NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N4616 **NAFO SCR Doc. 02/15**

SCIENTIFIC COUNCIL MEETING – JUNE 2002

Spatial Structure of Pelagic Concentrations of *Sebastes* mentella of the Irminger Sea and Adjacent Waters

by

S. P. Melnikov, and Yu. I. Bakay

Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO),
6, Knipovich Street, Murmansk, 183763, Russia

Abstract

Redfish (*Sebastes mentella* Travin 1951) widely distributed in pelagic waters of the North Atlantic was the object of investigations. The aim of the paper is studying of ecological and biological peculiarities and spatial structure of redfish feeding concentrations within the whole range of depths of their distribution in pelagic waters of the Irminger Sea and the adjacent Labrador Sea.

Results of analysis of spatial distribution of the length-age composition, as well as sex ratio and ratio between mature and immature specimens, and feeding of redfish caught at different pelagic depths of the Irminger and Labrador Seas are presented. The spatial variability of the analyzed biological characteristics of redfish in the feeding ground was revealed. This variability is caused by the existence of ontogenetically and geographically differentiated habitats of young and adult mature fish in the Irminger Sea. The change of ecological living conditions in the life history is probably characteristic of redfish.

Ecological peculiarities of parasite fauna, which point to the weakening of a relationship between redfish and bottom biocenoses are discussed. Parasite fauna of parasites of *S. mentella* is typical of plankton-eaters. The ecological and trophic factor is the main one in its formation. Widely specific species dominate in the parasite fauna, which develop with the participation of the intermediate hosts - plankton crustaceans (euphausids, copepods, hyperids) – which are the main food for *S. mentella*. The results of studying of parasite fauna and occurrence of two natural signs (copepod *Sphyrion lumpi* and pigment patches on the skin) on *S. mentella* from different Subareas of the pelagic Irminger Sea are presented.

The common nursery and feeding grounds, a single migration cycle, the absence of stable isolated groups and spatial and temporal isolation of specimens from different parts of stock, as well as a single composition of the parasite fauna, similar peculiarities of infestation with copepod *S. lumpi* and pigment patches of redfish taken from different Subareas for investigation prove the unity of the reproductive part of the *S. mentella* population dwelling in the pelagic waters of the Irminger Sea and adjacent area of the Labrador Sea. This means that a single commercial stock of redfish *S. mentella* the basis of which is the spawning part of the population inhabit the pelagic waters of this part of the North Atlantic over 420 miles^2.

Introduction

Problem on the spatial structure of concentrations (commercial stock) of redfish (*Sebastes mentella* Travin, 1951) distributed in the pelagic Irminger Sea and adjacent area of the Labrador Sea at depths down to 1 000 m was several times discussed in the scientific publications and at meetings of managing structures engaged in regulating of fishery in this area of Atlantic.

By results of the Russian investigations carried out in the 1980's (Bakay, 1988), the opinion was advanced on the unity of the commercial stock of redfish from the pelagic part of the Irminger Sea within the area from EEZ of Iceland in the north to 52°N in the south and on the isolation of this concentration from redfish dwelling on the Flemish Cap Bank. The conclusion of the author was based on the results of application of the parasitological method successfully used in the investigations of marine fish populations. Due to this method, parasites are used as indicators of the populational structure and ecological peculiarities of their hosts (fish). The results of the subsequent investigations carried out in PINRO proved this conclusion.

The supposition on the unity of the commercial stock of *Sebastes mentella* dwelling in the pelagic parts of the Irminger and Labrador Seas has been expressed recent years as well (Sigurdsson *et al*., 1999 and 2001). It was based on the primary results of studying of ecological and parasitological peculiarities of *S. mentella* obtained during two international trawl acoustic surveys (TAS) of this species stock.

In the 90's, the Icelandic researchers supposed that two stocks (types) of redfish (*Sebastes mentella* Travin) – the "oceanic" and "pelagic deep-sea" ones – inhabit the pelagic layer down to 1 000 m of the Irminger Sea (Anon., 1998). The first one ("oceanic *S. mentella*") inhabit a wide range of depths from 50 to 700 m, whereas the second one ("pelagic deep-sea S. mentella") dwell deeper than 500 m only. Scientists of Iceland (Magnusson, 1991; Magnusson *et al*., 1995) based their opinion concerning the existence of two types of *S. mentella* on five criteria of differentiation:

1. intensity of red colour of fish body;
2. length composition;
3. length of fish, maturing for the first time;
4. thickness of neck part;
5. infestation with copepod *Sphyrion lumpi,* occurrence of pigment patches on the skin and in muscle tissues of fish.

To verify the second and third items of the proposed by the Icelandic scientists criteria of differentiation of redfish stocks dwelling at different depths, the Russian researchers performed the comparative analysis of the length-age composition, as well as rates of maturation of redfish by their length and age. More over, as additional criteria, the results of comparative analyses of rates of linear and weight growth and absolute and relative increments, as well as peculiarities of feeding of redfish from different age groups caught in the wide range of depths in the pelagic Irminger Sea, were used. To our opinion, the first and fourth criteria (intensity of red colour of body and thickness of the neck part of redfish) are groundless ones since they are subjective and connected with ecological and age specific features of fish.

In PINRO, investigations of *S. mentella* were performed to analyse and verify the fifth criterion of those proposed by the Icelandic scientists for differentiation of redfish which includes the level of infestation with copepod *S. lumpi*, the occurrence of pigment patches on the skin and melanin (melanocytes) inclusions in the muscle tissue of fish caught at different depths of the pelagic Irminger Sea. More over, the comparison of the qualitative and quantitative compositions of the parasitic fauna of redfish caught in both studied layers of the sea in various years was done.

By results of investigations of redfish from different layers of their habitat in the pelagic Irminger Sea (Bakay, 2000; Bakay and Melnikov, 2001), the following facts were stated:

a) the absolute similarity of qualitative and quantitative compositions of redfish parasite fauna;
b) the similar peculiarities of infestation with copepod *S. lumpi* and pigment patches on the skin;
c) a sufficient similarity of rates of linear and weight growth, as well as absolute and relative increments, rates of maturation by length and age.

The obtained data point to the equal conditions of fish dwelling and indicate to the common origin and unity of the stock of deep-sea redfish from the upper (0-500 m) and low (500-1 000 m) layers of their distribution in the pelagic Irminger Sea. In connection with that, the concentrations of redfish distributed at depths more than 500 m, a part of which consist of old specimens (18 years old and older), which are as a rule absent in the upper layer in summer, should be considered as a deep water compound of the reproductive part of the single *S. mentella* population from the pelagic North Atlantic.

Due to data of Russian and international trawl-acoustic surveys of recent years (Magnusson *et al*., 1996; Shibanov *et al*., 1996; Pedchenko, Shibanov and Melnikov, 1997; Melnikov *et al*., 1998; Sigurdsson *et al*., 1999; Sigurdsson *et al*., 2001) the feeding concentrations of pelagic redfish are distributed within the wide area of the Irminger Sea and adjacent waters of the Labrador Sea between 52°-64°N, 26°- 52°W. During investigations of redfish stock structure and analysis of spatial and vertical distribution of concentrations, a sufficient variability of length-weight and age compositions of *S. mentella,* as well as sex ratio and a portion of mature fish in the surveyed area was revealed. NEAFC regulates the fishery for pelagic redfish in the ICES Subareas XII, XIV, Va coming from the unity of their stock in those Subareas. Recent years, a wide-scale fishery for redfish began to develop west of 42° W in the NAFO Regulatory Area (Divs. 1F, 2J, 2H). Since the status of the commercial stock of redfish is not determined, it is managed by the agreement between NEAFC and NAFO.

The aim of the paper is to study the ecological and biological peculiarities and spatial structure of feeding concentrations of redfish by the whole depth range of their distribution in the pelagic layer of the Irminger Sea and adjacent area of the Labrador Sea. The obtained results will be the basis for development of advice on management of the redfish pelagic stock of the Irminger Sea and adjacent waters.

Authors of the paper come from the idea accepted earlier (Bakay, 2000; Bakay and Melnikov, 2001) on the unity of the population and the commercial stock of redfish distributed in the upper (0-500 m) and low (500-1 000 m) layers in pelagic waters of the Irminger Sea. The idea is based on the sufficient similarity of the biological status, identical qualitative and quantitative compositions of the parasite fauna, similar peculiarities of infestation with copepod *S. lumpi* and pigment patches of redfish from different layers of their habitat.

It is known that recent decades, a positive experience was accumulated on usage of parasite data in investigations of ecology and intraspecies structure of marine fishes. Such data and other natural marks (pigment patches on the skin) were used to single out local groups of marine redfishes of the *Sebastes* genus of the North-West Atlantic (Herrington, 1939; Sinderman, 1961; Yanulov, 1962; Kabata, 1963; MacKenzie, 1983; Bakay, 1998 and 1999), as well as intraspecies differentiation of *S. mentella* of the Irminger Sea and other areas of their habitat (Templeman, 1963); Bakay, 1988, 1989, 1999, 2000, and 2001; Bakay, 1999; Sigurdsson *et al*., 1999; Sigurdsson *et al*., 2001). In connection with that we used parasites and pigment patches of redfish for studying of spatial structure of *S. mentella* concentrations distributed in the pelagic waters of the North Atlantic in the area more than 420 thou. miles^2 (Sigurdsson *et al*., 2001).

Materials and Methods

The paper presents the results of investigations of redfish *Sebastes mentella* caught in the layer 0-1 000 m of the pelagic Irminger Sea (between 64°-52°N) and adjacent area of the Labrador Sea (to 54°W and the border of the Economic Zone of Canada) in the period of feeding (June-August). In order to study the spatial variability of parasite fauna and other parameters of redfish, the surveyed area was conventionally divided into seven Subareas: Subareas 1-5 – the NEAFC Regulatory Area, Subareas 6-7 – the NAFO Regulatory Area (Fig. 1).

Ichthyological material on *Seabstes mentella* is collected in accordance with methods accepted in PINRO. Data used are those obtained during research and research/fishery cruises in June-August, 1995-2001. Samples were collected from catches taken by a mid-water trawl from the depth 100 to 1 000 m. The study of the spatial distribution of *S. mentella* concentrations included the analysis of the length-age composition of redfish, the ratio between sexes and mature and immature specimens, and feeding of redfish in the 0-1 000 m layer. Scales for age determination were taken from both 50 males and 50 females from each 1-cm length class. Age data were recalculated for the whole age frequency. The volume of the analysed ichthyological material is presented in Table 1.

The results of parasitological studies of redfish *S. mentella* in the Irminger Sea carried out by PINRO since 1983 are used. 1 096 individuals of redfish were examined by the method of full parasitological dissection (Dogel, 1933; Donets and Shulman, 1973; Bykhovskaya-Pavlovskaya, 1985). More then 50 thou. individuals of *S. mentella* were investigated to determine the occurrence of copepod *Sphyrion lumpi* and pigment patches on the skin, as well as peculiarities of infestation with them. Localization of alive individuals of *S. lumpi* and signs of their parasitizing, as well as pigment patches was considered by each of four investigated zones of a redfish body by a scheme we have described (Fig. 2) (Bakay and Karasev, 2001). Criteria used for levels of infestation with parasites were as follows:

- prevalence of infestation which is percentage of fish infested with parasites of the given species of the total number of examined fish;
- abundance index – the number of parasites of the given species per one investigated fish specimen.

Differences in prevalence of infestation with each parasite by the surveyed areas were verified by the statistical importance (P) with the use of Chi-Square Test and Fisher's Exact Test.

Results

Spatial structure of concentrations and biological characteristics of Sebastes mentella

<u>Length-age composition</u>. Length-age composition of redfish in the area of the Irminger Sea in the period of feeding is characterized by heterogeneity and a sufficient spatial variability. In 1995-2001, fish length in the area varied from 20 to 52 cm. The basis of catch consisted of males 33-39 cm long and females 34-46 cm long. Mean length of fish in Subareas 1-4 decreased gradually southwards from 41.3-42.8 cm to 36.4-37.8 cm (Fig. 2). In the zone of the East Greenland (Subarea 5) mean length of redfish was less and constituted 34.7-35.3 cm. The least length of fish (33.9-33.6 cm) was registered in the zone of the West Greenland (Subarea 6). Besides, in areas of the West and East Greenland a big portion of small immature redfish 23-30 cm long was found. Mean length of redfish increased with the distance from the West Greenland slope (Subarea 7).

To investigate redfish concentrations structure in the period of feeding profoundly, redfish length composition was analyzed with the use of data of the international TAS for redfish stock carried out in June-July 2001. Due to the performed analysis, the spatial structure of feeding redfish concentrations was comprehended, and some peculiarities of vertical fish distribution in various parts of the area were specified. During the short period (about 3 weeks) four research vessels collected biological material by main horizons of fish distribution. As a result, a probability of the repeated observations of the same redfish concentrations migrating for feeding was excluded.

Analysis of spatial distribution of fish concentrations in the upper 500- meter layer has shown that the largest redfish males and females with mean length of 35-39 cm inhabited the central part of the feeding area. On the periphery, mean length of fish was 3-6 cm less (Fig. 3A). Strongly pronounced diminishing of linear sizes of redfish was observed in the direction of Greenland. The similar characters of distribution of linear sizes of redfish were also revealed by results of the Russian and International TAS carried out in 1995 and 1996 (Pedchenko, Shibanov and Melnikov, 1997). This proves the idea that pelagic *S. mentella* stock of the Irminger Sea is recruited by young redfish from their nursery area on the Greenland slope (Stransky, 2000).

At the depth more than 500 m a big part of large redfish with the predominating length of 40-46 cm was found in the areas of the Reykjanes Ridge (Fig. 3B). South of 55°N in the area of the ridge, mean length of fish constituted 33.7-36.6 cm, and in the direction of Greenland it decreased to 31-35 cm. The comparative analysis of 2001 TAS materials has shown that in the southern part of Subarea 5 and in Subarea 6 in two surveyed layers 0-500 and 501-1 000 m mean lengths of redfish were practically equal (Figs. 3A and 3B). Probably, the individuals maturing during the migration from the area of the Greenland slope are at first distributed within the wide range of depths. The vertical dividing of different length-age groups of redfish takes part later on, with the entering of fish into the areas of the oceanic depths of the Irminger and Labrador Seas.

The revealed regularity in the spatial distribution of linear sizes of fish in the layers 0-500, 501-1 000 m proves the belonging of *Sebastes mentella* in both surveyed layers to the single stock with common nursery and feeding grounds.

In 1995-2001 in the surveyed area the age of redfish varied from 6 to 24. In general, the spatial and vertical distribution of the age composition fully reflected the dynamics of the length composition of fish. In the area of Iceland (Subarea 4) redfish at the age of 17-22 predominated in catches. Southwards (Subareas 1, 2 and 3) the age of fish in concentrations decreased, and redfish at the age of 12-20 predominated. In areas of the East and West Greenland, the basis of catches consisted of fish at the age of 12-17. At the same time, in latter areas a sufficient portion of young redfish at the age of 6-10 was registered. In the NAFO area (Subarea 7), the same as in the NEAFC area (Subareas 1, 2 and 3), a portion of older fish increased moving off the Greenland slopes (Fig. 4).

Thus, the performed analysis has shown the absence of stable isolated length-age groups of redfish and spatial-temporal isolation of individuals from different parts of the investigated area. The largest individuals dwell in the area of the west slope of the Reykjanes Ridge. Young redfish were found on the west and east slopes of Greenland. Moving off the slopes the mean length of fish increases. The connection between different length-age parts of the population is supported by means of the back migrations of young fish from the Greenland slope to areas of feeding and reproduction, i. e. to the open sea.

Sex ratio. In the north of the feeding ground (Subareas 1 and 4) sex ratio of redfish was approximately equal. In the open Irminger Sea (Subareas 2 and 3) males in catches predominated and constituted 56.2-58.3 %. The largest portion of males (61.3-64.4 %) was registered in areas of smaller fish distribution, namely in the East and West Greenland (Fig. 5).

Ratio between immature and mature redfish. In the area of Iceland (Subarea 1) a portion of mature redfish was maximum and constituted 93.9 % in the average. Moving southwards in the open Irminger Sea a portion of immature fish increased two times and reached 12.3%. In areas of the East and West Greenland a portion of immature redfish was maximum and constituted 16.8% and 22.9 %, correspondingly. In the direction to the open part of the Labrador Sea, a portion of immature fish in catches decreased gradually (Fig. 6).

The analysis of a portion of mature fish in catches proves that areas of the slopes of the East and West Greenland are the nursery grounds of *Sebastes mentella*.

Feeding. In summer, redfish feeding takes place within the wide area of the Irminger and Labrador Seas. Redfish begin to feed actively in the south of the area where the extrusion of larvae by females terminates earlier. In the Irminger Sea in the area of the Reykjanes Ridge slope (Subareas 1-4) in the direction to the north, the intensity of fish feeding decreased, mean index of stomach fullness diminished from 1.3 to 0.3 (Fig. 7). The most active feeding of redfish was in areas of the East and West Greenland where mean index of stomach fullness constituted 1.9. In the open Labrador Sea fish fed also actively (mean index of fullness was 1.2).

In summer, the main concentrations of the food zooplankton were mainly found in the upper 400-meter layer in the pelagic waters of the Irminger Sea. Concentrations of mezopelagic fish and shrimp were registered at large depths (Pavlov, 1992). During investigations, feeding selectivity of redfish from different length-age groups was revealed (Bakay and Melnikov, 2001). Therefore, in Subareas 1 and 4, where mainly large redfish were distributed, the dominating food was fish objects of mezopelagic complex (*Myctophidae, Paralepididae*), shrimp and young squid *Gonatus fabricii*. At diminishing of linear sizes of redfish in Subareas 2 and 3 a portion of crustacean zooplankton (*Copepoda, Hyperiidae, Euphauseacea*) in fish feeding increased, whereas a portion of fish objects, shrimp and squid decreased. In Subareas 5, 6, and 7, where mid-size and small redfish were distributed, the crustaceans predominated in their feeding (Table 2).

Thus, the most intensive feeding of *Sebastes mentella* was registered over the whole area excluding the northern parts. Redfish fed mainly on crustacean zooplankton. Only in the north of the feeding ground the predominating objects in redfish feeding were those from the mezo-pelagic complex, shrimp and young squid.

Investigation of parasites and pigment patches

Since parasites are the indicators of ecological peculiarities of their hosts, the results of analysis of qualitative and quantitative composition of parasitic fauna of *S. mentella* from different areas of investigations let us express the opinion on the spatial structure of concentrations in the area of their distribution. In connection with that the parasite fauna of redfish from the seven conventionally marked Subareas within the Regulatory Areas of NAFO and NEAFC was investigated (Fig. 1, Tables 3 and 4).

As it is seen from the tables, the obtained data point as a rule to the equal level of infestation (prevalence and abundance index) both with parasites-indicators (*Myxidium obliquelineolatum, M. incurvatum, Leptotheca adeli, Pseudalataspora sebastei, Hepatoxylon trichiuri pl., Anisakis simplex l., Sphyrion lumpi*) and with parasites of the majority of other species. The registered differences in prevalence of infestation with parasites of the majority of species are not statistically significant (P > 0.05) (Table 5). Significances of occurrence of redfish individuals with pigment spots on the skin and inclusions of melanin in muscles were also close to each other (P > 0.05). Only rarely found parasites of five species (*Hepatoxylon trichiuri* pl., *Diphyllobothrium* sp. pl., *Anomalotrema koiae*, *Lecithophyllum bothriophoron*, *Acanthocephala* sp. l.) were not observed in redfish from one and sometimes from two Subareas of the NAFO Regulatory Area and in the south-eastern part of the fishery zone of Greenland. This is explained by the fact that in those Subareas there is the larger portion of younger *S. mentella* and less number (3-7 times) of redfish chosen for examination. However, the absence of mentioned parasites in redfish from those Subareas are not statistically significant either (P > 0.05).

Statistically significant differences (P < 0.05) were registered only in some cases (marked with *) of insufficiently increased (10.4-26.1 % against 0.7-5.5% in the open areas) occurrence of parasites (*Myxosporea*) of three species (*Myxidium obliquelineolatum, Leptotheca adeli, Pseudalatasporam sebastei*) in areas of the Greenland fishery zone (Table 5). This is explained by the larger than in pelagic waters occurrence of mentioned parasites in young redfish on the Greenland slope. Their recent shift into pelagic waters and relative (to compare with open areas) predomination in the Greenland fishery zone stipulate the increase of peculiar for pelagic redfish rare occurrence of these parasites.

The increased occurrence of Cestoda *Bothriocephalus scorpii* (marked ** in Table 5) in redfish from the open Labrador Sea to compare with other areas is caused by the relative predomination in samples of fish caught deeper than 500 m where the dominating food objects of redfish are small fish which are the second intermediate hosts in the life cycle of this parasite.

In general it was revealed that valid differences (P > 0.05) in occurrence of the whole parasite fauna complex of redfish between pairs of adjacent areas or groups of areas were absent.

The results of long-term (1982-2001) monitoring of pelagic redfish infestation with copepod *Sphyrion lumpi* and occurrence of fish with pigment patches on the skin show the relatively stable year-to-year level of these events by each of the considered Subarea (Figs. 8, 9, and 10). The level of infestation similar to that mentioned by us has been registered since 1960's both in the Irminger Sea and in the Labrador Sea (Jones, 1968, 1970; Templeman, 1967). The insufficient spatial variability of the redfish infestation level with copepod *S. lumpi* and occurrence of fish with pigment patches has also been registered. Both year-to-year and spatial variability of occurrence of these events are dependant on the length-age and sex composition of the surveyed concentrations in a certain year, since it is known that their occurrence increases with redfish age and is always 1.5–2 times higher in females than in males (Bakay, 1988, 1989, 2000; Bogovsky and Bakay, 1989; Magnusson *et al*., 1992, 1994; Sigurdsson *et al*., 1999 and others). This explains the relatively less infestation of redfish with copepod *S. lumpi* and occurrence of pigment patches in the fishery zone of Greenland and in Labrador, since in the mentioned areas, younger redfish individuals (often immature ones)(Figs. 2 and 3) entering the pelagic waters from the Greenland slope are more often found (Stransky, 2000). In these fish the insufficient infestation with copepod *S. lumpi* and occurrence of pigment patches is observed in the initial period of habitation in pelagic waters.

Results of long-term investigations show that the presence of *S. lumpi* in redfish is a very reliable natural tag if to account not only the alive crustaceans but the signs of their parasitizing since they are kept in fish for a long time (evidently, till the end of the host's life) (Bakay, 2000). In all Subareas of the sea, the peculiarities of redfish infestation with copepod *S. lumpi* were similar. Of the total number of alive crustaceans and signs of their parasitizing, 66-70 % in the average located in the fillet part of redfish, 16-18 % - in the area of the anal opening, 10-12 % - in the abdominal part of redfish and 2-5 % - on the head. Alive *S. lumpi* were found in the average in 7-16 % of redfish at the index of abundance 0.25. After summarizing of all cases of infestation, the prevalence increases to 28.1-43.4 % at the abundance index 0.5-0.6 in males and to 39.8-59.9 % at the abundance index 1.0-1.6 in females. In all Subareas the level of infestation of females always exceeded that of males (prevalence – 1.3-1.6 times, abundance index - 1.8-2.6 times) (Table 6).

As for the occurrence of redfish with pigment patches on the skin, no sufficient differences by areas and years of investigations were registered (Table 6, Fig. 10). Everywhere in the area the occurrence of patches in females exceeds that in males 1.3-1.8 times. In all areas pigment patches in females were located as a rule (in 95-100 % of cases) on the sides of the body (under the first dorsal fin), and in males – on the head (gill perculum) and on the tail fin (in 80-90 % of cases), more rare - on the pectoral and dorsal fins. The most probable reason of such a specific, long-term and relatively high and stable occurrence of pigment patches on the redfish skin is, to our opinion, re-combinations of gene complexes caused by the character of reproduction of *S. mentella* population, the reproductive part of which is distributed in pelagic waters of the Irminger and Labrador Seas (Bogovsky, Bakay and Karasev, 1986; Bogovsky and Bakay, 1989; Bogovsky and Bakay, 1989).

Thus, the similar composition of parasite fauna and a level of infestation with parasites of the majority of species, as well as identical and stable for many years peculiarities of invasion with copepod *S. lumpi* and pigment patches of redfish examined in seven Subareas of the North Atlantic point to the similar conditions of redfish habitation and prove the common origin and the unity of *S. mentella* stock dwelling in pelagic waters of the Irminger Sea and adjacent waters of the Labrador Sea.

Conclusion

In the result of biological investigations the following conclusions have been made:

1. There is a spatial and vertical variability of length-age composition of *Sebastes mentella* feeding concentrations in the Irminger Sea. Redfish of younger groups are mainly distributed in the area of the West and East Greenland slopes within the wide range of depths. Moving off the slopes the mean lengths of fish increases. The largest individuals dwell deeper than 500 m in the area of the Reykjanes Ridge western slope.

2. In general, over the whole feeding ground of redfish males dominate. Females predominate insufficiently only in the north of the Irminger Sea.

3. Analysis of spatial distribution of length-age composition and a portion of mature redfish corroborates the idea that pelagic *S. mentella* stock in the Irminger and Labrador Seas is recruited from the deep-water areas of the Greenland slope, which are the nursery grounds of the immature part of *Sebastes mentella*. In the process of migration into the pelagic waters from the Greenland slope the maturing individuals distribute within the wide range of depths. Vertical differentiation of length-age groups of redfish takes place later on, when fish go to the areas of oceanic depths of the Irminger and Labrador Seas.

4. The most intensive feeding of redfish was observed in the southern part of the open Irminger Sea, in the open Labrador Sea and in the areas of the East and West Greenland. Redfish fed there mainly on crustacean zooplankton. Intensity of redfish feeding was lower in the north of the feeding ground, and fish objects of the mezopelagic complex, as well as shrimp and young squid predominated in redfish stomachs.

5. Results of parasite investigations of *S. mentella* prove the absolute similarity of parasite fauna composition and equal levels of invasion with parasites of the majority of the revealed species in all investigated Subareas. The available data point to the identical and stable for many year peculiarities of invasion with copepod *S. lumpi* of redfish examined in all Subareas of the North Atlantic. The occurrence of redfish with pigment patches on the skin is characterized by the relative year-to-year stability, the absence of sufficient differences by the surveyed areas, as well as the presence of location peculiarities of pigment patches in redfish males and females. Year-to-year and spatial variability of the level of invasion with copepod *S. lumpi* and occurrence of pigment patches depend on the length-age and sex composition of investigated concentrations since the occurrence of these events increases with the age of redfish and is always higher in females.

Thus, in the pelagic waters of the Irminger and Labrador Seas in summer the concentrations of *Sebastes mentella* have a complicated structure and are characterized by the sufficient spatial and vertical variability of length-age and sex composition and ratio between mature and immature individuals. This variability is caused by the existence in the North Atlantic of ontogenetically and geographically differentiated habitats of young and mature redfish and by the fact that redfish are aimed at change of ecological conditions of their existence with the age. The mature and immature parts of the population are connected by means of back migrations of maturing redfish from their habitat to areas of dwelling and reproduction of the mature part of population, i. e. from the Greenland slope to the pelagic waters of the open sea.

Thus, common nursery and feeding grounds, a single migration cycle, the absence of stable isolated groups and spatial-temporal isolation of redfish from different parts of the stock, as well as the absolute similarity of the parasite fauna composition, similar peculiarities of invasion with copepod *S. lumpi* and pigment patches of redfish taken from different Subareas are indicative of the unity of the reproductive part of the *S. mentella* population dwelling in pelagic waters of the Irminger Sea and adjacent area of the Labrador Sea. This means that in pelagic waters of this area of the North Atlantic over 420 thou. miles^2 a single commercial stock of *Sebastes mentella* dwell, the basis of which is the spawning part of the given population.

In connection with that, when discussing problems of seasonal and by areas prohibition of fishery it is appropriate to consider the commercial stock of *Sebastes mentella* in the area of the Irminger Sea and adjacent area of the Labrador Sea as single one and the total allowable catch as a single TAC for this single stock.

References

ANON. 1998. Report on the Study Group on Redfish Stock. ICES C.M.1998/G:3, Ref.H.

BAKAY, Yu. I. 1988. Application of results from parasitological investigations in redfish (*Sebastes mentella* Travin) populational structure studies. ICES C.M./G:35.

BAKAY, Yu. I. 1989. On infestation of marine redfishes (*Sebastes* genus) of the North Atlantic by the copepod *Sphyrion lumpi* (Krøyer, 1845). Proc. Of the Workshop on "*Sphyrion lumpi*". Gustrow (GDR). P. 29-36.

BAKAY, Yu. I. 1997. On results of usage of parasitological data during studying the intraspecies structure of *Sebastes mentella* Travin of the North Atlantic. The first congress of ichthyologists of Russia. Theses of papers. Moscow. VNIRO. 35 pp. (in Russian).

BAKAY, Yu. I. 1998. Ecological and geographical characteristics of parasites of *Sebastes fasciatus* Storer. Parasites and diseases of marine and freshwater fishes of the Northern Basin. Selected papers. Murmansk. PINRO. P. 5-21 (in Russian).

BAKAY, Yu. I. 1999a. Parasites of redfishes (*Sebastes* genus) of the North Atalantic. Abstract of Doctor Thesis. Moscow. 23 pp. (in Russian).

BAKAY, Yu. I. 1999b. Ecological and geographical analysis of *Sebastes mentella* parasite fauna in the North Atlantic. Bull. Of the 19th Symp.Soc. for Parasitology, vol. 9(1). P. 28.

BAKAY, Yu. I. 2000. Parasites and pigmented patches as indicators of intraspecific structure of *Sebastes mentella* in the Irminger Sea. ICES C. M. 2000/Z:06.15pp.

BAKAY, Yu. I. 2001. Results from the analysis of geographical variability in parasite fauna of redfish *Sebastes mentella* from the North Atlantic. Deep-Sea Fisheries Symposium. Sept. 2001/NAFO SCR Doc. 01/115. Serial No. 4503. 11 pp.

BAKAY, Yu. I., and A. B. KARASEV. 2001. Registration of ectolesions of redfish from *Sebastes* genus in the North Atlantic (methodical guidelines). NAFO SCR Doc. 01/27. Serial No. 4401. 8 pp.

BAKAY, Yu. I., and S. P. MELNIKOV. 2001. Peculiarities of aggregations of redfish *S. mentella* in the Irminger pelagial. NWWG 2001, Working Document N5.20 pp.

BOGOVSKY, S. P., and Yu. I. BAKAY. 1989. Pigment patches in redfish *Sebastes mentella*. Eksperimentalnaya onkologiya. Vol. 11(3): 18-21 (in Russian).

BOGOVSKY, S. P., and Yu. I. BAKAY. 1989. Chromatoblastomas and related pigmented lesions in deepwater redfish, *Sebastes mentella* (Travin), from North Atlantic areas, especially from the irminger Sea. Journal of Fish Diseases. No.12:1-13.

BOGOVSKY, S. P., Yu. I. BAKAY, and A. B. KARASEV. 1986. Hystological investigations of black spots and melanomas in marine *Sebastes mentella*. Eksperimentalnaya i klinicheskaya onkologiya. Tallin. No. 7:114-120 (in Russian).

BYKHOVSKAYA-PAVLOVSKAYA, I. E. 1985. Parasites of fish. Guidelines on studies. Leningrad. Nauka. 120 pp. (in Russian).

DOGEL, V. A. 1933. Problems of investigation of fish parasite fauna. Guidelines and problems of ichthyoparasitological investigations. Trudy Leningradskogo obshchestva estestoispytateley. Vol. 62(3): 247-268 (in Russian).

DONETS, Z. S., and S. S. SHULMAN. 1973. On methods of investigations of *Myxosporidia (Protozoa: Cnidosporidia)*. Parazitologiya. Vol. 7(2): 191-193 (in Russian).

GAEVSKAYA, A. V. 1984. Copepod *Sphyrion lumpi* as a bio-tag in populational investigations of *Sebastes mentella*. In: Intra-species differentiation of marine commercial fishes and invertebrates. Trudy AtlantNIRO. Kaliningrad. P. 90-99 (in Russian).

HERRINGTON, W. 1939. Observations on the life history, occurrence and distribution of the redfish parasite *Sphyrion lumpi*. U. S. Dept. Commerc. Bur. Fish., Miteo Report, 7855. P. 1-12.

KABATA, Z. 1963. Parasites as biological tags. ICNAF, Spec. publ. No. 4(6). P. 31-37.

MACKENZIE, K. 1983. Parasites as biological tags in fish population studies. Adv. Appl. Biol. Vol. 7: 251-331.

MAGNUSSON, J. 1991. Eitt og annad um uthafskarfa. Egir, 1. Tbl 1991.

MAGNUSSON, J., J. V. MAGNUSSON, and P. SIGURDSON. 1995. On the distribution and biology of the oceanic redfish in March, 1995. ICES C. M./G:40.

MAGNUSSON, J., J. V. MAGNUSSON, T. SIGURDSSON, P. REYNISSON, C. HAMMER, E. BETHKE, A. PEDCHENKO, E. GAVRILOV, S. MELNIKOV, M. ANTSIFEROV, and V. KISELEVA. 1996. Report on the Joint Icelandic/German/Russian Acoustic Survey on Oceanic Redfish in the Irminger Sea and Adjacent Waters in June/July, 1996. ICES C. M./G:8 Ref.h. 27 pp.

MELNIKOV, S. P. 1998. Peculiarities of deepwater redfish, *Sebastes mentella*, distribution by depths in the Irminger Sea. NAFO SCR Doc. 98/16. Ser.No.N2995. 9 pp.

MELNIKOV, S. P., V. S. MAMYLOV, V. N. SHIBANOV, and A. P. PEDCHENKO. 1998. Results from Russian trawl-acoustic survey on *Sebastes mentella* stock of the Irminger Sea in 1997. ICES CM/O:12. 8 pp.

PAVLOV, A. I. 1992. Feeding and peculiarities of *Sebastes mentella* distribution in the pelagic waters of the Irminger Sea. In: Investigations of bioresources of the North Atlantic. Selected papers. PINRO. Murmansk. P. 96-116 (in Russian).

PEDCHENKO, A. P., V. N. SHIBANOV, and S. P. MELNIKOV. 1997. Spatial distribution of deepwater redfish, *Sebastes mentella*, in the Irminger Sea: characteristics of biology and habitat conditions. ICES C. M./CC:03. 15pp.

PERLMUTTER, A. 1953. Population studies of the Rosefish. Trans. N. Y. Acad. Sci., Vol. 15(3):189-199.

SHIBANOV, V. N., A. P. PEDCHENKO, S. P. MELNIKOV, V. S. MAMYLOV, and M. I. POLISHCHUK. 1996. Assessment and Distribution of the Oceanic-type Redfish, *Sebastes mentella*, in the Irminger Sea in 1995. ICES CM 1996/G:44. 21 pp.

SIGURDSSON, T., H-J. RATZ, A. PEDCHENKO, V. MAMYLOV, J. MORTENSEN, E. BETHKE, C. STRANSKY, S. MELNIKOV, Yu. BAKAY, and K. DREVETNYAK. 1999. Report on the Joint Icelandic/German/ Russian Acoustic Survey on Pelagic Redfish in the Irminger Sea and Adjacent Waters in June/July, 1999. ICES C.M./ACFM:17. 38 pp.

SIGURDSSON, T., A. PEDCHENKO, C. STRANSKY, V. MAMYLOV, E. BETHKE, P. REYNISSON, Yu. BAKAY, S. MELNIKOV, S. MALMBERG, K. NEDREÅS, and J. DALEN. 2001. Draft report on the Joint German/Iceland/Norwegian/Russian Trawl-Acoustic Survey on Pelagic Redfish in the Irminger Sea and Adjacent Waters in June/July 2001. NAFO SCR Doc. 01/161. 32 pp.

SINDERMANN, C. J. 1961. Parasitological tags for redfish of the western North Atlantic. Rapp. Et proces-varnaux reunions. Conseil Perman. Intern. Expl. Mer. Vol.150: 111-117.

STRANSKY, C. 2000. Migration of juvenile deep-sea redfish *Sebastes mentella* Travin from the East Greenland shelf into the central Irminger Sea. ICES C.M./N:28.

TEMPLEMAN, W. 1967. Adult redfish, *Sebastes mentella*, pelagic over oceanic depths in the Labrador Sea. J. Fish. Res. Bd. Canada. Vol. 6(24): 1275-1290.

TEMPLEMAN, W., and H. SQUIRES. 1960. Incidence and distribution of infestation by *Sphyrion lumpi* (Krøyer) on the redfish, *Sebastes marinus* (L), of the Western North Atlantic. J. Fish. Res. Bd. Canada. Vol.17(1): 9-31.

YANULOV, K. P. 1962. On groups of *Sebastes mentella* Travin in the Labrador-Newfoundland area. In: The Soviet fisheries investigations in the north-western part of the Atlantic Ocean. Moscow. P. 285-296 (in Russian).

ZAKHAROV, G. P. 1964. Redfish above the Ocean Depths. ICNAF Research Doc. Bull. No. 1. P. 39-42.

Table 1. Volume of the analyzed ichthyological material

Kind of work	No., spec.
Mass measuring	69949
Analysis of maturity	13795
Feeding analysis	6425

Table 2. Diet (%) of *Sebastes mentella* by Subareas groups in the Irminger Sea in 1995-2001

Food Composition	*Subareas*						
	1	2	3	4	5	6	7
Calanus	11,5	31,4	26,6	-	25,2	29,9	20,4
Euphausiids	4,6	9,4	11,1	4,0	19,4	11,6	6,5
Themisto	10,9	30,6	29,5	4,0	25,8	40,2	46,4
Sagitta	0,3	2,1	4,1	-	3,2	4,6	1,5
Shrimp	17,0	6,3	6,0	20,0	5,9	1,1	2,8
Squid	29,4	12,3	8,6	16,0	13,8	7,5	8,1
Fish	18,3	4,8	5,5	36,0	4,9	4,0	5,9
Other species	8,0	3,1	8,6	20,0	1,8	1,1	8,4

Table 3. Parasite fauna of *Sebastes mentella* from different Subareas of the Irminger Sea (NEAFC Regulatory Area)

Parasites, bio-tags	Open sea						Southeast of Greenland fishing area (Subarea 5) (n = 67)		Southwest of EEZ of Iceland (Subarea 4) (n = 55)	
	Subarea 1 (n = 434)		Subarea 2 (n = 218)		Subarea 3 (n = 183)					
	Prevalence, %	Abundance index	Prevalence, %	Abundance index	Prevalence, %	Abundance index	Prevalence, %	Abundance index	Prevalence, %	Abundance index
Myxidium incurvatum	4,8	+	6,0	+	3,3	+	7,5	+	5,5	+
M. obliquelineolatum	4,6	+	3,2	+	4,9	+	10,4	+	3,6	+
Leptotheca adeli	0,7	+	0,9	+	1,1	+	1,5	+	5,5	+
Pseudalataspora sebastei	0,9	+	2,3	+	2,2	+	3,0	+	9,1	+
Bothriocephalus scorpii	10,1	0,13	8,3	0,23	12,6	0,21	7,5	0,12	5,5	0,05
Hepatoxylon trichiuri pl.	0,5	0,005	0,5	0,005	1,6	0,02	3,0	0,03	3,6	0,04
Scolex pleuronectis pl.	8,8	0,14	13,8	0,33	15,8	0,58	16,4	0,19	9,1	0,09
Phyllobothrium sp. pl.	0,9	0,02	1,4	0,03	2,2	0,06	1,5	0,03	1,8	0,02
Diphyllobothrium sp. pl.	0,5	0,005	0,5	0,005	0,5	0,005	-	-	1,8	0,02
Grillotia sp. pl.	0,9	0,01	0,9	0,01	1,1	0,01	1,5	0,02	1,8	0,02
Derogenes varicus	0,5	0,005	0,5	0,005	1,6	0,02	1,5	0,02	-	-
Podocotyle reflexa	0,9	0,01	2,8	0,03	2,2	0,02	1,5	0,02	3,6	0,04
Anomalotrema koiae	0,9	0,01	1,4	0,01	1,1	0,01	-	-	1,8	0,02
Lecithophyllum bothriophoron	0,7	0,007	0,5	0,005	3,8	0,09	-	-	1,8	0,02
Anisakis simplex l. [1]	79,0	6,3	83,9	6,6	78,7	6,0	79,1	4,03	74,5	5,3
A. simplex l. [2]	46,5	1,5	50,0	1,2	48,1	1,2	34,3	0,64	38,2	1,15
Hysterothylacium adun	5,5	0,13	8,7	0,12	7,8	0,13	8,9	0,12	5,5	0,07
Acanthocephala sp. l.	0,7	0,007	0,5	0,005	0,5	0,005	-	-	-	-
Sphyrion lumpi [3]	42,7	1,0	46,9	0,93	46,2	1,1	36,6	0,8	52,3	1,1
Pigment patches on the skin	20,2	+	23,9	+	24,9	+	18,7	+	19,2	+
Melanin in muscles	47,1	+	41,9	+	39,3	+	47,7	+	40,3	+

Note: n – examined fish (spec.), [1] – invasion of all fish with *A. simplex*, [2] - invasion of the abdominal muscles with *A. simplex*, [3] – invasion with the account of alive *S. lumpi* and signs of their parasitizing.

Table 4. Parasite fauna of *Sebastes mentella* from different Subareas of the Labrador Sea (NAFO Regulatory Area)

Parasites, bio-tags	Subarea 7 (open sea) (n = 93)		Subarea 6 (Greenland fishing area) (n = 46)		Summarized by NAFO Regulatory Area (n = 139)	
	Prevalence, %	Abundance index	Prevalence, %	Abundance index	Prevalence, %	Abundance index
Myxidium incurvatum	3,2	+	6,5	+	4,3	+
M. obliquelineolatum	5,4	+	21,7	+	10,8	+
Leptotheca adeli	2,2	+	26,1	+	10,1	+
Pseudalataspora sebastei	2,2	+	13,0	+	5,8	+
Bothriocephalus scorpii	20,4	0,35	4,3	0,04	15,1	0,25
Scolex pleuronectis pl.	7,7	0,22	6,5	0,22	7,2	0,22
Phyllobothrium sp. pl.	1,1	0,02	2,2	0,02	1,4	0,02
Grillotia sp. pl.	1,1	0,01	-	-	0,7	0,01
Derogenes varicus	1,1	0,01	-	-	0,7	0,01
Podocotyle reflexa	1,1	0,01	4,3	0,04	2,2	0,02
Anomalotrema koiae	1,1	0,01	4,3	0,11	2,2	0,06
Lecithophyllum bothriophoron	2,2	0,02	-	-	1,4	0,01
Anisakis simplex l. [1]	82,8	5,54	65,2	4,43	77,0	5,17
A. simplex l. [2]	38,7	0,83	23,9	0,65	33,8	0,77
Hysterothylacium aduncum	10,7	0,12	4,3	0,07	8,6	0,10
Echinorhynchus sp.	-	-	2,2	0,02	0,7	0,01
Sphyrion lumpi [3]	43,0	1,0	33,5	0,8	39,4	0,9
S. lumpi [4]	7,5	0,22	14,7	0,3	11,1	0,25
Pigment patches on the skin	19,3	+	18,3	+	19,0	+
Melanin in muscles	47,3	+	32,6	+	42,4	+

Note: n – examined fish (spec.), [1] – invasion of all fish with *A. simplex*, [2] - invasion of the abdominal muscles with *A. simplex***,** [3] – invasion with the account of alive *S. lumpi* and signs of their parasitizing; [4] - invasion with alive *S. lumpi.*

Table 5. Occurrence (prevalence, %) of parasites in redfish *Sebastes mentella* from different Subareas of pelagic waters of the North Atlantic

Parasites, bio-tags	Southwest of EEZ of Iceland (Subarea 4) (n = 55)	Open part of Irminger Sea			Open part of Labrador Sea (Subarea 7) (n = 93)	Southeast of Greenland fishing area (Subarea 5) (n = 67)	Southwest of Greenland fishing area (Subarea 6) (n = 46)	P
		Subarea 1 (n = 434)	Subarea 2 (n = 218)	Subarea 3 (n = 183)				
Myxidium incurvatum	5,5	4,8	6,0	3,3	3,2	7,5	6,5	> 0,05
M. obliquelineolatum	3,6	4,6	3,2	4,9	5,4	10,4*	21,7*	< 0,05
Leptotheca adeli	5,5	0,7	0,9	1,1	2,2	1,5	26,1*	< 0,05
Pseudalataspora sebastei	9,1	0,9	2,3	2,2	2,2	3,0	13,0*	< 0,05
Bothriocephalus scorpii	5,5	10,1	8,3	12,6	20,4**	7,5	4,3	< 0,05
Hepatoxylon trichiuri pl.	3,6	0,5	0,5	1,6	-	3,0	-	> 0,05
Scolex pleuronectis pl.	9,1	8,8	13,8	15,8	7,7	16,4	6,5	> 0,05
Phyllobothrium sp. pl.	1,8	0,9	1,4	2,2	1,1	1,5	2,2	> 0,05
Diphyllobothrium sp. pl.	1,8	0,5	0,5	0,5	-	-	-	> 0,05
Grillotia sp. pl.	1,8	0,9	0,9	1,1	1,1	1,5	-	> 0,05
Derogenes varicus	-	0,5	0,5	1,6	1,1	1,5	-	> 0,05
Podocotyle reflexa	3,6	0,9	2,8	2,2	1,1	1,5	4,3	> 0,05
Anomalotrema koiae	1,8	0,9	1,4	1,1	1,1	-	4,3	> 0,05
Lecithophyllum bothriophoron	1,8	0,7	0,5	4,2	2,2	-	-	> 0,05
Anisakis simplex l.	74,5	79,0	83,9	78,7	82,8	79,1	65,2	> 0,05
Hysterothylacium aduncum	5,5	5,5	8,7	7,8	10,7	8,9	4,3	> 0,05
Acanthocephala sp. l.	-	0,7	0,5	0,5	-	-	2,2	> 0,05
Sphyrion lumpi [1]	52,3	42,7	46,9	46,2	43,0	36,6	33,5	> 0,05
Pigment patches on the skin	19,2	20,2	23,9	24,9	19,3	18,7	18,3	> 0,05
Melanin in muscles	40,3	47,1	41,9	39,3	47,3	47,7	32,6	> 0,05

Note: P – statistical significance of difference between occurrence; n – examined fish (spec.);
[1] - invasion with the account of alive *S. lumpi* and signs of their parasitizing.

Table 6. Level of invasion with parasitic copepod *Sphyrion lumpi* and occurrence of pigment patches on the skin of redfish *Sebastes mentella* from different Subareas in June-July 2001 (Russian data).

Invasion			NEAFC				NAFO	
			Southwest of EEZ of Iceland	Open sea		Southeast of Greenland fishing area	Southwest of Greenland fishing area	Open sea
				north	south			
Invasion level with copepod *Sphyrion lumpi* *	Prevalence, %	males	43,4	38,2	37,9	26,9	28,1	34,2
		females	59,9	49,5	58,4	44,1	39,8	48,7
		males+females	52,3	42,7	46,2	36,6	33,5	40,2
	Abundance index	males	0,6	0,6	0,6	0,5	0,6	0,6
		females	1,6	1,3	1,4	1,0	1,1	1,2
		males+females	1,1	1,0	1,0	0,8	0,8	0,9
Occurrence of fish with pigment patches on the skin, %		males	15,8	15,5	20,1	13,8	16,5	15,1
		females	22,5	23,8	32,7	23,0	21,6	27,1
		males+females	19,2	20,2	24,9	18,7	18,3	19,3

* - prevalence (%) and abundance index are given with the account of signs of parasitizing of *S. lumpi* (alive *S. lumpi* + old cephalothoraxes of *S. lumpi*).

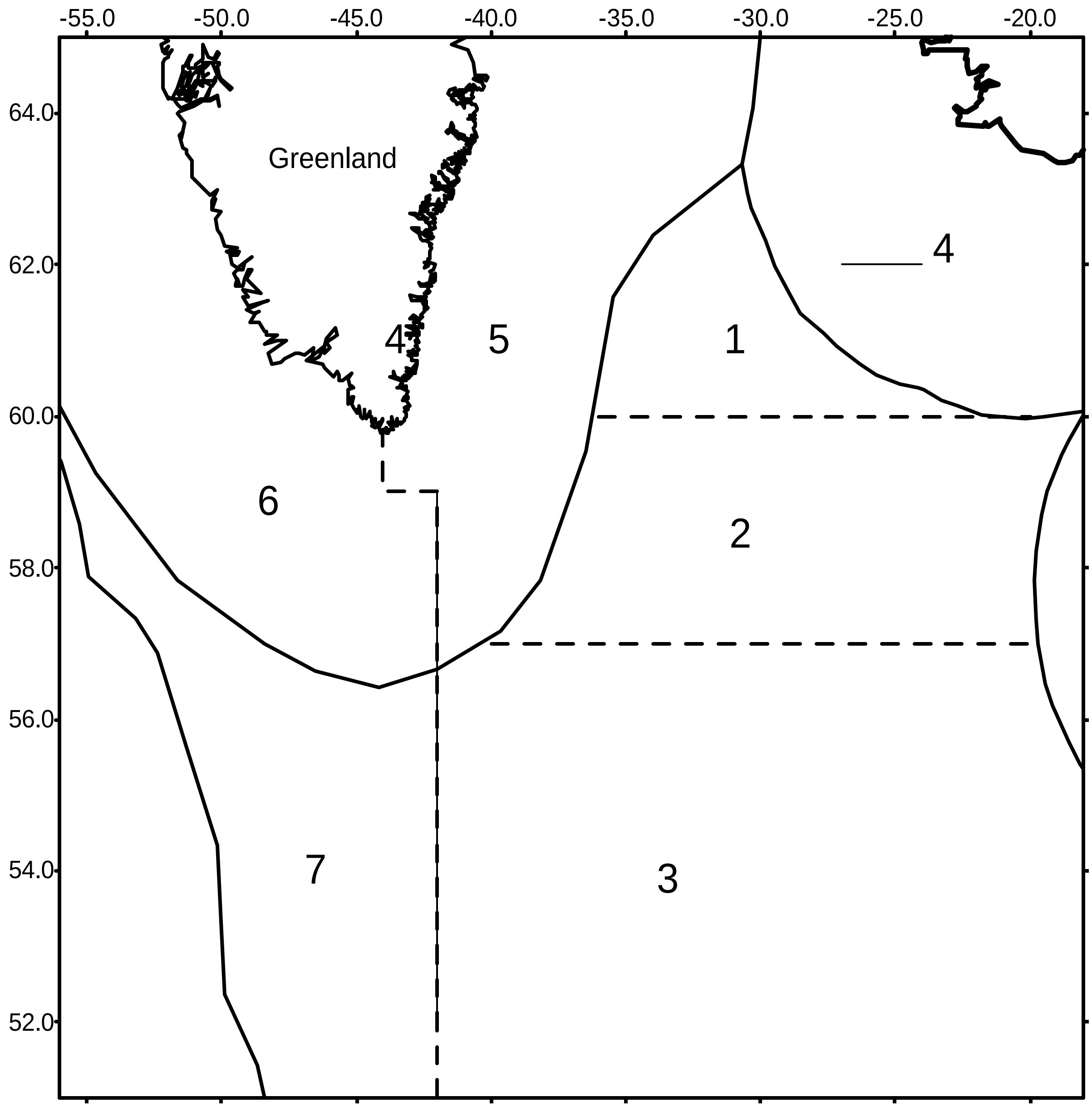

Fig. 1. Conventional division of the area surveyed by seven Subareas.

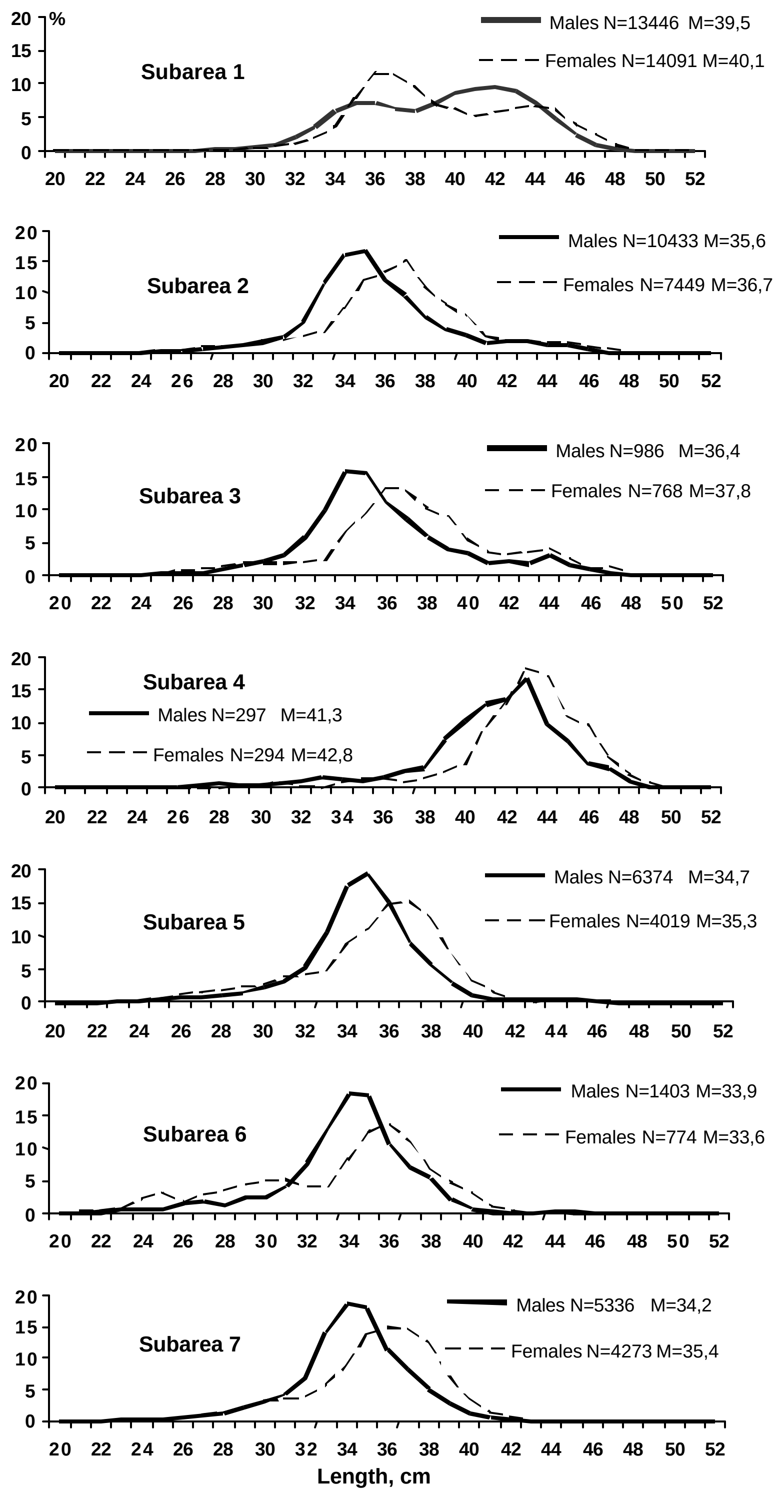

Fig. 2. Length composition of redfish by Subareas in the NEAFC and NAFO Regulatory Areas in June-August, 1995-2001.

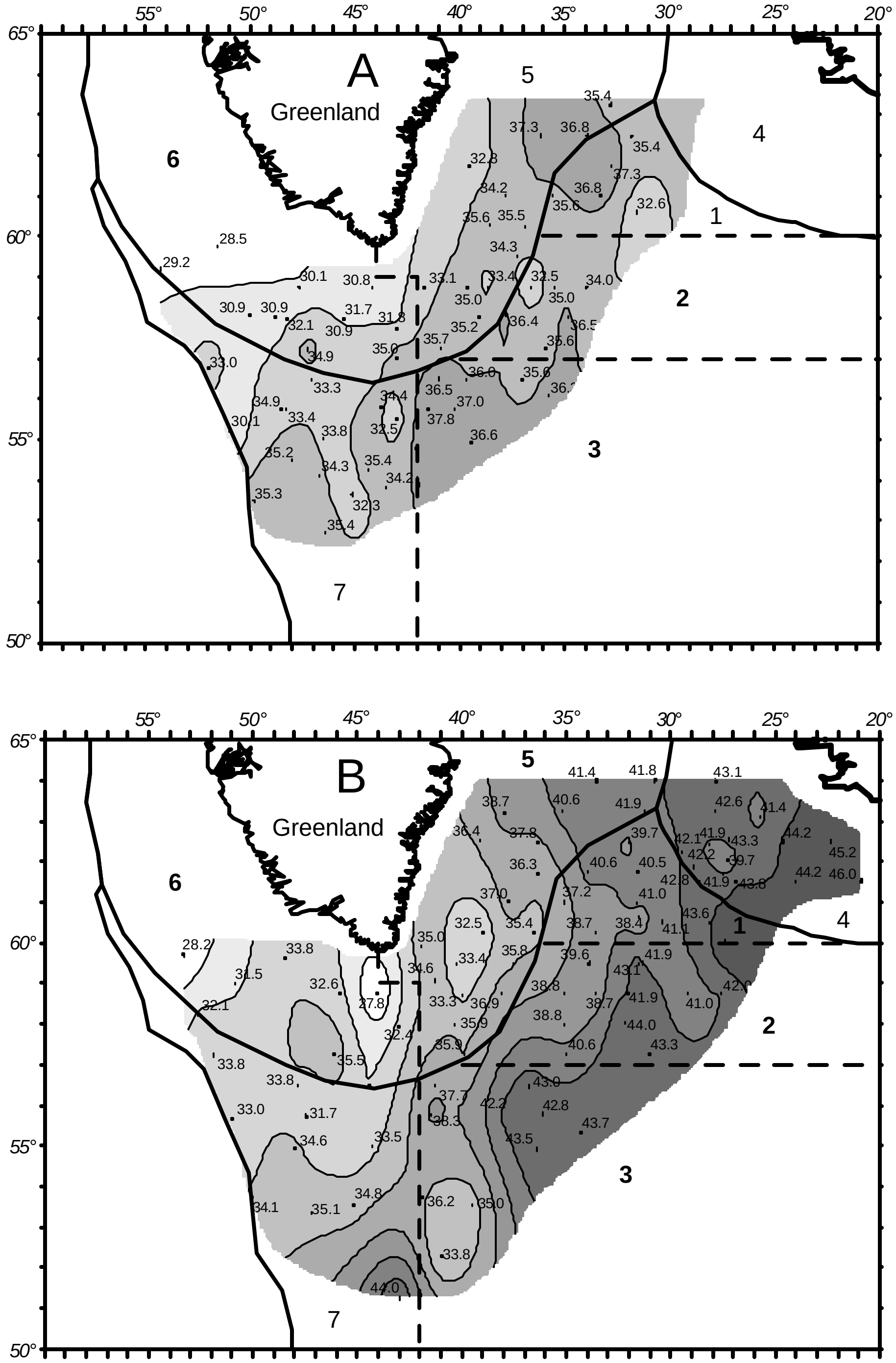

Fig. 3. ength composition of redfish by Subareas in the layer 0-500 m (A), 500-1000 m (B) by results of the international TAS of 2001

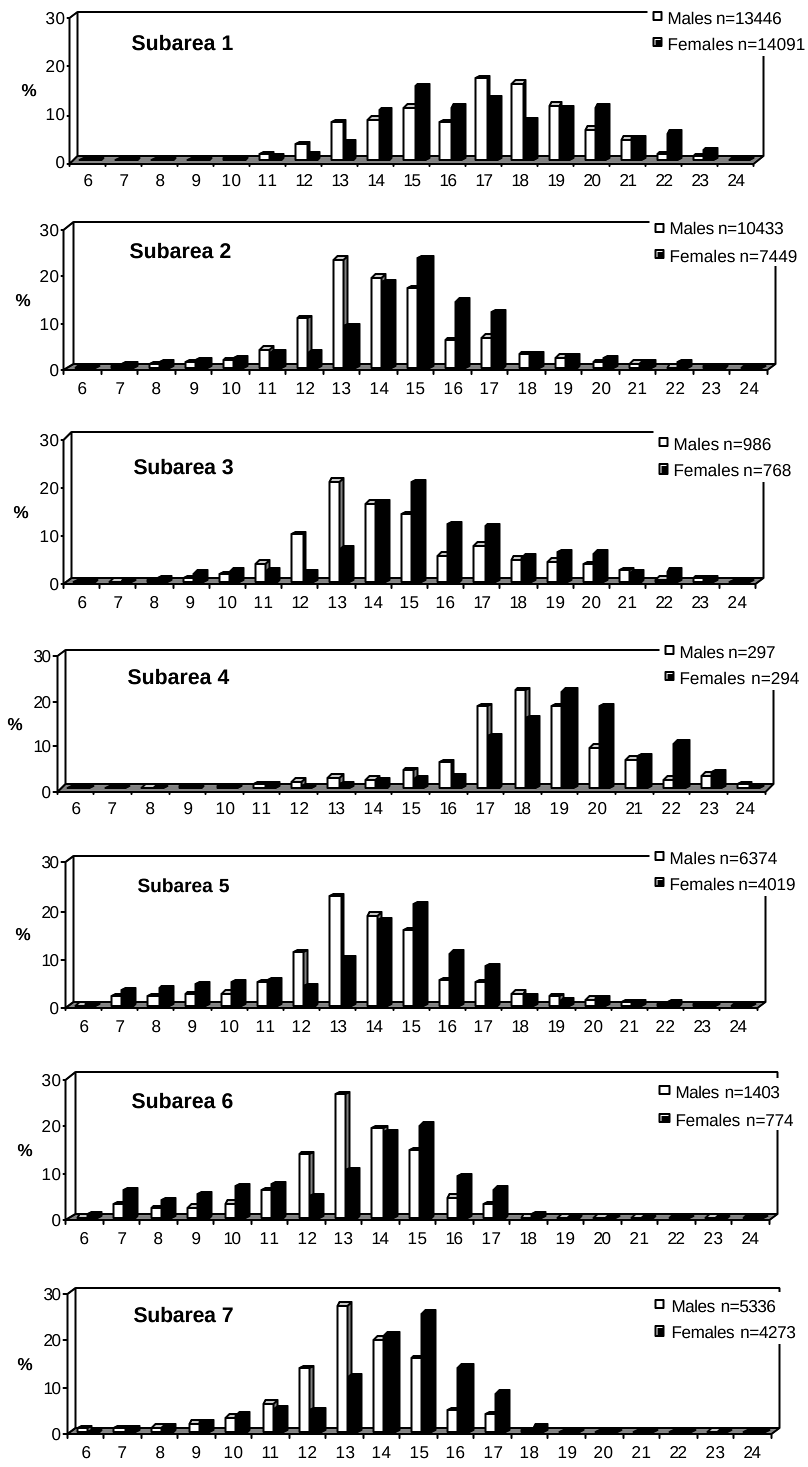

Fig. 4. Age composition of redfish by Subareas in the NEAFC and NAFO Regulatory Areas in June-August, 1995-2001.

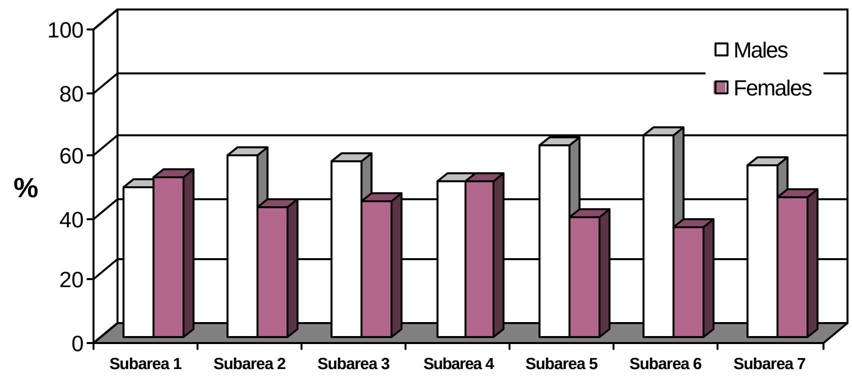

Fig. 5. Ratio of mature redfish by Subareas within NEAFC and NAFO Regulatory Areas in June-August, 2001

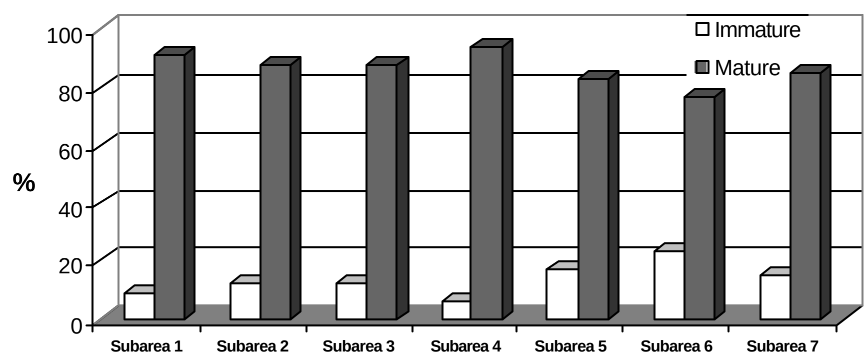

Fig. 6. Portion of mature redfish by Subareas within NEAFC and NAFO Regulatory Areas in June-August, 2001

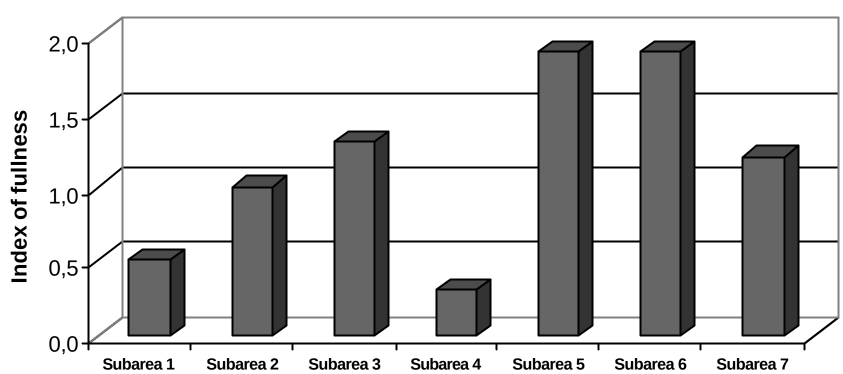

Fig. 7. Mean index of stomach fullness of redfish by Subareas within NEAFC and NAFO Regulatory Areas in June-August, 2001

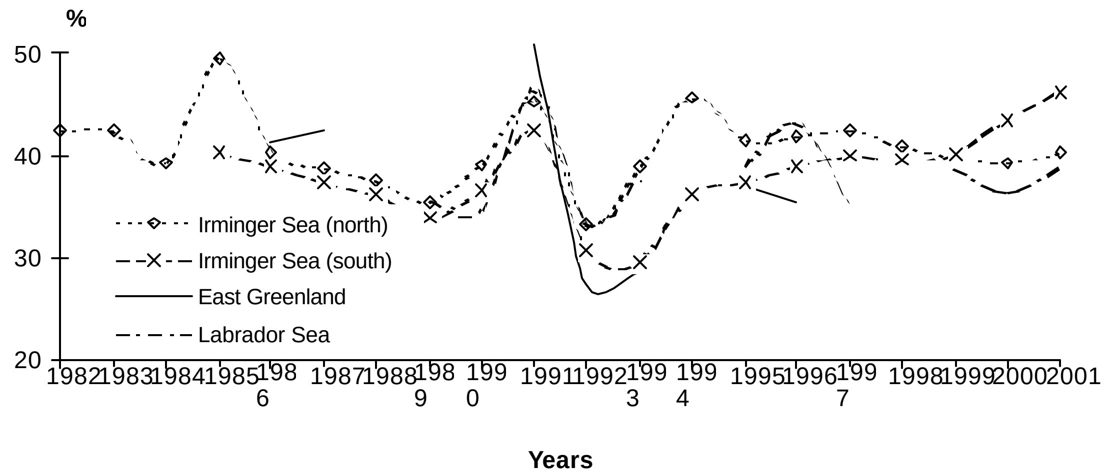

Fig. 8. Prevalence (%) of infestation with copepod Sphyrion lumpi of redfish Sebastes mentella by areas and years (June-July).

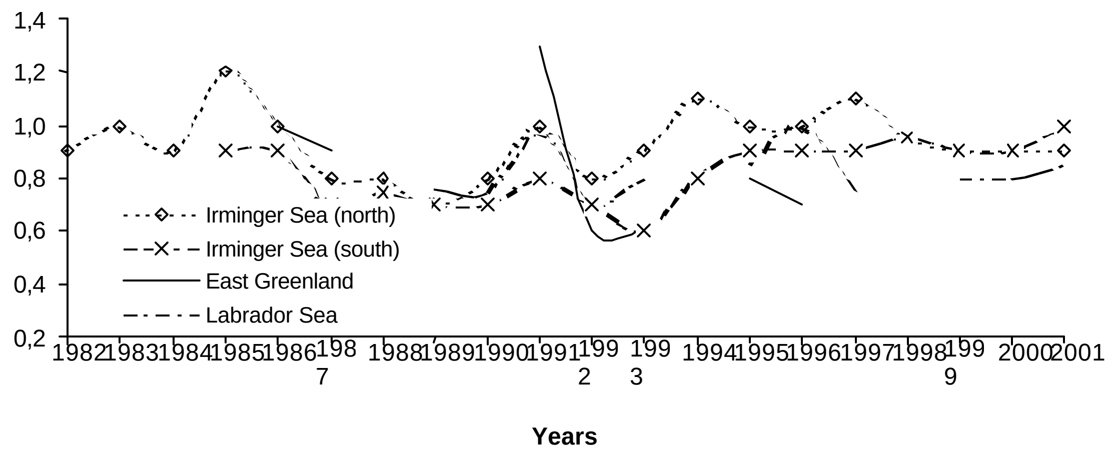

Fig. 9. Abundance index of infestation with copepod Sphyrion lumpi of redfish Sebastes mentella by area and years (June-July).

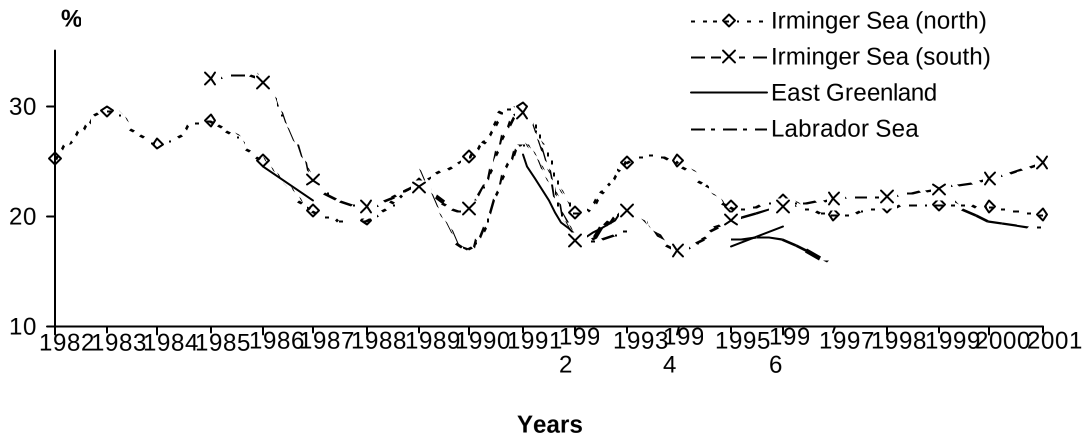

Fig. 10. Occurrence (%) of redfish Sebastes mentella with pigment patch on the skin by areas and years (June-July).