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Stock report for American plaice (Hippoglossoides platessoides (Fabricius)) and other flatfishes in the Gulf of St. Lawrence. Including a discussion of discard levels and mesh selectivity of plaice.

by

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ABSTRACT

American plaice in the southern Gulf of St. Lawrence were found to be in a relatively stable state over the past several years. A changing pattern of discarding at sea was found and this has eroded further the confidence of the commercial catch sampling data. These data are normally used in the preparation of the annual catch-at-age matrix. Without these data no analytical assessment is possible. Possible reasons for the changing discard pattern include changes in minimum mesh size regulations, changes in abundance of the Gulf cod stock, changes in the prices paid for plaice with regards prices paid for cod, and changes in gear composition of the fishing fleet.

No change in the status of the northern Gulf of St. Lawrence American plaice, Gulf yellowtail, witch, winter flounder, or Atlantic halibut was observed.

Mesh selection ogives were calculated for 60, 90, 100, 110, 120, 130 mm mesh codend nets for American plaice. These ogives were used in the estimation of discard levels over the previous decade.

RESUME

Au cours des dernières années, la situation de la plie canadienne dans le sud du golfe du Saint-Laurent s'est avérée relativement stable. On a constaté que le modèle suivi pour le rejet des poissons à la mer changeait, ce qui affaiblit encore davantage la fiabilité des données d'échantillonnage des prises commerciales. Ces données servent normalement à la préparation d'une matrice annuelle des prises par âge. Sans elles, aucune évaluation analytique n'est possible. Le changement du modèle suivi pour le rejet de poissons à la mer peut avoir plusieurs causes, notamment les modifications apportées à la réglementation de la grandeur minimale des mailles, la variation de l'abondance du stock de morues dans le Golfe, les variations des prix de la plie par rapport à ceux de la morue et enfin les changements apportés aux engins de la flottille de pêche.

Aucun changement dans la situation de la plie canadienne, de la limande à queue jaune du Golfe, de la plie grise, de la plie rouge et du flétan de l'Atlantique pêchés dans le nord du golfe du Saint-Laurent n'a été enregistré.

Des courbes cumulatives de sélection de maille ont été calculées pour les culs-de-chaluts à maille de 60, 90, 100, 110, 120 et 130 mm, servant à la pêche de la plie canadienne. Ces courbes ont été utilisées pour l'évaluation des niveaux de rejet au cours des dix dernières années.

INTRODUCTION

The flatfish of the Gulf of St. Lawrence (NAFO divisions 4RST) make up significant landings, historically in excess of 20,000 tonnes annually (Table 1.). Much of this is in the form of by-catches in the Gulf cod fishery. However there are small directed fisheries for NAFO division 4R witch (Glyptocephalus cynoglossus, Linnaeus) in St. George's Bay and NAFO division 4T winter flounder (Pseudopleuronectes americanus, Walbaum). The largest flatfish fishery is NAFO division 4T American plaice (Hippoglossoides platessoides, Fabricius). Most flatfish stocks in the Gulf of St. Lawrence are small and widely distributed. Because of this, no analytical assessments are carried out on these stocks and little if any sampling data are available. Analytical assessments have at various times been carried out on NAFO division 4T plaice and division 4R witch.

SAMPLING

4RST AMERICAN PLAICE

During 1983, American plaice were sampled at twelve ports in the five provinces bordering the Gulf of St. Lawrence. A total of 7,387 fish were measured and otoliths obtained from 1,023. Length measurements were obtained for 203 fish landed by a non-Gulf based vessel from Nova Scotia. There were no otoliths obtained from any of the fish sampled in Quebec (total of 854 fish from 4 ports). Only fish from NAFO division 4T have been aged.

4T YELLOWTAIL

Yellowtail (Limanda ferruginea, Storer) were sampled at two ports in the Magdalen Is.. A total of 521 fish were measured, however no otoliths were collected. Two additional samples were obtained from Arisaig, N.S., totalling 69 fish from which 21 otoliths were obtained. No yellowtail have been aged this year.

4RS WITCH

A total of 2,895 witch were sampled from 9 ports situated in the Magdalen Is.; the Gaspe region of Quebec; Cape Breton, Nova Scotia; and Souris, P.E.I. Otolith samples were obtained from 172 fish. There were no otoliths obtained from witch sampled in Quebec (where 1,240 witch were sampled at 6 ports). Length measurements were obtained from 200 witch landed by a non-Gulf based vessel in Nova Scotia. No witch have been aged this year.

4T WINTER FLOUNDER

Winter flounder were sampled at 7 ports situated in the Gaspe region, Magdalen Is.,Gulf shore Nova Scotia and Souris, P.E.I. A total of 3,687 fish were measured. The only otoliths sampled (149) were obtained from Arisaig, N.S. No winter flounder have been aged this year.

4RST TURBOT

A total of 1,958 turbot (Reinhardtius hippoglossoides, Walbaum) were measured from three ports in Quebec. There were no otolith samples taken.

STOCKS

YELLOWTAIL FLOUNDER

The landings from the Gulf yellowtail fishery are extremely small, having a mean catch of less than 54 tonnes over the last twenty years (Table 1). In most years the major portion is taken in NAFO division 4T. There is no seasonality or spacial distribution of the landings. The landings for 1983 were 50 tonnes.

This is an unregulated fishery and no data are available to support any change in the status of management advice.

ATLANTIC HALIBUT

Atlantic halibut (Hippoglossus hippoglossus (Linnaeus)) is a commercially preferred fish, with declining landings over the last 20 years (Table 1). The landings have tended to be split somewhat equally over the 3 NAFO divisions of the Gulf. The landings for 1983 were 173 tonnes (90 tonnes of this was from Quebec). This is down considerably from the 20 year average of 350 tonnes.

The landings from this stock are no doubt greater than those figures recorded in the statistics. This is because many fisherman keep their occasional halibut by-catch for their own consumption or use.

This is an unregulated fishery and no data are available to support any change in the status of management advice.

WITCH FLOUNDER

The witch (greysole) landings were spread relatively evenly between NAFO divisions 4R and 4S in the Gulf until 1973, however, since then there has been a shift in the landings to NAFO division 4R. There has been a steady decline in this local (4R) fishery since 1979 from 4500 tonnes to the present 686 tonnes landed in 1983 in 4R and 4S (Table 1). The total landings for the Gulf in 1983 were 1030 tonnes.

The 4R fishery was expanded in the late 1970's in an attempt to remove the stock of old fish (Table 2) which, it was felt, was limiting production and had a high proportion of fish with jellied flesh. Most of this increase took place in the trawler sector of the fleet. The surplus standing crop appears to have been harvested and the trawler component has dropped since 1981 to less than that of the seiner component. This may indicate a tendency for trawlers to direct for witch only at times of high stock abundance.

Due to the declining nature of the landings there has not been a research vessel survey for this stock since 1981 and little or no commercial sampling data are available.

No data are available to support any change in the status of management advice.

WINTER FLOUNDER

Landings of winter flounder are over 95% from the southern Gulf - NAFO division 4T. It is predominantly a small vessel, inshore, summer/autumn fishery. The mean of the last twenty years' landings have been in excess of 2000 tonnes (Table 1). The major portion of these landings has been with small draggers (tonnage class 1 & 2).

This fishery has often been discussed as a mixed white hake (Urophysis tenuis, Mitchill) - winter flounder inshore fishery. Although the same size class of vessels are involved, the fishermen are able to direct to one or other of these species. The white hake to winter flounder catches are generally in the ratio of 9:1 or greater.

Winter flounder is often used for lobster bait, especially when more preferred species are not available. This unreported portion of this fishery (in 4T) could amount to more than the entire reported landings (ie. 1799 tonnes in 1983). The discard rate for the trawler portion of this fishery adds a further complication and could be well over 50% by numbers.

This is an unregulated fishery and no data are available to support any change in the status of management advice.

AMERICAN PLAICE in the Gulf of St. Lawrence

The American plaice landings in the Gulf are largely in NAFO division 4T. Although the landings in NAFO division 4R are only in the order of 2000 tonnes, they are larger than that of any other flatfish fishery in that division. Plaice landing statistics have, in the past included 90% of the unspecified flounder landings. This is as a result of ICNAF's request in 1973 to scientists of each country to estimate the quantities of individual flounder species recorded as "Flounders (NS)" between 1963 and 1971. Consequently plaice landing statistics for 1963 to 1971 were 'corrected' to include approximately 90% of flounders which had been reported as "Flounders (NS)" (this is considered to be the most up to date information available). The unspecified portion of the flounder catch has decreased considerably in the past five years, due, presumably, to better statistical reporting. The 1972 to 1983 landings reported here (Tables 1 and 3) do not include any of the unspecified flounders in the plaice statistics. The 4T plaice landings for 1983 were 6030 tonnes, with an additional 2238 tonnes taken in divisions 4RS for a total Gulf landed 'catch' of 8268 tonnes an increase of 200 tonnes over last year.

AMERICAN PLAICE in NAFO division 4T

i. Description of the Southern Gulf Fishery

Commercial (nominal) landings of American plaice in NAFO division 4T, the southern Gulf of St. Lawrence, were 6019 tonnes in 1983, down nearly 10% from 1982 (Table 3). This has continued the downward trend prevalent since 1976, resulting in an overall drop of nearly 50%. The majority of the landings are taken by mobile gear (OTB-1 and SNU) with the remaining 10% being taken by fixed gear (GN and LL) (Table 4).

ii. Commercial Fishing Data and Discarding

The off shore portion of this fishery is generally a by-catch of the 4T-Vn cod fishery. The major areas of high catches are eastward of Miscou Island, New Brunswick and north-east of Cheticamp, Nova Scotia. Minor fisheries occur off eastern P.E.I. and around the Magdalen Islands. The two major gear types, trawlers and Danish seiners, have quite different catch rates; the CPUE of Danish seiners is generally double that of trawlers. This is likely due to both the greater efficiency of these seiners and to the more directed nature of the Danish seiner fishery. There has been a shift in the proportion of the landings by these two gears in the past five years. The trawler catch is down to only 25% of what it was in 1978 while the seiner landings are up by 10% to a level 4 times that of trawlers in the same period.

A major problem in sampling commercial landings of American plaice (and presumably other flatfish) has been the discarding of small fish at sea. Studies in 1959-61 (Jean, 1963) and 1976 (D.F.O. unpublished study) have shown levels of 30-60% discards by weight and 55-85% by number. These reports indicate that all fish under 30cm and a decreasing percentage of each length interval above that size are discarded at sea. This poses a serious problem and requires either accurate on board sampling of the 'catch', or faith in past discard studies (to correct samples of landings) and the assumption of a fleet with similar discard habits. Of necessity, managers have accepted the latter.

The mean age and weight of fish in the landings have dramatically increased in the last three years (Figure 1). Clay and Nielsen (1983) suggested this might be due to either a strong year class moving into the older age groups and/or a poor recruitment in recent years or an increasing rate of discarding of small fish due to the abundance of cod. They found that the mean weights of fish caught in the research vessel surveys (Figure 2) did not show the same marked trend - indicating the latter assumption was the more likely. It has since come to the attention of the authors that the minimum mesh size regulations have changed twice since 1976. Prior to June 1977 the minimum codend mesh size was 4 1/8 inches (105 mm) [for cotton, hemp, polyamide, and polyester] or 4 1/2 inches (114 mm) [for all other materials]. In June 1977 the minimum mesh sizes were increased to 4 3/4 inches (120 mm) and 5 1/8 inches (130 mm) respectively. In July 1981 they were increased to 130 mm for all materials. Such a significant change from 110 mm to 130 mm (20 mm increase) would raise the 50% retention point from 25 cm to 30 cm (Clay, 1979), this would certainly reduce the retention of small fish and thus the quantity of discarded fish, all other factors being equal. If the increasing mesh size were the only factor, the landing length frequencies should retain approximately the same distribution, as all fish below 30cm were discarded and the 50% retention point has not been raised above 30cm. This does not, however, appear to be the case - the mean size (weight) in the landings is increasing as well as the average age (up from 11 and 12 in 1981 and 1982 to 14 in 1983). Therefore some other factor(s) are exerting a strong influence on discarding of American plaice.

An investigation has been conducted on four possible causes of this change in the size frequency distribution of the landings. These are the increasing mesh size, increasing cod abundance, changing price ratio paid for cod and plaice and a shift in the gear mix.

Two of these potential causes of the increasing size of discarded fish are probably inter-related. The long term increasing cod abundance may, in part, be due to the increase in mesh size in use in the Gulf groundfish fisheries. This will also lead to an increase in mean size of cod. In order to quantify any changes that these two items may have had on the discard pattern we must generate the required test data. Two historical data series were utilized, these were the commercial landing length frequency samples from fishing ports and the annual September groundfish research vessel (R.V.) cruise length frequencies. The technique outlined below was carried out for the data series from 1970 to 1983.

The method can be summarized as:

Population = R.V.Catch (length frequency)

Commercial Landings = Port Samples (length frequency)

Commercial Catch = Population x Selectivity ogive

Discards = Commercial Catch - Commercial Landings

where: population is taken as the smoothed (running average of 3) research vessel catch length frequency; the commercial landing length frequencies are assumed to be represented by the smoothed port sample length frequencies; the selectivity ogive for 110 mm (1970 to 1976), 120 mm (1977 to 1980), and 130 mm mesh codends (1981 to 1983) were taken from Appendix I. Both the 'commercial catch' and the 'commercial landings' were standardized to a value of 1000 fish at length 40 cm. This length was assumed to be greater than that of any discards and so should be equal in both the catch and the landings. The discards are then calculated as the difference between the commercial catch and the commercial landing length frequencies. This technique is somewhat comparable to that used by Mayo et al. (MS1981) in their simulation of escapement rates for various fisheries in the New England area.

iii. Discard Frequencies

The resulting (standardized) discard length frequencies (Figure 3) show a shift of over 2 cm to the right (larger mean size) during the last five years. The cumulative percent of the discards (Figure 4) shows this same phenomenon more clearly. Data for the year 1979 is anomalous in both of these data sets. These two figures provide strong evidence that the discard ogive has not remained constant and that the mean size of discards has in fact increased. The increase in the 50% discard point of 3 cm (Figure 4) between the period (1971 to 1974) and 1983 is close to the 5 cm suggested increase in the 50 % retention point in moving from 110 mm to 130 mm codend mesh nets (It should be noted that many vessels had moved voluntarily to larger mesh sizes prior to the regulations coming into effect, thus reducing the resulting

increase). The value of 2.5 cm, the shift in the 50% discard point between the 1975 and 1976 lines and the 1982 and 1983 lines is probably more realistic of the true increase caused by the mesh regulations. This implies that fishermen, who are now catching fewer small fish, are discarding slightly larger fish now than they did previously.

The relative importance of landings by trawlers and seiners has changed dramatically from 1972 to 1983 (Table 3). The contribution by trawlers to the total landings has decreased from 62% in 1976 to 18% in 1983. Over the same period, seiners increased from 30% in 1976 to 68% in 1983 of the total catch, although in absolute terms the seiners have remained relatively stable. To determine whether the change in discarding habits was simply due to the relative importance of landings by gear types, the technique for calculating discards described above was used for data from these two gear categories.

Commercial length frequencies for trawlers and seiners were regrouped separately into three time periods (1974-76, 1977-80, 1981-83) corresponding to periods of uniform mesh size regulations. The resulting cumulative discard ogives (Figure 5) show that there is no marked difference between these gears within a period although seiners appear to be discarding at a slightly smaller size. The progression between time periods is clear (Figures 5 and 6) and again indicates that fishermen are discarding larger fish in the more recent times.

iv. Economic Influences of Discards

One additional data set was developed in order to investigate why fishermen may have been discarding larger fish since 1978. The price paid for cod and plaice in the province of New Brunswick (Figure 7) was used to generate a cost price index. This price index (Table 5), based on the ratio of the cod price to the plaice price in the same year, was used to remove the effects of increases due to inflation in the economy. The change in this index from year to year will be an indication of changing price preferences for cod over plaice (a negative change indicates a decreasing preference for cod, a positive change an increasing preference for cod). Cod has, for the past 15 years, always obtained a higher price than plaice in New Brunswick. The anomalous year, 1979 (see above), is partially explained by this price index. There was a 25% increase in the price paid for plaice in 1979 and only a 10% rise in the price of cod in the same year. This may have encouraged fishermen to retain more plaice in their catches - leading to an apparent drop in the 50% dicard length (Figures 3 & 4).

v. Multispecies Influences on Discards

Two abundance indices (Table 6) for divisions 4T-4Vn cod are available for this investigation (Lever, MS 1984). A stepwise multiple

regression was run on the 14 years of data for the following nine variables:

	variable	type	importance	R.Sq.
1.	50% discard length	dependent	-	-
* 2.	cod abundance (RV)	independent	4	0.89
3.	cod abundance (mult)	"	6	0.91
4.	mesh size	"	1	0.80
5.	cod/plaice $ index	"	3	0.88
6.	change in #5 index	"	6	0.91
7.	trawler catch (%)	"	7	0.92
8.	seiner catch (%)	"	2	0.85
9.	ratio trawler:seiner	"	5	0.90

*NOTE: 1981 was accepted as an anomolous year in the RV abundance index series and corrected by applying the mean value of 1980 and 1982 in its place (TABLE 6).

The correlation is very high (r^2 =0.92) and indicates that mesh size (and thus cod abundance - which has increased with increasing mesh size), seiner catch levels, and the change in the cod/plaice price index have exerted the major influence on the discard pattern of the division 4T American plaice fishery. As we previously showed there was no difference in the discarding habits of seiner and trawler fisherman, the relationship provided by the seiner catches are thought to be spurious.

Due to the stepwise nature of the values of the variable 'mesh size', it was felt that the relationship may not be a true cause-effect type and thus a second model was run without the mesh size. In this second case the correlation coefficient was also very high (r^2 =0.90) with the first three contributors being seiner catch (r^2 =0.82), cod abundance (r^2 =0.82), and the cod/price index (r^2 =0.88). The most applicable equation therefore appeared to be based on two of those three variables:

50% DISCARD LGTH = 25.12 + 0.008(cod abund.RV) + 1.720(cod/plaice $ index)

r^2 =0.77 ; n=14

As discussed previously, the gear mix does not appear to be a major contributor to the discard pattern although seiners did appear to discard slightly smaller fish. The major factor in the changing discard pattern may in fact be the cod abundance (which it is assumed will influence the prices paid for cod and plaice). The relationship between the 50% discard length of plaice and the research vessel abundance index of cod (Figure 8) is given by the equation :

50% DISCARD LENGTH = 27.66 + 0.007 (COD ABUNDANCE Nos.),

r^2 = 0.65 , n = 14

vi. Sampling With Respect to Discarding at Sea

The changing discard pattern of the southern Gulf American plaice stock(s) poses fundamental questions as to the type of sampling that should be conducted for commercial stocks where significant unrecorded discarding takes place. One consideration may be increased coverage by research vessels to provide increased, accurate data on the population. The length frequencies from the September groundfish cruises (1970 to 1983) provide an indication of a relatively stable stock in the southern Gulf (Figure 9). It is interesting to note the change in population modal length over this period. The 1970 to 1974 period has a mean modal length of 26 to 28 cm. During the 1975 to 1979 period the modal length decreased to a low of 21 cm in 1977 (the year of the first mesh size increase and high landings) and has subsequently increased back to 26 to 28 cm in 1982 and 1983. It would thus appear that the increased mesh size has had a "savings" effect on the juvenile portion of the Gulf plaice stock.

With
(1) no adequate commercial sampling of the 'catch' (despite improved sampling of 'landings' in recent years),
(2) a relatively stable research vessel survey index of mean weight and age,
(3) age and growth (from cruise samples) data similar to earlier years,
(4) the knowledge that despite increasing size of discards, the fishery is, as a whole, less destructive now than it was three years ago (due to increased mesh size), and
(5) a declining landings, possibly due to both the increased mesh size and the increased 50% discard length,

it is not possible to make any recommendation for a change in the management advice of NAFO division 4T American plaice for 1985.

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Table 1. Landing statistics (tonnes) for NAFO divisions 4RST flatfish.

	YEAR	YELLOW -TAIL	ATLANT HALIBUT	GREEN. HALIBUT	WITCH	WINTER FLOUNDER	PLAICE	UNSPEC. FLOUNDER	TOTAL FLATFISH
	1963	107	537	0	4250	3165	8470	0	16529
	1964	65	615	0	3350	3014	8803	9	15856
	1965	53	693	24	3608	4419	11098	5	19900
	1966	157	612	365	3712	3136	12720	0	20702
	1967	79	459	365	2714	2454	10478	24	16573
	1968	12	443	686	3388	551	11911	0	16991
	1969	268	506	801	4652	1710	10841	0	18778
	1970	59	509	1112	4801	2694	13132	0	22307
	1971	40	454	954	3821	2842	11765	0	19876
	1972	3	310	681	2001	1911	9724	1373	16003
	1973	6	385	756	2224	2384	8007	2426	16188
	1974	27	418	1011	3247	1976	11261	999	18939
	1975	3	272	1544	2722	2050	10177	3951	20719
	1976	37	196	2019	6875	2471	14265	1785	27648
	1977	30	150	3961	3039	1358	12665	1995	23198
	1978	13	135	6247	4510	1236	12375	1196	25712
	1979	69	132	8791	4561	1722	12943	894	29112
	1980	46	202	7006	3527	2053	11115	1163	25112
	1981	14	95	3176	1912	2013	10210	532	17952
	1982	5	90	2269	1282	2317	8074	479	14516
*	1983	50	173	1577	1030	1799	8268	0	12897
	AVERAGE	54	352	2064	3392	2251	10872	802	19786
	% of Total	0.3	2	10	17	11	55	4	

* all references to 1983 refer to provisional statistics.

Table 2. Landings for NAFO division 4R Witch by gear type from 1972 to 1983.

YEAR: GEAR:	TRAWL	SEINE	OTHER	TOTAL
1972	875	68	9	952
1973	312	559	16	887
1974	1248	1259	13	2520
1975	801	1134	10	1945
1976	5231	101	9	5341
1977	1984	606	9	2599
1978	3458	787	50	4295
1979	2676	1007	105	3788
1980	2099	797	77	2973
1981	455	731	33	1219
1982	276	733	19	1028
* 1983	128	527	31	686
AVERAGE	1629	692	32	2353
% of Total	69	29	1	

* all references to 1983 data are to provisional statistics

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Table 3. Landings for NAFO division 4T American plaice from 1972 to 1983.

YEAR: GEAR:	TRAWL	SEINE	GILLNET	OTHER	TOTAL
1972	5135	2315	286	558	8294
1973	3558	2743	241	363	6905
1974	4131	3661	250	443	8485
1975	3989	3878	217	359	8443
1976	6962	3376	225	630	11193
1977	4634	4004	242	350	9230
1978	4540	3489	379	623	9031
1979	4523	3724	750	999	9996
1980	3887	3472	726	207	8292
1981	2623	3575	1084	552	7834
1982	1459	4124	807	119	6509
* 1983	1084	4091	485	359	6019
AVERAGE	4044	3482	470	472	8469
PERCENT	47	41	5	5	

* all references to 1983 data are to provisional statistics

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Table 4. Landing statistics for NAFO division 4T American plaice in 1983 broken down by month and gear. (Provisional statistics.)

YEAR::GEAR	TRAWL	SEINE	GILLNET	OTHER	TOTAL
JANUARY	15	0	0	1	16
FEBRUARY	5	0	0	2	7
MARCH	3	0	0	0	3
APRIL	18	204	0	0	222
MAY	70	630	39	9	748
JUNE	130	883	241	8	1262
JULY	53	556	51	2	662
AUGUST	341	382	73	10	806
SEPTEMBER	238	545	60	9	852
OCTOBER	153	401	20	8	582
NOVEMBER	36	373	1	12	422
DECEMBER	16	117	0	0	133
NFLD -unspec.	6	0	0	0	6
QUEBEC "	0	0	0	298	298
TOTAL	1084	4091	485	359	6019
PERCENT	18	67	8	5	100

Table 5. Plaice price preference index (PPP I) for New Brunswick. The price index is the landed value of round cod divided by the comparable value for plaice in the same year. (See text).

YEAR	PPP Index	Change in PPP I
1970	1.03	-
1971	1.26	+ 0.23
1972	1.29	+ 0.03
1973	1.45	+ 0.16
1974	1.64	+ 0.19
1975	1.54	- 0.10
1976	1.66	+ 0.12
1977	1.61	- 0.05
1978	1.60	- 0.01
1979	1.39	- 0.21
1980	1.32	- 0.07
1981	1.41	+ 0.09
1982	1.27	- 0.14
1983	1.41	+ 0.14

Table 6. Abundance indices for 4T-4Vn cod (Lever, MS 1984). The research vessel (R.V.) index is the total numbers of cod (000's) caught in the September groundfish cruise. The catch per unit effort index is from the multiplicative model (mult.). The mesh size in use in the appropriate years (mesh) is found in the lower row.

year :	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
R.V.:	63	63	63	59	55	44	98	79	91	231	259	406 (255)*	249	284
mult.:	.37	.32	.37	.30	.25	.25	.26	.36	.42	.55	.57	.59	.62	.75
mesh :	110						110	120			120	130		130

* This value is obviously anomolous and has been replaced for these calculations with the mean of 1980 and 1982.

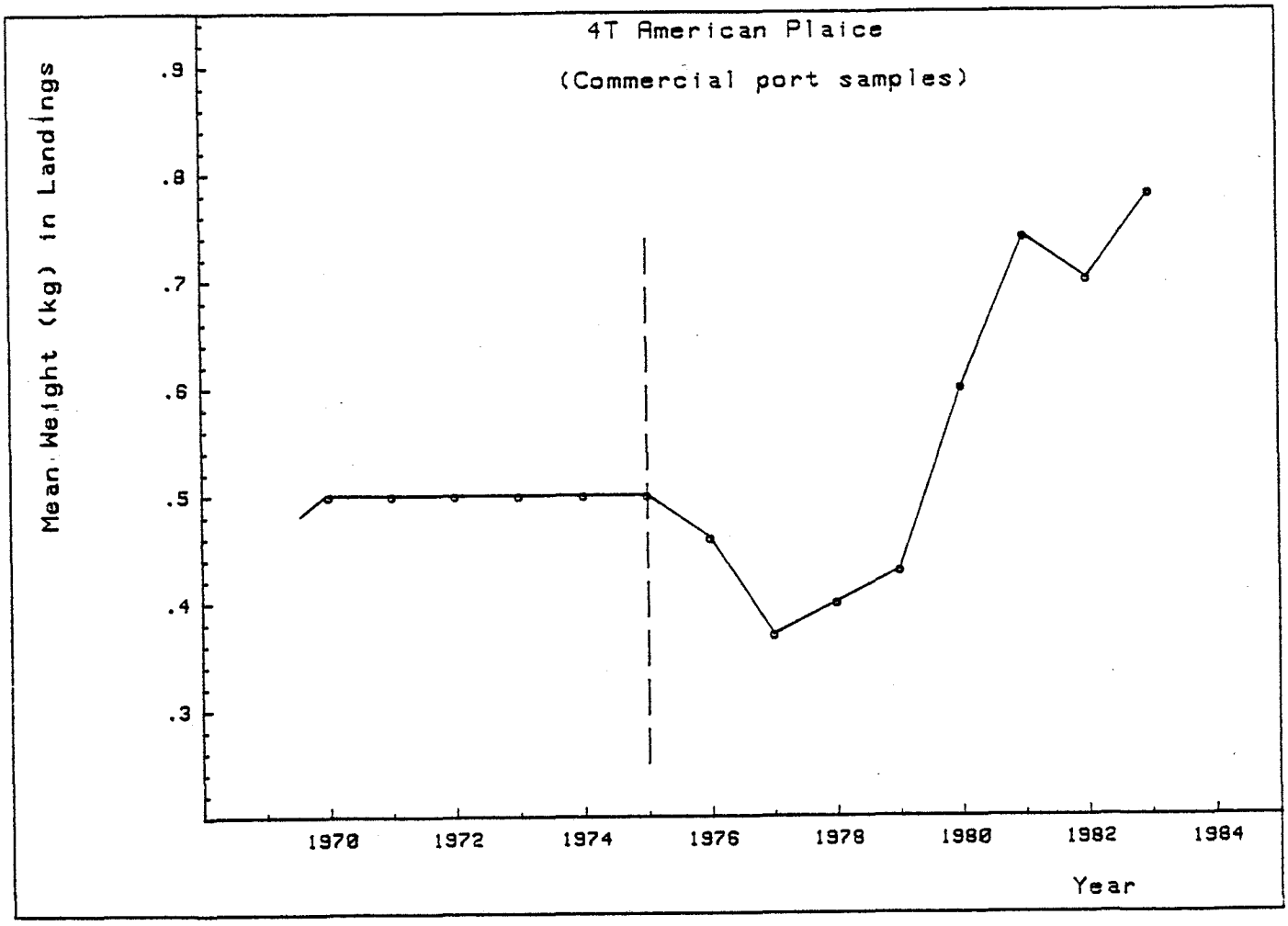

Figure 1. Mean weights of 4T American plaice in commercial landings from 1970 - 1983. (Values left of the vertical line were calculated from one combined age-length-key, due to a lack of adequate sampling).

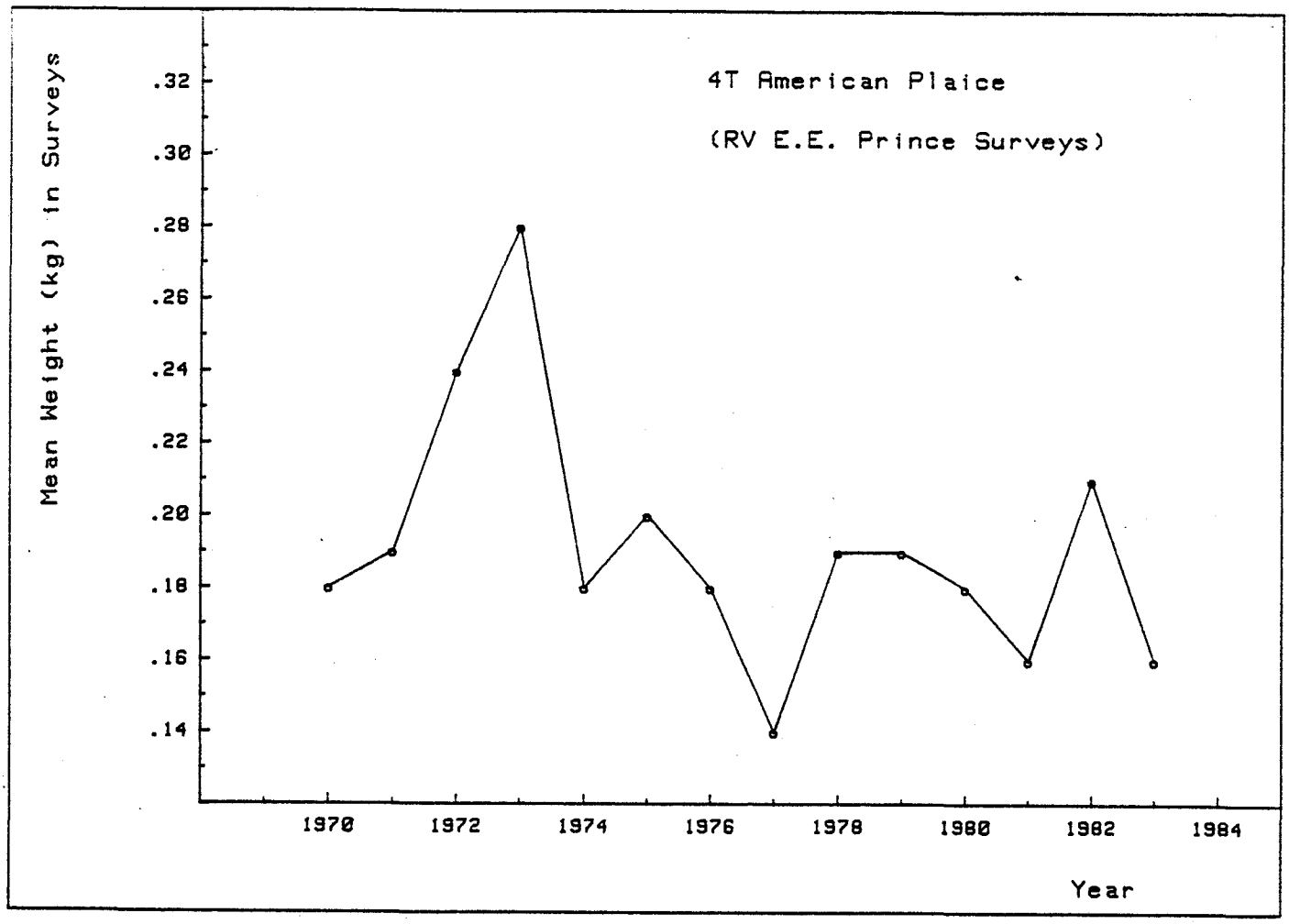

Figure 2. Mean weights of 4T American plaice from the E. E. Prince September R.V. surveys from 1970 - 1983.

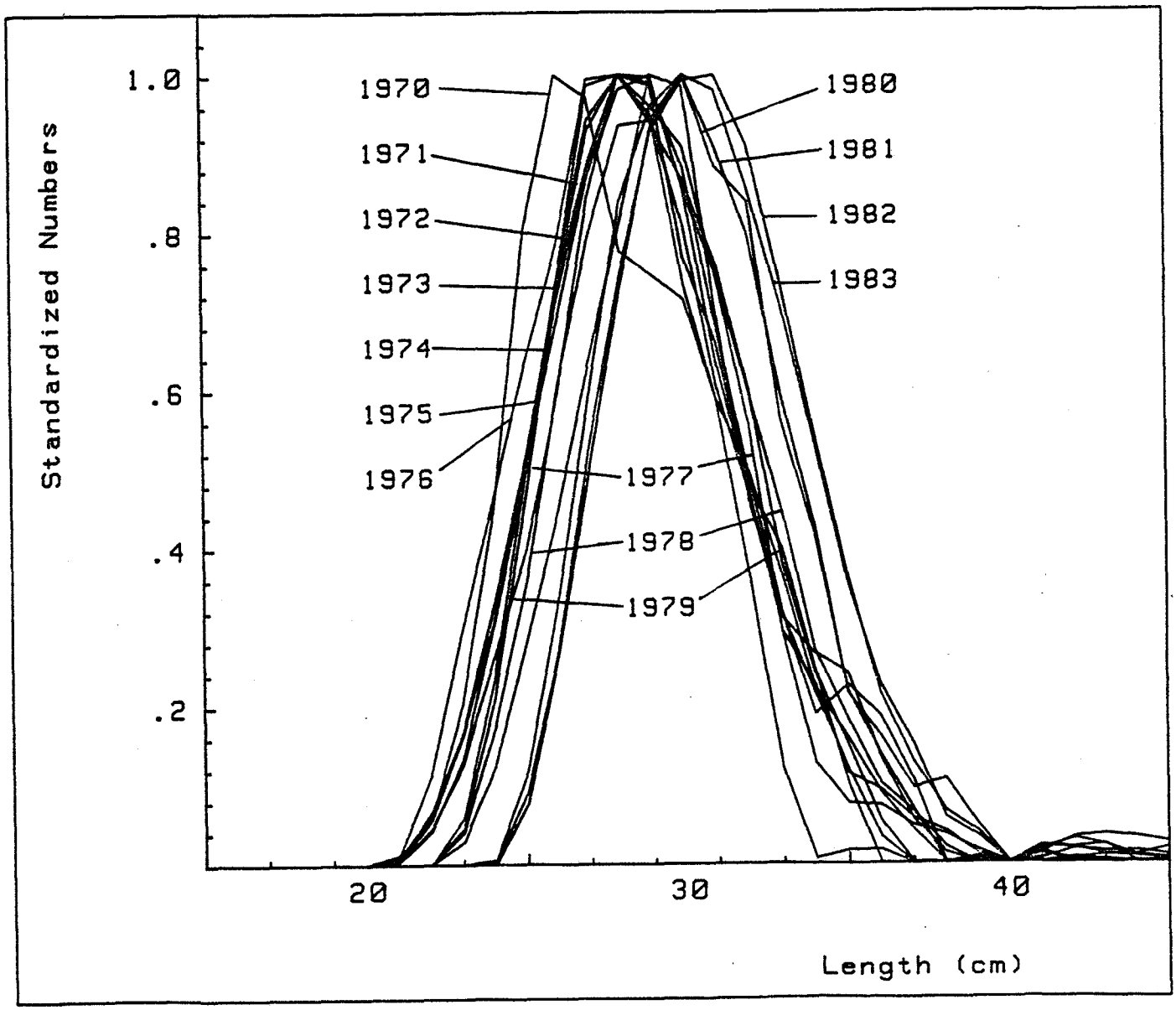

Figure 3. Discard length frequencies of 4T American plaice from 1970 to 1983. All years standardized to 1 at their peak value.

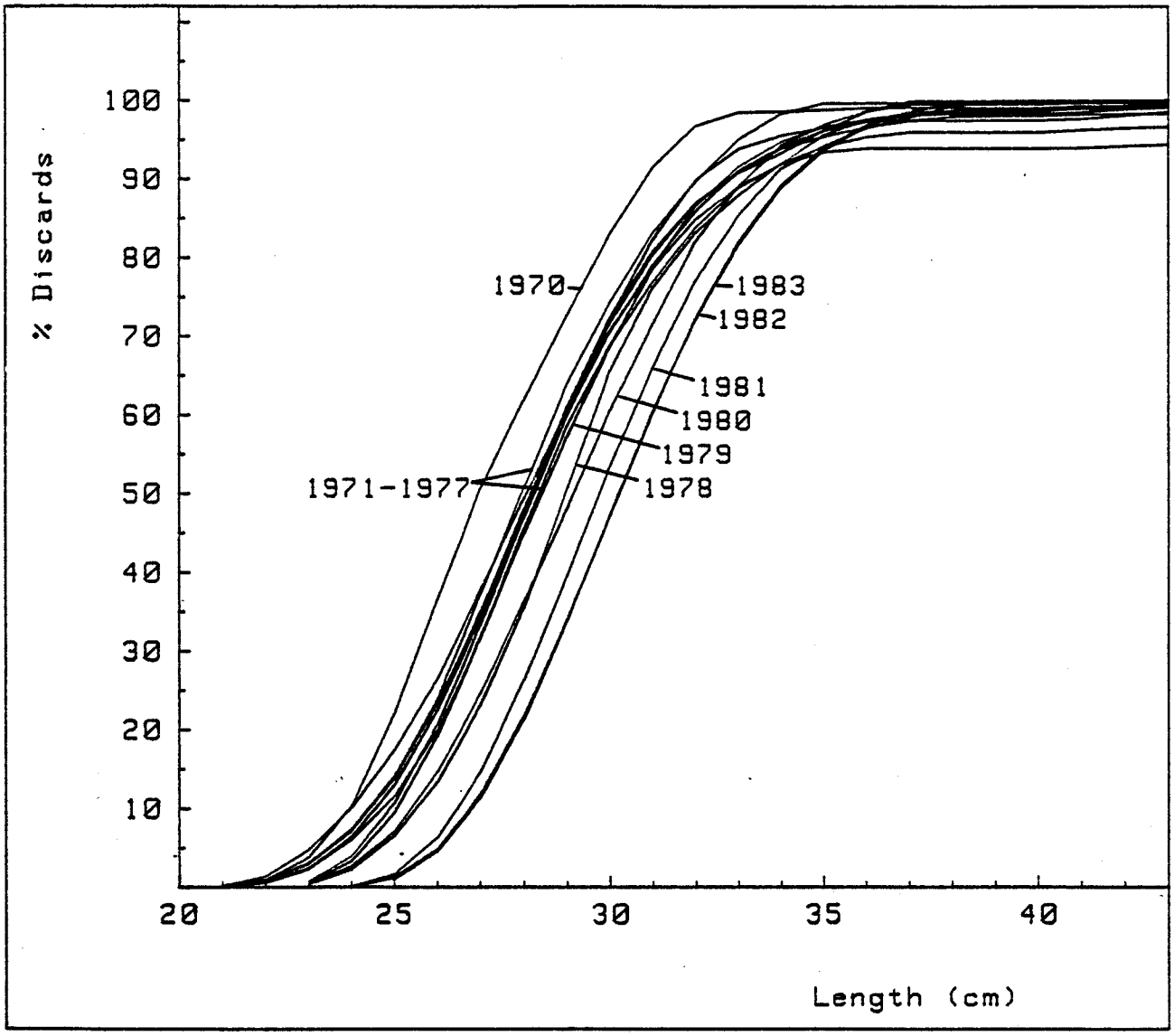

Figure 4. Cumulative percentages of 4T American plaice discards from 1970 to 1983.

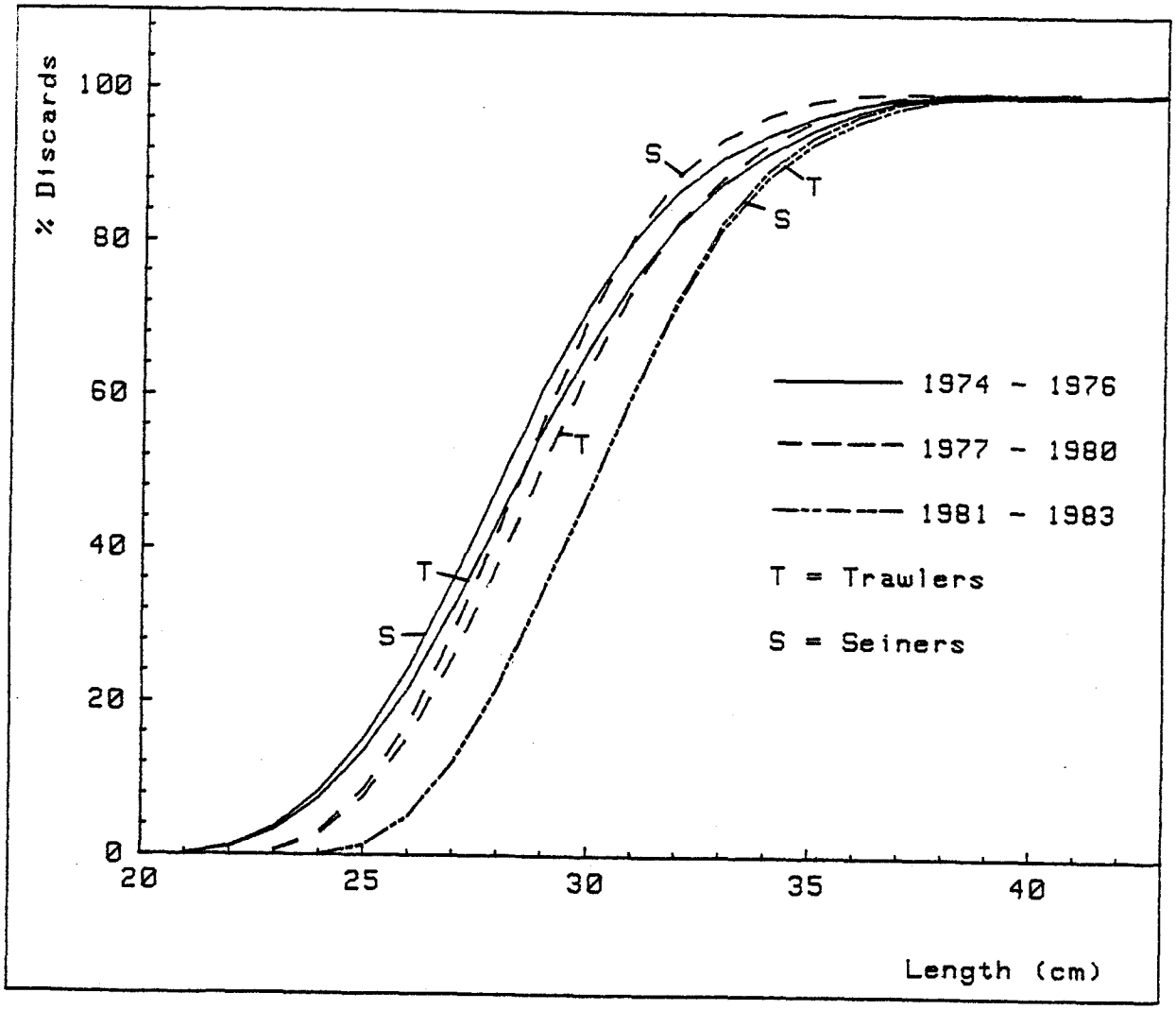

Figure 5. Cumulative percentages of 4T American plaice discards by period and gear type from 1974 to 1983.

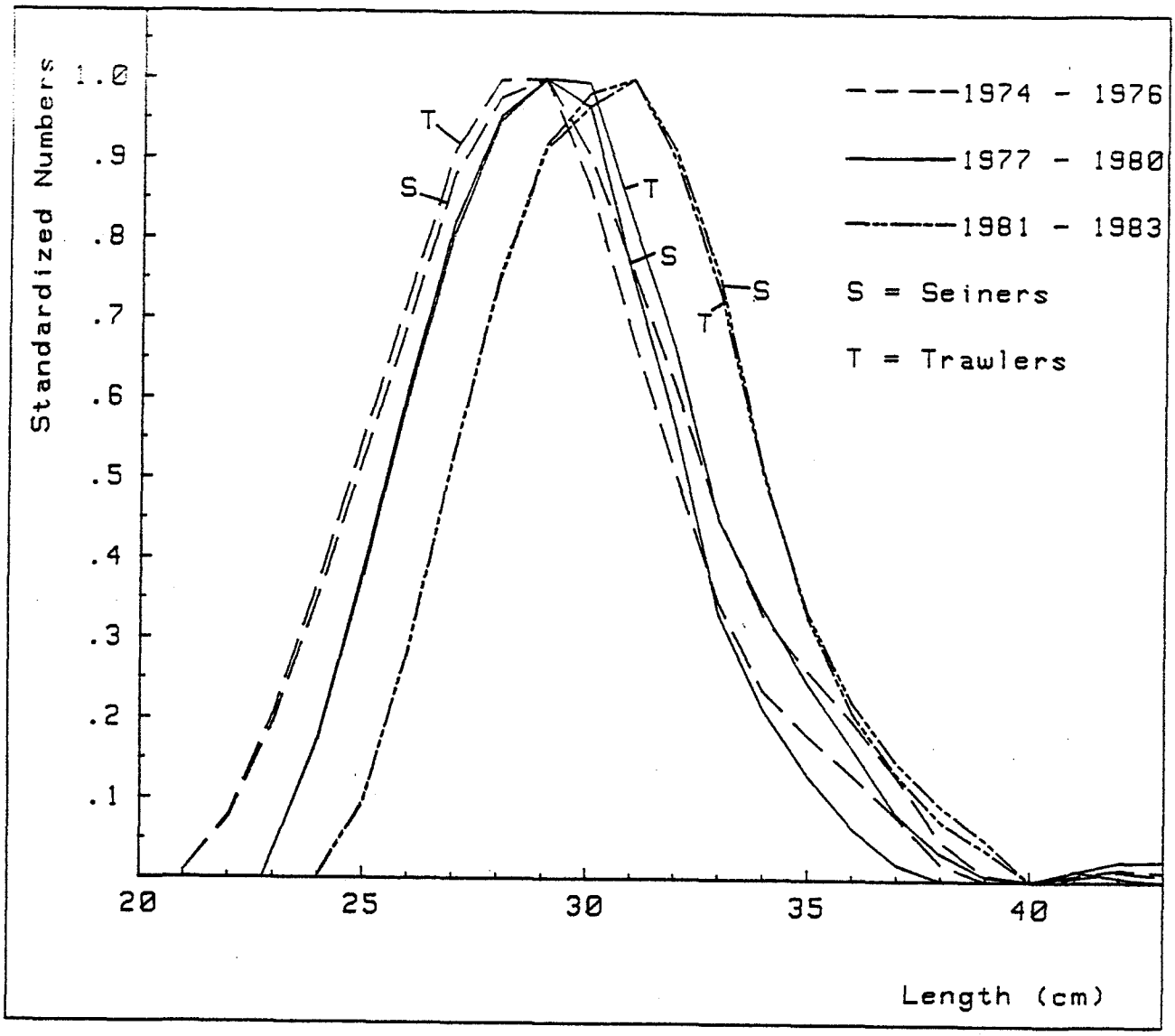

Figure 6. Standardized length frequencies of 4T American plaice discards by period and gear type from 1974 to 1983.

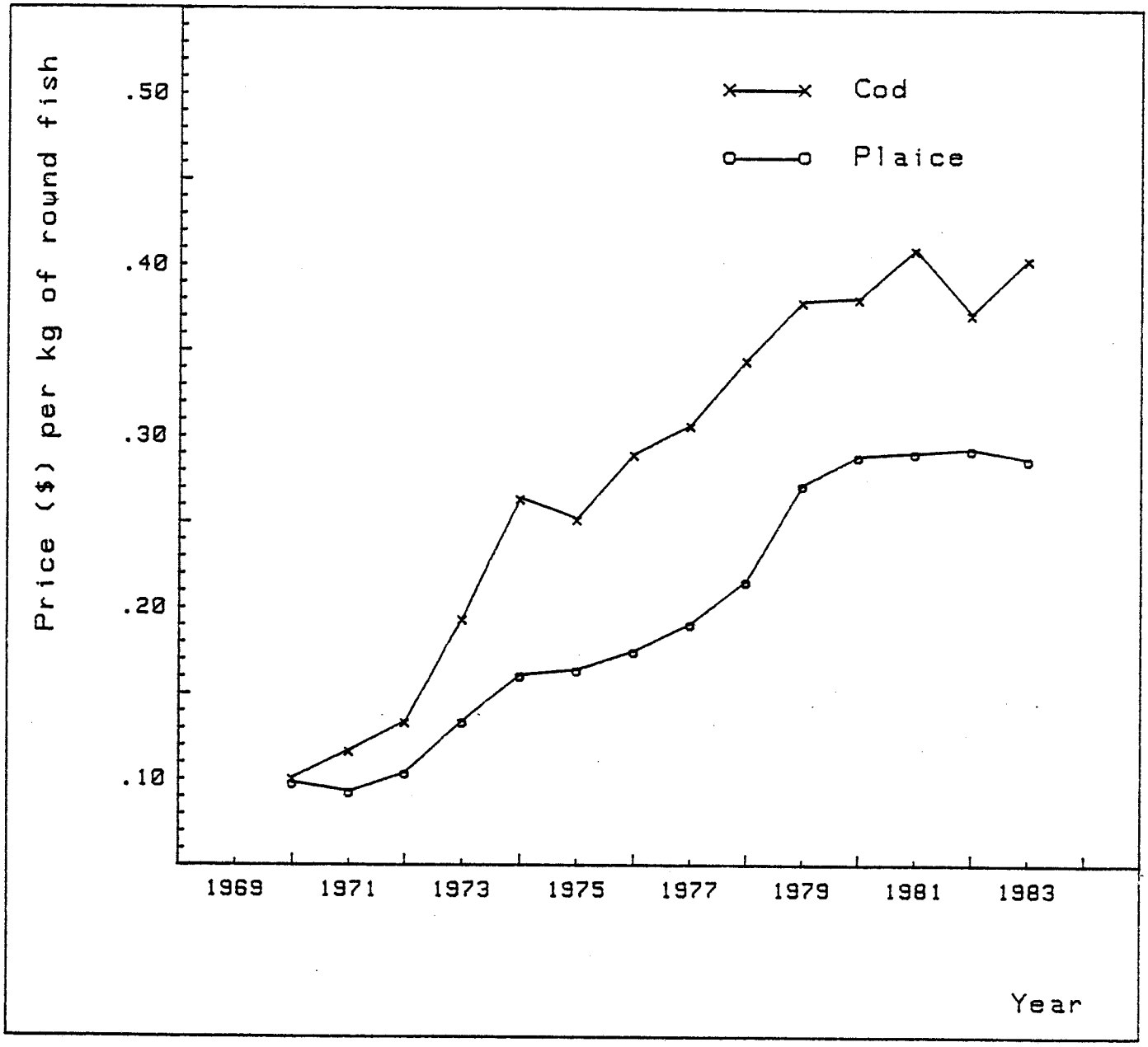

Figure 7. Average yearly prices paid per kg for cod and plaice in New Brunswick from 1970 to 1983.

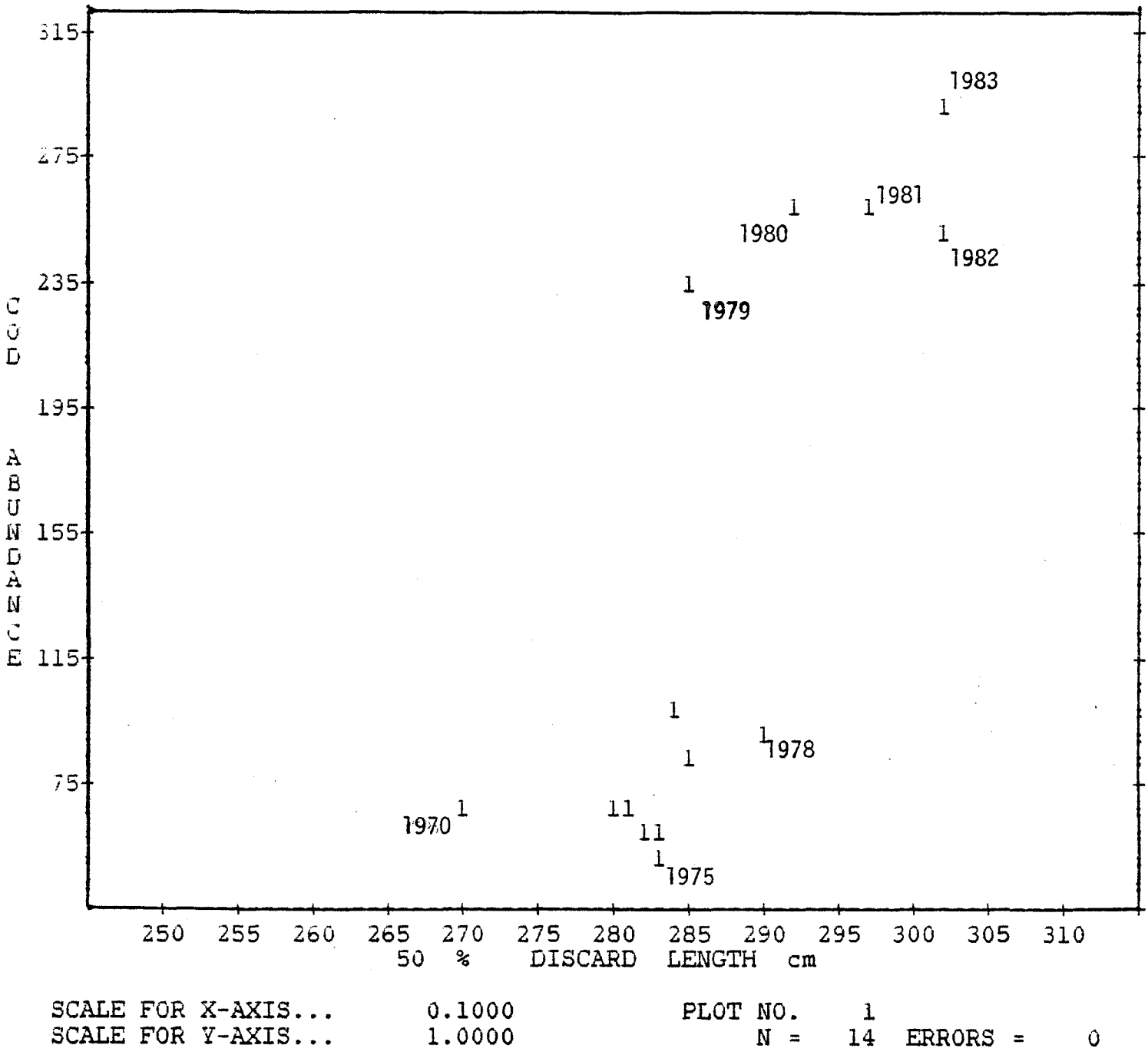

Figure 8. 50% discard length of 4T American plaice vs 4TVn cod research vessel abundance index.

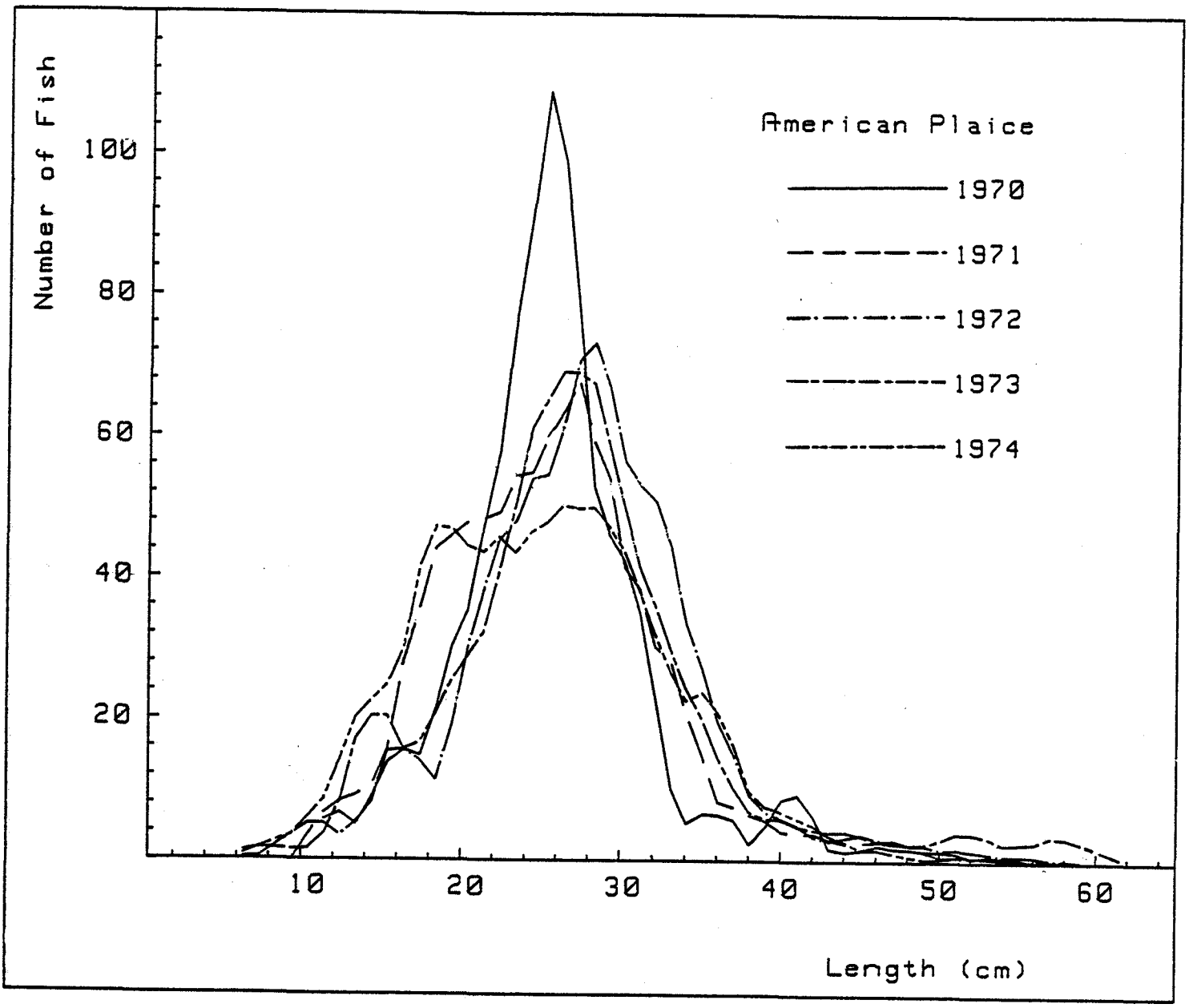

Figure 9a. Length frequencies of 4T American plaice from the E. E. Prince annual R.V. groundfish surveys. 1970 to 1974.

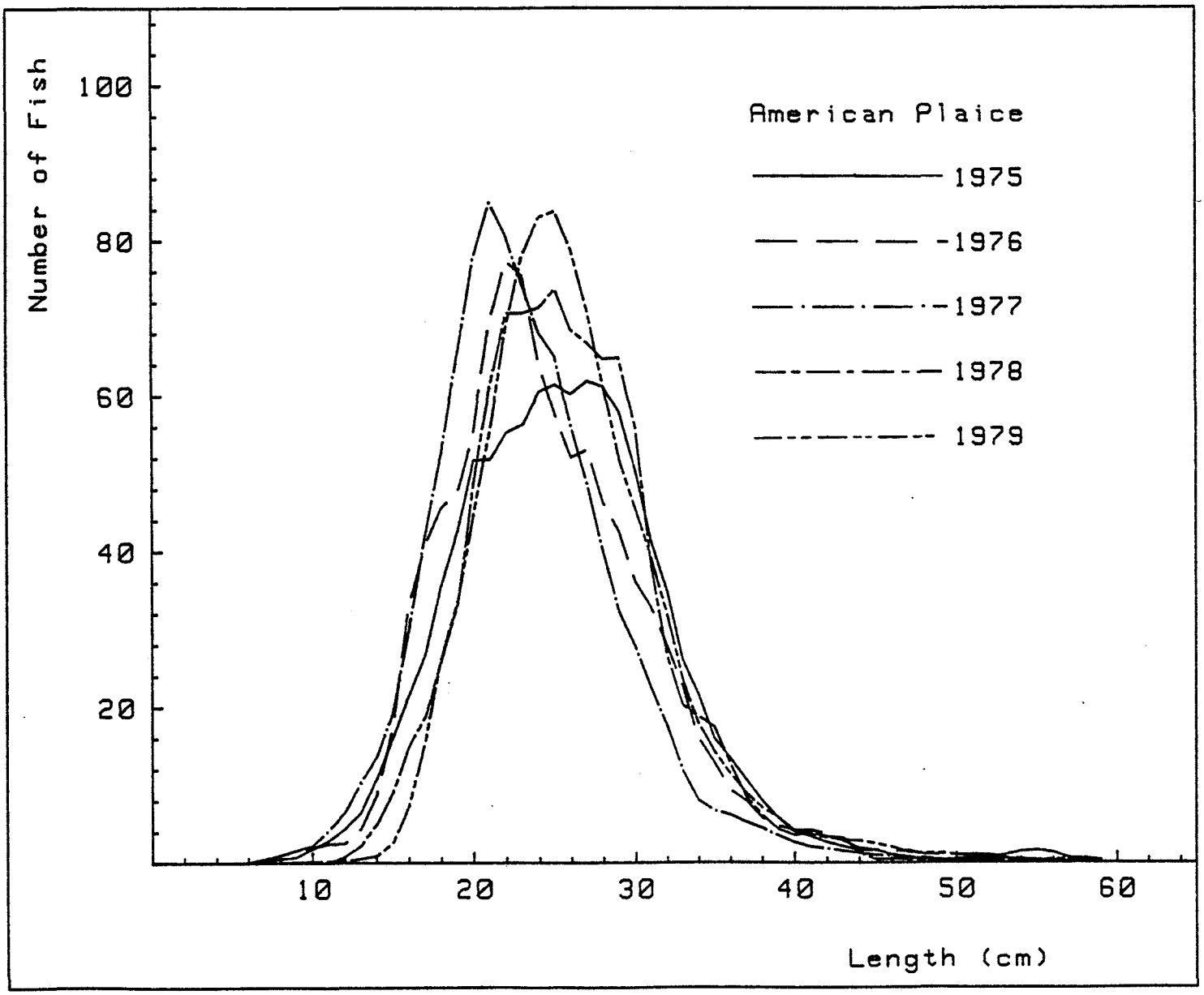

Figure 9b. Length frequencies of 4T American plaice from the E. E. Prince annual R.V. groundfish surveys. 1975 to 1979.

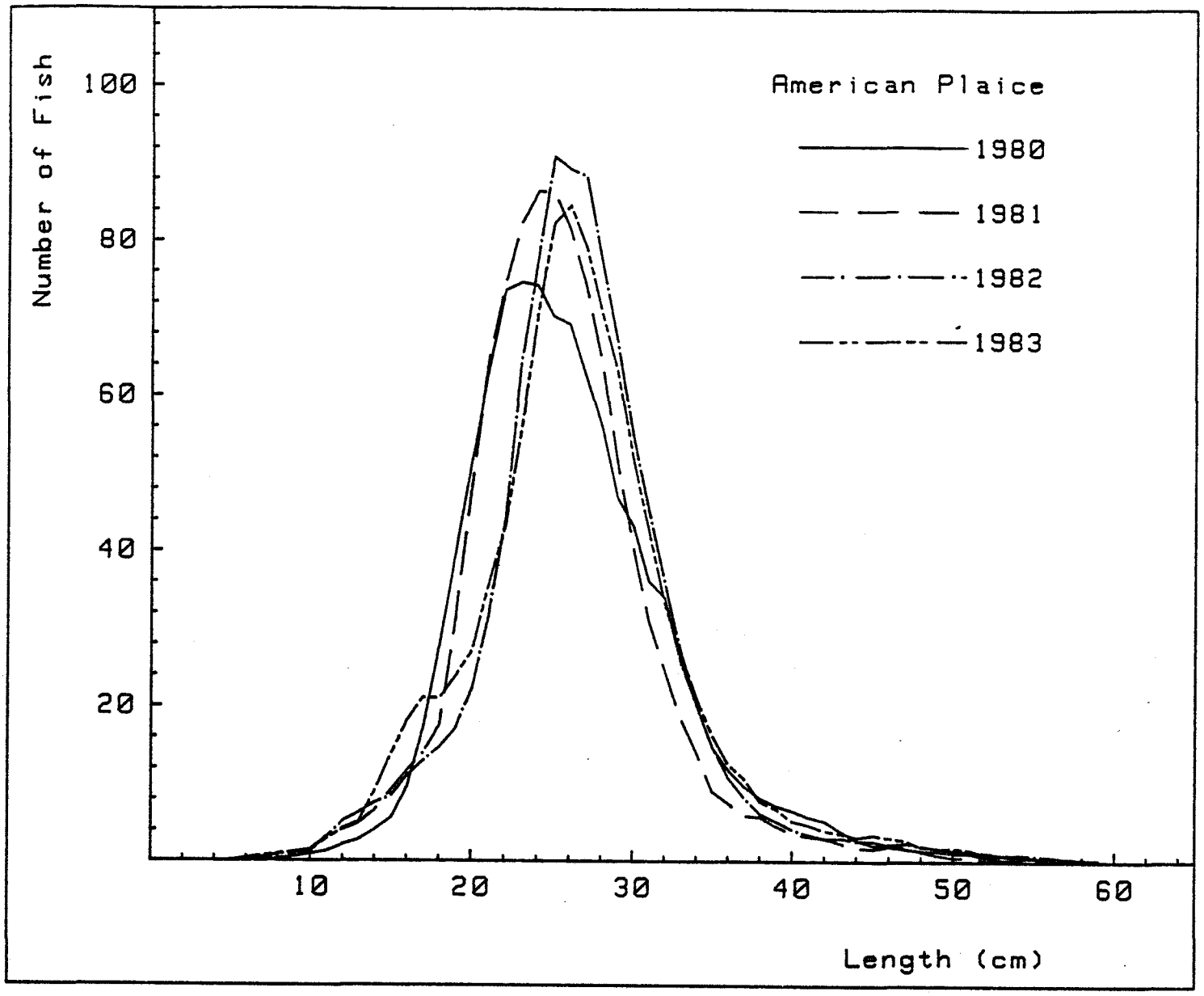

Figure 9c. Length frequencies of 4T American plaice from the E. E. Prince annual R.V. groundfish surveys. 1980 to 1983.

APPENDIX I

Synthesis of selection curves for American plaice, (*Hippoglossoides platessoides*, Fabricius)

INTRODUCTION

Mesh selection is a major tool available to fisheries management. With this tool the fisheries scientist can take limited data and transform it between population and catch. Even so, the amount of effort put into studies on this topic has diminished in the last ten to twenty years. One reason for this reduced effort was pointed out by Clay (1979) as: "the inherent variability in mesh selection studies which raises the question of the necessity and value for further studies on species for which much data already exists". This review suggested "the possibility of utilizing past studies ...to produce general selection patterns which may be useful in analyzing the effects of mesh regulations ..." when adequate data are not available.

TECHNIQUE

Figure 1 (after Clay,1979) shows the general selection pattern of American plaice. From the GM regression of these data:

$$TL = 2.32M - 3.29; \quad r^2 = 0.95, \; n = 25$$

(of 50% retention)

(where TL is total length in mm and M is codend mesh size in mm) the 50% retention points can be estimated for any mesh size. Using the historic data summarized by Holden (1971) the selection range was plotted against the mesh size . The selection range of any mesh size can then be estimated from the GM regression of the ln transformation:

$$SR = 0.17945 \times M^{1.1041}; \quad r^2 = 0.45, \; n = 22$$

(where SR is the selection range in mm and M is the codend mesh size in mm). Table 1 summarizes the selection parameters of American plaice for 60, 90, 100, 110, 120, 130 mm mesh codends.

Table 1. Synthesized selection parameters for American plaice (*Hippoglossoides platessoides*).

Mesh Size (mm)	50% Retention Length (mm)	Range (mm)	Selection Factor (rounded)
60mm (2 3/8 in)	149	16.5	2.5
90mm (3 1/2 in)	212	25.8	2.4
100mm (4 1/8 in)	233	28.9	2.3
110mm (4 1/2 in)	254	32.8	2.3
120mm (4 3/4 in)	275	35.4	2.3
130mm (5 1/8 in)	296	38.7	2.3

From these values the selection curves can be approximated by assuming a straight line between the 25% and 75% retention points and adding the characteristic sigmoid curves on the two ends. Such synthetic curves are shown in Figure 2 with detailed selection values as given by sine approximation shown in Table 2.

Table 2. Selection ogives for American plaice (Hippoglossoides platessoides)as calculated by computer (sine) simulation.

	CODEND MESH SIZE (mm)					
length cm :	60	90	100	110	120	130
12	0.0					
13	3.8					
14	23.6					
15	53.4					
16	81.9					
17	98.4	0.0				
18	100.0	2.2	0.0			
19		11.7	0.1			
20		27.1	4.0	0.0		
21		46.2	13.7	0.7		
22		65.8	27.9	5.8	0.0	
23		83.0	44.8	15.4	1.8	0.0
24		95.0	62.4	28.5	7.6	0.2
25		99.9	78.5	43.8	16.9	3.1
26		100.0	91.0	59.7	29.0	9.2
27			98.4	74.6	42.9	18.2
28			100.0	87.0	57.4	29.5
29				95.7	71.2	42.2
30				99.8	83.3	55.4
31				100.0	92.6	68.3
32					98.3	79.9
33					100.0	89.3
34						96.1
35						99.6
36						100.0

REFERENCES

Clay, D. (1979) Current mesh selection studies on the Scotian shelf in relation to historical selectivity data. ICNAF Sel. Pap. 5:49-60.

Holden, M.J. (ed). (1971) Report of the ICES/ICNAF Working Groups on selectivity analysis. Coop.Res.Rep.ICES.25:144 p.

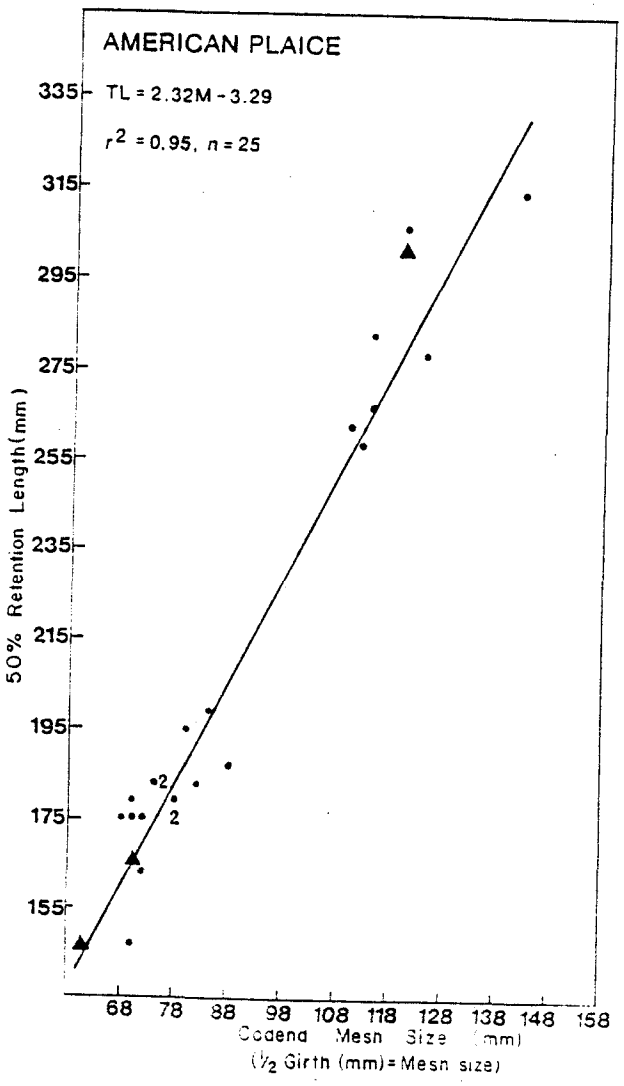

Figure 1. General selection pattern for American plaice based on historical mesh selection studies. (Each dot represents a single observation and numbers indicate points with two or more observations; triangles indicate points from the 1977 studies (Clay, 1979).

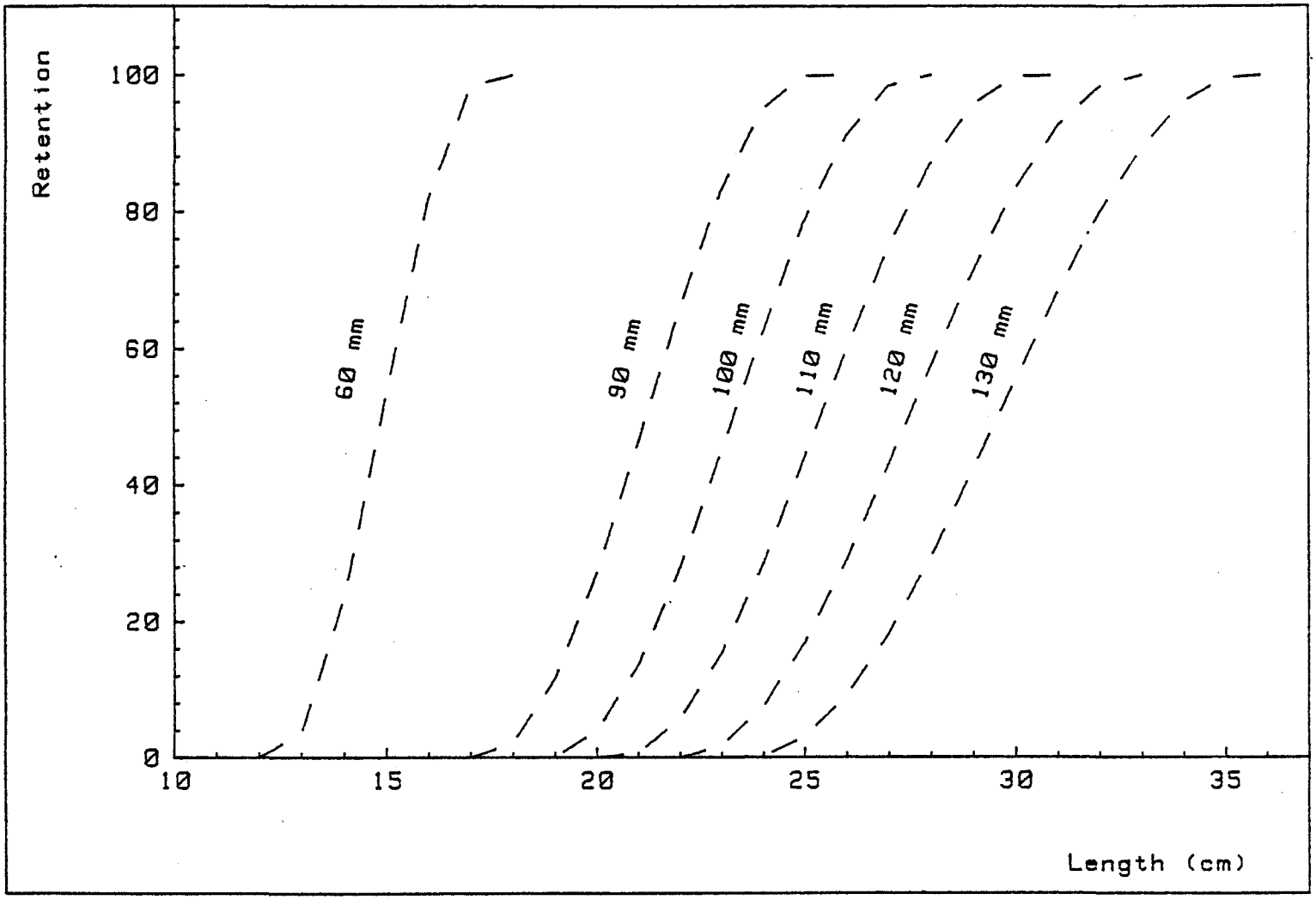

Figure 2. Mesh selectivity ogives for American plaice using 6 different codend mesh sizes (mm).