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International Council for the
Exploration of the Sea

C.M.1990/G:2
Demersal Fish Committe

REPORT OF THE STUDY GROUP ON OCEANIC-TYPE SEBASTES MENTELLA

Reykjavik, 21-23 February 1990

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https://doi.org/10.17895/ices.pub.9332

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1.1 Participants

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A.I. Pavlov	USSR
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G. Stefánsson	Iceland

1.2. Terms of Reference

At the Statutory Meeting in the Hague 1989, the Council adopted the following resolution (C. Res. 1989/2:9).

A Study Group on Oceanic Type *Sebastes mentella* will be established under the chairmanship of Dr. J. Magnússon (Iceland), with membership to include at least Dr. K. Kosswig (Federal Republic of Germany), Mr. J. Reinert (Faroe Islands), Mr. I. Pavlov (USSR), Mr. O. Jørgensen (Denmark), and Ms V.J. Magnússon (Iceland), and will meet in Reykjavík from 21-23 February 1990 at national expense to:

a. review the work on stock identification;

b. consider the problems of age determination of both *Sebastes mentella* and *S. marinus;*

c. coordinate national research programmes;

d. consider assessment approaches other than age-based VPA

e. report to the North-Western Working Group.

1.3 Background

In the stock assesssment work at ICES, the redfish (*S. marinus* and *S. mentella*, respectively) at East Greenland, Iceland and the Faroe Islands are treated as unit stocks, however, there have been some doubts about the data e.g. the age-readings, and on some occasions it has been impossible to run a VPA because of difficulties with the data.

Since 1982, there has been a commercial fishery on the oceanic type *S. mentella* in the open Irminger Sea, and the total effort in this fishery has increased greatly. This has naturally caused a need for an assessment of this type of *S. mentella* to be able to trace impacts of the fishery on this stock and to manage it adequately.

There have, however, been some difficulties in establishing such an assessment work. Apparantly there have been two main points of view with regarding to the status of this oceanic tuype *S. mentella.* The one states, that the oceanic type mentella is a separate stock, the other, that it is a part of the common S. mentella at East Greenland, Iceland and Faroe Islandes.

Most of the existing published material on the oceanic-type *S. mentella* was available to the group. Further new unpublished material was presented.

It should be noted that the expression "spawning" is used for the extrusion of larvae.

2. Stock identification

2.1. Characteristics

The oceanic type redfish have morphological characteristics closely resembling *S. mentella* but they are easily distinguished by a darker complexion and abnormal coloration of the skin, i.e. dark and/or orange-red patches and by a heavy infestation of the parasite copepod *Sphyrion lumpi* besides by ulcers caused by remnants of the parasite in the tissue after the external part has fallen off. Further, grey or dark spots in the muscle tissue are very frequent. There are also differences in the spawning depths and in the size of newly extruded larvae. Further, it appears that the adult stock is staying pelagic after the first "spawning".

Because of the above described differences of the oceanic type compared to *S. mentella* the study group concluded that it should be looked upon as a separate stock as had already been pointed out in the Report on the Joint NAFO/ICES Study Group on Biological Relationships of the West Grenland and Irminger Sea Redfish Stocks (ICES C.M. 1983/G:3).

2.2. Distribution

Oceanic type mentella in the Irminger Sea have been commercially exploited since 1982 mainly by the USSR fleet during the time of extrusion and during the feeding period after the extrusion, i.e. from April through July. Considerable information on this population has been collected and evaluated by several nations.

The densest concentrations known so far, are found during the time of extrusion of larvae, above and west of the Reykjanes Ridge but later on in the western part of the Irminger Sea. However, the area of distribution is probably very extensive. Thus, redfish of similar appearance (dark complexion, black and/or orange spots, high rate of infestation with (*Sph. lumpi*) was observed on the Hamilton Inlet Bank . Juvenile *S. mentella* type redfish observed off Baffin Land and in the Davis Strait are believed to belong to this population.

2.3 "Spawning"

Oceanic type mentella "spawn" in the eastern part of the Irminger Sea during April-May. The size of newly extruded larvae is reported on in a range of 7.0-8.1 mm by th USSR and of 7.8-8.9 mm by Iceland which is larger than the range for larvae of *S. mentella*

The spawning areas of *S. mentella* and the oceanic type mentella overlap to some degree in the eastern Irminger Sea. They are, however, separated in depth, the main spawning of the oceanic type mentella taking place in 200-400 m depth while the true *S. mentella* stock spawns in greater depths mostly deeper than 500 meters and also partly closer to the shelf area of SW Iceland. The larvae of this population drift over to the East Greenland shelf area where the fry seeks bottom mainly in the Angmagssalik to Strædebank/Dohrnbak area.

2.4 Hypothesis on the life-cycle of the oceanic type mentella

After extrusion the adults move westwards towards East Greenland. Since the main extrusion probably takes place farther to the south and even southeast of Cape Farewell, the bulk of the larvae may drift by the current offshore around Cape Farewell and northwards along the West Greenland coast while some might be taken across the Davis Strait to the shelf area off Baffinland and Labrador. This drift pattern could explain the existence of small *S. mentella* on the banks around Disko Island at West Greenland. The nursery grounds would thus be in the Davis Strait, off West Greenland on the east side and off Baffinland and Labrador on the west side. The juvenile fish move southwards along the Baffinland and Labrador coasts and when mature eventually return to the spawning area over and west of the Reykjanes Ridge. It is reported that oceanic mentella mature at an earlier age than the true *S. mentella* at any rate at a smaller size. There is a great lack of information especially from the West Greenland area supporting this hypothesis of migration of the oceanic type mentella. However, no actual offshore spawning of redfish has been observed in that particular region so far but there seems to exist a nursery area for the species since large quantities of small redfish mainly *S. mentella* have been caught as by-catch in the shrimp fishery in the Davis Strait between 66 and 70 N.

2.5 Infestation

It is assumed that the onset of infestation with *Sph. lumpi* takes place in the area off Baffinland/Labrador but again, there is need for more information on this matter. According to Gaevskaya (1984), the centre of the infestation seems to be in the offshore parts of the offshore parts of the Irminger Sea. Females seems to be more heavily infested than males but this observation is not entirely agreed upon. Studies on the frequencies and location of the abnormalities in the appearance of oceanic mentella have been carried out and evaluation of further information on this subject is in progress.

The Study Group recommends that the area and the time of "spawning" of *S. marinus*, *S. mentella* and the oceanic type mentella should be defined (recommendation nr. 2). Also, more investigations are needed on the general biology of *Sph. lumpi* in connection with the stock identification (Rec. nr.3).

3. Problems of Age determination

3.1 Discrepancies in data sets

Inconsistencies are noted between (1) catch-at-age and recruitment data used by the North Western Working Group and (2) percieved recruitment according to length distributions from the annual Icelandic groundfish survey and from by-catch in Dohrn-bank shrimp trawls.

Data from the survey indicates strong peaks at lengths which increase by about 2cm per year (c.f. Figs 1-5). In 1986 a peak occurs at 7cm. As the 0-group survey in August estimates mean lengths to be typically 4-5cm, it is concluded that this peak must correspond to a 1-group, i.e. the 1985 yearclass. From there, the following information can then be extracted from the length curves (numbers in parenthesis are somewhat uncertain):

Sebastes marinus. Mean lengths at age.									
		Yearclass							
		(1981)	1982	1983	1984	1985	1986	1987	1988
	1985	15							
	1986	18				7			
Year	1987	(22)				9			
	1988					12			
	1989					14			7

These data indicate that there are 3 yearclasses during 1981-1988, which are much stronger than the surrounding ones. It seems likely that this pattern of strong yearclasses preceded and followed by weak ones has happened in earlier times as well as during this 5-year survey. The North Western Working Group report (Anon., 1988) further reports on length distributions of redfish from by-catch of Dohrn-bank shrimp trawls. The latter length distributions from March give peaks very similar to those obtained in the Icelandic survey.

This is in direct contrast with the recruitment estimates used by the Working Group. They indicate recruitment during the years 1977-1986 to be in the range 100-250 million, with no great between-year variation (Fig 6), except for the last recruitment estimate, which must be assumed to be very uncertain.

With the above type of recruitment it would for most species be easy to follow age groups in the catches. However, the catch-at-age table used by the Working Group gives no indication of yearclasses which are much stronger than the surrounding ones. These inconsistencies need to be explained.

Further, a simple anova on log-catches-at-age using year, age and yearclass effects yields very high residual variances. This is in accordance with the observation that it is hard to follow cohorts in the catch-at-age table, even though the numbers look quite distinguishable in the table, e.g. when tracing a fixed agegroup across years.

The working group considered the following potential explanations for the high variances and discrepancies between young fish measurements and adult catches.

1. Errors and variability in ageing.
2. Regional and age-directed behaviour of fleet.
3. Migratory behavior of the species.
4. High mortality on strong yearclasses, before they enter the catches.

3.1.1 Errors and variability in ageing.

Variability or errors in the ageing process can account for the high variances observed in the catch-at-age table. The group considered the following possible sources of such problems.

(a) If the rings read are not true annual rings, any form of distortion can occur in the catch-at-age (and recruitment) figures. This includes high variances and inconsistency with the survey results.

(b) If truly annual rings are hard to count, this would result in a smearing of counts between ages, yielding no strong yearclasses. However, the technique used yields easy-to-read rings for 12-19 year Thus, if the coloring process for the scales is appropriate, there should not be reading errors in 12-19 year olds. Even in those ages, however, the catch-at-age table yields no consistently strong yearclasses.

(c) Other uncertainty in ageing. Small sample sizes can indeed yield variations, but hardly of the form described here, where very strong and very weak yearclasses all become mediocre. To further substantiate this, it should be noted that when a proportion at age (p) is estimated using a random sample of size n, the standard deviation of the estimate is

$$\sqrt{\frac{p(1-p)}{n}}$$

With a sample of size 1000 of *S. marinus*, ages 11-25, p is typically estimated lower that 10% at each age, so the standard deviation is lower than 1%. (The theoretical maximum is when $p=0.5$, when the standard deviation is in this case 1.6%.) A very large yearclass might be expected to give over 20% of the catches, a small one only 5%. These should be clearly distinct in size in the catches if scales of 1000 fish are taken randomly from the whole population and used for computing the percentage in each age group.

In fact, even with scales from only 500 fish, a 5% yearclass should be clearly distinguishable from a 20% yearclass, if the age-reading methodology is correct and random sampling is used.

Thus, small sample sizes seem unlikely to be the explanation for the discrepancy at hand.

Similarly, biases in sampling schemes may introduce strange effects in the catch-at-age table, but hardly the amount of inconsistency mentioned here.

3.1.2 Regional and age-directed behaviour of the fleet.

The possibility exists that extensive juvenile fishing destroys recruiting age classes before they come into the fisheries. However, this is not a recurring phenomenon and does not fully explain the complete lack of what should have been quite a few very strong yearclasses expected among the 1960-1977 classes occurring in the catch-at-age table.

A hypothesis has been stated that the fleet may be mainly fishing in an area where the strong yearclasses do not enter in full strength. This seems a very unlikely possibility, as in this case the stronger year classes will somehow purposely have to avoid the main redfish areas.

It was noted that the fleet changed its main fishing grounds, following the expansion of the Economic Zone around Iceland into 200 miles in 1976. This might certainly introduce strange effects in the catch-at-age table, but does not explain the lack of a pattern after 1976.

3.1.3 Migratory behavior of the species.

The group noted that the Reykjanes Ridge is a spawning area and that during spawning very few females are found in the catch e.g. around the Faeroe Islands. This will most certainly affect the catch-at-age table. Further, 0-group redfish are known to drift in different directions away from the Reykjanes Ridge in the first few months.

It is therefore suggested that almost entire yearclasses may potentially drift away from the area covered by the Icelandic groundfish survey. If these same yearclasses come in later for spawning, then that can fully explain the differences between the structures observed in the surveys and those seen in the catches.

It is not obvious what the effect of migration is on the variances in the catch-at-age tables. If the migration is very systematic, the high variability should not occur, since a strong yearclass would be expected to behave consistently between years.

3.1.4 High mortality on strong yearclasses, before entering the catch

This must then happen at ages 5-11, in which case the yearclass is getting mixed with other ages and one would expect the mortality to affect those ages also, resulting in a remaining population where this yearclass is still relatively strong.

3.1.5 Summary

In conclusion, the only realistic explanations for the discrepancies between the data sets seem to be that there is some error introduced in the age-reading process and/or heavy migrations by almost entire yearclasses. It is imperative for proper management of the stock to know more about the weight of each of these factors.

The Study Group therefore recommends that samples of redfish be taken around Iceland and East Greenland at the same time at least three years in succession. These samples should be aimed at young *S. marinus* (below 20 cm). (Rec. 4). Ideally they should be obtained from simultaneous surveys, although this may not be possible. If entire yearclasses live in separate areas for some years, that fact should show up immediately in the length distribution of random samples.

The Study Group further recommends that samples of small *S. marinus* be taken during the Icelandic groundfish survey each year in order to verify the age reading process on the age groups which seem pronounced in the length distribution. (Rec. 5).

3.2 Comments on the Age Reading Method

In the ICES area, the ageing of redfish is almost exclusively carried out on scales. The age reading is based on rings which are believed to be annual rings. The scales are read either without any previous treatment or dyed as described in the "Report of the redfish (*S. mentella, S. marinus*) ageing work shop" (ICES C.M. 1983/GF:2).

The correctness of the age reading by this method has so far not been verified and unfortunately, there does not exist any direct method of testing it. Age determination of redfish exclusively based on otolith reading has not been verified either. Therefore, the latter cannot be recommended as already stated in the above mentioned report. The age reading method based on radioactive isotopes is - as far as known to the Study Group - still in an experimental stage.

A way of verifying age reading might be to compare dyed scales with otolith and/or scales from species where the age reading of otoliths and/or scales are considered to yield reliable results as e.g. by cod, haddock and herring.

The Study Group noted that there are considerable discrepancies in age reading between different countries and/or readers. These discrepancies may be caused by the use of different methods or they might also, at least partly, be caused by different interpretations of annuli.

It is crucial to verify the age reading of redfish and thus make it possible to use the age-based VPA method for the assessments. This is in particular important since assessment methods other than VPA which were tried during the meeting of the Study Group did not give satisfactory results.

It is therefore recommended that the age determination method should be carefully analyzed. The usual staining method should be applied to scales from fish species where the age reading of scales/otoliths is considered to yield reliable results (Rec. no. 6), e.g. for cod and haddock.

The Study Group also recommends that a special study group on ageing of redfish should be established (Rec. no. 7).

4. Assessment approaches other than age based VPA

Several methods based on catch and effort data, other than vpa- or age-based exist for assessing a stock such as *Sebastes marinus*:

1. Short-cut methods such as SHOT.
2. Length-based methods.
3. Stock-production models.

A priori these methods should not be expected to work for a species such as *Sebastes marinus*, as this is a long-lived species with a long delay between 0-group and recruitment to the fishery.

4.1 Shot-cut methods

The short-cut methods such as SHOT essentially attempt to maintain a status quo in terms of a constant effort. The Study Group noted their existence but also noted that if the primary purpose of assessment is reduced to maintaining a status quo, then it seems easier to simply set a constant TAC. This will have much the same effect as a constant effort, as the cpue has not varied very much in recent years.

4.2 Length based methods

During the meeting, the length based method ELEFAN (Pauly, 1987) was tested using the survey data given in figs. 1-5. Naturally the method failed completely as some intermediate yearclasses are missing each year. In short, the program always tried to fit only a few yearclasses to the data. (It was not possible in the time available to get the program to use the several length distributions as a time series.)

Even if a length-based method would be able to get reasonable results from the groundfish survey data, it would be close to a miracle if it could use the commercial length distributions, since these are always composed of a single lump with no distinguishable peaks (as is to be expected from any long-lived species).

4.3 Stock production models

Several stock-production models were considered, both for *S. marinus* and the oceanic type mentella. The results were fully in accordance with what is to be expected with these species and the fisheries. The basic characteristics, longevity, high age of recruitment and fairly constant effort do not lead to easy ways of fitting a production model of any sort.

The basic plots for *S. marinus* are given in Fig. 7-9. In the catch-effort plot it is obvious that it is quite impossible to fit any sort of production model with confidence. On the one hand it looks as if the species is underexploited. However, some models require a curvature at the origin which does not permit an emulation of the line drawn in fig 8. These models yield a fitted curve which has a peak below the aggregate of points. Other models will follow the points closely (starting at (0,0)), but the location of the peak is then well outside the range of the data and is very badly determined.

From a purely statistical point of view some points on each side of the peak are needed to fit the curve.

As stated above, the structure of the catch-effort plot seems to indicate that the species is underexploited. In this context, it must be noted the fleet has undergone development during the time period under consideration and it is therefore quite possible that the points in later years are only fictionally higher than those in earlier years.

For the oceanic type mentella, the data seem to indicate a slight curvature at the extreme levels of effort. Curves fit to the data tend to have a peak just to the right of the highest observed effort. As in the *S. marinus* case, however, the peak is automatically quite badly determined since this is outside the range of the data.

In conclusion, it does not seem feasible to use stock-production models with the limited effort and cpue ranges in the current data sets for *S. marinus* and oceanic type mentella.

Finally, the group noted that there are 3 different regions where fishing occurs, with likely migration between the regions. The use of cpue data from only one region can be quite dangerous. For example, a steady spawning migration into that region may yield a constant cpue although the total stock is diminishing.

If, from future experiments, the age readings are found to be accurate and a vpa-based assessment is chosen, then cpue and effort data from as many regions as possible should be used. (Rec. 8).

4.4 Assessments based on ichthyoplankton and echo surveys

The USSR has conducted ichthyoplankton surveys since 1982 and Poland in 1986. The data have i.a. been used for assessment purposes of the oceanic type mentella. This method is not considered to be very reliable since one might be dealing with larvae from two og even three stock units.

Echo surveys have been carried out in the Irminger Sea in June and July every year since 1982 by the USSR. The aim of these surveys has been to estimate the stock size of the oceanic type mentella.

The study group felt that the acoustic method is promising for the assessment of this stock (Rec. 9) and that the surveys should be continued.

5. Co-ordination of Research Programmes

Iceland and the U.S.S.R. reported planned research cruises in the Irminger Sea, in 1990.

The Icelandic cruise is scheduled to take place in April. The main goal of this cruise is the application of acoustic devices for assessment purposes of the oceanic type mentella at the beginning of the extrusion of the larvae. Simultaneously, a larval survey will be conducted.

The U.S.S.R. surveys are planned as larval surveys in April and May but as echo surveys for assessment purposes of the oceanic type mentella, in June-July.

Since at the time of preparing this report the above mentioned cruises were already fixed as to area and time, not much could be done about coordination in the current year.

Considering the facts that

- the fishery on the oceanic type mentella is rather new and with a great input of effort,
- the knowledge on the stock is very limited
- the area in question is vast, it is obvious that such a situation calls for an immediate increased international effort in research.

The study group therefore suggests to the North-Western Working Group that the Working Group considers the possibility of recommending a setting up of a co-ordinating group for research on the oceanic type mentalla. This group should define the most urgent needs in research and should start with co-ordinating the research programmes on the oceanic type mentella stock in 1991 (rec. no.10).

6. Summary of Recommendations

1. To define areas and time of the spawning of *S. marinus, S. mentella* and of the oceanic type mentella.
2. To promote studies on the migration pattern of *S. marinus, S. mentella* and of the oceanic type mentella.
3. More investigations are needed on the general biology of *Sph. lumpi* in connection with the stock identification.
4. Samples of redfish should be taken around Iceland and at East Greenland at the same time at least three years in succession. These samples should be aimed at young *S. marinus* (below 20 cm).
5. Samples of small *S. marinus* should be taken during the Icelandic groundfish surveys each year.
6. Age determination methods should be analyzed. Scales of fish species with reliable ageing results should be stained and read for comparison.

7. A study group on ageing of redfish should be established.
8. More effort series in the fisheries on *S. marinus* and *S. mentella* should be made available by the national fisheries laboratories.
9. Acoustic surveys should be promoted for the purpose of assessing the oceanic type mentella stock.
10. A co-ordinating group for research on the oceanic type mentella should be set up.

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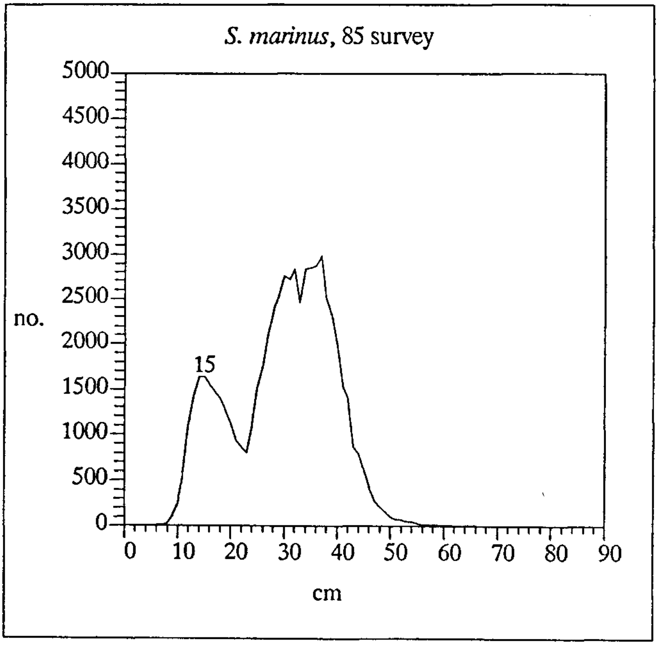

Figure 1. Length distribution of *S. marinus* in the Icelandic Groundfish Survey, March 1985

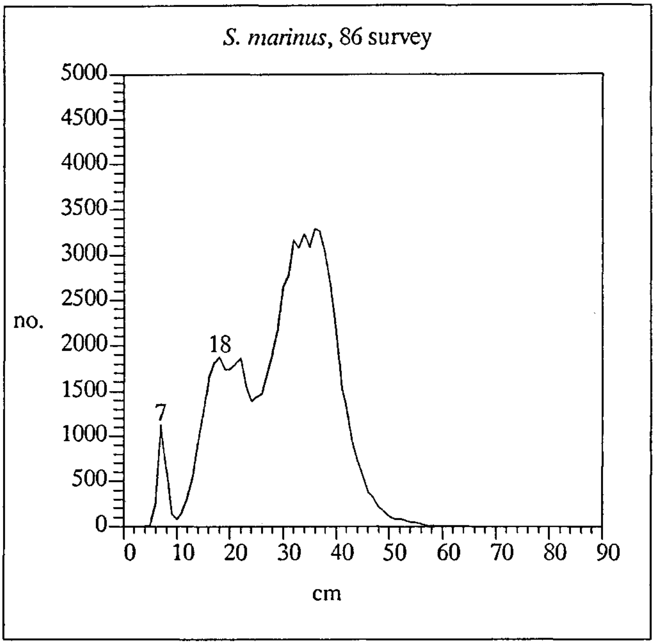

Figure 2. Length distribution of *S. marinus* in the Icelandic Groundfish Survey, March 1986

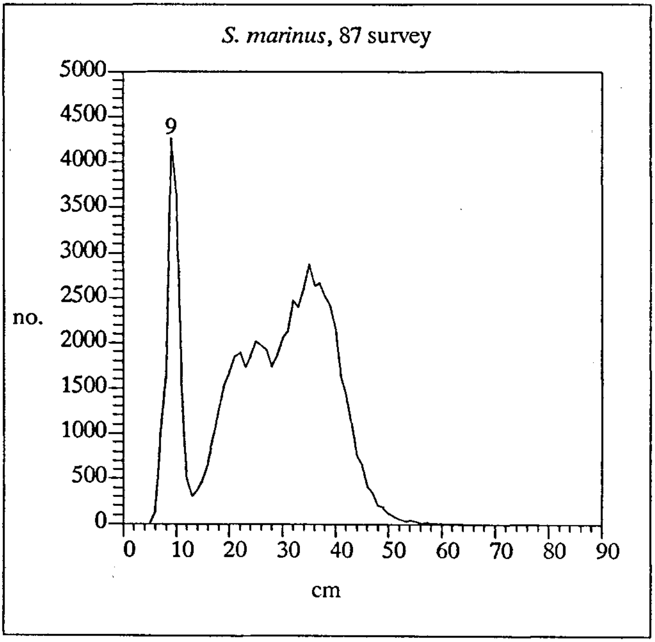

Figure 3. Length distribution of *S. marinus* in the Icelandic Groundfish Survey, March 1987

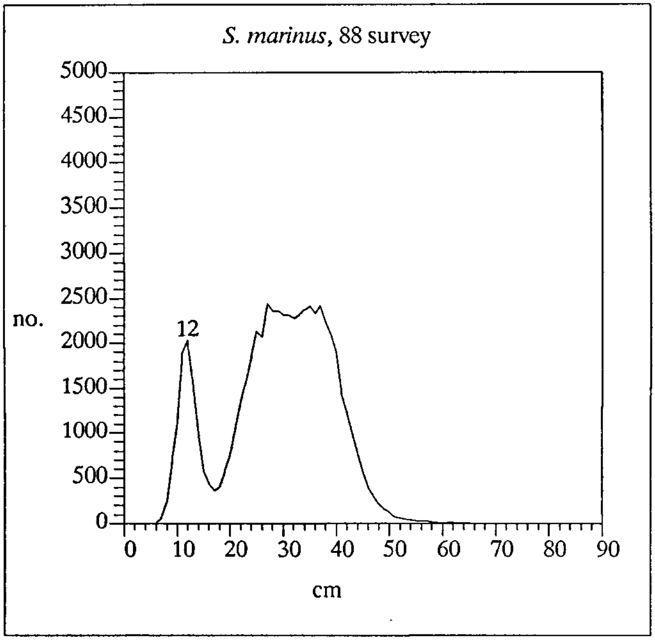

Figure 4. Length distribution of *S. marinus* in the Icelandic Groundfish Survey, March 1988

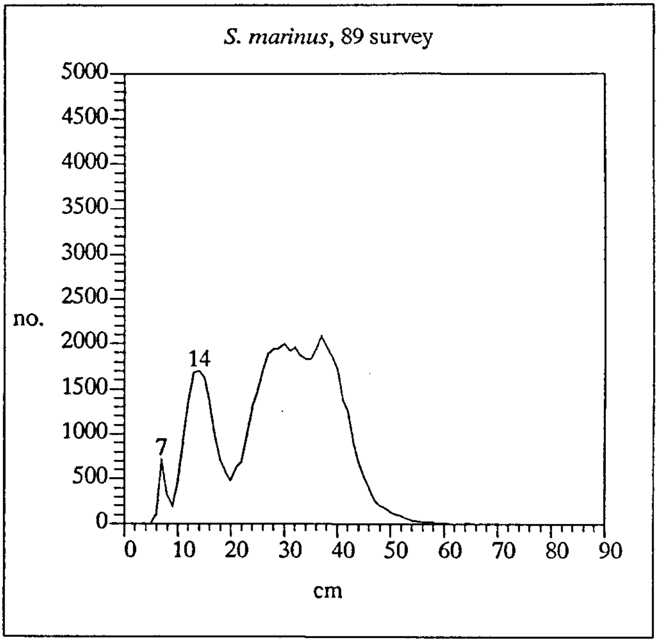

Figure 5. Length distribution of *S. marinus* in the Icelandic Groundfish Survey, March 1989

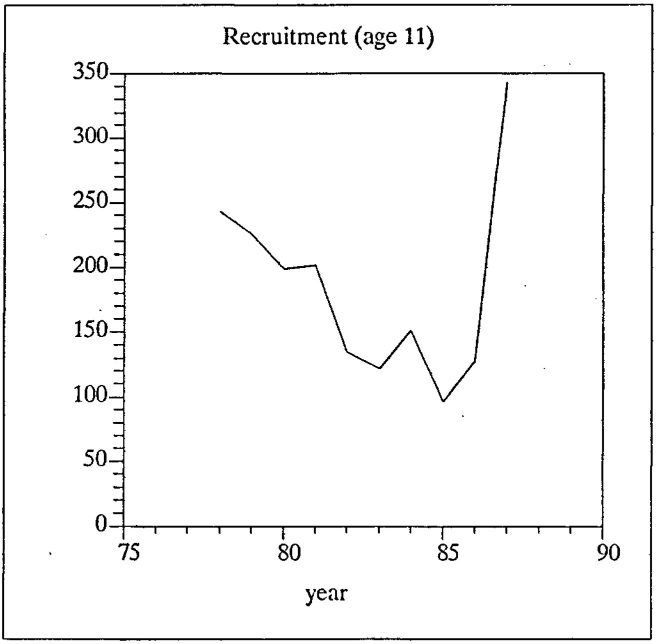

Figure 6. Recruitment estimates (numbers in millions at age 11) of *S. marinus* from VPA

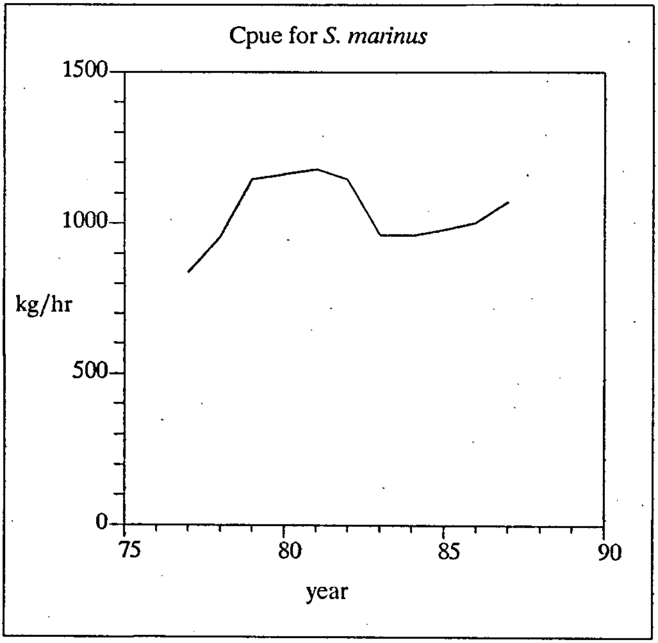

Figure 7. Catch-per-unit-effort for *S. marinus* in Icelandic area, based on Icelandic trawler reports.

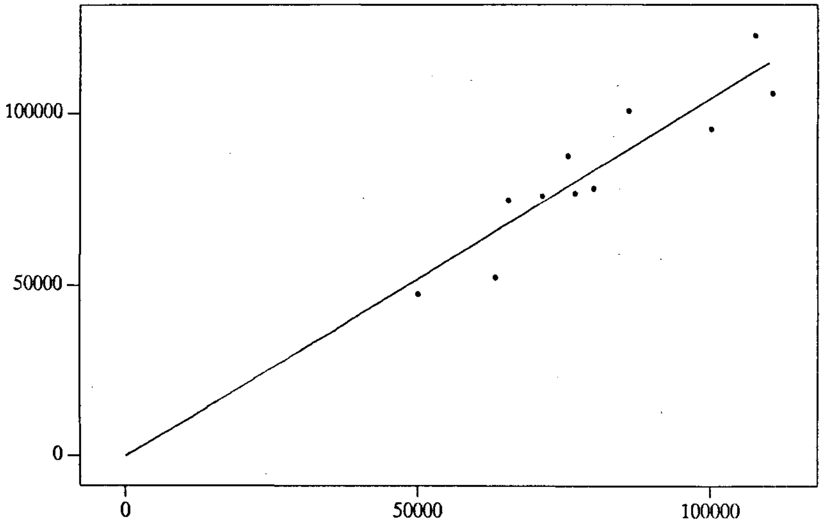

Figure 8. Total catch vs. estimated total effort for *S. marinus*, based on Icelandic trawler cpue data

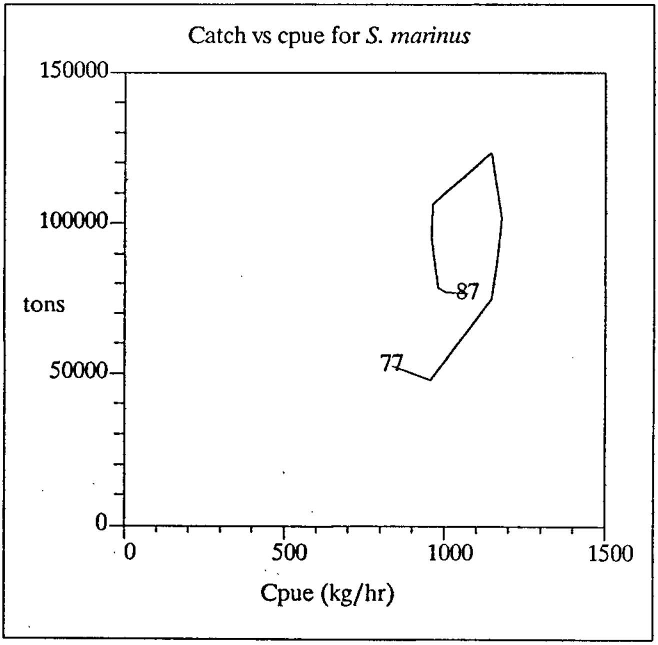

Figure 9. Catch versus catch-per-unit-effort for *S. marinus* in the Icelandic area, based on Icelandic trawler reports.