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Demersal Fish Committee

REPORT OF THE WORKING GROUP ON REDFISH AND GREENLAND HALIBUT IN REGION 1

Copenhagen, 18-25 March 1980

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TABLE OF CONTENTS

REPORT OF THE WORKING GROUP ON REDFISH AND GREENLAND HALIBUT IN REGION 1

Copenhagen, 18 - 25 March 1980

1. PARTICIPANTS AND TERMS OF REFERENCE

1.1 Participants

W R Bowering	Canada
K Kosswig	Germany, Fed.Rep.of
J Magnússon	Iceland
W D McKone	Canada
J Møller Jensen	Denmark
C J Rørvik	Norway
V Ryjov	USSR
H Schulz	Germany, Fed.Rep.of
A Schumacher	Germany, Fed.Rep.of
O M Smedstad	Norway
B Vaske (Chairman)	German Democratic Republic

V Nikolaev attended the meeting as the ICES Statistician.

1.2 Terms of Reference

At the 67th Statutory Meeting in 1979 it was decided (C.Res.1979/2:10) that:

"the Working Group on Redfish in Region 1 and the Working Group on Greenland Halibut in Region 1 should merge into one Working Group on Redfish and Greenland Halibut in Region 1 under the chairmanship of Mr B Vaske. It should meet at ICES headquarters 18-25 March 1980 to:

(1) assess TACs for 1981 for redfish and Greenland halibut,

(2) estimate effective mesh sizes in use for redfish,

(3) consider the scientific feasibility of producing assessments for redfish and Greenland halibut on a total stock basis in the Iceland-Greenland-Davis Strait area".

2. REDFISH IN THE NORTH-EAST ARCTIC REGION (Sub-areas I and II)

2.1 Status of the Fisheries

A further reduction in total redfish catches in the North-East Arctic region was recorded in 1979 (Table 1). The preliminary catch figures in 1979 were 110 623 tonnes compared to 125 352 tonnes in 1978. This was 46 377 tonnes lower than the recommended total TAC of 157 000 tonnes.

The total catch in Sub-area I decreased from 4 902 tonnes in 1978 to 2 953 tonnes in 1979 (Table 2).

As in the previous year a reduction of catch was observed in Division IIa from 72 209 tonnes in 1978 to 62 440 tonnes in 1979 (Table 3).

In Division IIb, the total catch in 1979 was 44 795 tonnes in comparison with 48 241 tonnes in 1978 (Table 4). Redfish catches were split into Sebastes mentella and Sebastes marinus on the same area basis as used in last year's report. All redfish landings from Division IIb, together with the USSR, German Democratic Republic and Polish catches from the northern

part of Division IIa (Kopytov area), are recorded as S. mentella. The total landings in Sub-area I, with the exception of 20% of the USSR catches, together with the rest of the German Democratic Republic, USSR and Polish catches from Division IIa and all catches by other countries from this area, are assumed to be S. marinus (Table 5).

Compared with 1978, the total landings in 1979 of S. mentella decreased from 92 911 tonnes to 85 182 tonnes, and S. marinus decreased from 32 441 to 25 441 tonnes.

2.2 Catch per Unit Effort and Effort

Catch figures per hour trawling were available from the USSR for the S. mentella fishery for 1965-79 (Table 6). A steady decrease is observed in the USSR catch per unit effort data since 1976, when the highest value was recorded for the period.

Using these catch per unit effort values from the USSR fishery as a standard, the effort for the total fishery decreased from 1976 to 1978, but from 1978 to 1979 effort increased by 3%.

2.3 Recruitment (Table 7)

In the International 0-Group Survey which began in 1965, only two year classes have been estimated as very poor, namely the 1967 and 1968 year classes. The 1965, 1971 and 1972 year classes were somewhat below average, while the 1966, 1969 and 1970 year classes were of average abundance. All the seven most recent year classes were above average, and most of them were strong. The 1979 year class is the most abundant year class observed at the Survey. The index of 1979 is 980 while that of 1977, which is second, is 472. The index appears high compared to the rest of the time series.

The Group noted that the 1979 Survey was carried out in the usual way.

2.4 Age and Length Compositions

For 1979, age and length composition data and age/length keys were available from the Federal Republic of Germany for S. marinus in Division IIa. In addition, Soviet length compositions were available from Sub-area I and Division IIa. Total age composition was calculated by applying the Federal Republic of Germany age composition for Division IIa to the total catch of all countries except USSR. The 1979 USSR length distributions were converted by means of the 1979 Federal Republic of Germany age/length key, which did not contain fish between 20 and 30 cm, and therefore an age/length key from 1975 was used for this age range.

The 1978 S. marinus and S. mentella age distributions were adjusted to the revised catches, and for years prior to 1978, the age distributions from the last year assessment were used. Input age composition data for S. marinus are given in Table 8.

The 1979 S. mentella age compositions as number landed were available from the German Democratic Republic for Sub-area II and the USSR fishery in Division IIa.

For the USSR catches in Division IIb, a biased age composition as a result of a small sample size together with a representative length distribution were presented. The length distributions covered a greater range of age groups which were not evident in the age composition. Thus the Division IIb S. mentella USSR length distribution was converted to age by applying a 1979 Federal Republic of Germany age/length key.

The total age compositions for S. mentella for the German Democratic Republic and the USSR were summed and then raised to total landings in 1979 (Table 13).

2.5 Mean Weight at Age

Weight per age data for S. marinus older than 11 years were available from the German Democratic Republic for 1978 and the Federal Republic of Germany for 1979. The two weight tables were weighted by numbers in the samples and then combined. The new average weights per age were higher for fish between 12 and 23 years (Table 12). Calculating the sum of products, the new weight table fitted well for the catches in 1978 and 1979, while the old table was used for the years prior to 1978.

2.6 Assessments (Sebastes marinus)

2.6.1 Parameters used

Since there were no data on which the terminal Fs could be estimated, a preliminary VPA run was carried out using the same F at age array as in the previous assessment. Further, an attempt to estimate F from catch curves for the years 1974, 1978, and 1979 having age/length keys was carried out. For 1974, the catch curve gave Z = 0.22 (r^2 = 0.91), in 1978 Z = 0.32 (r^2 = 0.95), in 1979 Z = 0.19 (r^2 = 0.87) and a catch curve for the average of these three years gave Z = 0.23. Fishing mortality F = 0.13 was thus estimated using the 3 year average Z and M = 0.10. To better represent mortality across the ages an average F = 0.13 was used for age groups 13 to 24. From the VPA mortalities at age it was determined that redfish were fully recruited at age 16. Thus it was necessary to put in a terminal F = 0.15 to achieve an average F = 0.13 for age groups older than 13 years. As there were no data for year classes younger than 13 years old, the completion of the exploitation pattern was determined by constructing a curve which fit the pattern for ages older than 13 years.

Natural mortality of 0.1 was used as in the previous assessments.

2.6.2 Stock size

Estimates of stock size in numbers for S. marinus are given in Table 10. Total stock biomass (age 12 and older) and the spawning stock biomass (age group 15 and older) (Table 11) were estimated by using the average weight at age data given in Table 12 (see also 2.5). These assessments show that both the total stock and the spawning stock have decreased steadily since 1974, whereas in the preceding period, the stock biomass seems to have been relatively stable.

2.6.3 Fishing mortality

Estimates of fishing mortalities from VPA are given in Table 9. Average fishing mortality at age 13 to 24 in the period 1965 to 1973 fluctuated around the average value of 0.045 following the trend in catches. Since 1974, when catches increased considerably over the previous level, mean weighted F increased to 0.132 for the 1974-78 period.

2.6.4 Yield per recruit

A new yield per recruit curve was calculated using the data for catch predictions given in Table 12. F_{max} derived from the curve is 0.23 and $F_{0.1}$ = 0.1 (Figure 1).

2.6.5 Catch predictions

Catches for 1981 and both total stock biomass and spawning stock biomass for 1982 have been calculated for different levels of F in 1981 (Figure 2). These calculations are based on the assumption that the

1980 TAC for S. marinus of 19 000 tonnes will be taken. This catch level is generating a fishing mortality of 0.115 in 1980.

Parameters used for the catch predictions are given in Table 12. Recruitment at age 12 used in VPA was taken as the average over the years 1965-76 for the years 1980, 1981 and 1982. The results of the calculations are given in Figure 2 and the following text table for the management options suggested by the ACFM.

1980					1981				1982	
Stock biom.	Spawning stock biom.	F	Catch	Management option for 1981	Stock biom.	Spawning stock biomass	F	Catch	Stock biom.	Spawning stock biomass
210	146	.115	19	$F_{0.1}$	216	148	.10	16	227	136
				F_{max}			.23	36	207	120
				$F_{1981} = F_{1980}$			.115	19	224	134
				$F_{1981}=F_{1979}$			.15	24	219	130
				$F_{1981}=F_{1980}$ recommended by ACFM			.145			

Weights in thousand tonnes.

Under Option 1, which means fishing at the $F_{0.1}$ level, total biomass will increase above the 1980 level by about 8% while the spawning stock decreases by 6%.

Fishing at F_{max} (Option 2) would keep the total stock biomass at the 1980 level, but the spawning stock biomass would be reduced by about 18%.

Option 3 (i.e., using the same F as in 1980) provides a possible catch of 19 000 tonnes in 1981, which is the same as the recommended TAC for 1980. Under this option, the total stock biomass increases by 7% while the spawning stock biomass decreases by 8%, compared to 1980.

Under Option 4, which means fishing at the 1979 level, and the recommended F of 1980, total stock biomass increases from the 1980 level by about 4%, while the spawning stock biomass is reduced by 11%.

2.7 Assessments (Sebastes mentella)

2.7.1 Parameters used

The terminal fishing mortality was calculated iteratively from a regression between estimated mean F values for age groups 13-21 from preliminary VPA runs and the total trawl effort in USSR units for the period 1965 to 1976 (Figure 3). The best fit from this procedure gives a terminal fishing mortality of F = 0.28 for the age groups

12-24 in 1979. (Results from the preliminary VPA runs indicate that under the present exploitation pattern, the age groups 12 and older are fully recruited.)

The fishing mortalities for the age groups 7 to 11 were set close to the average exploitation pattern in the period 1975-78.

The stock size and the corresponding F at age 6 in 1979 was derived from a relationship between the estimated year class strength from VPA at age 6 and the corresponding 0-group survey abundance indices (Figure 4).

Natural mortality of 0.1 was used as in the previous assessment.

2.7.2 Stock size

Estimates of stock size in numbers from VPA are given in Table 15. In addition, the total stock biomass (age 6 and older) and the spawning stock biomass (age 15 and older) were calculated using mean weights at age given in Table 17. The results summarised in Table 16 show that both the total stock biomass and the spawning stock biomass increased considerably during the period 1965-75. However, since 1975 the spawning stock biomass has declined steadily. The assessment indicates that the spawning stock size decreased further from 1978 to 1979 by 9%.

A similar declining trend in the total stock biomass was observed until 1977; however, according to the result of the assessment the total stock size has remained fairly stable in the period 1977-79.

2.7.3 Fishing mortality

Estimates of fishing mortalities from VPA are given in Table 14. The average weighted fishing mortality for the age group 13-21 was low in the period 1965 to 1974 and fluctuated around an average value of 0.10. Since 1975, the exploitation shifted towards younger ages and in addition, the total level of fishing mortality increased considerably in the period 1975-77 to an average of 0.55. Following the trend in the total effort the estimated average fishing mortality for the years 1978 and 1979 decreased to a level of around 0.28.

2.7.4 Yield and spawning stock per recruit

In Figure 5 yield per recruit and spawning stock biomass per recruit curves are plotted against the F values on age groups subject to maximum exploitation. The curves were calculated for the 1979 exploitation pattern and the average weights at age as given in Table 17. For the present exploitation pattern, the $F_{0.1}$ and F_{max} values are 0.12 and 0.23, respectively. As a result, the 1979 fishing mortality is somewhat above F_{max}.

For $F_{0.1}$ and F_{max}, the corresponding sustainable yield and equilibrium spawning stock biomass were calculated using the average recruitment level at age 6 for the period 1965-66. The results are given in the text table below.

R_6	F	Y/R	Sustainable yield (tonnes x 10^{-3})	S/R	Spawning stock biomass (tonnes x 10^{-3})
384 x 10^6	.12	.227	87	.940	361
	.23	.242	93	.323	124

2.7.5 Catch predictions

Catch predictions were made for 1981 using the exploitation pattern and the mean weight at age data given in Table 17. The stock size at the beginning of 1980 is estimated from the stock size and fishing mortalities in 1979.

Furthermore, it was assumed that the recommended TAC of 81 000 tonnes will be taken in 1980. This catch level in 1980 would be achieved by a fishing mortality on age groups subject to a maximum exploitation of F = 0.23, which is higher than F = 0.15, estimated in last year's report (Doc. C.M.1979/G:25) for this catch level.

Recruitment of 6 year old redfish for 1980-82 is calculated on the basis of 0-group survey abundance indices estimated at 555 x 10^6 in 1980, 537 x 10^6 in 1981 and 553 x 10^6 in 1982.

The results of the catch prediction, Figure 6, show the possible catch in 1981 plotted against the fishing mortality rate expressed as a proportion of that estimated for the year 1979. The resulting spawning stock biomass (fish at age 15 and older) and total stock biomass (fish at age 6 and older) at the beginning of 1982 are also included in Figure 6.

Furthermore, the following options of fishing mortality were selected as reference points:

Option 1: Fishing at $F_{0.1}$ in 1981

Option 2: Fishing at F_{max} in 1981 which is equal to the level of F required to take the TAC of 81 000 tonnes in 1980

Option 3: Fishing at the 1979 F level

Option 4: Fishing at the F level as recommended by the ACFM for 1980.

The results are summarised in the text table below.

1980					1981				1982	
Stock biom.	Spawning stock biomass	F	Catch	Management option for 1981	Stock biom.	Spawning stock biomass	F	Catch	Stock biom.	Spawning stock biomass
667	62	.23	81	$F_{0.1}$	713	73	.12	48	802	88
				$F_{max}=F_{1980}$			.23	89	757	79
				$F_{1981}=F_{1979}$			.28	106	738	75
				$F_{1981}=F_{1980}$ recommended by ACFM			.15	60	789	85

Stock biomass = fish at age 6 to 24

Spawning stock biomass = fish at age 15 to 24

Weights in thousand tonnes

Option 1 would require a considerable reduction of the catch in 1981 to 48 000 tonnes. The total stock biomass and the spawning stock biomass would increase from 1981 to 1982 under this option by 12% and 21%, respectively. Option 2 provides a possible catch of 89 000 tonnes in 1981. Under this option, both the stock biomass and the spawning stock biomass should increase slightly by 1982. Under Option 3, which projects a catch of 106 000 tonnes in 1981, the total stock biomass and the spawning stock biomass in 1982 will be kept relatively close to the 1981 level. Option 4 provides a possible catch of 60 000 tonnes in 1981. The total stock biomass and the spawning stock biomass in this case would increase in 1982 by 11% and 16%, respectively.

3. REDFISH IN SUB-AREAS V AND XIV

3.1 Status of the Fisheries (Tables 18-21)

The total catch from the Irminger Sea redfish stock complex increased from 65 888 tonnes in 1978 to about 100 000 tonnes in 1979, i.e., about 52%.

The catch increased in all three areas (i.e., Divisions Va and Vb, Sub-area XIV), particularly in Divisions Va and Vb. In Division Va (Iceland) the Icelandic fleet increased their effort in 1979 and the catch increased from 33 318 tonnes in 1978 to about 63 000 tonnes in 1979. Only about 2 000 tonnes were taken by other nations.

The Icelandic trawler fleet has changed their fishing pattern since 1977. In the years 1978 and 1979 a great part of the fishery took place in the area SW of Iceland. The areas W and NW of Iceland, which were the main fishing grounds in previous years for the Icelandic fleet, still remain important.

In Division Vb the catches increased from 9 806 tonnes in 1978 to about 14 000 tonnes in 1979, which is by far the highest catch figures on record for this Division. The Federal Republic of Germany fleet increased its catch from 7 767 tonnes in 1978 to about 8 400 tonnes in 1979, however, the main increase in catch was from the Faroe Islands fishery, which caught 1 525 tonnes in 1978 and 5 700 tonnes in 1979.

In Sub-area XIV (East Greenland) the total catch increased slightly from 20 880 tonnes in 1978 to about 21 100 tonnes in 1979 with these catches almost completely taken by the Federal Republic of Germany fleet.

3.2 Recruitment of Redfish in the Irminger Sea Area

The 0-group surveys in the past years have not covered the total area of distribution of redfish fry, as pointed out in the Redfish Working Group Reports. They indicate, however, a great variation in the number of fry found. Additionally, the unusual distribution of 0-group redfish found in 1979 was complicated by the late timing of the survey which was carried out 2-3 weeks later than usual. In a large part of the central Irminger Sea they were not found in the samples, and in most other areas only few 0-group redfish were found. 0-group redfish were reasonably abundant in a narrow belt along the East Greenland coast, but nowhere observed in such densities as known from all previous years.

It was obvious by the beginning of September that a substantial part of the 0-group redfish had left the plankton stage as verified by the fact that several demersal species caught with bottom trawl along the East Greenland coast were feeding heavily on 0-group redfish in some localities. The index figure calculated for 0-group redfish in 1979 is, therefore, not comparable to those of other years.

The year-to-year fluctuations in the abundance of 0-group redfish are presented in the following text table as index figure of individuals per nautical square mile.

Number of 0-group redfish x 10^6 per nautical square mile

Year class	No. of fish
1970	8.6
1971	12.6
1972	31.1
1973	74.0
1974	23.6
1975	12.6
1976	5.8
1977	13.0
1978	6.5
1979	1.3

For the first time an attempt was made to separate redfish fry in the Irminger Sea and off East Greenland into species (Method: Magnusson, 1979). According to this distinction Sebastes marinus amounted to 38.7% of the total.

3.3 Splitting of Catches into S. marinus and S. mentella Components

In Division Vb all the Federal Republic of Germany catches were S. mentella according to Federal Republic of Germany observations on the landed catches. Of the Faroe Islands catch 85% was allocated to S. marinus and 15% to S. mentella in accordance with information from Thorshavn. This splitting was confirmed by limited observation on Faroe Islands catches landed in the Federal Republic of Germany.

In Division Va the total catch was split on the area and depth basis by the same method as referred to in the 1979 Redfish Working Group Report (C.M.1979/G:25). According to this splitting, 13.7% were S. mentella and 86.3% S. marinus.

In Sub-area XIV the Federal Republic of Germany observations on landed catches were used for splitting the 1979 catches into S. marinus and S. mentella. Thus 75.08% were allocated to S. marinus and 24.92% to S. mentella in Sub-area XIV.

The total catch of Sebastes marinus and Sebastes mentella was estimated to be 76 865 tonnes and 23 397 tonnes, respectively (Table 21).

3.4 Length and Age Compositions: S. marinus and S. mentella

Division Va: Length frequencies from the Icelandic catches in 1979 were available for both species and were used to calculate the length distribution of the total catches of each species in Division Va.

Division Vb: Data on length composition of the 1979 catches from the Federal Republic of Germany were available for both species and were used to calculate the length distribution of the total catch of each species in this Division.

Sub-area XIV: Data on length compositions of the 1979 catches from the Federal Republic of Germany were available for both species and were used to calculate length distributions of the total catch.

Age/length keys for both S. marinus and S. mentella in Sub-area XIV and Division Vb from sampling of the fishery of the Federal Republic of Germany and age/length data from the Federal Republic of Germany research vessel catches for S. mentella in Division Va were made available to the Working Group. A combined 1979 age/length key from Sub-area XIV and Division Va was used to calculate the numbers at age for S. mentella in Division Va. For the fishery on S. marinus in Division Va, since there was no key available, the age/length key from Sub-area XIV was used to calculate the numbers at age. For Sub-area XIV and Division Vb, the respective 1979 age/length keys were used to calculate the numbers at age for S. marinus and S. mentella. The summed age compositions to the total catches in Sub-areas V and XIV are given in Table 27 for Sebastes mentella and Table 22 for Sebastes marinus.

3.5 Mean Weight at Age

The nominal catch weight of S. mentella and S. marinus for Sub-areas V and XIV combined was compared to the catch weight from average weight at age keys for each species. The estimated total biomass caught in 1979 for S. mentella using the key was higher than the 1979 nominal catch. The difference being insignificant no adjustment was made to the numbers at age.

For S. marinus there was a fairly large difference in the estimated total weight caught as calculated from the key and the reported nominal weight caught (see text table below).

Year	Nominal weight	Estimated weight from key	%
1973	41 818	44 773	6.6
1974	49 845	52 019	4.2
1975	60 980	61 773	1.3
1976	93 605	105 729	11.5
1977	52 752	55 709	5.3
1978	47 791	49 939	4.3
1979	76 865	89 887	14.5

To establish whether the discrepancy was a trend and thus indicating a change in growth rate, the nominal weight caught for 1973-79 was compared to the estimated weight from the key. No trend was indicated and the percent difference varied from 1.3 to 14.5 over the years. An attempt was made to correct for this error in 1979 by applying a new age/weight key derived from 1979 Icelandic research length/weight relationship and Federal Republic of Germany age/length key from

East Greenland. The new key was similar to that used in the past, thus little was gained in correcting the error by using the new age/weight key. Therefore, the Working Group decided to use the previous weight at age data for the assessments and catch predictions, since the possibility cannot be excluded that the discrepancy in 1979 could be attributed to sampling errors rather than to a change in growth.

3.6 Assessments

As in previous years, no data were available on effort, catch per unit of effort and survey results, which could give fishing mortality estimates for 1979. Therefore, only qualitative information on changes in fishing effort and area distribution could be considered and evaluated against earlier situations.

3.6.1 Sebastes marinus

3.6.1.1 VPA

Total catch of S. marinus increased by 61% in 1979 compared to 1978. This increase took place mainly off Iceland but also off the Faroe Islands, where a new fishery on redfish has been developed.

The remarkable increase in catch in 1979 appears to have been associated with a considerable increase in effort directed towards S. marinus generating fishing mortality in 1979 considerably above the level estimated for 1978.

Since the 1979 catch level of 76 000 tonnes is comparable to that of the 1967-70 period when the average catch was 74 000 tonnes, the average F on age groups 21 to 28 of the earlier period of F = 0.5 was used as an estimate of the 1979 fishing mortality on older ages. The catch in number in the 1967-70 period, however, was about 20% below the 1979 level, indicating that fishing mortality derived from the earlier years might be an underestimate of the true F in 1979.

The exploitation pattern used in previous assessments was derived from a cohort analysis using average length data over several years in which the high catches of small redfish taken in 1976 by the USSR fleet have been included. Since the length composition of the catches has now reverted to the pre-1976 pattern, the exploitation pattern for the present assessment had to be revised. This was done on the basis of the relative fishing mortality per age group in 1975. In Figure 7 the relative Fs are plotted for each age group and the new exploitation pattern was derived by connecting the highest values by a line from which the intermediate values were taken. The points below the line have been ignored having in mind that the fluctuations in F for the age group could be interpreted as the effect of the standard age/length key in this year. A similar exercise was made on average data for 1973 to 1975 with almost identical results. For comparison, the previous exploitation pattern for S.marinus was included in Figure 7.

The input data for the VPA are given in Table 22, the detailed results are given in Tables 23 and 24 and summarised in Figure 8 and Table 25. Trends in fishing mortality and stock size did not change markedly from the results of the previous assessment, only the fluctuations in estimated total biomass were reduced due to the application of the new exploitation pattern.

3.6.1.2 Yield per recruit (Figure 9)

A new yield per recruit curve has been calculated, using the new exploitation pattern. The curve has no maximum within the normal range

of fishing mortalities and, therefore, for consideration of management strategies F_{max} was substituted by that F at which the curve approaches the top level of the curve (F = 0.35), $F_{0.1}$ is 0.18.

3.6.1.3 Catch predictions

The basic data used in the catch predictions are given in Table 26. The new exploitation pattern was applied, since the fleets engaged in the fishery for S. marinus are expected to maintain their relatively stable fishing pattern; no changes were made in the average weight per age figures.

Average recruitment of 9 year old fish over the years 1967 to 1975 was used for the years 1979 to 1982.

The total catch in 1980 of Sebastes marinus from the Irminger Sea stock complex was assumed to be in the same order of magnitude as in 1979, possibly slightly higher. In the absence of management measures for 1980 limiting the catches in Sub-areas V and XIV, it is to be expected that the increasing trend in effort observed in 1979 will continue. On this basis a catch figure of 80 000 tonnes in 1980, associated with an F of 0.467, was applied in the catch predictions.

The results of the calculations are given in Figure 10, and in the following text table with reference to the management options suggested by ACFM.

1980					1981				1982	
Stock biom.	Spawning stock biomass	F	Catch	Management option for 1981	Stock biom.	Spawning stock biomass	F	Catch	Stock biom.	Spawning stock biomass
795	381	.467	80.0	$F_{0.1}$	782	352	.18	32.5	821	354
				F_{max}=top level			.35	60.0	792	330
				$F_{1981}=F_{1980}$			.467	78.0	773	314
				$F_{1981}=F_{1979}$			.50	86.0	768	310
				$F_{1981}=F_{1980}$ 1) recommended by ACFM			.075	14.0	840	371

1) Based on $F_{0.1}$ from old exploitation pattern.

Stock biomass = fish at age 9 to 30+

Spawning stock biomass = fish at age 16 to 30+

Weights in thousand tonnes

Under the assumption made for the 1980 catch the total stock biomass in 1980 and 1981 is expected to decrease slightly below the 1969-71 level of 80 000 tonnes, but, this should at present not be interpreted as a start of a downward trend since the reduction in total recruited biomass is relatively small and within the range of past fluctuations. If, however, no management action will be taken or a decision which

would imply the maintenance of the present high level of fishing mortality then a continuation of the declining trend in total recruited biomass as well as in spawning stock biomass is to be expected.

3.6.2 Sebastes mentella

3.6.2.1 VPA

The development of the fishery in 1979 as described in Section 3.1 and the separation of catches into the two species (see Section 3.3) indicate that the increased effort was mainly directed to S. marinus, and that the slight increase in the catch of S. mentella may be considered as by-catch. A preliminary VPA run, using the same fishing mortality for 1979 as in last year's assessment for 1978 was accepted by the Working Group. In the light of the very small 1978 catch the small reduction in F for 1978 in this run was in agreement with the opinion expressed during the discussions that in last year's assessment the terminal F has been overestimated. Therefore, fishing mortality of 0.4 was used for 1979.

The Working Group also considered possible changes in the pattern of exploitation and followed the same approach applied to S.marinus. Since the result of this exercise did not indicate the necessity for a change, the relative Fs to be used in the VPA and in catch predictions have not been changed.

The input data for the VPA are given in Table 27, and the results are given in detail in Tables 28 and 29 and are summarised in Figure 11 and Table 30.

The results are not very different from the previous assessment. The downward trend in total recruited biomass did continue in 1979, but the absolute figures of total biomass are somewhat higher compared to the previous assessment.

The estimated spawning stock biomass for 1979 indicates that the steady decline since 1967 did not continue in 1979. However, at present, this value is very much dependent on the estimated fishing mortality for 1979, and it would be premature at present to consider this as a termination of the trend.

3.6.2.2 Yield per recruit

Since no changes have been made in the exploitation pattern and the weight at age data, the yield per recruit curve from the previous assessment is still valid (Figure 12).

3.6.2.3 Catch predictions

The basic data used in the catch predictions are given in Table 31. Average recruitment at age 9 over the years 1967-75 of 86 million fish derived from the VPA run was applied for the years 1978-82.

Since it cannot be expected that the total catch of S. mentella in 1980 will be limited by fisheries regulations, and considering the possibility that effort on redfish may increase, a catch of 25 000 tonnes in 1980 was assumed which is slightly above the 1979 level.

The results of the calculations are given in Figure 13 and the predictions on catch for 1981 and the stock biomass in 1982 for the options suggested by the ACFM are given in the text table below.

1980				Management option for 1981	1981				1982	
Stock biom.	Spawning stock biomass	F	Catch		Stock biom.	Spawning stock biomass	F	Catch	Stock biom.	Spawning stock biomass
271	130	.407	25.0	$F_{0.1}$	271	142	.35	22.0	273	140
				F_{max}=top level			.50	30.4	265	132
				$F_{1981}=F_{1980}$			.407	25.2	270	137
				$F_{1981}=F_{1979}$			.40	25.0	270	137
				$F_{1981}=F_{1980}$ recommended by ACFM			.15	10.0	287	150

Stock biomass = fish at age 9 to 28+

Spawning stock biomass = fish at age 16 to 28+

Weights in thousand tonnes

Under all options the spawning stock biomass as well as the total stock biomass are expected to increase over the 1977-79 level. However, a direct comparison between the absolute figures in the text table with figures in Table 30 is somewhat biased since the former contain an estimated average recruitment for 4 years.

In considering the management options in the table above, it should be noted that the options associated with $F_{0.1}$ and F levels lower than $F_{0.1}$ maintain or even increase both the spawning stock biomass and the total stock biomass above the level estimated for 1981.

4. GREENLAND HALIBUT IN SUB-AREAS I AND II

4.1 Status of the Fisheries

The total nominal catches for the main fishing areas are included in Table 32 for 1969-79 and nominal catches by country for each area given in Tables 33, 34 and 35. In Table 36, the catches are summarised for Sub-areas I and II.

The catch from this stock reached a maximum in 1970 of 89 484 tonnes. From 1971 to 1973 the landings declined steadily to 29 938 t in 1973,but appeared to stabilise from 1974 to 1976 between 36 074 and 38 172 tonnes. From 1976, catch levels once again declined to 17 215 tonnes in 1979, the lowest catch level recorded in the last 12 years.

4.2 Catch per Unit Effort and Effort

Catch per hour trawling data were available from the USSR fishery from the period 1965-79 (Table 37).

Catch per day trawling was also calculated for the German Democratic Republic freezing trawlers for the period 1973-79. These catch data refer to the catch rate in Division IIb in October. The effort

The effort refers to the total effort exerted on all species; however, the monthly catches were dominated by Greenland halibut (Table 37).

From these cpue data, the total effort was calculated (Table 37). The cpue data for 1979 show some increase compared to 1978. The total effort exerted in 1979 was 36% lower than in 1978, using the USSR cpue data and 32% lower using the cpue data from the German Democratic Republic trawlers.

4.3 Virtual Population Analysis (VPA)

4.3.1 Age composition of landings

The age compositions for 1977 and 1978 were adjusted according to changes in the revised catch statistics. For 1979, age compositions were available for the trawl catches of the German Democratic Republic, Norway and USSR. These were raised to the total landings of the trawl fishery for each country independently.

Furthermore, age compositions for the Norwegian long-line and gill-net fishery were presented. All age compositions available for 1979 represent 96% of the total landings in Sub-areas I and II. The total age compositions for 1970-79 are given in Table 38.

4.3.2 Mean weight at age

The sum of products, using the mean weights from last year's report (Doc. C.M.1979/G:8, Table 12), and the age composition for 1970-79 (Table 38) were calculated. The sum of products divided by the observed catch becomes an average mean weight correction factor (Table 39). The weight correction factor shows no definite trend in the years 1970-78, varying between .923 in 1973 to 1.063 in 1978. In 1979, however, the earlier mean weights used have to be increased by 35.9% on the average in order that the calculated age distribution can account for the observed total catch.

The Group decided to use the old mean weight at age data for the period 1970-78, since weight corrections were considered to be sufficiently close to 1.

For 1979, however, the mean weights data were updated. Figure 14 shows the mean weight at age in the USSR fishery in 1979 (males and females combined). A curve was fitted to these data by eye, and new mean weights (to the nearest 100 g) were estimated. For comparison, the mean weights used for 1970-78 are also plotted in Figure 14.

The two sets of mean weight at age are given in Table 40.

The weight correction factor for 1979, using these weight at age data, is 1.017, which is sufficiently close to 1.

It was deciced to use the same set of mean weights in the prognosis for 1980-82 as used for 1979.

4.3.3 Estimation of the input fishing mortalities for 1979

As in last year's report (Doc. C.M.1979/G:8), the fishing mortalities on the oldest age group (16) in 1970-77 were set equal or close to the unweighted average fishing mortality on 8 to 13 year old fish in the same year. As in previous reports, a natural mortality of 0.15 was used.

The age groups are considered to be fully recruited from age 7. The fishing mortalities on the fully recruited age groups were taken to be 0.40 after some trials. Figures 15 and 16 show the corresponding values of the average unweighted fishing mortality on age groups 7 to 11 and the total effort in USSR units and German Democratic Republic units, respectively.

The USSR trawling effort seems to have been more efficient after 1975, that is, the same effort generates higher fishing mortalities compared with previous years (Figure 15). Such a change of efficiency is not discovered in the German Democratic Republic's measurements (Figure 16).

A line has been drawn through the origin and the average for 1975-78 in the case shown in Figure 15, and 1973-78 in the case shown in Figure 16. It appears that the chosen fishing mortality of 0.40 on 7 years and older fish in 1979 falls close to the fitted lines.

In the case of the fishing mortalities on the 3 and 4 year olds in 1979, $F_3 = 0.003$ and $F_4 = 0.035$ were chosen; the rationale being that these fishing mortalities gave an abundance of the 3 and 4 year olds at the beginning of 1979 close to the average for 1970-75 of 31 and 28 million, respectively.

The number of 5 and 6 year olds in 1979 comprised 46% of the catch compared with 33% in 1978 and 28% in 1977. There were some doubts as to whether this reflected a changed fishing pattern because of less older fish or an increased abundance of the age groups compared with the preceding years.

Although the 0-group indices for Greenland halibut (Table 41) have not been shown to reflect the strength of the incoming year classes, the increased indices of the 1974 year class compared with previous year classes might be an indication of increased recruitment.

The Working Group decided to select the fishing mortality on the 5 and 6 year olds so that the abundance of these age groups at the beginning of 1979 were close to the averages for the period 1972-76.

The estimated fishing mortalities and the stock by numbers are given in Tables 42 and 43.

The fishing pattern for 1979 is drawn in Figure 17, together with the average fishing patterns for 1972-75 and 1976-78.

The relations between the biomass of 4 year and older fish and the catch per unit effort are shown in Figures 18 and 19 for USSR and German Democratic Republic trawlers respectively. For reasons discussed above, only the years 1975-79 are considered in case of the USSR cpue data. The estimated stock size in 1979 is 98 000 tonnes applying the new mean weights (Table 40). This value for 1979 is somewhat above the fitted lines in Figures 18 and 19. If, however, the old weights were used, the stock biomass would be 69 000 tonnes, or somewhat below the fitted lines.

The input fishing mortalities on fish at age 7 and older also seem reasonable, judged from Figure 20 where the estimated biomass of 7 years and older fish is plotted versus the catch of the same age groups per unit effort by the German Democratic Republic trawlers. The latter figures are arrived at by calculating the proportion of 7 years and older fish (by weight) in the German Democratic Republic catches. These proportions were:

1973	1974	1975	1976	1977	1978	1979
0.99	0.96	0.93	0.91	0.82	0.87	0.47

These proportions were then multiplied by the cpue data of the same fleet (Table 37) year by year.

4.4 Yield and Spawning Stock per Recruit

The yield and spawning stock per recruit were calculated for the 1979 exploitation pattern (Figure 21, Table 44).

For the present exploitation pattern, the $F_{0.1} = 0.14$ and $F_{max} = 0.28$. This is somewhat above the corresponding values of 0.12 and 0.20 estimated in last year's report. The difference is caused by the increased new mean weights at age, in particular on the younger age groups (Figure 14), as well as the new fishing pattern (Figure 17).

The fishing mortality in 1979 of 0.40 is above the F_{max} level. For the 1979 fishing mortality, $F_{0.1}$ and F_{max}, the corresponding sustainable yield and equilibrium spawning stock biomass were calculated assuming an average recruitment equal to the average numbers of 3 year olds in 1970-74 of $R_{1970-1975} = 31.6 \times 10^6$. (See text table below.)

F	Y/R (kg)	Sustainable yield (tonnes)	S/R (kg)	Spawning stock biomass (tonnes)
$F_{79} = 0.40$	0.76	24 000	0.90	28 400
$F_{max} = 0.28$	0.77	24 300	1.65	52 100
$F_{0.1} = 0.14$	0.72	22 800	4.00	126 000

For comparison, the TAC for 1980 has been set at 14 000 tonnes, and the spawning stock (9 years and older) at the beginning of 1980 is 14 400 tonnes.

4.5 Catch Predictions and the State of the Stock

The stock was projected to 1982 assuming that the TAC of 14 000 tonnes in 1980 will be taken. The average recruitment for 1970-74 of 31.6×10^6 fish at age 3 was used for 1980 and 1981. The stock size in 1980 and the parameters used in catch predictions are given in Table 44. Four management options for 1981 were considered:

Option 1: Fishing at the $F_{0.1}$ level ($F_{1981} = 0.14$)

Option 2: Fishing at the F_{max} level ($F_{1981} = 0.28$)

Option 3: Fishing at the expected 1980 level ($F_{1981} = 0.26$)

Option 4: Fishing at the 1979 level ($F_{1981} = 0.40$).

For the catch in 1981 for these options, the resulting total stock (4 years and older) and the spawning stock (9 years and older) in 1982 are given in the text table below. Figure 22 shows the same parameters as a function of the fishing level in 1981 relative to the 1979 level.

1980				Management option for 1981	1981				1982	
Stock biom.	Spawning stock biomass	F	Catch		Stock biom.	Spawning stock biomass	F	Catch	Stock biom.	Spawning stock biomass
105	14	0.26	14	$F_{0.1}$	117	19	0.14	9 100	134	33
				F_{max}			0.28	17 300	125	29
				$F_{1981} = F_{1980}$			0.26	16 300	126	29
				$F_{1981} = F_{1979}$			0.40	23 600	117	26

Stock biomass = fish at age 4 to 16

Spawning stock biomass = fish at age 9 to 16

Weights in thousand tonnes

Figure 23 shows the estimated stock size and the spawning stock from 1970 to 1981. The estimated total stock decreased from 302 000 tonnes in 1970 to 105 000 in 1980. If the cpue data from the USSR trawl fishery (Table 37) are proportional to the total stock biomass in the period 1965-70, then the stock in 1965 was 1.51 times larger in 1965 than in 1970, or about 450 000 tonnes.

The present stock thus seems to be between 20% and 25% of what it was before heavy exploitation started in the middle of the 1960s.

The spawning stock in 1980 (14 400 tonnes) is 13% of what it was in 1970 (127 000 tonnes). Compared with the 1965 level the spawning stock has been essentially decimated, and is now less than 10% of the nearly unexploited level.

Some increase in the total stock and the spawning stock is expected in 1981 compared to 1979 and 1980 (Figure 23). A further increase in the spawning stock is expected in 1982 for all management options considered above. This is, however, to a large extent dependent on the strength of the 1973 and later year classes, of which little is known. Irrespective of the catch levels in 1981, but assuming that the 1979 fishing pattern prevails, about 50% of the spawning stock in 1982 will be comprised of the 1973 year class, if the present assessment of this year class as 6 year olds in 1979 is correct. The 1973 and 1974 year classes are expected to account for 50% of the catch in 1981.

However, despite the uncertainties it seems clear, that the present spawning stock is low and will be so in the next few years, and the possibility of recruitment failure due to a low spawning stock would appear to be real.

5. GREENLAND HALIBUT IN SUB-AREAS V AND XIV

The total nominal catch figures for Divisions Va and Vb and Sub-area XIV are presented in Tables 45 to 48 for 1969-79. Catches are presented for each fishing area by country.

In the period during 1968-75, total nominal catches for all areas combined ranged from 20 463 tonnes to 36 280 tonnes. In 1976, the catch

dropped to a low level of 6 045 tonnes but increased to 16 578 tonnes and 14 349 tonnes in 1977 and 1978, respectively. During 1979, catches increased to near the levels of the early 1970s at 23 327 tonnes. The Federal Republic of Germany catch during 1979 more than doubled from 1978 to 1979 and the Icelandic landings increased by 50%.

No new data were available at the time of the meeting, therefore the Working Group felt it was not in a position to provide any new scientific advice concerning this stock at this time.

6. ASSESSMENT OF EFFECTIVE MESH SIZE AND EFFECTS OF A CHANGE OF MESH SIZE IN THE REDFISH FISHERIES IN SUB-AREAS I AND II

Attached to this Working Group report as an Appendix there is a study on this problem done by Rørvik and Hylen prior to the meeting of the Working Group. For a brief description of the method used, it is referred to this Appendix, to Hoydal (Doc. C.M.1977/F:51) or to the Arctic Fisheries Working Group (Doc. C.M.1979/G:20). A detailed description of the method will be given by Hoydal, Rørvik and Sparre (in prep.).

Data from the period 1967-78 are used. It should be kept in mind that the assessment is of the average effective mesh sizes used in that period and not the current effective mesh size in use.

The data base seems poor for the present mesh assessment, particularly for Sebastes marinus. The available age composition from the total fishery was not suitable for an assessment because of its multi-modal shape. The length composition data were somewhat better, in particular for the USSR fishery on S. marinus.

For other countries, length compositions from the Federal Republic of Germany trawler landings were used. The large increase of the length frequency for these trawlers between 30 and 40 cm strongly indicates substantial discarding in this fishery. Data about the discarding practice, however, were not available and it makes the assessment of the effective mesh size in this fishery very uncertain and sensitive to the recruitment curve used. The recruitment curve was shifted towards higher length until an effective mesh size of 108 mm was achieved, which was close to findings by the Arctic Fisheries Working Group (C.M.1979/G:20). For the other estimates of effective mesh sizes, the findings by the Arctic Fisheries Working Group were not used as a facit.

For Sebastes mentella both age and length frequencies were used. The results in terms of the best estimate of effective mesh sizes and maximum (effective) mesh sizes were similar.

However, comparing the frequencies, it was found that the length compositions indicate that more smaller fish are taken than shown by the total age distribution. This indication of some inconsistency in the data base is, however, dependent on the assumption that the input parameters and the model are consistent.

A common problem for the whole assessment is the selective properties of the gear. These are expected to change with the size of the catches. As clogging of the net by fish ("meshing") increases, the effective mesh size decreases. These problems mean that the estimates of the effective mesh sizes should only be taken as indications, and they may in fact be quite different from the average real mesh sizes used in the period simulated. As described in the Appendix, when the effects of a mesh change are estimated, these uncertainties to some extent cross

out. This is also evident from the last figure in the Appendix, where the long-term effects of a mesh change in the S. mentella fishery are similar whether calculations are made on the basis of the age or the length distributions.

The shortcomings of the sub-model estimating the effects of the change of mesh size are similar to the yield per recruit model in that no changes of growth rate (as a function of stock size) is assumed to occur. A constant recruitment is also used.

In the discussions that followed the presentation of the paper, a number of points were expressed:

1. The paper has a lot of merit and its use of commercial data can only strengthen results collected from research data.
2. The findings for minimum and maximum mesh sizes are not inconsistent with results from the northwestern Atlantic.
3. Similar to recent findings in the northwestern Atlantic, there would be fairly large immediate losses, but in the long term slight gains might be realised by increasing the mesh size.
4. As redfish are known to be larger at greater depths, the fishermen would likely offset immediate losses by changing their fishing pattern if mesh size were increased. The Group felt that immediate losses would perhaps be overestimates of what would happen in the fishery.
5. There are presently regulations in Icelandic waters which prescribe greater meshes than those currently being used in Sub-areas I and II. From the length and age frequencies and discussions with fishermen, there appears to be less discarding of redfish and during the 3 years of larger mesh regulation being in force, the fishing industry has not indicated any losses.
6. Both in Icelandic waters and in certain regulated areas of the northwestern Atlantic mesh regulations larger than 125 mm indicate that the fishermen do not find it difficult to catch redfish.
7. Keeping in mind the problems associated with the data, the calculated effective mesh size was found to be about that found for cod and haddock by the Arctic Fisheries Working Group.
8. There might be problems with the age and length frequencies as a result of discards and variable recruitment. Thus, field surveys to estimate discards and frequencies over a greater number of years are needed to average recruitment.
9. Experiments at sea are necessary to better estimate selection ratios which could be biased mainly by gear type differences and by the rate at which the net encountered redfish.

In conclusion, the Working Group felt that the model required further work particularly on the data base, by improving the input parameters. The three assessments, however, indicate that there would be no substantial changes in the long-term yield of redfish if the effective mesh size were increased by up to 35 mm above the average effective mesh size used in the period 1967-78.

7. FEASIBILITY OF ASSESSING REDFISH AND GREENLAND HALIBUT OF EAST AND WEST GREENLAND AS A SINGLE UNIT

7.1 Redfish

The main spawning area for redfish in the Iceland/East Greenland region is in the Irminger Sea in an extensive area over the great oceanic depths, expanding from Reykjanes ridge and the area west off Iceland far to the southwest. Only very few newly spent redfish larvae are found along the banks of East Greenland and along the southernmost banks of West Greenland. Few mature Sebastes mentella have been observed in West Greenland waters, and no mature Sebastes marinus.

The redfish fry drift with the Irminger Current to the continental shelves of Iceland and East Greenland. Then they drift southward along the East Greenland coast and, to some extent, around Cape Farewell to West Greenland waters. Some of the redfish fry off West Greenland might originate from spawning areas south and southeast off Cape Farewell.

Tagging experiments were carried out in the Godthåb fjord in 1956-69; however, only 5% or 34 of the recaptures were caught outside the fjord. Of these 34, 24 were caught on the West Greenland banks, 7 on the East Greenland banks and 3 without information, only that they were caught at the Greenland banks.

Since there appears to be no substantial spawning of redfish off West Greenland, the redfish in this area must originate from spawning in other regions.

There is at least some connection between the Irminger Sea stock and the West Greenland stock as the drift of fry shows, although the magnitude of this recruitment to the West Greenland stock is not established. It is, however, uncertain as to what degree the spawning southwest off Iceland and that south of Cape Farewell are connected and to which of these two spawning areas the West Greenland redfish migrate for spawning.

In view of these uncertainties the Working Group is at the present time of the opinion that the West Greenland stock should not be included in the assessments for the Irminger Sea stock.

7.2 Greenland Halibut

The Greenland halibut off East Greenland , ICES Sub-area XIV, is presently assessed as part of the East Greenland-Icelandic stock, ICES Sub-areas XIV and V, under ICES. On the other hand, the Greenland halibut off West Greenland, NAFO Subarea 1, is presently being assessed as part of the West Greenland-Baffin Island stock, NAFO Subareas 0 and 1, by NAFO Scientific Council.

Greenland halibut of the Northwest Atlantic area is distributed from the northwest coast of Greenland as far south as the northern portion of the Grand Bank of Newfoundland (NAFO Division 3L). Canadian research vessel survey results (Bowering, 1979a) indicate that Greenland halibut in the Labrador-Northeast Newfoundland shelf region are mainly smaller immature fish. Smidt (1969) has shown, on the other hand, that Greenland halibut of the West Greenland fjords and Davis Strait region are commonly found in both mature and immature conditions with spawning occurring to the south of the Greenland-Canadian ridge in Davis Strait. Zilanov et al. (1976) and Bowering (1977) have both indicated that

there appears to be a northern migration of maturing fish from the Labrador-Newfoundland area into what is probably the same spawning area described by Smidt (1969) with larval drift moving down the Baffin coast and into Greenland waters. Large numbers of juveniles off the east coast of Baffin Island (Bowering, 1979b) would tend to support this idea.

Greenland halibut off the east coast of Greenland are generally distributed in the mid to the northern part of East Greenland, where they are usually found in fishable concentrations on the continental slope of northwest Iceland after spawning. According to Icelandic investigations (Sigurdsson, 1979), the Greenland halibut of this area move to the western part of the Icelandic continental slope to spawn and afterwards form a general northeast feeding migration off the north coast of Iceland. 0-group surveys have shown that some Greenland halibut juveniles are found south towards Cape Farewell but in very minor and incidental quantities in comparison to the more northerly regions.

While detailed scientific information was not available at the time of the meeting, the Working Group felt that, with this general knowledge of the two areas, these stocks were probably not linked; however, a more thorough scientific investigation into the matter should be carried out before conclusions are reached.

References

Anon. 1979. Report of the Working Group on Greenland Halibut in Region 1. ICES, Doc. C.M.1979/G:8 (mimeo.).

Anon. 1979. Report of the Arctic Fisheries Working Group. ICES, Doc. C.M.1979/G:20 (mimeo.).

Anon. 1979. Report of the Working Group on Redfish in Region 1. Doc. C.M.1979/G:25 (mimeo.).

Bowering, W R. 1977. Trends in the Greenland halibut fishery in Sub-area 2 and Divisions 3K and 3L. ICNAF Res.Doc. 77/VI/11, Ser.No. 5031.

Bowering, W R. 1979a. The Greenland halibut fishery in the continental shelf of ICNAF Sub-area 2 and Divisions 3KL. ICNAF Res.Doc. 79/VI/71, Ser.No. 5413.

Bowering, W R. 1979b. Recruitment prospects for Greenland halibut in Statistical Area 0. ICNAF Res.Doc. 79/VI/60, Ser. No. 5401.

Magnússon, J. 1979. Identification of Sebastes marinus and Sebastes mentella in 0-group redfish. ICES Symp. Early Life History of Fish. Doc. ICES/ELH Symp./SD:8 (mimeo.).

Sigurdsson, A. 1979. Greenland halibut in Icelandic waters. Publ. of the Fisheries Inst. of Iceland.

Smidt, E. 1969. The Greenland halibut (Reinhardtius hippoglossoides Walb.). Biology and exploitation in Greenland waters. Medd. Danmarks Fisk. & Havunders., Ny Ser. 6(14):79-148.

Zilanov, V K, A A Stroganov, F M Troyanovsky and A K Chumakov. 1976. The results of the study of commercial reserves of Greenland halibut at the continental slope in the Northwest Atlantic. ICNAF Res.Doc. 76/VI/109, Ser.No. 3932.

Table 1. Nominal catch of Redfish (in tonnes) by countries (Sub-area I, Divisions IIa and IIb combined)

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Belgium						30	28	2	2	-	-
Faroe Isl.		60		9	32	6	67	137	8	1 477	160
France						1 116		-	660	3 608	-
German Dem. Rep.	1 069	7 149	14 786	9 972	11 756	28 275	28 020	22 636	17 614	16 165	16 162
Germany, Fed. Rep.	5 573	2 416	3 076	1 697	3 479	6 597	5 182	7 894	7 231	11 483	12 244
Netherlands	20							127	-	-	-
Norway	3 904	3 832	4 644	6 776	7 714	7 055	4 966	7 305	7 381	7 802	10 218
Poland	5 973	4 631	2 532	1 112	215	1 269	4 711	4 137	175	2 957	272
Portugal							331	3 463	1 480	378	638
Spain							1 194	3 398	-	-	6
U.K.	5 224	4 554	4 002	4 379	4 791	3 509	2 746	4 961	6 330	3 390	3 000
USSR	9 144	13 091	29 839	22 647	31 829	48 787	230 950	263 546	144 993	78 092	67 488
Total	30 907	35 733	58 879	46 592	59 816	96 644	278 195	317 606	185 874	125 352**	110 623**

* Provisional data

** The total figure used by the Working Group for assessments (including catches by non-members)

Table 2. Nominal catch of Redfish (in tonnes) by countries in Sub - area I

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Belgium						30		2	1	-	-
Faroe Islands					6	6				-	-
France						26				27	-
German Dem. Rep.	23	4 912	78	36		358	201	90	-	-	-
Germany Fed.Rep.		133	148	7	76	1 086	483	635	786	-	-
Netherlands											
Norway	365	141	316	1 000	1 917	194	482	739	1 181	1 333	1 681
Poland	5 973	6	1	22			93	47	-	-	-
Portugal							331	478	55	8	-
Spain							820	301	-	-	-
U.K.	1 385	1 384	1 406	1 363	1 894	1 320	1 048	1 392	1 686	959	668
USSR	3 647	2 281	3 743	4 403	4 885	9 318	30 750	12 411	13 154	2 575	604
Total	11 393	8 857	5 692	6 831	8 778	12 338	34 208	16 095	17 012	4 902	2 953

* Provisional data

Table 3 Nominal catch of Redfish (in tonnes) by countries in Division IIa

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Islands		60		9	22		67	137	8	1 171	160
France						980			478	3 575	-
German Dem.Rep.	812	2 212	12 339	8 963	11 474	27 153	22 778	16 921	12 688	12 993	12 439
Germany Fed.Rep.	5 573	2 165	1 188	1 466	2 207	4 167	4 263	6 722	4 764	11 482	12 244
Netherlands	20							127	-	-	-
Norway	3 510	3 679	4 277	5 720	5 564	6 837	4 444	6 515	6 050	6 369	8 362
Poland		269	1 605	784	156	869	920	217	47	2 477	261
Portugal								2 849	1 249	352	549**
Spain							153	2 082	-	-	4
U.K.	3 578	2 741	2 463	2 680	2 125	1 991	1 621	2 919	4 064	2 067	1 632
USSR	14	142	209	291	131	14	39 138	20 307	94 639	31 783	26 789
Total	13 507	11 268	22 081	19 913	21 679	42 011	73 384	58 796	123 987	72 209	62 440

* Provisional data

** As reported to Norwegian authorities

Table 4. Nominal catch of Redfish (in tonnes) by countries in Division IIb

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Belgium							28		-	-	-
Faroe Islands					4				-	-	-
France						110			33	306	-
German Dem.Rep	234	25	2 369	973	282	764	5 041	5 625	4 926	3 232	3 723
Germany Fed.Rep.		118	1 740	224	1 196	1 344	436	537	1 681	1	-
Norway	29	12	51	56	233	24	40	51	150	100	175
Poland		4 356	926	306	59	400	3 698	3 873	128	480	11**
Portugal								136	176	18	89**
Spain							221	1 015	-	-	2**
U.K.	261	429	133	336	772	198	77	650	580	364	700
USSR	5 483	10 668	25 887	17 953	26 813	39 455	161 062	230 828	37 200	43 734	40 095
Total	6007	15 608	31 106	19 848	29 359	42 295	170 603	242 715	44 874	48 241	44 795
Non-members										296	435**

* Provisional data

** As reported to Norwegian authorities

Table 5. Nominal catch of Sebastes marinus and Sebastes mentella in Sub-area I and Divisions IIa and IIb combined (in tonnes)

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
S. marinus	24 071	12 817	13 816	17 730	21 436	27 272	39 125	48 584	39 509	32 441	25 441
S. mentella	6 836	22 916	45 063	28 862	38 380	69 372	239 070	269 022	146 365	92 911	85 182
Total	30 907	35 753	58 879	46 592	59 816	96 644	278 195	317 606	185 874	125 352	110 623

* Provisional data

Table 6. *Sebastes mentella* in Divisions IIa and IIb
Effort and catch per unit of effort 1965 - 1979.

Year	USSR catch/hour (tonnes)	USSR effort (hours trawling)	Total effort (hours trawling)
1965	0.38	37 895	41 216
1966	0.39	22 308	26 008
1967	0.37	15 135	16 862
1968	0.45	9 778	12 029
1969	0.48	11 458	14 242
1970	0.46	23 261	49 817
1971	0.38	68 158	118 587
1972	0.38	47 368	79 953
1973	0.45	59 556	85 289
1974	0.69	60 000	100 539
1975	0.95	217 789	251 653
1976	0.99	244 379	271 739
1977	0.77	132 866	190 084
1978	0.63	118 356	147 478
1979	0.56	114 868	152 111

Table 7. Year class strength of Redfish in Sub-area I and Divisions IIa and IIb.

Year Class	Dragesund 1971	Surkova, 1960		Baranenkova, 1968		0-group surveys Abundance indices
		S.marinus	S.mentella	S.marinus	S.mentella	
1956	strong		strong	strong		
1957	average	average	strong	average	average	
1958	poor	poor	poor	below average	poor	
1959	average		average	strong	strong	
1960	poor			poor	poor	
1961	poor					
1962	very poor					
1963	poor					
1964	strong					
1965	strong					159
1966	strong					236
1967	average					44
1968	average					21
1969	very strong					295
1970	strong					247
1971	average					172
1972	average					177
1973	strong					385
1974						468
1975						315
1976						447
1977						472
1978						460
1979						980

Table 8. *Sebastes marinus* in Sub-area I and Division IIa. Age composition of the total catch in numbers (x 10^3), 1968-79.

AGE	1968	1969	1970	1971	1972	1973
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	43	51	62	46	261	590
13	32	35	122	41	332	570
14	74	97	229	107	633	913
15	165	209	444	239	1137	1527
16	550	666	1232	886	2563	3266
17	364	556	723	594	1261	1441
18	611	954	1138	935	2014	2157
19	684	1223	997	990	2046	1892
20	131	223	185	185	385	342
21	753	1456	1003	858	1732	1420
22	555	1084	750	595	1112	849
23	898	1518	921	779	1251	1123
24	1266	2259	966	1123	1121	1248
25	993	1845	716	776	746	884
26	887	1667	623	636	585	729
27	644	1362	526	426	429	568
28	614	1038	347	431	377	508
TOTAL	9264	16243	10984	9647	17985	20027

AGE	1974	1975	1976	1977	1978	1979
3	0	0	0	86	0	0
4	0	0	0	428	0	0
5	0	0	530	1839	20	0
6	0	0	2884	1831	13	0
7	0	0	5719	1621	31	12
8	0	0	12162	4179	335	70
9	0	0	10250	4620	655	97
10	0	0	9515	4501	951	143
11	0	0	5963	2359	629	139
12	387	693	5008	3306	2048	695
13	455	868	1686	2557	2894	878
14	1049	1638	2670	4242	5573	3288
15	2079	2984	2991	5334	6545	3148
16	5479	7397	6775	6072	6010	3415
17	2757	3563	2707	2372	2626	1659
18	4164	5117	3938	3462	3750	2126
19	3528	4402	3417	3115	2779	2150
20	638	775	614	964	1572	1743
21	2359	2829	2475	2408	1754	2150
22	1373	1721	1529	1170	390	922
23	1527	1813	1814	1464	502	909
24	1103	1432	1672	1318	420	922
25	702	930	1106	923	246	647
26	530	817	918	772	179	605
27	369	701	822	666	158	520
28	332	589	624	677	144	230
TOTAL	28831	38269	87789	62286	40224	26463

Table 9. Sebastes marinus in Sub-area I and Division IIa. Fishing mortalities estimated by VPA (M = 0.10).

AGE	1968	1969	1970	1971	1972	1973
3	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000	.000
6	.000	.000	.000	.000	.000	.000
7	.000	.000	.000	.000	.000	.000
8	.000	.000	.000	.000	.000	.000
9	.000	.000	.000	.000	.000	.000
10	.000	.000	.000	.000	.000	.000
11	.000	.000	.000	.000	.000	.000
12	.001	.001	.001	.001	.005	.012
13	.001	.001	.003	.001	.006	.011
14	.002	.002	.005	.003	.011	.019
15	.005	.006	.012	.006	.030	.029
16	.018	.021	.041	.027	.079	.102
17	.016	.021	.026	.023	.045	.052
18	.036	.049	.048	.038	.090	.090
19	.029	.085	.060	.049	.099	.102
20	.007	.011	.015	.013	.022	.019
21	.048	.088	.056	.080	.143	.094
22	.054	.081	.054	.038	.127	.087
23	.079	.182	.083	.066	.095	.164
24	.158	.260	.152	.124	.114	.116
25	.139	.321	.110	.157	.102	.112
26	.178	.323	.153	.121	.153	.123
27	.075	.401	.143	.133	.101	.195
28	.150	.150	.150	.150	.150	.150

MEAN F FOR AGES >= 13 AND <= 24 (WEIGHTED BY STOCK IN NUMBERS)

	.023	.038	.031	.024	.050	.054
AGE	1974	1975	1976	1977	1978	1979
3	.000	.000	.000	.010	.000	.000
4	.000	.000	.000	.176	.000	.000
5	.000	.000	.075	.801	.010	.000
6	.000	.000	.360	.350	.010	.000
7	.000	.000	.440	.314	.008	.010
8	.000	.000	.740	.590	.088	.020
9	.000	.000	.384	.618	.150	.030
10	.000	.000	.380	.258	.217	.040
11	.000	.000	.105	.136	.047	.040
12	.010	.013	.101	.070	.150	.060
13	.011	.024	.036	.062	.073	.080
14	.023	.043	.087	.108	.166	.100
15	.050	.075	.094	.225	.216	.120
16	.126	.223	.216	.248	.376	.150
17	.106	.102	.106	.098	.145	.150
18	.187	.260	.140	.173	.199	.150
19	.187	.275	.248	.141	.183	.150
20	.041	.051	.050	.092	.088	.150
21	.162	.229	.206	.252	.215	.150
22	.111	.153	.167	.127	.053	.150
23	.199	.188	.213	.214	.066	.150
24	.215	.259	.236	.212	.079	.150
25	.080	.254	.291	.177	.050	.150
26	.081	.113	.378	.301	.043	.150
27	.076	.132	.142	.458	.083	.150
28	.150	.150	.150	.150	.150	.150

MEAN F FOR AGES >= 13 AND <= 24 (WEIGHTED BY STOCK IN NUMBERS)

.091	.131	.128	.147	.163	.132

Table 10. Sebastes marinus in Sub-area I and Division IIa. Stock size in numbers (x 10^3) estimated by VPA.

AGE	1968	1969	1970	1971	1972	1973
3	139718	63467	61369	40040	25105	13476
4	122001	126422	57428	55529	36230	22716
5	112324	110391	114392	51963	50244	32782
6	77244	101635	99886	103506	47018	45463
7	83624	69893	91963	90380	93656	42543
8	91017	75666	63242	83212	81780	84743
9	84410	82356	68466	57224	75293	73997
10	92182	76378	74519	61950	51778	68128
11	60218	83410	69109	67427	56055	46851
12	53819	54487	75472	62533	61011	50721
13	47169	48657	49254	68231	56538	54957
14	39562	42650	43993	44451	61699	50842
15	37178	35727	38499	39589	40119	55226
16	32172	33483	32128	34413	35594	35220
17	23384	28588	29663	27900	30296	29772
18	18076	20812	25339	26153	24680	26215
19	24765	15775	17925	21846	22776	20418
20	20139	21758	13111	15272	18826	18665
21	16895	18098	19475	11688	13643	16668
22	11137	14571	14993	16669	9760	10699
23	12363	9550	12155	12853	14517	7775
24	9105	10333	7200	10123	10890	11947
25	8031	7037	7206	5597	8093	8788
26	5701	6324	4618	5841	4328	6614
27	3320	4316	4141	3586	4681	3361
28	4626	7821	2615	3247	2841	3828
TOTAL	1236180	1169605	1098160	1021223	937450	842415

AGE	1974	1975	1976	1977	1978	1979
3	9442	4254	3076	9082	0	0
4	12194	8543	3849	2783	0	0
5	20554	11033	7730	3483	2112	0
6	29663	18598	9983	6491	1414	0
7	41137	26840	16829	6299	4137	1267
8	38495	37222	24286	9809	4162	3714
9	76679	34832	33680	10481	4921	3448
10	66955	69382	31517	20760	5113	3831
11	61645	60584	62780	19499	14514	3724
12	42392	55779	54818	51140	15403	12535
13	45333	37990	49812	44844	43132	11992
14	49185	40586	33550	43469	38146	36278
15	45136	43507	35167	27820	35302	29225
16	48519	38865	36531	28979	20111	25731
17	28766	38698	28146	26625	20460	12500
18	25569	23409	31630	22896	21837	16019
19	21670	19183	16327	24880	17430	16200
20	16677	16259	13181	11531	19554	13133
21	16563	14484	13975	11343	9517	16200
22	13733	12747	10421	10296	7979	6947
23	8875	11122	9900	7977	8205	6849
24	5969	6581	8342	7236	5829	6947
25	9625	4354	4596	5962	5296	4875
26	7112	8042	3057	3109	4518	4558
27	5292	5932	6500	1896	2081	3918
28	2502	4438	4702	5101	1085	1733
TOTAL	749682	653263	554384	423791	312260	241623

Table 11. *Sebastes marinus* in Sub-area I and Division IIa. Total stock biomass (age 12+) and spawning stock biomass (age 15+) (in '000 tonnes).

Year	Total Stock	Spawning Stock
1965	325	257
1966	318	248
1967	310	239
1968	313	240
1969	314	238
1970	308	222
1971	318	228
1972	328	234
1973	326	244
1974	316	244
1975	308	239
1976	287	216
1977	(262)	(189)
1978	(243)	(184)
1979	(215)	(176)

Table 12. Sebastes marinus in Sub-area I and Division IIa. Parameters used in catch prediction.

Age	Stock size beginning of 1980 x 10-3	Relative fishing mortality	Mean weight used 1965 to 1977	Mean weight for 1978 and later
12	55 211	0.4	.477	.520
13	10 682	0.5	.512	.564
14	10 016	0.7	.577	.703
15	29 702	0.8	.611	.750
16	23 454	1.0	.710	.846
17	20 039	1.0	.761	.860
18	9 735	1.0	.826	.931
19	12 476	1.0	.895	.991
20	12 617	1.0	.947	1.028
21	10 228	1.0	1.093	1.148
22	12 617	1.0	1.145	1.207
23	5 410	1.0	1.293	1.410
24	5 334	1.0	1.580	1.521
25	5 410	1.0	1.793	1.702
26	3 796	1.0	1.885	1.693
27	3 550	1.0	2.393	2.393
28+	3 051	1.0	2.454	2.454

Table 13. Sebastes mentella in Divisions IIa and IIb. Age composition of the total catch in number (x 10^3), 1968-79

AGE	1968	1969	1970	1971	1972	1973
6	7	31	0	0	466	172
7	0	94	0	0	792	1660
8	15	409	33	114	5728	4865
9	89	524	131	284	3586	9729
10	192	838	620	681	2049	4636
11	355	933	2122	1590	1770	2633
12	436	954	3428	4429	3865	3148
13	554	849	3983	4884	4564	5208
14	864	618	3526	5451	4704	5666
15	768	482	2808	4940	4098	4578
16	931	807	3983	7496	4704	5380
17	694	451	2743	4486	3632	3777
18	665	849	3559	7382	3167	2747
19	702	786	2318	4770	1816	1316
20	369	555	1567	3918	885	973
21	347	440	784	2385	373	630
22	251	514	653	1874	279	114
23	89	199	327	1590	47	10
24	44	42	65	397	47	10
TOTAL	7372	10375	32650	56671	46572	57252

AGE	1974	1975	1976	1977	1978	1979
6	606	5834	18891	0	2914	3551
7	4847	19417	29815	2418	30256	20035
8	15451	42425	59395	17175	65373	42572
9	28781	82480	78241	33454	53564	45937
10	30144	108462	110712	52102	33377	36625
11	19843	119075	112524	49617	19973	25706
12	10603	57231	93144	53938	17298	20250
13	8634	29651	49550	33287	9300	15973
14	8634	20894	26134	19095	7434	5923
15	6514	16499	13881	12605	5474	3508
16	5908	13465	9639	5796	4147	3387
17	3332	13668	6300	4874	2141	2411
18	2878	12207	7233	5499	1550	1920
19	1666	6757	3486	3155	668	1680
20	2121	7112	3168	3941	1064	1863
21	757	5113	1818	2955	424	1918
22	454	2242	1715	2531	309	547
23	151	735	1041	1062	302	317
24	151	407	211	322	159	106
TOTAL	151475	563674	627098	303796	255727	234233

Table 14. Sebastes mentella in Divisions IIa and IIb. Fishing mortalities estimated by VPA (M = 0.10).

AGE	1968	1969	1970	1971	1972	1973
6	.000	.000	.000	.000	.001	.000
7	.000	.000	.000	.000	.002	.003
8	.000	.003	.000	.000	.013	.011
9	.001	.005	.001	.002	.014	.025
10	.002	.008	.006	.007	.014	.021
11	.004	.009	.023	.017	.019	.021
12	.007	.013	.037	.054	.048	.039
13	.010	.015	.060	.062	.066	.077
14	.021	.013	.072	.099	.071	.098
15	.026	.013	.067	.123	.090	.082
16	.053	.032	.129	.228	.148	.148
17	.054	.030	.129	.188	.147	.153
18	.081	.078	.303	.522	.176	.142
19	.146	.116	.280	.740	.207	.093
20	.085	.148	.316	.917	.256	.146
21	.108	.125	.285	.971	.173	.260
22	.323	.207	.246	1.961	.240	.066
23	.298	.406	.177	1.357	.188	.011
24	.200	.200	.200	.300	.100	.050
MEAN F FOR AGES >= 13 AND <= 21 (WEIGHTED BY STOCK IN NUMBERS)	.034	.029	.109	.195	.104	.107

AGE	1974	1975	1976	1977	1978	1979
6	.002	.014	.040	.000	.006	.006
7	.013	.058	.080	.006	.086	.050
8	.036	.132	.226	.055	.192	.150
9	.073	.240	.339	.172	.215	.180
10	.089	.375	.515	.352	.231	.200
11	.105	.520	.734	.406	.197	.250
12	.097	.432	.885	.853	.215	.280
13	.127	.378	.724	.827	.298	.280
14	.158	.447	.592	.603	.384	.280
15	.140	.448	.534	.563	.305	.280
16	.130	.418	.466	.395	.322	.280
17	.115	.436	.312	.393	.220	.280
18	.149	.677	.385	.436	.186	.280
19	.108	.539	.366	.257	.076	.280
20	.190	.768	.463	.800	.116	.280
21	.146	.810	.397	.926	.158	.280
22	.270	.714	.622	1.363	.195	.280
23	.105	.805	.765	.813	.488	.280
24	.200	.400	.500	.500	.250	.280
MEAN F FOR AGES >= 13 AND <= 21 (WEIGHTED BY STOCK IN NUMBERS)	.137	.467	.562	.607	.272	.280

Table 15. *Sebastes mentella* in Divisions IIa and IIb. Stock size in numbers (x 10^3) estimated by VPA.

AGE	1968	1969	1970	1971	1972	1973
6	227324	358371	575172	590018	568644	445257
7	148518	205685	324238	520437	533870	514088
8	131608	134384	186022	293383	470911	482312
9	122672	119070	121207	168288	265355	420652
10	120793	110914	107241	109548	152003	236694
11	88617	109116	99562	96446	98476	135590
12	66536	79847	97845	88070	85756	87422
13	57031	59790	71341	85275	75480	73922
14	43578	51077	53293	60767	72519	63960
15	30902	38609	45629	44871	49806	61148
16	18918	27231	34477	38618	35908	41172
17	13872	16233	23873	27413	27829	28024
18	9019	11893	14259	18996	20545	21732
19	5431	7529	9954	9527	10199	15583
20	4739	4247	6066	6808	4112	7505
21	3547	3937	3316	4002	2463	2881
22	953	2879	3145	2257	1372	1874
23	362	624	2118	2226	287	976
24	255	243	376	1606	519	215
TOTAL	1094675	1341679	1779133	2168555	2476055	2641009

AGE	1974	1975	1976	1977	1978	1979
6	399798	454825	501392	426898	479947	546000
7	402722	361176	405996	435722	386273	431504
8	463587	359789	308352	339030	391959	320767
9	431789	404784	285256	222639	290444	292600
10	371373	363349	287996	183926	169689	211965
11	209762	307391	225964	155769	117027	121866
12	120184	170950	165405	98114	93927	86931
13	76110	98674	100459	61742	37849	68570
14	61938	60667	61179	44066	24430	25427
15	52490	47846	35100	30629	21807	15059
16	50979	41308	27663	18620	15785	14540
17	32145	40516	24619	15711	11355	10350
18	21771	25921	23711	16301	9597	8242
19	17055	16966	11912	14599	9540	7212
20	12850	13849	8955	7474	10217	7998
21	5867	9614	5812	5102	3040	8234
22	2009	4590	3870	3536	1828	2348
23	1538	1387	2034	1879	819	1361
24	874	1293	561	856	754	455
TOTAL	2734891	2784895	2486235	2082614	2076286	2181427

Table 16. Sebastes mentella in Divisions IIa and IIb. Biomasses of the recruited stock B (N_{6+}), the spawning stock B (N_{15+}) and the year class strength (estimates from VPA).

Year	B(N_{6+}) (tonnes x 10^{-3})	B(N_{15+}) (tonnes x 10^{-3})	Year class	Year class strength at age 6 (millions)
1965	281	48	1965	590
1966	308	52	1966	569
1967	343	59	1967	445
1968	392	74	1968	400
1969	465	96	1969	455
1970	575	122	1970	501
1971	675	134	1971	(427)
1972	762	129	1972	(480)
1973	854	152	1973	(546)
1974	939	169		
1975	991	177		
1976	842	126		
1977	660	100		
1978	616	74		
1979	645	68		

Table 17. Sebastes mentella in Divisions IIa and IIb
Parameters used in catch predictions.

Age	Stock size at the beginning of 1980	Proportional fishing mortality (1979-1981)	Mean weight at age (kg)
6	550 000	.02	.168
7	491 282	.18	.183
8	371 250	.54	.225
9	249 513	.64	.311
10	221 319	.71	.367
11	157 216	.89	.432
12	85 946	1.00	.508
13	59 449	1.00	.611
14	46 892	1.00	.679
15	17 389	1.00	.753
16	10 298	1.00	.821
17	9 943	1.00	.872
18	7 077	1.00	.910
19	5 636	1.00	.923
20	4 932	1.00	.985
21	5 470	1.00	1.056
22	5 631	1.00	1.124
23	1 606	1.00	1.193
24	1 242	1.00	1.215

Table 18. Nominal catches of Redfish (in tonnes) by countries in Division Va (Iceland).

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Belgium	3 360	2 204	2 798	2 484	1 622	2 114	1 945	1 522	1 395	1 549	1 290
Faroe Isl.	8		35	9	243	254	82	211	292	242	698
German Dem.Rep.	656	827	238	135		11		-	-	-	-
Germany, F.R.	55 831	48 907	46 580	43 963	38 358	36 398	33 602	32 948	31 632	-	-
Iceland	24 321	23 807	29 118	26 973	26 470	27 799	32 659	34 028	28 119	33 318	63 035
Netherlands	2							-	-	-	-
Norway			1	1	4	15	22	31	87	93	50
Poland		259	17	35		18		-	-	-	-
U.K.	2 302	2 948	3 552	3 697	2 951	2 519	2 424	1 124	+	-	-
USSR	1 256	10	31	28	2			-	-	-	-
Total	87 736	78 962	82 370	77 325	69 650	69 129	70 734	69 864	61 525	35 202	65 073

Table 19. Nominal catches of Redfish (in tonnes) by countries in Division Vb (Faroe Islands).

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Isl.	5				121	28	9	33	54	1 525	5 694
France						300	800	-	1 368	448	-
German Dem.Rep.						1	1	-			
Germany, F.R.	1 293	1 914	2 328	4 034	9 490	7 328	7 628	5 255	5 854	7 767	8 373
Netherlands							105	-	-	-	-
Norway						10	7	17	10	9	10
U.K.	28	33	24	53	85	98	41	59	116	57	-
Total	1 326	1 947	2 352	4 087	9 696	7 765	8 591	5 364	7 402	9 806	14 077

*) provisional data

Table 20. Nominal catch of Redfish (in tonnes) by countries in Sub-area XIV (East Greenland). Total nominal catch in ICNAF Sub-area I (West Greenland).

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Canada								420	-	-	-
Greenland								129	1	3	-
Faroe Isl.					13	43	1	3	19	-	20
German Dem.Rep.	154	409	611	703	841	1 275	4 490	-		-	-
Germany, F.R.	26 289	16 316	17 062	7 287	4 491	2 632	4 979	4 403	13 347	20 711[1]	21 092[1]
Iceland	3 906	1 001	2 380	5 490	2 144	9 777	5 632	7 410	81	151	-
Norway							63	5	112	2	-
Poland		436	312	464	281	6	276	-	-	-	-
U.K.		+	+	5	65	127	56	286	622	13	-
USSR	18		71	21	64	118	9 830	101 000	251	-	-
Total SA XIV	30 367	18 162	20 436	13 970	7 899	13 978	25 329	113 656	14 433	20 880	21 112
Total ICNAF SA I	4 252	4 101	2 756	2 988	3 319	3 324	8 629	13 698	31 808	8 053	

[1] catches updated for Sub-area XII included.

Table 21. Nominal catch (in tonnes) of Redfish in Sub-area XIV, Divisions Va and Vb, and by species for Sub-area XIV and Sub-area V combined.

Year	Div. Va	Div. Vb	Sub-area XIV	Total	S. marinus	S. mentella
1965	114 100	5 862	36 513	156 475	97 006	59 469
1966	107 068	3 297	23 290	133 655	80 347	53 308
1967	95 083	5 013	33 198	133 294	85 249	48 045
1968	96 475	6 637	23 074	126 191	68 712	57 479
1969	87 736	1 326	30 367	119 429	79 467	39 962
1970	78 962	1 947	18 162	99 071	62 020	37 051
1971	82 370	2 352	20 436	105 158	68 374	36 784
1972	77 325	4 087	13 970	95 382	50 961	44 421
1973	69 650	9 696	7 899	87 245	41 818	45 347
1974	69 129	7 765	13 978	90 872	49 845	41 027
1975	70 734	8 591	25 329	104 654	60 980	43 674
1976	69 864	5 364	113 656	188 884	93 605	95 279
1977	61 525	7 402	14 433	83 360	52 752	30 608
1978	35 202	9 806	20 880[1]	65 888	47 791	18 097
1979*	65 073	14 077	21 112[1]	100 262	76 865	23 397

*) provisional data

[1] catches updated for Sub-area XII included.

Table 22. Sebastes marinus in Sub-areas V and XIV. Input catch data for VPA.

AGE	1968	1969	1970	1971	1972	1973
9	0	0	8	4	59	21
10	0	0	15	5	65	28
11	138	137	183	102	503	402
12	1101	1108	1148	803	3066	2624
13	1996	2141	1826	1565	4539	4017
14	3971	4891	3599	3713	5998	5652
15	3519	4354	3133	3323	4044	4106
16	5373	6617	4706	5081	4469	4873
17	2718	3200	2352	2424	1928	2074
18	6618	7746	5814	5798	4269	4287
19	5272	6047	4824	4712	3003	2883
20	1964	2245	1908	1841	1020	934
21	6025	6567	5844	6152	3217	2786
22	4252	4608	4592	4939	2304	1798
23	5892	6240	6596	7342	3269	2349
24	5619	6204	6856	7233	3066	2536
25	2502	2868	3076	3189	1268	1239
26	1630	1894	1956	2205	726	783
27	774	910	916	981	303	360
28	527	717	683	762	211	255
29	210	324	275	259	59	84
30	117	264	184	121	29	11
TOTAL	60218	69102	60494	62554	47415	44102

AGE	1974	1975	1976	1977	1978	1979
9	48	273	2023	50	89	66
10	68	374	2715	71	170	318
11	533	878	6229	556	1039	1074
12	3232	3009	19819	3539	5957	2670
13	4987	3320	19604	5398	5667	2907
14	7437	4282	15776	7820	8023	6341
15	5261	3620	8889	5327	6451	6411
16	6152	5536	9193	5898	5702	10419
17	2518	2704	3780	2392	2188	9354
18	5159	6545	8440	5108	3173	10548
19	3322	4744	5596	3512	2959	5771
20	1028	1570	1844	1213	3186	4892
21	3096	4799	5552	3753	3401	5809
22	1956	2973	3389	2484	1511	3293
23	2537	3724	4348	3323	1746	4006
24	2549	3763	3817	2832	1474	2425
25	1229	1740	1751	1170	827	2265
26	845	1160	1283	798	611	2176
27	407	558	587	364	378	1303
28	306	425	429	271	156	765
29	118	197	173	112	99	463
30	12	110	73	69	37	269
TOTAL	52860	56304	125310	56060	54844	83545

Table 23. *Sebastes marinus* in Sub-areas V and XIV. Fishing mortalities from VPA (M = 0.10).

AGE	1968	1969	1970	1971	1972	1973	1974	1975
9	.000	.000	.000	.000	.000	.000	.000	.003
10	.000	.000	.000	.000	.000	.000	.000	.003
11	.001	.001	.002	.001	.003	.002	.003	.006
12	.011	.011	.009	.008	.028	.016	.021	.017
13	.026	.023	.021	.014	.050	.042	.036	.024
14	.053	.073	.044	.049	.061	.072	.091	.035
15	.048	.068	.055	.047	.062	.049	.080	.053
16	.090	.109	.088	.107	.075	.090	.087	.102
17	.053	.064	.046	.053	.048	.041	.055	.045
18	.152	.189	.142	.138	.113	.130	.121	.177
19	.148	.181	.155	.147	.088	.094	.127	.140
20	.057	.078	.072	.073	.039	.032	.039	.073
21	.193	.245	.266	.306	.159	.127	.128	.232
22	.174	.199	.242	.334	.161	.113	.111	.156
23	.331	.367	.426	.656	.343	.219	.205	.283
24	.567	.609	.771	1.024	.559	.432	.347	.467
25	.455	.564	.614	.907	.427	.408	.342	.375
26	.544	.657	.842	1.107	.467	.451	.477	.552
27	.440	.590	.686	1.308	.370	.395	.397	.591
28	.539	.830	1.092	2.261	1.029	.538	.605	.821
29	.334	.663	.795	1.746	1.348	1.551	.454	.892
30	.130	.130	.130	.130	.130	.130	.130	.130
MEAN F FOR AGES >= 16 AND <= 30 (WEIGHTED BY STOCK IN NUMBERS)	.162	.196	.197	.243	.121	.109	.114	.153

AGE	1976	1977	1978	1979
9	.011	.000	.001	.001
10	.030	.000	.001	.003
11	.055	.007	.007	.005
12	.170	.036	.087	.020
13	.130	.058	.067	.050
14	.135	.063	.102	.090
15	.085	.055	.061	.100
16	.164	.067	.070	.120
17	.085	.053	.029	.140
18	.174	.142	.083	.170
19	.203	.091	.103	.190
20	.067	.055	.101	.220
21	.351	.168	.194	.240
22	.228	.234	.085	.260
23	.318	.325	.229	.300
24	.461	.315	.209	.500
25	.366	.222	.127	.500
26	.462	.252	.155	.500
27	.531	.204	.162	.500
28	1.143	.443	.114	.500
29	.849	.961	.255	.500
30	.130	.130	.130	.500
MEAN F FOR AGES >= 16 AND <= 30 (WEIGHTED BY STOCK IN NUMBERS)	.194	.117	.087	.192

Table 24. Sebastes marinus in Sub-areas V and XIV. Stock size in numbers from VPA.

AGE	1968	1969	1970	1971	1972	1973
9	148569	158923	228351	227279	256414	180534
10	161499	134431	143799	206613	205647	231957
11	113667	146130	121638	130101	186946	186015
12	110443	102719	132094	109889	117623	166678
13	82817	98886	91890	118432	98668	103515
14	81254	73038	87441	81410	105674	84964
15	78322	69748	61440	75699	70134	89917
16	65574	67524	58973	52616	65337	59616
17	54892	54229	54812	48890	42782	54873
18	49389	47085	46027	47360	41933	36878
19	40204	38404	35251	36126	37347	33888
20	37083	31371	29009	27315	28213	30940
21	35979	31688	26253	24435	22966	24559
22	27960	26835	22441	18210	16275	17726
23	21901	21262	19907	15948	11794	12538
24	13573	14230	13324	11763	7487	7572
25	7162	6963	7007	5578	3824	3873
26	4065	4110	3586	3430	2038	2258
27	2277	2135	1928	1398	1026	1156
28	1323	1327	1071	879	342	641
29	775	698	524	325	83	111
30	207	502	326	214	51	19
TOTAL	1138935	1132240	1187090	1243908	1322603	1332228

AGE	1974	1975	1976	1977	1978	1979
9	149920	105999	194776	276622	123378	69089
10	163334	135607	95652	174318	250250	111553
11	209856	147726	122347	83969	157661	226274
12	167931	189379	132833	104784	75449	141670
13	150131	148821	168497	101375	91448	62609
14	89846	131104	131502	133842	86597	77361
15	71508	74230	114558	104005	113674	70735
16	77458	59704	63726	95210	89045	96726
17	49313	64242	48763	48932	80545	75152
18	47679	42227	55558	40531	42002	70800
19	29297	38242	31995	42258	31823	34990
20	27924	23354	30097	23638	34900	25984
21	27107	24289	19639	25480	20236	28552
22	19575	21587	17424	12507	19492	15082
23	14331	15854	16710	12549	8959	16202
24	9116	10559	10813	10996	8204	6450
25	4449	5832	5990	6169	7264	6024
26	2330	2860	3627	3760	4471	5787
27	1302	1308	1490	2067	2645	3466
28	705	792	656	793	1525	2035
29	339	348	315	189	461	1231
30	21	195	129	122	65	323
TOTAL	1313473	1244260	1267098	1304116	1250096	1148393

Table 25. Sebastes marinus in Sub-areas V and XIV.
Total stock biomass (age 9+) and spawning stock biomass (age 16+) (in 1 000 tonnes)

Year	Total stock biomass	Spawning stock biomass
1967	857	452
1968	816	413
1969	802	397
1970	803	363
1971	811	330
1972	827	303
1973	847	311
1974	858	336
1975	845	343
1976	856	338
1977	(854)	(348)
1978	(843)	(375)
1979	(817)	(416)

Table 26. Sebastes marinus in Sub-areas V and XIV. Parameters used in catch predictions.

Age	Stock size beginning of 1980 x 10^{-3}	Relative fishing mortality	Mean weight at age (kg)	
9	182 000	.002	0.399	
10	62 723	.006	0.440	
11	100 635	.010	0.486	
12	203 720	.04	0.536	Recruitment: (average over 1967-1975) 182 000 x 10^{-3}
13	125 650	.10	0.591	
14	53 888	.18	0.652	
15	63 974	.20	0.720	
16	57 913	.24	0.794	M = 0.1
17	77 624	.28	0.876	
18	59 117	.34	0.966	
19	54 047	.38	1.066	
20	26 182	.44	1.176	
21	18 868	.48	1.297	
22	20 322	.52	1.431	
23	10 522	.60	1.579	
24	10 861	1.00	1.742	
25	3 540	1.00	1.922	
26	3 306	1.00	2.120	
27	3 176	1.00	2.339	
28	1 902	1.00	2.580	
29	1 117	1.00	2.846	
30+	853	1.00	3.905	

Table 27. Sebastes mentella in Sub-areas V and XIV. Input catch data for VPA.

AGE	1968	1969	1970	1971	1972	1973
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	1
11	0	0	0	0	0	2
12	12	46	75	19	15	122
13	40	137	218	66	46	269
14	250	649	975	372	320	549
15	292	606	891	385	414	408
16	1024	1576	2142	1066	1567	1068
17	1221	1492	1871	1059	1685	1107
18	2260	2362	2649	1691	2743	1874
19	3433	3000	2923	2284	3500	2586
20	1136	844	820	699	993	779
21	9195	6578	5822	5609	6885	5741
22	3945	2610	2043	2528	2483	2379
23	12819	9126	6632	8854	8162	9044
24	6473	5960	3673	4758	4703	5862
25	2908	2390	1792	2186	2285	3063
26	2149	2079	1441	1647	1844	2551
27	914	717	704	666	824	1158
28	441	899	516	385	492	565
TOTAL	48512	41071	35187	34274	38961	39128

AGE	1974	1975	1976	1977	1978	1979
8	0	0	0	0	0	221
9	0	0	3202	2	321	190
10	0	0	2948	2	656	497
11	0	1	6533	3	908	663
12	71	87	22608	142	1521	1554
13	196	262	21121	362	664	1406
14	802	1331	14107	1438	816	2685
15	677	1161	5547	1334	1206	2792
16	1591	2384	4431	3411	1577	2028
17	1445	1797	2619	2897	882	1060
18	2242	2285	2841	3722	1581	1603
19	2790	2202	2229	3454	1371	2071
20	795	605	541	802	1089	937
21	5467	4474	3625	4884	1688	3209
22	2029	1785	1192	1314	1264	1984
23	7398	6357	4050	3958	2070	1783
24	4602	4093	2403	2172	1388	1484
25	2306	2147	1232	1089	823	862
26	1935	1862	1061	928	506	304
27	900	913	544	480	104	55
28	489	581	331	377	0	0
TOTAL	35735	34327	103165	32771	20435	27388

Table 28. Sebastes mentella in Sub-areas V and XIV. Fishing mortalities from VPA (M = 0.10).

AGE	1968	1969	1970	1971	1972	1973	1974	1975
8	.000	.000	.000	.000	.000	.000	.000	.000
9	.000	.000	.000	.000	.000	.000	.000	.000
10	.000	.000	.000	.000	.000	.000	.000	.000
11	.000	.000	.000	.000	.000	.000	.000	.000
12	.000	.001	.001	.001	.000	.003	.002	.001
13	.001	.003	.005	.001	.002	.006	.005	.007
14	.005	.016	.021	.010	.006	.020	.019	.040
15	.006	.014	.025	.010	.012	.008	.029	.032
16	.022	.039	.058	.033	.044	.034	.036	.120
17	.025	.037	.053	.033	.061	.036	.054	.046
18	.045	.055	.077	.056	.101	.081	.085	.102
19	.076	.070	.081	.080	.142	.117	.149	.101
20	.028	.022	.022	.022	.041	.038	.043	.039
21	.284	.201	.183	.185	.283	.307	.361	.319
22	.157	.109	.080	.101	.105	.134	.152	.171
23	.673	.569	.389	.503	.477	.587	.671	.830
24	.716	.680	.417	.472	.484	.663	.597	.876
25	.572	.558	.392	.417	.387	.594	.527	.546
26	.870	.936	.688	.667	.656	.868	.832	.961
27	.571	.718	.868	.705	.743	1.025	.775	1.125
28	.400	.400	.400	.400	.400	.400	.400	.400
MEAN F FOR AGES >= 12 AND <= 24 (WEIGHTED BY STOCK IN NUMBERS)								
	.096	.084	.072	.079	.095	.103	.104	.100

AGE	1976	1977	1978	1979
8	.000	.000	.000	.040
9	.057	.000	.023	.040
10	.057	.000	.035	.040
11	.068	.000	.021	.040
12	.252	.002	.038	.040
13	.394	.005	.009	.040
14	.494	.037	.013	.040
15	.208	.069	.036	.050
16	.147	.171	.098	.070
17	.168	.121	.055	.080
18	.087	.338	.081	.120
19	.123	.129	.179	.130
20	.029	.053	.049	.160
21	.308	.351	.136	.180
22	.117	.156	.128	.210
23	.626	.607	.348	.240
24	.777	.725	.392	.400
25	.629	.888	.591	.400
26	.506	1.293	1.315	.400
27	.738	.400	.400	.400
28	.400	.400	.000	.000
MEAN F FOR AGES >= 12 AND <= 24 (WEIGHTED BY STOCK IN NUMBERS)				
	.263	.097	.055	.081

Table 29. Sebastes mentella in Sub-areas V and XIV. Stock size in numbers from VPA.

AGE	1968	1969	1970	1971	1972	1973
8	80397	65493	69586	112027	158650	141706
9	46985	72747	59261	62964	101367	143553
10	88317	42514	65824	53621	56972	91720
11	56061	79912	38468	59560	48518	51551
12	59073	50726	72308	34807	53892	43901
13	47857	53440	45855	65355	31477	48749
14	50095	43265	48224	41284	59073	28438
15	48216	45090	38531	42708	37001	53147
16	48495	43350	40223	34017	38278	33087
17	52474	42906	37727	34360	29767	33146
18	53847	46320	37405	32358	30083	25333
19	49204	46575	39667	31328	27672	24615
20	43086	41259	39292	33115	26177	21715
21	39009	37906	36530	34773	29299	22742
22	28455	26575	28055	27527	26139	19980
23	27343	22001	21566	23444	22506	21293
24	13221	12620	11271	13228	12829	12634
25	6984	5844	5784	6718	7463	7154
26	3858	3568	3026	3535	4007	4587
27	2198	1462	1266	1375	1641	1882
28	551	1124	645	481	615	706
TOTAL	845726	784696	740514	748588	803428	831638

AGE	1974	1975	1976	1977	1978	1979
8	68274	67116	24821	16636	5626	5921
9	128221	61777	60729	22459	15053	5090
10	129892	116019	55898	51907	20320	13315
11	82991	117531	104978	47777	46966	17762
12	46643	75093	106346	88780	43227	41633
13	39608	42137	67865	74774	80196	37668
14	43854	35652	37878	41390	67314	71933
15	25210	38919	30994	20915	36084	60133
16	47702	22167	34111	22780	17657	31504
17	28923	41650	17793	26657	17373	14478
18	28939	24797	35978	13613	21369	14882
19	21141	24055	20267	29855	8789	17833
20	19816	16480	19674	16221	23734	6651
21	18908	17174	14337	17288	13915	20440
22	15133	11926	11297	9534	11012	10988
23	15819	11766	9096	9090	7379	8764
24	10709	7318	4643	4400	4480	4714
25	5838	5336	2758	1931	1928	2738
26	3576	3145	2796	1330	719	966
27	1742	1408	1089	1525	330	175
28	611	726	414	471	0	0
TOTAL	783599	742192	663761	519331	443470	387587

Table 30. Sebastes mentella Sub-areas V and XIV.

Total stock biomass (age 9+) and spawning stock biomass (age 16+) in 1 000 tonnes

Year	Total stock biomass	Spawning stock biomass
1967	511	351
1968	476	331
1969	440	299
1970	410	275
1971	390	258
1972	379	241
1973	373	216
1974	361	196
1975	337	167
1976	317	150
1977	(265)	(136)
1978	(237)	(114)
1979	(223)	(117)

Table 31. Sebastes mentella Sub-areas V and XIV
Parameters used in catch predictions

Age	Stock size in numbers beginning of 1980 ($x10^{-3}$)	Relative fishing mortality	Mean Weight at age (kg)	
9	86 000	0.10	0.260	
10	74 765	0.10	0.292	
11	64 997	0.10	0.327	
12	37 780	0.10	0.367	Recruitment: (average over 1967-75) 86 000 x 10^3
13	36 194	0.10	0.410	
14	32 747	0.10	0.461	M = 0.1
15	62 536	0.13	0.516	
16	51 757	0.18	0.578	
17	26 579	0.20	0.648	
18	12 093	0.30	0.726	
19	11 943	0.33	0.813	
20	14 169	0.40	0.912	
21	5 128	0.45	1.022	
22	15 448	0.53	1.145	
23	8 059	0.60	1.284	
24	6 238	1.00	1.438	
25	2 859	1.00	1.614	
26	1 661	1.00	1.809	
27+	692	1.00	2.028	

Table 32. Greenland halibut. Total nominal catch by main fishing areas (tonnes)

Year	Sub-area I	Div. IIb	Div. IIa	Div. Va	Div. Vb	Sub-area XIV	Total catch
1969	8 393	25 010	10 386	23 141	906	280	68 116
1970	4 011	70 523	14 950	30 001	-	3 822	123 307
1971	5 413	62 764	10 857	15 049	11	13 913	108 007
1972	8 549	18 873	15 633	10 666	417	15 389	69 527
1973	5 667	16 081	8 190	7 386	358	12 719	50 401
1974	5 251	24 660	7 852	7 866	325	28 089	74 043
1975	6 495	28 511	3 166	3 308	560	19 627	61 667
1976	2 479	29 610	3 985	5 448	324	273	42 119
1977	2 222	16 221	10 384	15 679	658	241	45 465
1978	1 591	10 134	12 892	11 588	592	2 166	38 963
1979*	788	12 946	3 481	16 966	316	6 039	40 536

* Preliminary

Table 33. Greenland halibut. Nominal catch (tonnes) in Sub-area I.

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
German Dem.Rep.	256[1]	- [1]	14[1]	1[1]	-	-	5	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	25	22	6	2	1	-	-
Norway	689	1 675	1 951	3 116	2 947	2 167	2 160	1 203	1 320	1 148	529[1]
Poland	5 314	-	7	117	-	1	-	9	-	-	-
UK (Engl.& Wales)	-	-	-	949	995	732	550	665	541	232	77[2]
USSR	2 134	2 336	3 441	4 366	1 700	2 329	3 774	600	360	211	182[1]
Total	8 393	4 011	5 413	8 549	5 667	5 251	6 495	2 479	2 222	1 591	788

*Preliminary
1) From national statistics
2) December catch estimated.

Table 34. Greenland halibut. Nominal catch (tonnes) in Division IIa

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Islands	-	44	-	-	-	-	-	2	21	-	-
German Dem.Rep.	501[1]	2 131[1]	353[1]	1 069[1]	52	656	172	354	1 641	1 398	787
Germany, Fed.Rep.	+	-	3	3	+	49	41	17	22	321	423[3]
Norway	9 885	6 408	4 974	11 715	7 861	6 593	2 265	3 490	1 434	2 084	2 158[1]
Poland	-	6 291	5 036	2 643	137	499	66	31	95	197	4
UK (Engl. & Wales)	-	-	-	182	118	55	107	48	211	82	14[2]
USSR	-	76	491	21	22	-	515	43	6 960	8 809	95[1]
Others										1	-
Total	10 386	14 950	10 857	15 633	8 190	7 852	3 166	3 985	10 384	12 892	3 481

* Preliminary
1) From national statistics
2) December catch estimated
3) Includes IIb

Table 35. Greenland halibut. Nominal catch (tonnes) in Division IIb

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
German Dem.Rep.	3 031[1]	16 598[1]	2 582[1]	563[1]	3 902	5 258	8 295	8 601	6 535	3 213	2 701
Germany, Fed.Rep.	71	-	-	-	34	17	47	12	125	-	-
Norway	4 282	7 788	2 541	1 152	3 181	31	433	1 312	1 400	850	73[1]
Poland	-	12 971	7 234	5 221	2 003	4 646	3 579	3 526	129	347	102
UK (Engl.& Wales)	-	-	-	131	122	79	74	222	307	93	21[2]
USSR	17 626	33 166	50 407	11 806	6 839	14 629	16 083	15 937	7 725	5 631	10 049[1]
Others											5[1]
Total	25 010	70 523	62 764	18 873	16 081	24 660	28 511	29 610	16 221	10 134	12 951

* Preliminary
1) From national statistics
2) December catch estimated

Table 36. Greenland halibut. Nominal catch (tonnes) in Sub-areas I and II, 1969-79
(Data for 1969-79 from Bulletin Statistique)

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*)
Faroe Islands	-	44 [1]	-	- [1]	-	-	-	2	21	-	
German Dem.Rep.	3 788 [1]	18 729 [1]	2 949 [1]	1 633 [1]	3 954	5 914	8 472	8 955	8 176	4 611	3 488
Germany, Fed.Rep.	71	-	3	3	59	88	94	31	148	321	423
Norway:											
trawl catch [1]:	-	1 638	2 309	9 656	10 217	4 656	1 686	4 030	2 526	2 302	887 [1]
long-line catch and gill net [1]:	14 856	14 233	7 157	6 327	3 772	4 135	3 172	1 975	1 628	1 780	1 873 [1]
Poland	5 314	19 262	12 277	7 981	2 140	5 146	3 645	3 566	224	544	106
UK (Eng.&Wales)	-	-	-	1 262	1 235	866	731	935	1 059	407	112 [1]
USSR	19 760	35 578	54 339	16 193	8 561	16 958	20 372	16 580	15 045	14 651 [1]	10 326 [1]
Others	-	-	-	-	-	-	-	-	-	1 [1]	5 [1]
Total	43 789	89 484	79 034	43 055	29 938	37 763	38 172	36 074	28 827	24 617	17 2

*)Preliminary 1) From national statistics

Table 37. Greenland halibut in Sub-areas I and II
Catch per unit effort and total effort

Year	USSR catch/hour trawling (tonnes)	Hours trawling (USSR effort)	Total effort (USSR units)	German Dem.Rep. catch/day trawling (tonnes)	Proportion Greenland halibut (%)	Total effort (GDR units)
1965	.80	20 853	43 558			
1966	.77	12 587	34 084			
1967	.70	8 196	34 667			
1968	.65	5 226	40 258			
1969	.53	37 283	82 621			
1970	.53	67 128	168 838			
1971	.46	118 128	171 813			
1972	.37	43 765	116 365			
1973	.39	21 951	76 764	10.7	98	2 798
1974	.40	42 395	94 408	9.6	96	3 934
1975	.39	52 236	97 877	8.5	81	4 491
1976	.40	41 458	90 185	6.9	90	5 228
1977	.27	55 722	106 989	4.3	84	6 704
1978	.21	69 767	117 224	4.7	82	5 238
1979	.23	44 896	74 848	4.8	94	3 586

Table 38. Greenland halibut in Sub-areas I and II. Input catch data for VPA.

AGE	1970	1971	1972	1973	1974	1975
3	1	1	1	1	1	22
4	34	1	461	19	276	334
5	526	80	1109	212	917	840
6	2792	4486	3521	1117	2519	2337
7	10464	12712	9605	3923	6204	6520
8	18562	12283	6438	3515	3838	4118
9	10034	6130	2775	2551	1834	2265
10	6671	4339	1734	1919	1942	1654
11	2517	2703	1368	1536	1622	1857
12	1250	1660	1234	1127	1338	1536
13	616	1044	675	716	734	1122
14	1104	300	200	251	531	600
15	266	123	40	70	137	270
16	15	20	40	56	79	98
TOTAL	54852	45882	29201	17013	21972	23573

AGE	1976	1977	1978	1979
3	1	62	78	88
4	98	755	532	885
5	830	2037	1897	2218
6	2982	3255	3589	3150
7	5824	4200	4118	2704
8	5002	2524	2365	1222
9	3000	1610	1509	481
10	1350	1104	946	309
11	915	1062	934	278
12	1212	858	438	226
13	698	595	349	94
14	526	384	147	45
15	254	93	83	30
16	104	87	29	15
TOTAL	22796	18626	17014	11745

Table 39. The estimated catch (sums of products) compared with the observed catch using the age compositions (Table 38) and last year's mean weights (C.M.1979/G:8, Table 12).

Year	Observed catch	Sum of products	Weight correction factor
1970	89 484	94 846	0.943
1971	79 034	75 749	1.043
1972	43 055	44 353	0.971
1973	29 938	32 440	0.923
1974	37 763	38 557	0.979
1975	38 172	43 505	0.877
1976	36 074	39 022	0.924
1977	28 827	28 902	0.997
1978	24 617	23 150	1.063
1979	17 215	12 665	1.359

Table 40. The two sets of mean weight at age data, one used for the period 1970-78, and the other used for 1979 and in the prognosis.

Age	$\bar{w}$(kg) 1970-1978	$\bar{w}$(kg) 1979-
3	0.200	0.3
4	0.441	0.6
5	0.567	0.9
6	0.737	1.2
7	1.079	1.5
8	1.421	1.8
9	1.848	2.2
10	2.281	2.6
11	2.887	3.0
12	3.247	3.5
13	4.303	4.1
14	4.931	4.8
15	5.765	5.6
16	6.308	7.0

Table 41. 0-group indices for Greenland halibut in Sub-areas I and II, and the VPA estimates at age 3.

Year class	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0-group index	<1	<1	8.0	3.2	13.4	21.1	15.6	9.0	35.4	22.5
N_3 (VPA) x 10^{-6}	24	24	25	38	32	32	32			

Table 42. Greenland halibut in Sub-areas I and II. Fishing mortalities from VPA (M = 0.15).

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	.000	.000	.000	.000	.000	.001	.000	.002	.003
4	.001	.000	.015	.001	.015	.018	.005	.025	.021
5	.014	.003	.039	.008	.047	.053	.054	.126	.078
6	.067	.153	.164	.047	.117	.153	.254	.288	.320
7	.296	.454	.526	.261	.374	.466	.644	.637	.669
8	.696	.630	.414	.349	.413	.429	.750	.608	.870
9	.594	.490	.263	.269	.292	.431	.603	.542	.866
10	.606	.524	.233	.277	.319	.438	.467	.438	.674
11	.492	.498	.292	.315	.376	.539	.436	.782	.774
12	.479	.667	.420	.391	.469	.692	.778	.898	.839
13	.626	.900	.594	.434	.450	.868	.748	1.104	1.157
14	1.490	.677	.396	.433	.629	.770	1.378	1.229	.868
15	1.827	.597	.163	.221	.421	.726	.843	.947	.940
16	.580	.620	.370	.340	.390	.570	.650	.750	.850
MEAN F FOR AGES >= 7 AND <= 11 (NOT WEIGHTED BY STOCK IN NUMBERS)	.537	.519	.346	.294	.355	.461	.580	.602	.771

AGE	1979
3	.003
4	.035
5	.110
6	.170
7	.400
8	.400
9	.400
10	.400
11	.400
12	.400
13	.400
14	.400
15	.400
16	.400
MEAN F FOR AGES >= 7 AND <= 11 (NOT WEIGHTED BY STOCK IN NUMBERS)	.400

Table 43. Greenland halibut in Sub-areas I and II. Stock size in numbers from VPA.

AGE	1970	1971	1972	1973	1974	1975
3	42361	39274	29169	23943	23524	25154
4	33997	36459	33803	25105	20607	20246
5	40102	29230	31380	28667	21590	17481
6	46306	34029	25084	25982	24478	17734
7	43843	37271	25139	18333	21328	18737
8	39511	28073	20363	12793	12155	12633
9	23951	16950	12866	11590	7767	6923
10	15694	11383	8942	8510	7619	4991
11	6927	7371	5801	6094	5552	4765
12	3515	3644	3854	3730	3827	3283
13	1415	1874	1610	2180	2171	2061
14	1508	652	656	765	1216	1192
15	334	293	285	380	427	558
16	36	46	139	208	262	241
TOTAL	299501	246547	199091	168279	152523	135999

AGE	1976	1977	1978	1979
3	37657	31642	32263	31635
4	21630	32411	27177	27697
5	17117	18526	27197	22893
6	14268	13964	14060	21652
7	13101	9525	9013	8789
8	10119	5921	4336	3972
9	7077	4116	2775	1563
10	3871	3331	2060	1004
11	2771	2087	1850	904
12	2392	1542	822	735
13	1414	946	541	306
14	745	576	270	146
15	475	162	145	98
16	232	176	54	49
TOTAL	132868	124924	122561	121446

Table 44. Greenland halibut in Sub-areas I and II.
Input parameters used in the catch predictions

Age	Exploitation pattern	Mean weights (kg)	Stock in size 1980 (x 10-3)
3	.01	.3	31 600
4	.09	.6	27 147
5	.28	.9	23 019
6	.43	1.2	17 656
7	1.00	1.5	15 723
8	↓	1.8	5 071
9		2.2	2 292
10		2.6	902
11		3.0	579
12		3.5	522
13		4.1	424
14		4.8	177
15		5.6	84
16		7.0	57

Catch 1980 = 14 000 tonnes

M = 0.15

Recruitment at age 3 in 1981 : 31 600 x 10^3

Table 45. Greenland halibut. Nominal catch (tonnes) in Division Va.

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Islands	-	4 122	1 316	1 180	188	41	2	373	947	256	42[1]
German Dem.Rep.	7 768[1]	14 958[1]	3 317[1]	159[1]	320	388	-	-	-	-	-
Germany, Fed.Rep.of	1 488	-	882	1 119	826	1 786	887	1 719	4 642	-	-
Iceland	5 856	7 343	5 020	4 640	2 115	2 842	1 212	1 687	10 090	11 319	16 924
Norway	54	338	369	186	-	-	-	-	+	13	-
Poland	-	1 127	899	31	-	485	-	-	-	-	-
U.K. (Engl. + Wales)	-	-	-	2 223	3 648	2 314	1 207	1 669	-	-	-
USSR	7 975[1]	2 113	3 246	1 128	289	10	-	-	-	-	-
Total	23 141	30 001	15 049	10 666	7 386	7 866	3 308	5 448	15 679	11 588	16 966

*) Preliminary. 1) From national statistics.

Table 46. Greenland halibut. Nominal catch (tonnes) in Division Vb.

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Islands	-	-	-	-	-	7	6	2	304	2	108[1]
France	-[1]	-	-	-	-	-	-	-	-	12	-
German Dem.Rep.	855[1]	-	-	-	-	147	91	-	-	-	-[1]
Germany, Fed.Rep. of	51	-	11	405	287	163	437	309	341	570	208
Norway	-	-	-	-	-	-	7	7	5[1]	3	-
Poland	-	-	-	-	9	-	18	-	-	-	-
U.K. (Engl. + Wales)	-	-	-	12	61	8	+	6	8	8	-
USSR	-	-	-	-	1	-	-	-	-	-	-
Total	906	-	11	417	358	325	559	324	658	595	316

*) Preliminary. 1) From national statistics.

Table 47. Greenland halibut. Nominal catch (tonnes) in Sub-area XIV.

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
German Dem. Rep.	42[1]	2 981[1]	3 491[1]	7 328[1]	8 806	25 266	16 872	-	-	-	-
Germany,Fed.Rep. of	183	-	270	5	7	+	64	191	224	2 156	6 039[1]
Greenland	+	-	2	3	4	2	1	1	4	6	-
Iceland	24	2	+	-	3	1	+	2	-	-	-
Norway	-	-	-	-	-	-	-	-	2[1]	3	-
Poland	-	732	7 910	7 847	3 122	1 057	1 054	-	-	-	-
U.K. (Engl. + Wales)	-	-	-	1	1	1	2	5	11	1	-
USSR	31	107	2 240	205	776	1 762	1 634	74	-	-	-
Total	280	3 822	13 913	15 389	12 719	28 089	19 627	273	241	2 166	6 039

*) Preliminary. 1) From national statistics.

Table 48. Greenland halibut. Nominal catch (tonnes) in Sub-areas V and XIV, 1969-1979. (Data for 1969-78 from Bulletin Statistique)

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
Faroe Islands	-	4 122	1 316	1 180	188	48	8	375	1 251	258	150
France	-	-	-	-	-	-	-	-	-	12	-
German Dem. Rep.	8 665[1]	17 939[1]	6 808[1]	7 487[1]	9 126	25 801	16 963	-	-	-	-
Germany, Fed. Rep.	1 686	-	1 163	1 529	1 120	1 949	1 388	2 219	5 207	2 726	6 247
Greenland	+	-	2	3	4	2	1	1	4	6	6
Iceland	5 880	7 345	5 020	4 640	2 118	2 843	1 212	1 689	10 090	11 319	16 924
Norway	-	338	369	186	-	-	7	7	7	19	-
Poland	-	1 859	8 809	7 878	3 131	1 542	1 072	-	-	-	-
U.K. (Engl. + Wales)	-	-	-	2 236	3 710	2 323	1 209	1 680	19	9	-
USSR	8 006[1]	2 220	5 486	1 333	1 066	1 772	1 634	74	-	-	-
Total	24 237	33 823	28 973	26 473	20 463	36 280	23 494	6 045	16 578	14 349	23 327

*) Preliminary. 1) From national statistics.

Figure 1. Sebastes marinus in Sub-area I and Division IIa. Yield per recruit and spawning stock per recruit curves for the present exploitation pattern.

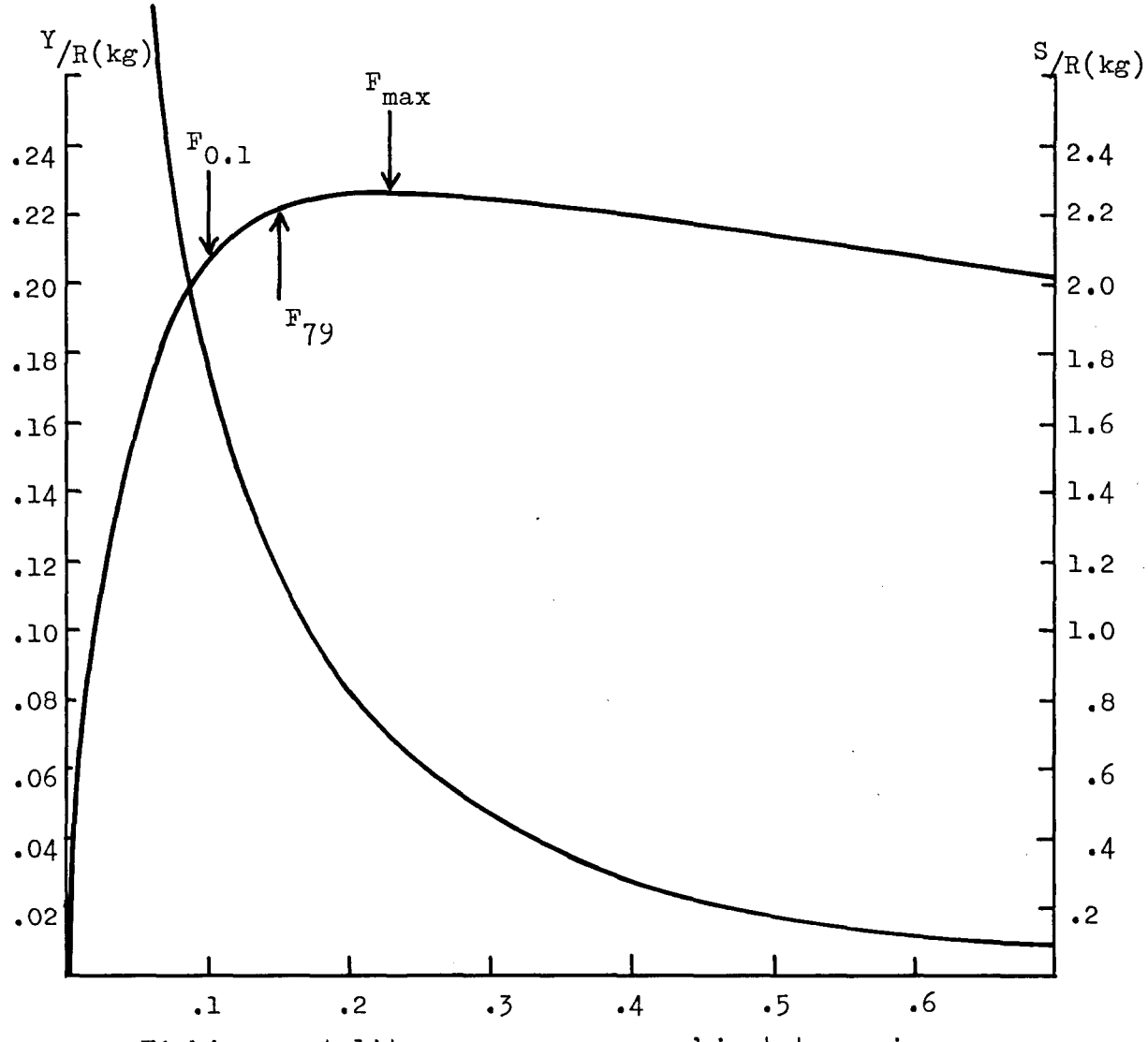


Figure 2. Sebastes marinus in Sub-area I and Division IIa. Catch in 1981 and biomass and spawning stock biomass 1982 at different levels of F in 1981.

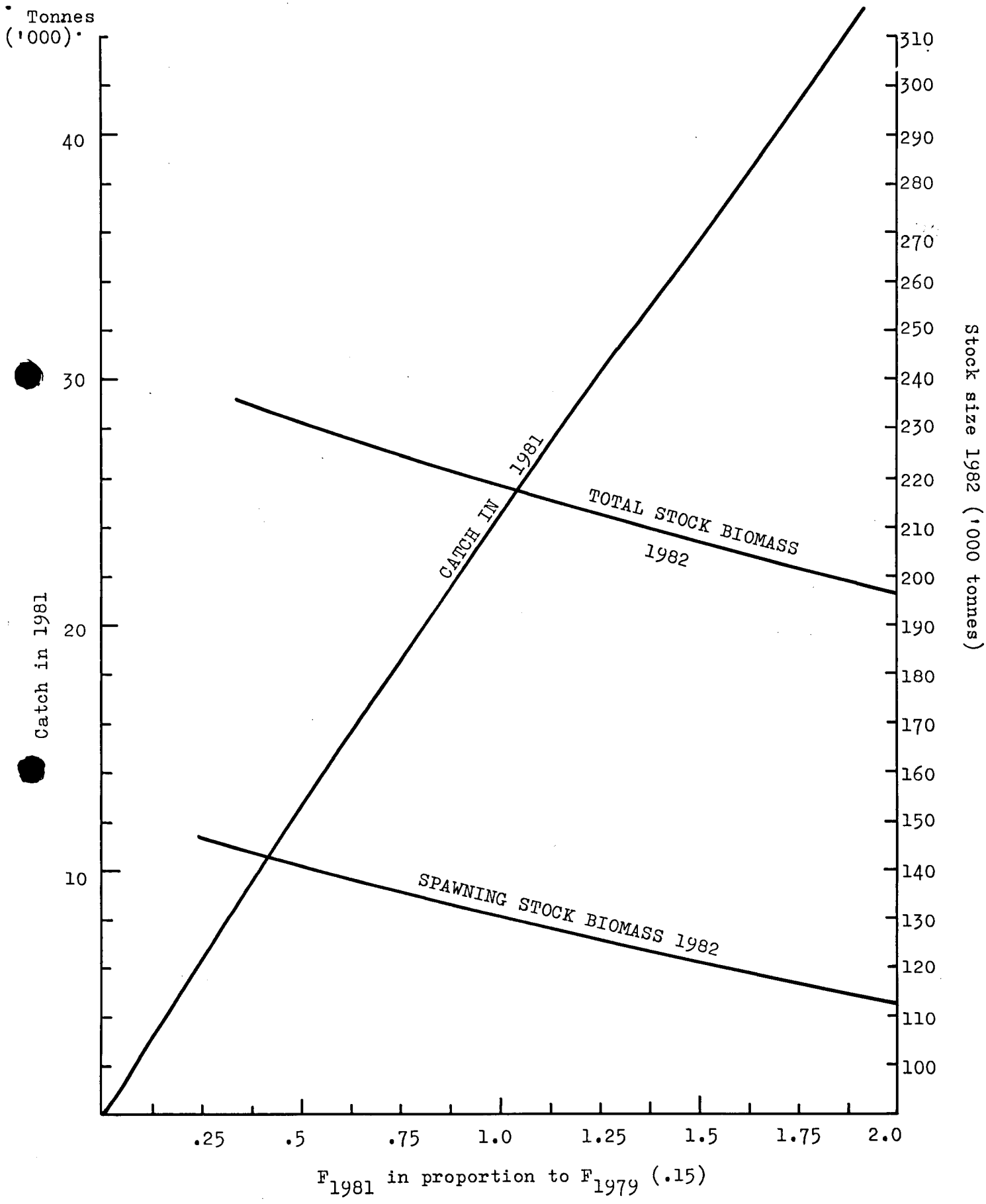


Figure 3. Sebastes mentella, in Divisions IIa and IIb. Relation of weighted mean fishing mortality (ages 13-21) to total effort.

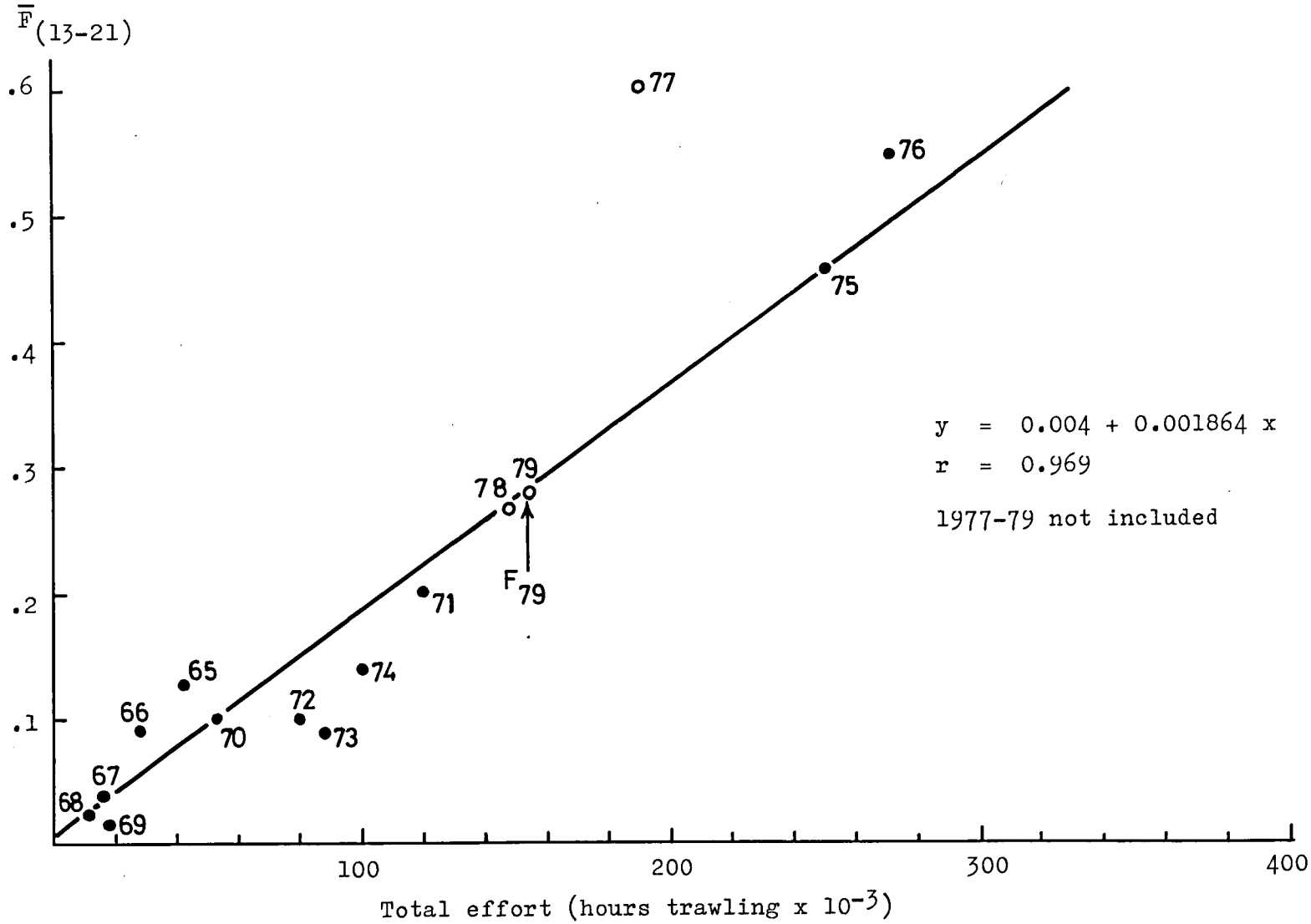


Figure 4. Sebastes mentella in Divisions IIa and IIb. Relation of year class strength at age 6 (from VPA) to corresponding 0-group survey abundance indices.

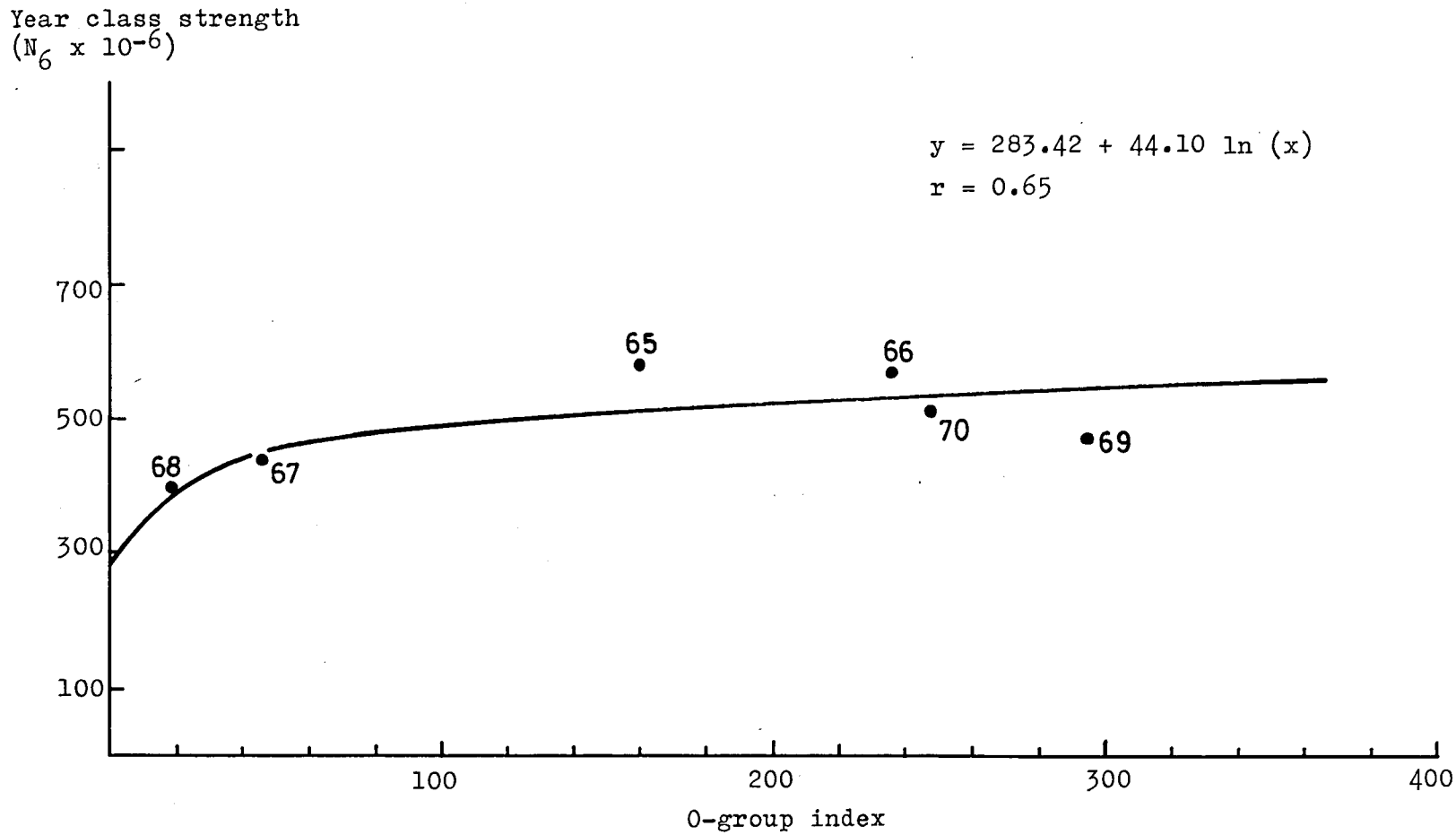


Figure 5. Sebastes mentella in Divisions IIa and IIb. Yield per recruit and spawning stock per recruit curves for the present exploitation pattern (M = 0.1).

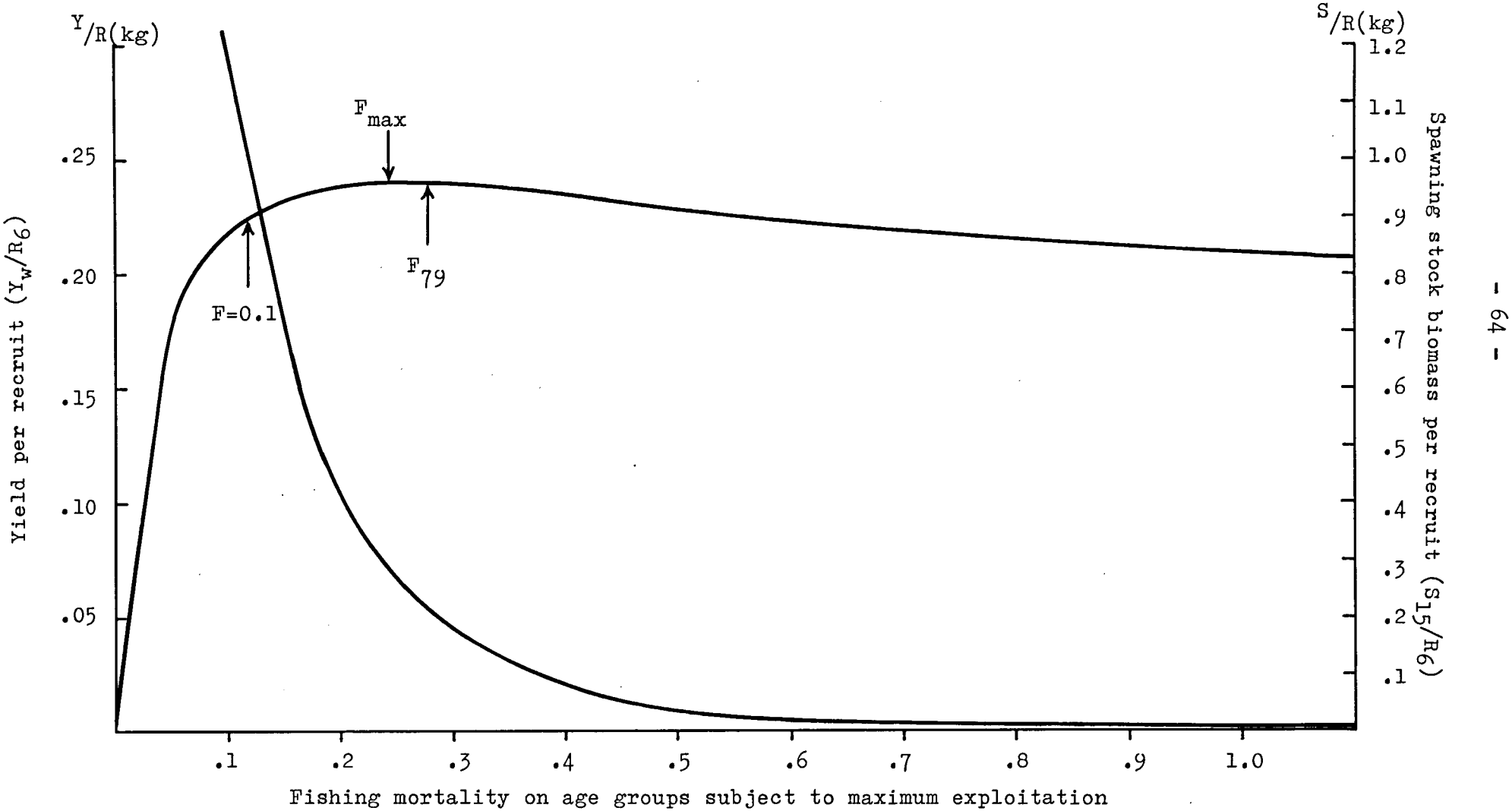


Figure 6. Sebastes mentella in Divisions IIa and IIb. Catch in 1981; total biomass (age 6+) and spawning stock biomass (age 15+) 1982 at different levels of F in 1981.

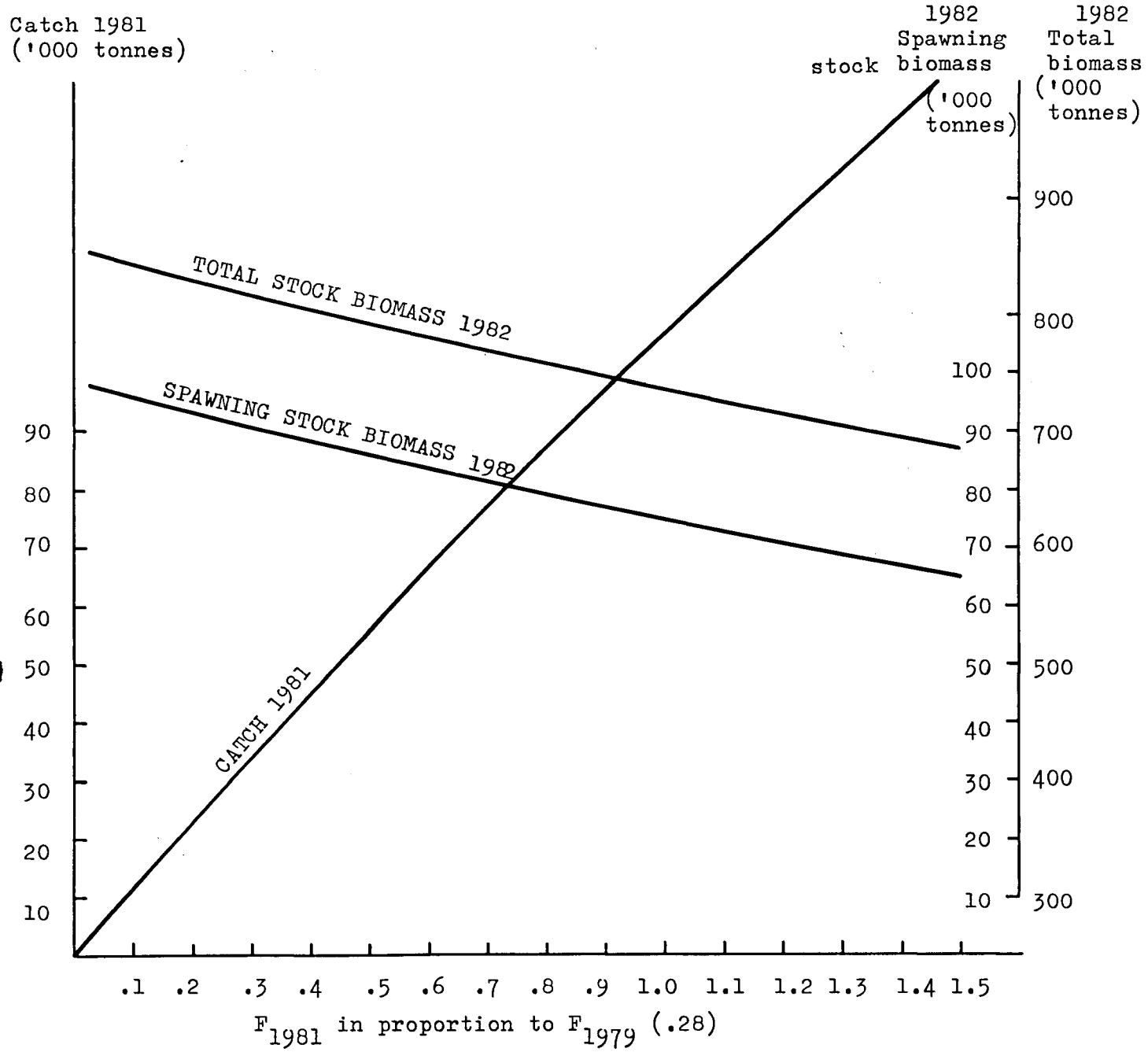


Figure 7. Sebastes marinus in Sub-areas V and XIV. Exploitation pattern (Relat. F).

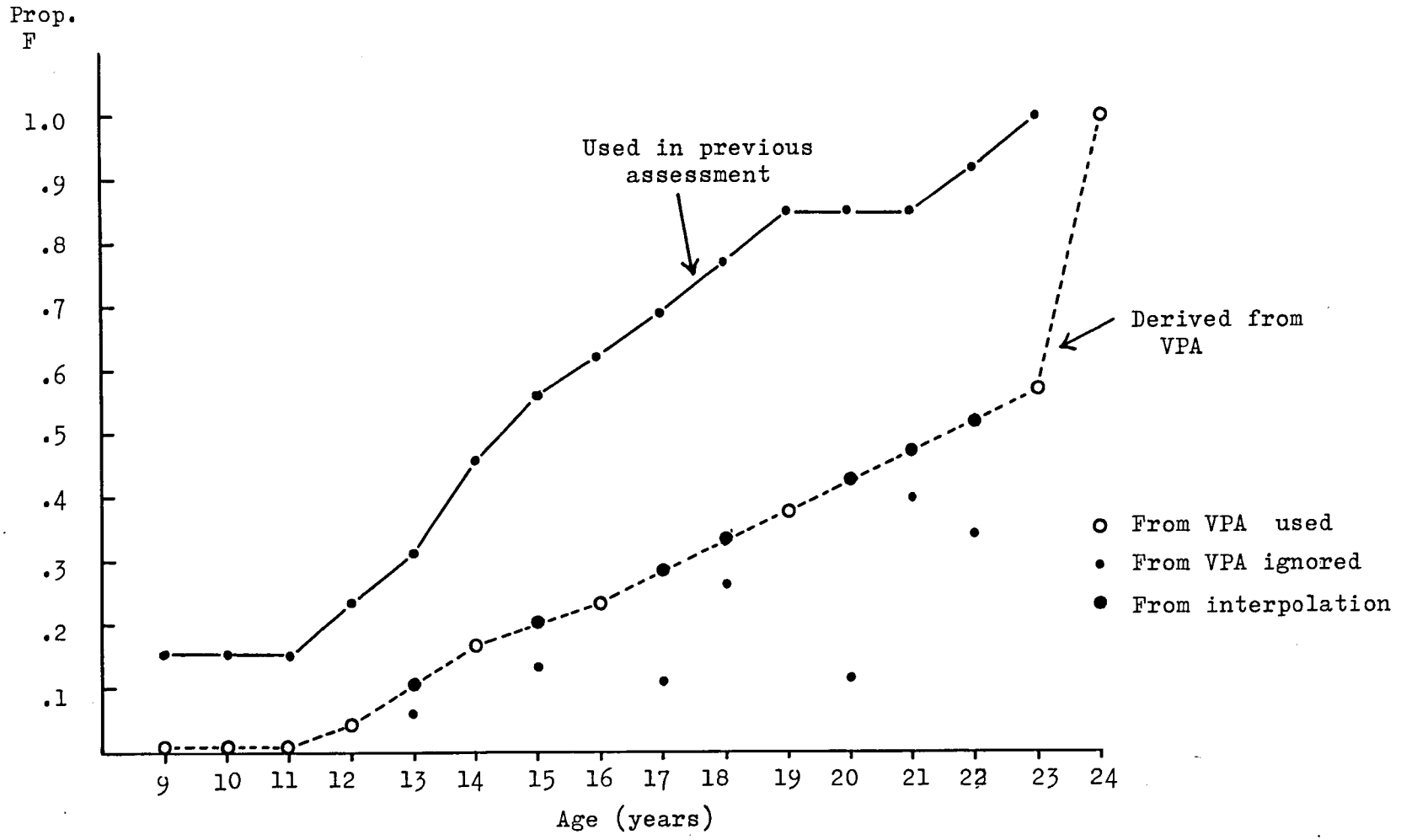


Figure 8. Sebastes marinus in Sub-areas V and XIV.

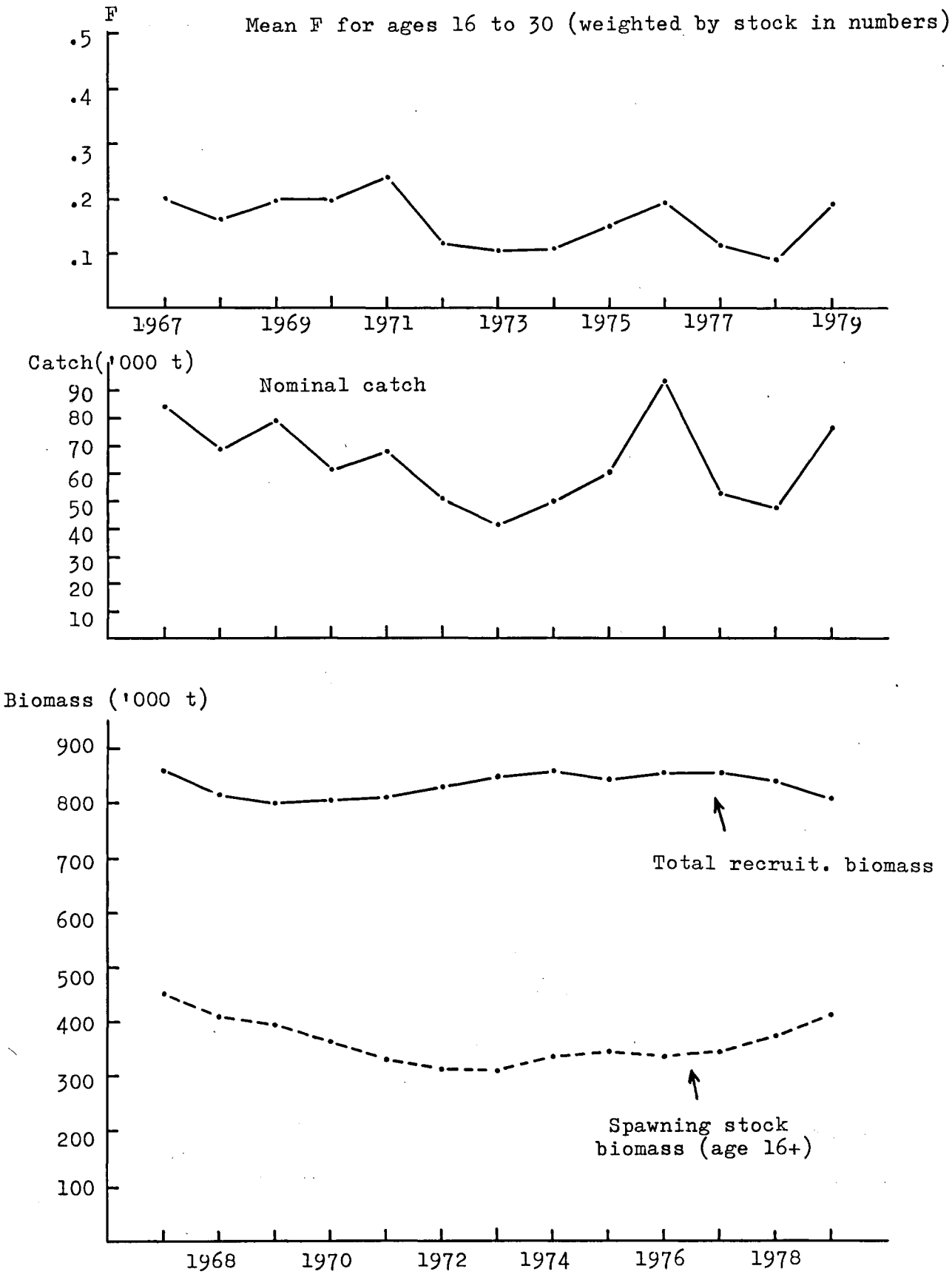


Figure 9. Sebastes marinus in Sub-areas V and XIV. Yield and spawning biomass per recruit in weight.

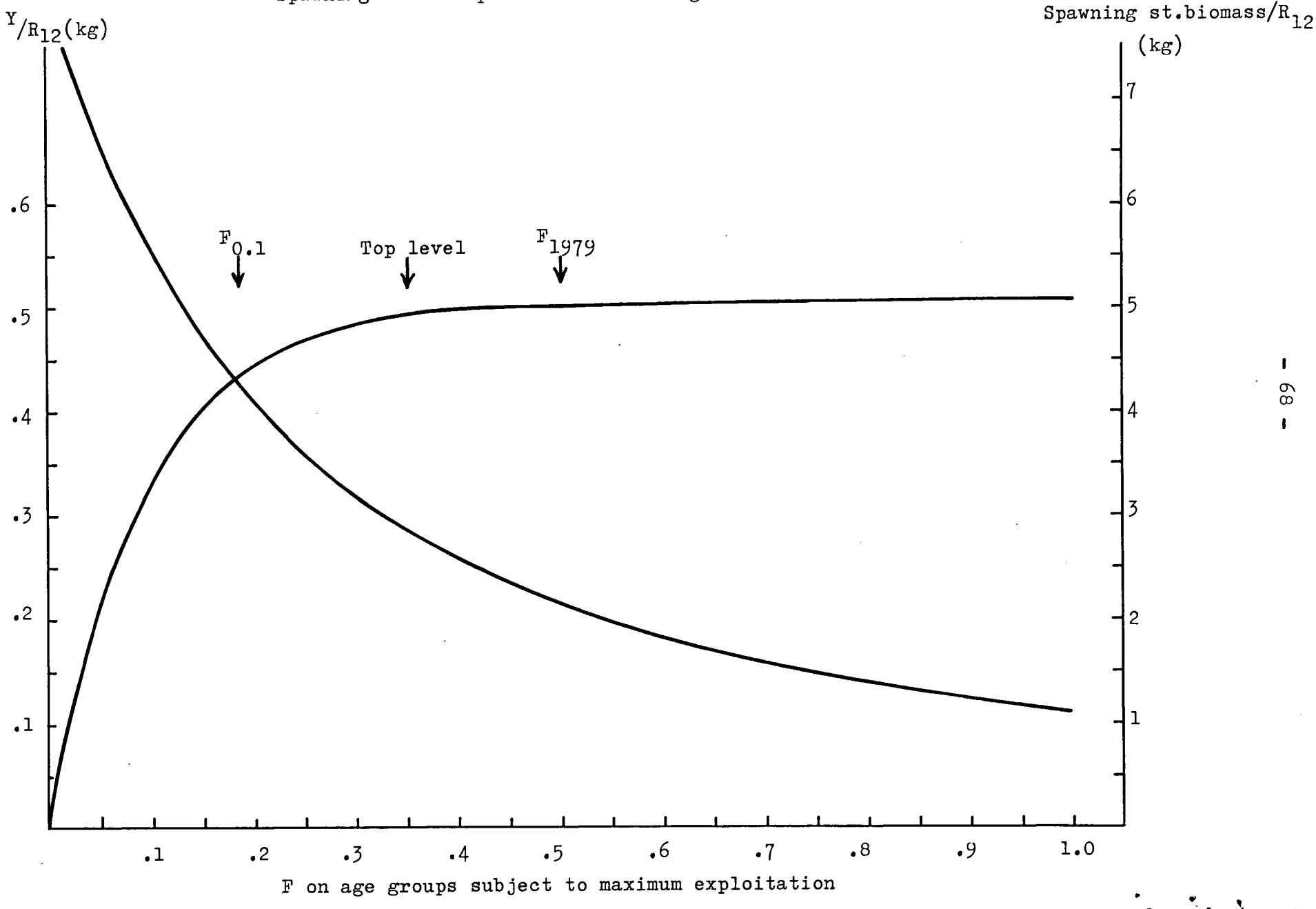


Figure 10. Sebastes marinus in Sub-areas V and XIV. Catch in 1981 and biomass (age 9+) and spawning stock biomass (age 16+) 1982 at different levels of F in 1981.

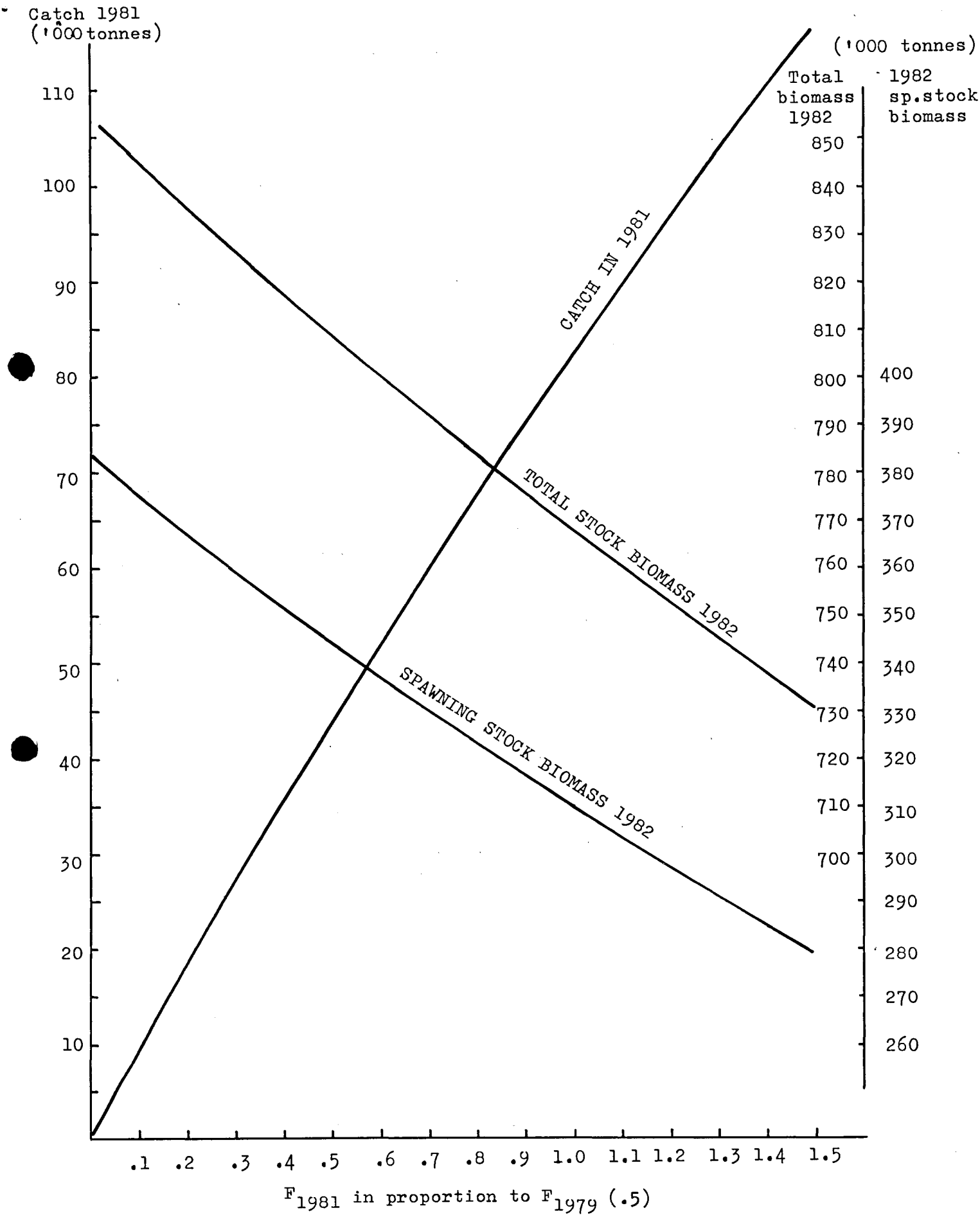


Figure 11. Sebastes mentella in Sub-areas V and XIV.

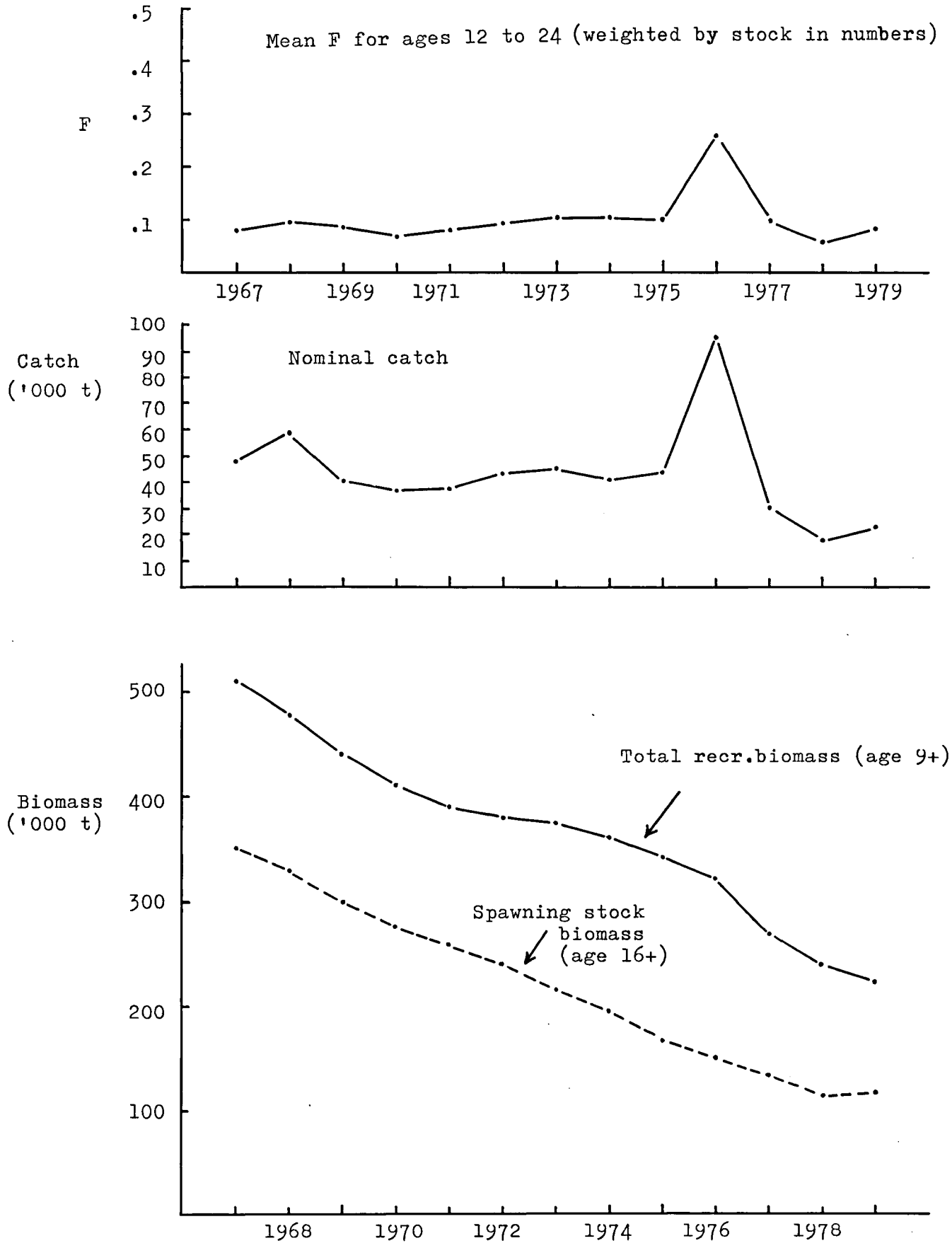


Figure 12. Sebastes mentella in Sub-areas V and XIV
Yield and spawning biomass per recruit in weight

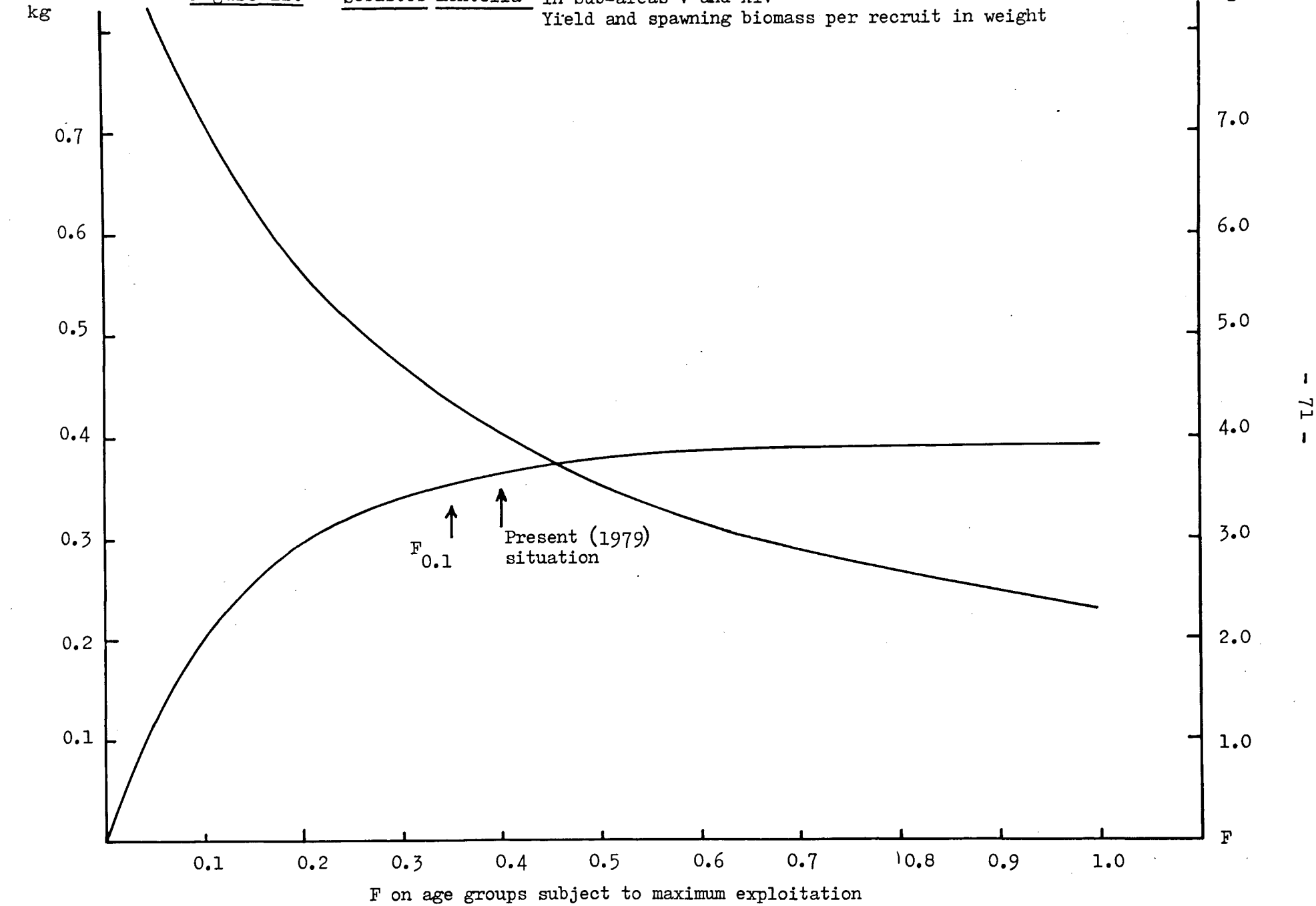


Figure 13. Sebastes mentella in Sub-areas V and XIV. Catch in 1981, total biomass (age 9+) and spawning stock biomass (age 16+) in 1982 at different levels of F in 1981.

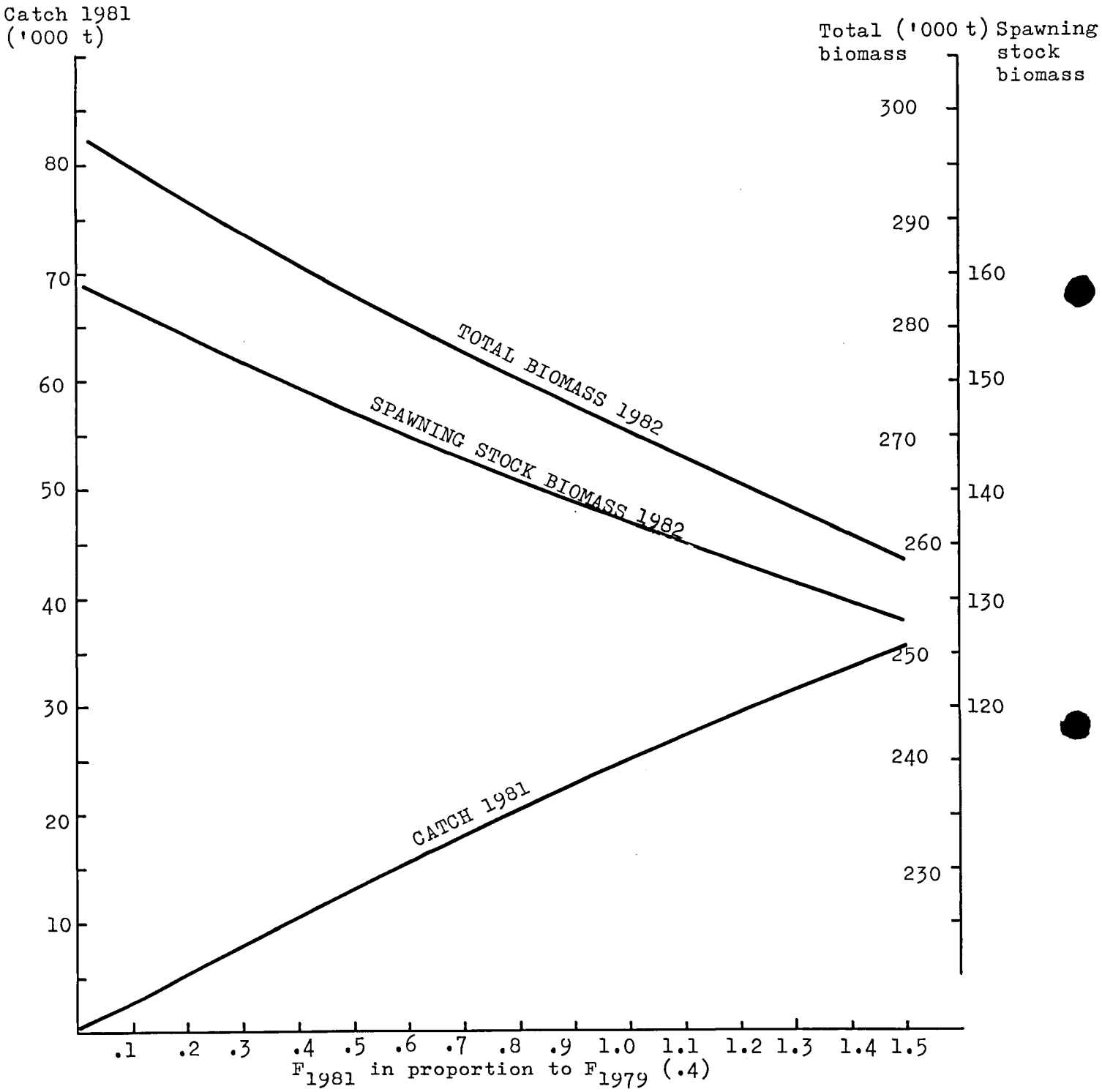


Figure 14. Mean weight at age for Greenland halibut in Sub-areas I and II (both sexes). Line fitted on the bases of the data from 1979 (USSR fishery). The mean weights used for the period 1970-78 plotted for comparison.

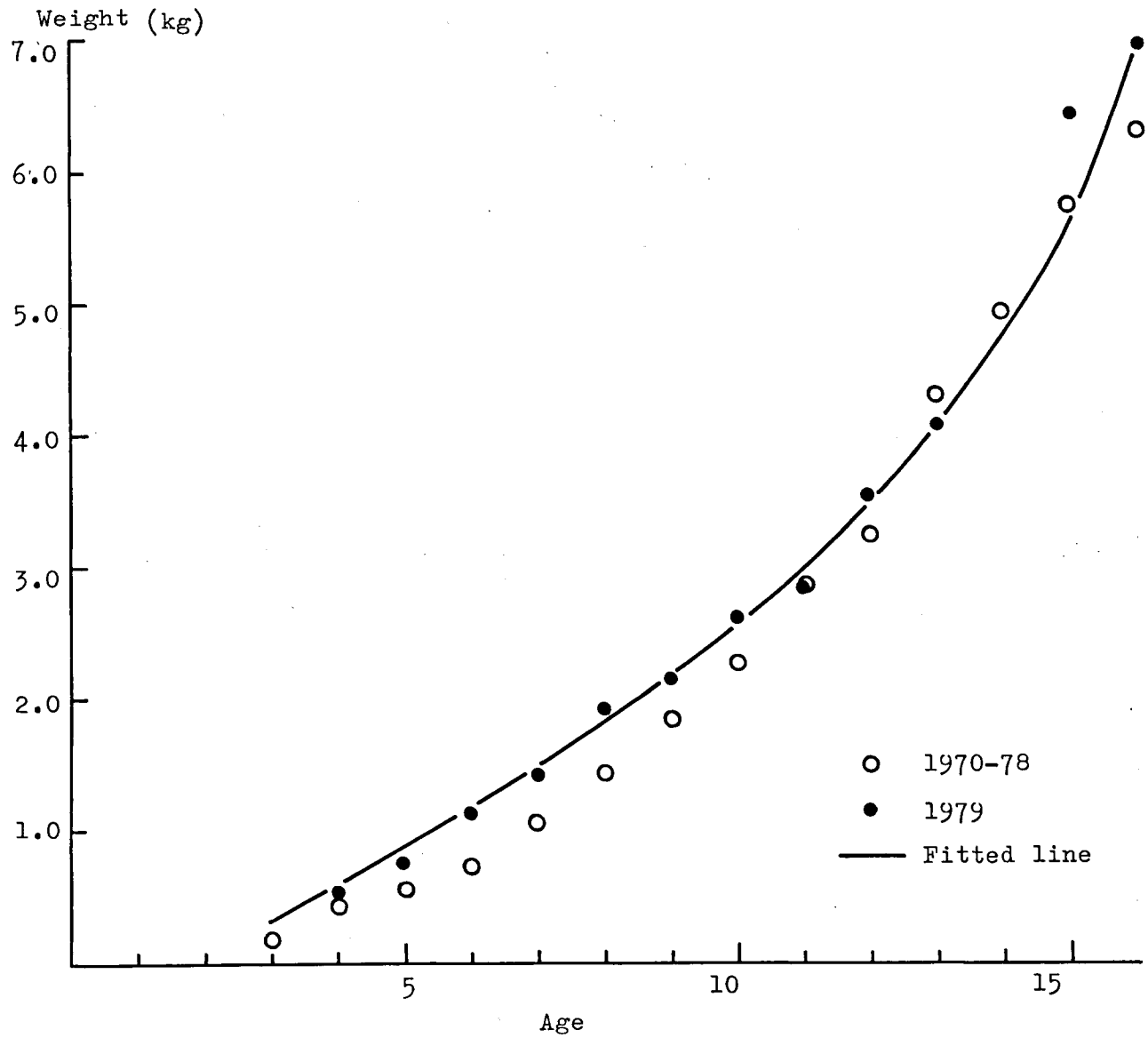


Figure 15. Greenland halibut in Sub-areas I and II. The relation between the mean fishing mortalities on age groups 7-11 (unweighted) and the total effort based on cpue data from the USSR trawl fishery. Open symbols not considered in drawing the line.

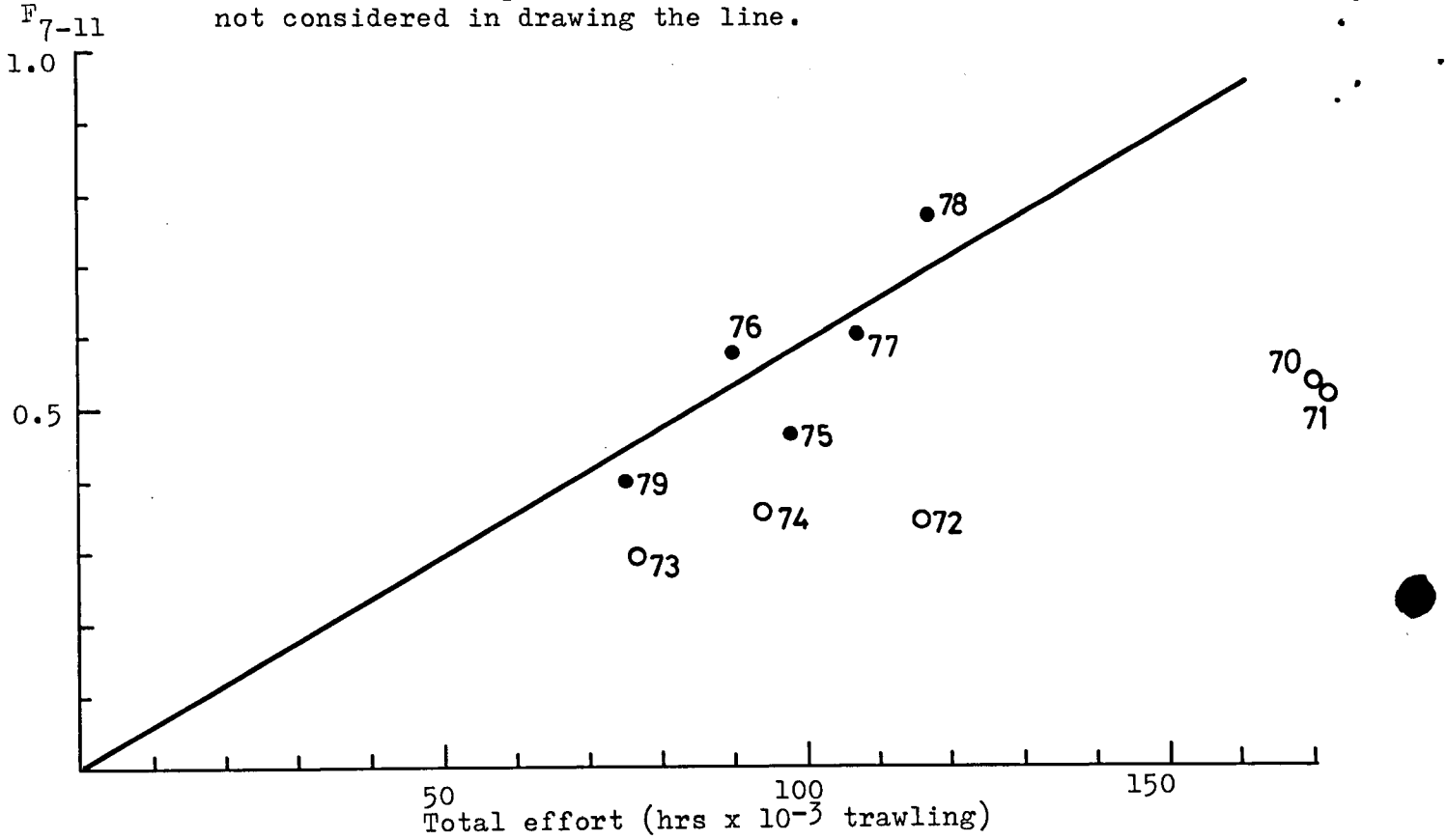


Figure 16. Greenland halibut in Sub-areas I and II. The relation between the mean fishing mortalities on age groups 7-11 (unweighted) and the total effort based on cpue data from German Democratic Republic trawlers. Open symbols not considered in drawing the line.

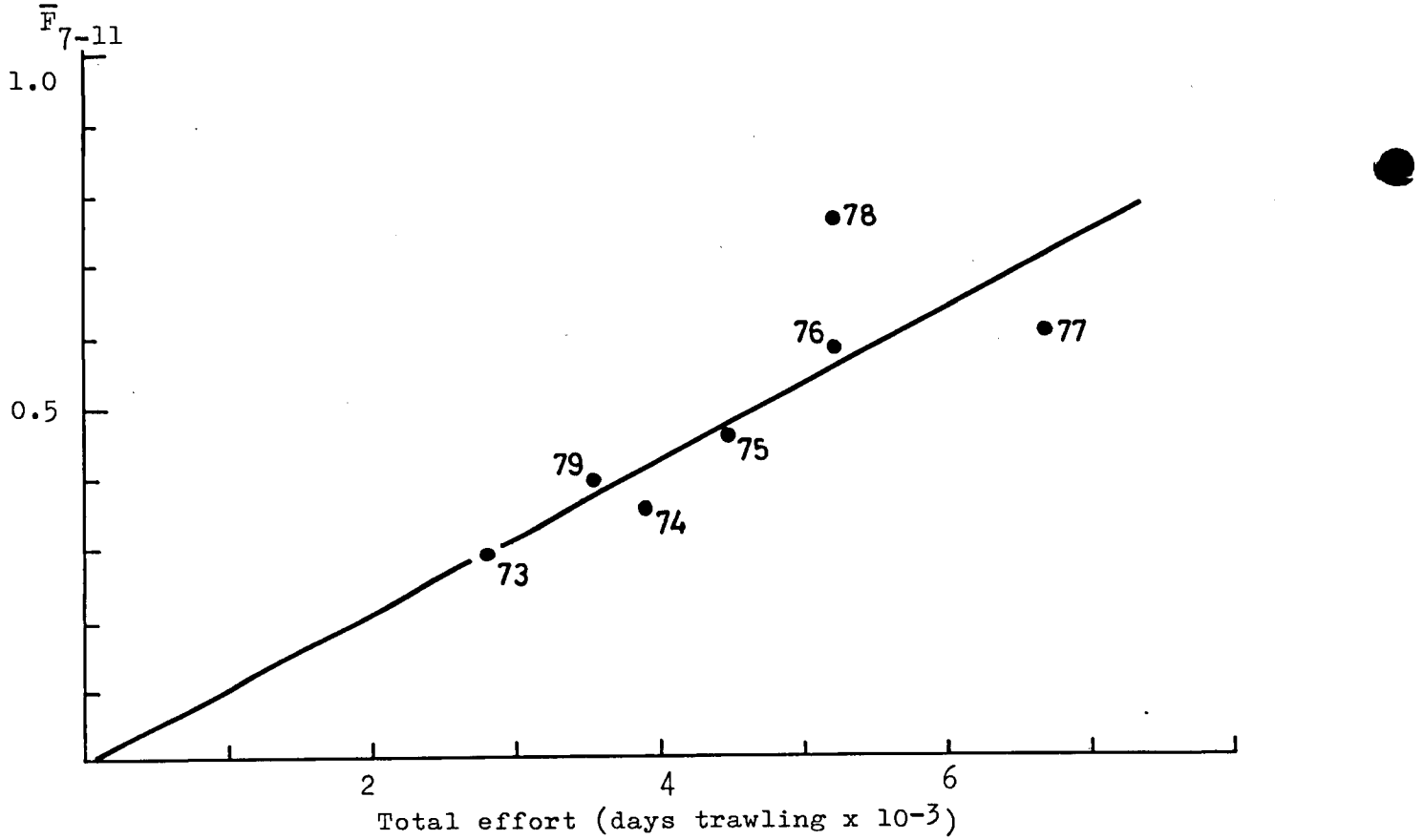


Figure 17. Greenland halibut in Sub-areas I and II. Fishing pattern for 1972-75, 1976-78 and 1979.

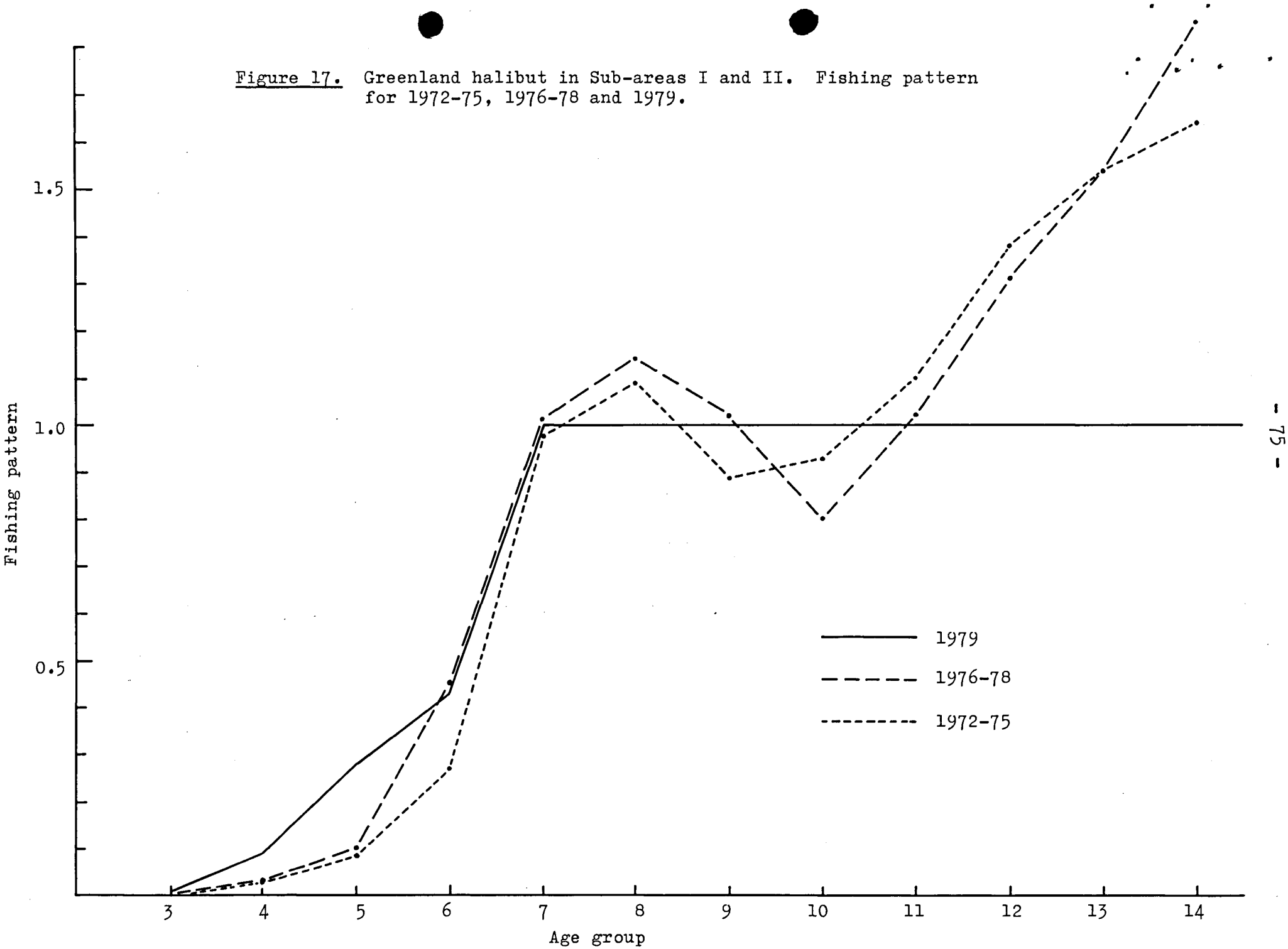


Figure 18. Greenland halibut in Sub-areas I and II. The relation between the cpue of German Democratic Republic trawlers and the biomass of 4 years and older fish.

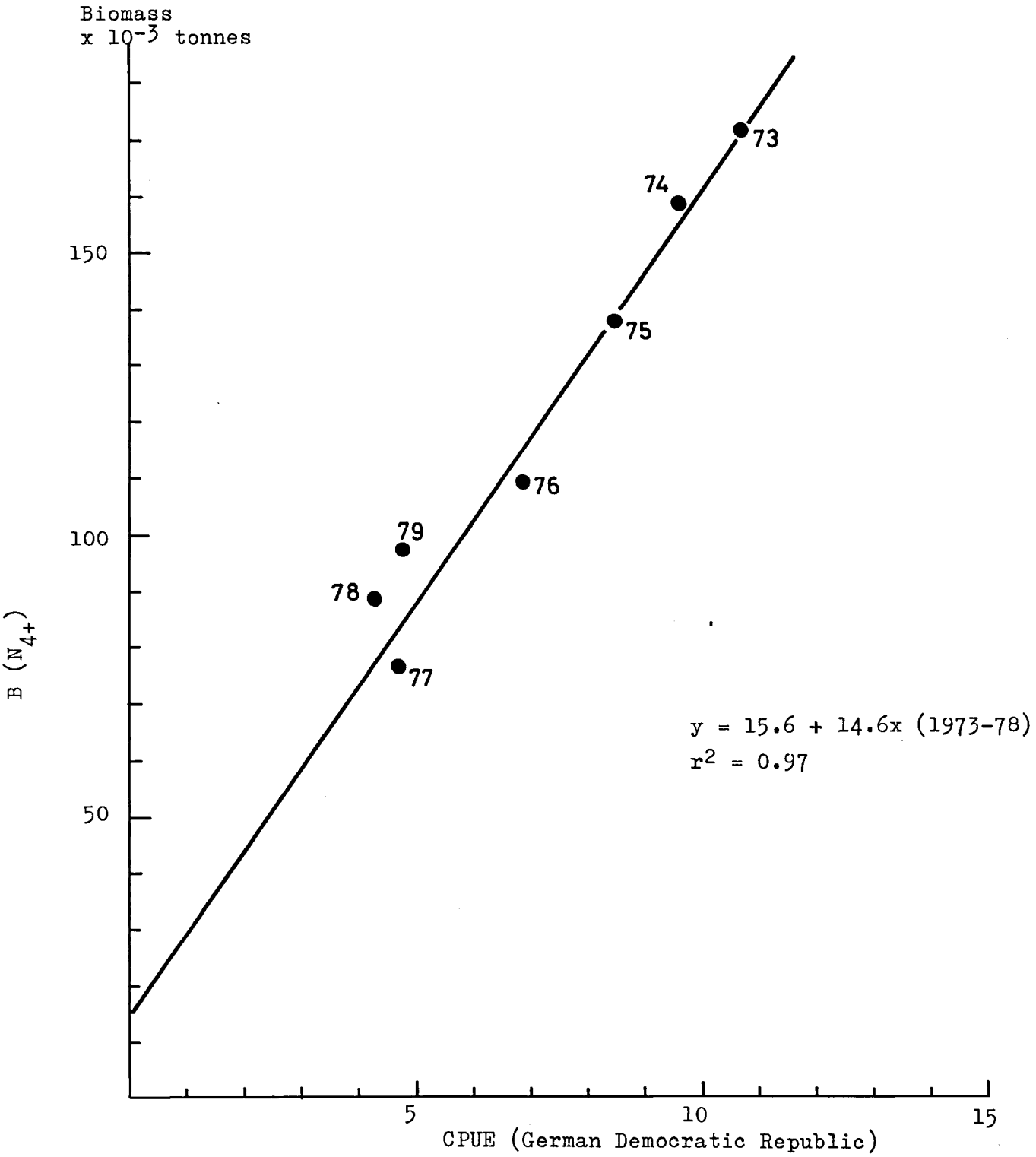


Figure 19. Greenland halibut in Sub-areas I and II. The relation between the cpue of USSR trawlers and the biomass of 4 years and older fish.

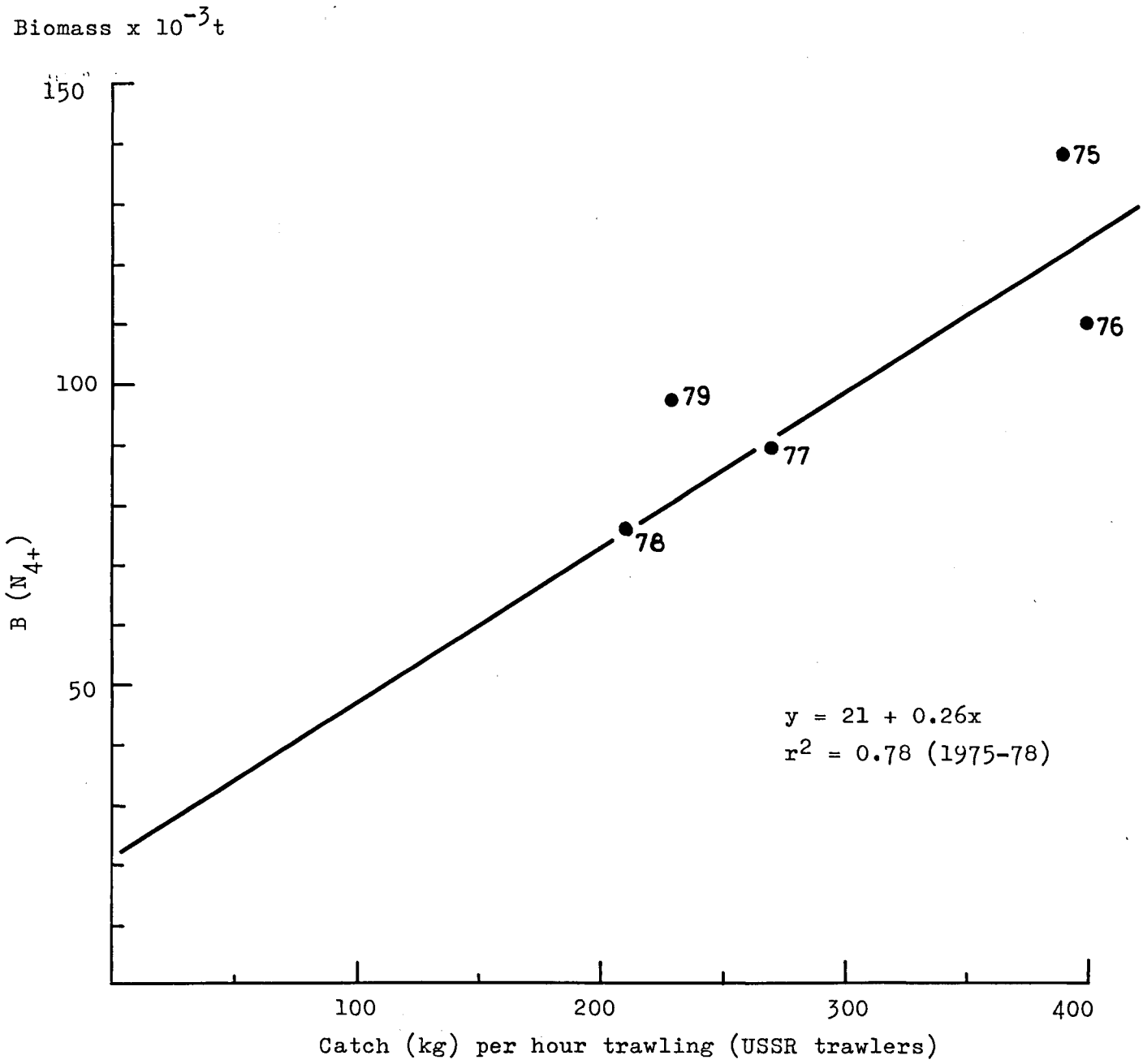


Figure 20. Greenland halibut in Sub-areas I and II. Catch per unit of effort of 7 years and older fish by German Democratic Republic trawlers versus the estimated biomass of the same age groups.

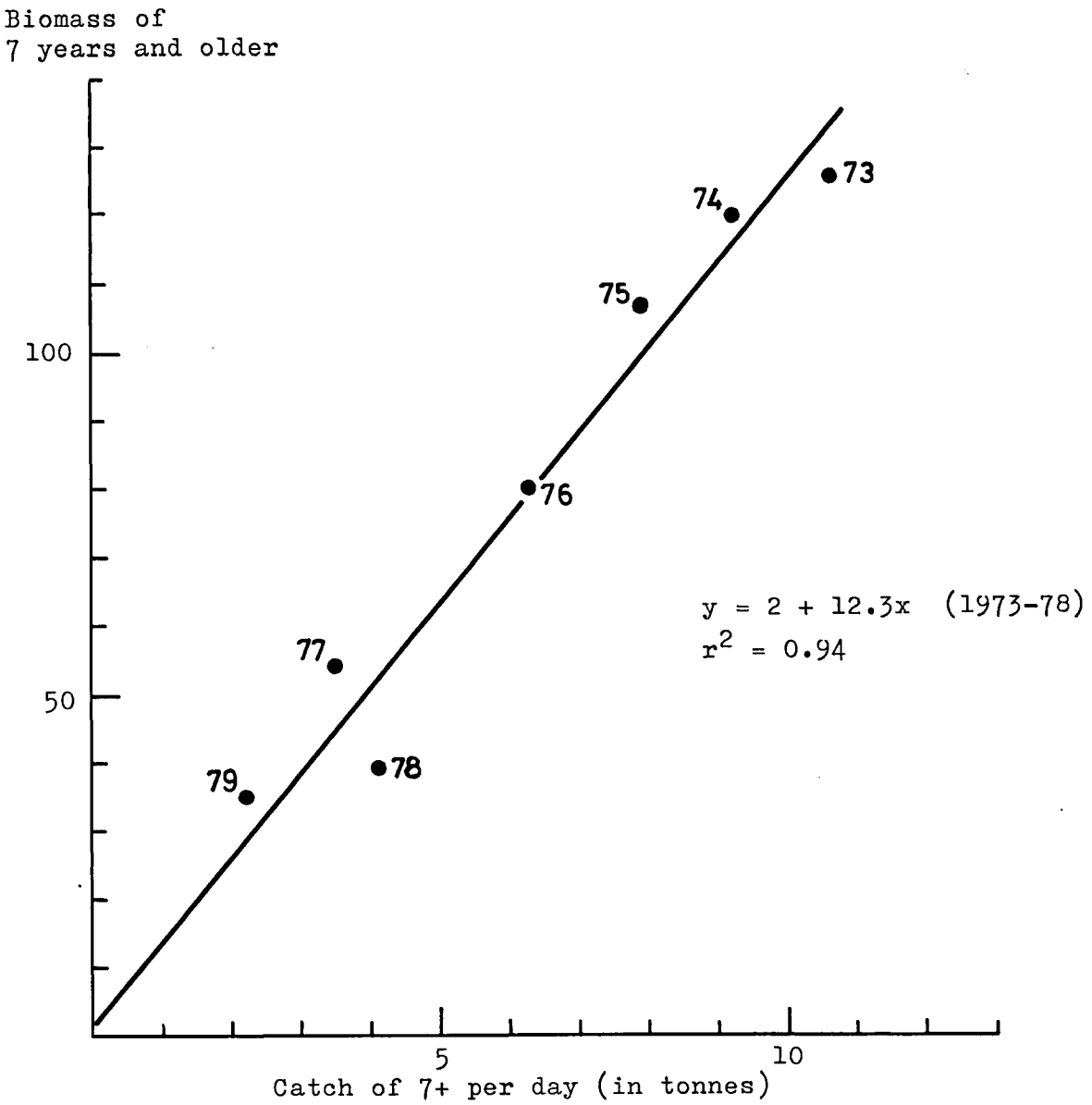


Figure 21. Greenland halibut in Sub-areas I and II. Yield per recruit and spawning stock per recruit as a function of the fishing mortality on 7 years and older fish.

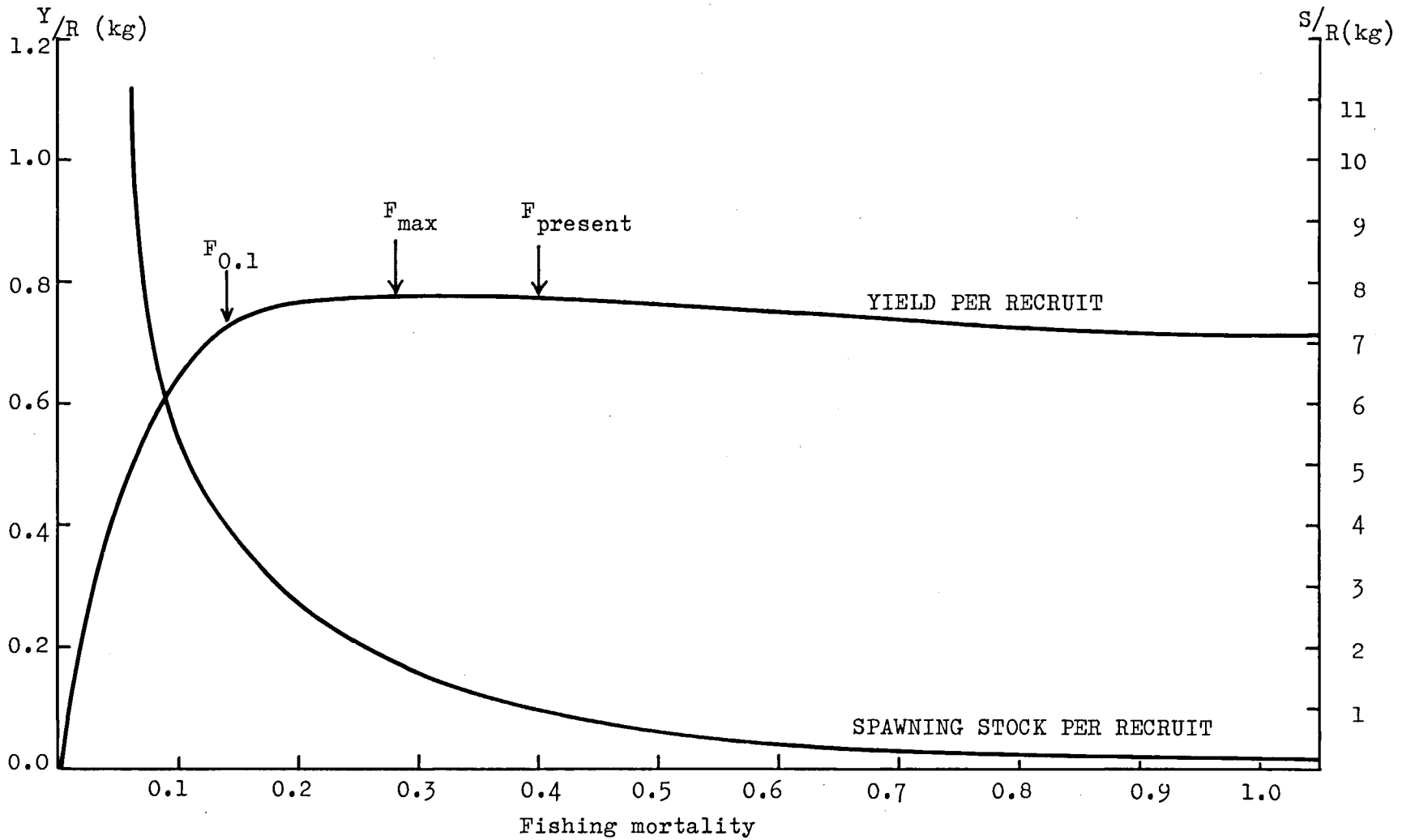


Figure 22. Greenland halibut in Sub-areas I and II. Prognosis of the total stock, the spawning stock in 1982, and catch taken in 1981 versus the fishing mortality in 1981 versus the fishing mortality in 1979. (F_{1979} = 0.40).

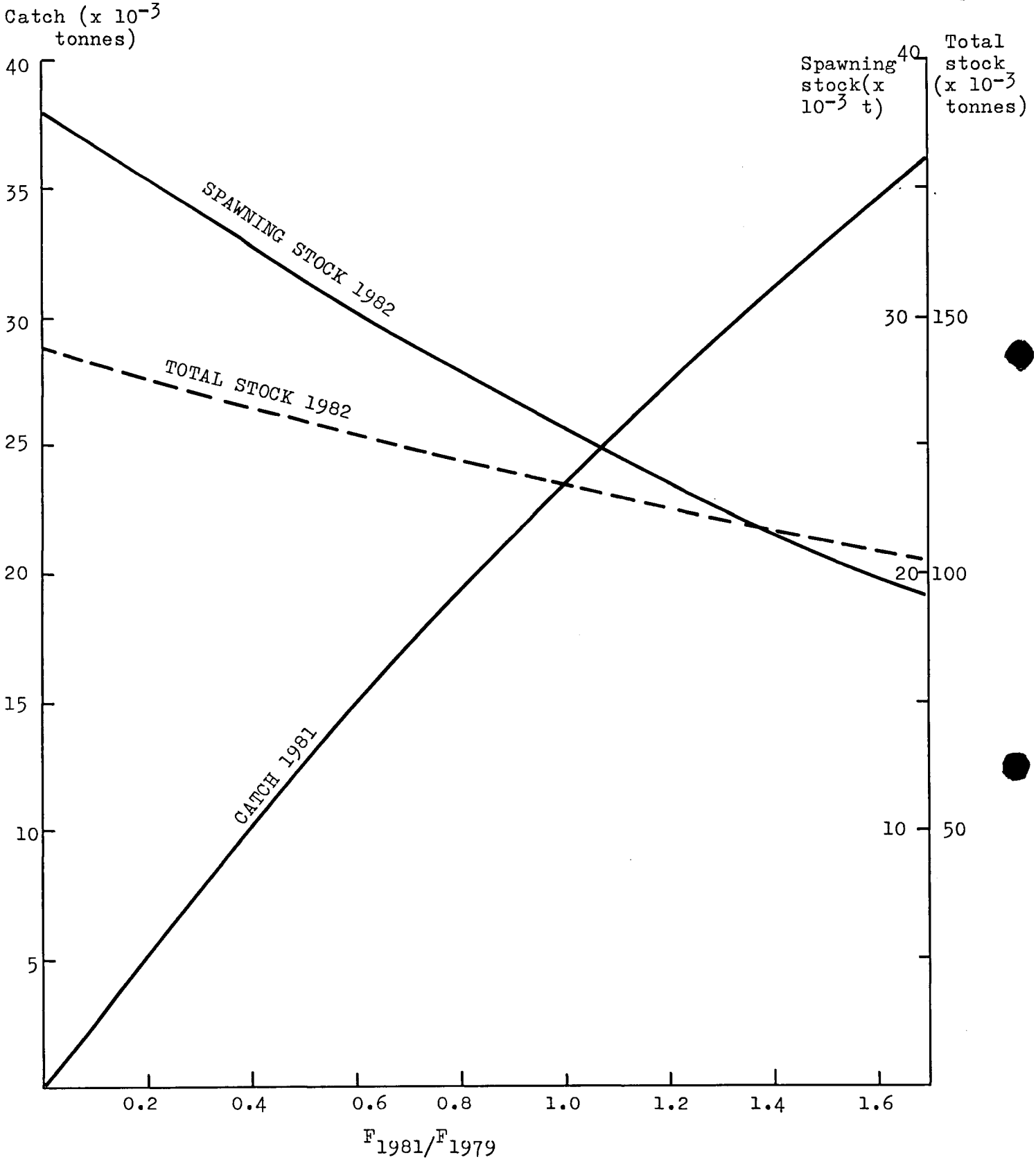
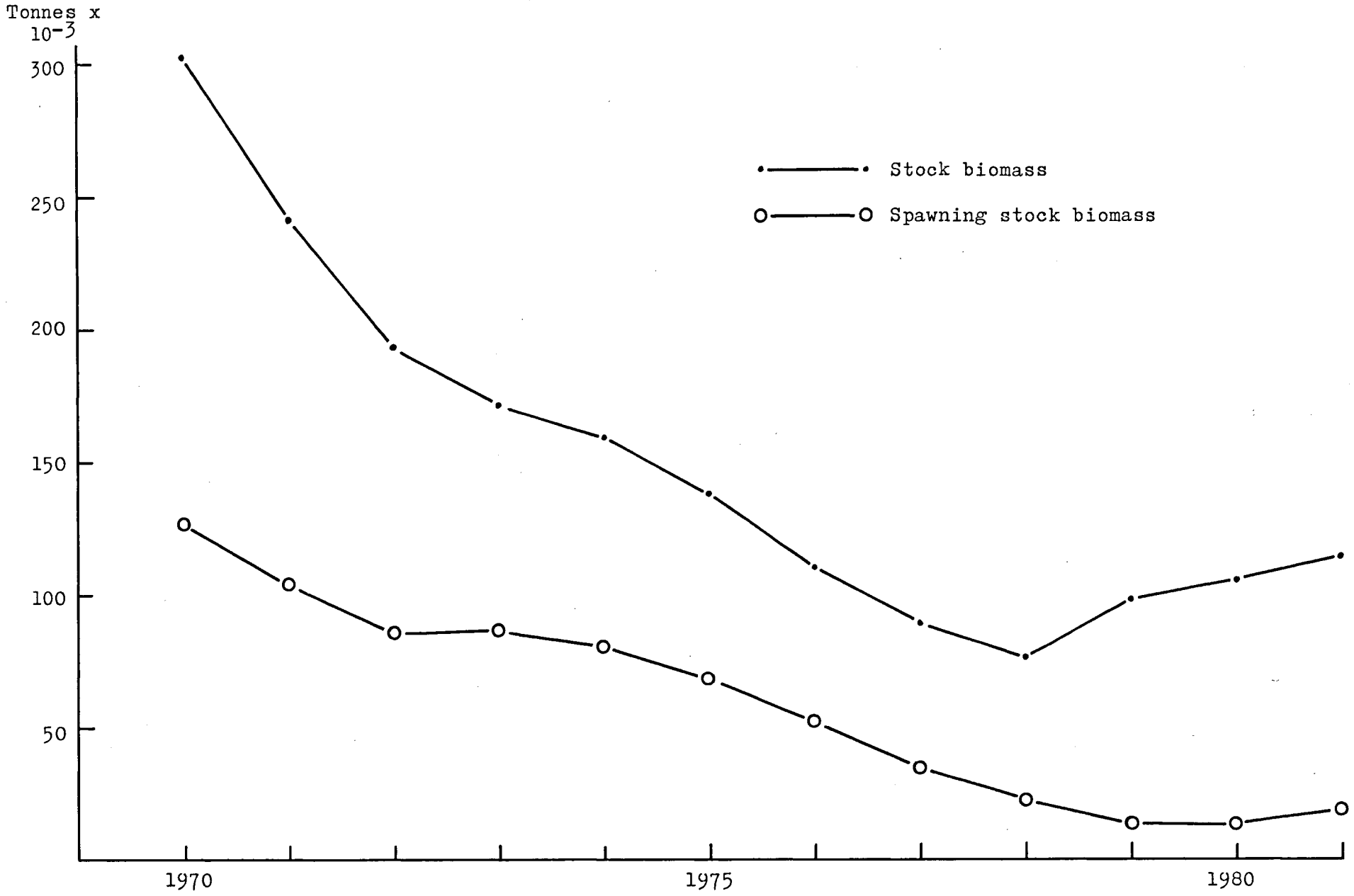


Figure 23. The stock biomass (4 years and older) and the spawning stock biomass (9 years and older) for Greenland halibut in Sub-areas I and II.



APPENDIX

A NOTE ON MESH ASSESSMENT OF THE REDFISH FISHERIES IN SUB-AREAS I AND II

by C.J. Rørvik and A. Hylen

INTRODUCTION

The basic ideas of the mesh assessment method were developed by K.P. Andersen at the Danish Institute for Fisheries and Marine Research. The method is partly described by Hoydal (C.M.1977/F:51), and it has been used by the Arctic Fisheries Working Group (C.M.1979/G:20). A detailed description of the method will be given in Hoydal, Rørvik and Sparre (in prep.).

The essence of the method is that the simulated relative length (or age) distribution of the catches on each of the fisheries (one or several) of the same stock is compared with the observed relative length (or age) distributions. The mesh sizes of the fisheries are systematically changed until the sum of the squared distances between the observed and the estimated relative length distributions are minimised. The outcome is the estimations of the effective mesh sizes.

In the simulations discard practice, the recruitment and possible later de-recruitment of the fish are taken into account for each fishery, as well as the selective properties of the gears. The von Bertalanffy parameters and fishing mortalities are fixed input parameters.

The second stage of the method compared the simulated age distributions of two different sets of mesh sizes (or any other fixed input parameters). The method computes the yearly changes of the yields until it stabilizes the new long-term averages corresponding to the new effective mesh sizes.

The model assumes a stable recruitment, therefore the age and length compositions used are the average from as many years as possible from the period 1967-78 when the legal mesh size was 120 mm in the fisheries concerned in the present assessment.

1. INPUT DATA

1.1. Von Bertalanffy Parameters L_∞, K, t_o

1.1.1. Sebastes mentella

We used the averaged data in document C.M.1978/G:4 (Table 12). The results are given in Appendix Figure 1.

1.1.2. Sebastes marinus

We used the averaged data from paper C.M.1978/G:4 (Table 11). The results are given in Appendix Figure 2.

1.2. Age Data

1.2.1. Sebastes mentella

Averaged 1967-78, from Table 14 in document C.M.1979/G:25. Only total available.

1.2.2. Sebastes marinus

Averaged 1969-78, from Table 9 in document C.M.1979/G:25. Shown in Appendix Figure 3. This age distribution has a multi-mode shape (Appendix Figure 3), which may have been caused by several fisheries fishing in areas with large different recruitment curves etc. We evaluated this age distribution (from the total fishery) not too suitable for an optimization.

1.3. Length Data

1.3.1. Sebastes marinus

Length composition data for USSR in areas I and IIa, and for the Federal Republic of Germany in Division IIa were available. The length compositions of the total catch were split in the USSR fishery and other countries' fisheries (the rest). The class intervals in the USSR length compositions were adjusted to correspond with those for other countries. For details, see Appendix A.

1.3.2. Sebastes mentella

USSR data for 1965-78 in areas I, IIa and IIb are available. Used Divisions IIa and IIb data for 1968-78. (1967 not available.) For those years (1973-75) when Division IIa data were not available, Division IIb data were applied to the total catch. Total number caught was adjusted to be equal to that given in Table 12 in document C.M.1978/G:4. As for S. marinus an adjustment for the 0.5 cm difference in length measuring was done.

1.4. Catch Data

1.4.1. Sebastes marinus

The total catch in Sub-area I and Division IIb was given for 1967-78 in Table 5 of document C.M.1979/G:25. The total USSR catches for 1967-75 in Sub-area I and Division IIa were available in Table 7 of document C.M.1978/G:14. For 1976-78 the USSR catch was estimated by subtracting the USSR catch of S. mentella calculated from cpue and effort in Table 6 in C.M.1979/G:25 from the total USSR catch of redfish available in Table 1 of document C.M.1979/G:25. Total catches by all countries except USSR were calculated by subtracting the USSR catch from the total.

The USSR catch in Division IIa was estimated as the difference between its total catch and the Sub-area I catch available in Table 2 of document C.M.1979/G:25.

1.4.2. Sebastes mentella

Total catches were available for the period 1967-78 in Table 5 of document C.M.1979/G:25.

1.5. Discards

With the lack of data, no discard curve was applied (see also Section 2.2.1.1).

1.6. Gear Parameters

1.6.1. Selection factor

Selection factor - L_{75}/L_{50} ratio

Source: Coop.Res.Rep., No.25 (Ser.A).

Range: 2.5 - 3.5

Average: 2.90

L_{75}/L_{50}: 1.17

1.7. Selection Curve and Recruitment Curve F & M

Modified tangens hyperbolicus curves are used:

Let:

$$f(L) \stackrel{def}{=} EXP\ (Ln\ 3 \times (L - L_{50})/(L_{75} - L_{50}))$$

Then the selection curve as a function of length l is:

$$S(L) = f(L)/(1 + f(L))$$ (a modified tan?)

Recruitment curve:

$$R(L) = (f'(L)/(1 + f'(L))\ (f''(L)/(1 + f''(L))$$

where $f'(L)$ describes the ascending part ($L_{75} > L_{50}$) and $f''(L)$ the descending part ($L_{75} < L_{50}$) of the recruitment curve.

L_{75} = Length at 75% selection/recruitment

L_{50} = Length at 50% selection/recruitment

The von Bertalanffy equation gives the relation between the length and age.

The level of the fishing mortalities were taken from VPA (last Working Group report), and in the case of the S. marinus it was split so that the percentage split of the catch corresponded to the observed split (1969-78). $\mathcal{M}$ = 0.10 is used.

2. RESULTS

2.1. Sebastes mentella

2.1.1. Length data

2.1.1.1. Maximum mesh size

That is using full recruitment for all age/length groups exploited. Results are given in Appendix Figure 4. The fit between the observed and estimated curve is expressed by the object function (= sum of squared distances between observed and estimated values).

Max. mesh size: 96.5 mm
Object function: 7251

2.1.1.2. Effective mesh size

The recruitment curve shown in App. Figure 5 gave a reasonable fit between the observed and estimated length distributions (Appendix Figure 6).

Eff. mesh size: 80.0 mm
Object function: 4755

2.1.2. Age data

2.1.2.1. Maximum mesh size

Results shown in Appendix Figure 7.

Max. mesh size: 140 mm
Object function: 16511

2.1.2.2. Effective mesh size

The recruitment curve shown in Appendix Figure 8 gave a reasonable fit between the observed and the estimated age distribution (Appendix Figure 9). This reduced the object function from 16511 to 2168.

Eff. mesh size: 70.0 mm
Object function: 2168

2.1.3. Comparison of the estimation based on age and length data

The estimations based on the age distribution generally gave lower values of effective mesh size than the length distributions.

For comparison, Appendix Figure 6 shows the length distribution as generated by the results from the optimization based on age data, and vice versa in Appendix Figure 9.

Appendix Figure 10 shows the observed distribution of the fishing mortalities with age, compared with the fishing mortalities generated by the effective mesh size and recruitment curves as estimated from the age and length distributions, respectively.

Accepting the von Bertalanffy parameters (Appendix Figure 1) the length data indicate that the catches are comprised by more younger fish than the age data (Appendix Figure 9). The peaks

in Appendix Figure 9 are 2 years apart. A difference of 0.5 years can be explained by the fact that $t_0 = -0.29$ (Appendix Figure 1) was used in these calculations. However, if the samples on which Appendix Figure 1 is based are taken throughout the year, rather than in the beginning of the year (the "birthday"), t_0 will be increased by 0.5 year ($t_0 = -0.29 + 0.5 = +0.21$). This would change the age distributions based on the length estimation 0.5 years to the right (Appendix Figure 9).

2.2. Sebastes marinus

2.2.1. Length data

2.2.1.1. Effective mesh size

	USSR	Other countries
Effective mesh size	86.7 mm	107.7 mm
Object function	2450	4115 (Σ = 6565)

For the recruitment curves shown in Appendix Figures 11-12, the results shown in Appendix Figures 13-14 are achieved.

The fit between the observed and estimated fishing mortalities (as generated by the results above) is shown in Appendix Figure 15.

It seems reasonable to conclude from the length distributions of "Other countries" (Appendix Figure 14) (based on data from the Federal Republic of Germany) that a lot of discarding takes place. With the lack of data on discarding, an extra steep recruitment curve (Appendix Figure 12) was applied, although a discard curve (with the basic assumption that discards die) would be the best. Furthermore, the estimates of the effective mesh size for "Other countries" (107.7 mm) is highly dependent on this recruitment curve, which we really do not know much about. The reason for picking the curve shown in Appendix Figure 12 was that it gave a good fit between the observed and estimated length distributions, as well as what was (subjectively) thought as a reasonable value.

For these reasons, as well as for reasons discussed below in Section 2.3, it could well be, we believe, 30 mm higher or lower.

2.3. Some Evaluation of the Results

The effective mesh sizes are inversely proportional to the selection factor applied (2.90). A selection factor of, say, 2.5 would for example change the effective mesh size from 80 mm to 93 mm (= 80 x 2.90/2.5) in the case of the S. mentella (Section 2.1.1.2). Uncertainties because of "meshing" exist. This affects the selection factor as well as the L_{75}/L_{50} ratio. "Effective" mesh size might thus be quite different from the average real mesh sizes used in this period. There are uncertainties about the catch statistics (the split between S. mentella and S. marinus), the age distributions (especially the age distribution for S. marinus)(App. Figure 3) do not look very convincing to us. The length distribution shown in Appendix Figure 13, especially the ascending part, is somewhat difficult to simulate. The results from the simulations on S. mentella

gave different results (Appendix Figures 5, 6, 8, 9 and 10). This indicates that some inconsistencies exist in the basic data (or in the method).

The basic method assumes a constant recruitment. However, this is seldom (or never) the case in natural fish populations. For this reason the length (or age) data used should be the average for a period of years of at least the same length as the number of main-exploited age groups, in order to average out the effects of a varying recruitment. For S. marinus that should be nearly 20 years (Appendix Figure 3); for S. mentella about 10 years at least (Appendix Figure 9).

This makes the results from the S. mentella fishery more credible than the results from the S. marinus fishery.

A further complication arises because of great changes in the fishing mortalities, as the distribution used may differ significantly from a (age or length) distribution in an equilibrium situation.

Given these uncertainties we would not put too much weight on the actual values of the effective mesh sizes.

However, this does not render the results useless. Let the effective mesh size be m with some uncertainties; let the legal mesh size be increased by b mm, and let us assume that this also increases the effective mesh sizes by b mm. The second step in the mesh assessment method is to compare the age distributions generated by these two effective mesh sizes and to estimate the immediate and the long-term effects of a mesh size change. This is, simply speaking, similar to dividing m+b by m. In the ratio (m+b)/m, the uncertainties in m are within reasonable limits crossed out. That is, the relative effects of a change in the effective mesh size are less uncertain than the value of the effective mesh size.

2.4. Changing the Mesh Size

Four alternatives were considered. Let m be the effective mesh size.

m - 10 mm,	corresponding to	110 mm
m + 15 mm,	"	135 mm
m + 35 mm,	"	155 mm
m + 55 mm,	"	175 mm

2.4.1. Sebastes mentella

The long-term effects for changes of the effective mesh size are shown in App. Figure 16. It shows the results based on the age optimization, and the results from the length optimization. The trend is similar. [Note that the considerations at the end of Section 2.3 do not fully apply to these results, as the two curves are based on data that do not seem to be fully consistent, see also Section 2.3.]

Although it seems that the effects on the long-term yield of S. mentella is not very dependent on a change of the effective mesh (whatever it may be) of -10 mm to +35 mm.

Appendix Figure 17 indicates the expected yearly catches (in an initial equilibrium situation!!) until the long-term catch is achieved with the new effective mesh sizes.

2.4.2. Sebastes marinus

In Appendix Figure 18 the immediate and the long-term changes in the yield are given as a function of the change of the effective mesh size.

It appears that the long-term yield of the total fishery will be larger than or equal to the present for an increase of up to 55 mm (175 mm legal size). The "inclusion" of the discards in the recruitment function in the case of "Other countries" (see Section 2.1.1.1) works in the direction that this long-term gain may be somewhat underestimated. However, the long-term gains or losses are rather different for the two fisheries.

The immediate effects of a mesh change seem rather similar for the two fisheries. Again, however, if a large amount of discarding takes place in "Other countries" fisheries, as indicated by the length distribution (Appendix Figure 14) in our opinion, the immediate effects of a mesh change for this part of the total fishery is definitely overestimated. Changes of the mesh would mostly affect the amount of discards, leaving the retained (landed) catch[1] almost unchanged for relatively large changes of the effective mesh size.

3. CONCLUSIONS

With the probable exception of the USSR S. marinus fishery, but in the other cases, and in the total fisheries (for both species of redfish) an increase of the legal mesh size by up to 35 mm seems beneficial for the long-term yield from these stocks.

The basic age and length data, the background of independent information to "calibrate" input parameters (recruitment, discarding, selection etc.) are generally poor.

The values of the effective mesh sizes given above should therefore only be taken for what they are worth - first tentative suggestions.

1) = the yield in these calculations.

APPENDIX A

Sebastes marinus

Length Compositions

All countries, except USSR, for Sub-area I and Division IIa.

For 1969-1975, Federal Republic of Germany length compositions for Division IIa have been used.

For 1976-1978, Federal Republic of Germany length compositions for Division IIa have been used. Total length compositions taken from Table 8 in 1979 Report C.M.1979/G:25.

For USSR, length compositions submitted late 1979 have been used.

Sub-area I

Data for 1970 and 1974 missing.

For 1970, the average length compositions for 1969 and 1971 have been used.

For 1974, the average for 1973 and 1975 have been used.

Division IIa

Data for 1970 were missing. The average length composition for 1969 and 1971 has been applied.

Average Weights

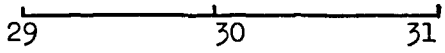
For all countries except USSR, the Federal Republic of Germany average weights in Division IIa have been used. The average weights for USSR both in Division IIa and Sub-area I have been calculated from the length/weight relationship established on the data given in Table 12 from the 1978 Report (C.M.1978/G:14).

Mean length in each cm group is 0.5 (30.5 cm). This gives:-

$$W = 0.016259\ l^{2.9506}$$

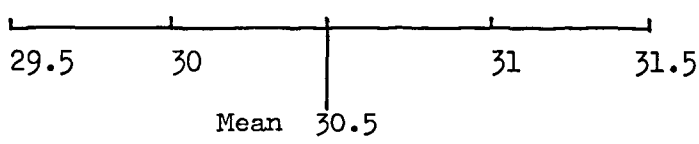
$$r^2 = 0.99688$$

All other countries except USSR have a class interval as follows:-

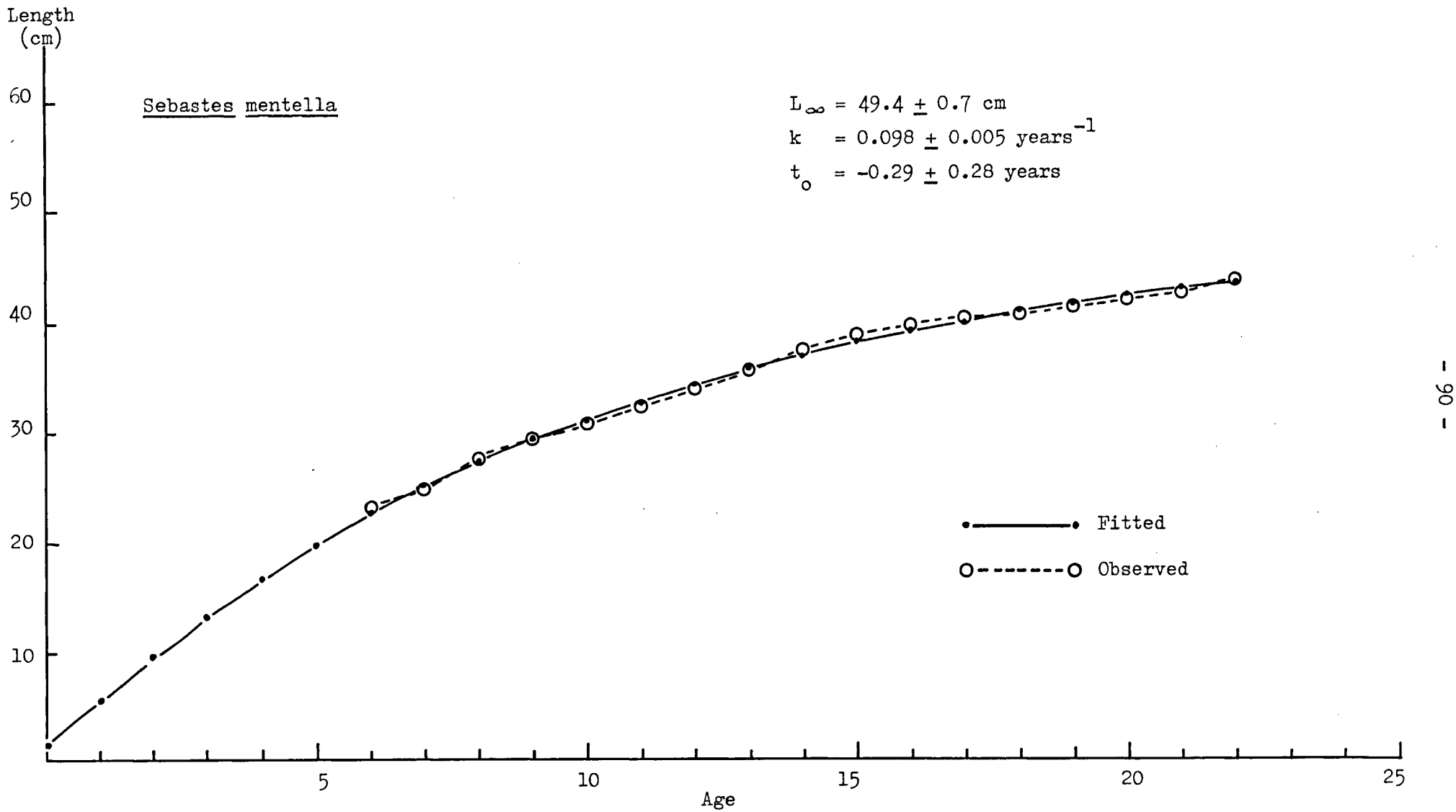


Average: 30.0 cm.

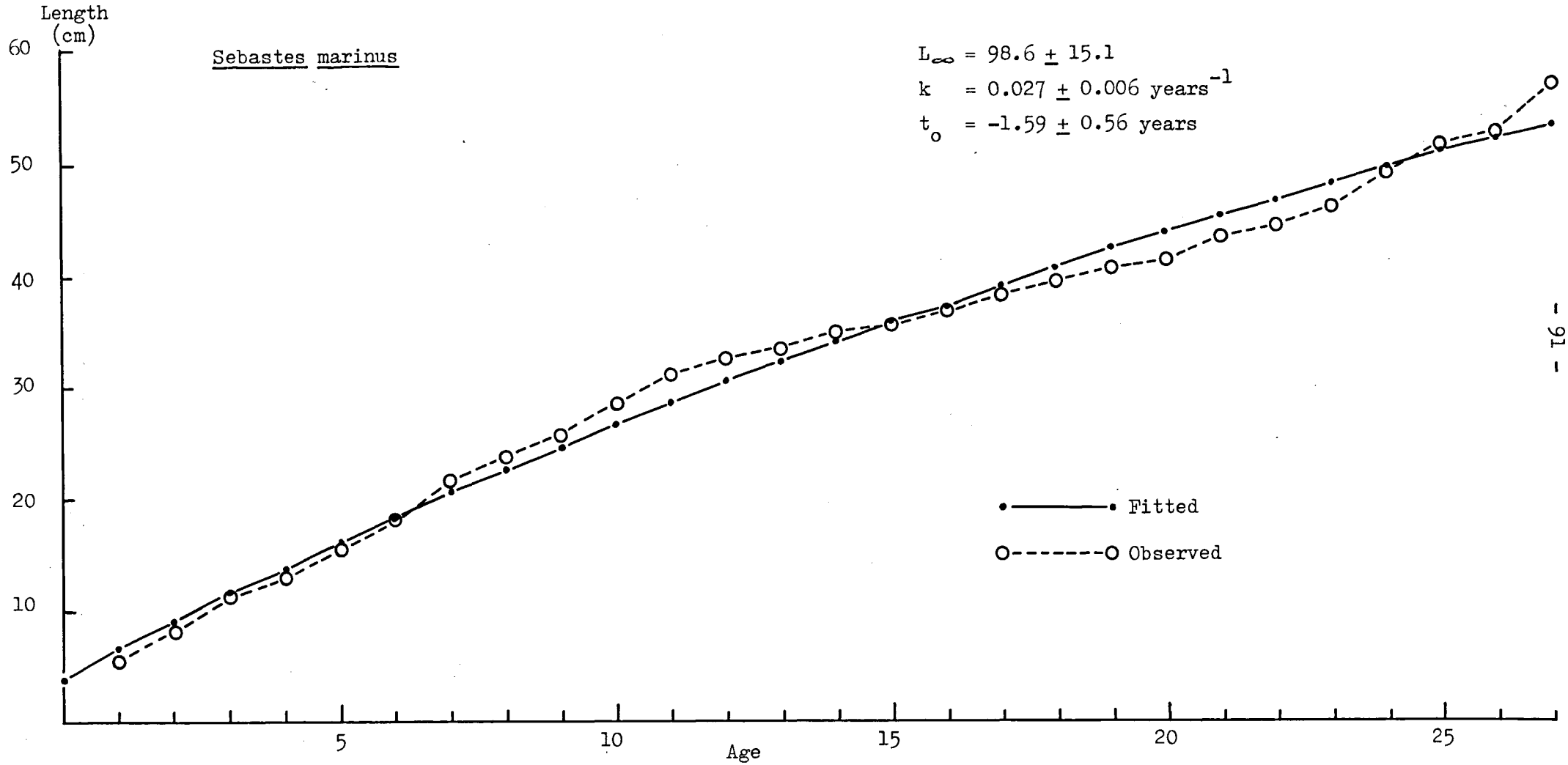
USSR has a class interval as follows:-



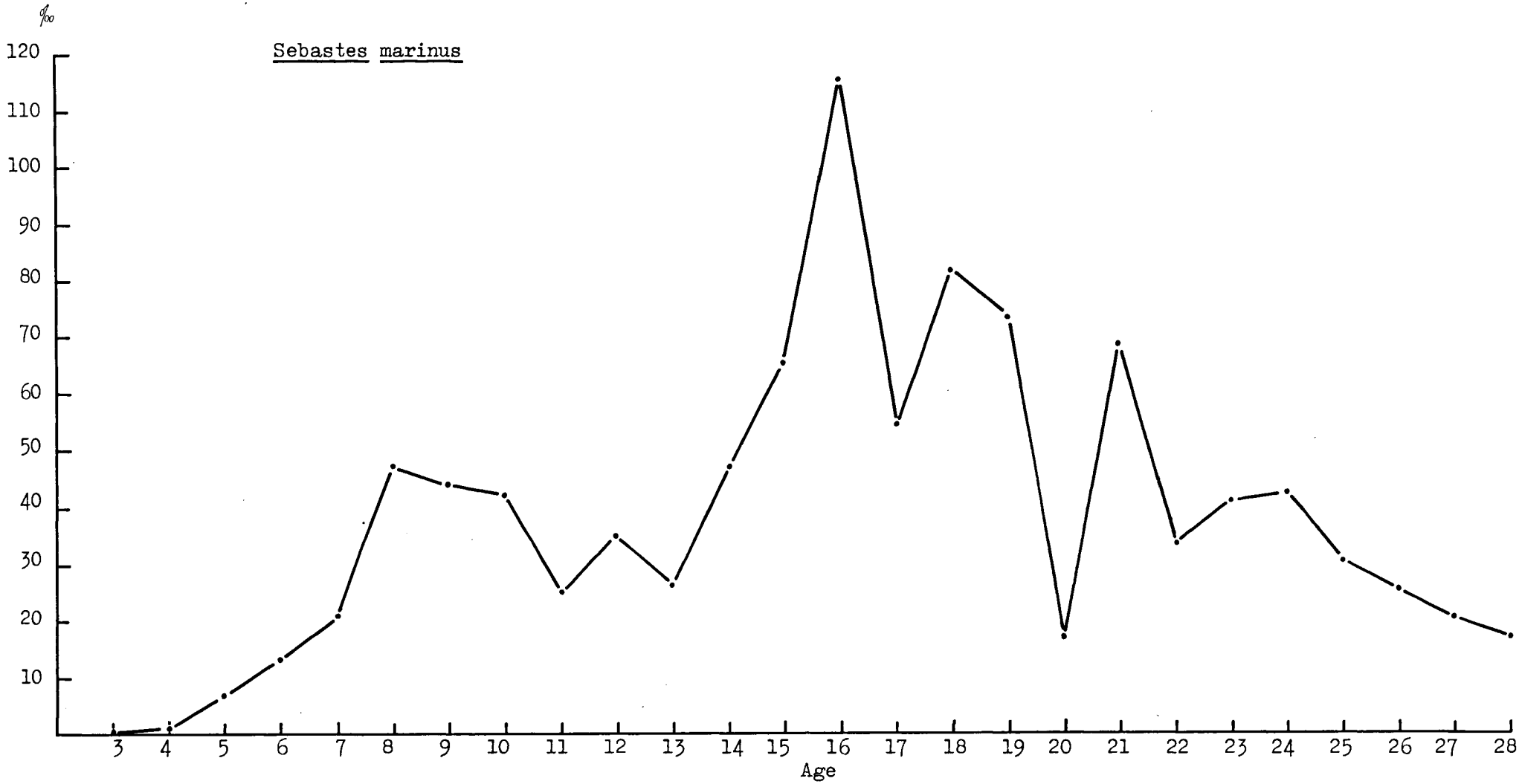
Average weights are calculated for 30.5, 32.5, 34.5 cm, etc.



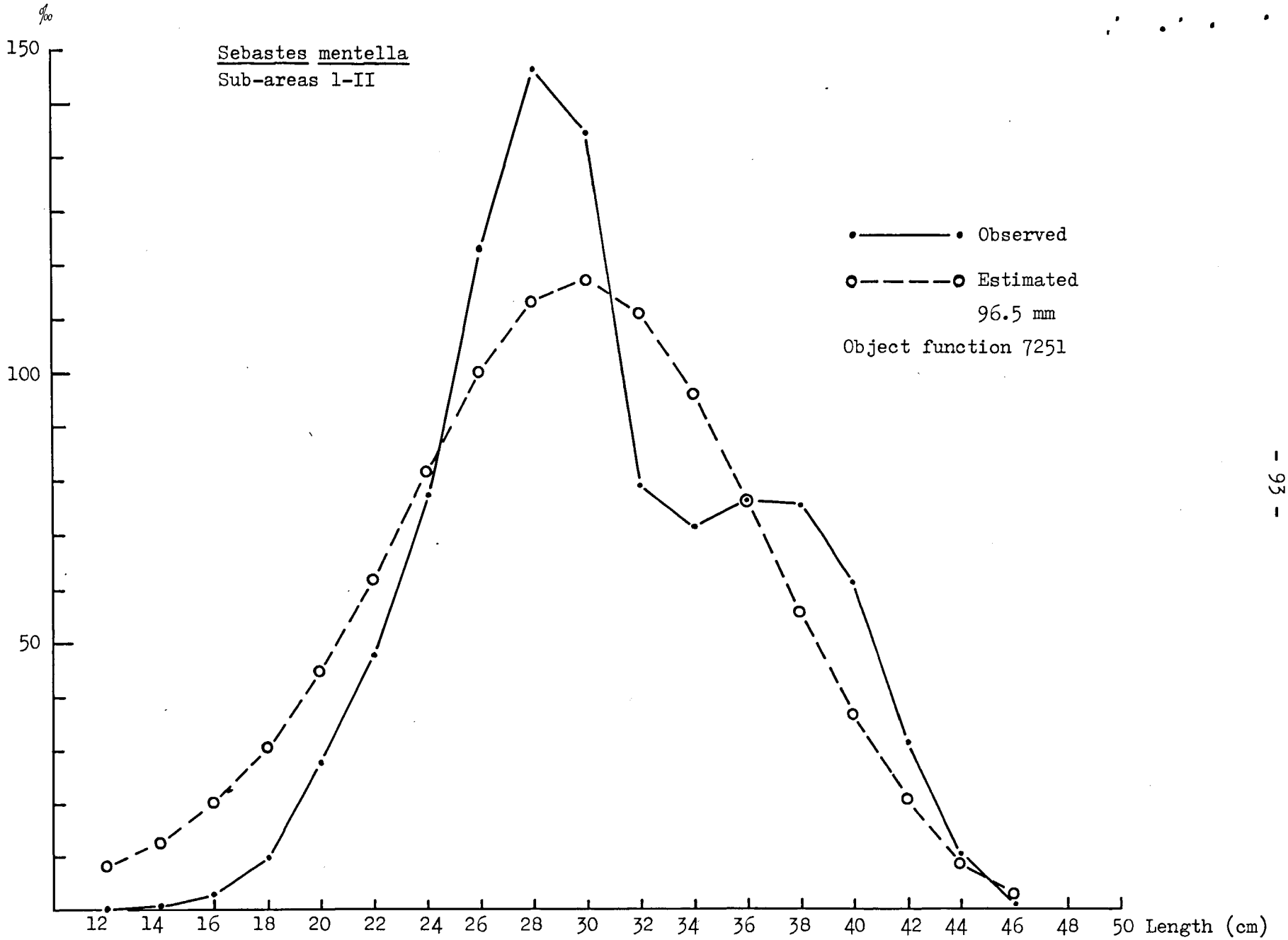
Appendix Figure 1. Von Bertalanffy fit for Sebastes marinus. Sub-areas I and II.



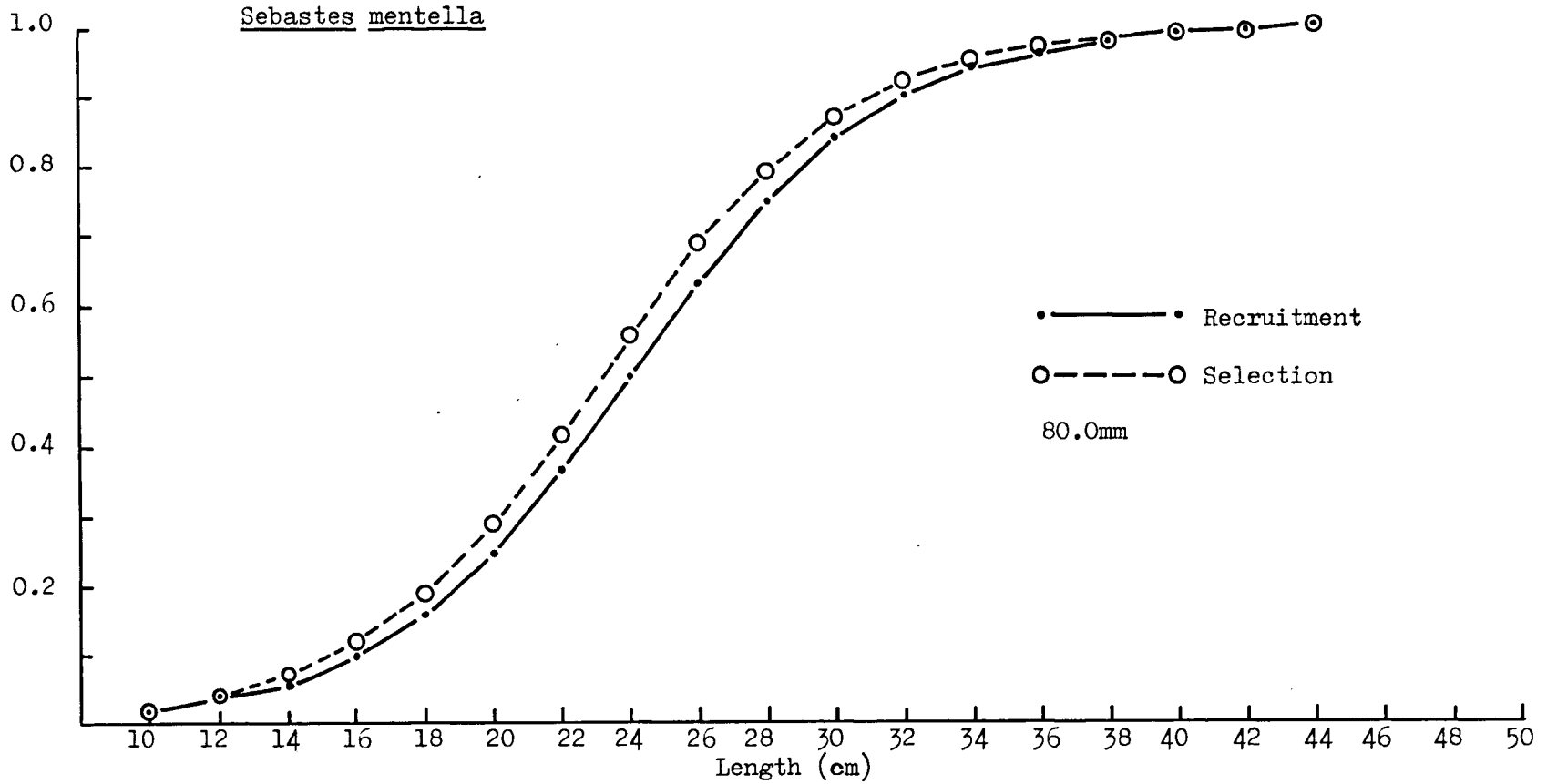
Appendix Figure 2. Von Bertalanffy fit for Sebastes marinus. Sub-areas I and II.



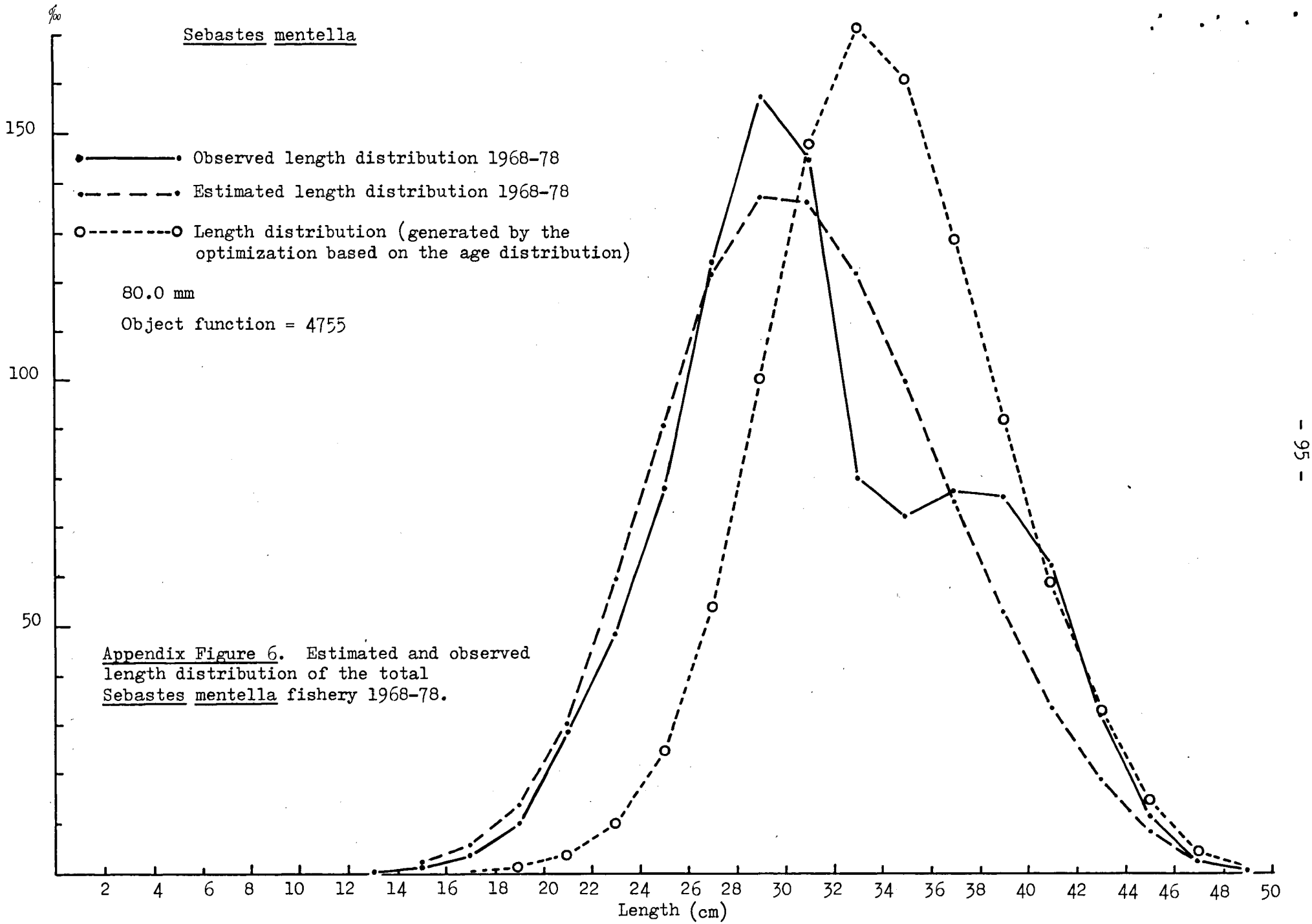
Appendix Figure 3. Observed relative age distribution of the Sebastes marinus catch 1967-78 (Sub-areas I and II).



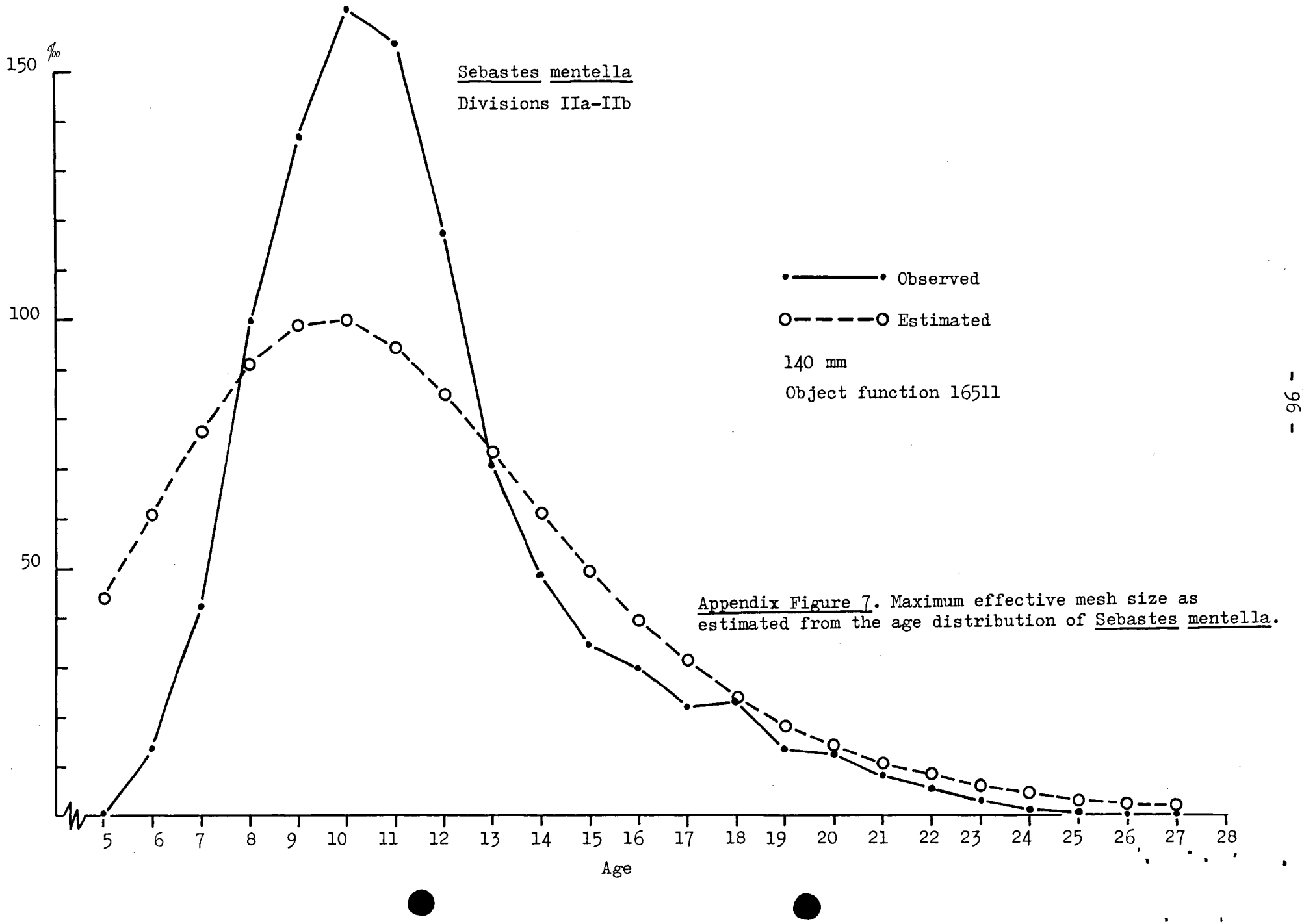
Appendix Figure 4. Observed and estimated length distribution for maximum mesh size. Sebastes mentella. Length optimization.



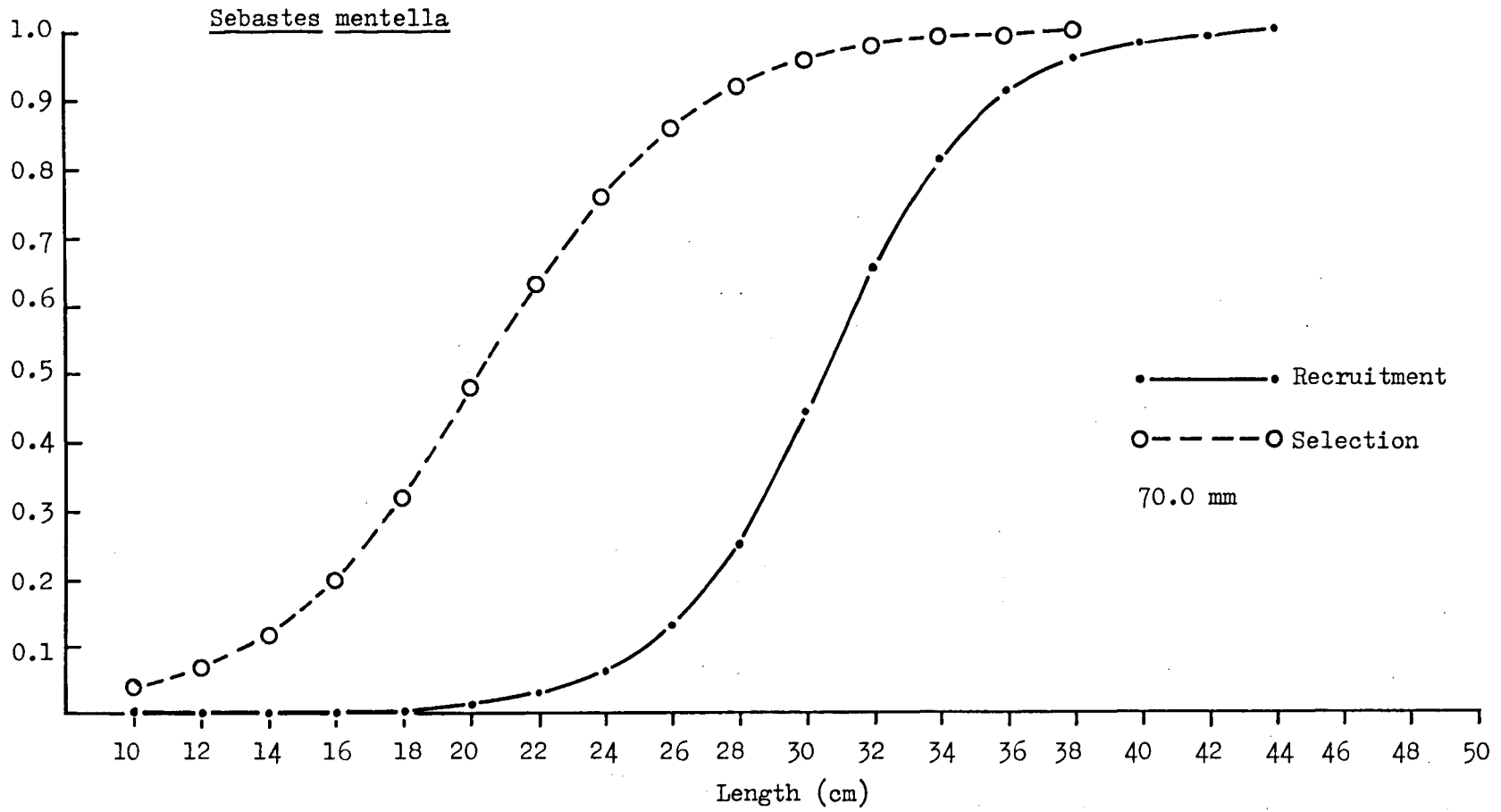
Appendix Figure 5. Applied recruitment curve and estimated selection surve. Sebastes mentella. Length optimization.



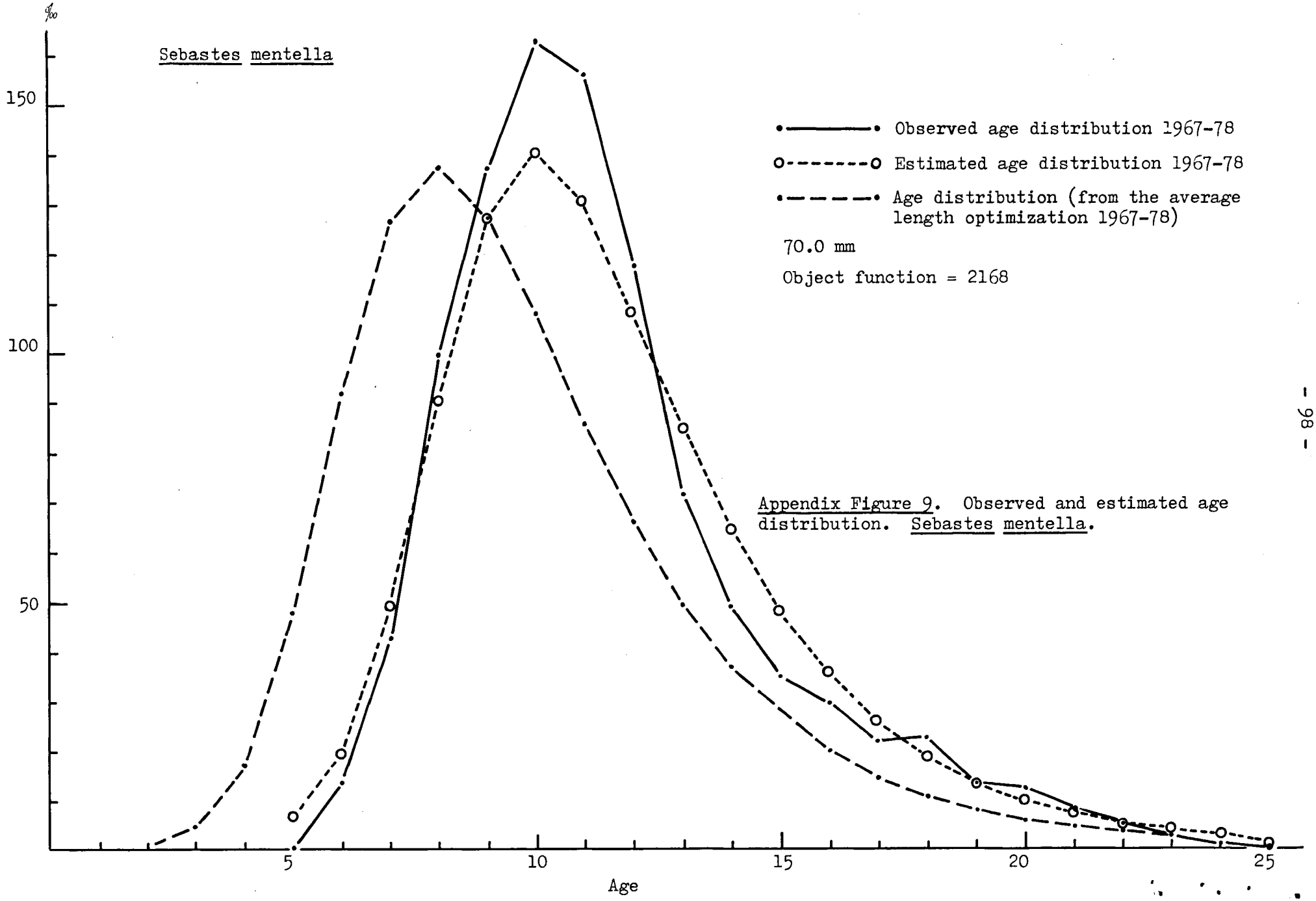
Appendix Figure 6. Estimated and observed length distribution of the total Sebastes mentella fishery 1968-78.



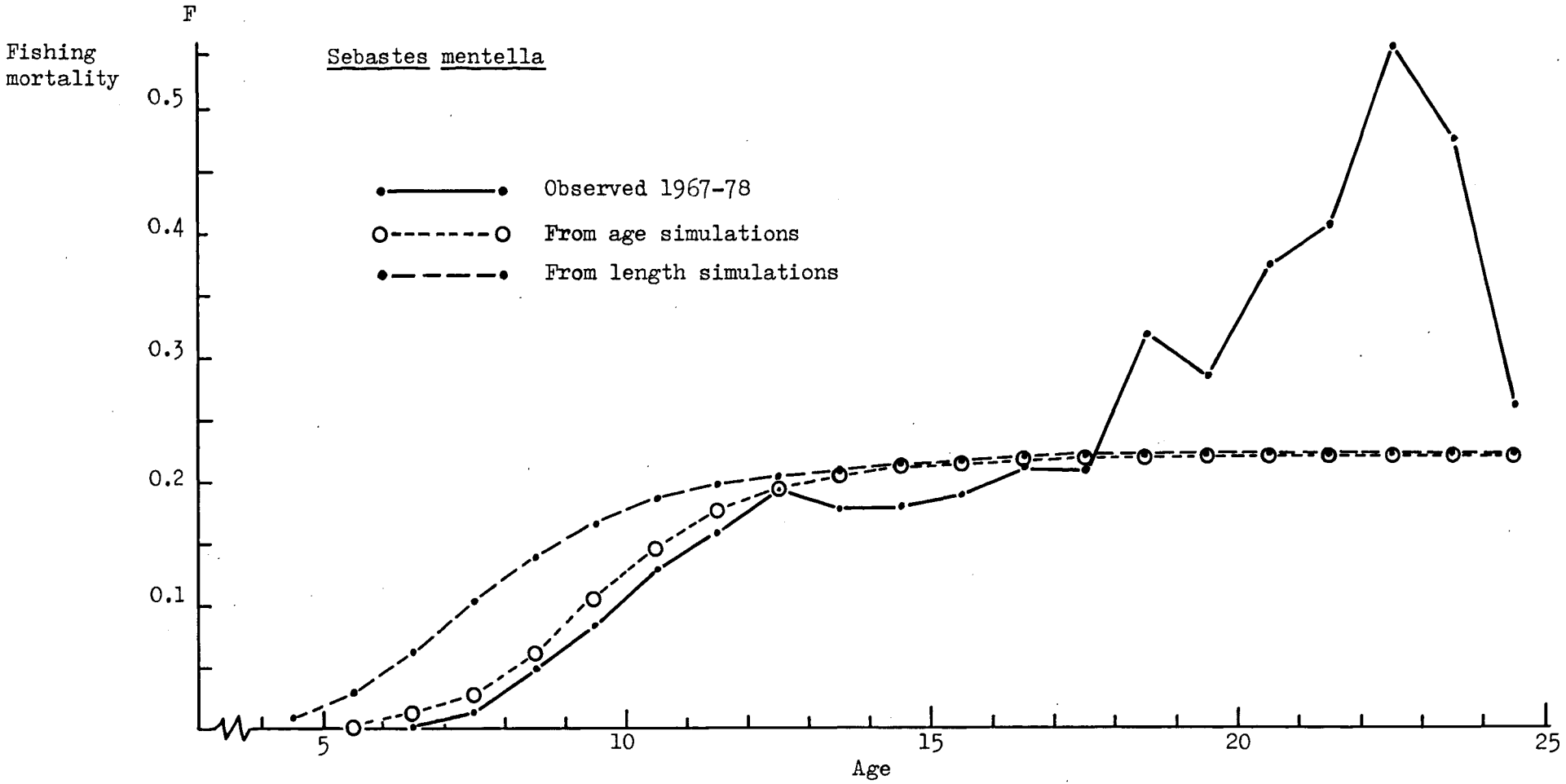
Appendix Figure 7. Maximum effective mesh size as estimated from the age distribution of Sebastes mentella.



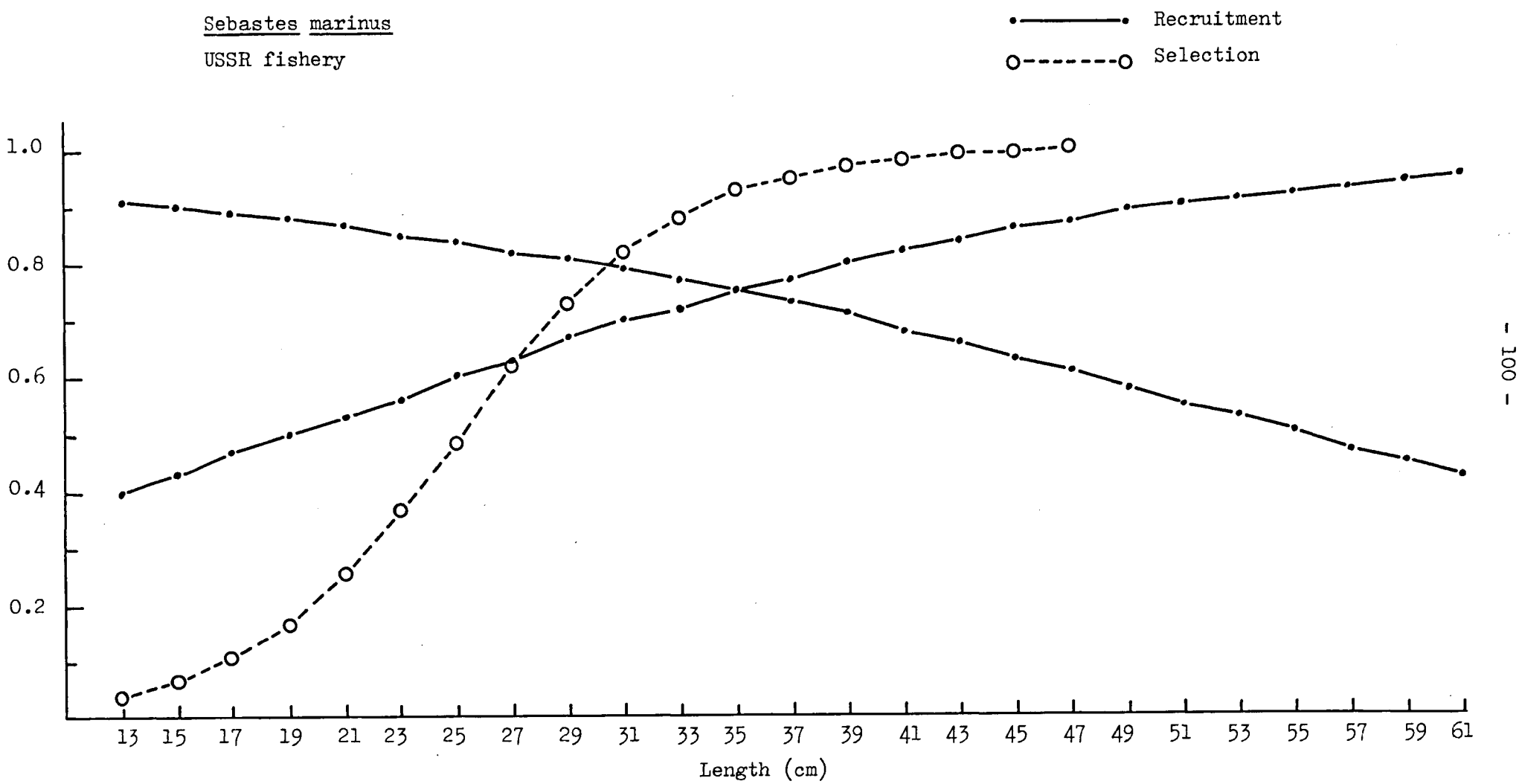
Appendix Figure 8. Applied recruitment curve and estimated selection curve. Sebastes mentella. Age optimization.



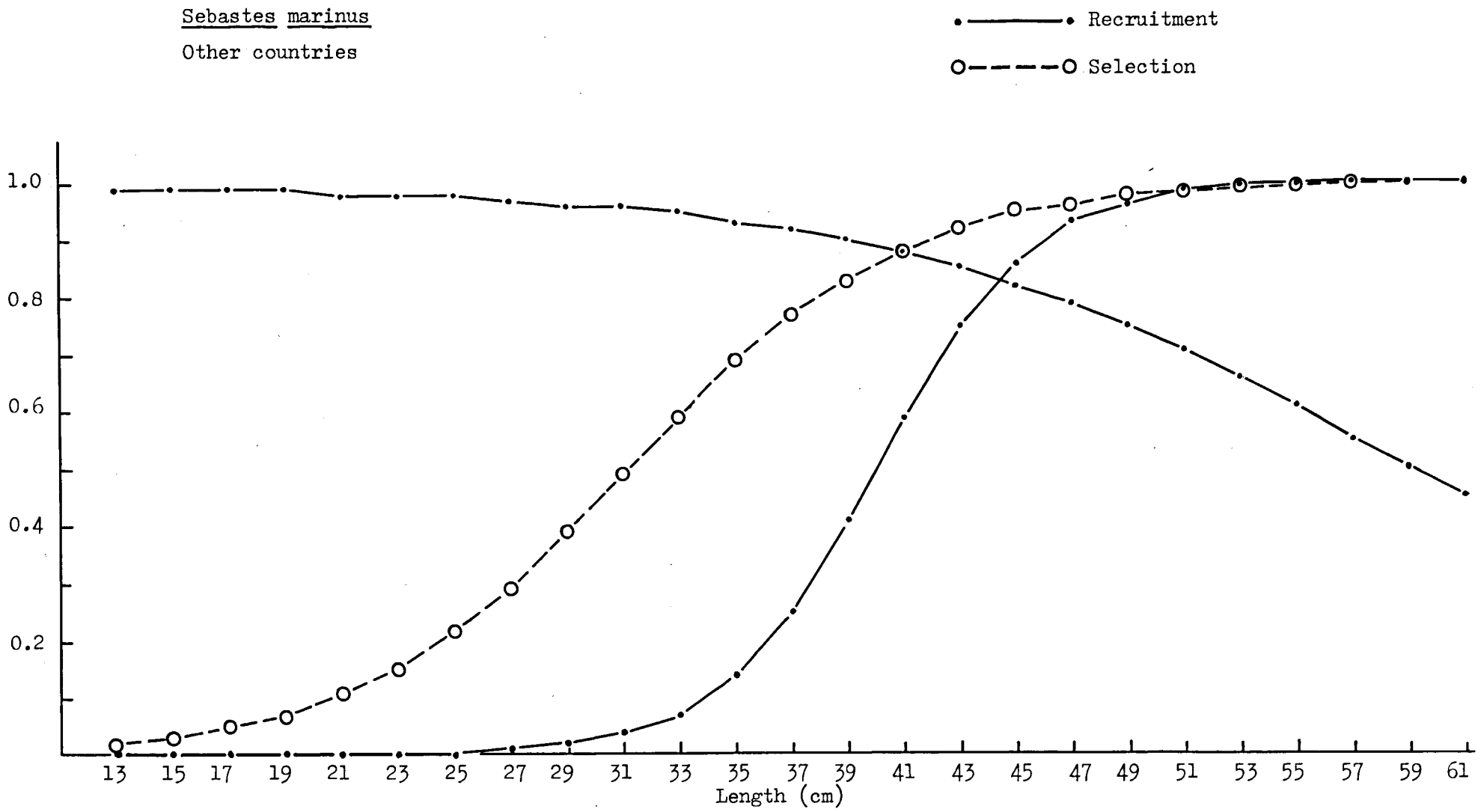
Appendix Figure 9. Observed and estimated age distribution. Sebastes mentella.



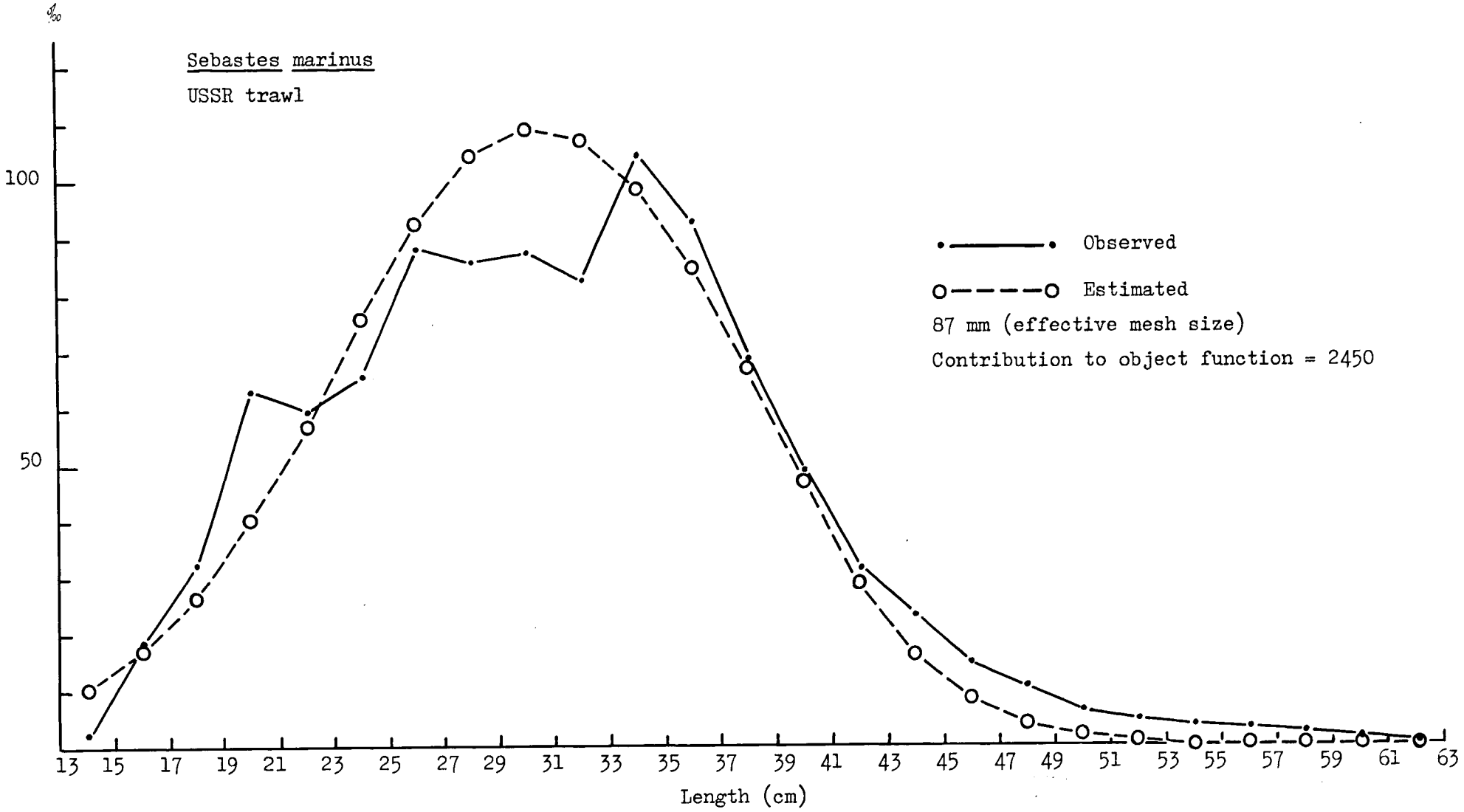
Appendix Figure 10. Observed and estimated fishing mortalities. Total fishery of Sebastes mentella.



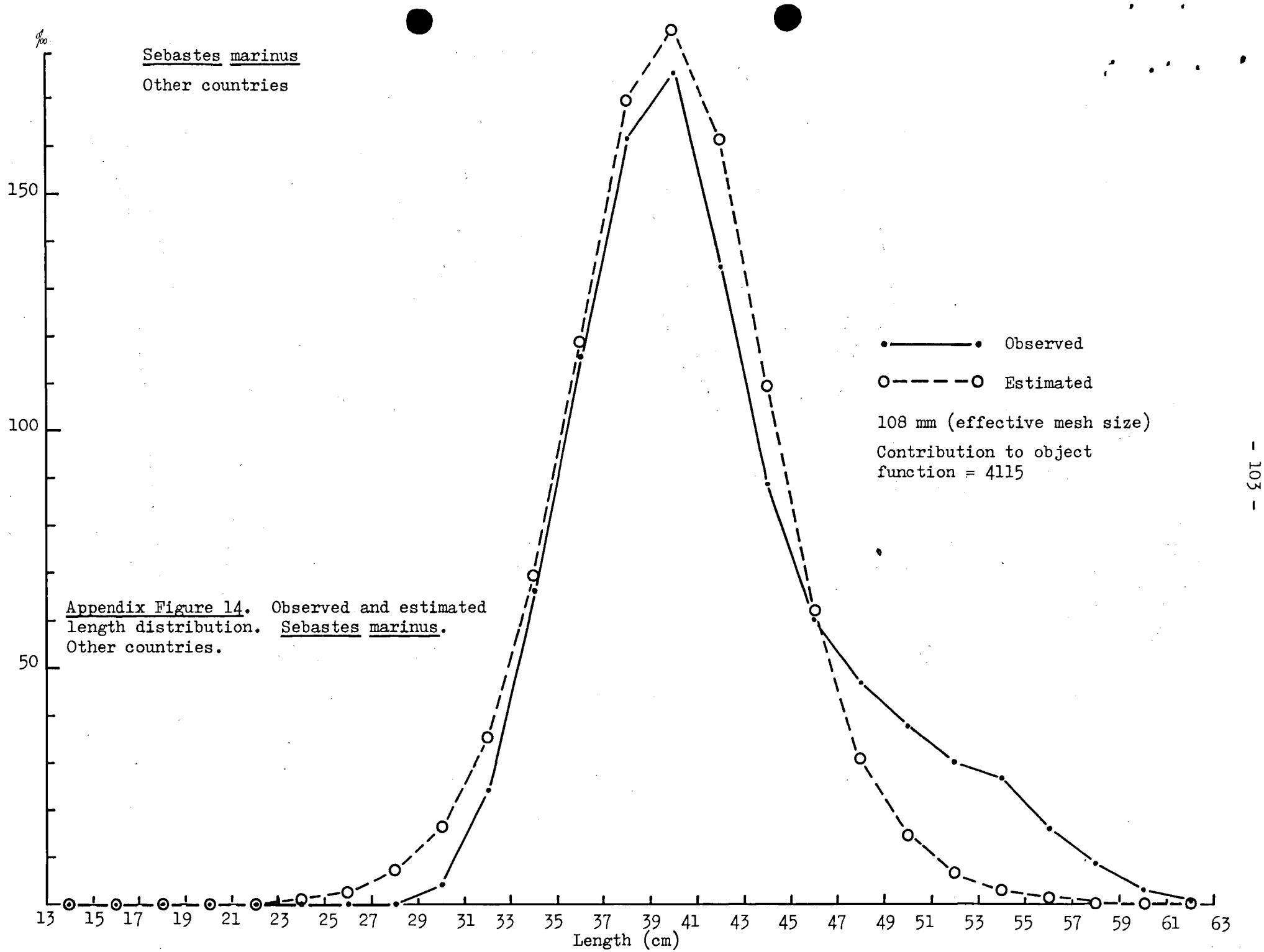
Appendix Figure 11. Applied recruitment curves and estimated selection curve. USSR trawl. Sebastes marinus.



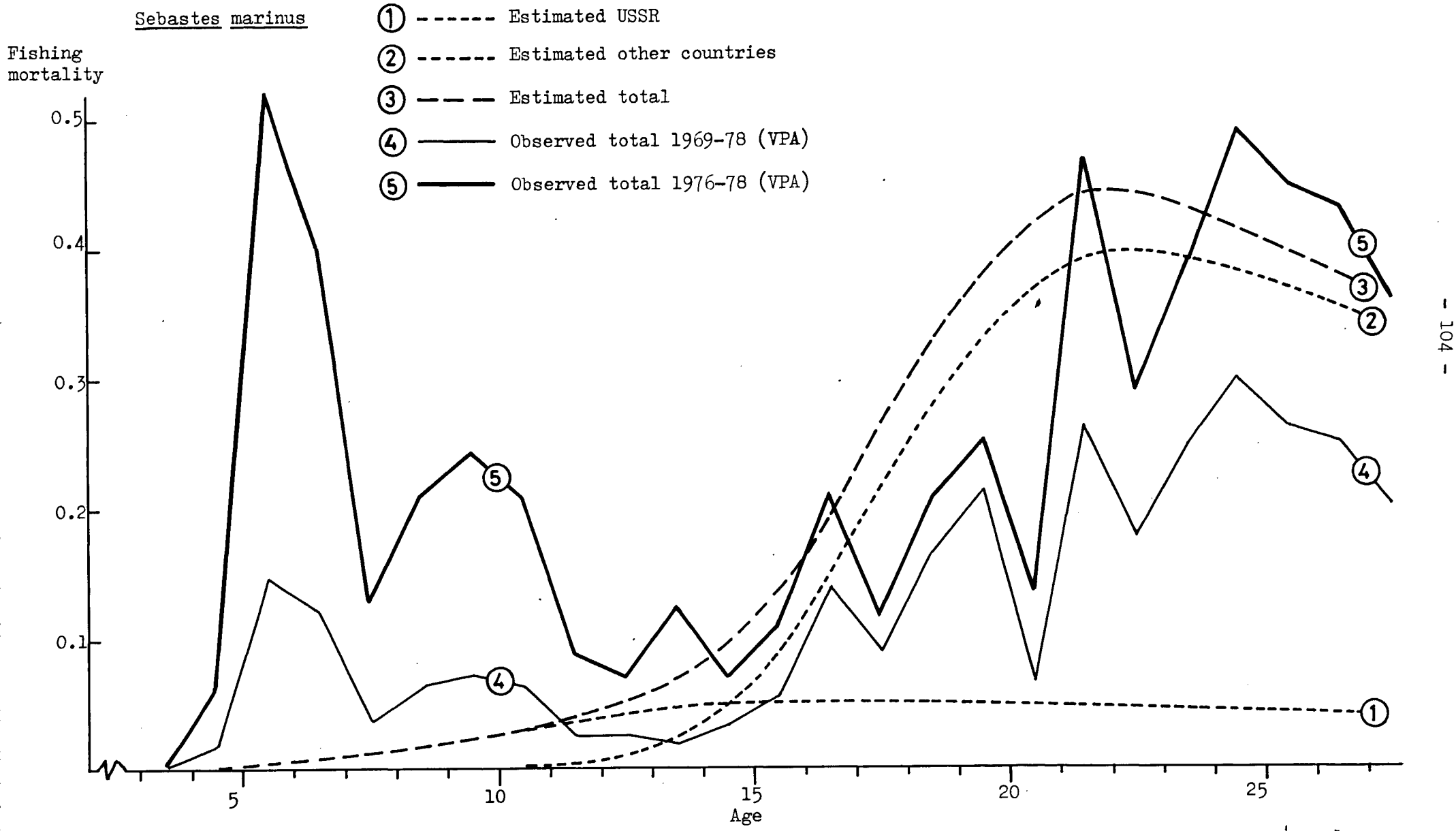
Appendix Figure 12. Applied recruitment curves and estimated selection curve. Other countries. Sebastes marinus.



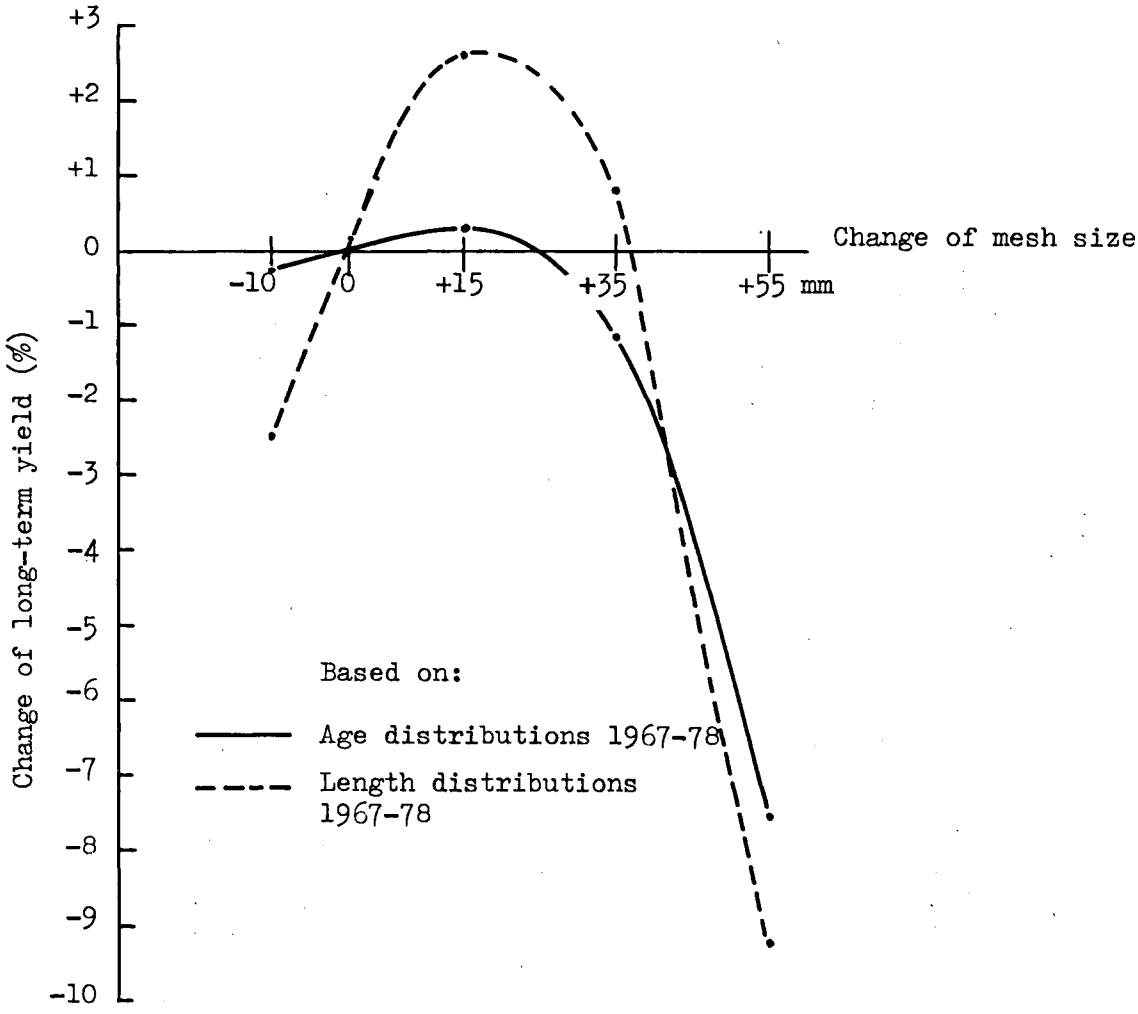
Appendix Figure 13. Observed and estimated length distribution. Sebastes marinus. USSR trawl.



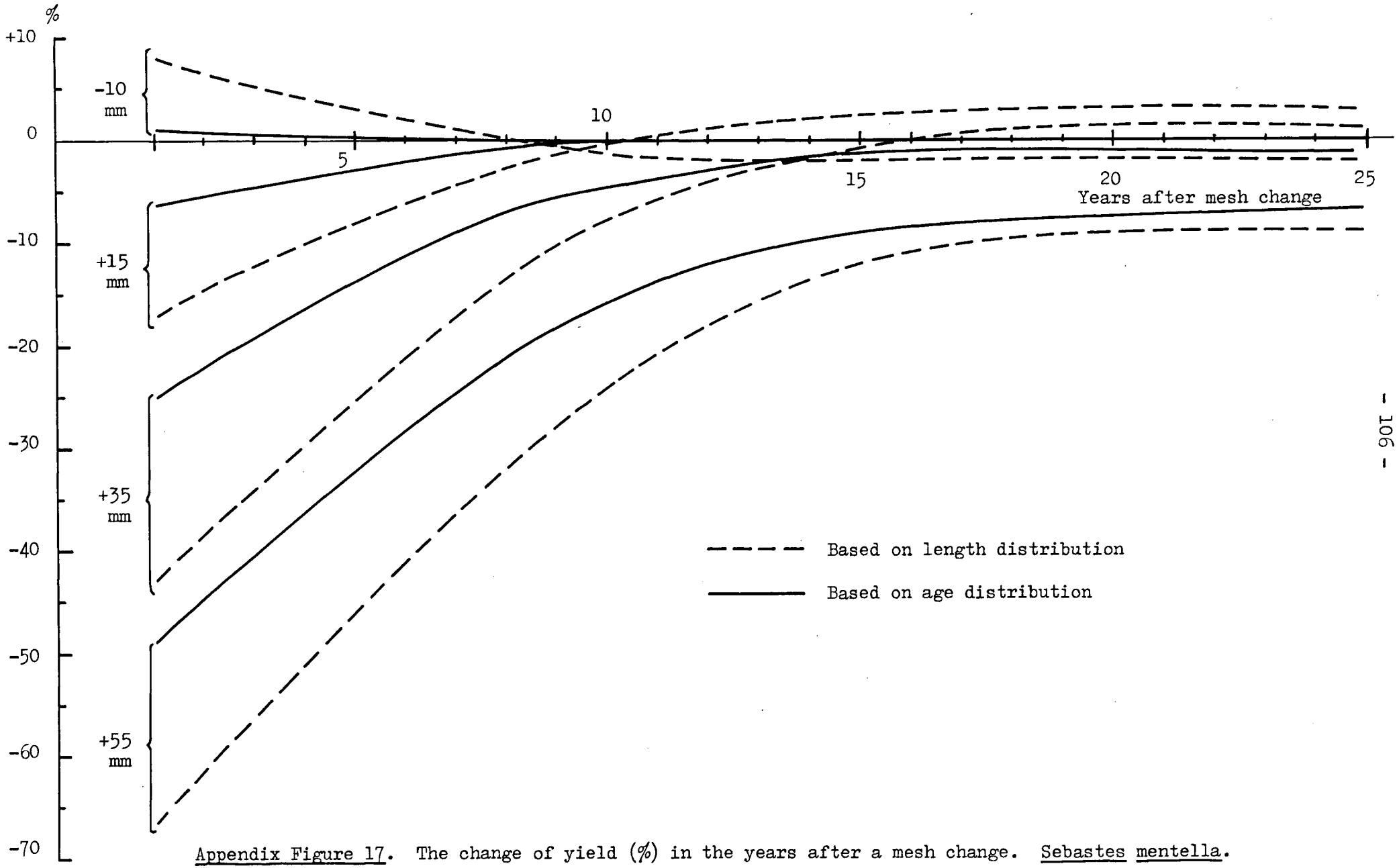
Appendix Figure 14. Observed and estimated length distribution. Sebastes marinus. Other countries.



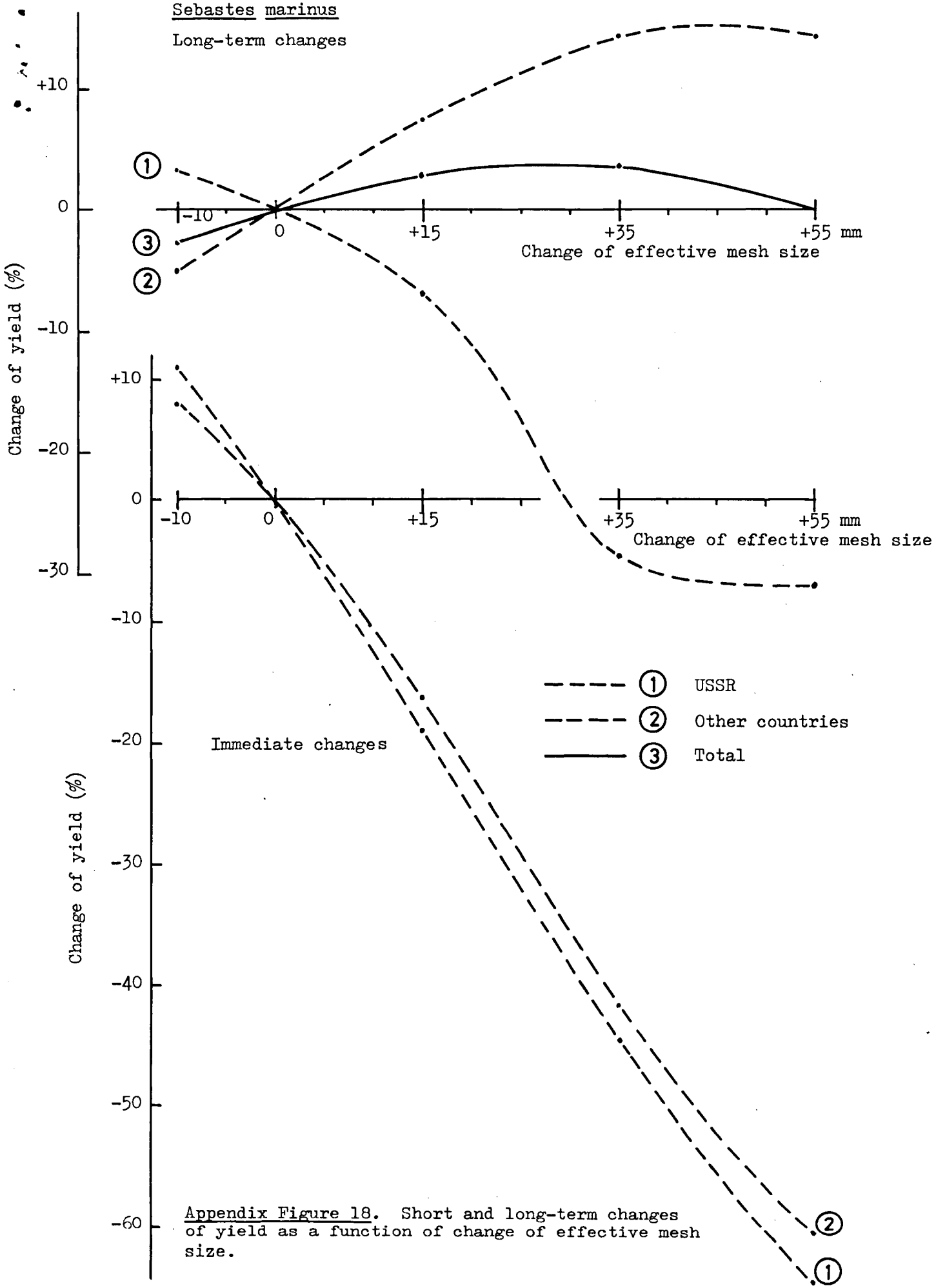
Appendix Figure 15. Observed and estimated fishing mortalities.



Appendix Figure 16. Long-term yield of Sebastes mentella as a function of a change of mesh size.



Appendix Figure 17. The change of yield (%) in the years after a mesh change. Sebastes mentella.



Appendix Figure 18. Short and long-term changes of yield as a function of change of effective mesh size.