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REPORT OF THE WORKING GROUP ON REDFISH IN REGION 1

Hamburg, 21 - 25 February 1977

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Report of the Working Group on Redfish in Region I

1. Participants and terms of Reference

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At the 1976 Statutory Meeting of ICES it was decided (C.Res. 1976/2:8) that:

"a Working group to be referred to as "The Working Group on Redfish in Region I" should be convened by Dr. A.Schumacher and should meet in Hamburg for 1 week from 21 February to 25 February 1977 to:

(a) assess TACs for 1978 for redfish;

(b) assess, if possible, the effective mesh size in use, and report on the effects of an increase in mesh size".

In addition, the Working Group was asked by the Chairman of the Liaison Committee of ICES, following a NEAFC request, to provide advice on the biology and distribution of some commercial species in the North-East Atlantic. Drafts were prepared on this subject during the meeting in Hamburg and issued at the 65th Statutory meeting of ICES (Review by the Working Group on Redfish in Region I on some Fish Resources within the NEAFC Area, C.M. 1977/F : 12).

The Working Group was not able to complete the work at the Hamburg meeting. Therefore it was decided to hold a second meeting of the Working Group just prior to the Statutory Meeting in Reykjavik. A kind invitation by the Icelandic Institute of Marine Research made it possible to hold the meeting from 20 to 24 September.

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1) Attended both meetings

2) Attended Reykjavik meeting only

2. General Biology of Redfish in Region I

Two of the three known species of redfish, Sebastes marinus and Sebastes mentella, are of commercial interest in the North-East Atlantic. These species are widely distributed and subject to exploitation. Besides these two species, Sebastes viviparus inhabiting the warmer regions of the area, and an oceanic population of redfish considered as S. mentella, inhabiting the Irminger Sea have not yet been subject to the commercial fishery.

The redfish is ovoviviparous, i.e. the hatching takes place within the female gonads and the brood is released as larvae. The release of fry is here referred to as spawning. The mating takes place during August-November, mainly in September, but the fertilisation of eggs inside the ovaries in February-March. The spawning time is April-June, mainly in May.

Redfish has a slow growth except in the first year of life. Thus, 5 year old fish is about 20-22 cm long, 10 year old fish is about 30-32 cm in length, and at an age of 20 years it has reached a length of about 42 cm. The age of maturity is about 14-18 years.

Temperature conditions are an important factor in the geographical distribution of the two species. S. mentella is bound to bottom temperatures of above 4°C, S. marinus is preferably found in temperatures of 3.5° - 7°C. However, juveniles of both species seem to tolerate lower temperatures than the adult fish.

3. Sub-area I and Divisions IIa and IIb

3.1. Biology and Distribution of Redfish

There are two main spawning stocks of redfish is the Barents Sea-Bear Island - Spitsbergen area. The main spawning area for S. marinus is situated along the continental slope west

of Vesterålen (Lofoten). Some spawning is also recorded in the fjords of Northern Norway.

For S. mentella, the main spawning area is the region southwest of the Kopytov area between 70°N-71°N and 11°E - 16°E.

The larvae of both species drift with the Atlantic current northwards along West-Spitsbergen and eastwards into the Barents Sea.

Young redfish is migrating only to a small extent, i.e. to deeper waters in winter and back to shallow waters in spring.

The main distribution area of adult S. marinus and S. mentella is along the continental slope to about 80°N. S. marinus is also distributed in the southern part of the Barents Sea.

S. marinus is most abundant in depths of 100 to 350 m, but S. mentella prefers deeper waters, i.e. 200 to 500 m depth.

The reasons for migrations of adult fish are spawning and feeding. After spawning, females of S. marinus migrate northwards an eastwards and mix with the males at Tromsøflaket or the Bear Island. From there, they migrate together to the borders of the distribution area for feeding and copulation. In early winter, the females move back in direction to the spawning ground, while the males stay behind in the area of Bear Island-Tromsøflaket.

S. mentella migrate to the feeding areas in July-August. Copulation takes place in August-November. In January-February, the females migrate towards the spawning area while the males mainly migrate towards the Kopytov area in late March. After spawning, the females mix with the

males and they move together to the feeding grounds.

3.2. Status of the fisheries (tables 1 - 4)

The fishery in the area is based on both species (S.marinus and S.mentella). In tables 2 - 4, the nominal catches of redfish (both species together) are given by Sub-area and Division and by countries for the period 1965 to 1976. In table 1, the catches of Sub-areas I and II are summarized. According to table 1, the total catches in the area have had an increasing trend since 1968, but the catches of 1975 and 1976 were remarkably high. In 1976, the total catch increased to about 313 000 tons which is nearly three times the highest catch recorded in earlier years. This increase of the total catches in 1975 and 1976 is mainly due to the increased catches in Division IIb.

3.3. Catch per unit effort and effort data (table 5)

The catch of S.marinus is to a great extent a by-catch in the fishery for cod and haddock in the North East Arctic. Meaningful effort figures are therefore non-existing. However, the Soviet fishery for redfish in the Kopytov area is a direct fishery for S.mentalla. The catch per hour fishing of this fishery was relatively stable in the period 1965 to 1973. From 1974, it started to increase to more than the double of the period 1965 to 1973.

The U.S.S.R. figures for catch per unit effort have been used to estimate the total international effort. This indicates a very high effort in the Fishery for S.mentella during the last 2 years, about 2 - 3 times the effort of the preceding period.

3.4. Recruitment

The year-class strength in qualitative terms is given for some year-classes of redfish for the period 1956 - 1964

(Table 6). It indicates a period of relatively low recruitment for the year-classes 1957 - 1963, but a somewhat higher abundance for the 1956- and the 1964 year-classes.

Since 1965, more quantitative data were available for calculations of the year-class strength. The international 0-group survey in the Barents Sea and adjacent waters has each year given an abundance index for the 0-group redfish S.marinus and S.mentella combined . According to these investigations, only the 1967 and 1968 year-classes were very poor at an age of 6 month. The 1966, 1969 and 1970 year-classes were of average abundance and the 1965, 1971 and 1972 year-classes were somewhat below average. The year-classes 1973 to 1976 were estimated to be rich or even very rich.

3.5. Assessments

3.5.1. Basic material

3.5.1.1. Separation of catches into S.marinus and S.mentella components and trends in the fishery of these species.

Since the catches of the two species in the area are not separated in the statistics it was necessary to split the reported catches into the respective species components according to the available information on their geographical distribution and on information about the fishing pattern of different countries fisheries.

All catches taken in Div. IIb and Subarea I are assumed to be S.mentella and S.marinus respectively.

In Div. IIa, nominal catches for the period 1965 to 1976 are assumed to be S.marinus with two exemptions:

i) catches of GDR and Polish vessels for which the this assumption is only valid up to 1971

ii) catches of USSR vessels for the whole period and catches of GDR and Polish fisheries from 1972 onwards were separated into the respective species components according to their geographical distribution.

Thus, the catches reported from the northern part of Div. IIa, the Kopytov area, were assumed to the taken in a directed fishery for S.mentella and the remainder was throught to be taken in a mixed fishery for cod, haddock and saithe.

Table 7 shows a decreasing trend in catches of S.marinus in the period 1965 to 1970. Since 1970 the catches increased steadily from 12 709 tons to the level of about 39 000 tons in 1975-1976.

As for S.marinus a decreasing trend is observed in the catches of S.mentella in the period 1965-1968. Since 1968 the total catch has increased with some fluctuations from 5 413 to 274 516 tons in 1976 which corresponds to an increase by a factor of 13 compared to the 1965-74 average. The high catches of redfish in 1975 and 1976 are therefore mainly due to increased catches of S.mentella in the Kopytov area.

3.5.1.2. Age and length compositions

For S.marinus only limited age determinations were available and the Working Group decided to use an age/length key based on landings in 1976 from Division IIa. This age/length key was applied to the total length composition from the German (F.R.) fishery in Div.IIa available for each year in order to get a total annual age composition in the period 1965-1976 (Table 9). It is obvious that the age group 20 is too low represented in the age compositions caused by a low representation of this age-group in the age/length key applied.

Age compositions as number landed were available for USSR landings of S.mentella in the period 1965-1976 and for GDR landings for 1975 and 1976. To obtain age compositions for the total fishery in each year, these available age compositions were raised to the total landings (table 10).

Only limited length compositions were available for this species and length compositions for the total landings could not be obtained for each year in the period 1965-1976.

3.5.2. Parameters used in assessments

3.5.2.1. Natural mortality

For S.mentella in Subarea II an estimation of the natural mortality was made by plotting Z against total effort. Z was estimated by means of the catch per unit effort ratio of the age groups 14 to 24 in successive years in the USSR fishery.

The effort corresponding to the two values between the successive years was estimated as the average total trawling effort for the corresponding years. The intercept of the fitted linear regression is 0.104 which gives an estimate of M. However, the calculated correlation coefficient of r = 0.43 is not statistically significant (5% significance level).

In some other areas M of 0.1 has been assumed for redfish. In the Gulf of St. Lawrence Sandeman (1973) considers that the most likely value for redfish lies somewhere between 0.05 and 0.1. The value of M of 0.1 for S.marinus in the Nova Scotia area has been assumed by Mayo and Möller (1977).

Therefore the Working Group decided at the present state to use an M of 0.1 for both S.marinus and S.mentella in Region 1.

3.5.2.2. Estimation of the input fishing mortalities in the VPA

In a preliminary run of the VPA the initial guess of the F values for 1976 was 0.12, 0.35, 0.50 for age groups 8 to 10, 0.60 for age groups 11 to 12 and 0.40 for age groups 13 + . The fishing mortalities for the oldest age groups (F_{24}) for the years 1965 to 1975 were set equal to the unweighted mean of the age groups 10-23 in each year.

The bias on the calculated F values introduced by incorrect assumptions of terminal F's in 1976 will be reduced to a minimum for 1971 and the years before.

Therefore the weighted mean F values were calculated for age groups 13 to 22 (F_{13-22}) in the years 1965-71 and plottes against the total trawl effort.

This linear regression (Fig. 1) shows that the F_{13-22} corresponding to the effort in 1976 would be 0.397 and therefore the assumed terminal F's for age groups 13 to 24 of 0.40 in the preliminary run was accepted as estimate for 1976. The fishing mortality for age group 10 was reduced to 0.40 and the terminal F's for age groups 8, 9, 11 and 12 were also left unchanged.

To determine 1976 F values for age groups 8 to 11 informations from the international 0 - group surveys (Table 6) were used. The relationship between the estimated year class strength from VPA ($F_{(100\%)} = 0.4$) at age 6 and the corresponding 0 - group survey abundance indices (using $\log_e$ transformation) for year classes 1965-68 is shown in Figure 2.

The high correlation ($r = 0.97$) indicates that the chosen 1976 F-array for age-groups 8 to 11 could be appropriate.

The relatively high fishing mortality of 0.60 for age 12 in 1976 was chosen, because this corresponds to the highest year class strength at age 6, estimated by VPA during the period 1965 to 1974.

3.5.2.3. Growth parameters

Length at age and weight at length data are given for S.marinus (tables 10 and 11). These are used to obtain weight at age data which are needed for the estimation of TAC's. The relationship between length and weight is calculated on the basis of the average weight data given for the length groups 28-55 cm and is estimated to be $W = 0.019959\, l^{2.8937}$. The weight at age was then calculated from this relationship and the average length at age (s. table 10). The estimated figures are given in table 19.

For S.mentella weight at age data were available from direct observations (table 20).

3.5.3. Cohort Analysis

3.5.3.1. Stock size

S. mentella

Estimates of stock size from Cohort analysis are given in table 13. In addition the total stock biomass, age 6 and older and the spawning stock biomass, age 15 and older, were calculated using the mean weights given in table 20). The results are summarised in table 14.

Both the total stock size and the spawning stock size increased from 1965 to 1975 considerably. The estimated stock level in 1975 is 4-5 times higher than in 1965. From 1975 to 1977 the calculations show a reduction in total stock biomass(- 25%)and spawning stock biomass(- 28%).

S. marinus

Estimates of stock size in numbers are given in table 15. The total stock biomass of fish 12 years and older was relatively stable during the period 1965-1974 (s.table 16). It decreased in the years 1975 to 1977 by about 19% compared to the average stock biomass for the previous period. The spawning stock biomass (age 15 and older)

decreased year by year in the period 1965-1974 and reached in 1974 a level of about 86% of that in 1965. Following an increase in spawning stock size from 1974 to 1975 a further decrease over the years 1975 and 1976 was estimated. The spawning stock size at the beginning of 1977 is about 71% of the 1965 level.

3.5.3.2. Fishing mortality

On the S. marinus stock there have been no overall changes in the level of fishing mortality in the period 1965-1974 (s. table 17). Due to the influence of the input F in the Cohort analysis it is difficult to evaluate changes in fishing mortality in the more recent years. However, it appears that fishing mortality has been somewhat higher in 1975 and 1976 compared to previous years.

For S. mentella (table 18). The estimated fishing mortalities indicate that during the period 1965 to 1971 the exploitation pattern was relatively stable. The fishery was concentrated on the older age groups (13-24). Since 1973 the exploitation shifted towards younger ages. This was mainly a result of the relatively abundant incoming year classes of 1964 and the following years. As a result there were changes in the exploitation pattern and in the level of fishing mortality.

3.5.4. Yield per recruit

An yield per recruit curve has been calculated for the Sebastes marinus stock using the exploitation pattern also used in the Cohort analysis and a natural mortality rate of M = 0.10. Yield per recruit for fishing mortality rates on the age groups subject to maximum exploitation is given in Fig. 3.

The yield curve has no maximum. The estimated fishing mortality on the fully exploited age groups in 1976

was 0.35 and the corresponding yield per recruit is situated on the flat top part of the curve.

A reduction in fishing mortality from the present F = 0.35 to F = 0.25 the level of F when the yield curve starts to flatten off would give only a small decrease in yield per recruit. A reduction in fishing mortality to $F_{0.1}$ = 0.09 would give a reduction in yield per recruit of about 16% compared to the present situation.

In figure 4 curves of yield per recruit and spawning stock biomass per recruit for Sebastes mentella for F-values of age groups subjected to maximum exploitation are given. The curves were calculated for the present exploitation pattern as used in the Cohort analysis and the average weights per age group as given in table 20. The present situation (F = 0.6) and the

position of F_{max} = 0.35 are marked with arrows.

For these fishing mortalitys the corresponding sustainable yield and spawning stock biomass assuming average recruitment

($R_{1965-72}$ = 480 x 10^6) is given in the following text table:

F	Y/R	Sustainable Yield (tons x 10^{-3})	S/R	Spawning stock biomass (tons x 10^{-3})
0.60	.237	113.8	.048	23.0
0.35	.242	116.2	.222	106.6

If fishing mortality is reduced from its present high level of 0.6 to $F_{(max)}$ the yield per recruit will increase by 2%. The spawning stock per recruit will increase by about 5 times.

The fishing mortality level corresponding to $F_{0.1}$ is very close to F = 0.25.

3.5.5. Catch prediction

TAC's were estimated for 1978. Data used in the calculations are given in table 19 and 20. The stock size in 1977 is estimated from the stock and fishing mortalities in 1976. For 1977 it was assumed a catch of about 30 ooo tons which together with about 165 ooo tons of S. mentella gives about 200 ooo tons, the expected total catch of redfish from the area.

3.5.5.1. Sebastes marinus

A catch of 30 ooo tons of S. marinus in 1977 would result in a fishing mortality on the age groups subject to maximum exploitation of F = 0.35 assuming the 1976 exploitation pattern. The estimated stock in the beginning of 1978 was calculated from the stock size and the fishing mortality rates in 1977.

The present level of fishing mortalitiy is somewhat beyond the level when the yield per recruit curve starts to flatten off. The ideal management objective should be to bring the level of fishing back to $F_{0.1}$ = .09. However, this would correspond to a drastic cutback in fishing activity by 74% in one year.

In order to stop the reduction in spawning biomass as estimated in the Cohort analysis for the years 1975 to 1978 a reduction in fishing effort already in 1978 is desirable. This could be achieved by reducing the level of fishing mortality on the fully exploited age group to F = 0.25 which corresponds to the fishing mortality at which the yield per recruit curve start to flatten off. This reduction in fishing mortality will prevent a further decline in spawning stock biomass during 1978 from the lowest level estimated for the preceeding period (table 21). This management objective could be achieved by a TAC for 1978 of 20 ooo tons.

3.5.5.2. Sebastes mentella

The results of the TAC calculations are summarised in the text table below:

	1976	1977	1978	1979
Catch (tons)	274 516	164 901	127 060	
Fishing mortality on age groups subjected to maximum exploitation	0.60	0.45	0.35	
Total stock biomass (6+) (thousand tons)	1228	1056	1021	1045
Spawning stock biomass (15 +) (thousand tons)	208	173	182	189

In the above strategy to reduce F in 1978 to the level of $F_{(max)}$ the total stock biomass will remain nearly unchanged from the 1977 level.

Although the spawning stock biomass is reduced from 1976 to 1977 fishing at $F_{(max)}$ in 1978 will maintain the spawning stock during 1978 at a relatively high level compared to the years 1972 and earlier. Therefore there seems to be no reason for concern for recruitment failure due to a reduced spawning stock (s.table 14).

Therefore, the Working Group recommends that the TAC for Sebastes mentella for 1978 in Division IIa and IIb should be set at

130 000 tons.

3.5.6. Change in exploitation pattern

S. mentella

The estimated fishingmortalities indicate that during the period 1965 to 1971 the exploitation pattern was relatively stable. The fishery was concentrated on the older age groups (13-24). Since 1973 the exploitation shifted towards younger ages. This was mainly a result of the relatively abundant incoming year classes of 1964 and the following years. As a result there were changes in the exploitation pattern and in the level of fishing mortality.

To evaluate the effects, which would result from an increase in age at first capture yield per recruit curves were calculated by using different age at first capture (t_c) as shown in Figure 5. The calculations were made by assuming a knife edge selection at age t_c (i.e. all ages $\geq$ t_c subject to maximum exploitation) and for the weights at age as given in Table 20.

From the results it can be seen, that an increase in age at first capture would result in an increase in yield per recruit. For instance an increase of t_c from 8 to 12 years would cause a change in yield per recruit (and therefore in long term yield) by + 17% as derived from yield per recruit curve.

Under the present conditions the age at first capture is estimated at approximately 8 to 9 years, by increasing t_c to 12 years a gain in long term yield of about 15% could be expected.

4. Subareas V and XIV

4.1. General Biology

The redfish spawns over the great ocean depths and along the continental slope to some extent. Concentrated spawning takes place in the southeastern Irminger Sea,

particularly in the Reykjanes Ridge area and south of it. Another less important spawning area lies off East Greenland.

Spawning does not seem to take place off West Greenland, the redfish off West Greenland derives from larvae which have been carried there by drift from the spawning areas mentioned above.

The drift of larvae takes place from the oceanic areas to the continental shelves off Iceland, East Greenland and West Greenland. There are extensive nursery grounds for redfish both around Iceland, particularly west of Iceland, and on the East Greenland shelf, where dense accumulations of young redfish have been observed both for S. marinus and S. mentella. Thus, the East Greenland shelf area seems to be the most important nursery area for the Subarea V and Subarea XIV stocks of redfish. The juveniles usually inhabit shallower waters than the adult fish and are mostly found closer to the shore than the adults.

When approaching sexual maturity, they migrate to the offshore banks and to the continental slopes.

The redfish has a wide distribution in Subareas V and XIV, extending along the coasts from the Faroe Islands, around Iceland and along East Greenland. The depth range in which it is found is relatively wide, from 100 to 800 meters, but it is most abundant in 200 m to 500 meters depth. S. mentella inhabit greater depths in general than S. marinus. Thus S. marinus is mostly caught in depths from 200 m to 400 m, while S. mentella is mostly caught in 300 m to 500 m depth.

The migration of adult redfish is conditioned by spawning and feeding. Thus, in the Iceland-East Greenland area, the females migrate in late winter and spring from Iceland and East Greenland to the Irminger Sea for spawning. After spawning they return to the feeding

grounds. Summer- and autumn feeding migration along the offshore banks and slopes off Iceland and East Greenland are common for both sexes. There is also some migration of redfish from West Greenland to East Greenland as tagging experiments of redfish at West Greenland indicate.

4.2. Status of the fishery

The main areas of exploitation are on the offshore banks on the continental slopes off East Greenland from Cape Farewell to Dohrn Bank, off the Icelandic coast, on the Iceland-Faroe Ridge and off the Faroe Islands.

The redfish fishery was carried out almost exclusively with bottom trawl. During the last few years, however, the midwater trawl has also been used.

Tables 22-24 show the total catch of redfish in Divisions Vb, Va and SA XIV by year and country from 1965-76.

The total redfish catch in these areas decreased steadily from 156 thousand tons in 1965 to a minimum of 88 thousand tons in 1973. In 1974, it increased slightly again (to 91 th. t) mainly due to an increased Icelandic effort in SA XIV. In 1975 and particularly in 1976, there was a sudden increase in the catches to 191 th. tons in 1976. This sudden increase in the fishery in 1975 is due to the USSR fishing in SA XIV.

The Federal Republic of Germany has taken by far the largest catch of redfish in the areas Va, Vb and XIV until 1976, when both Iceland, and particularly USSR exceeded the German (F.R.) catch. The catch in Div. Va decreased from 114 thousand tons in 1965 to about 70 th. tons in 1973 but was, however, relatively stable since 1970.
In Subarea XIV, the catches decreased from about 37 thous. t in 1965 to 8 th. t in 1973. The suddern rise in the catch in Subarea XIV in 1975 and 1976 to a level of 114 ooo t is due to a great increase in effort of USSR

vessels in that area. The USSR has in these two years engaged a big fleet of factory trawlers in the redfish fishery off East Greenland.

In Div. Vb, the redfish catch fluctuated within a range from 1 ooo t to about 10 ooo tons with the lowest catch during 1969-71. Almost the entire catch of redfish in this area was taken by vessels of the Federal Republic of Germany.

4.3. Effort in Subarea XIV and Div. Va

The effort figures in table 25 for the fishery on S. marinus include only the Icelandic and German (F.R.) components in the fisheries. The fishery in both areas is a mixed fishery. In Subarea XIV, the main species are cod and redfish in Div. Va they are saithe, cod and redfish.

The catch per unit effort figures are therefore difficult to use. Even trough increased in efficiency has not been taken into account the German (F.R.) figures show however a downward trend to the year 1972, both in Subarea XIV and in Div. Va followed by an increase in catch per unit effort in both areas, probably due to more aimed redfish fishery by the German (F.R.) trawlers.

No effort figures from the fishery of USSR trawlers in SA XIV, which resulted in considerable high catches were available.

4.4. Recruitment of redfish in the Irminger Sea area (ICES SA XIV and Div. Va)

Redfish larvae surveys to the Irminger Sea in the past and later O-group surveys have shown, that there is in some years a very great number of redfish brood in the area. None of the surveys have covered the total area of distribution. Nevertheless, it is obvious that the number of O-group redfish surpass the producing capacity

of any known and exploited stock in the area.

In order to indicate the year to year fluctuations in abundance the 0-group surveys results are presented as index figure of individuals per nautical square mile. The results are shown in the following text table.

Number of 0-group redfish X 10^{-6} per $n.m^2$

Yearclass	No. of fish
1970	8,6
1971	12,6
1972	38,1
1973	74,0
1974	23,6
1975	12,6
1976	5,8

According to the 0-group-survey reports a substantial part of the 0-group redfish drift over the East Greenland shelf.

In late years big nursery grounds for redfish have then located on the East Greenland continental shelf. But because of the very slow growth of the redfish it is not possible to estimate the recruitment to the exploited part of the stock.

4.5. Assessments

4.5.1. Basic material

4.5.1.1. Splitting of catches into S. marinus and S. mentella

Since redfishes are not separated in the landings according to species the group had to find a way to split the catches into S. marinus and S. mentella. The

geographical distribution of the two species and information on the fisheries of the respective countries formed the basis for splitting the catches into the two species. Thus the catches of the German (F.R.) trawlers taken at the Faroe Islands, SE and S of Iceland were considered as S. mentella. In the area SW of Iceland both species are caught in quantities. In that particular area the catches of the German (F.R.) trawlers were splitted according to the saithe/redfish ratio in the catches assuming that S. marinus was caught together with the saithe. The catches off W-Iceland and East Greenland taken by Icelandic and German (F.R.) vessels were considered to be for the far greatest part S. marinus. The USSR catches off East Greenland in 1975 and 1976 were split into S. mentella and S. marinus according to Icelandic investigations in the area, only limited information on this subject was available from USSR. Catches of other countries in areas Va, Vb and XIV were allocated to the two species according to location and/or the nature of the fishery.

4.5.1.2. Length composition

4.5.1.2.1. Allocation of catches of S. marinus into length groups for the Subarea XIV and Div. Va (s. table 26)

Subarea XIV

In general the figures for the length composition of the catches from the fishery of the Federal Republic of Germany have been used to split catches from other countries into length groups, where no other information was available.

In 1975 and 1976 a change in the pattern of fishing took place. In contrast to the former years where the fishery was carried out in the more deeper waters on the edges of the banks, a major part of the fishery in 1975 and 1976 took place in more shallow waters,

where nursery grounds for both S. marinus and S. mentella were found some years before. The catches from that fisherey in 1975 and 1976 have a length composition completely different from the length distribution in earlier years.

For catches from the shallow waters information collected from the Icelandic research vessels have been used both for dividing the catches into the two species components and into length groups.

Division Va

In Div. Va the Icelandic figures for the length composition were used to split up other nations' catches into length groups, if no information was available. In some years no information from Iceland was available and in these cases the German (F.R.) figures were used

4.5.1.2.2. Allocation of catches of S. mentella in the Subarea V (a and b) and XIV for length groups (s. table 27)

The numbers of S. mentella in length groups were calculated on the basis of length composition of the commercial catches of the Federal Republic of Germany in Va (SW-Iceland and Rosengarten) and Vb for the catches of all countries with the exception of the USSR catches in 1975 and 1976 taken in Subarea XIV. The numbers in the USSR catches in 1975 and 1976 taken there were estimated according to Icelandic research vessel data taken in the area in 1975 and 1976.

No length data were available for the Division Vb in 1967-1969 and 1971 and 1972. Numbers of fishes landed were therefore calculated by the length data of the South Iceland area. Also no length data were available for the catches of Poland and USSR in the period 1965 to 1974 probably taken during the Greenland Halibut season off West Iceland. Numbers of fishes landed from

these fisheries were also calculated on the basis of the German (F.R.) length data of South Iceland.

4.5.1.3. Grouping of years for cohort analysis using length data

Since the cohort analysis based on length composition data requires to work on an average length composition over several years of sampling, the group had selected two periods according to the trends in the fishery (S. Sect. 4.2.). In order to describe the relatively stable situation in the past the period 1965-74 was chosen.

Considering the sudden rise in effort and catch in the years 1975 and 1976 and at the same time the increase of the proportion of small redfish in the catches, it was decided to combine in a second group the years 1975-1976.

4.5.2. Parameter

4.5.2.1. Input value of $\frac{F}{Z}$ for S. marinus and for S. mentella in Subarea V and XIV.

The choice of $\frac{F}{Z}$ for starting the cohort analysis based on length for estimating the numbers in the sea has not the same critical influence on the results as the assumptions made about L or M/K (R. Jones 1974). Several runs made show that the influence of different input F'_s is already leveling off after the calculation of 3 or 4 length groups.

Since the proportion of the largest fish in a length composition is very small the resulting bias from a wrongly estimated input F is also very small.

Therefore the group used a value of $\frac{F}{Z}$ of 0.8 which correspond to an F of 0.4, when M is 0.1 to start the analysis on the largest fish.

4.5.2.2. Natural mortality (s. section 3.5.2.1.)

4.5.2.3. Growth parameters

Some age determination data both from Subarea XIV and Division Va were available to the working group. From age determination data of Fed. Rep. of Germany using scales and Icelandic age determinations using otoliths, the mean length at age were calculated for both S. marinus (table 28) and S. mentella (table 29). The mean length in the last column are weighted with numbers of observations at each age. These values were used to calculated the von Bertanlanffy's growth equation. The estimated growth parameters are as follows:

	K	L
S. marinus	0.0192	101.67 cm
S. mentella	0.0082	173.70 cm

4.5.3. Cohort analysis using length data

For the redfish stocks in the area around Iceland and off the coast of Greenland (SA XIV + V) no age composition data which would allow an assessment of the state of the stock and a catch projection for 1978 were available to the working group. However, the length composition data presented to the group made it possible to use the cohort analysis on the basis of length composition of catches. This method developed by R. Jones allows to estimate fishing mortality and stock size. There are some limitations for the use of this method. The growth parameters to be used in this type of analysis should be derived from back calculations of length from scales rather then from mean length at age. The relation of the difference in length to the corresponding difference in time is a critical factor in this analysis and it was thought that the growth of individual fish reflects this relation more precise.

In case of redfish, this condition could not be met

because age determination on redfish scales and otoliths is very difficult and the very narrow distances between the age rings do not allow a precise bac calculation of the individual growth history of the redfish. Since the redfish is a very slow growing species however, it was assumed that the variation in the length of time required for a fish to grow from one length to another is relatively small compared to fast growing species and therefore the data for mean length at age over the exploited component of the stock have been used to calculate the growth parameters to be used in this method.

A second limitation is that in order to estimate the effect of variations in year class strength it is necessary to use an average length composition based on a number of years sampling.

It follows that catch projection based on this method can only provide information on longterm effects of changes in fishing effort assuming constant recruitment. Since this method was for the first time used in an ICES working group the results obtained have been compared with results obtained by the cohort (age) analysis. This was possible for the Sebastes marinus stock in Subarea I and Div. IIa, for which both data on length and age composition were available. The average stock biomass for the years 1965-74 was calculated and the results - 238 ooo tons (cohort/length) and 239 ooo tons (cohort/age) show a surprisingly good agreement.

On the other hand by comparing the cohort by age with cohort by length in the 1975-1976 period differences in the results appears. From cohort age analysis the average F-value is 40% higher and the total stock biomass 34% lower than by cohort length analysis. This discrepancies are to some extent influenced by

the input F-values since the cohort age analysis is more sensitive to the input F than the cohort by length.

4.5.3.1. Results of the cohort analysis (s.following text table)

In both species average fishing mortality (weighted by stock size) on the adult stock (fish of 34 cm and longer) has increased in the period 1975-1976 compared to the period 1965-1974.

In case of Sebastes marinus a decrease in adult stock size for the years 1975-76 by about 20% in numbers and 23% in weight of the previous level was calculated. The size of the adult stock of S. mentella decreased from the 1965-74 period by about 34% both in numbers and in weight.

In the spawning stocks the declining trend is more pronounced. The spawning stock is defined as fish from that length group onwards where at least 50% is mature (i.e. 38 cm and longer). For S mentella the spawning biomass decreased from the 1965-1974 period by 35% compared to 1975-76. The spawning stock biomass of S. marinus showed a decline of about 25%.

Adult redfish in SA XIV and V.

		1965-1974	1975-1976
S. mentella			
$\bar{F}$	Adult	0.074	0.086
(weighted by stock size)	Spawners	0.136	0.134
Stock size	Adult	634.3	422.1
in number	Spawners	328.8	210.2
(millions)			
Stock size	Adult	509.0	338.2
in weight	Spawners	311.1	201.4
(1000 tons)			
S. marinus			
$\bar{F}$	Adult	0.069	0.088
	Spawners	0.092	0.110
Stock size	Adult	958.4	766.1
in numbers	Spawners	553.2	416.7
(millions)			
Stock size	Adult	912.4	707.1
in weight	Spawners	651.6	482.6
(1000 tons)			
	Adult	34 cm and longer	
	Spawner	38 cm and longer	

4.5.4. Estimation of TAC's

Due to uncertainties about the comparability of basic data and the results obtained by the cohort (length) analysis it was not possible at present to construct an yield per recruit curve to define the present situation on it and to develop a management objective.

In formulating advice on management the group was guided by the results of the cohort (length) analysis (s. section 4.5.3.1.). The reduction in spawning stock biomass from the 1964-74 period to the more recent years of about 25% for S. marinus and 37% for S.mentella gave reason for concern. Therefore the group decided to recommend a precautionary TAC based on the average catches over the period 1972-1974 of 90 ooo tons for both species combined. This TAC would prevent a further increase in effort in the redfish fishery in Subarea V and XIV until the situation could be properly assessed and a more accurate management strategy could be developed.

4.5.5. Change in exploitation pattern

The recent changes in the pattern of exploitation towards the smaller redfish as reflected in the length composition of catches for both species, but for S. mentella in particular, will certainly have an adverse effect on the recruitment to the spawning stock (s.table below)

% of redfish below the 50% retention length (32 cm) in the catches

	1965-1974	1975-1976
S. marinus	3.1	25.6
S. mentella	0.3	84.9

Young redfish stay for several years in their nursery grounds particularely on the East Greenland banks. If the exploitation of young fish is to be continued an

year-class of redfish will for several years be exposed to possibly increasing fishing mortality. It is therefore advisable to prevent heavy exploitation of young redfish by prohibiting fishing for redfish in areas which are known as nursery grounds.

5. Mesh assessments

A method to assess the present mesh size in use and the effect of changes in mesh size has been developed by Mr. K. P. Andersen at the Danish Institute of Fisheries and Marine Research. The time and expertise to use this method has not been available to the working group during the meetings and therefore it is not possible to report on the effective mesh size in use or on the effect of changes in mesh size. Mainly length compositions of the landings were available to the working group. These do not always correspond to the length composition of catches. Due to lacking length compositions of discarted fish which are mainly small, mesh assessments on the length composition available might therefore be biased. Furthermore it is known that the selection of redfish can be reduced considerably due to meshing of redfish and big catches. The benefit by increasing mesh size might therefore be less than estimated by assuming that selection follows the selection ogive calculated from selectivity experiments with moderate catches.

6. Discussion

The calculation of TAC's is based on the assumption, that selectivity of trawls in the redfish fishery is following the selection ogive of a 120 mm net. It is, however, a well known fact that the selectivity of trawls in the redfish fishery can be reduced quite considerably even to zero due to meshing of redfish and when large hauls are being made. Therefore even fishing with large meshes does not in the areas where

small fish are concentrated prevent the taking of juvenile redfish which theoretically are protected by large trawl meshes. A catch limitation itself, however could discourage fisherman to take the TAC in areas in which smaller fish of less commercial value are dominating the catches. This development could be initiated by closing areas known as nursery grounds. In such a case, only the unavoidable by-catch of smaller fish could generate some fishing mortality in the juvenile component of the stock.

Since both species of redfish are often caught together and could not be recorded separately in the statistics the calculated TAC's have to be combined as a TAC for redfish. This necessary procedure includes the danger that one species on which fishing has been concentrated might be overexploited whereas the other species remaines only lightly fished. If, however, the management advice could be based on $F_{0.1}$ there will be a margin between this level and fishing at $F_{(max)}$. This margin will reduce the danger of undetected overexploitation of one species due to the combination of both species in the statistics.

In view of the fact that the assessments presented here are workt out on a limited data base and on the basis of restricted information as to the species composition of catches in different areas, it has to be pointed out that the calculated TAC's are less accurate than comparable figures for other species.

7. Advice on management

7.1. The working group recommends for the fishery on redfish in Subareas I and II the following TAC's in 1978

Sebastes marinus	20 ooo tons
Sebastes mentella	130 ooo tons

The total TAC in redfish in 1978 should be set at 150 000 tons.

The working group recommends to consider prohibition of fishing for redfish on nursery grounds.

7.2 The working group recommends for the fishery on redfish in Subareas V and XIV that a precautionary TAC should be set at 90 000 tons.
The working group recommends to prohibit fishing for redfis in two nursery areas off the east coast of Greenland limited by a line as described below:

Northern area

From the coast of Greenland at 67°N to
67°N, 30°30'W to
65°40'N, 30°30'W to
65°40'N, 31°50'W to
65°30'N, 33°10'W to
65°10'N, 34°00'W to
65°10'N, 35°00'W to
64°45'N 35°20'W to the coast of Greenland at 64°35'N.

Southern area

From the coast of Greenland at 64°20'N to
64°20'N 36°20'W to
63°50'N 36°50'W to
63°15'N 39°30'W to
63°45'N 39°30'W to the coast of Greenland at 63°45'N.

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Table 1 : Nominal catch of Redfishes (in metric tons) by countries (Sub-area I, Divisions IIa and II b combined)

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Belgium										30	28	
Faroe Isl.						60		9	32	6	67	
France	897									1116		
GDR	151	976	311	921	1069	7032	14786	9972	11756	28275	28020	22636
Germany,F.R.	4766	5389	5550	3258	5573	2416	3076	1697	3479	6616	5182	7357
Netherlands	345	33			20							127
Norway	6617	6931	5205	4024	3904	3832	4644	6776	7714	7055	4966	7000
Poland					5973	4631	2532	1112	215	1269	4711	4137
Portugal											331	
Spain											1194	
U.K.	4899	6546	5607	5058	5224	4554	4002	4379	4791	3509	2746	186
USSR	22300	15900	7300	5500	9100	13100	29800	22700	31800	48800	230950	271500
Total	39975	35775	23973	18761	30863	35625	58840	46645	59787	96676	278195	312943

* preliminary data

Table 2 : Nominal catch of Redfishes (in metric tons) by countries in Sub-Area I

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Belgium	-								-	30	-	
Faroe Isl.	-								6	6	-	
France	-								-	26	-	
GDR	-	-	81	25	23	-	78	36	-	358	201	90
Germany,F.R.	-	7	354	-	-	133	148	7	76	1086	483	476
Netherlands	-								-	-	-	-
Norway	333	159	242	464	365	141	316	1000	1917	194	482	a)
Poland	-				5973	6	1	22	-	-	93	47
Portugal	-										331	
Spain	-								-	-	820	
U.K.	1016	1706	1419	1163	1385	1384	1406	1363	1894	1320	1048	29
USSR	4974	4511	1640	1076	3647	2281	3743	4403	4885	9318	30750	12411
Total	6323	6383	3736	2728	11393	3945	5692	6831	8778	12338	34208	13053

* preliminary data

a) Div. I and Div. IIb included in Div. IIa

Table 3 : Nominal catch of Redfishes (in metric tons) by countries in Division IIa

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*	
Belgium	-								-	-	-		
Faroe Isl.	-					60		9	22	-	67		
France	897	b)								980			
GDR	34	285	26	69	812	2243	12339	8963	11474	27153	22778	16921	
Germany,F R.	4766	5382	5196	3258	5573	2165	1188	1466	2207	4167	4263	6379	
Netherlands	345	33			20				-	-	-	127	
Norway	6129	6772	4961	3518	3510	3679	4277	5720	5564	6837	4444	7000	a)
Poland	-				-	269	1605	784	156	869	920	217	
Portugal	-								-	-	-	-	
Spain	-								-	-	153	-	
U.K.	2927	4373	3781	3820	3578	2741	2463	2680	2125	1991	1621	141	
USSR	13991	8565	4715	3779	14	142	209	291	131	14	39138	23192	
Total	29089	25410	18679	14444	13507	11299	22081	19913	21679	42011	73384	53977	

* preliminary data

a) Sub-area I and Div. IIb included

b) Div. IIb included

Table 4 : Nominal catch of Redfishes (in metric tons) by countries in Division IIb

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Belgium											28	
Faroe Isl.									4			
France	b)									110		
GDR	117	691	204	827	234	4789	2369	973	282	764	5041	5625
Germany,F.R.						118	1740	224	1196	1344	436	502
Netherlands												
Norway	155		2	42	29	12	51	56	233	24	40	...a)
Poland						4356	926	306	59	400	3698	3873
Portugal												
Spain											221	
U.K.	956	467	407	75	261	429	133	336	772	198	77	16
USSR	3356	2813	914	622	5483	10668	25887	17953	26813	39455	161062	235903
Total	4584	3971	1527	1566	6007	20372	31106	19848	29359	42295	170603	245919

* preliminary data

a) Div. I and IIb included in Div. IIa

b) Div. IIa included Div. IIb

Table 5 : Sebastes mentella in Divisions II a and II b

Effort and catch per unit of effort 1965-76

Year	USSR catch/hour (tons)	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	251 818	277 289

Table 6 : 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

Table 7 : Nominal catch of Sebastes marinus (in metric tons) by countries (Sub-area I, Divisions IIa and IIb combined)

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Belgium										30		
Faroe Isl.						60	-	9	28	6	67	
France	897									1006		
GDR			81	25	23	-	78	753	2561	3158	1376	2003
Germany, F.R.	4766	5389	5550	3258	5573	2298	1336	1473	2283	5272	4746	6855
Netherlands	345	33			20							127
Norway	6462	6931	5203	3982	3875	3820	4593	6720	7481	7031	4926	7000
Poland					5973	6	1	85	35	90	140	72
Portugal											331	
Spain											820	
U.K.	3943	6079	5200	4983	4963	4125	3869	4043	4019	3311	2669	170
USSR	7900	7200	1700	1100	3600	2400	3900	4700	5000	7400	24100	22200
Total	24313	25632	17734	13348	24027	12709	13777	17783	21407	27304	39175	38427

* preliminary data

Table 8 : Nominal catch of Sebastes mentella (in metric tons) by countries (Sub-area I, Divisions IIa and IIb combined)

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Belgium											28	
Faroe Isl.									4			
France										110		
GDR	151	976	230	896	1046	7032	14708	9219	9105	25117	26644	20633
Germany,F.R.						118	1740	224	1196	1344	436	502
Netherlands												
Norway	155		2	42	29	12	51	56	233	24	40	
Poland						4625	2531	1027	180	1179	4571	4065
Portugal												
Spain											374	
U.K.	956	467	407	75	261	429	133	336	772	198	77	16
USSR	14400	8700	5600	4400	5500	10700	25900	18000	26800	41400	206900	249300
Total	15662	10143	6239	5413	6836	22916	45063	28862	38380	69372	239070	274516

* preliminary data

Table 9 : Age composition of the total catches of S. marinus (in 1000's) in Sub-area I and Division IIa 1965-1976

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
12	256	41	44	43	51	62	46	261	590	294	693	226
13	322	118	94	32	35	122	41	332	570	345	868	489
14	805	370	199	74	97	229	107	633	913	796	1638	1286
15	1531	863	406	165	209	444	239	1137	1527	1578	2984	2558
16	3505	2952	1363	550	666	1232	886	2563	3266	4159	7397	6599
17	1529	1737	919	364	556	723	594	1261	1441	2093	3563	2836
18	2321	2753	1536	611	954	1138	935	2014	2157	3161	5117	4143
19	2231	2718	1695	684	1223	997	990	2046	1892	2678	4402	3634
20	445	503	310	131	223	185	185	385	342	484	775	653
21	2223	2471	1459	753	1456	1003	858	1732	1420	1791	2829	2724
22	1624	1687	951	555	1084	750	595	1112	849	1042	1721	1714
23	1758	2158	1167	898	1518	921	779	1251	1123	1159	1813	2032
24	1741	1924	1241	1266	2259	966	1123	1121	1248	837	1432	1974
25	958	960	896	993	1845	716	776	746	884	533	930	1355
26	637	615	723	887	1667	623	636	585	729	402	817	1133
27	460	406	504	644	1362	526	426	429	568	280	701	1012
28	328	405	432	614	1038	347	431	377	508	252	589	711
	22674	22681	13939	9264	16243	10984	9647	17985	20027	21884	38269	35079

based on annual length compositions and an age/length key from the German (F.R. fishery in Div. IIa (1976)

Table 10 : Age composition of the total catches of S. mentella (in 000's) in Divisions IIa and IIb 1965-1976

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
5					63						185	
6	48			7	31			466	172	606	5334	551
7	285			-	94			792	1660	4847	19417	9125
8	1592	27	7	15	409	33	114	5728	4865	15451	42425	29133
9	2163	279	15	89	524	131	284	3586	9729	28781	82480	73640
10	1141	532	182	192	838	620	681	2049	4636	30144	108462	127306
11	1545	465	285	355	933	2122	1590	1770	2633	19843	119075	141823
12	1972	731	343	436	954	3428	4429	3865	3148	10603	57231	120489
13	2471	1223	394	554	849	3983	4884	4564	5208	8634	29651	65138
14	2804	1927	489	864	618	3526	5451	4704	5666	8634	20894	28416
15	1996	2007	496	768	482	2808	4940	4098	4578	6514	16499	19685
16	2067	1741	628	931	807	3983	7496	4704	5380	5908	13465	16980
17	1592	1422	613	694	451	2743	4486	3632	3777	3332	13668	11719
18	1473	944	540	665	849	3559	7382	3167	2747	2878	12207	11218
19	1069	837	949	702	786	2318	4770	1816	1316	1666	6757	4315
20	689	532	649	369	555	1567	3918	885	973	2121	7112	4017
21	404	346	693	347	440	784	2385	373	630	757	5113	2596
22	261	186	598	251	514	653	1874	279	114	454	2242	1668
23	71	66	248	89	199	327	1590	47	10*	151	735	1682
24	95	13	117	44	42	65	397	47	10*	151	407	761
25	24		36	15	31		57				204	309
26			7		10		57					
27			7									

* assumed

Table 11 : Sebastes marinus. Mean length at age (Sub-area I and Division IIa)

Age \ Length (cm)	Norway Bratberg 1956	Germany, FR Kosswig 1976	Germany, FR 1976	GDR 1975	Average
1	5.6				5.6
2	8.4				8.4
3	11.3				11.3
4	13.1				13.1
5	15.8				15.8
6	18.0				18.0
7	21.5	21.9			21.7
8		23.9			23.9
9		25.9			25.9
10		28.8			28.8
11		31.2			31.2
12		32.7	31.9	33.2	32.6
13		33.6	33.1	33.5	33.4
14		35.5	34.3	34.5	34.8
15		35.0	35.4	36.2	35.5
16		38.0	37.1	37.1	37.4
17		38.5	39.0	37.5	38.3
18		39.8	39.5	38.8	39.4
19		-	40.7	40.4	40.5
20		-	41.0	41.6	41.3
21		44.5	42.6	43.1	43.4
22		45.3	43.6	43.4	44.1
23		48.5	45.1	44.5	46.0
24		50.0	48.5		49.3
25		52.5	50.4		51.5
26		52.5	52.2		52.4
27		58.2	55.6		56.9
28		60.1	54.6		57.4

Table 12 : Sebastes marinus. Mean weight at length (Sub-area I and Division IIa)

Length (cm) \ Weight (g)	GDR 1974	GDR 1975	Germany, FR	Norway 1971	Average
28	--	--	--	292	292
29	400	--	--	309	355
30	388	400	--	352	380
31	500	400	440	389	432
32	483	450	478	513	481
33	512	500	532	--	515
34	606	575	595	585	590
35	618	633	638	645	634
36	665	675	635	--	658
37	727	739	749	--	738
38	723	789	790	850	783
39	860	784	854		833
40	956	883	924		921
41	987	948	959		965
42	1054	1000	1039		1031
43	1183	1076	1097		1119
44	1180	1150	1197		1176
45	1333	1257	1267		1286
46	1075	1350	1354		1352*
47	1166	1387	1352		1370*
48	1500	1500	1550		1525*
49	1187	1630	1720		1680*
50	1433	--	1660		1660*
51	--	--	1800		1800
52	--	--			--
53	--	--			--
54	--	2000			2000

* First column excluded

Table 13 : Sebastes mentella in Division IIa and IIb

Stock size (in 000's) estimated by VPA for 1965 - 1976

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
6	203577	232258	231691	292127	573289	782891	759502	742403	412884	353504	750000	750000
7	199273	184158	210156	209643	264323	518704	708389	687226	671315	373430	319296	673500
8	127265	180040	166633	190157	189693	239082	449343	640977	621078	605854	333286	270459
9	104531	113641	162883	150771	172048	171253	216300	424573	574536	557351	533513	261279
10	86512	92527	102562	147370	136339	155178	154832	195447	380761	510613	476959	404434
11	66118	77195	83217	92626	133164	122568	139822	139451	174900	340121	433376	328676
12	55817	58357	69407	75027	83477	119605	108887	125005	124438	155753	288898	279234
13	36616	48631	52109	62476	67473	74626	104964	94316	109435	109658	130856	207094
14	25086	30784	42841	46776	56004	60245	63739	90334	81003	94072	91019	90274
15	19095	20035	26023	38299	41503	50087	51161	52495	77267	67911	76917	62537
16	11693	15382	16222	23075	33925	37095	42652	41600	43606	65564	55260	53943
17	10313	8618	12264	14082	19995	29929	29782	31478	33173	34346	53712	37239
18	7190	7820	6448	10515	12082	17663	24475	22688	25033	26429	27913	35638
19	4128	5108	6179	5321	8882	10125	12605	15149	17522	20041	21180	13708
20	2845	2721	3628	4690	4148	7290	6963	6889	11983	14604	16551	12761
21	1853	1920	1957	2847	3893	3226	5110	2602	5393	9918	11201	8247
22	1497	1294	1409	1115	2247	3105	2176	2368	2000	4281	8255	5298
23	829	1238	1933	1373	1328	2054	3278	703	2029	3391	4839	7761
24	605	131	944	688	575	529	1091	475	156	1659	1408	2424

Table 14 : Sebastes mentella in Divisions IIa and IIb

The biomass 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+}) tons x 10^{-3}	B (N_{15+}) tons x 10^{-3}	Year class	Year class strength at 6 years old (Millions)
1965	315	51	1965	760
1966	356	55	1966	742
1967	406	60	1967	413
1968	471	86	1968	354
1969	585	109	1969	(750)
1970	735	137	1970	(750)
1971	872	153		
1972	1010	149		
1973	1114	184		
1974	1213	213		
1975	(1326)	(240)		
1976	(1228)	(208)		
1977	(1056)	(173)		
1978	(1021)	(182)		
1979	(1045)	(189)		

Table 15: Stock size of S. marinus Div. IIa and Subarea I 1965-1976 (in 000's) estimated by VPA for M = 0.10.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
12	39249	34618	37312	27227	45858	49198	39314	68899	45250	43399	29404	39698
13	37663	35271	31284	33720	24595	43840	43552	35529	62094	40383	38989	25946
14	33368	33773	31802	28218	30481	22663	39552	39369	31833	55643	36212	34453
15	31585	29427	30207	28586	25462	29330	20289	35686	35020	27935	49591	31208
16	30813	27123	25806	26946	25709	24000	26117	18131	31209	30235	23775	42033
17	26514	24547	21734	22053	23859	23887	20544	22788	13967	25132	23402	14477
18	21607	22536	20559	18791	19609	22394	20926	18024	19420	11267	20750	17785
19	16206	17343	17772	17141	16422	17752	19181	18046	14393	15520	7188	13908
20	17317	12542	13107	14469	14859	14459	15114	16414	14382	11223	11496	2317
21	15452	15246	10870	11565	12968	13918	12910	13500	14486	12688	9695	9665
22	13919	11867	11444	8448	9748	10829	11639	10865	10557	11756	9777	6081
23	10848	11050	9933	9451	7116	8150	9085	9965	8774	8754	9646	7210
24	11051	8144	7946	7154	7697	4995	6498	7480	7827	6870	6819	7004
25	5721	8343	5539	6009	5269	4816	3601	4812	5702	5895	5420	4808
26	3275	4265	6636	4159	4493	3012	3676	2520	3644	4318	4827	4020
27	2294	2358	3274	5317	2920	2479	2133	2722	1723	2604	3525	3591
28	1327	1638	1747	2483	4198	1403	1743	1522	2055	1019	2090	2533

Table 16: Sebastes marinus. Subarea I and Division IIa. Spawning stock biomass (age 15 and older) and Stock biomass (age 12 and older)

Year	Spawning stock biomass (15+)	Stock biomass (12+)
1965	195827	253086
1966	191988	246047
1967	183562	235727
1968	181212	227746
1969	178837	213304
1970	170910	229423
1971	167556	231429
1972	174127	247899
1973	174620	246364
1974	168429	241912
1975	176867	231749
1976	158184	210284
1866	139386	191423
1978	119313	178834
1979	107569)$F_{(78)}$=0.35 114903)$F_{(78)}$=0.25	175151

Table 17: Fishing mortalities of S. marinus in Sub-area I and Division IIa in 1965-1976 estimated by VPA for M = 0.10

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 *
12	.007	.001	.001	.002	.010	.001	.001	.004	.014	.007	.025	.006
13	.009	.004	.003	.001	.002	.003	.001	.010	.010	.009	.024	. 02
14	.026	.012	.007	.003	.003	.011	.003	.017	.031	.015	.049	. 04
15	.052	.031	.014	.006	.009	.016	.013	.034	.047	.061	.065	. 09
16	.127	.122	.057	.022	.028	.056	.036	.161	.117	.156	.396	. 18
17	.063	.077	.046	.018	.025	.033	.031	.060	.115	.092	.174	. 23
18	.120	.138	.082	.035	.053	.055	.048	.125	.124	.350	.300	. 28
19	.156	.180	.106	.043	.082	.061	.056	.127	.149	.200	1.032	. 32
20	.027	.043	.025	.010	.016	.013	.013	.025	.025	.046	.074	. 35
21	.164	.187	.152	.071	.126	.079	.072	.145	.109	.161	.366	. 35
22	.131	.162	.092	.072	.124	.076	.055	.114	.088	.098	.205	. 35
23	.187	.230	.144	.105	.254	.127	.095	.142	.145	.150	.220	. 35
24	.181	.286	.179	.206	.369	.227	.201	.171	.184	.137	.250	. 35
25	.194	.129	.186	.191	.459	.170	.257	.178	.178	.100	.199	. 35
26	.229	.164	.122	.254	.494	.245	.201	.280	.236	.103	.196	. 35
27	.237	.200	.177	.136	.633	.252	.236	.181	.425	.120	.230	. 35
28*	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.35	. 35

* Assumed values

Table 18: Sebastes mentella in Division IIa and IIb

Fishing mortalities estimated by VPA for 1965 - 1976

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
6	.000	.000	.000	.000	.000	.000	.000	.001	.000	.002	.008	.0007
7	.002	.000	.000	.000	.000	.000	.000	.001	.003	.014	.066	.015
8	.013	.000	.000	.000	.002	.000	.000	.009	.008	.027	.143	.120
9	.022	.003	.000	.001	.003	.001	.001	.009	.018	.056	.177	.350
10	.014	.006	.002	.001	.006	.004	.005	.011	.013	.064	.272	.400
11	.025	.006	.004	.004	.007	.018	.012	.013	.016	.063	.340	.600
12	.038	.013	.005	.006	.012	.031	.044	.033	.027	.074	.233	.600
13	.074	.027	.008	.009	.013	.058	.050	.052	0.51	.086	.271	.400
14	.125	.068	.012	.020	.012	.063	.094	.056	.076	.101	.275	.400
15	.116	.111	.020	.021	.012	.061	.107	.086	.064	.106	.255	.400
16	.205	.126	.042	.043	.025	.120	.204	.126	.139	.099	.295	.400
17	.177	.190	.054	.053	.024	.101	.172	.129	.127	.107	.310	.400
18	.242	.135	.092	.069	.077	.237	.380	.158	.122	.121	.611	.400
19	.317	.189	.176	.149	.098	.274	.504	.134	.082	.091	.407	.400
20	.293	.229	.196	.086	.151	.255	.884	.145	.089	.165	.597	.400
21	.260	.209	.463	.137	.126	.294	.669	.163	.131	.084	.648	.400
22	.202	.164	.587	.269	.274	.249	2.206	.132	.062	.118	.335	.400
23	.414	.065	.303	.141	.316	.251	1.404	.258	.006	.098	.253	.400
24	.179	.110	.140	.072	.082	.144	.481	.107	.072	.099	.364	.400

Table 19 : Parameters used in TAC Calculation

Sebastes marinus in Sub-area I and Division IIa

Age	Stock size beginning of 1978	Proportional fishing mortality (1976-1978)	Mean weight year age (kg)
12	42 932	.02	.477
13	38 614	.05	.512
14	31 667	.10	.577
15	20 006	.25	.611
16	24 769	.50	.710
17	19 505	.65	.761
18	22 839	.80	.826
19	7 119	.90	.895
20	7 991	1.00	.947
21	5 827	1.00	1.093
22	942	1.00	1.145
23	3 930	1.00	1.293
24	2 472	1.00	1.580
25	2 931	1.00	1.793
26	2 848	1.00	1.885
27	1 955	1.00	2.393
28	4 124	1.00	2.454

Table 20: Sebastes mentella in Division II a and II b

Parameters used in catch prediction

Age	Stock size beginning of 1978	Proportional fishing mortality (1976 - 1978)	Mean weight per age (kg)
6	700 000	.0012	.168
7	632 800	.025	.183
8	606 944	.20	.255
9	496 273	.58	.311
10	151 591	.67	.367
11	111 686	1.00	.432
12	141 648	1.00	.508
13	94 254	.67	.611
14	92 982	.67	.679
15	84 223	.67	.753
16	36 713	.67	.821
17	25 433	.67	.872
18	21 938	.67	.910
19	15 141	.67	.923
20	14 493	.67	.985
21	5 575	.67	1.056
22	5 190	.67	1.124
23	3 354	.67	1.193
24	2 155	.67	1.215

Table 21: Calculations of TAC

Sebastes marinus in Sub-area I and Division IIa

	1976	1977	1978	1979
Catch (tons)				
Fishing mortality	362/7	3/575	20524	
on age groups subject to maximum exploitation	,35	,35	.25	
Total stock biomass(12+) (000's tons)	210	191	179	175
Spawning stock biomass (15+) (000's tons)	158	139	119	115

Table 22 : Nominal catch (in metric tons) of Redfish in Division Va (Iceland) by country 1969-1976 (Data for 1965-1974 from Bull.stat.)

Countries	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Belgium	3841	3800	3788	4117	3360	2204	2798	2484	1622	2114	1945	1447
Faroe Isl.	16	--	3	2	8	--	35	9	243	254	82	211
GDR	274	441	341	419	656	827	238	135	--	11	--	--
Germany, F.R.	73982	73974	66638	62521	55831	48907	46580	43963	38358	36398	33602	33047
Iceland	23663	16607	17857	24716	24321	23807	29118	26973	26470	27799	32659	35022
Netherlands	1528	36	--	--	2	--	--	--	--	--	--	--
Norway	--	50	--	20	--	--	1	1	4	15	22	37
Poland	--	--	--	--	--	259	17	35	--	18	--	--
Scotland	619	249	279	144	128	138	116	89	28	37	56	18
UK	9764	5913	5742	3727	2174	2810	3436	3608	2923	2482	2368	2000*
USSR	413	5998	435	809	1256	10	31	28	2	--	--	--
TOTAL	114100	107068	95083	96475	87736	78962	82370	77325	69650	69129	70734	71782

* Estimated

Table 23: Nominal catches in metric tons of Redfish in Division Vb 1965-76 (Faroe Island) by country

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Faroe Isld.	1	--	--	1	5	--	--	--	121	28	9	33
Franco	582	--	--	--	--	--	--	--		300	800	
GDR	55	6	18	45	--	--	--	--	--	1	1	--
Germany (F.R.)	5159	3243	4949	6538	1293	1914	2328	4034	9490	7328	7628	4939
Netherlands	--	--	--	--	--	--	--	--	--	--	105	--
Norway	--	--	--	--	--	--	--	--	--	10	7	19
UK(England&Wales)	38	8	24	43	13	13	12	40	72	74	18	--
UK (Scotland)	27	40	22	10	15	20	12	13	13	24	23	43
TOTAL	5862	3297	5013	6637	1326	1947	2352	4087	9696	7765	8591	5043

Table 24 : Nominal catch (metric tons) of Redfishes in Sub-area XIV b (East Greenland) and ICNAF Sub-area I (West Greenland), 1965 - 1976 by country

(Data for 1965- 1974 from ICES - Bulletin Statistique and ICNAF Statistical Bulletin)

Country	Year 1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Denmark	-	-	-	-	-	-	-	-	-	-	-	129
Faroe Islands	-	-	-	-	-	-	-	-	13	43	1	+
GDR	110	99	28	-	154	409	611	703	841	1275	4490	-
GFR	33253	19845	23225	17552	26289	16316	17062	7287	4491	2632	4979	3944
Iceland	3082	3342	9935	5527	3906	1001	2380	5490	2144	9777	5632	7367
Norway	-	-	-	-	-	-	-	-	-	-	63	-
Poland	-	-	-	-	-	436	312	464	281	6	276	-
U.K.	68	4	10	-	-	+	+	5	65	127	56	-
USSR	-	-	-	-	18	-	71	21	64	118	9830	102297
Total XIV b (East Greenland)	36513	23290	33198	23079	30367	18162	20436	13970	7899	13978	25329	113737
Total ICNAF Sub-area I (West-Greenland)	19052	16758	13210	9606	4252	4101	2756	2988	3319	3324	8629	13682

Table 25 :

Effort table for S. marinus in the Div. Va and Subarea XIV.

Catches and catch-per unit-effort are given in metric tons. (*the figures from 1976 are preliminary)

Year	Division Va						Subarea XIV					
	GERMANY (F.R.)			ICELAND			GERMANY (F.R.)			ICELAND		
	Day fished			Hour trawled			Day fished			Hour trawled		
	catch	effort	cpue	catch	effort	cpue	catch	effort	cpue	catch	effort	cpue
1965	18058	3635	5.0	23190	55478	0.4	33253	2726	12.2	3082	4763	0.6
1966	26508	4384	6.1	16275	48438	0.3	19845	1563	12.7	3342	4074	0.8
1967	19329	4068	4.8	17500	45103	0.4	23225	2191	10.6	9935	7619	1.3
1968	11637	3281	3.6	24222	55301	0.4	17552	1553	11.3	5527	5143	1.1
1969	16962	3968	4.3	23835	56750	0.4	26289	2306	11.4	3096	3906	0.8
1970	13070	3542	3.7	23331	56766	0.4	16316	1584	10.3	1001	2447	0.4
1971	12216	3785	3.2	28636	58203	0.5	17062	2106	8.1	2380	3075	0.8
1972	4125	1872	2.2	26434	52448	0.5	7287	1777	4.1	5490	4923	1.1
1973	3067	803	3.8	25677	48722	0.5	4491	935	4.8	2144	2328	0.9
1974	4324	668	6.5	26965	50402	0.5	2632	309	8.5	9777	7794	1.3
1975	4250	458	9.3	31353	59268	0.5	5632	593	9.5	5632	4570	1.2
1976*	4260	470	9.1	33271	65365	0.5	7367	944	7.8	7367	-	-

Table 26. Sebastes marinus. Mean length at age.
Subarea XIV, Div. Va.

Length cm	Germany (F.R.) Data	Icelandic Data	Icelandic Data	Icelandic Data	Weighted Mean Length	
Age	Subarea XIV		Division Va			
7		27.0		26.3	26.9	0.728
8		29.2		26.8	29.9	0.385
9		33.0		29.0	32.2	0.454
10		39.0		30.2	32.4	0.494
11	31.0			31.0	31.0	0.431
12	31.8		33.4	32.8	32.6	0.503
13	32.7		33.9	37.8	33.7	0.557
14	35.8		35.6	35.0	35.7	0.666
15	36.1		36.8	37.0	36.5	0.714
16	38.1		37.7		37.8	0.795
17	39.1		38.9		39.0	0.875
18	40.2		40.2		40.2	0.961
19	41.0		41.5		41.3	1.045
20	42.8		42.0		42.5	1.141
21	43.7		43.1		43.4	1.218
22	45.8		44.9		45.5	1.409
23	47.0		46.7		46.8	1.537
24	49.6		49.4		49.5	1.828
25	50.6		51.2		50.8	1.980
26	52.9		53.3		53.0	2.257
27	54.5				54.5	2.461
28	54.8				54.8	2.502

Table 27: S. mentella. Mean length at age.
Subarea XIV and Div. Va.

German (F.R.) data only.

	Subarea XIV	Iceland 1975	Iceland 1976	Weighted mean length
12	28.5	33.2	32.6	32.7
13	29.6	35.0	34.2	33.5
14	31.4	35.2	35.2	34.6
15	31.6	35.7	37.0	35.5
16	34.1	37.6	38.5	37.3
17	36.6	40.1	40.0	39.1
18	37.5	41.2	40.7	39.9
19	38.5	41.2	42.3	40.6
20	40.2	42.3	42.3	41.6
21	42.0	42.5	43.4	42.1
22		43.9	44.7	42.8
23		45.1	47.0	44.8
24		47.3	48.5	46.1
25		47.5	48.2	47.6
26		50.2	48.0	48.3
27		-	49.1	49.1

Table 28: Sebastes marinus Mean weight at length in grams

(Subarea XIV and Division Va)

Length cm	Iceland	Germany, F.R.	Average
6	3		
7	5		
8	6		
9	9		
10	12		
11	17		
12	22		
13	28		
14	33		
15	42		
16	53		
17	60		
18	81		
19	94		
20	114		
21	147		
22	174		
23	185		
24	207		
25	235		
26	256		
27	286		
28	329		
29	355		
30	385		
31	441	350	396
32	480	405	443
33	536	495	516
34	583	538	561
35	655	605	630
36	699	668	684
37	759	689	724
38	862	759	811
39	916	828	872
40	961	904	933
41	1008	950	979
42	1107	1047	1077
43	1162	1117	1140
44	1373	1172	1273
45	1380	1274	1327
46	1455	1349	1402
47	1790	1360	1470
48	1588	1516	1552
49	1710	1650	1680
50	1810	1740	1775
51	2050	1625	1838
52		1805	1805

Table 29: Sebastes mentella Mean weight at length (Subarea XIV and Division V a) in grams

Length cm	Iceland	Germany, F.R.	Average
10			
11			
12	26		
13	27		
14	35		
15	43		
16	52		
17	61		
18	76		
19	92		
20	108		
21	122		
22	149		
23	170		
24	186		
25	217		
26	233		
27	281		
28	313		
29	336		
30	402		
31	435		
32	483	449	466
33	527	497	512
34	592	520	556
35	684	580	632
36	720	637	679
37	808	694	751
38	815	727	771
39	843	808	826
40	858	864	861
41	939	932	936
42	973	1002	988
43	1083	1075	1079
44	1133	1136	1135
45	1150	1209	1180
46	1210	1274	1242
47	-	1360	1360
48	1300	1456	1378
49	-	1540	1540
50	1600	1715	1658
51		1650	1650
52			

Table 30 *Sebastes marinus* SAI + DIV. IIa. Cohort (length) analysis
M= 0.1, K = 0.042, Lo_o = 77 cm, $\frac{F}{Z}$ = .8

1965-1974 Cm	C $x10^{-3}$	F (year)	N $x10^{-6}$	1975-1976	C $x10^{-3}$	F (year)	N $x10^{-6}$
28	3	.0001	22.7		10	.0002	43.4
29	6	.0003	22.0		21	.001	42.2
30	30	.002	21.4		122	.003	41.0
31	94	.005	20.8		302	.008	39.8
32	188	.010	20.1		480	.013	38.5
33	275	.015	19.5		908	.026	37.2
34	360	.020	18.7		1189	.036	35.6
35	518	.031	18.0		2027	.065	34.0
36	642	.040	17.1		2223	.076	31.8
37	813	.054	16.2		2738	.102	29.6
38	1089	.078	15.2		3423	.142	27.1
39	1176	.092	14.1		3828	.182	24.2
40	1442	.125	12.9		3281	.181	20.8
41	1246	.121	11.4		2960	.191	17.9
42	1178	.130	10.2		2502	.190	15.1
43	1056	.132	9.0		1904	.171	12.1
44	931	.133	7.8		1421	.148	10.8
45	746	.122	6.8		1206	.146	9.3
46	595	.111	6.0		930	.130	8.0
47	603	.129	5.2		756	.122	6.9
48	609	.152	4.5		615	.114	6.0
49	473	.140	3.8		627	.135	5.2
50	467	.165	3.2		587	.150	4.4
51	366	.156	2.7		320	.096	3.7
52	314	.164	2.2		408	.144	3.2
53	348	.231	1.8		461	.203	2.6
54	283	.253	1.3		388	.223	2.0
55	231	.291	1.0		366	.290	1.5
56	145	.263	.7		217	.247	1.0
57	114	.305	.5		201	.338	.7
58	66	.268	.3		132	.362	.5
59	44	.270	.2		79	.372	.3
60	38	.385	.1		70	.686	.1
61	22	.432	.1		24	.753	.1
62	7	.265	.1		0	0	.1
63	7	.518	.1		3	.324	.1
64	1	.168	.1		3	.4	.1
65	1	.276	.1				

Table 31. Cohort analysis using length data.

	Sebastes marinus								Sebastes mentella							
	M=0.1; K=0.0192; L_∞ = 101.67 $\frac{F}{Z}$ = 0.8								M = 0.1; K=0.0082; L_∞ = 173.7; $\frac{F}{Z}$ = 0.8							
	1965-74				1975-76				1965-74				1975-76			
cm	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}
9													56	.00005	.00007	833.5
10													56	.00006	.00007	778.9
11													42	.00004	.00006	727.5
12													309	.00036	.00047	679.3
13													512	.00063	.00084	633.8
14													1754	.0024	.0031	590.9
15													6609	.010	.013	549.7
16													11009	.018	.023	507.5
17													12317	.022	.028	464.6
18													16850	.033	.042	423.4
19													14468	.031	.040	381.4
20	1	.000003	.000004	255.4	60	.00015	.00024	259.0					19659	.048	.061	343.9
21	3	.000008	.000013	242.7	60	.00016	.00024	246.1					14301	.040	.050	304.8
22	1	.000003	.000004	230.5	135	.00039	.00060	233.6					11921	.037	.046	272.3
23	4	.000012	.000019	218.7	197	.0006	.0009	221.6					8856	.031	.038	243.7
24	10	.000033	.000050	207.4	784	.0026	.0039	210.0					14948	.059	.073	219.4
25	6	.000021	.000032	196.5	1207	.0043	.0063	198.5					6554	.029	.036	192.0
26	12	.000046	.000067	186.1	1333	.0050	.0074	187.2					7986	.040	.049	172.9
27	28	.000114	.000165	176.1	2342	.0096	.0138	176.3					9528	.055	.066	154.0
28	52	.00023	.00032	166.5	2093	.0093	.0132	165.1					10795	.072	.086	135.1
29	111	.0005	.0007	157.3	3017	.0145	.0204	154.6					10851	.085	.101	116.4
30	354	.0018	.0025	148.5	2911	.0153	.0211	143.8	12	.00009	.00011	118.4	6858	.063	.074	99.0
31	500	.0027	.0037	139.8	3856	.022	.030	133.6	33	.00027	.00031	109.5	3855	.041	.048	86.0
32	1013	.006	.008	131.4	5421	.034	.046	128.2	68	.00060	.00070	101.2	2377	.028	.033	76.4
33	1662	.011	.014	123.1	5004	.035	.047	112.1	135	.00130	.00151	93.5	1827	.024	.028	68.6
34	2555	.018	.023	114.6	5115	.041	.053	101.8	253	.0027	.0031	86.3	1549	.023	.026	61.9
35	3390	.026	.034	105.8	5200	.047	.060	91.9	398	.0046	.0052	79.5	1890	.031	.036	55.8
36	3860	.033	.042	96.9	5260	.054	.068	82.4	670	.008	.010	73.0	2085	.039	.044	49.9
37	4479	.043	.054	87.9	5184	.061	.076	73.3	953	.013	.015	66.7	2187	.047	.053	44.3
38	4564	.050	.062	78.9	5372	.073	.090	64.7	1475	.023	.026	60.7	2291	.057	.063	38.9
39	4433	.056	.067	70.3	4709	.074	.090	56.3	1874	.033	.036	54.6	1682	.048	.053	33.9
40	4327	.063	.075	62.2	5036	.094	.112	48.9	3053	.061	.068	48.7	2097	.069	.076	29.7
41	3868	.065	.076	54.6	4588	.103	.121	41.6	3625	.086	.094	42.1	2144	.084	.092	25.5
42	4191	.082	.095	47.8	3469	.094	.108	35.1	4605	.134	.145	35.5	2380	.113	.122	21.6

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Table 31 (ctd).

	Sebastes marinus							Sebastes mentella						
	M=0.1; K=0.0192; L_∞ = 101.67; $\frac{F}{Z}$ = 0.8							M = 0.1; K=0.0082; L_∞ = 173.7; $\frac{F}{Z}$ = 0.8						
	1965-74				1975-76			1965-74				1975-76		
cm	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}
43	3523	.082	.093	41.1	3057	.099	.112	29.8	5071	.190	.203	28.5	2488	.147	.158	17.7
44	3029	.084	.094	35.2	2650	.104	.116	25.1	5128	.264	.280	21.7	2679	.207	.220	14.0
45	2958	.098	.108	30.1	2245	.107	.117	21.1	4709	.363	.380	15.3	2480	.267	.281	10.5
46	2744	.111	.119	25.4	1752	.102	.110	17.6	3511	.445	.459	9.7	2017	.319	.332	7.3
47	2460	.123	.130	21.1	1614	.115	.121	14.7	2258	.505	.515	5.7	1722	.436	.447	4.9
48	2381	.150	.155	17.3	1469	.130	.135	12.2	1389	.591	.593	3.1	1116	.496	.502	2.9
49	2044	.166	.168	13.8	1196	.133	.135	9.9	698	.593	.590	1.6	629	.509	.511	1.6
50	1711	.182	.182	10.8	1302	.187	.187	8.0	344	.582	.576	.8	399	.627	.616	.9
51	1293	.183	.179	8.3	838	.158	.155	6.1	156	.506	.499	.4	160	.490	.484	.4
52	941	.176	.169	6.4	706	.175	.168	4.8	89	.537	.524	.2	76	.404	.399	.2
53	660	.163	.153	4.9	529	.173	.163	3.7	38	.411	.402	.1	51	.461	.450	.1
54	336	.106	.098	3.8	253	.106	.098	2.9	33	.669	.634	.1	34	.567	.543	.1
55	294	.115	.104	3.1	276	.146	.182	2.4	19	.940	.853	<.1	17	.551	.524	<.1
56	135	.065	.057	2.6	212	.145	.128	1.9	7	1.028	.913	<.1	5	.275	.265	<.1
57	95	.054	.047	2.2	70	.060	.052	1.5	2	.855	.772	<.1	5	.433	.409	<.1
58	36	.024	.020	1.9	20	.020	.017	1.3	0	0	0	<.1	2	.276	.261	<.1
59	29	.022	.019	1.7	46	.054	.044	1.1	1		.4		3	.755	.678	<.1
60	25	.022	.018	1.5	31	.043	.035	1.0					2		.4	
61	21	.022	.017	1.3	15	.024	.019	.8								
62	23	.028	.021	1.2	15	.028	.022	.7								
63	26	.037	.028	1.0	9	.020	.015	.7								
64	22	.037	.027	.9	12	.031	.023	.6								
65	27	.054	.039	.8	31	.098	.070	.5								
66	21	.051	.036	.6	12	.047	.033	.4								
67	22	.066	.045	.5	12	.057	.039	.3								

continued on page 63

Table 31 (ctd).

	Sebastes marinus								Sebastes mentella							
	M=0.1; K=0.0192; L_∞ = 101.67 $\frac{F}{Z}$ = 0.8								M = 0.1; K=0.0082; L_∞ = 173.7; $\frac{F}{Z}$ = 0.8							
	1965-74				1975-76				1965-74				1975-76			
cm	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{6}	Catch (No.) x 10^{-3}	FΔt	F (year)	Stock (No.) x 10^{-6}
68	23	.087	.057	.5	11	.065	.043	.3								
69	20	.097	.061	.4	9	.066	.042	.2								
70	18	.113	.070	.3	15	.144	.089	.2								
71	15	.125	.075	.2	13	.172	.103	.1								
72	14	.160	.092	.2	9	.168	.097	.1								
73	11	.177	.099	.1	27	1.047	.533	.1								
74	12	.292	.156	.1	5	.542	.285	<.1								
75	6	.229	.119	.1	5		.4									
76	8	.539	.263	<.1												
77	8		.4													
Total	64415				90819				40607				226486			

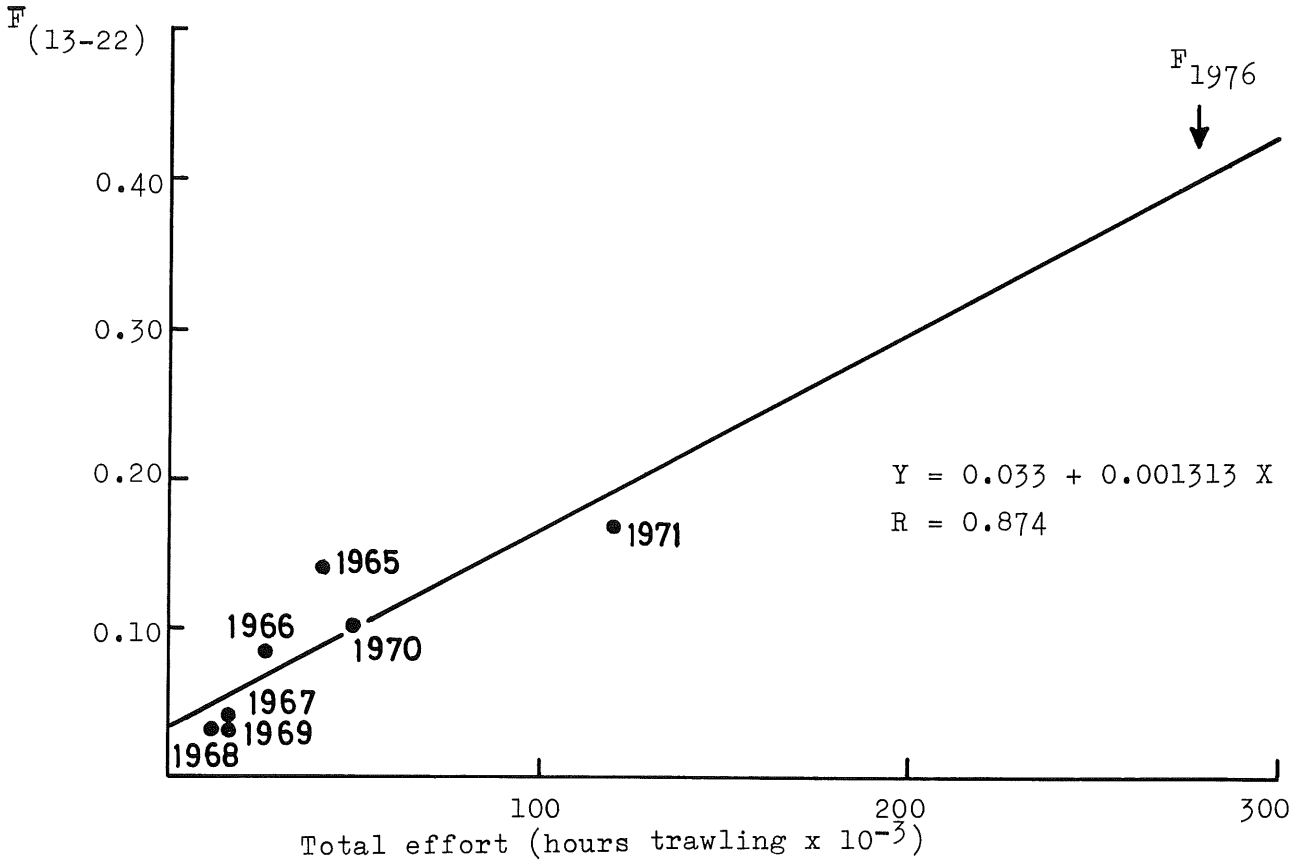

Figure 1. Sebastes mentella. Divisions IIa and IIb. Relation of weighted mean fishing mortality (Age 13-22) to total effort.

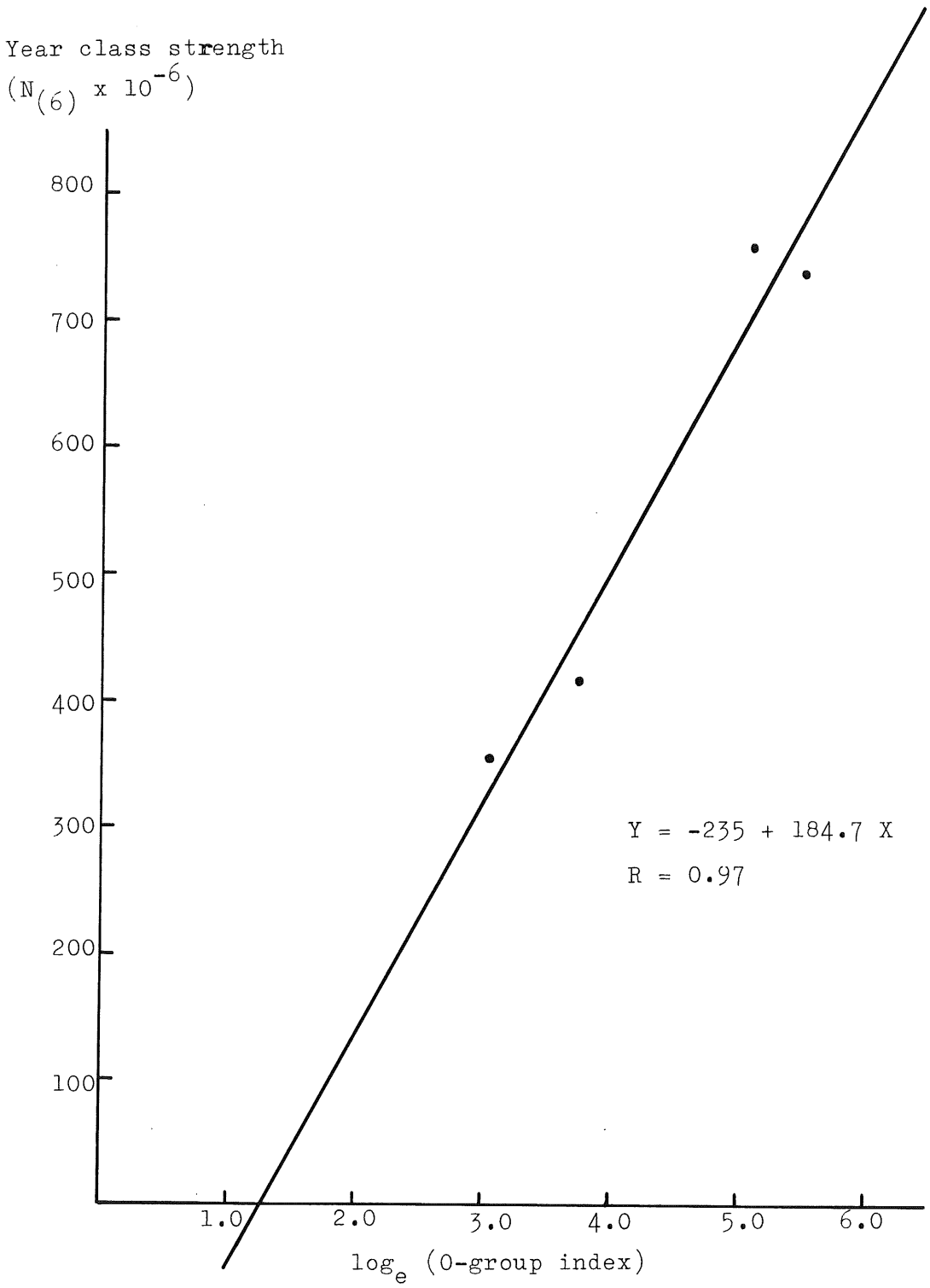

Figure 2. Sebastes mentella. Divisions IIa and IIb. Relation of year class strength at age 6 (from VPA) to corresponding 0-group survey abundance indices ($\log_e$ transformed).

Figure 3. Sebastes marinus.Sub-area I and Division IIa. Yield per recruit curve for present exploitation pattern (M = 0.1).

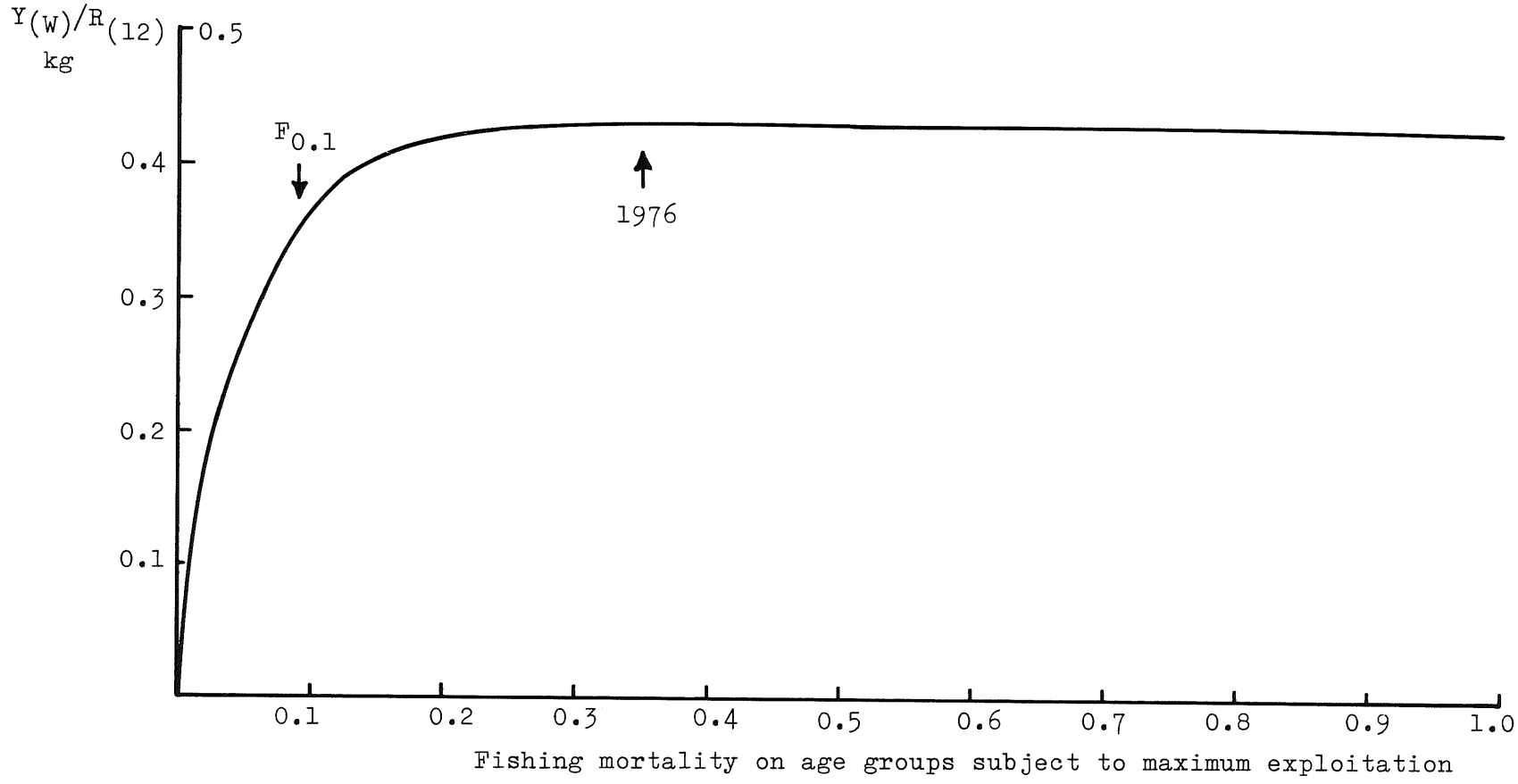

Figure 4. Sebastes mentella. Divisions IIa and IIb.
Curves for yield per recruit and spawning stock biomass per recruit for present exploitation pattern (M = 0.1).