	0.78	457	2442
	6	0.0	-	-	-
		1.0	0.83	374	2128
		2.0	0.84	449	2348
South Atlantic	4	0.0	0.51	∞	2456
		1.0	0.50	660	2103
		2.0	0.47	650	2213
	5	0.0	0.63	∞	1984
		1.0	0.59	529	2004
		2.0	0.55	577	2118
	6	0.0	0.66	∞	1769
		1.0	0.62	460	1920
		2.0	0.57	539	1991
Atlantic-wide	4	0.0	0.64	∞	5074
		1.0	0.66	470	4340
		2.0	0.66	481	4857
	5	0.0	-	-	-
		1.0	0.76	412	4233
		2.0	0.77	440	4860
	6	0.0	-	-	-
		1.0	0.81	353	4229
		2.0	0.83	425	4697

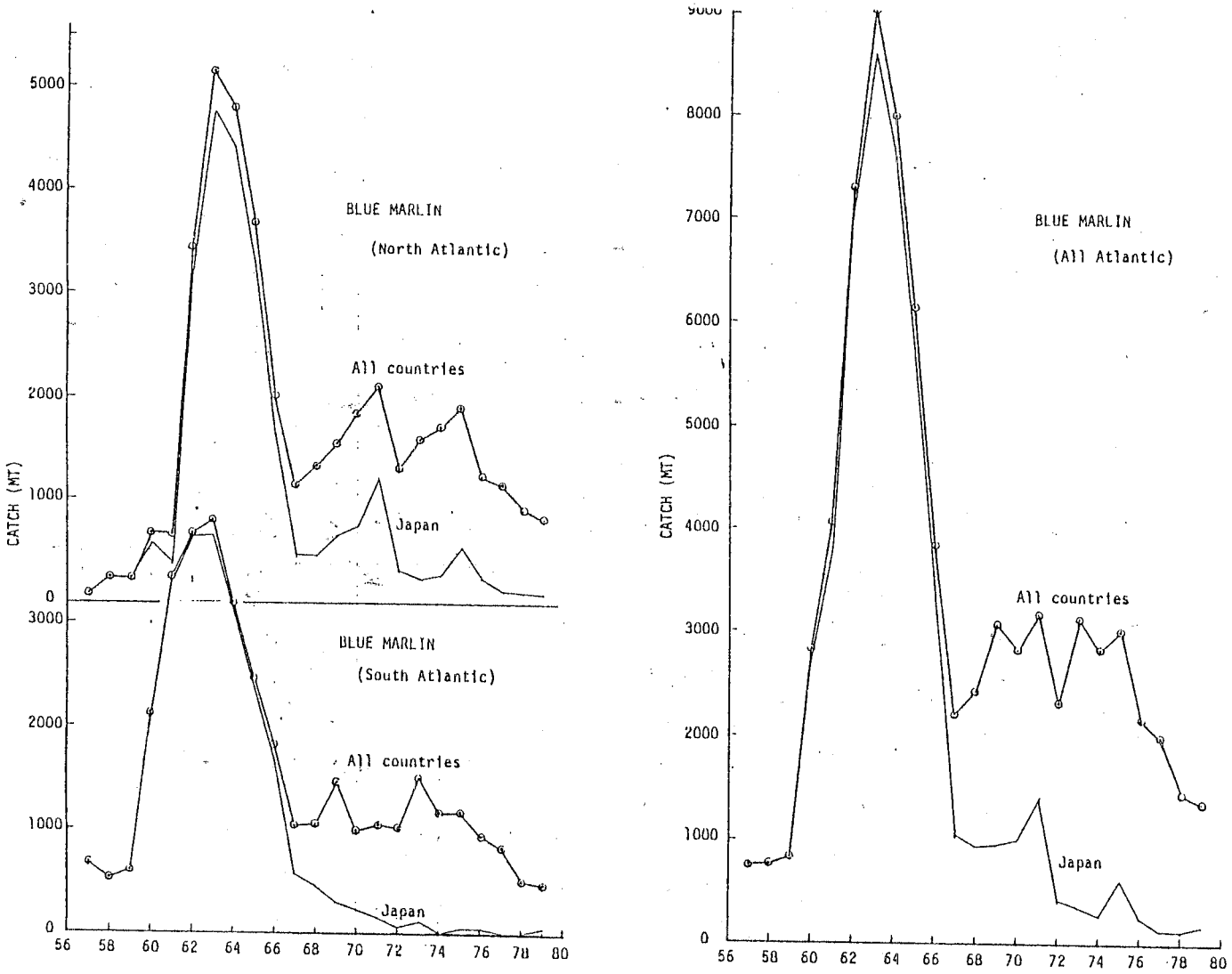


Figure 1 Change in Japanese and aggregate Atlantic blue marlin catches in the North, South and all Atlantic.

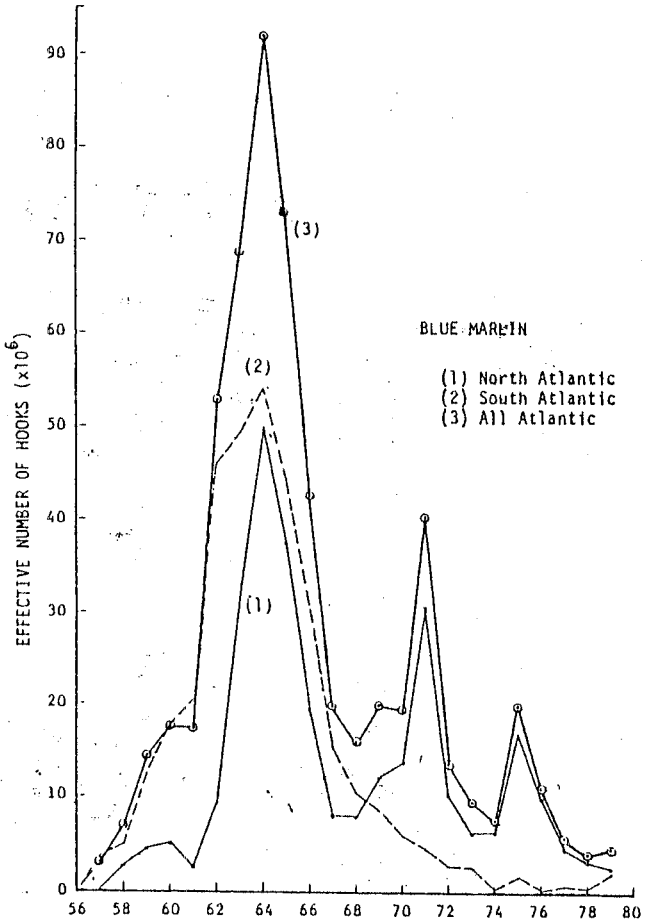


Figure 2 Change in effective fishing effort of Japanese longline fishery for blue marlin.

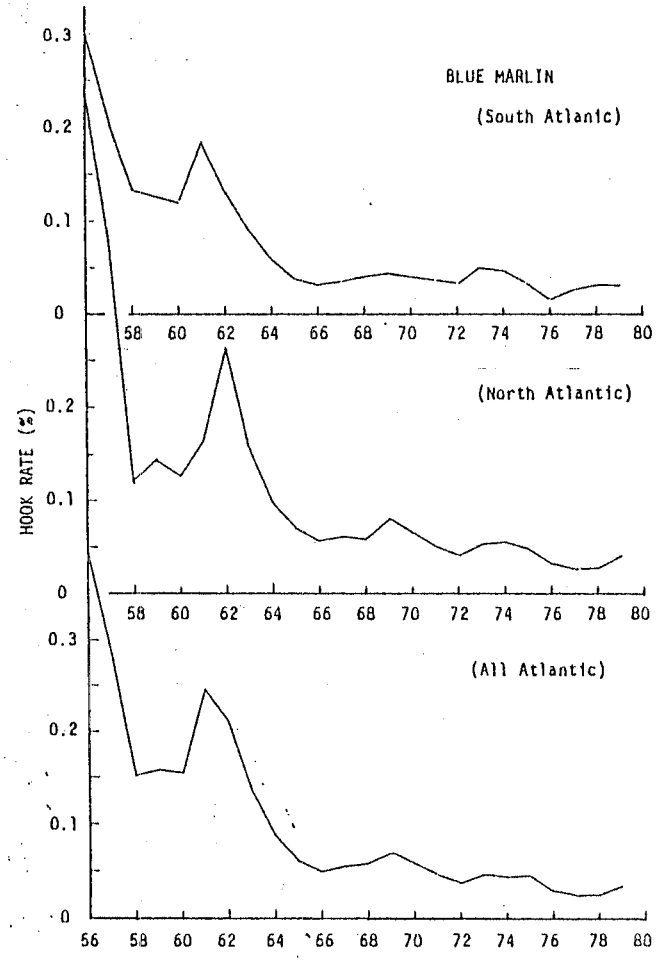
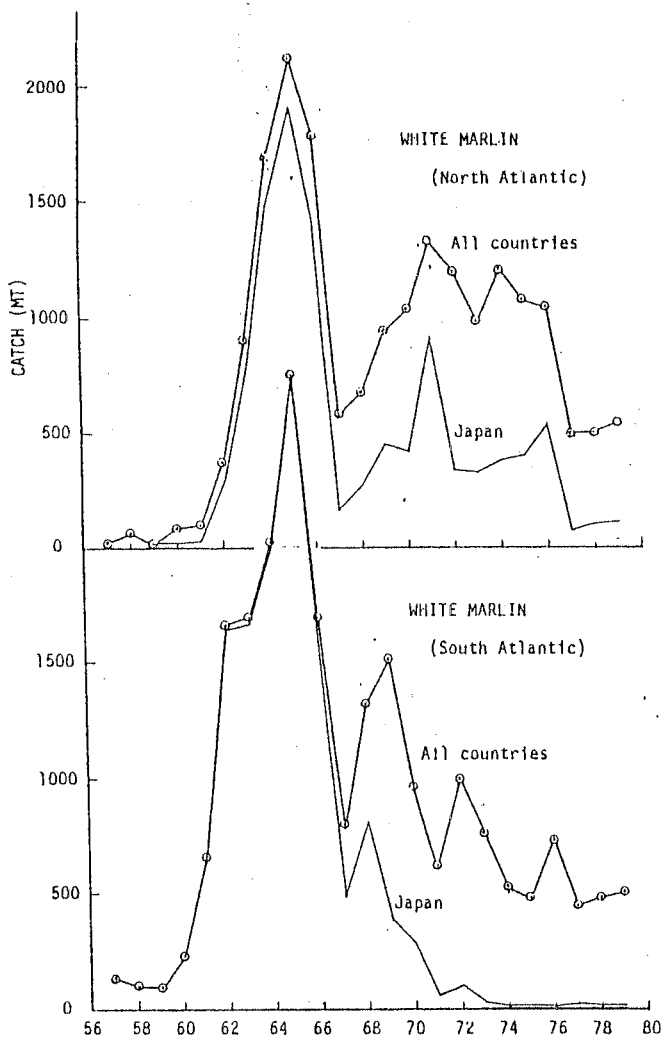


Figure 3 Change in CPUE of Japanese longline fishery for blue marlin.



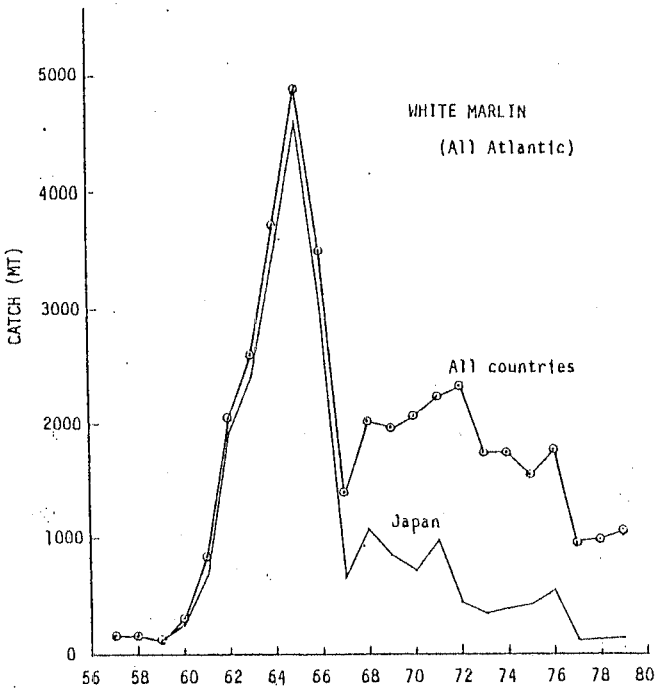


Figure 4 Change in Japanese and aggregate Atlantic white marlin catches in the North, South and all Atlantic.

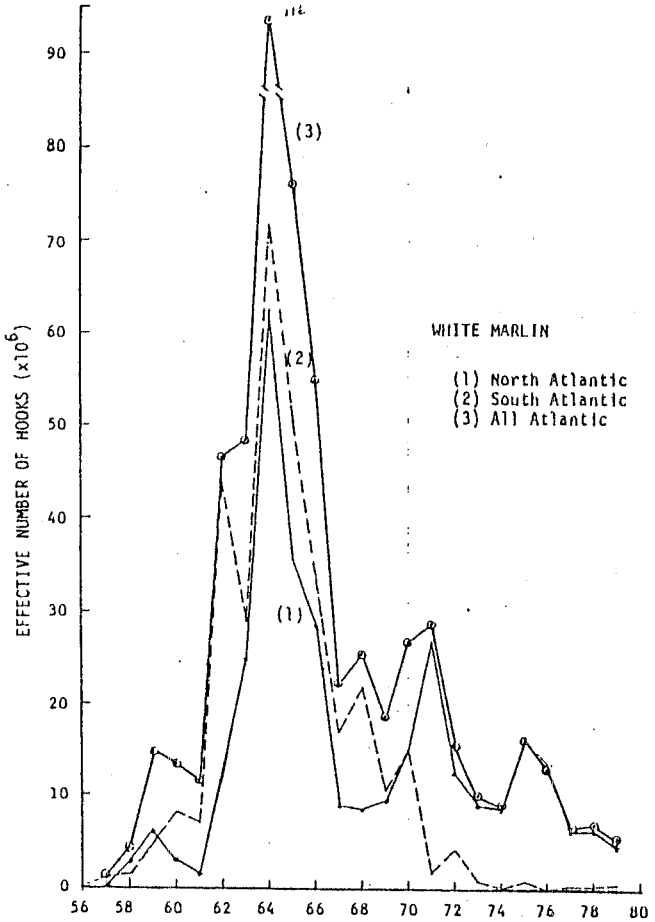


Figure 5 Change in effective fishing effort of Japanese longline fishery for white marlin.

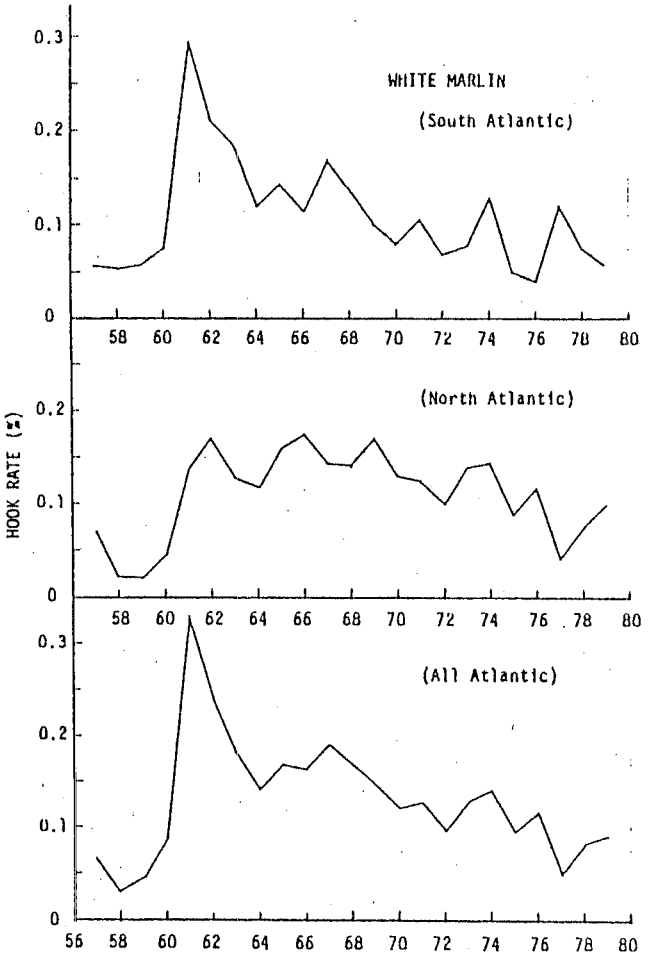


Figure 6 Change in CPUE of Japanese longline fishery for white marlin.

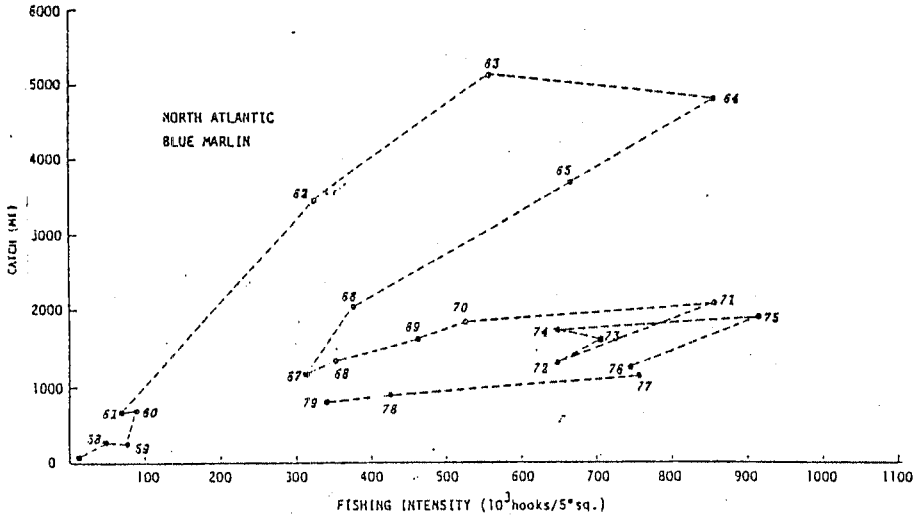


Figure 7 Catch/fishing intensity plots for North Atlantic blue marlin.

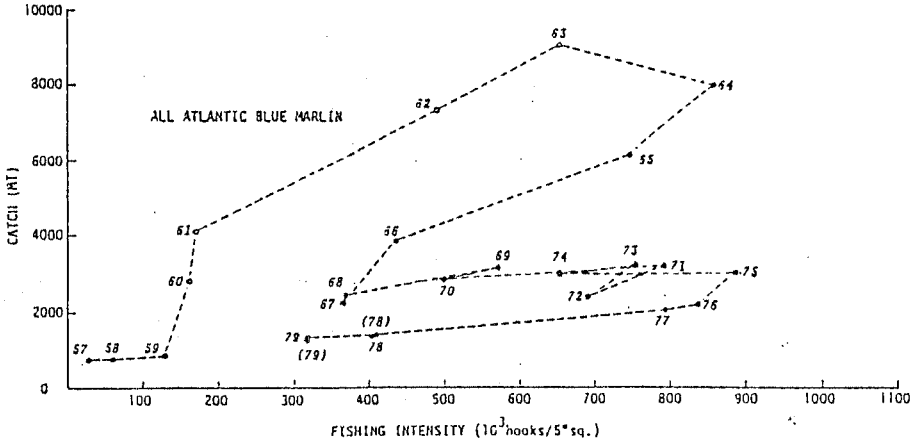


Figure 9 Catch/fishing intensity plots for all Atlantic blue marlin.

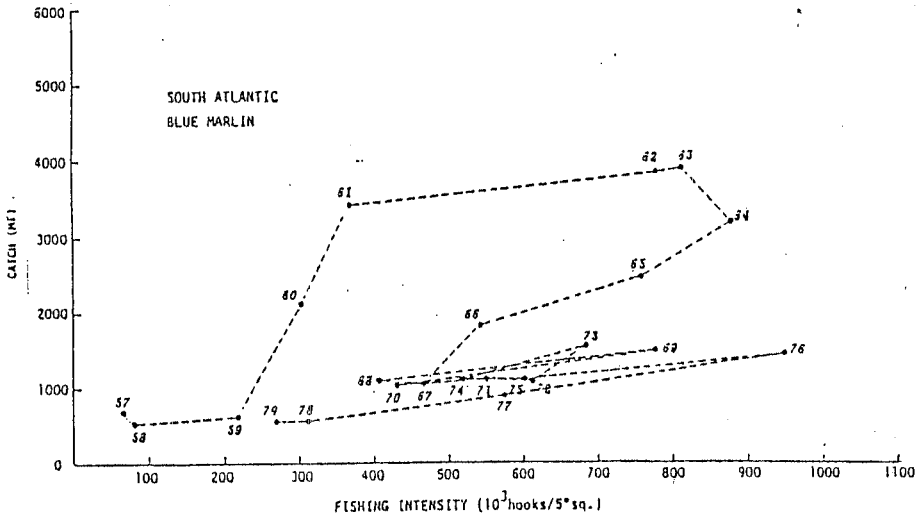


Figure 8 Catch/fishing intensity plots for South Atlantic blue marlin.

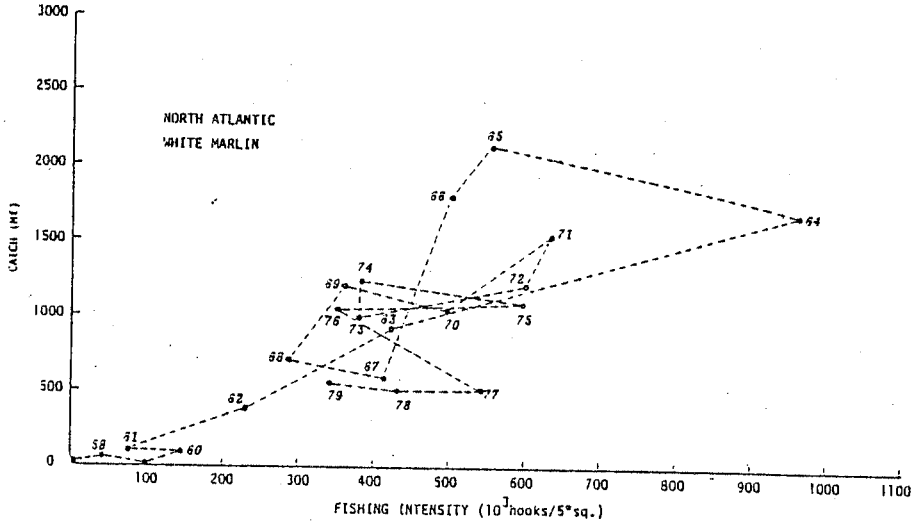


Figure 10 Catch/fishing intensity plots for North Atlantic white marlin.

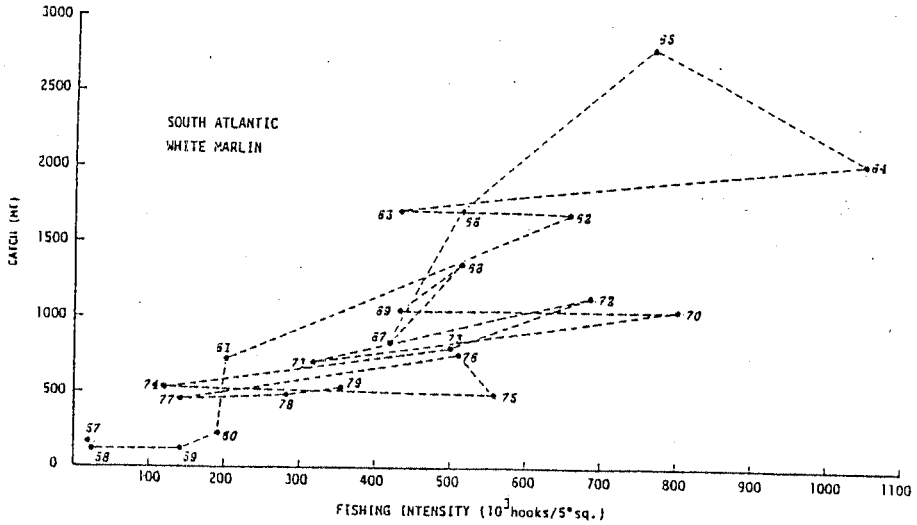


Figure 11 Catch/fishing intensity plots for South Atlantic white marlin.

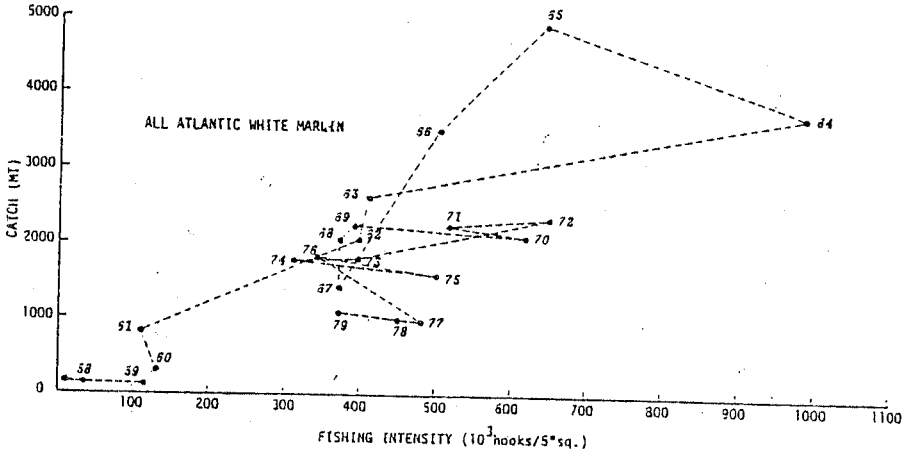


Figure 12 Catch/fishing intensity plots for all Atlantic white marlin.