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A PRELIMINARY REPORT ON THE NATURAL OCCURRENCE AND ECOLOGY OF ATLANTIC HALIBUT, HIPPOGLOSSUS HIPPOGLOSSUS, POSTLARVAE AND YOUNG IMMATURE STAGES

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ABSTRACT

Surveys designed to capture Atlantic halibut, Hippoglossus hippoglossus, postlarvae and young immatures were carried out around Sørøya in North Norway in 1985, 1986 and 1987. Hydrographical conditions and the current features in the area were also investigated. The ichthyoplankton trawls (MOCNESS, Tucker-trawl) filtered more than 200.000 m^3 of sea water in the March months. Only one single pelagic postlarvae, 11.9 mm long and in a stage of first feeding, was captured, near the center of a cyclonic vortex in Sørøysundet. Most probably, the filtering capacity of the equipment used was too low given the low concentrations in which halibut larvae seem to occur. Trawling with a pelagic trawl in May yielded no pelagic postlarvae. The shallow (20-60 m) area north of sørøya act as a halibut nursery area where considerable amounts of young, immature fish aged 2-4 years are found.

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INTRODUCTION

In recent years a large interest in developing methods for artificial rearing of Atlantic halibut, Hippoglossus hippoglossus, in future commercial aquaculture has emerged in several North Atlantic countries. Previous rearing experiments have clearly revealed that domestication of the Atlantic halibut is by no means an easy task, and it has especially been acknowledged that more field data and knowledge about the natural biology/ecology of the species is extremely necessary.

Among the items of special interest and relevance to the ongoing rearing experiments are studies of spawning biology and natural biology and ecology of the earliest stages of the species. Quite substantial knowledge has now been gained about the halibut spawning grounds and seasons in various parts of the northeast Atlantic (Devold 1938, Tjemsland 1960, Kjørsvik et al. 1987, Jakupsstovu & Haug 1987, in prep.) and field studies on halibut spawning grounds in North Norway have also revealed good insight into the dynamics involved in the vertical, mesopelagic distribution of halibut eggs (Haug et al. 1984, 1986).

The present knowledge of the natural occurrence, biology and ecology of halibut larvae, postlarvae and young immature stages is, however, much more fragmentary and inadequate. This paper present results from surveys aimed to localize halibut postlarvae in Sørøysund, North Norway (Fig. 1), in March 1986 and 1987, and around Sørøya in May 1987. Furthermore, we present results from exploratory Danish seine and shrimp trawl fisheries. These were performed in order to catch young halibut to be used in growth experiments in captivity and carried out in September 1985 and July 1986 respectively in the fjords and shallow areas on the north side of Sørøya, North Norway. Hydrographical data were recorded in all areas and, as an integrated part of the postlarvae surveys, the current features in the area were also investigated in more detail to reveal vortex structures where fish larvae are more frequently found.

The halibut spawning in Sørøysund is at its most intensive by the end of January / beginning of February (Kjørsvik et al. 1987). Based on observations from recent rearing experiments (Berg & Øiestad 1986, Rabben et al. 1986), the postlarvae surveys were conducted either in the middle of March, when larvae could be expected to be in a stage of first feeding, or in the middle of May, which is immediately before the larvae are expected to settle onto the bottom.

MATERIAL AND METHODS

The hydrographical data were recorded using a Neill Brown CTD profiler connected to a Nord-10 computer. During the 1986 postlarvae surveys, two hydrographical surveys were performed in Sørøysundet on March 17-18 (23 CTD-stations) and on March 20 (14 CTD-stations). Two drift experiments were carried out using drougued buoys. The buoys were traced by radar from the vessel. In 1987, a hydrographical survey including 33 CTD-stations was carried out on March 9/10. Based on the hydrographical data, maps of dynamical topography (ΔD, given as dynamic depth anomalies in dyn mm) were drawn to vizualize the geostrophic circulation pattern.

In March 1986, vertical profiles were made of temperatures using the CTD profiler in Galtefjord on the north side of Sørøya. Such profiles were also recorded in the areas of investigation during the exploratory trawl fisheries in July 1986 and May 1987.

During postlarvae surveys, three different sampling devices were used to capture ichthyoplankton in horizontal hauls performed at various depths:

A MOCNESS multiple opening-closing net and environmental sensing system (Wiebe et al. 1976) was applied in March of 1986 and 1987. Each sampling net (mesh size 1000 µ in 1986, 320 µ in 1987) was hauled for 30 or 60 minutes, and volumes filtered were calculated from flowmeter readings.

Due to some technical problems with the MOCNESS in 1987, a Tucker trawl (for a more detailed description, see Hopkins et al.

1982) was also used to perform some 120 minute hauls. Approximate volume sea water filtered during each haul (5.600 m^3) was calculated using the area of the trawl opening (1 m^2) and the cruising speed of the ship (1.5 knots).

During the late postlarvae surveys (May 1987) the main sampling device was a pelagic trawl with an extremely fine meshed (2.0 mm) net in the cod end. The opening height of this trawl was about 12 m, and a Simrad trawl eye (giving the distance from surface and bottom, see Hopkins et al. 1982) was mounted on to the roof of the trawl. Thus, the sampling depths of 0, 20, 40 and 100 m actually represent the depth intervals 0-12, 20-32, 40-52, and 100-112 m respectively.

During the bottom surveys for young, immature fish, four different types of sampling gear were applied:

In September 1985, bycaptured small halibut were sampled from fishing vessels operating mainly on the north side of Sørøya using Danish seines (mesh size 135 mm).

During the July 1986 surveys, a shrimp trawl with rubber bobbins and a general cod end (mesh size 35 mm) combined with a net (mesh size 22 mm) in the rear end, were applied to capture small halibut north and west of Sørøya.

Also during the 1986 surveys, a small Danish seine ("flatfish trawl") specially designed to capture flatfish in shallow waters (< 30 m depth), and with a herring net (35 mm mesh size) in the cod end, was applied. A beach seine (mesh size 22 mm) was used to search for juvenile (0-group) halibut on sandy beaches in the same areas where immature specimens were captured at deeper strata using Danish seines and trawls.

In most halibut, total lengths were measured to the nearest cm and round weights to the nearest 0.01 kg. In the September 1985 material, otoliths were sampled from the fish after the growth experiment was terminated; age at capture was then estimated by back calculations from otolith readings which were performed as described by Devold (1938).

Cod, Gadus morhua, was regarded as a potential predator upon the youngest bottom stages of halibut. For this reason, stomach contents were examined in some of the cod caught in the shrimp

trawl in July 1986 and May 1987.

Generally, the fish larvae captured were identified according to Russell (1976) and Fahay (1983). Determination of Atlantic halibut still rely on the descriptions and plates given by Schmidt (1904), although the detailed drawings given by Thompson & van Cleve (1936) of the closely related and morphologically similar Pacific halibut, Hippoglossus stenolepis, are also quite helpful.

Larvae were fixed in a solution of 2.5% glutaraldehyde in 0.05 mol/l cacodylate buffer (pH = 7.2, 350 mosmol/kg) for later measurements and observations.

RESULTS

EARLY POSTLARVAE SURVEYS

Hydrographical conditions and circulation patterns

Figs 2-4 show dynamical topography (ΔD) at the surface relative to 200 m (Figs 2 and 3) and 150 m (Fig. 4) respectively, for the surface at three surveys in Sørøysund. The hydrographical data from the two surveys in 1986 (Figs 2 and 3) and the one in 1987 (Fig. 4) all show the existence of a semi-enclosed cyclonic vortex in Sørøysundet where the Atlantic halibut spawn (mostly on the north and west side of Silda and along the north side of Stjernøy, Tjemsland 1960). The centre of the vortex is to some extent displaced towards Sørøya rather than along the axis of Sørøysundet. During the survey in 1987 another cyclonic vortex seemed to exist at the entrance to the sound.

During the 1986 surveys, drifting buoys were deployed and the trajectories are indicated in Figs 2 and 3. The trajectory indicated for the buoy in Fig. 3 is an estimate based on the dynamical topography, since the buoy was lost from the radar and was not retrieved before the day after the hydrographical survey. Both drift experiments indicate fairly good agreement with the circulation pattern deduced from the dynamical topography.

Figs 5 and 6, showing the depth of the 34.4 o/oo isohaline during the surveys in 1986, and Fig. 7, showing the depth of the 34.3 o/oo isohaline during the 1987 survey, all indicate that high saline water rose in the core of the vortex.

In the upper 50 m, where most ichthyoplankton hauls were made both in 1986 and 1987, temperatures and salinities remained between 2.40-2.70^{0}C and 34.08-34.34 o/oo respectively (Table 1).

Ichthyoplankton trawling

During the 1986 surveys a total of 13 hauls with MOCNESS were performed in various depths in Galtefjord, Ofjord and Sørøysundet during the period 18-25 March (Fig. 8). The surveys included hauls which covered depths between 5 and 80 m and filtered a total of nearly 97.000 m^3 of sea water. In the areas north of Sørøya, a few postlarvae of capelin, Mallotus villosus, and redfish, Sebastes sp., were the only fish fry recorded. In Sørøysundet, only one single fish fry was caught in the nine MOCNESS hauls made (Fig. 8): At 10 m depth a halibut larva, 11.9 mm long and apparently in a stage of first feeding (quite similar to the stage 3 larvae of the Pacific halibut given by Thompson & van Cleve 1936) was collected.

All ichthyoplankton trawl hauls during the 1987 surveys (10-14 March) were performed in the cyclonic vortex area in Sørøysund where the halibut larva was found in the 1986 surveys (Fig. 8). Hauls were performed using a MOCNESS and a Tucker-trawl at depths ranging between 10 and 150 m, and the total volume filtered during these surveys was approximately 110.000 m^3. No halibut larvae were captured. Only one single fish fry was recorded, a wolffish, Anarhicas lupus.

LATE POSTLARVAE SURVEYS

During the pelagic trawl surveys in May 1987, various depths at a total of 18 localities were investigated (Fig. 9). The most commonly recorded fish fry during the surveys was wolffish, A.

lupus, larvae, which occurred in absolutely all of the hauls, often with more than 100 individuals per haul. A few capelin, M. villosus, and gadoid larvae were also recorded, while no registrations were made of flatfish fry.

Trawling with shrimp trawl in Sandfjord and Ofjord (Fig. 10) yielded considerable numbers of cod, 249 of which were later examined to determine contents. The main food constituent was sand eels, Ammodytes sp., which were encountered in 86% of the stomachs. A few c. 40 mm long individuals of flatfish fry were also found. Although species determination was difficult, we doubt that these were halibut; more likely they were sand dab (Limanda limanda).

On the localities around Sørøya, recorded temperatures and salinities in the sampling depths ranged between 3.06-3.70^{0}C and 34.29-34.35 o/oo respectively (Table 2). In the more northeastern areas, sampling depth temperatures were somewhat lower (2.55-3.07^{0}C), while salinities were similar to those further west. This was also true for bottom salinities, which ranged from 34.29-34.49 o/oo, while bottom temperatures varied, depending on total depth, from 2.21-3.79^{0}C at the sampling sites.

STUDIES OF YOUNG IMMATURE STAGES

The September 1985 surveys

During the period 2-27 September 1985 a total of 81 halibut were sampled from Danish seine catches obtained in the shallow (20-40 m depths) areas north of Sørøya while only a single specimen was captured north of Kvaløya (Fig. 10). North of Sørøya, 67 fish were taken in the western areas (most of them in Ofjord, see Fig. 10), while further to the east only 14 specimens were taken. Whenever weather conditions allowed fishing, Danish seine vessels apparently operated in all areas north of Sørøya, although no systematic records were made of the general distribution of the fisheries effort in the area during the sampling period.

The 73 fish which were measured ranged in lengths between 40-75

cm, with 75.5% between 40-50 cm (Fig.11). Among 65 fish, in which sex was determined, there was a slight excess (57%) of females. Age determinations were performed on 66 fish. Two year old fish constituted 55% of the catches, while the remaining fishes were 3 and 4 years old (Table 3).

The average yearly increment in total length for the age groups present was calculated to be c. 6.5 cm, while the weight gain in two years from age class 2 to 4 years averaged c. 1.0 kg (Table 3).

The July 1986 surveys

During the period 14-26 July 1986, 13 young halibut were captured in shrimp trawl (11 specimens) and the small flatfish trawl (2 specimens) at 20-30 m depths in the northwestern Sørøya areas (Breivikfjord, Sandfjord and Ofjord, see Fig. 10). These fishes ranged in size between 31 and 87 cm (Fig. 11).

Cod was the most frequent species encountered in the shrimp trawl in all areas. The content of 155 cod stomachs were examined in the catches from Sandfjord and Ofjord. Sand eels were found in 73% of the stomachs and was the most conspicuous food item. In three stomachs, single specimens of 0-group flatfish were found. From the number of dorsal and anal rays it appeared that these were all plaice (Pleuronectes platessa) fry.

Ten hauls using beach seine on sandy beaches in the same localities where immature halibut were caught in trawls at deeper strata (Fig. 10) yielded several juvenile specimens (0-group) of plaice, sand dab and flounder (Plathichthys flesus), but never of halibut.

Hydrographical data recorded in the areas of trawling showed bottom temperatures and salinities of 7-8^{0}C and 33.9-34.2 o/oo respectively.

DISCUSSION

The hydrographical data from the surveys invariably show low saline water along the southern border of Sørøysundet. The maps of dynamical topography and the drifting buoys indicate a cyclonic circulation in the sound with a vortex in the eastern part and a semi-enclosed vortex in the western part of the sound. The circulation is indicated in Fig. 12. Such a circulation implies that eggs spawned along the southern border of the sound and in the eastern parts will tend to have a longer residence time than eggs spawned in the western part of the sound, since they will more likely be trapped by the enclosed vortex in the eastern part. Therefore, it is to be expected that halibut larvae would be found in, or in the vicinity of, this vortex. The single larva that was found with a Mocness $1m^2$ plankton trawl was located in this vortex at a depth of 10 m.

From a review of the litterature (Schmidt 1904, Jespersen 1917, Cox 1924, Jensen 1926, Rollefsen 1934, Vedel-Tåning 1936) it appears that a total of 56 Atlantic halibut planktonic postlarvae, ranging in size between 13.5 and 34 mm, have been recorded. Most of these postlarvae were taken in open Atlantic waters south west of the Greenland-Iceland-Faroes-Scotland ridge, although specimens have also been observed off Nova Scotia, to the west of Greenland, and in fjords along the western coast of Norway (for review, see Vedel-Tåning 1936). Most previous records of Atlantic halibut postlarvae have been made in the upper layers (5 - 50 m depths) of the water column, generally with the smaller specimens occurring above greater depths whilst the older ones are usually found over shallower depths (Vedel-Tåning loc.cit.). Similar observations have been made for Pacific halibut larvae which rise into the upper layers of the water column during their development where they encounter currents which will bring them into inshore, shallow waters where they settle onto the bottom after metamorphosis (Thompson and van Cleve 1936).

The reason why so few pelagic stages have been recorded is, undoubtedly, that they are more or less uniformly distributed in a very large expanse of water. Halibut spawning stocks have proved very vulnerable and easy to overexploit when subjected to gill net

fishery (Devold 1938, Haug 1984). This may indicate that the number of fish present at the spawning sites are small, thus, giving a small number of offspring. Haug et al. (1984, 1986) found that the egg concentration in Sørøysundet was less than 1 egg/m^2 surface and approximately 0.01 egg/m^3 volume max. concentration. Observations from spawning fields for cod in the vicinity of Sørøysundet show that the maximum concentration of larvae found near the spawning fields seldom exceeds 0.01 of the intial concentration of the eggs (Svein Sundby, unpublished data). The reduction of the peak concentration from eggs to larvae is due to mortality, transport away from the spawning site and spreading of the eggs. If one assumes approximately the same order of reduction of halibut from eggs to larvae, then no more than 10^{-4} larvae/m^3 volume would be expected as peak concentration. From this it is obvious that the filter capacity of the MOCNESS with 1 m^2 net opening is rather low to be used in halibut larval surveys. The finding of one 11.9 mm larva in 1986 must, therefore, be considered as good fortune, although the possibility cannot be excluded that some concentration of larvae may occur in the cyclonic vortex in which the larva was actually found. To obtain a spatial distribution of halibut larvae, most likely a plankton trawl with a considerably higher filtering capacity is needed.

Most observed halibut postlarvae, the present finding included, were recorded in 5 - 50 m depths (see Vedel-Tåning 1936). If we assume that this represents the true picture in Sørøysundet as well, it appears that the hydrographical conditions the larvae are exposed to here in March will be temperatures of 2.4-2.7^{0}C and salinites of 34.0-34.3 o/oo. The relatively low temperatures will probably account for a slower developmental rate for "wild" larvae in Sørøysundet as compared, for example, with the artificially reared larvae in the experiments of Berg & Øiestad (1986) and Rabben et al. (1986) in which water temperatures were above 9^{0}C for long periods.

From the circulation patterns in Sørøysundet, it seems reasonable to believe that halibut larvae may be transported from the vortex area and westwards in the northern part of the sound. Furthermore, they will be carried by currents northwards and eastwards on the north side of Sørøya; eventually, they will end up in the fjords

on the north side of Sørøya. No pelagic postlarvae were recorded, however, in May 1987 in this area. This is, of course, no confirmation that the area is free of pelagic postlarvae. The negative impact of low halibut larvae concentration upon sampling with conventional gear has already been mentioned. If bottom settling of halibut larvae really occurred in the shallow areas (20-60 m) of the fjords on the north side of Sørøya in May, the newly settled individuals would be subjected to approximate temperatures and salinities of 3.2-3.8^{0}C and 34.3-34.4 o/oo respectively.

Obviously, the shallow area (20-60 m) to the north of Sørøya serves as a nusery area for the halibut. The size ranges observed in fishes caught in trawl and seines is consistent with observations in other halibut nursery areas on the Norwegian coast (Godø & Haug in press). The low number of 4 year old fish and the total lack of fish older than 4 years indicate that, as a general rule, the juveniles start to leave the nursery areas when they are 3-4 years old. These observations are also similar to observations made in Faxa Bay, a large halibut nursery area on the west coast of Iceland (Sigurðsson 1956). From the present study, it is evident that young halibut occur in the nursery areas in July and September. In July, bottom temperatures and salinities were 7-8^{0}C and 33.9-34.2 o/oo respectively. Tagging experiments in other halibut nursery areas on the coast of North Norway have revealed a year round occurrence of halibut (Godø & Haug in press). We do not yet know whether this is also the case in the Sørøya area.

From the current features observed in the area, it is tempting to assume that the young, immature halibut observed north of Sørøya are offspring from the spawning stock in Sørøysundet, although our data are not sufficient for such a conclusion. The complete absence of the I-group in the area is quite odd, although the possibility can not be excluded that the applied gear was insufficient to catch this group of fish. In the Faxa Bay nursery area the I-group was quite numerous (Sigurðsson 1956).

The present growth data given in Table 1 clearly demonstrate that young halibut today grow considerably faster than some 40-45 years ago (see Tjemsland 1960). Similar changes in growth rate were

observed in North Norway also in the adult part of the population from 1955-60 to 1980-85, and probably present a warning that halibut stocks are now significantly reduced compared to their initial sizes (Haug & Tjemsland 1986).

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Table 1. Vertical profiles of temperatures (T, in ^{0}C) and salinities (S, in o/oo) in the sampling layers in Galtefjord in March 1986 and in Sørøysundet (in the cyclonical vortex, see text) in March 1986 and 1987.

Depths (m)	Galtefjord 1986		Sørøysundet 1986		Sørøysundet 1987	
	T	S	T	S	T	S
5	2.40	34.08	2.41	34.16	2.63	34.31
10	2.41	34.08	2.49	34.18	2.64	34.31
20	2.42	34.09	2.56	34.19	2.67	34.32
30	2.44	34.09	2.57	34.19	2.69	34.32
40	2.47	34.11	2.62	34.20	2.72	34.33
50	2.50	34.13	2.67	34.21	2.75	34.34
60	2.40	34.13	2.71	32.23	2.79	34.35
70	2.31	34.14	2.72	34.23	3.00	34.38
80	2.22	34.14	2.71	34.24	3.22	34.41
90	2.22	34.15	2.85	34.26	3.42	34.46
100			3.21	34.35	3.83	34.51
150			4.09	34.55	4.39	34.62

Table 2. Temperatures (T, in ^{0}C) and salinities (S, in o/oo) in the approximate sampling depths and along the bottom in some of the localities surveyed with pelagic trawl in May 1987. Map references refer to Fig. 8.

Locality	Map ref.	Tot. depth (m)		Sampling depths			
				5m	25m	45m	Bottom
Breivikfjord	1	80	T:	3.44	3.23	3.19	3.02
			S:	34.29	34.30	34.34	34.31
Sandfjord	2	27	T:	3.70			3.79
			S:	34.31			34.37
Ofjord	3	40	T:	3.43	3.24		3.23
			S:	34.26	34.29		34.28
Galtefjord	4	85	T:	3.60	3.63	3.61	2.80
			S:	34.24	34.35	34.36	34.35
W of Kamøy	5	80	T:	3.42	3.43		3.42
			S:	34.35	34.35		34.37
Sandøyfjord	6	135	T:	3.28	3.26	3.06	2.47
			S:	34.29	34.30	34.34	34.33
Gamvikfjord	7	25	T:	3.29			3.33
E of Kamøy	8	30	T:	3.19			3.20
			S:	34.32			34.33
E of Tarhalsen	9	75	T:	3.40	3.41		3.61
			S:	34.39	34.40		34.49
Bakfjord	10	100	T:	2.55	2.65	2.67	2.31
			S:	34.29	34.31	34.31	34.32
Havøysund	11	70	T:	2.72	2.73		2.75
			S:	34.32	34.32		34.33
Breisund	12	65	T:	2.72	2.72		2.73
			S:	34.33	34.33		34.33
Revsbotn	13	200	T:	3.07	2.96	2.92	2.21
			S:	34.29	34.32	34.32	34.33

Table 3. Relative abundance, average lengths (cm), and average round weights (kg) of various year classes of halibut obtained in the September 1985 catches.

	Age classes (years)		
	2	3	4
Number present	36	21	7
Average length (± S.D.)	43.8 ± 2.4	50.2 ± 6.8	56.7 ± 7.6
Average weight (± S.D.)	0.87 ± 0.14	1.37 ± 0.56	1.90 ± 0.71

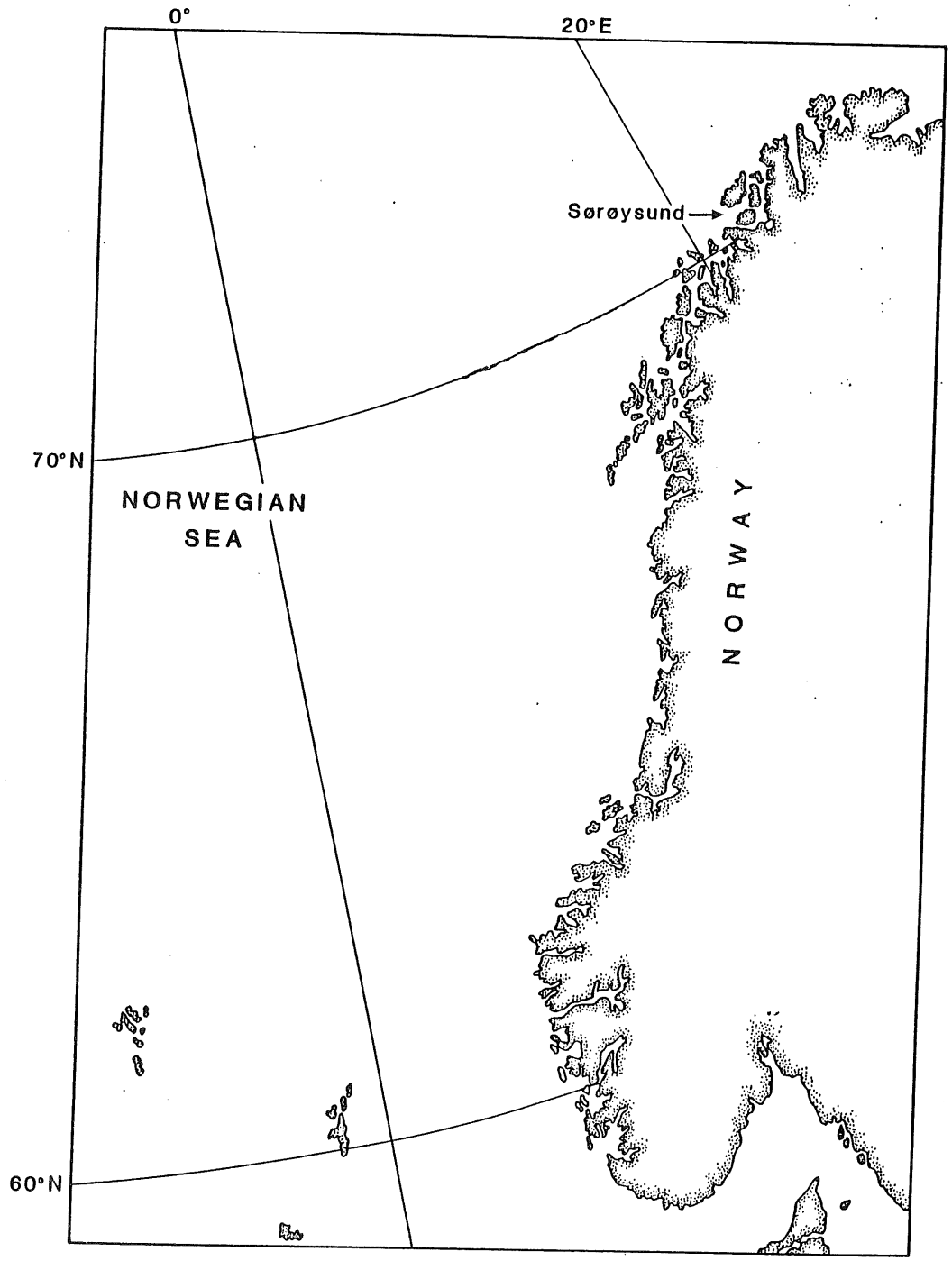

Fig. 1. The localisation of the halibut spawning area in Sørøysund, North Norway.

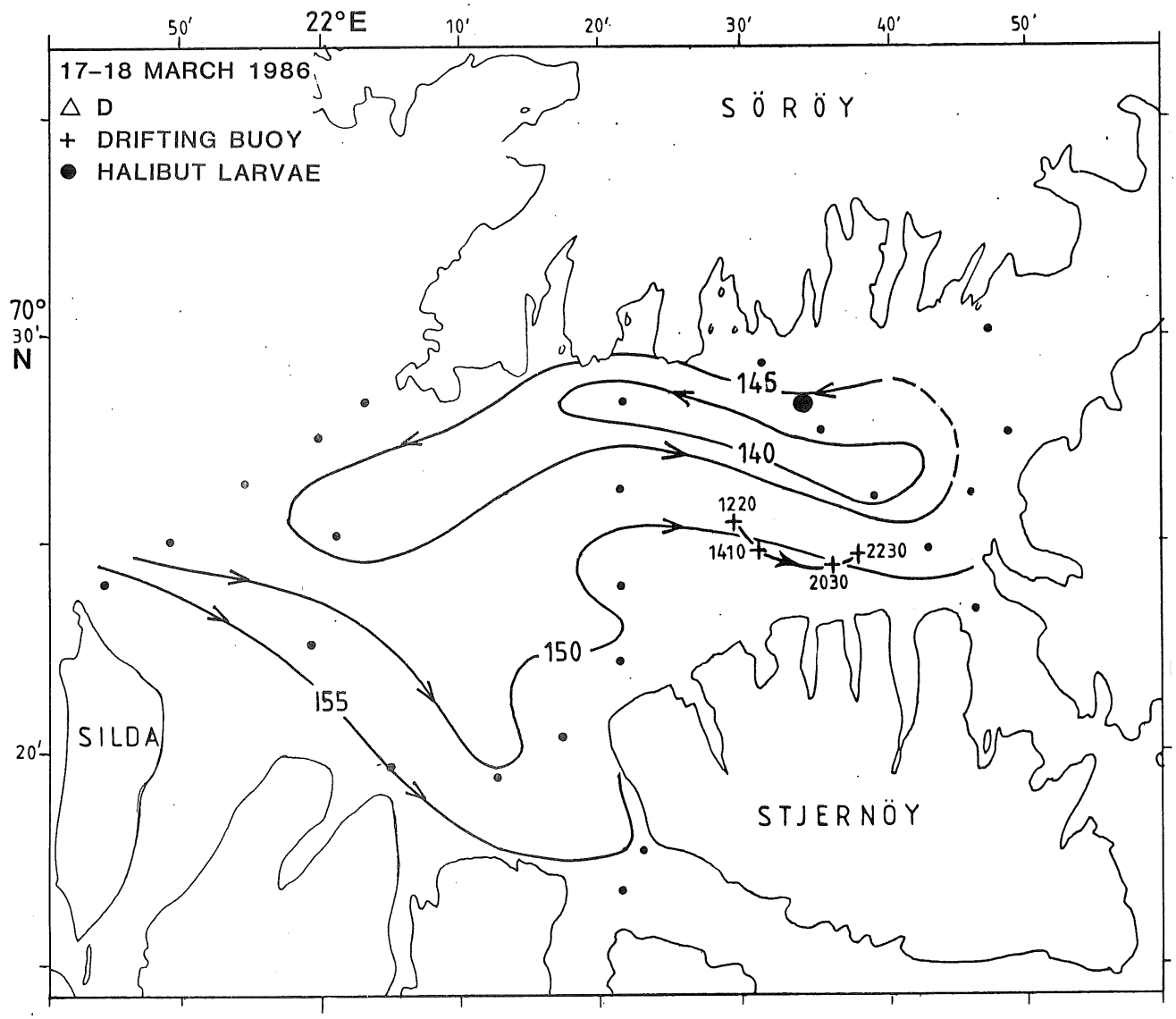

Fig. 2. Dynamic topography (ΔD, at the surface relative to the 200 m depth) for Sørøysundet 17-18 March 1986. The trajectory of a drifting buoy, drogued at 80 m, is plotted.

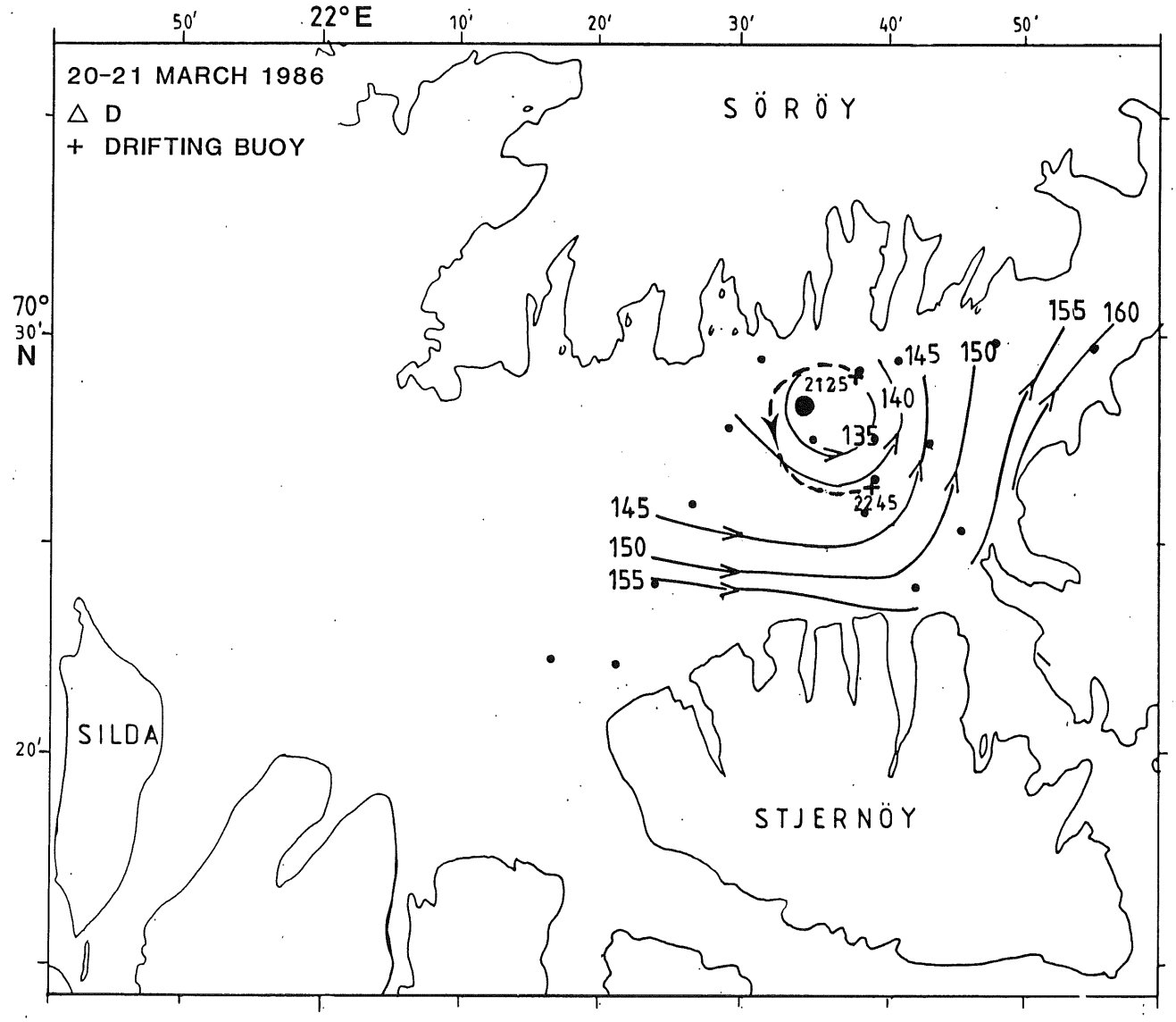

Fig. 3. Dynamic topography (ΔD, at the surface relative to the 200 m depth) for Sørøysundet 20 March 1986. The expected trajectory of a drifting buoy, drogued at 60 m, is shown (se text).

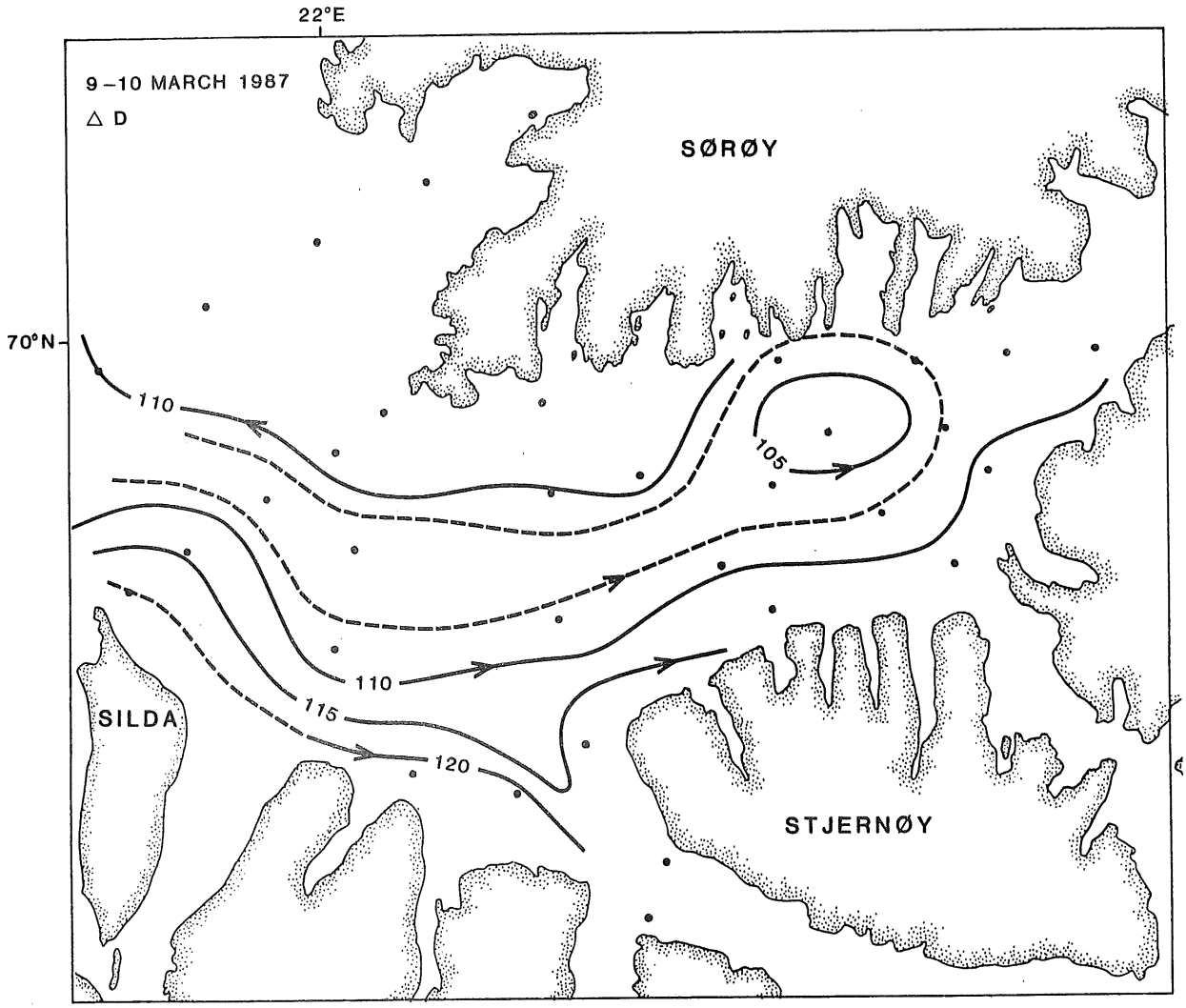

Fig. 4. Dynamic topography (ΔD, at the surface relative to the 150 m depth) for Sørøysundet 9-10 March 1987.

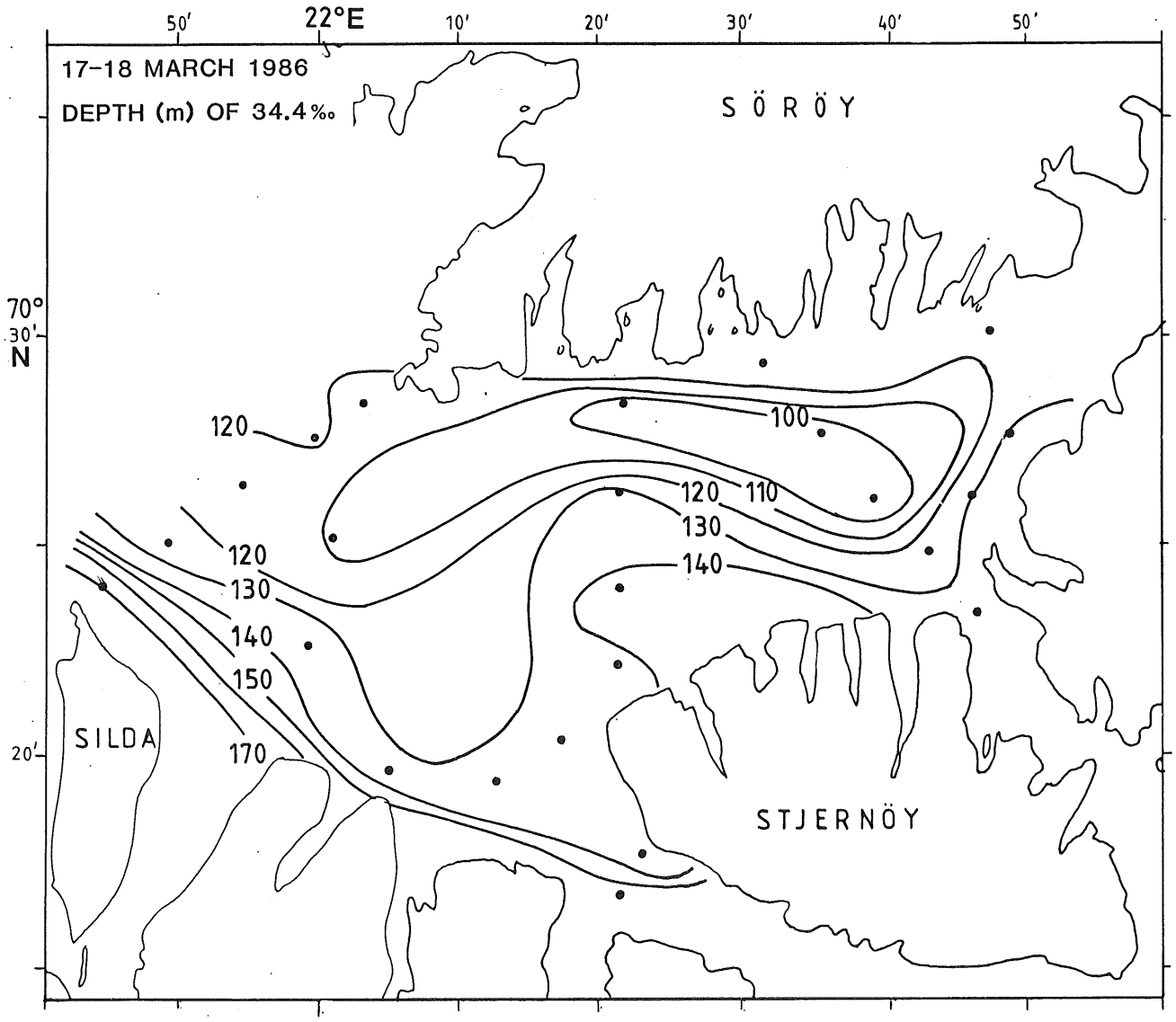

Fig. 5. Depths of the 34.4 o/oo isohalines in Sørøysundet 17-18 March 1986.

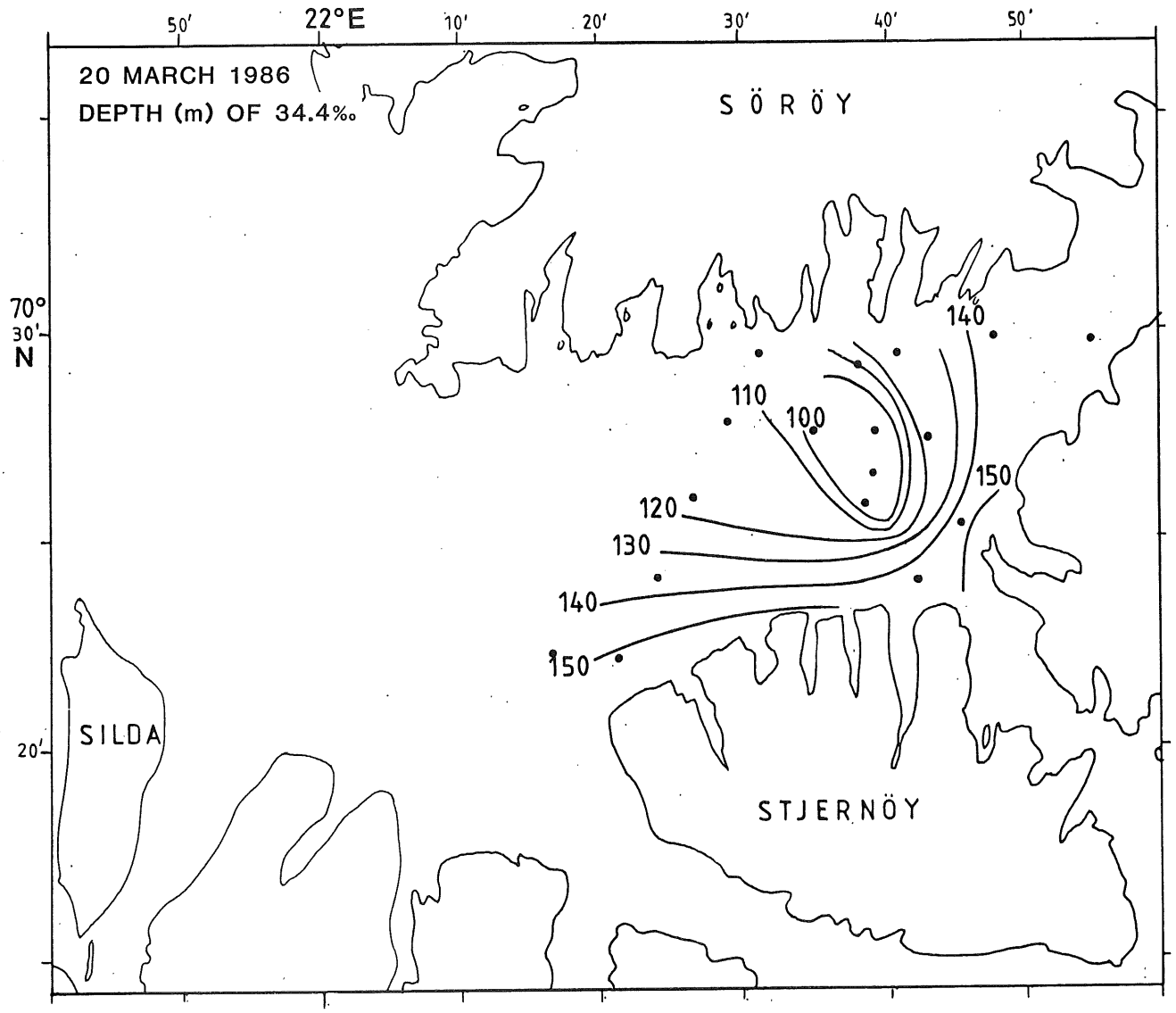

Fig. 6. Depths of the 34.4 o/oo isohalines in Sørøysundet 20 March 1986.

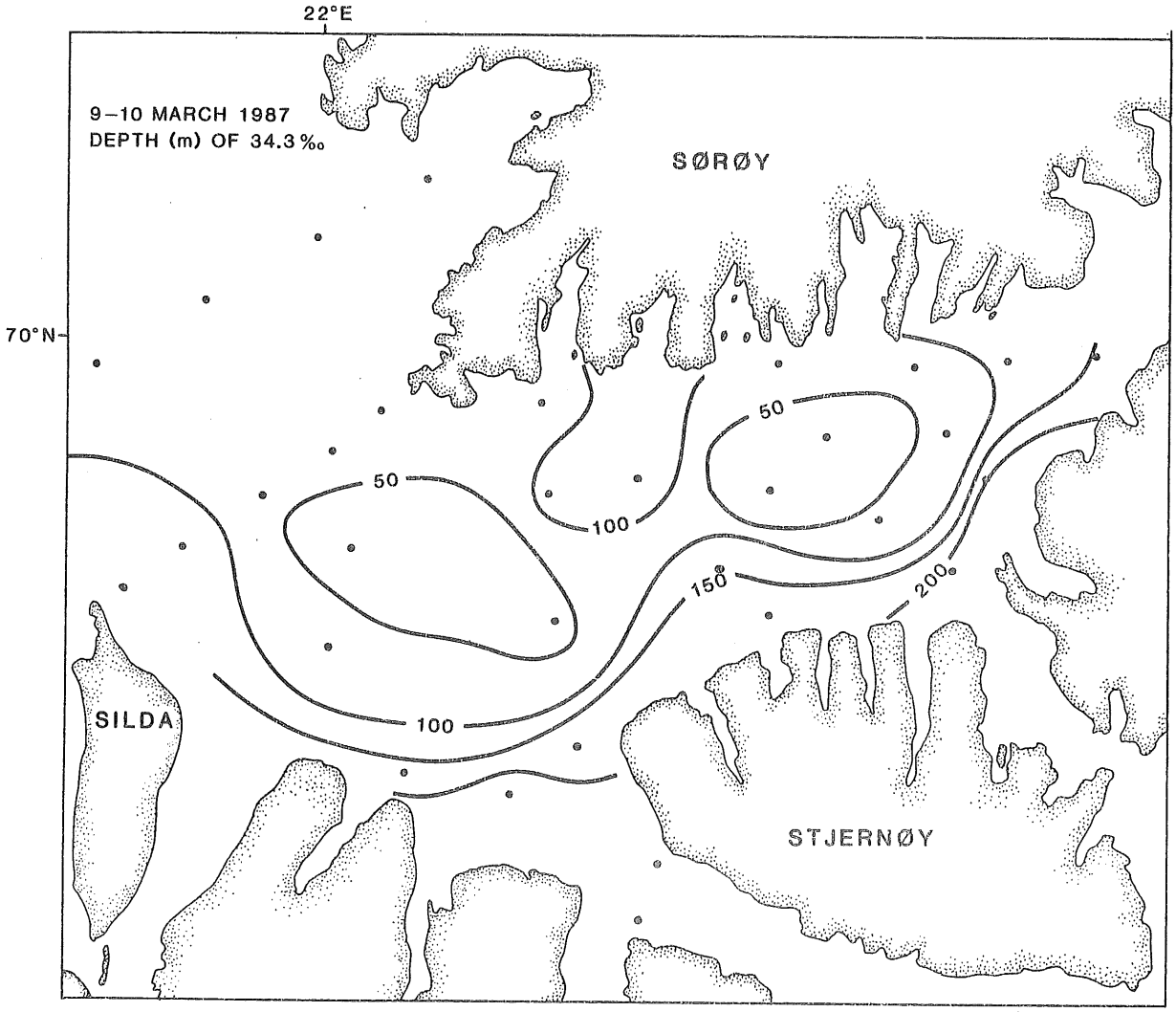

Fig. 7. Depths of the 34.3 o/oo isohalines in Sørøysundet 9-10 March 1987.

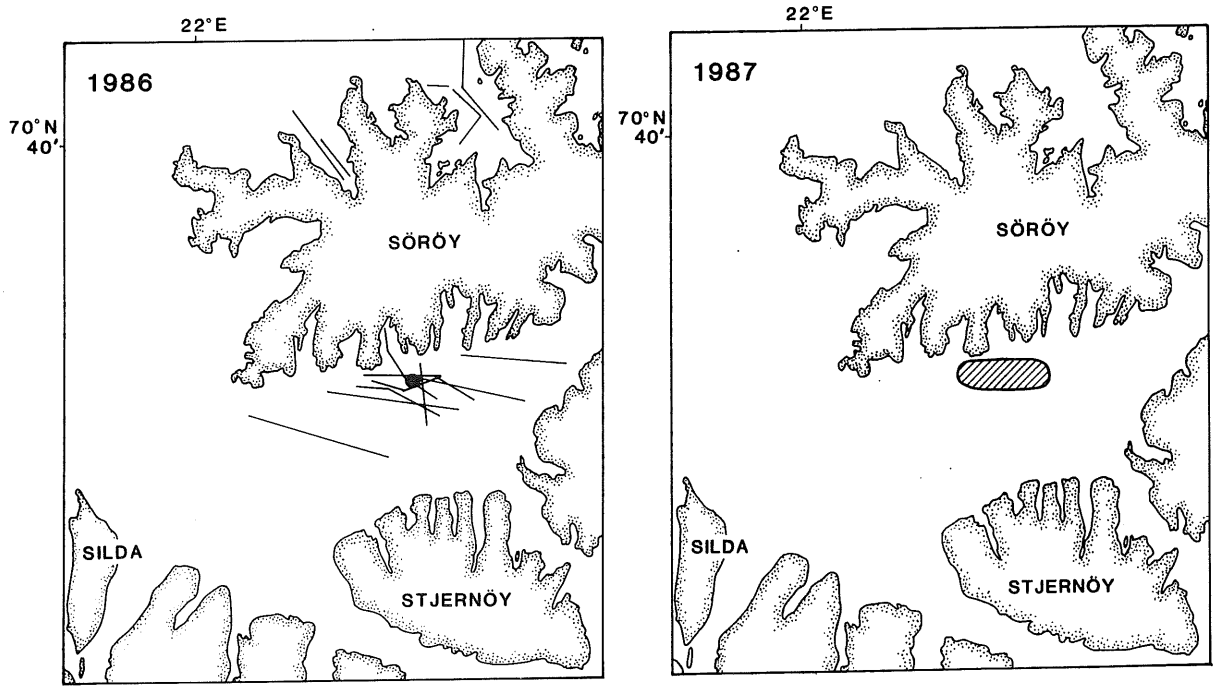

Fig. 8. MOCNESS hauls performed in March 1986 in Galtefjord, Ofjord and Sørøysundet (left), and the localisation of the March 1987 area of ichthyoplankton trawling in Sørøysundet (hatched area in right map). The latter area was also the area of zooplankton sampling in March 1987.

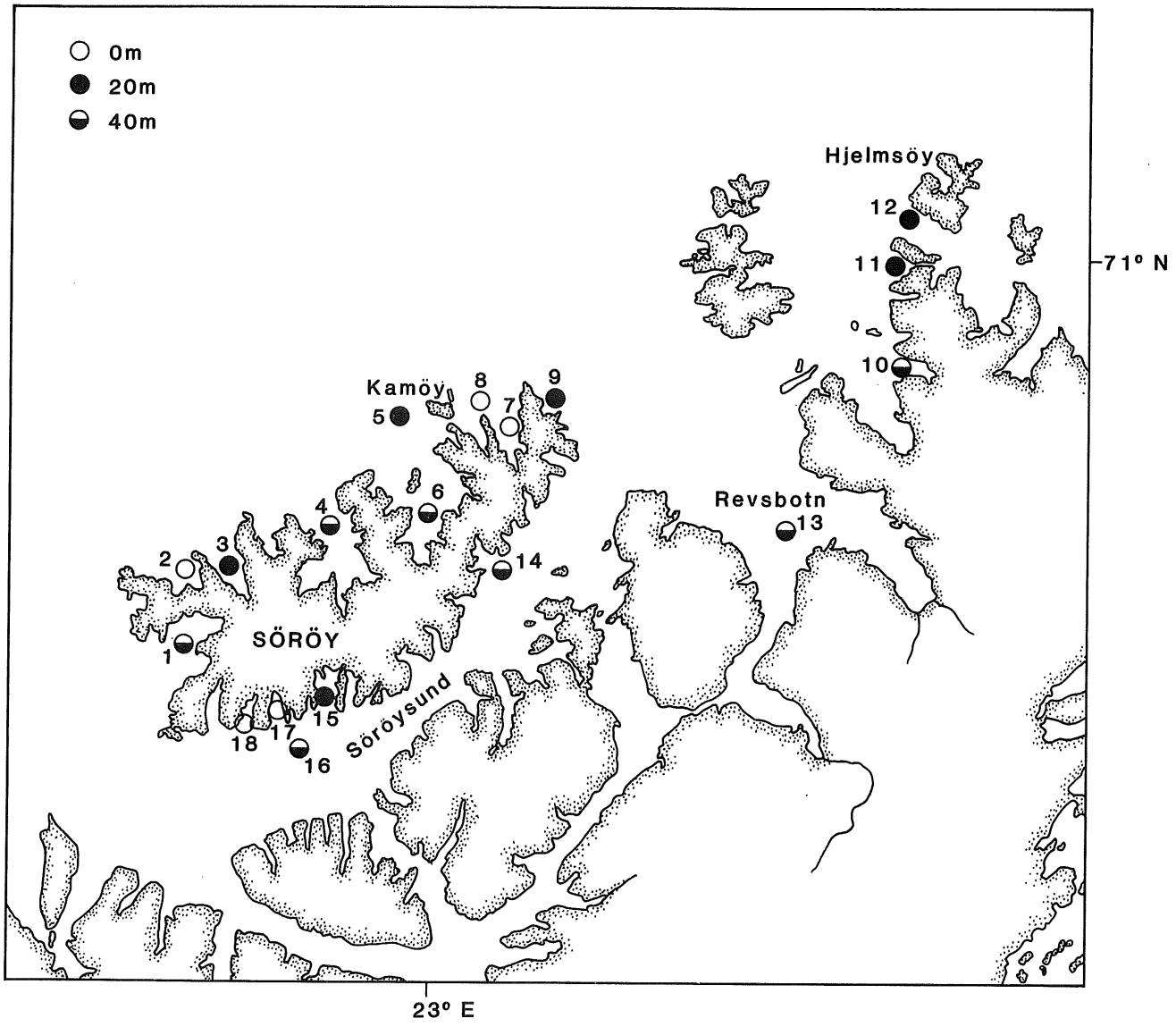

Fig. 9. Areas where pelagic trawling was carried out in various depths in May 1987. The map references are: 1.Breivikfjord; 2.Sandfjord; 3.Ofjord; 4.Galtefjord; 5.West of Kamøy; 6.Sandøyfjord; 7.Gamvikfjord; 8.East of Kamøy; 9.East of Tarhalsen; 10.Bakfjord; 11.Havøysund; 12. Breisund; 13.Revsbotn; 14.Sørøysund north; 15.Øyfjord; 16.Sørøysund south; 17.Kipperfjord; 18.Maltefjord. In Sørøysundet south (ref. 16) also one haul was carried out at 100 m depth.

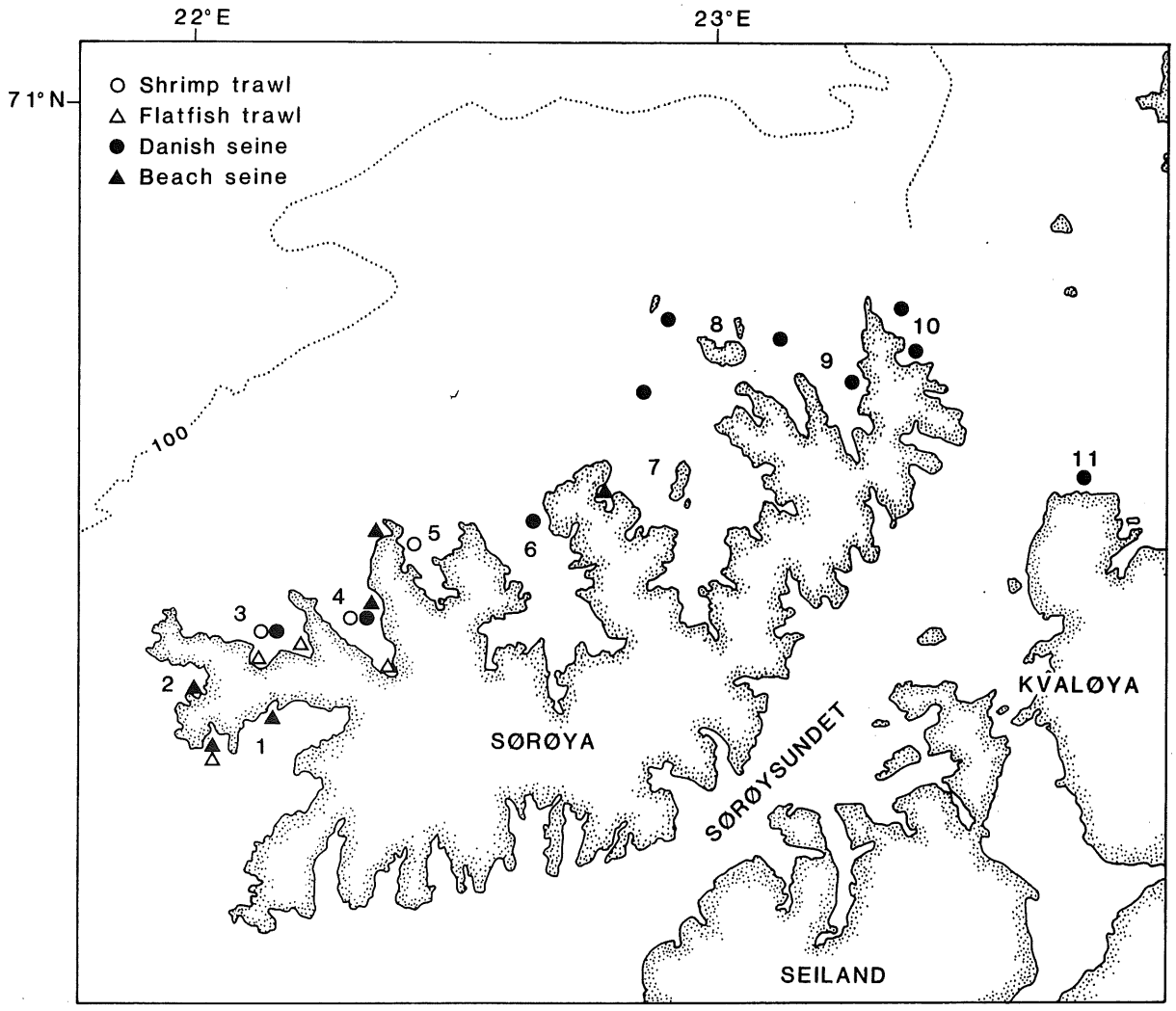

Fig. 10. Areas surveyed with various bottom gear in 1985-1987 in the Sørøya area. Map references are: 1.Breivikfjord; 2.Sørvær; 3.Sandfjord; 4.Ofjord; 5.Bølefjord; 6.Galtefjord; 7.Sandøyfjord; 8.Kamøy; 9.Gamvikfjord; 10.Tarhalsen; 11.Mylingen.

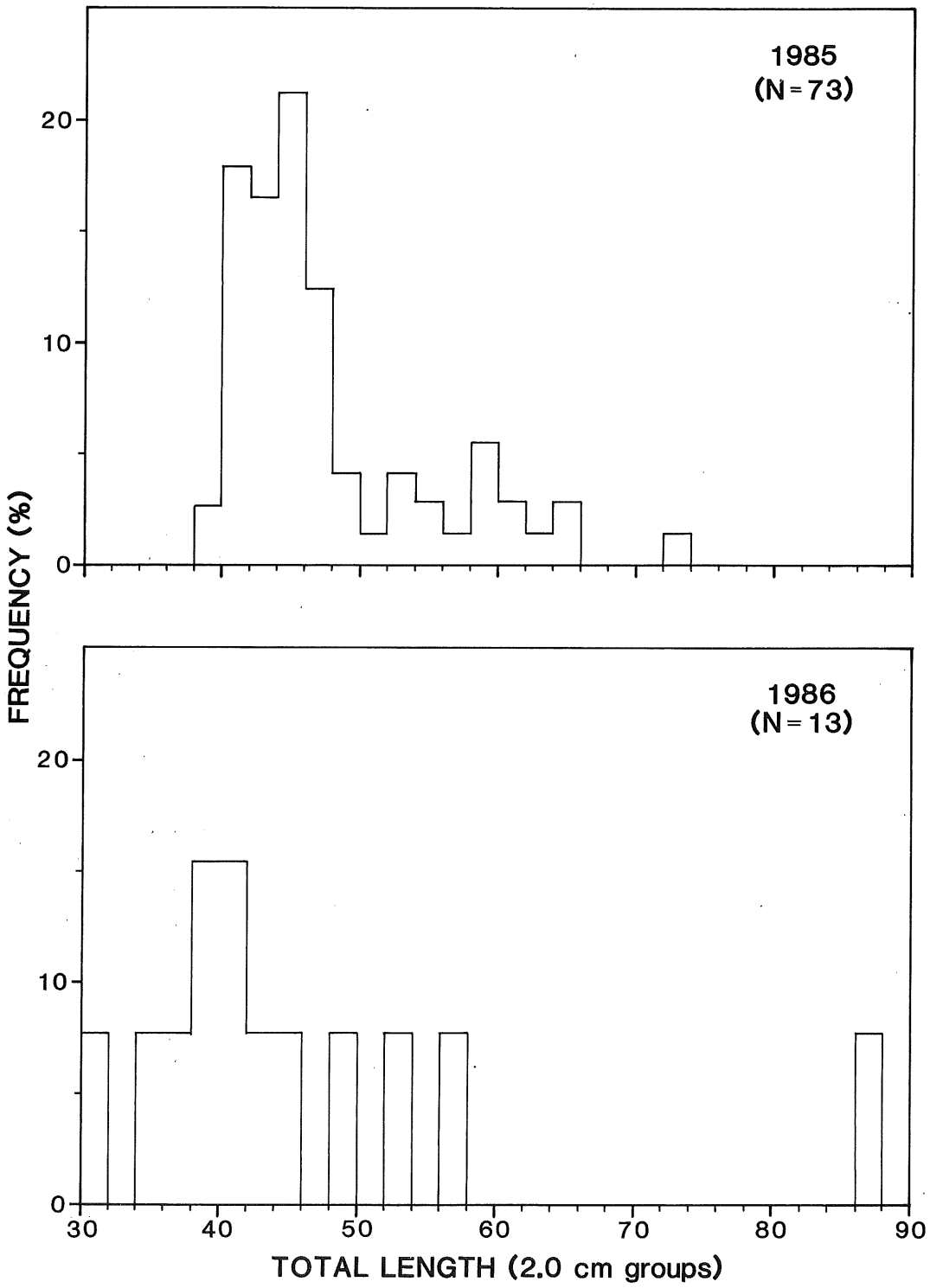

Fig. 11. Length distribution of immature halibut caught north of Sørøya in September 1985 and July 1986.

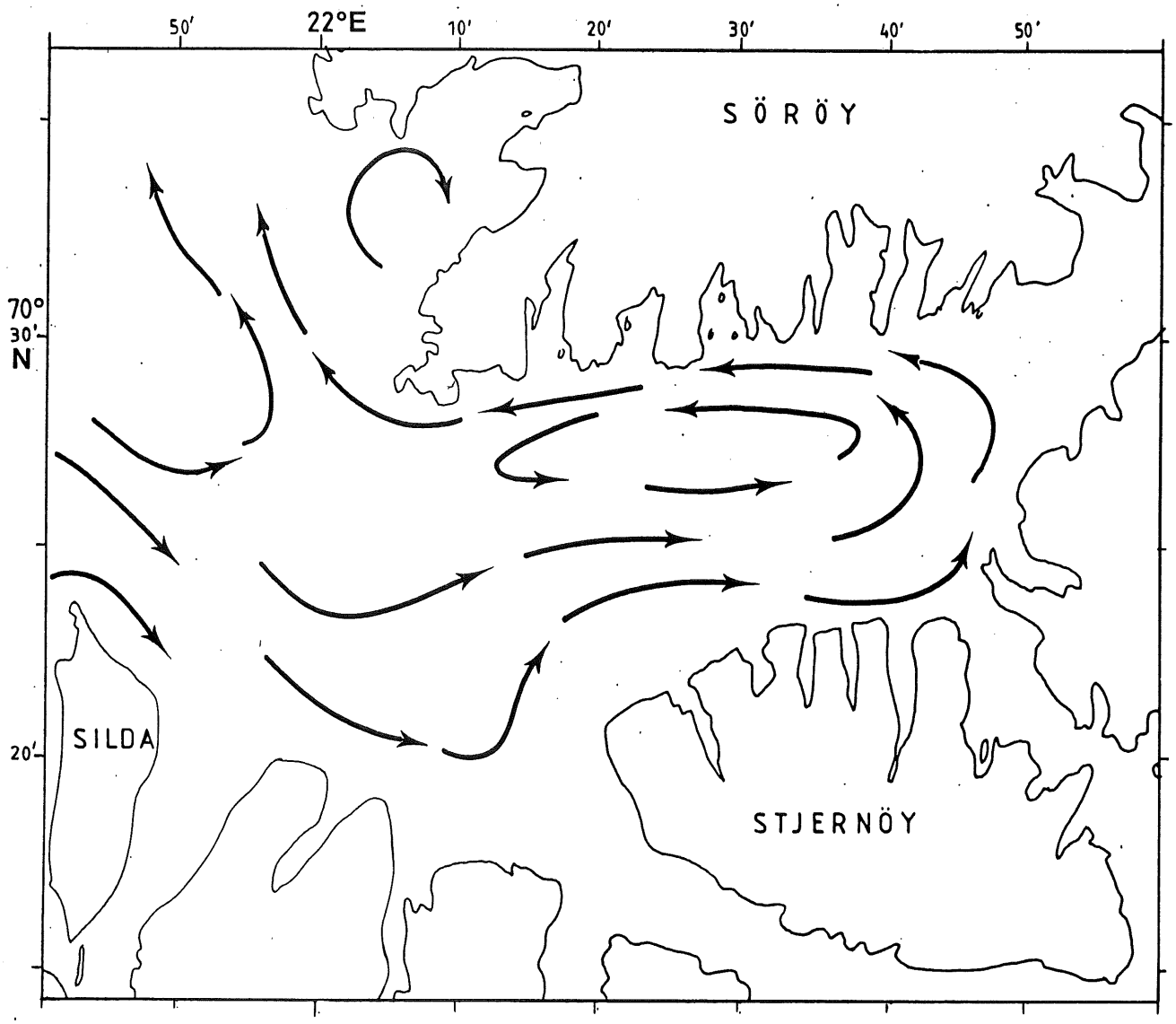

Fig. 12. The circulation system in Sørøysundet as interpreted from the present hydrographical data.