

Northwest Atlantic



Fisheries Organization

Serial No. N654

NAFO SCS Doc. 83/VI/6

SCIENTIFIC COUNCIL MEETING - JUNE 1983

First Report of the Joint NAFO/ICES Study Group on Biological Relationships
of the West Greenland and Irminger Sea Redfish Stocks

Copenhagen, 21-23 February 1983

Introductory Comment

At its meeting in June 1981, the Scientific Council of NAFO proposed that a special NAFO/ICES study group should be established to examine the biological relationships of the West Greenland and Irminger Sea redfish stocks, and that ICES be requested to make the necessary arrangements at the earliest possible opportunity, the suggested terms of reference being (a) to evaluate all available data on the subject, (b) to plan and coordinate special research on the relationships of the West and East Greenland stocks, and (c) to evaluate the data from such research projects (NAFO Sci. Coun. Rep. for 1981, page 27). Subsequently, in October 1982, ICES adopted a similar resolution with the same terms of reference and arranged the first meeting of the Study Group in February 1983. Its report for consideration by the NAFO Scientific Council follows.

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REPORT ON THE JOINT NAFO/ICES STUDY GROUP ON BIOLOGICAL RELATIONSHIPS
OF THE WEST GREENLAND AND IRMINGER SEA REDFISH STOCKS

1. PARTICIPANTS AND TERMS OF REFERENCE

1.1 Participants

B Atkinson	Canada
K Kosswig	Federal Republic of Germany
A Kristiansen	Faroe Islands
J Magnússon (Chairman)	Iceland
J V Magnússon	Iceland
J P Minet	EEC/NAFO (France)
J Messtorff	EEC/NAFO (Federal Republic of Germany)
J Møller Jensen	Denmark
R Noé	EEC/NAFO (EEC Commission)
A Schumacher	Federal Republic of Germany

K Hoydal attended the meeting as ICES Statistician.

1.2 Terms of Reference

At the last Statutory Meeting, the Council adopted the following resolution (C.Res.1982/3:2):

"It was decided that a Joint NAFO/ICES Study Group should be established to further examine the biological relationships of the West Greenland and Irminger Sea redfish stocks. This Group should meet for 3 days at the earliest opportunity, under the chairmanship of Dr J Magnússon (Iceland), in order to prepare a report for the relevant Assessment Working Groups. The terms of reference should be:

- (i) to evaluate all available data on the subject;
- (ii) to plan and coordinate special research on the relationships of the West and East Greenland stocks;
- (iii) to evaluate the data from such research projects."

2. INTRODUCTION

The existing data on redfish at West Greenland relevant to the objectives of the Study Group are rather poor, in particular for recent years. Since the older data do not distinguish between the different species of redfish, some of them are of limited value in this context. It is known that both *Sebastes marinus* and *Sebastes mentella* exist in West Greenland waters, but the species identification is deficient. Thus, although there are extensive areas inhabited by redfish, it is not known with certainty to which species they belong except to a limited degree.

The current system in the area indicates that there might be some drift of redfish larvae and post-larvae from the West Greenland area to Baffin Island and Labrador. The distribution and drift of larvae of the Labrador and Newfoundland stocks are not fully known. The Study Group felt that there might possibly be some relationships between the stocks at West Greenland and those off Labrador and Newfoundland, and thus they had to be included in this study.

The relationships between the different stocks in the Irminger Sea are in many respects unknown. The ICES Working Group on Redfish and Greenland Halibut in Region 1 has, therefore, in its assessment work, considered the redfish stocks at the Faroes, Iceland and East Greenland as one stock complex. Consequently, when dealing with the relationships between the redfish stocks off West Greenland and the stocks in the Irminger Sea, one has to consider the whole stock complex including the redfish at the Faroes.

The Group decided to limit the study to the commercially exploited species. Thus, S. viviparus has been excluded as well as the so-called "giant" redfish in the Irminger Sea which might belong to a separate stock or population.

In the Irminger Sea there is a redfish stock which was not fished commercially until 1982. This stock has not been considered in the assessment to date. In the report, this stock is frequently referred to as the "oceanic stock".

It should also be noted that the expression "spawning" is used for the extrusion of the larvae and consequently "spawning" concentrations consist primarily of females.

The area of study is shown in Figure 1.

3. ENVIRONMENTAL CONDITIONS

There is no recent and regular information (on a yearly basis) on the oceanographic regime in the Iceland-Irminger Sea-East and South Greenland area. However, from studies by Herman and Thomsen (1946), Dietrich (1957, 1961) and from results of the NORWESTLANT surveys in 1963 (ICNAF, 1968), the main characteristics of the current systems and water temperatures can be abstracted.

The Irminger current originating from Atlantic waters south of Iceland turns westward (with associated eddies) across the Denmark Strait and then southerly to run parallel to the Polar current along the east coast of Greenland to Cape Farewell. Both the Polar and Atlantic water components of the East Greenland current pass around Cape Farewell to the west and follow the coast of southwest Greenland introducing warmer water masses to the West Greenland current. This northward current initiates several branches to the west across the Davis Strait. After turning southward, these branches form the warmer component of the Labrador current (see Figure 2).

Dynamic topographic charts from May to August 1963 indicate high velocities from the area far offshore of South Greenland (about 50°N) to Iceland, along the east and west coasts of Greenland and along the Baffin Island/Labrador coasts (values higher than 20 cm/sec., i.e., roughly 8 miles per day).

Temperature data from different depths (0 to 100 m) collected during the NORWESTLANT surveys indicate that the layer from 5.5°C to 7.5°C (i.e., temperatures suitable for redfish spawning and larval development) is mainly observed in the southwestern Iceland/eastern Greenland area with a very small incursion to the southwest of Greenland in May-June. However, in July-August this layer is reduced to a small band along the East Greenland coast but is further spread out south and west of Greenland, indicating more likely conditions for a larval drift from the south and east to West Greenland.

However, there is a large variability in the current velocity as well as in the temperature regime from one month to another, and recent observations indicate furthermore that high variability can also occur from one year to another.

4. SPECIES IDENTIFICATION

4.1 Fry (Larvae and Post-Larvae)

4.1.1 Larvae

Youngest larval stages of S. viviparus can be distinguished from other redfish larvae by distinct melanophores in the caudal region (Tåning, 1961), but early stages of S. marinus and S. mentella of the Irminger Sea-Iceland regions are not distinguishable by pigment patterns. In later larval stages, with increasing pigmentation, the characteristic pattern of S. viviparus is lost.

The identification of S. mentella from the western North Atlantic by caudal melanophores (Templeman and Sandeman, 1959) did not work for the Northeast Atlantic (Kotthaus, 1961; Henderson, 1964; Magnússon et al., 1965). Recently, however, Templeman (1980) found out, that the presence of caudal melanophores was typical in S. fasciatus which does not occur in the Northeast Atlantic.

Identification characteristics other than melanophore patterns were reported by Magnússon and Magnússon (1977). There are definite size differences between S. marinus and S. mentella larvae at the time of extrusion, the latter being larger and more slender. Comparative measurements of pre-extruded larvae not only show distinct size differences between the two species, but also between S. mentella and the "oceanic" type of S. mentella. The corresponding mean lengths are 6.48 mm for S. marinus, 7.52 mm for S. mentella and 8.35 mm for the "oceanic" type of S. mentella.

4.1.2 Later larval and post-larval stages (0-group fish)

The characteristics described above cannot be used in the more developed stages, but other differences become apparent in comparing the development of spines in the head region (J V Magnússon, 1981).

S. viviparus: At about 9 mm total length a typical outstanding spine in the occipital region occurs. This is not the case for S. mentella or S. marinus. Further, the lower one of the two most prominent pre-opercular spines is distinctly larger than the upper one. Thirdly, the spreading of melanophores over the body sides seems to take a longer time. Thus, 0-group fish appear more pale than comparable stages of fry from other redfish species.

S. marinus and S. mentella: Distinction can be made by comparing two spines, definitely larger than the neighbouring ones, located on the posterior margin of the pre-operculum. The lower one is larger in S. marinus whereas in S. mentella, the upper one is larger.

4.2 Adult Fish

Besides other known characteristics, the distinction between S. mentella and S. marinus is possible by typical shapes of the pre-opercular spines.

In S. mentella the first spine at the anterior margin of the pre-operculum is pointed forward, and the lower spines are distinctly pointed whereas in S. marinus they are more blunt.

5. STOCKS

5.1 Labrador-Newfoundland

Research survey results indicate that except shallower waters (100 to 300 m) of NAFO Divisions 3K and 3M, S. marinus are only present in small numbers throughout the Northwest Atlantic. S. mentella are present in Subarea 0 and Divisions 2G and 2H, but are mixed with S. fasciatus further south, S. mentella being found in deeper water (Ni, 1982). There is no information concerning spawning locations and thus stock boundaries. It is thought that although the adult stock is not related to those of West Greenland and more eastern areas, larval drift from these other stocks may contribute to the Labrador stock.

5.2 Faroes-Iceland-East Greenland

Spawning stocks of S. mentella and S. marinus exist in the Iceland-East Greenland area. In addition, the results of a 1982 research survey indicated the possible presence of a separate spawning stock of S. marinus south of the Faroe Islands. In all areas S. mentella are generally found at greater depths than S. marinus. At present it is not possible to differentiate between S. marinus and S. mentella from West and East Greenland but that does not mean that differences do not exist.

5.3 Irminger Sea - "Oceanic" Stock

The fish of this stock have characteristics more closely resembling S. mentella. They are easily identified in that dark red or black spots are frequently present and the fish are generally darker or "dirty" looking compared to individuals from the S. mentella stock (Magnússon, 1977). This colour difference may be related to the fact that these fish are found in shallower water than S. mentella. These fish are frequently infested with Sphyrion lumpi although this may in part be due to the fact that this stock was largely unexploited before 1982.

The stock is distributed throughout the Irminger Sea and the large numbers of small mentella type redfish found in the East Greenland grounds are thought to be a mixture of the "oceanic" stock and the Irminger Sea S. mentella stock. Larvae from this "oceanic" stock may contribute to other stocks. It is possible that the "oceanic" stock is quite large.

6. SPAWNING AREAS AND TIME

6.1 Faroe

S. marinus in spawning (running) condition were observed south of the Faroes during a research vessel cruise in late May 1982. This was the first observation of this kind. The size of the fish ranged from about 40 cm to about 60 cm, mean length was 50 cm. A commercial fishery on these concentrations of spawning redfish lasted until the end of June.

S. mentella were observed in ripening condition in February around the islands. However, this cannot be interpreted as an indication that there is a spawning ground for this species since ripening redfish can still undertake extensive migrations. The possibility that the S. mentella population at the Faroes is linked with the population at "Rosengarten" (Iceland-Faroe Ridge) was suggested. Since no detailed information on spawning grounds for this species is available it is not possible at present to prove that this stock is self-contained.

On Lousy Bank pregnant females of "Norway haddock" (S. norvegicus) were found in 1921 (Goodchild, 1924). The description of the female gonads indicates that the embryos were well developed and almost ready to be extruded. A precise description of the species according to present nomenclature was not given.

6.2 Irminger Sea

Spawning of redfish in the Irminger Sea takes place in a wide area southwest of Iceland and above and northwest of the Reykjanes Ridge with extension in a southwesterly direction. Three stock components are believed to contribute to this spawning community:

1. The "oceanic" stock inhabiting the Irminger Sea beyond the continental slopes of East Greenland and Iceland, this stock was unfished until 1982.
2. Redfish from Icelandic waters.
3. Redfish from Greenland waters.

Separate spawning areas for the different species within the region cannot be identified with certainty although there are some indications that the main spawning area for S. marinus might be situated in the northeastern part and the spawning area for S. mentella in the southwestern part of the whole region with a large area of overlap between:

However, the main spawning of the two species takes place in different depth zones with some overlapping and at somewhat different times of the year. Spawning of S. marinus has been observed in late April and May at depths of about 300 to 550 m at temperatures of 5.5°C to 7.5°C. Spawning of S. mentella occurs later, up to July-August, in water approximately 550 m and deeper at about 5.5°C to 6.0°C. However, the "oceanic" stock of S. mentella is found in spawning condition at depths of about 200 to 300 m with temperatures of 6°C to 8°C.

6.3 West Greenland

No actual offshore spawning of redfish has been observed at West Greenland so far. However, small larvae found during the NORWESTLANT surveys off the most southern part of West Greenland indicate that there might be some spawning in adjacent waters. In addition, spawning of a small local S. mentella type population has been observed in the Godthåb fjord.

7. DRIFT OF FRY

The main sources of information on the drift of redfish fry in the Irminger Sea-East Greenland region are from Kotthaus (1961), Magnússon (1962), the NORWESTLANT surveys in 1963 (ICNAF Spec.Publ., 1968), from the O-group surveys in the Irminger Sea which have been carried out since 1970, mainly in August (Annls biol., 1970-80), and from Vilhjálmsson and Magnússon (1981a, 1982). The reports on the surveys have been presented every year at the ICES Statutory Meetings. In recent years, it was possible to separate the fry into S. mentella and S. marinus according to areas.

A comparison of the distribution and abundance of redfish larvae in all three NORWESTLANT surveys indicated a general trend in the drift of larvae from the central and eastern Irminger Sea towards the slopes along the East Greenland shelf and to some extent around Cape Farewell. This general drift pattern has been confirmed during the O-group surveys. Results of the O-group surveys show S. mentella to be mainly present in the northern portions of the survey area while S. marinus is found predominantly in the south. An area of mixing of the two species exists between these northern and southern areas. The surveys also indicate that there might be a considerable drift of O-group S. marinus from the locations of heavy concentrations off East Greenland to West Greenland, while a similar drift of O-group S. mentella is less likely.

During the NORWESTLANT surveys in May and June, concentrations of redfish larvae were observed southeast and southwest of Cape Farewell. These patches could be traced during the NORWESTLANT survey in June-July south and southwest of Cape Farewell, i.e., farther to the west. Concentrations of larvae in this area are also indicated in reports on the results of the continuous plankton recorder sampling (Henderson, 1961; Bainbridge and Cooper, 1971) and from older Danish records (Tåning, 1949; Hansen and Andersen, 1961).

Redfish fry off West Greenland have only been observed in rather small quantities. Little information is available on a drift in that area. The NORWESTLANT surveys and the older Danish records indicate a northerly drift, but generally fry have not been observed north of Fyllas Bank (64°N). No observations are available from recent years.

According to the continuous plankton recorder information as presented in a general distribution chart for the years 1958 to 1972 combined (Coombs, 1980), there is a break in the concentration of redfish fry between the western and the central North Atlantic areas.

A possible drift of fry in the Faroe region can only be postulated since observations on redfish fry in the O-group surveys (Annls.biol.) in this area are made in June, i.e., at a time too soon after "spawning" to provide adequate information. It remains open whether an isolated population exists in the area (see Section 6.1).

8. NURSERY AREAS

8.1 Faroe

No information on nursery areas in the Faroe area is available except some observations on O-group redfish (species unknown) all around the islands.

8.2 Iceland

Nursery areas for S. marinus are found off the east, north and west coasts of Iceland. Slow migration of young redfish along the north coast to the west coast takes place associated with an increase in length. No specific nursery grounds for S. mentella have been found in Icelandic waters and there is also no record of nursery grounds off the south coast of Iceland.

8.3 East Greenland

Nursery grounds off the East Greenland coast are found on the continental shelf. Young S. mentella dominate in the Dohrn Bank - Gauss Bank area. Further to the south the two species are mixed in almost equal proportions. In the most southerly part of the region S. marinus is dominant.

8.4 West Greenland

Large quantities of small (16 to 18 cm) redfish, mainly S. mentella, have been caught as by-catch in the shrimp fishery in Davis Strait between 66°N and 70°N. This indicates that there must be a nursery area for this species on these grounds. However, there is no information on the origin of these young redfish. No larval drift from southern to northern areas was observed during past surveys, and the possibility that the young S. mentella may originate from spawning concentrations off Labrador-Newfoundland cannot be excluded. It was also suggested that these fish may originate from the larvae found south of Cape Farewell (see Section 6.3).

The commercial fishery for redfish in West Greenland waters is mainly based on concentrations of S. marinus. The origin of these fish cannot be identified with certainty. Smaller S. marinus of about 20 cm length have been observed in nearshore waters at south-west Greenland, and the possibility exists that they may originate in East Greenland waters.

Small redfish have been observed in nearshore waters along the coast of West Greenland as far up as 70°N. However, the species composition is not known.

9. MIGRATION

It is a general trend that small redfish move from shallow waters to deeper waters concurrently with their growth. This has been observed at Iceland and also on the bank area of East Greenland where the small redfish migrate from the coastal area into the deeper waters along the shelf of the Irminger Sea. When the redfish are mature (initial maturity at about age 16), a spawning migration from the feeding areas along the shelf to the Reykjanes Ridge and the Irminger Sea area takes place (at least for females) with a return migration after "spawning".

A southward migration presumably takes place along the west coast of Greenland. Since, in the area of the offshore shrimp fishery it has been observed that the length of the small S. mentella increases from north to south, and in the commercial fishery for S. marinus, which mainly takes place in NAFO Divisions 1D to 1F, the catches in Division 1F generally contain bigger fish than those in Division 1D.

This slow southward migration along the coast of West Greenland into warmer waters south and east of Greenland is in accordance with the fact that no "spawning" of redfish has been observed so far in the waters of West Greenland.

During the period 1956 to 1969, 3 825 redfish were tagged in Godthåb fjord (NAFO Division 1D). The redfish were caught in a pound net (depth of the net 15-18 m), and the tagging took place in May and June. The mean size of the tagged fish was 44.4 cm \pm 3.5 cm. Unfortunately, they were not identified as to species but more recent investigations indicate that the main part of the tagged fish could be a local population of S. mentella or a similar type.

From 1958 to 1982, 680 recaptures were reported, 645 from the fjord itself. Of the 35 offshore recaptures, 24 were reported from West Greenland, 7 from East Greenland, 1 from Iceland, and 3 from either West Greenland or the Irminger Sea. Some of those recovered from the Irminger Sea were identified as S. marinus. This indicates that a possible spawning migration of adult S. marinus takes place from West Greenland to the Irminger Sea.

10. CONCLUSIONS

Two main questions have to be answered in clarifying the biological relationship between the West Greenland and the Irminger Sea redfish stocks.

1. Where are the "spawning" grounds of the West Greenland redfish population(s)?

There are no direct observations of spawning redfish in the West Greenland area. The slow southward migration of young S. mentella as indicated by an increase in length from north to south in the shrimp fishing area, as well as the presence

of adult S. mentella in the southern divisions, lead to the conclusion that the adult females of this species leave the West Greenland area to release the larvae.

Similar observations from the commercial fishery for S. marinus, together with information from tagging experiments, indicate that the same conclusion might be valid for S. marinus.

2. Where is the origin of the young redfish in the West Greenland area?

This question cannot be answered from direct observations of larval and young fish drift at present. The species composition of the small redfish which have been observed along the West Greenland coast is not known. Since no spawning grounds in West Greenland waters are known, the interim conclusion has to be that the redfish fry originate from spawning outside the West Greenland region and for S. marinus, very likely in the Irminger Sea. This conclusion is supported by the existing current system in the Irminger Sea and off West Greenland.

It should be noted, however, that the evidence on which these conclusions are based is of an indirect nature and, therefore, not very strong.

11. FUTURE RESEARCH REQUIREMENTS

To validate the conclusions drawn from the information available at present, the following course of action is recommended:

1. Existing material including environmental data from previous research activities in the area should be scrutinised in view of obtaining additional information relevant to these problems.
2. Since it is well known that offshore tagging of redfish is virtually impossible, the feasibility of tagging S. marinus in the Godthåb fjord should be investigated.
3. Direct observations of drift, in connection with the relevant environmental conditions, of redfish fry to West Greenland should be obtained. This will allow the determination of the origin of the small redfish present off the West Greenland coast. This approach will require an extensive multi-ship research programme probably over several months and possibly years.

In view of the terms of reference, work on Item 1 above will start as soon as possible, and another meeting will be convened when results are available.

12. REFERENCES

Literature referred to in this list are cited in the report of the Study Group. Not all of the documents discussed during the meeting necessarily appear here.

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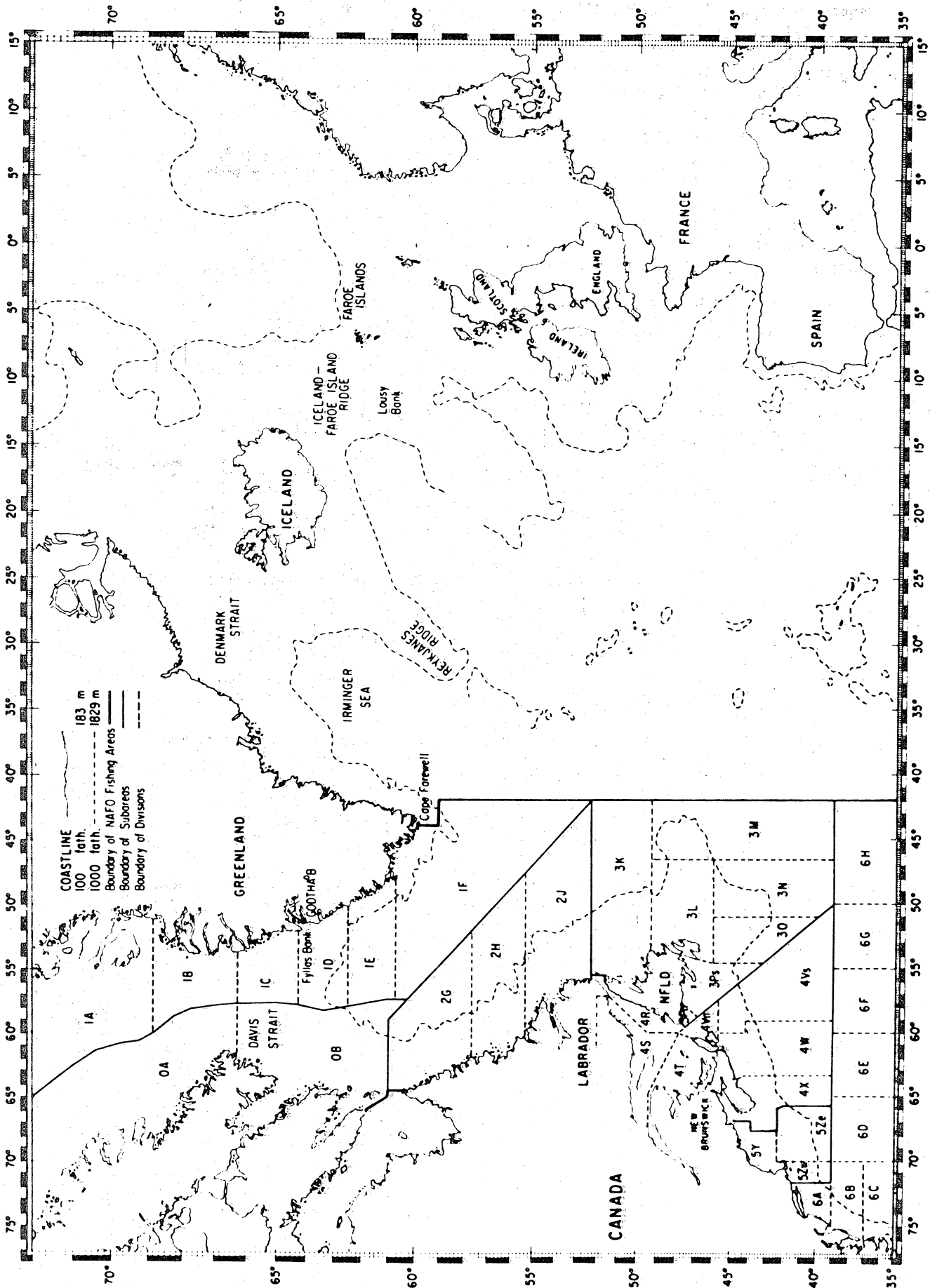


Figure 1. The area of study.



Fig. 2. Surface currents in Greenland waters. (From Hansen and Hermann.)

