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Flatfish of the Scotian Shelf

by

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INTRODUCTION

There are six species of the family Pleuronectidae fished commercially on the Scotian Shelf:

Witch flounder [Glyptocephalus cynoglossus) (L.)]
American plaice [Hippoglossoides platessoides (Fabricius)]
Atlantic halibut [Hippoglossus hippoglossus (L.)]
Yellowtail flounder [Limanda ferruginea (Storer)]
Winter flounder [Pseudopleuronectes americanus (Walbaum)] and
Greenland halibut [Reinhardtuis hippoglosoides (Walbaum)]

Commercial samples of flatfish are restricted to American plaice, witch flounder, yellowtail and winter flounder.

Canadian summer research cruises provide information for the American plaice, witch and yellowtail flounders, but the data provided for all other flatfish is quite inconsistent.

Consequently, basic data being very scarce for most Scotian Shelf flatfish, and in any case quite dubious with the exception of American plaice and witch since 1976, any attempt to assess the stocks using the commercial and research information presently available would be unreliable. The present document does not include assessments of the flatfish species, but summarizes the information presently available.

General data on all flatfish is first presented, followed by a more detailed presentation of each of the 6 flatfish species.

LANDINGS AND CATCH RATES FOR ALL SHELF FLATFISH

Canada is the main exploiter of the flatfish on the Scotian Shelf. However, the USSR has made sporadic, large landings from 1965 to 1977, after which time it lowered its effort in the area. In all cases, the flatfish fishery is mainly a by-catch fishery.

The total catch of flatfish increased considerably between 1963 to 1968 (Table 1, Figure 1), when it reached a maximum value of 56,483 t. Then came a period of fluctuation in landings (1969-1973), followed by a steady decline, from 31,482 t in 1973 to 12,909 t in 1978. This drop in landings is mainly due to a decrease in witch flounder (decrease of 87%) and American plaice catch (decrease of 50%) from 1973 until 1978.

American plaice and witch flounder represent up to 85% of the total landings, while yellowtail and winter flounder never exceeded 30% of the catch.

The catch and effort data for all six species of flatfish were put together to calculate catch rates, as a population abundance index. The Chikuni index (Chikuni, 1976) was calculated using the Canadian side trawler of tonnage class 4 as standard gear. This gear was selected because it is responsible for most of the flatfish landings by the Canadian fleet, and also because it has been in the fishery for a longer time than the stern trawler. Calculations were restricted to the months of January, February, March and April. A standard percentage of 50% of total catch was choosen for the estimation of the catch per unit of effort. The resulting index (Figure 2) shows a definite decline in catch rates from 1969 to 1974, followed by a more or less stable phase, from 1975 to 1978. This would suggest that the overall flatfish stocks are not being presently overfished.

ATLANTIC HALIBUT

The highest concentration of Atlantic halibut on the Scotian Shelf is found in ICNAF Division 4X (Table 2). Total landings have decreased since 1965, but catches have leveled off, from 1973 to 1977 with an average catch of 694 t a year and then increased slightly in 1978.

TURBOT

Turbot is a species rather scarce on the Scotian Shelf, and can be found mainly in the colder water of the eastern part of the Shelf (Halliday, 1973). Most landings on the Shelf are recorded in ICNAF Division 4V, which have been increasing from 1975 to 1977 and dropped again in 1978 (Table 3).

WINTER FLOUNDER

Winter flounder is a costal species, particularly abundant in the Bay of Fundy. The Canadian catch is thus almost entirely taken by inshore vessels (Halliday, 1973).

Landings

Landings are almost restricted to ICNAF Division 4X. The total catches on the Shelf are quite constant although they have slightly

decreased since 1974 (Table 4). This phenomenon could be partly, if not all, explained by the lower activity of the Soviet fleet on the Shelf, compared to the activity of mid-sixties.

Sampling

Commercial samples for length and age have been taken irregularly aboard Canadian vessels since 1948 (Table 5). The data collected is not sufficient to give reliable age-length or length frequency samples, thus preventing any attempt to determine the numbers at age of winter flounder caught.

YELLOWTAIL

Yellowtail is distributed all over the Scotian Shelf, in shallow waters. The densest concentrations are located on Banquereau, particularly on the eastern Shoal, Sable Island and Middle Banks (Halliday, 1973).

Landings

Canadian catch is concentrated in ICNAF Division 4V, while Soviet landings are recorded mostly in ICNAF Division 4W.

Total landings have fluctuated considerably from 1963 to the present, with a maximum value of 13,128 t in 1968 (Table 6) and a minimum value of 904 t in 1976.

Sampling

Length and age samples of fish caught in Canadian commercial trawlers and seines have been available since 1948 (Table 7). However, the seasonal coverage is quite incomplete, and the number of fish aged does not allow reliable age length keys. No foreign sampling data are available. Consequently numbers at age of fish landed could not be prorated in a satisfactory way.

Catch rates

Canadian summer research cruises provide catch rates in number at age per tow since 1970 (Table 8). Catch rates are fairly constant from 1970 to 1973, increase in 1974, and reach a maximum value in 1977 for both male and female fish. In 1978, the catch rate recorded is the lowest value since 1970. However, a three year running average of total number caught per tow with sexes separate, show a gradual increase in catch rates from 9.79 in 1970 to 18.19 in 1978 for the males, and from 8.79 in 1970 to 16.11 in

1978 for the females. These results suggest an increase in population number.

Commercial catch rates have been calculated by the Chikuni method (Chikuni, 1976) using Canadian side trawlers of tonnage class 4 as a standard gear. The index was calculated for the months of March-April-May. The catch per unit of effort value was estimated for a catch of yellowtail representing 50% of the total catch. The absence of index in 1976 is due to the lack of data necessary to draw the regression line of catch per unit of effort versus % of total catch. The results (Figure 3) show a drastic decline in catch rates between 1972 and 1974, followed by a slight increase from 1974 to the present. It would then tend to agree with the research catch rates calculated as a three year running average.

Total mortality coefficient

Total mortality coefficients were calculated using the research catch rates (Table 9 & Table 10). On a yearly basis, the total mortality coefficient for 1977-78 is the highest recorded since 1970. But on a three year running average basis, total mortality does not seem to be higher in the most recent years than in the mid seventies.

WITCH FLOUNDER

Witch flounder is distributed all over the Scotian Shelf, predominantly in waters deeper than 100 fm. It is also more abundant in the Banquereau and Sable Island area (Halliday, 1973).

Landings

The biggest landings are recorded in ICNAF Division 4V (Table 11), where Canada does most of its fishing activity. The USSR which leads the second most important witch fishery (Table 12) concentrates its activity in ICNAF Division 4W. The Canadian fishery is mostly concentrated in spring while the Soviet fishery dominates during the summer months.

Since 1973, a drop of 87% has been noticed in the Scotian Shelf catch of witch. In ICNAF Division 4W alone, a decrease of 93% in landings was reported for the same period, probably due to the lower intensity of fishing from the Soviet fleet.

Sampling

Canadian commercial samples of witch flounder have been taken since 1948 for trawlers and seines (Table 13). Data for the last quarter of the year is almost non-existent, and in general the

number of fish aged is not sufficient to get valid information. No foreign fleet samples are available.

Landings have been broken down into numbers caught using the Canadian age-length keys and length frequency samples (Table 14 and 15). Sexes were assessed separately, their respective proportions in the total catch assumed equal to their proportions in the samples. Both males and females are recruited to the commercial fishery at age 5. However a close look at the number at age tables shows the insufficiency of data.

Irregularities in tables such as these can be explained by many factors, most of which are related to the fact that low numbers of samples taken represent only a restricted view of the population, and any change in composition (i.e. with time, space, etc.) will become very evident. The yearly number of samples taken has exceeded 10, only since 1975. The coverage prior to 1975 was concentrated in the first four months of the year, while in 1975, 1976 and 1977 samples were taken throughout the year.

Variability in composition can also appear due to the fact that proportion in numbers of samples taken yearly, in the two ICNAF areas, 4V and 4W, was not constant from 1970-1978 inclusive. From 1970 to 1974 the ratio samples taken was 1 to 1, but beyond that, an average of 1 sample was taken in 4W for every 7 samples in 4V.

Finally, it was found that although the catches of Trawlers and Danish Seiners seemed to have the same range of length of fish, the fact that the two gears were not sampled in a constant proportion could eventually affect the composition at age of fish.

Catch rates

Catch rates provided by the Canadian summer research cruises are shown in Table 16 and 17. The numbers of witch caught per tow is very constant since 1976 indicating the stability of the population numbers (Figure 4).

Chikuni's catch rates were also calculated as an index of population abundance. The standard gear choosen to calculate the indices was the trawler, since it predominates in the fishery (Table 18). Thus, catch and effort data from Canadian side trawlers of tonnage class 4, which records the highest catch in Canadian fishery (Table 19), were used in the calculations. Only the data for the months of March-April-May were considered, because they represent the time of the year where high catches correspond to high effort (Figure 5). The standard percentage of total catch was fixed at 50%, when estimating the catch per unit of effort.

The Chikuni indices show a general decline in catch rates (Table 16, Figure 4) from 1972 to 1977. However, the decrease is very slight for the most recent years, indicating a trend towards stablization of population numbers.

Mortality coefficients

The total mortality coefficients values calculated with the research cruise catch rates (Table 20 and 21) decreased since 1974, showing the possibility of the population recovering after being overfished.

AMERICAN PLAICE

American plaice is found all over the Scotian Shelf, with major concentration in less than 100 fm (Halliday, 1973).

Landings

American plaice landings decreased slightly since 1976 (Table 22). It is fished mainly by Canada in area 4V and USSR in area 4W. The drop in catch in area 4W can thus be explained by the complete exclusion of the Soviet fleet from this fishery (Table 23) since 1977. The USSR used to be the second harvester of American plaice, catching up to 50% of the total catch.

Sampling

Prior to 1969, an average of 2 samples a year were taken aboard Canadian commercial vessels in order to get age and length frequencies (Table 24). Most samples were taken in the ICNAF Division 4V, and seasonal coverage was quite incomplete before 1974 There are no biological sampling data available for Soviet landings.

Nevertheless landings were converted into numbers caught at age using the Canadian age-length keys and length frequencies (Table 25). Sexes were assessed according to the sex-ratio in the commercial samples. The numbers at age indicate that males tend to recruit to the fishery at age 4 and 5, while females are recruited at age 5 and 6. However, upon closer examination of the cohort numbers, it has become evident that for American Plaice, as well as witch flounder, the table of the numbers at age is not an accurate representation of the population composition. Here again, low numbers of yearly samples taken (below 10 until 1976), and the discrepancy of proportions of samples taken by gear, season and area can explain in part the irregularity of the table.

Catch rates

Canadian research catch rates have been decreasing since 1976 (Table 26 and 27). It should be noticed that in 1976, the high catch rate is not due to one tow particularly full of fish, but to a general increase in the number of fish per tow.

Commercial catch rate, using the Chikuni method, were calculated using the Canadian side trawlers, tonnage class 4, catch and effort data. For plaice as well as witch, trawlers are predominent in the fishery (Table 28), and tonnage class 4 of the Canadian side trawlers recorded the highest catch (Table 29). Only the months of February-March-April were considered in the calculations, since it is the time of the year where highest catch and high effort value are reported (Figure 6). The percentage of catch choosen to calculate the catch per unit of effort was 50%. The Chikuni index shows a decline in catch rate between 1972 and 1976, then followed by an increase until 1978 (Table 27, Figure 4)

There is thus a disagreement between research and commercial data. But although a slight increase in catch rate is apparent in commercial data, the actual value are very much lower than the early seventies values. Consequently, it cannot, at present, be determined if there is a recovery of stock.

Weight at age

The weight at age of American Plaice caught in Canadian trawlers is shown in Table 32. No attempt was made to relate the growth to density estimates, the data being unreliable in most cases, however these weight were used to get the numbers of fish landed.

MORTALITY COEFFICIENT

Coefficients of total mortality calculated with research catch rates show an increase in mortality in the most recent years (Table 30 and 31). The three year running average shows its maximum value between 1976-1978, both for male and female plaice.

CONCLUSION

Since the almost complete retirement of the USSR fleet from the Scotian Shelf, the flatfish stock seem to be recovering. For most species, catch rates and landings have leveled off or increased since 1976. There is some evidence that the biomass is fairly constant for the same years.

Acknowledgements

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Table 1. Total landings (t) for flatfish in ICNAF area 4VWX, between 1963-1978.

Year	American Plaice	Witch Flounder	Yellowtail Flounder	Winter Flounder	Atlantic Halibut	Turbot	Flatfish (N.S.)	Total
1963	2309	7486	3972	696	1533	-	-	15,996
1964	3082	8629	5399	1311	1541	2	194	20,158
1965	8198	12943	6104	1339	1609	-	90	30,283
1966	14206	14512	4851	1346	1176	1	30	36,122
1967	10770	7816	5196	944	1248	2	-	25,976
1968	19265	21682	13128	1181	1217	10	-	56,483
1969	13735	14093	3826	1416	1064	39	-	34,173
1970	8358	6048	3682	1530	830	20	11	20,479
1971	14301	17864	1775	3084	1005	24	1	38,054
1972	10653	11351	1485	1454	850	18	724	26,535
1973	12432	13969	1513	1909	774	12	873	31,482
1974	16772	7415	939	2756	655	35	811	29,383
1975	11747	8922	1568	1374	649	29	1118	25,407
1976	11147	5742	904	1297	714	69	1043	20,916
1977	7757	2431	1443	1259	679	215	944	14,728
1978[a]	6815	2178	1621	1208	501	452	64	12,839

[a] provisional

Table 2 Atlantic Halibut landings (t) for Scotian Shelf. 1963-78.

Year	4V	4W	4X	TOTAL
1963	214	479	840	1533
1964	332	358	861	1551
1965	486	458	665	1609
1966	532	313	331	1176
1967	380	322	546	1248
1968	250	363	604	1217
1969	192	431	441	1064
1970	115	349	366	830
1971	231	360	414	1005
1972	178	216	456	850
1973	147	226	401	774
1974	124	127	404	655
1975	114	159	376	649
1976	144	148	422	714
1977	51	177	448	676
1978 [a]	220	278	3	501

[a] provisional

Table 3 . Turbot landings (t) for Scotian Shelf 1963-77

Year	4V	4W	4X	Total
1963	0	0	0	0
1964	1	0	1	2
1965	0	0	0	0
1966	1	0	0	1
1967	2	0	0	2
1968	10	0	0	10
1969	36	0	3	39
1970	14	3	3	20
1971	19	2	3	24
1972	11	0	7	18
1973	10	1	1	12
1974	35	0	0	35
1975	27	2	0	29
1976	57	6	6	69
1977	179	9	9	**197**

Table 4 . Winter Flounder landings (t) for Scotian Shelf Flatfish between 1963-78.

YEAR	4V	4W	4X	TOTAL
1963	17	65	614	696
1964	12	19	1280	1311
1965	32	179	1128	1339
1966	55	34	1257	1346
1967	37	5	902	944
1968	10	28	1143	1181
1969	4	12	1400	1416
1970	8	44	1478	1530
1971	237	1364	1483	3084
1972	78	551	825	1454
1973	480	655	774	1909
1974	777	1005	974	2756
1975	179	525	670	1374
1976	235	345	717	1297
1977	226	9	1024	1259
1978[a]	185	146	877	1208

[a] provisional

Table 5 Canadian commercial sample available for Winter flounder since 1948 in ICNAF Divisions 4VWX-5. [a]

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
						4V						
1953												
OTB1	-	-	-	-	-		-	-	-	-	18/100	-
						4W						
1951												
OTB1	-	-	-	-	-	0/52	-	-	-	-	-	-
1953												
OTB1	17/100	-	-	-	-	-	-	-	-	-	-	-
1954												
SNU	-	-	-	-	-	0/100	-	-	-	-	-	-
						4X						
1948												
OTB1	-	-	-	0/400	-	0/300	0/260	0/100	-	0/350	-	-
1949												
LHP	-	-	-	0/172	-	-	-	-	-	-	-	-
OTB1	-	-	-	80/390	-	40/200	40/200	-	-	-	20/100	-
1950												
OTB1	-	-	-	54/272	60/300	50/350	30/250	0/100	-	-	-	-
1951												
OTB1	-	-	-	80/480	60/360	29/29	-	40/240	40/240	-	-	-
1952												
OTB1	-	-	-	18/100	38/200	-	37/200	-	37/200	-	-	-
1953												
OTB1	-	-	-	20/100	-	20/100	40/200	-	-	18/100	-	-
1954												
OTB1	-	-	-	-	79/300	-	40/100	-	-	-	-	-
1955												
OTB1	-	-	-	-	99/479	20/100	-	-	-	-	-	-
1961												
OTB1	-	-	-	-	-	-	-	-	-	0/206	-	-
1962												
OTB1	-	-	-	-	-	0/120	-	-	-	-	-	-
1965												
OTB1	-	-	-	-	-	-	0/162	-	-	-	-	-
1973												
OTB1	-	-	-	-	-	-	-	-	-	91/359	-	-
1976												
OTB2	-	-	-	-	-	-	41/109	-	-	-	-	-
OTB1	-	-	-	-	-	-	81/400	315/1583	-	-	-	-
1977												
OTB2	-	-	-	-	-	-	-	-	123/602	-	-	-
						5ZE						
1976												
OTB2	-	-	-	-	-	-	-	62/146	-	-	-	-
1978												
OTB1	-	0/129	-	-	-	-	-	-	-	-	-	-

[a] The first number represents the number of fish aged and the second number is the number of fish measured. The gear code is the same as the one used by ICNAF.

Table 6 . Yellowtail flounder landings (t) for Scotian Shelf Flatfish between 1963-77.

YEAR	4V	4W	4X	TOTAL
1963	1740	2148	84	3972
1964	4084	1165	150	5399
1965	4330	1550	224	6104
1966	3521	1164	166	4851
1967	3808	1163	225	5196
1968	6953	5970	205	13128
1969	2491	1134	201	3826
1970	670	2686	326	3682
1971	889	668	218	1775
1972	697	624	164	1485
1973	980	394	139	1513
1974	573	130	236	939
1975	1101	254	213	1568
1976	473	201	230	904
1977	1101	40	302	1443
1978 [a]	1076	158	387	1621

[a] provisional

Table 7 Canadian commercial samples available for Yellowtail since 1948 in ICNAF Divisions 4VWX-5.[a]

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
						4V						
1948												
OTB1	-	-	-	-	-	-	20/100	20/100	-	-	-	-
1949												
OTB1	-	-	-	-	-	0/100	-	-	-	0/100	0/91	-
1950												
OTB1	-	-	-	-	-	0/200	-	-	-	-	0/100	-
1953												
OTB1	-	-	-	-	20/100	-	-	-	-	-	-	-
1958												
OTB1	-	-	-	0/200	-	-	-	-	-	-	-	-
1964												
OTB1	-	-	-	-	-	69/400	-	-	0/214	-	-	-
1965												
OTB1	-	-	-	-	-	0/200	-	-	-	0/200	-	-
1966												
OTB1	-	-	-	-	35/200	-	-	-	36/200	-	-	-
1967												
OTB1	-	-	-	-	-	-	17/200	-	-	39/200	32/200	-
1968												
OTB2	-	-	-	-	-	-	-	-	-	-	-	29/204
OTB1	-	-	-	-	40/200	30/139	-	-	-	-	-	-
1969												
OTB2	-	-	-	-	0/200	-	-	-	-	-	-	-
1972												
OTB1	-	-	-	-	-	32/100	-	-	-	-	-	-
1974												
OTB1	-	-	-	-	29/219	-	-	-	-	-	-	-
1975												
OTB2	-	-	-	59/200	-	-	-	-	-	-	-	-
1977												
OTM	-	-	-	-	-	34/200	-	-	-	-	-	-
OTB2	-	-	-	-	-	30/200	-	40/200	-	-	-	-
OTB1	-	-	-	-	-	35/200	32/200	-	32/200	-	-	-
1978												
SNU	-	-	-	-	-	-	75/572	-	-	-	-	-
OTB1	-	-	-	-	-	71/600	-	78/535	-	-	-	-
						5W						
1948												
OTB1	20/100	20/100	20/100	-	-	20/100	-	-	-	-	20/100	-
1949												
OTB1	20/100	-	-	-	-	0/100	-	-	-	-	0/100	0/100
1950												
OTB1	-	-	-	0/100	-	-	-	-	-	-	-	-
1951												
OTB1	-	-	-	-	-	-	-	-	-	0/100	-	19/119
1952												
OTB1	-	-	-	-	-	-	19/19	-	-	-	-	-
1962												
OTB1	0/248	-	-	-	0/113	-	0/163	-	0/187	-	-	-
1966												
OTB1	-	-	-	-	-	-	-	-	-	-	25/100	-
1968												
OTB1	-	-	-	-	35/201	-	-	-	-	-	-	-
1973												
OTB1	-	-	30/200	-	-	-	-	-	-	-	-	-
1978												
OTB2	-	-	31/182	-	-	-	-	-	-	-	-	-
						5ZE						
1976												
OTB2	-	-	-	-	-	-	-	-	0/92	-	-	-

[a]The first number represents the number of fish aged and the second number is the number of fish measured. The gear code is the same as the one used by ICNAF.

Table 8. Stratified mean catch per tow at age (number) calculated for yellowtail, from Canadian summer bottom trawl surveys in ICNAF division 4VWX, 1970-78.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978
					MALE				
1	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
2	0.453	0.145	0.000	0.214	1.099	0.145	0.687	0.208	0.089
3	1.423	0.704	0.165	1.080	1.733	2.895	1.671	1.965	0.454
4	1.812	1.357	0.451	1.674	1.824	2.226	1.994	10.342	1.219
5	3.176	1.986	1.011	2.168	2.312	3.218	1.159	6.522	1.899
6	2.469	2.252	1.279	2.162	2.142	2.667	1.586	3.205	1.654
7	1.216	1.409	3.437	1.663	2.149	2.451	1.553	4.256	1.015
8	0.266	0.664	1.888	0.683	0.981	1.585	0.599	2.889	0.239
9	0.032	0.043	0.898	0.036	0.192	0.085	0.110	0.353	0.043
10	0.015	0.000	0.192	0.045	0.000	0.069	0.000	0.000	0.000
11	0.000	0.000	0.033	0.000	0.003	0.000	0.000	0.000	0.000
12	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000
13+	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000
NK	0.043	0.115	0.018	0.081	0.000	0.769	0.011	0.000	0.028
Total	10.908	8.679	9.383	9.804	12.435	16.118	9.369	29.739	6.635
Average of 3 Years	9.794	9.657	9.289	10.541	12.786	12.641	18.409	15.248	18.187
					FEMALE				
1	0.000	0.000	0.000	0.000	0.035	0.035	0.000	0.000	0.000
2	0.326	0.151	0.007	0.197	0.860	0.542	0.095	0.086	0.031
3	0.921	0.932	0.167	0.427	1.250	2.205	1.051	1.808	0.263
4	1.646	0.974	0.460	1.189	1.362	2.789	1.659	6.349	1.114
5	3.267	1.853	0.963	1.801	2.030	1.838	1.595	4.762	1.449
6	1.624	2.452	1.264	1.968	3.018	1.794	1.572	2.294	1.477
7	0.710	1.390	2.277	1.682	2.538	2.067	1.796	2.065	1.118
8	0.383	0.263	2.250	1.311	1.513	1.271	1.316	2.086	0.444
9	0.135	0.106	1.141	0.437	0.459	0.657	0.462	0.617	0.095
10	0.048	0.059	0.361	0.095	0.039	0.100	0.231	0.095	0.014
11	0.000	0.023	0.107	0.037	0.022	0.007	0.002	0.031	0.000
12	0.007	0.000	0.026	0.017	0.000	0.007	0.013	0.000	0.000
13+	0.000	0.004	0.015	0.000	0.000	0.000	0.000	0.009	0.000
NK	0.020	0.284	0.000	0.051	0.000	1.274	0.007	0.011	0.000
Total	9.087	8.490	9.044	9.209	13.128	14.587	9.806	20.210	5.999
Average of 3 Years	8.789	8.874	8.914	10.460	12.308	12.507	14.868	12.005	13.105

Table 9. Total mortality coefficient (Z) for yellowtail, calculated from stratified mean catch per tow at age area 4WX, 1970-78.

Age	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
				MALE				
1-2	-	-	-	-	-	-5.434	-	-
2-3	-.441	-.130	-	-2.091	-.969	-2.444	-1.050	-.780
3-4	.048	.444	-2.316	- .524	-.250	.373	-1.823	.477
4-5	-.092	.294	-1.570	-.323	-.567	.652	-1.185	1.695
5-6	.344	.440	-0.760	.012	-.143	.707	-1.017	1.372
6-7	.561	-.423	-0.262	.006	-.135	.541	-0.987	1.149
7-8	.605	-.293	1.616	.527	.305	1.409	-.621	2.878
8-9	1.827	-.303	3.961	1.269	2.452	2.664	0.528	4.213
9-10	-	-1.502	2.994	-	1.023	-	-	-
10-11	-	-	-	2.708	-	-	-	-
11-12	-	-	-	-	-	-	-	-
$\bar{Z}a$	.834	-.145	1.139	.454	.620	1.330	-.524	2.403
				FEMALE				
1-2	-	-	-	-	-2.754	-1.007	-	-
2-3	-1.050	-.102	-4.124	-1.849	-.942	-.662	-.2951	-1.114
3-4	-.056	.708	-1.960	-1.160	-.802	.284	-1.799	.484
4-5	-.119	.012	-1.366	-.535	-.300	.559	-1.054	1.477
5-6	.287	.383	-.715	-.516	.124	.157	- .364	1.171
6-7	.155	.074	-.286	-.254	.379	-.002	-.273	-.719
7-8	.992	-.481	.552	.106	.691	.452	-.150	1.537
8-9	1.284	-1.466	1.638	1.049	.834	1.011	.757	3.092
9-10	.822	-1.225	2.483	2.417	1.524	1.045	1.584	3.800
10-11	-.755	-.595	2.282	1.484	1.792	3.833	2.001	-
11-12	0.000	-.141	1.820	-	.201	-.693	-	-
$\bar{Z}a$	.680	-.373	.297	.096	.507	.405	-.008	1.630

$\bar{Z}$ Calculated for age 5-6 to 8-9

Table 10. Total mortality coefficient (Z) for 4VWX yellowtail calculated as 3-year running average from Canadian research data.

Age	1970-72	1971-73	1972-74	1973-75	1974-76	1975-77	1976-78
				MALE			
5-7	-.047	.104	-.306	-.064	.165	-.196	.034
6-8	.162	.323	.107	.144	.409	-.051	.262
7-9	.185	.539	1.549	.908	.790	1.164	.415
$\bar{Z}$	.100	.322	.450	.329	.455	.306	.237
				FEMALE			
5-7	.190	.056	-.430	-.054	.063	-.064	.131
6-8	-.189	.276	-.081	.168	.408	-.078	.371
7-9	-.367	.304	.707	.387	.788	.560	.577
$\bar{Z}$	-.122	.212	.065	.167	.420	.139	.360

Table II . Witch Flounder landings (t) for Scotian Shelf between 1963-78.

Year	4V	4W	4X	TOTAL
1963	4971	2440	75	7486
1964	5808	2564	257	8629
1965	5068	7454	421	12943
1966	5241	9047	224	14512
1967	5740	1693	383	7816
1968	7598	13349	735	21682
1969	4338	8963	792	14093
1970	3282	1959	807	6048
1971	5640	11083	1141	17864
1972	4894	5759	698	11351
1973	6572	6862	535	13969
1974	4913	2004	498	7415
1975	3284	5307	331	8922
1976	2718	2683	341	5742
1977	1555	455	421	2431
1978 [a]	1528	463	188	2179

[a] provisional

Table 12. Witch Flounder landings (t) by month and country for ICNAF Div. 4VW

YEAR	JAN	FEB	MARCH	APR.	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
						CANADA							
1970	505	251	745	251	525	463	221	176	152	266	265	340	4160
1971	347	722	1285	803	791	477	298	192	243	149	287	447	6041
1972	330	871	1540	873	277	327	206	188	152	144	152	286	5346
1973	646	738	908	1187	559	253	124	207	125	151	217	356	5471
1974	205	1012	1884	676	306	323	206	110	225	174	187	149	5457
1975	165	265	734	693	324	278	100	103	142	131	88	102	3125
1976	81	159	573	360	253	158	125	87	105	109	103	68	2181
1977	89	204	473	106	208	276	100	155	89	69	103	33	1905
1978[b]	29	264	380	207	239	304	148	105	106	88	67	19	1956
						USSR							
1970	-	-	77	-	98	88	142	238	203	47	83	83	1059
1971	-	48	773	1159	1556	2449	2601	1340	487	80	119	49	10661
1972	-	2	430	47	790	852	1035	900	702	287	67	-	5112
1973	-	-	46	22	777	1360	770	3602	1249	32	3	39	7900
1974	25	-	5	188	313	170	252	197	22	30	20	122	1344
1975	53	85	134	446	405	472	713	719	764	722	453	453	5419
1976	4	8	164	143	304	413	183	124	431	629	-	807	3210
1977	-	0	6	4	4	3	81	-	-	-	-	-	98
1978[b]	-	-	-	-	-	-	-	-	-	-	-	-	-
						TOTAL[a]							
1970	512	256	832	251	623	551	363	414	355	313	348	423	5205
1971	351	773	2072	1962	2347	2926	2899	1532	730	229	406	496	16723
1972	330	932	2096	929	1067	1179	1241	1088	854	432	219	286	10653
1973	668	754	978	1209	1336	1613	894	3809	1374	183	220	396	13434
1974	234	1107	1889	875	619	494	463	307	247	204	207	271	6917
1975	228	369	879	1139	730	750	813	823	906	855	541	558	8591
1976	85	167	745	503	557	572	308	211	536	738	103	875	5400
1977	93	205	479	111	212	279	181	155	89	69	104	33	2010
1978[b]	29	266	387	211	244	311	151	107	108	90	68	19	1991

[a] including France, Japan and Poland

[b] provisional

Table 13a. Canadian commercial samples available for Witch flounder since 1948, in ICNAF Division 4VWX-5.

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
						4V						
1950												
OTB1	-	-	-	-	-	0/100	-	-	-	-	-	-
1952												
OTB1	-	-	-	-	-	-	-	-	-	18/100	-	-
1955												
OTB1	-	-	-	-	30/250	-	-	0/100	-	-	-	-
1956												
OTB1	-	-	-	20/200	0/300	-	-	-	-	-	-	-
1960												
LL	-	-	-	-	-	-	-	-	0/200	-	-	-
1962												
SNU	-	-	-	-	-	-	-	-	0/200	-	-	-
OTB1	-	-	-	-	-	-	-	-	-	-	0/200	-
1963												
SNU	-	-	-	-	-	-	-	-	-	-	40/200	-
OTB1	-	-	0/200	50/201	-	-	-	-	-	-	-	-
1964												
OTB1	-	0/200	0/200	-	-	-	0/351	3100 -	-	-	-	-
1965												
OTB1	0/200	0/200	0/244	-	-	-	-	-	-	-	-	-
1966												
SNU	-	-	-	-	-	-	-	0/200	-	-	-	-
OTB1	0/200	0/200	-	-	-	-	-	-	-	-	-	-
1967												
SNU	-	-	-	-	-	-	-	-	-	0/200	-	-
OTB1	0/200	0/347	0/600	-	-	-	-	-	-	-	-	-
1968												
SNU	-	-	-	-	0/200	3703-	0/200	-	-	0/200	-	-
OTB1	-	-	0/400	-	-	-	-	-	-	-	0/203	-
1969												
OTB1	-	0/200	-	-	-	-	-	-	-	-	-	-
1970												
SNU	-	-	-	-	-	-	-	-	-	39/200	-	-
OTB1	37/200	36/109	78/400	-	-	-	-	-	-	-	-	36/200
1971												
OTB1	-	79/400	34/200	-	-	-	-	-	-	-	-	-
1972												
OTB1	-	31/117	39/200	-	-	-	-	-	-	-	-	-
1973												
OTB1	-	-	39/200	-	-	-	-	-	-	-	-	-
1974												
OTB2	-	-	71/400	-	-	-	-	-	-	-	-	-
OTB1	39/200	-	78/400	40/200	-	-	-	-	-	-	-	-
1975												
SNU	-	-	-	-	25/200	-	-	-	-	-	-	-
OTB2	-	-	87/461	34/200	-	-	-	-	-	-	-	-
OTB1	57/400	35/200	-	37/200	-	-	40/200	-	-	-	-	-
1976												
SNU	-	-	-	-	-	115/600	146/800	111/600	-	-	-	-
OTB2	-	-	-	31/200	-	-	-	-	-	-	54/200	-
1977												
SNU	-	-	-	-	33/200	70/400	-	28/200	66/400	-	-	-
OTB2	25/200	42/201	91/600	-	30/200	-	-	-	-	-	-	-
OTB1	-	-	33/200	-	-	-	-	-	-	-	-	-
1978												
SNU	-	-	-	-	-	153/1276	94/779	60/494	-	-	-	-
OTB2	-	-	44/179	-	-	-	-	-	-	-	-	-
OTB1	29/202	58/400	138/1000	-	32/395	-	-	-	-	-	-	-

[a]The first number represents the number of fish aged and the second number is the number of fish measured. The gear code is the same as the one used by ICNAF.

Table 13b. Canadian commercial samples available for Witch flounder since 1948, in ICNAF Division 4VWX-5.

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1948						4W						
OTB1	-	20/100	19/100	20/100	-	-	-	-	-	-	-	-
1949												
OTB1	20/100	-	-	-	-	-	-	-	-	-	-	-
1950												
OTB1	-	-	0/100	-	-	-	-	-	-	-	-	-
1951												
SNU	-	-	-	-	-	20/100	-	-	-	-	-	-
OTB1	-	-	19/100	20/100	-	-	-	-	-	-	-	-
1952												
OTB1	-	20/100	0/100	-	-	19/100	18/18	-	-	-	-	-
1953												
OTB1	-	20/100	29/129	-	-	20/100	-	-	-	-	-	-
1954												
SNU	-	-	-	-	-	0/100	-	-	-	-	-	-
1962												
SNU	-	-	-	-	-	-	-	0/200	-	-	-	-
1963												
SNU	-	-	-	-	-	-	-	-	-	-	0/125	-
OTB1	-	-	-	0/160	-	-	-	-	-	59/167	-	-
1964												
SNU	-	-	-	-	-	-	0/128	-	-	-	-	-
OTB1	-	-	-	53/157	-	-	-	-	-	-	-	-
1965												
SNU	-	-	-	-	-	0/100	-	-	-	-	-	-
OTB1	-	0/200	-	-	0/100	-	-	-	-	-	0/203	-
1966												
SNU	-	-	-	0/126	-	-	0/108	-	-	-	-	-
1968												
SNU	0/200	-	-	-	-	-	-	-	-	-	-	-
1969												
SNU	-	-	-	-	0/209	-	-	-	-	0/200	-	-
1971												
SNU	-	-	-	-	-	29/207	-	-	-	-	-	-
OTB1	33/203	31/255	-	-	-	-	-	-	-	-	-	-
1972												
SNU	-	-	-	30/100	-	-	-	-	-	-	33/200	-
1973												
SNU	-	-	-	33/203	-	-	-	-	-	-	-	-
OTB2	-	-	-	33/202	-	-	-	-	-	-	-	-
OTB1	43/198	-	-	-	-	-	-	-	-	-	-	-
1974												
SNU	-	-	-	25/202	-	-	-	-	31/200	-	-	-
1975												
OTB2	-	-	-	61/200	-	-	-	-	-	-	-	-
1976												
SNU	-	-	-	-	30/200	-	-	-	-	-	30/200	-
1977												
SNU	-	-	-	0/400	-	-	-	-	-	-	-	-
OTB2	-	-	29/192	-	-	-	-	-	-	-	-	-
OTB1	-	31/200	-	-	-	-	-	-	-	-	-	-
1978												
OTB2	-	-	39/201	-	-	-	20/70	-	-	-	-	-
OTB1	-	-	41/318	-	-	-	-	-	-	-	-	-
1948						4X						
OTB1	-	-	-	20/100	-	-	-	-	-	-	-	-
1975						4WX						
OTB2	-	-	-	-	-	-	-	-	-	51/200	-	-
1978						4VW						
OTB1	-	-	-	35/339	-	-	-	-	-	-	-	-

[a]The first number represents the number of fish aged and the second number is the number of fish measured. The gear code is the same as the one used by ICNAF.

Table 14 4VW Witch, Male, Removals at Age ($\times 10^{-3}$)

AGE:	1970	1971	1972	1973	1974	1975	1976	1977	1978
4	0	18	0	0	0	0	0	0	0
5	285	137	125	0	53	20	0	3	0
6	626	939	267	560	131	168	95	15	20
7	887	1452	2794	523	389	161	151	46	67
8	902	2136	2301	2118	742	564	351	27	73
9	573	1291	943	2283	538	845	809	42	113
10	530	939	1040	1452	732	1032	607	117	75
11	149	533	397	377	576	589	1507	101	108
12	44	269	295	480	498	944	1535	196	138
13	0	0	55	159	241	484	987	284	147
14	0	61	0	217	109	285	742	203	110
15	0	98	0	0	90	137	620	97	66
16	0	0	0	34	23	540	399	59	71
17	0	0	0	0	0	0	122	33	49
18	0	0	0	0	0	0	85	55	26
19	0	0	0	0	0	60	20	11	19
20	0	0	0	0	0	0	35	6	10
21	0	0	0	0	0	0	33	1	15
22	0	0	0	0	0	0	0	3	3
23	0	0	0	0	0	0	74	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26+	0	0	0	0	0	0	0	0	7

Table 15. 4VW Witch Female, Removals at age (x 10^{-3})

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978
5	20	16	60	0	0	3	0	1	8
6	104	106	166	408	19	0	20	3	24
7	573	578	911	681	203	0	18	12	80
8	600	2030	2248	2196	293	456	69	10	98
9	420	2190	1654	1205	457	405	0	14	120
10	837	2299	836	2631	663	836	181	117	43
11	638	2434	1303	1066	526	1333	142	66	317
12	424	1809	1240	1482	519	1244	433	252	263
13	318	802	309	1288	652	726	311	298	295
14	103	857	276	1035	712	691	304	261	387
15	0	319	0	501	1108	690	391	195	340
16	158	723	216	897	890	564	402	165	159
17	37	389	0	0	138	627	316	303	200
18	0	0	0	0	19	268	352	83	157
19	0	0	0	0	0	122	158	108	87
20	0	0	0	0	0	88	149	70	77
21	0	0	0	0	0	39	68	22	60
22	0	0	0	0	0	120	41	43	13
23	0	0	0	0	0	2	1	12	5
24	0	0	0	0	0	0	6	17	27
25	0	0	0	0	0	0	37	9	5
26+	0	0	0	0	0	0	62	22	20

Table 16 Witch flounder research and commercial catch per unit of effort in ICNAF Division 4VW, 1970-1978.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
Canadian side trawler t/tow	-	-	.431	.304	3.15	.231	.190	.183	-
Research summer cruise no/tow	5.13	5.92	4.23	9.13	18.39	5.55	3.08	3.52	3.12

Table.17 Stratified mean catch per tow at age (number) calculated for Witch flounder from Canadian summer bottom trawl surveys in ICNAF division 4VW, 1970-78.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978
					MALE				
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.016	.038	.000	.000	.000
3	.021	.000	.007	.036	.118	.103	.000	.125	.022
4	.000	.000	.000	.091	.249	.086	.107	.039	.082
5	.238	.029	.114	.047	.080	.051	.134	.219	.166
6	.211	.029	.137	.021	.047	.141	.091	.195	.198
7	.325	.098	.244	.090	.278	.100	.127	.126	.150
8	.402	.165	.429	.174	.359	.267	.045	.039	.078
9	.228	.197	.284	.361	1.112	.325	.233	.069	.102
10	.110	.079	.185	.345	1.262	.224	.167	.230	.192
11	.021	.137	.061	.136	1.149	.207	.299	.166	.122
12	.096	.086	.100	.192	.810	.081	.128	.142	.087
13+	.021	.000	.047	.183	1.076	.041	.182	.472	.368
NK	.604	.609	.047	.371	.062	.300	.173	.023	.034
TOTAL	2.268	1.437	1.650	2.047	6.618	1.964	1.675	1.841	1.602
Average of 3 Years	1.853	1.785	1.711	3.438	3.543	3.419	1.827	1.706	1.722
					FEMALE				
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.056	.000	.000	.038	.000	.000	.007
3	.010	.007	.003	.054	.083	.093	.017	.007	.044
4	.000	.000	.000	.495	.131	.188	.103	.041	.022
5	.183	.096	.100	.244	.064	.055	.065	.114	.023
6	.145	.063	.069	.102	.083	.071	.041	.176	.151
7	.217	.121	.197	.636	.318	.144	.021	.034	.172
8	.371	.572	.569	.823	.966	.406	.031	.027	.095
9	.223	.669	.313	.637	1.121	.425	.072	.023	.261
10	.113	.510	.260	.732	1.311	.484	.081	.175	.133
11	.110	.419	.275	.457	2.214	.240	.159	.147	.081
12	.301	.274	.263	.676	1.697	.399	.163	.176	.094
13+	.306	.325	.348	1.198	3.374	.701	.579	.693	.421
NK	.882	1.432	.123	1.014	.409	.353	.057	.049	.018
TOTAL	2.863	4.486	2.581	7.078	11.776	3.587	1.405	1.674	1.521
Average of 3 Years	3.675	3.310	4.715	7.145	7.480	5.589	2.222	1.533	1.598

Table 18. Catch of Witch flounder in t (and corresponding percentage of total catch) by fishing gear. All countries, in ICNAF area 4VW.

	Trawlers						Danish Seine		Scottish Seine		Others		Total	
Year	Side		Stern		Total[b]									
1972	2459	(26%)	6925	(74%)	9384	(88%)	1022	(10%)	235	(2%)	12	(<1%)	10653	(100%)
1973	2194	(18%)	9700	(82%)	11942	(89%)	1166	(97%)	298	(2%)	28	(<1%)	13434	(100%)
1974	1968	(35%)	3675	(65%)	5643	(82%)	911	(13%)	310	(4%)	53	(1%)	6917	(100%)
1975	1121	(15%)	6360	(85%)	7488	(87%)	918	(11%)	77	(1%)	108	(1%)	8591	(100%)
1976	751	(17%)	3709	(83%)	4462	(83%)	843	(16%)	26	(<1%)	39	(1%)	5401	(100%)
1977	272	(26%)	785	(74%)	1057	(53%)	830	(41%)	8	(<1%)	115	(6%)	2010	(100%)
1978[a]	387	(39%)	596	(61%)	983	(50%)	921	(47%)			52	(3%)	1956	(100%)

[a] Provisional, Canada only.

[b] includes landing of otter trawlers

Table 19. Catch of Witch flounder in mt by vessel size for Canadian side trawlers in ICNAF area 4VW, 1972-1978

	Vessel Size (tons)					
Year	0-24.9 (1)	25-49.9 (2)	50-149.9 (3)	150-499.9 (4)	500-999.9 (5)	Total
1972	1		36	2233		2270
1973			88	1885		1973
1974	1		-	1891		1892
1975	1		-	1049	17	1067
1976	4		6	451		461
1977	8	3	44	217	-	272
1978						

Table 20. Total mortality coefficient (Z) for Witch flounder, calculated from stratified mean catch per tow at age, ICNAF area 4VW, 1970-78.

Age	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
				MALE				
1-2	-	-	-	-	-	-	-	-
2-3	-	-	-	-	-1.862	-	-	-
3-4	-	-	-2.586	-1.943	0.320	-0.040	-	0.418
4-5	-	-	-	0.140	1.594	-0.445	-0.714	-1.444
5-6	2.109	-1.557	1.712	0.016	-0.569	-0.583	-0.377	0.101
6-7	0.770	-2.135	0.419	-2.598	-0.760	0.105	-0.330	0.263
7-8	0.678	-1.480	0.335	-1.383	0.041	0.799	1.173	0.478
8-9	0.715	-1.541	0.172	-1.852	0.099	0.134	-0.424	-0.959
9-10	1.063	0.060	-0.196	-1.252	1.602	0.666	0.014	-1.029
10-11	-0.216	0.250	0.311	-1.202	1.808	-0.287	0.007	0.636
11-12	-1.398	0.311	-1.411	-1.786	2.652	0.478	0.741	0.642
$\bar{Z}a$	0.041	-0.230	-0.214	-1.523	1.540	0.248	0.085	-0.178
				FEMALE				
1-2	-	-	-	-	-	-	-	-
2-3	-	-	-0.160	-	-	0.804	-	-
3-4	-	-	-4.967	-0.882	-0.818	-0.100	-0.875	-1.159
4-5	-	-	-	2.046	0.871	1.057	-0.103	0.571
5-6	1.061	0.329	-0.019	1.079	-0.111	0.302	-0.988	-0.284
6-7	0.181	-1.138	-2.216	-1.139	-0.549	1.241	0.164	0.023
7-8	-0.967	-1.547	-1.430	-0.417	-0.244	1.539	-0.274	-1.011
8-9	-0.589	0.602	-0.112	-0.309	0.822	1.735	0.292	-2.261
9-10	-0.826	0.944	-0.849	-0.722	0.840	1.653	-0.896	-1.755
10-11	-1.308	0.616	-0.564	-1.107	1.699	1.110	-0.590	0.771
11-12	-0.917	0.464	-0.898	-1.311	1.713	0.386	-0.100	0.445
$\bar{Z}$	-0.910	0.657	-0.606	-0.862	1.269	1.221	-0.324	-0.700

[a] $\bar{Z}$ calculated for age 8-10 to 11-12

Table 21. Total mortality coefficients (Z) for 4VW Witch calculated as 3 year running averages from Canadian Research Cruise data.

AGE	1970-72	1971-73	1972-74	1973-75	1974-76	1975-77	1976-78
				MALE			
8-10	.450	-.337	-.720	-.038	.329	.077	-.828
9-11	.785	.174	-.865	.100	.938	.390	.274
10-12	.041	-.592	-1.081	.194	1.478	.171	.275
$\bar{Z}$	.425	-.252	-.889	.085	.915	.213	-.093
				FEMALE			
8-10	.113	-.166	-.479	.192	1.011	.660	-1.061
9-11	-.069	.259	-1.036	.228	.915	.797	-.036
10-12	-.248	-.192	-1.100	.120	1.348	.652	-.055
$\bar{Z}$	-.068	-.033	-.872	.180	1.091	.703	— 0.384

Table 22. American Plaice landings (t) for Scotian Shelf between 1963-78.

YEAR	4V	4W	4X	TOTAL
1963	1376	683	250	2309
1964	1967	603	512	3082
1965	4707	2797	694	8198
1966	8167	5313	726	14206
1967	8884	780	1106	10770
1968	10489	7830	946	19265
1969	8076	4789	870	13735
1970	5242	2481	635	8358
1971	7765	5991	545	14301
1972	6912	3175	566	10653
1973	8686	3407	339	12432
1974	11363	4951	458	16772
1975	7336	4115	296	11747
1976	8488	2350	309	11147
1977	6716	592	449	7757
1978	5469	824	522	6815

Table 23. American Plaice landings (t) by month and country for ICNAF Division 4V

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL[a]
						CANADA							
1970	1062	845	967	185	312	271	162	47	200	161	244	573	5029
1971	985	950	887	1001	620	207	224	141	250	96	252	714	6327
1972	712	776	1161	1007	810	215	206	123	111	68	166	268	5623
1973	919	620	226	619	388	169	303	120	56	43	93	677	4233
1974	523	914	1760	775	794	423	274	107	71	55	115	401	6212
1975	621	599	1544	545	844	296	333	275	188	135	118	255	5753
1976	423	481	1137	968	459	382	626	350	319	304	377	343	6169
1977	446	529	432	592	1120	829	1045	724	173	172	503	136	6701
1978[b]	38	426	363	870	1092	686	889	318	176	263	223	125	5469
						USSR							
1970	-	-	-	-	-	-	-	-	79	-	113	-	192
1971	-	14	6	9	389	47	498	169	194	81	13	-	1420
1972	-	-	120	-	6	56	83	280	464	145	-	-	1154
1973	-	-	-	-	531	96	77	2644	1013	14	-	-	4375
1974	597	-	-	-	-	812	722	1254	920	780	-	-	5085
1975	14	25	38	125	114	132	199	201	213	201	126	134	1522
1976	35	65	74	62	109	72	142	57	304	494	316	402	2132
1977													-
1978													-
						TOTAL[c]							
1970	1062	845	968	187	312	271	166	47	286	161	364	573	5242
1971	988	966	906	1010	1009	254	722	310	444	177	265	714	7765
1972	718	782	1379	1010	827	271	289	403	575	220	166	272	6912
1973	932	628	283	619	919	265	380	2764	1069	57	93	677	8686
1974	1124	974	1760	775	794	1235	996	1363	991	835	115	401	11363
1975	646	643	1596	670	958	438	532	476	401	336	251	389	7336
1976	459	546	1279	1030	568	454	768	407	623	898	693	763	8488
1977	446	532	432	592	1120	829	1045	724	173	172	503	148	6716
1978	38	426	363	870	1092	686	889	318	176	263	223	125	5469
			1		1		1		1	2	2	2	10

[a] includes NK months of the year
[b] provisional
[c] includes France, Japan and Poland

Table 24. Canadian Commercial samples for American Plaice since 1948 in ICNAF Division 4VWX-5[a]

	JAN	FEB	MAR	APR	MAY	June	JULY	AUG	SEPT	OCT	NOV	DEC
						4V						
[illegible] LL	-	-	-	-	0/100	-	0/100	-	-	20/20	-	-
1951												
LL	-		-	-	-	20/20	-	-	-	-	-	-
OTB1	-			-	-		-	-		-	-	-
[illegible]												
LL				-	-	20/20	-	-	-	-	-	-
1963												
SNU	-	-	-	-	-	-	-	-	-	-	0/218	-
OTB1	-	-	0/206	-	-	-	-	-	-		-	-
1966												
OTB1	-	-	-	-	-	0/107	-	-	-	-	-	-
1967												
OTB1	-	0/131	0/200	-	-	-	-	-	-	-	-	-
1968												
SNU	-	-	-	-	35/200	-	-	-	-	-	-	-
OTB1	-	-	73/350	36/200	-	-	-	-	-	-	-	-
1969												
OTB1	-	34/200	-	-	-	-	-	-	-	-	-	-
1970												
OTB1	37/200	36/200	-	-	-	-	-	-	-	-	-	31/200
1971												
OTB1	31/200	34/200	-	-	-	-	-	29/200	-	-	-	-
1972												
OTB1	32/200	-	38/200	36/200	29/100	-	-	-	-	-	-	-
1973												
OTB2	-	-	-	32/99	-	-	-	-	-	-	-	60/201
OTB1	-	40/200	-	-	-	-	-	-	-	-	-	68/200
1974												
OTB1	40/200	-	81/400	140/591	71/200	-	-	-	-	-	-	-
1975												
OTB2	-	-	50/203	-	-	-	-	-	-	-	-	-
OTB1	131/800	36/200	-	-	-	-	64/200	-	-	-	-	-
1976												
SNU	-	-	-	-	-	116/530	79/400	120/600	-	-	-	-
OTB2	-	-	-	37/199	-	-	40/200		-	77/184	-	-
OTB1	40/200	40/200	37/200	-	-	-	-	-	-	-	37/200	-
1977												
SNU	-	-	-	-	-	276/1400	142/800	134/800	77/400	-	-	-
OTB2	38/152	-	38/200	38/200	-	-	-	47/172	-	-	-	-
OTB1	-	41/200	45/200	39/200	-	-	-	37/200	34/200	-	-	-
1978												
SNU	-	-	-	-	-	117/565	214/1157	68/426	-	-	-	-
OTB2	-	69/405	40/129	-	123/625	-	-	-	-	-	-	-
OTB1	-	169/817	89/400	45/164	91/400	-	-	-	-	-	-	-
						4W						
1948												
OTB1	0/100	-	-	0/100	-	-	-	-	-	-	0/99	-
LIV	-	-	0/100	-	-	-	-	-	-	-	-	-
1949												
OTB1	20/100	-	-	-	-	-	-	-	-	-	0/100	-
1951												
LL	-	-	-	-	-	-	-	-	-	20/0	-	-
SNU	-	-	-	-	-	20/0	-	-	-	-	-	-
OTB1	-	-	-	-	-	20/0	-	-	-	-	-	-
1952												
OTBL	-	-	-	-	-	10/0	-	-	-	-	-	-
1977												
OTB2	-	-	55/199	-	-	-	-	-		-	-	-
						4X						
1975												
OTB2	-	-	-	-		-	-	-	-	73/162	-	-
1977												
OTB2	-	-	-	-	-	-	-	-	0/200	-	-	
1978												
OTB1	-	-	42/100	-	-	-	-	-	-	-	-	-
						5ZE						
1967												
OTB2	-	0/121	-	-	-	-	-	-	-	-	-	-
1976												
OTB2	-	-	-	-	-	-	-	-	52/94	-	-	-
						4VW						
1967												
OTB1	-	-	-	-	-	-	-	-	-	-	26/150	[illegible]
1977												
OTB2	-	-	46/208	111 -	-	-	-	-	-	-	-	-

[a] The first number represents the number of fish aged and the second number is the number of fish measured. The gear code is the same as the one used by ICNAF.

Table 25. Catch at age ($x10^{-3}$) of A. Plaice in ICNAF division 4V, 1970-1978.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978
					Male				
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	22	0	0	0
5	0	0	0	0	9	74	6	36	1
6	31	111	157	84	105	25	25	66	71
7	444	312	88	552	342	445	131	232	95
8	1130	591	601	665	993	1337	240	363	143
9	445	466	1453	640	1191	1152	581	714	362
10	373	573	651	749	1041	1183	758	447	401
11	142	282	388	272	759	430	1762	945	494
12	208	286	237	373	876	194	1130	505	245
13	242	44	394	275	337	29	714	265	260
14	0	277	0	224	139	37	405	78	128
15	124	132	13	876	199	0	113	15	107
16	40	97	13	622	51	0	45	1	70
17	85	101	0	0	23	0	14	0	24
18	0	0	0	0	0	0	35	0	12
19	0	0	0	0	0	0	31	0	0
20	0	0	0	0	0	0	3	0	12
21	0	0	0	0	0	0	2	0	0
22	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
					Female				
3	0	0	0	0	0	0	0	2	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	12	3
6	0	0	0	186	0	127	23	114	67
7	21	0	117	232	52	66	30	359	149
8	8	69	624	565	248	544	107	671	260
9	132	135	818	200	720	1382	427	592	412
10	33	0	1254	354	843	1195	534	1212	400
11	103	104	723	503	1077	526	1243	1147	636
12	174	334	472	499	756	655	750	924	897
13	224	304	346	252	640	365	820	803	817
14	0	480	68	197	478	291	607	535	373
15	207	293	206	275	497	365	228	379	312
16	609	1157	620	1604	1038	71	266	87	271
17	302	435	0	0	334	91	183	50	200
18	0	0	0	0	0	18	246	50	94
19	0	0	0	0	0	36	141	25	65
20	0	0	0	0	0	18	120	19	43
21	0	0	0	0	0	0	77	23	17
22	0	0	0	0	0	18	57	17	18
23	0	0	0	0	0	0	26	1	12
24	0	0	0	0	0	0	26	2	8
25	0	0	0	0	0	0	0	0	6
26	0	0	0	0	0	0	0	0	14

Table 26. Stratified mean catch per tow at age (number) calculated for American plaice, from Canadian summer bottom trawl survey in ICNAF division 4V, 1970-78.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978
					MALE				
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.047	0.000
2	0.069	0.473	0.841	0.084	1.893	0.878	0.260	0.085	0.153
3	2.453	0.542	2.075	1.000	3.359	5.817	3.863	0.878	0.099
4	4.201	7.369	0.979	1.203	3.471	2.727	18.292	2.671	0.901
5	11.550	7.462	2.744	1.177	5.331	2.523	6.166	5.741	1.328
6	8.608	12.575	4.205	3.087	1.368	1.792	6.650	2.339	2.902
7	7.036	6.865	12.237	3.910	5.927	1.606	4.208	3.131	1.806
8	5.015	4.669	2.916	5.536	6.530	4.006	4.929	3.068	1.574
9	2.467	3.299	2.847	2.043	5.341	2.699	8.009	3.918	1.369
10	0.725	1.664	3.245	0.933	2.346	3.486	5.965	2.314	1.448
11	0.624	0.931	0.689	0.697	1.199	2.356	2.464	0.636	0.858
12	0.405	0.567	1.022	0.417	1.265	0.628	1.351	0.457	0.960
13+	0.246	1.526	0.976	0.163	0.377	1.456	0.626	0.488	0.122
NK	0.616	0.237	0.000	1.121	0.495	0.957	0.023	0.076	0.000
TOTAL	44.014	48.164	34.768	21.362	38.240	30.930	62.795	25.841	13.528
Average of 3 years	46.089	42.315	34.765	31.457	30.177	43.988	39.855	34.055	19.685
					FEMALE				
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.275	0.231	0.137	1.488	0.328	1.137	0.015	0.053
3	1.398	0.252	1.051	0.977	3.204	5.436	3.466	0.200	0.099
4	4.514	2.061	2.354	1.440	3.559	2.483	16.305	1.989	0.771
5	7.613	2.991	4.015	0.611	4.009	2.707	6.661	8.515	1.115
6	6.462	6.987	4.158	3.065	2.687	1.587	7.544	2.339	2.953
7	5.999	2.727	7.348	3.182	3.466	1.028	5.106	5.188	1.088
8	3.494	3.669	4.981	4.527	5.850	2.521	3.258	4.501	1.154
9	2.276	3.065	1.817	1.678	6.815	2.697	7.269	2.058	0.937
10	1.055	2.123	3.729	1.183	2.727	4.191	4.298	2.681	0.925
11	0.649	0.887	1.168	0.366	2.305	1.853	4.714	2.537	1.144
12	0.557	1.990	0.660	0.504	1.034	1.886	2.847	1.606	0.889
13+	1.636	3.760	3.370	0.412	2.557	2.467	3.701	1.127	2.077
NK	0.615	0.157	0.000	1.177	0.000	0.401	0.092	0.000	0.031
TOTAL	36.257	30.942	34.868	19.262	39.613	29.574	66.994	32.745	13.240
Average of 3 years	33.600	34.022	28.357	31.248	29.483	45.394	43.104	37.660	22.993

Table 27. A. Plaice research and commercial catch per unit of effort in ICNAF Division 4V, 1970-1978.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
Canadian side trawler t/tow	-	-	.614	.343	.342	.288	.215	.295	.297
Research summer cruise no/tow	80.27	79.11	69.64	40.62	95.17	60.50	127.79	58.59	26.77

Table 28. Catch of American Plaice in mt. (and corresponding percentage of total catch) by fishing gear, all countries, in ICNAF area 4V, 1972-78.

	Trawlers						Danish Seine		Longline		Others		Total	
Year	Side		Stern		Total[a]									
1972	3012	(48%)	3267	(52%)	6279	(91%)	364	(5%)	189	(3%)	80	(1%)	6912	(100%)
1973	1971	(26%)	5909	(74%)	7958	(92%)	482	(6%)	152	(1%)	94	(1%)	8686	(100%)
1974	2193	(21%)	8318	(79%)	10511	(92%)	510	(5%)	125	(1%)	217	(2%)	11363	(100%)
1975	2779	(45%)	3455	(55%)	6234	(85%)	657	(9%)	171	(2%)	274	(4%)	7336	(100%)
1976	2438	(34%)	4678	(66%)	7116	(84%)	1178	(14%)	87	(1%)	107	(1%)	8488	(100%)
1977	2661	(54%)	2285	(46%)	4951	(74%)	1443	(21%)	218	(3%)	104	(2%)	6716	(100%)
1978[a]	1759	(45%)	2127	(55%)	3886	(71%)	1147	(21%)	163	(3%)	263	(5%)	5459	(100%)

[a] includes other trawlers landing

Table 29. Catch of American Plaice in mt by vessel size for Canadian side trawlers in ICNAF area 4V, 1972-1978

Year	0-24.9	25-49.9	50-149.9	150-499.9	500-999.9	Total
1972	-	-	63	2826	-	2889
1973	18	-	66	1811	-	1895
1974	78	-	102	1959	-	2139
1975	101	-	15	2476	32	2624
1976	63	2	126	2022	-	2213
1977	58	15	88	2497	3	2661
1978						

Table 30. Total mortality coefficient (Z) for American plaice, calculated from stratified mean catch per tow at age. ICNAF area 4V, 1970-78.

Age	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
				MALE				
1-2	-	-	-	-	-	-	-	-1.171
2-3	-2.066	-1.478	-0.173	-3.689	-1.123	-1.482	-1.219	-0.149
3-4	-1.100	-0.591	0.545	-1.244	.208	-1.146	0.369	-0.025
4-5	-0.574	0.988	-0.184	-1.489	.319	-0.816	1.159	0.699
5-6	-0.085	0.574	-0.118	-0.150	1.090	-0.969	0.970	0.682
6-7	0.226	0.027	0.073	-0.652	0.160	-0.854	0.753	0.259
7-8	0.410	0.856	0.793	-0.513	0.392	-1.122	0.316	0.688
8-9	0.419	0.494	0.356	-0.036	0.884	-0.693	0.230	0.807
9-10	0.394	0.017	1.115	-0.138	0.427	-0.793	1.242	0.996
10-11	-0.249	0.882	1.537	-0.251	0.004	0.347	2.238	0.993
11-12	0.095	-0.093	0.501	-1.596	0.647	0.556	1.684	-0.411
12-13	-1.328	-0.543	1.836	0.101	-0.141	0.003	1.019	1.320
$\bar{Z}$	0.214	0.431	0.860	- .780	.231	-0.341	1.142	0.615
				FEMALE				
1-2	-	-	-	-	-	-	-	-
2-3	-	-1.341	-1.442	-3.152	-1.296	-2.357	1.738	-1.872
3-4	-0.388	-2.235	-0.315	-1.293	.255	-1.098	0.555	-1.349
4-5	0.412	-0.667	1.349	-1.024	.274	-0.987	0.650	0.579
5-6	0.086	-0.329	0.270	-1.481	.927	-1.025	1.046	1.059
6-7	0.863	-0.050	0.267	-0.123	.961	-1.168	0.374	0.766
7-8	0.492	-0.602	0.484	-0.609	.318	-1.153	0.126	1.503
8-9	0.131	0.703	1.088	-0.409	.774	-1.059	0.460	1.569
9-10	0.069	-0.196	0.429	-0.486	.486	-0.466	-0.997	0.800
10-11	0.174	0.598	2.320	-0.667	.386	-0.118	0.527	0.852
11-12	-1.121	0.295	0.841	-1.039	.201	-0.429	1.077	1.049
12-13	-1.909	-0.527	0.471	-1.624	- .870	-0.674	0.927	-0.257
$\bar{Z}$	-0.051	0.160	1.032	-1.082	.220	-0.645	0.637	1.155

[a] $\bar{Z}$ calculated for age 7-8 to 11-12

able 31. Total mortality coefficient (Z) for 4V plaice calculated as 3 years running average from research cruise data.

AGE	1970-72	1971-73	1972-74	1973-75	1974-76	1975-77	1976-78
			MALE				
7-9	0.443	0.679	0.491	0.123	-0.190	-0.303	0.495
8-10	0.239	0.687	0.122	0.209	0.063	0.152	0.500
9-11	0.563	0.507	0.573	-0.069	0.394	0.272	1.180
10-12	-0.165	0.755	0.698	0.154	0.238	0.711	1.420
$\bar{Z}$	0.270	0.657	0.471	0.104	0.126	0.208	0.899
			FEMALE				
7-9	0.567	0.146	0.046	0.055	-0.492	-0.215	0.569
8-10	-0.035	0.604	0.413	0.030	0.200	-0.016	0.578
9-11	0.290	0.506	-0.151	-0.039	0.212	0.023	0.956
10-12	0.227	0.677	1.073	-0.184	-0.026	0.343	0.691
$\bar{Z}$	0.262	0.483	0.345	-0.035	-0.027	0.034	0.699

Table 32. Commercial weight (kg) at age of American Plaice caught by otter trawler in ICNAF division 4V.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978
					Male				
4	0.19	0.19		0.19	0.19	0.19			
5	0.28	0.25	0.28	0.28	0.28	0.26		0.15	0.17
6	0.36	0.35	0.36	0.34	0.35	0.32	0.38	0.25	0.22
7	0.33	0.29	0.36	0.29	0.31	0.29	0.34	0.34	0.27
8	0.45	0.47	0.41	0.37	0.37	0.34	0.36	0.41	0.38
9	0.45	0.45	0.45	0.44	0.43	0.41	0.38	0.43	0.41
10	0.52	0.54	0.50	0.49	0.47	0.43	0.43	0.48	0.45
11	0.53	0.55	0.53	0.44	0.44	0.44	0.44	0.46	0.49
12	0.78	0.80	0.74	0.79	0.84	0.79	0.52	0.55	0.58
13	0.62	0.62	0.62	0.62	0.62	0.62	0.56	0.60	0.56
14	0.86	0.85	0.79	0.91	0.84	0.86	0.72	0.71	0.72
15							0.98	0.55	0.92
16							2.44	1.24	1.10
17							1.43	1.14	1.12
18							0.57		1.28
19							0.53		
20	1.40	1.40							
					Female				
5								0.19	
6	0.32	0.29	0.36	0.32	0.31	0.32	0.38	0.40	0.27
7	0.34	0.34	0.34	0.34	0.34	0.34		0.63	0.41
8	0.44	0.41	0.45	0.43	0.42	0.42	0.45	0.56	0.40
9	0.50	0.54	0.56	0.50	0.50	0.47	0.53	0.56	0.52
10	0.67	0.83	0.74	0.69	0.69	0.61	0.64	0.65	0.59
11	0.84	0.90	0.82	0.79	0.82	0.70	0.64	0.74	0.64
12	0.79	0.87	0.79	0.78	0.80	0.76	0.71	0.82	0.79
13	1.21	1.23	1.07	1.19	1.15	1.15	0.88	0.97	0.82
14	1.07	1.06	1.06	1.02	1.04	0.86	0.94	0.96	1.05
15	1.42	1.36	1.20	1.42	1.37	1.32	1.52	1.07	1.05
16	1.69	1.59	1.31	1.65	1.72	1.73	1.01	1.45	1.29
17	1.91	1.78	1.58	1.94	1.77	1.76	1.89	1.41	1.20
18	1.58	1.58	1.32	1.58	1.58	1.58	1.43	1.77	1.66
19	1.64	1.51	1.58	1.68	1.57	1.63	1.75	1.52	1.68
20	1.58	1.58		1.58	1.58	1.58	1.67	1.74	1.54
21							1.95	1.72	1.73
22	2.44	2.44		2.44	2.44	2.44	2.00	1.95	2.53
23	2.32	2.32		2.32	2.32	2.32	2.14		1.70
24							2.10	2.71	2.15
25									2.77
26							3.32		3.25

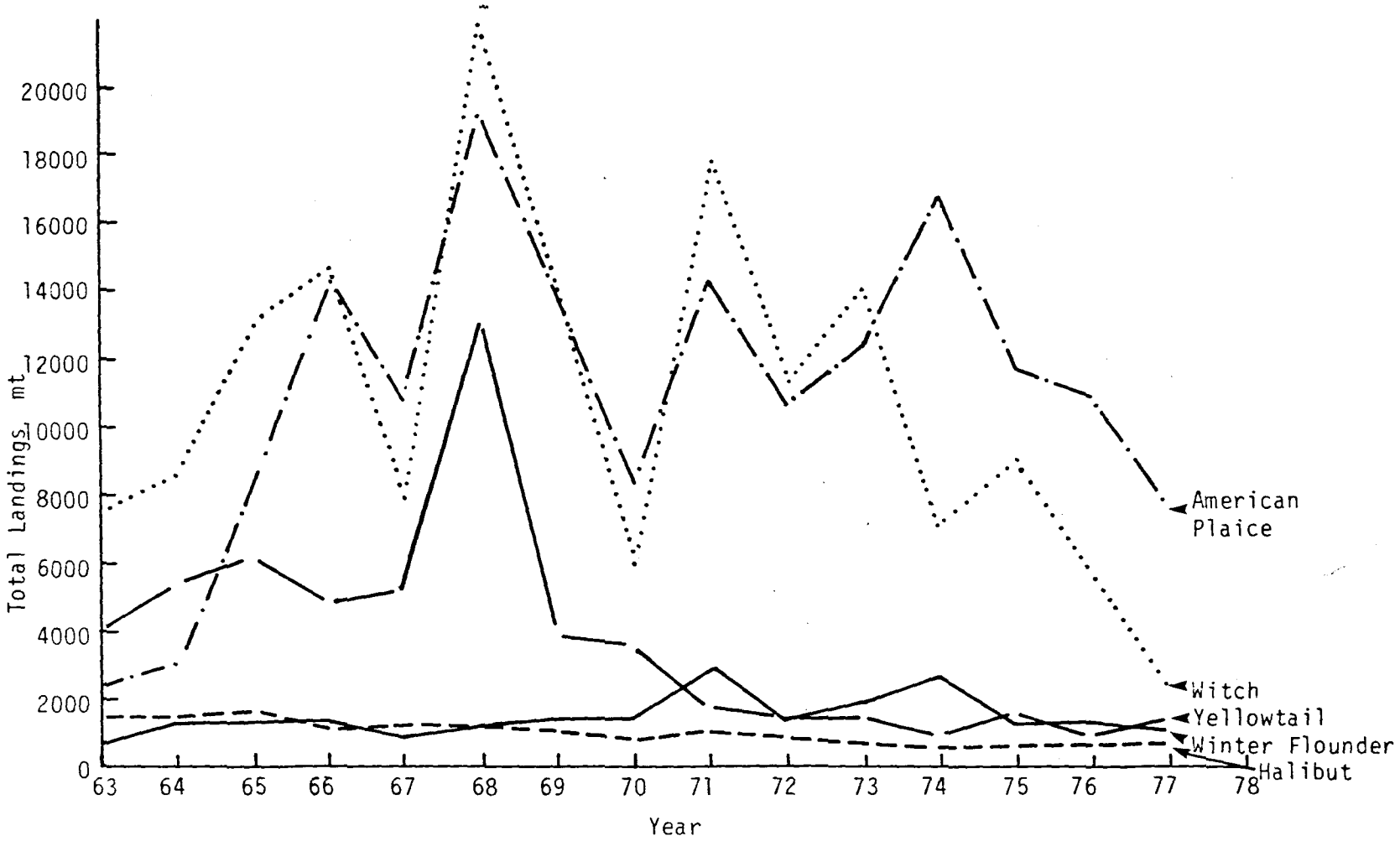

Figure 1. Total landings of flatfish, 1963-77, on the Scotian Shelf.

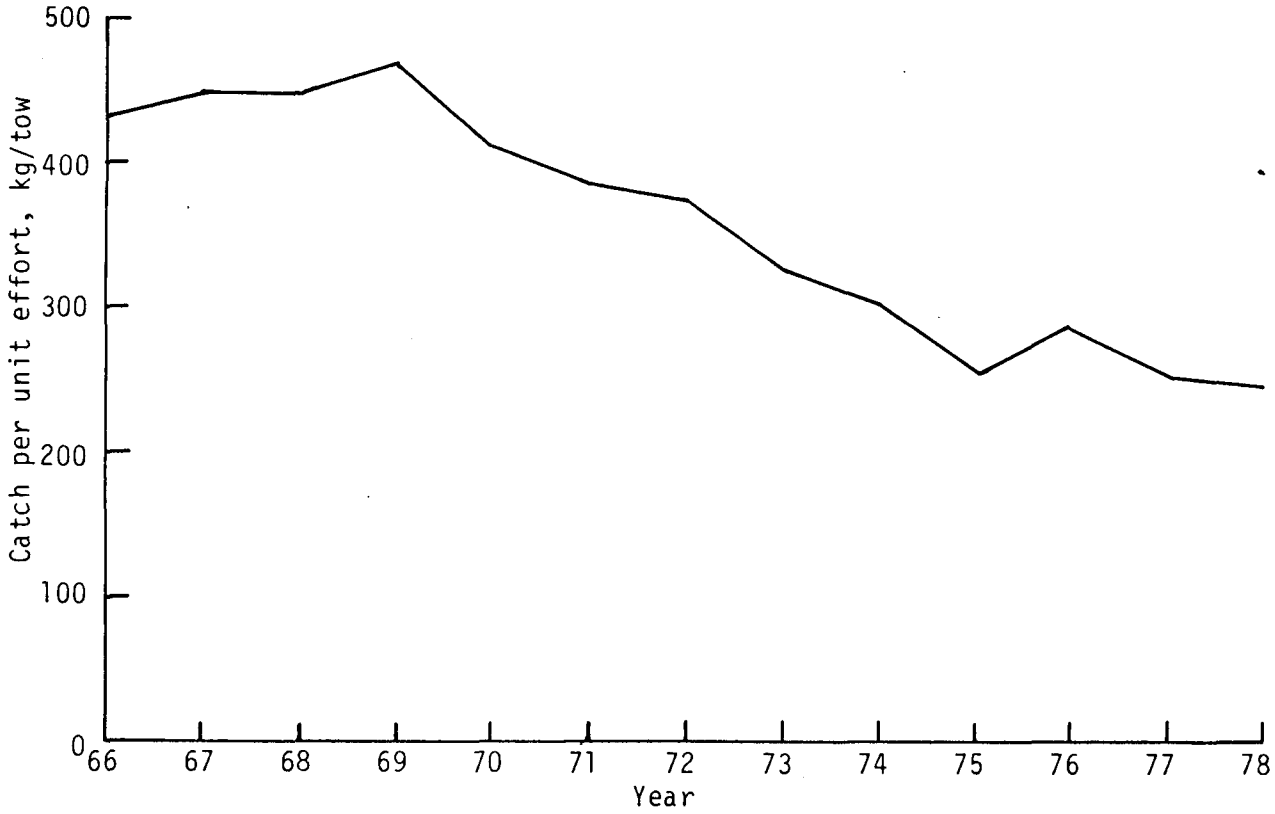

Figure 2 Canadian commercial catch per unit of effort indices for Scotian Shelf flatfish, for the months of Jan-Feb-March-April, 1966-1978, (with witch, plaice, winter flounder, yellowtail, halibut, turbot and flatfish non-specified).

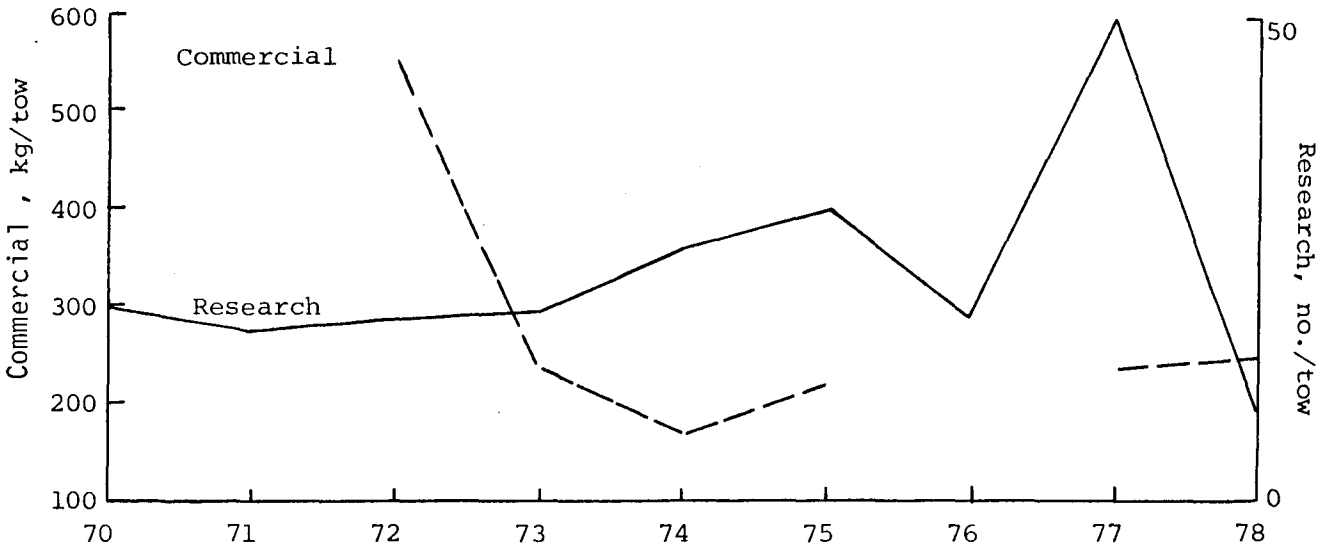

Figure 3 Yellowtail catch per unit of effort from commercial and research data in division 4 VWX, 1970-78.

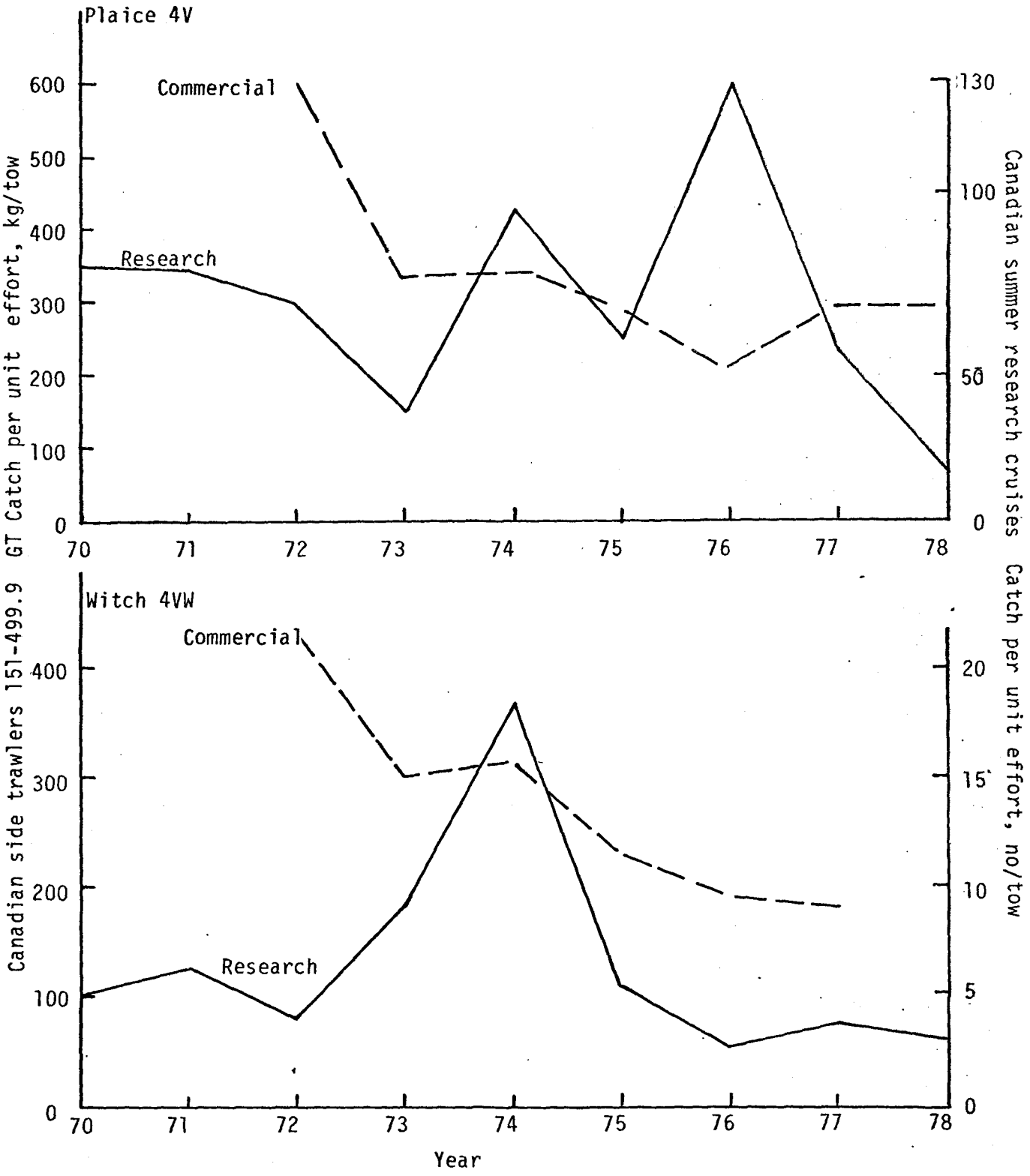

Figure 4. Catch per unit effort indices for American Plaice and Witch Flounder on the Scotian Shelf, 1970-78.

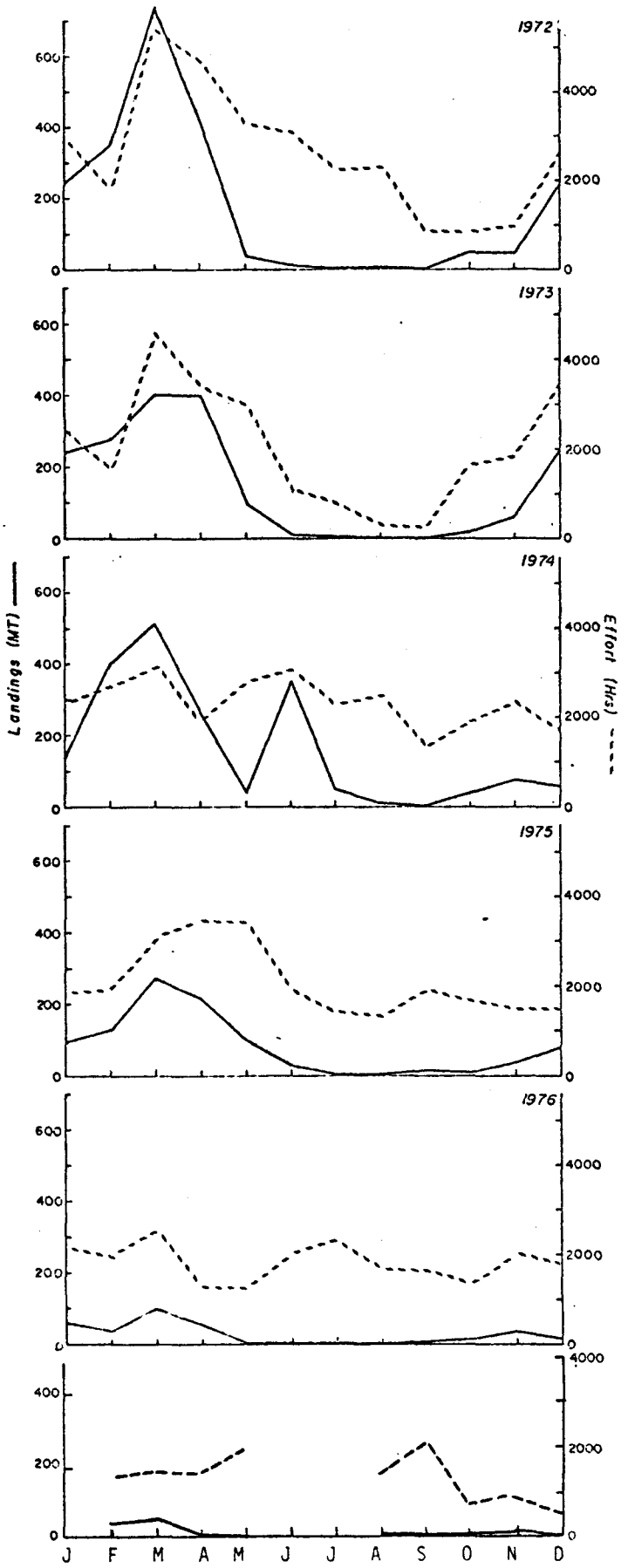

Figure 5. Landings of witch flounder (mt), and corresponding effort (hrs) for Canadian side trawl of 151-500 gross tons in Div. 4VW, 1972-77.

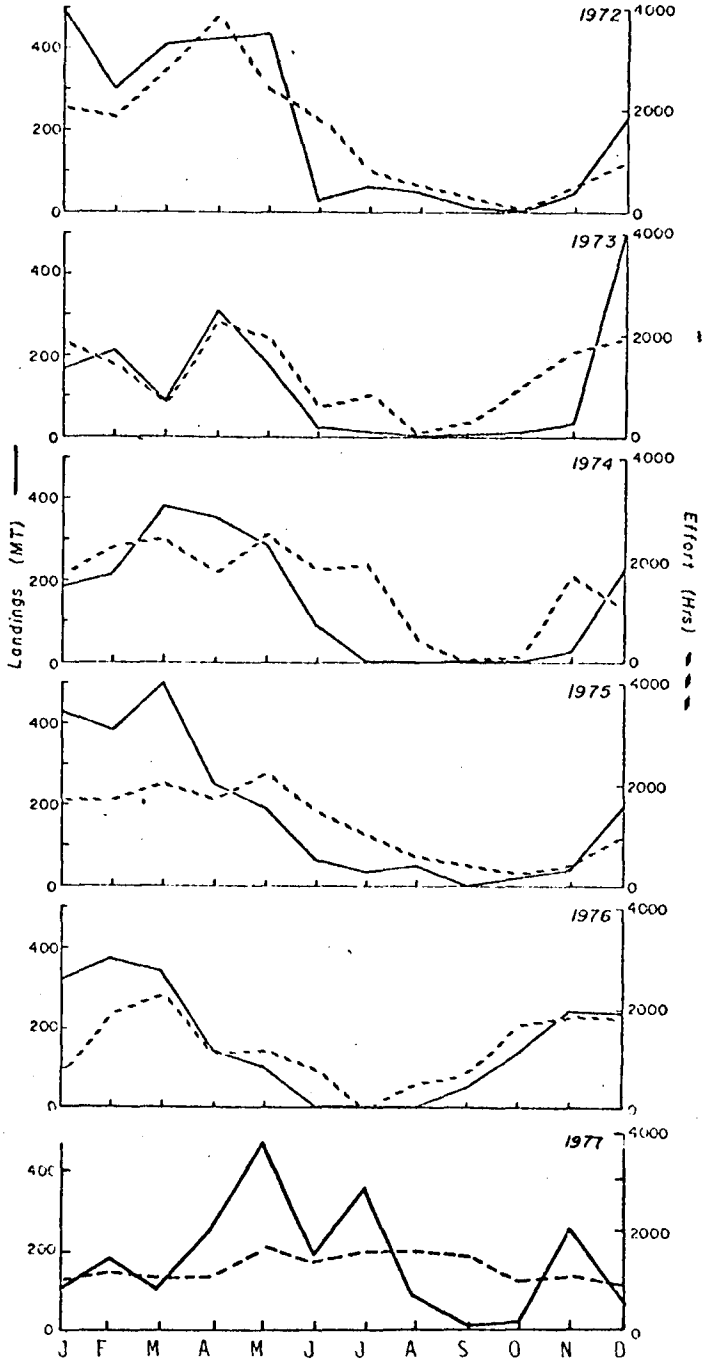

Figure 6. Landings of American plaice (mt), and corresponding effort (hrs) for Canadian (MQ) side trawl of 151-500 gross tons in Div. 4V, 1972-77.