International Council for the Exploration of the Sea

CM 1996/M: 12
ANACAT *Fish Committee*

Sampling Atlantic salmon in the NE Atlantic during summer: methods of capture and distribution of catches

by

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Abstract

In July/ August 1991 the Institute of Marine Research (IMR, Norway) performed a pairtrawling (two boat trawl) experiment with a surface trawl to catch young herring in the northern Norwegian Sea. 34 postsmolts and two 1- sea-winter salmon were caught as bycatch. This was the first time that postsmolts were recorded in larger numbers during fishery in open sea in the North East Atlantic, although the area is beleived to be the one of the main feeding areas for salmon during summer. A (one boat) pelagic research trawl has been developed by IMR for scientific surveys of the pelagic fish stocks. This trawl, an Åkra trawl, can be rigged both for mid water and surface trawling (0- ~ 25 m), and is currently in use on all pelagic research cruises. In 1993 a study was made to test whether the new trawl would catch salmon. This study proved successful, and consequently, Atlantic salmon was included in a large scale ecology study in the Norwegian Sea, the so called "Mare Cognitum Programme" (MCP). In 1995, the first year of salmon surveys in the MCP framework, in addition to the trawl surveys, otter- board salmon trolling and salmon drift line fishery with an experimental line with 200 hooks were developed and tested from the R/V "Johan Hjort". A total of 157 postsmolts and nine 1-sea-winter salmon have been caught in surface hauls since 1991. The fish have been caught in an area stretching from west of Scotland and the Hebrides up to 75°N and 18°E. The samplings have been performed from June to mid August.

Introduction

In the natural distribution area of Atlantic salmon, the smolts leave their respective home rivers during April-July, and the farther north, the later seasonal smolt migration. When entering the sea, the movement of postsmolts seems to be highly dependent on speed and direction of surface currents (Holm *et al.* 1982; Hvidsten *et al.* 1994). However, inshore, the postsmolts also have periods of active and directed movement. There is some information available of Atlantic salmon the first weeks after they have left freshwater (Holm *et al.* 1982; LaBar *et al.* 1978; Jonsson *et al.* 1993; Levings *et al.* 1994; Sturlaugsson and Thorison 1995 ; Hvidsten *et al.* 1995), but information about the postsmolts after they have entered the open ocean is very sparse (Reddin and Short 1988; Holst *et al.* 1993). Environmental conditions in the ocean is believed to play an important role for the dispersion and survival of the salmon in the sea (Friedland *et al.* 1993) Based on information on where the salmon longline and driftnet fishery in the high seas was performed, there has been a general thought that the Norwegian Sea is an important feeding area for the salmon. This has been confirmed by data from the sampling programme for microtags in the commercial salmon catches undertaken at the Faroes (e.g. Anon. 1990 - 95) and a scientific salmon fishery (tagging and release) project performed in the Faroese EEZ (cf. Jacobsen and Hansen 1995). This fishery is performed during November - April, thus there is little knowledge of where the salmon stay during summer.

In pelagical research cruises conducted by the Institute of Marine Research (IMR), Norway, in the north-east Atlantic and the western Barents Sea, small numbers of Atlantic salmon postsmolts and larger salmon have occasionally been caught in the trawl. However, in an experiment for studying herring in 1991 a two boat surface trawl (pair trawl) was used in the northern Norwegian Sea. Postsmolts were caught as a by-catch (Holst *et al.* 1992). This was the first substantial catch of postsmolts in these areas, and it initiated trials in 1993 to collect salmon postsmolts in the ocean from the IMR research vessels which were doing regular surveys in the Norwegian Sea and adjacent areas. From 1995 onwards salmon surveys have been included in the research cruises, as a part of a large scale ecologial research programme, the Mare Cognitum Programme (**MCP**) initiated by the Institute of Marine Research. These investigations are based on trawl sampling, but in 1995 we also made attempts to catch salmon with other gear.

In this paper we describe different methods used to catch salmon in the open ocean, and discuss our experience with them. The salmon fishing methods have been specially developed to enable use in combination with the regular hydrographical and plancton and fish sampling carried out by the IMR research vessels.
Furthermore, we present data on distribution of postsmolts in the catches and give the first tentative estimates of catch per unit effort for the area and comment other fishing activities as observed during a cruise in 1995.

Fishing methods

Pelagic trawling

The salmon sampling was carried out within the framework of the surveys on pelagic fish stocks and zooplancton included in the MCP in the Norwegian Sea and adjacent areas. A surface trawl that can be operated from one vessel was used in the 1993 and the 1995 surveys. This trawl was developed at the IMR in 1992 (Valdemarsen and Misund 1995) and consists of four identical panels of black nylon netting with a mesh size ranging from 3200 mm in the front to 20 mm in the cod end. The trawl can be used either in midwater or in surface mode.

When used for surface trawling, a 12 m extension is linked to the upper bridles and two large buoys (each 675 kg buoyancy) are attached to each of the upper wings. With 7 m^2 trawl doors and ~ 3.5 knots towing speed, the vertical opening is ~ 30 m and the horizontal spread is ~ 75 m. At the same speed and a warp length of ~ 350 m the trawl is well outside the propeller wake (Valdemarsen and Misund 1995). The Åkra trawl is now in standard use on the IMR pelagic fish surveys (Figure 1.).

Salmon long-line
An experimental floating longline consisting of 200 hooks (a short version of the commecial Faroese salmon lines) baited with half-thawed fresh-frozen sprat, was tested twice during a cruise in July 1995. The distance between the hooks was 10 m and they were hanging at aproximately 5 m depth. The aim was to test whether such longlines could be operated from the large research vessel Johan Hjort (Figure 2.) which has not been fitted for linefishing earlier.

Otter-board trolling
Because conventional salmon otter-boards proved to be too fragile for use in open sea, a new experimental otter-board trolling method was developed for use at R/V "Johan Hjort". The dimensions of the otter- board used were: 2 parallell boards of 2.5 x 0.37 m with a distance of 0.43 m between them. On top of each board a 3" PEH tube with both ends sealed was mounted in full 2.5 m length to give floatation. Additional stability and uplift was obtained by attaching four trawl floats (Ø= 17.5 cm), one in front and one at the rear end of each board of the otter.

The otter-board was attached to a rope and floated a distance of 40 - 50 from the starboard side of the ship.Two lines with 3 hooks each were attched to this head rope and towed during plancton trawling with the MOCNES sampler or during trawling as shown in Figure 3. Fresh-frozen sprat and/or a variety of commercial salmon lures were attached to the hooks. Weights of 1.2 and 1.5 kg were attached to the end of each line in order to keep it at suitable fishing depth. The towing speed was 3.5 -4 knots for pelagic trawling and 1.5 - 2 knots for the plancton sampler.

Materials
In 1991 the cruise was mainly aimed at sampling young herring, and lasted between 23 July and 27 August, and the area covered was delinetaed by 66° and 74°N and 6°W an 23°E. In total 75 hauls were performed. The duration of the hauls is presented in Table 1. In 1993 the cruise lasted from 25 July to 15 August, and the area covered was delineated by 66° and 73°N and 7°W and 17°E. A total of 61 hauls were performed. From 30 May to 1 July 1995, during a cruise aimed at surveying mackerel west of Scotland and the Hebrides (delineated by 50° N and 62° and 11° W and 2°E) postsmolts were caught as bycatch. In total 47 surface hauls were performed. During a MCP cruise from 7 July to 1 August the cruise area covered was within 62° and 72°N and 16°E and 7°W, and a total of 60 surface hauls were carried out. At the last 1995 cruise (30 July to 14 August) the area covered was delineated by 64° and 74°N and 8° W and 19°E, and 50 surface hauls were performed.

Table 1. Data from surface trawl sampling in the north east Atlantic 1991, 1993 and 1995.

Year	Time of sampling	Type of trawl	Towing time per	Total no of

	(date to date)		haul (min)	hauls
1991	23 July / 27August	Pair trawl	45	75
1993	25 July / 15August	Åkra trawl	30	61
1995a	30May / 1 July	"	30	47
1995b	7 July / 1 August	"	30	60
1995c	30 July / 14 August	"	30	50

The otter-board trolling was performed mainly in the area between 63 and 68°N and 10°W to 8°E. Close to 25 hours of tests were made during MOCNES plancton sampling, pelagic mid-water and occasionally also during surface trawling. One special test was made with depth and temperature recording data-storage fish tags (Star Oddi, Reykjavik, Iceland) attached close to the hook. The aim of this test was to get an impression of the fishing depth of the hooks at different towing speeds.

There was limited time for line fishing, and the longline could only be set twice. Both times it was standing for about three hours, and was set in areas where drift net fishing for salmon was frequent before this fisherey was closed in 1989.

Results

Technically the applied fishing methods served their purpose well even on the relatively large vessel «Johan Hjort». The line was easily set in around one hour from the trawl port and was hauled manually from the starboard side in two hours. The otter-board was convenient in use in conjunction with the other samplings carried out during the cruise. The recordings made by the data storage tags showed that with towing speed of 3.7 knots (mid-water trawling) the hooks were towed at 2.5 - 6 m depth and between 6 -10 m when the speed was 1.7 knots (MOCNES sampler). However, we did not catch salmon on neither the longline nor the otter-board troller.

Postsmolts of Atlantic salmon were caught with surface trawl at all cruises, but in variable numbers (Table 2). All postsmolts were caught by surface trawling. They were more abundant, and occured more frequently in the trawl hauls in the areas surveyed in 1991, and in June and July 1995. In total we have caught 157 postsmolts and 9 1-SW salmon in 293 hauls since 1991.

Table 2. Catch of salmon postsmolts and 1-SW fish in surface trawl hauls in the North East Atlantic 1991, 1993 and 1995.

Year	No of postsmolts caught	No of 1SW salmon caught	Total no of hauls	% surface hauls containing salmon
1991	34	2	75	24
1993	13	1	61	3
1995a	46	2	47	19
1995b	62	4	60	32
1995c	2	0	50	4
Total	**157**	**9**	**293**	-

A total of five postmolts with adipose finclips were recorded in the catch in 1995. Of these two were caught west of the Hebrides and three in the northern part of the area surveyed. One

of these fish was microtagged and released in the river Test, south England, in April. This smolt was recaptured close to 71° N and 2°30' E.

The distribution of postsmolts caught at the different cruises in the different zones is shown in Figures 4, 5 and 6, and the respective CPUE values (number of postsmolts caught per trawling hour) are presented in Table 3. The cruises have been made at slightly different time periods, and covering slightly different areas, but a highdensity area of postsmolts seems to occur between 65° and 74°N, and 1°W and 13°E .

Table 3. Catch per unit effort (CPUE) (number of postsmolts caught per trawling hour) in Norwegian and British EEZ and in international waters in the Norwegian Sea

Year	British EEZ area I	Norwegian EEZ, Mainland area II	Norwegian EEZ, Jan Mayen area III	Spitsbergen Comission area IV	International waters, Norwegian Sea V	Total area
1991	--	0.46	1.50	0.67	0.55	0.60
1993	--	0.00	0.50	--	2.17	0.43
1995	1.96	2.06	0.00	0.00	2.78	1.40

Discussion

Our results indicate that, during summer, Atlantic salmon postsmolts are distributed in large areas in the North East Atlantic. The total number of postsmolts caught was small, but they were observed in trawl catches from west of Scotland to 72° N in 1995, and even further north in 1991.

There are some evidence, based on smolt age distribution, that a relatively large proportion of the postsmolts caught in the Norwegian sea in 1995 originates from more southern areas of Europe. The microtagged English smolt found far north is supporting this observation (c.f. Holst et al. 1996). When smolts move from freshwater into the sea their movements seem at least partly to be dependent on the surface currents (Holm et al. 1982; Hvidsten et al. 1994). Their occurence in the Norwegian sea could thus be explained by displacement by ocean currents. On the other hand, there may also be active components in migration of postsmolts in the ocean as has been observed in the coastal areas (Holm et al 1982, 1984 and 1996 unpublished and Sturlaugsson 1995).

Although the CPUE values seem to indicate that postsmolts were more abundant in 1995 than in previous years it must both be noted that these figures are based on small samples, and that large areas in the Norwegian sea are still uncovered by surface trawling. In addition, since data collection in these areas has not been possible during the whole spring and summer season, the CPUE figures must be regarded as tentative values only serving as a basis for further work when the time series have become longer. The value of these observations for the management will also grow as the time series grow.

There may be several reasons why long-lines and trolling did not catch salmon. First, long-lines are used in the commercial salmon fishery at Faroes, and they are baited with fresh sprat

which will be a too large prey for postsmolts. This fishery takes place in late autumn and winter, and exploits mainly salmon in their second sea-year. In the present study we used sprat and lures of about the same size at the bait used at Faroes, which will undoubtedly select for larger fish than postsmolt salmon. The catch of other fish species like spiny dog-fish, lumpsucker and mackerel confirmed that the bait and lures were attractive for fish, and the lack of salmon in the catches could be due to small numbers of larger salmon in the fished areas.
According to information provided by some fishermen that used to do driftnetting for salmon in the area where line was set, the best season was from mid- June to around the first week of July, while we were fishing on the 17 -18 of July when the maturing fish probably already had left the area.

Another explanation may be that there was sufficient natural food available for salmon in the fished areas at the time, so the fish would not actively take the bait.

The use of surface trawls of the type described by Valdemarsen and Misund (1995) seems efficient to sample postsmolts, and will advance our knowledge of this phase of the salmon biology. Because this trawl does not seem to catch larger salmon in sufficient number to allow for scientific treatment of the data, other methods e.g. lines and driftnets should be further explored as means to uncover also this stage in the marine life of the salmon.

During the cruise in July 1995 (Fig. 6.) a fishing fleet was observed trawling in international waters just outside the Norwegian EEZ at about 66°N. According to information provided by the Norwegian Coast Guard in 1995, there is an international fishery for mackerel in the international zone betweeen Iceland and Norway which can consist of up to 30 vessels. The catch by this fleet is estimated to 20 - 50.000 mt of mackerel annually (*Anon.* 1995b). These ships are fishing mainly with surface trawls, but no information about the fishing efforts are available. This fishery, and possibly also other fisheries, occur in areas where postsmolts are abundant. Due to increased abundance of herring in recent years, it is reasonable to assume that the effort in these fisheries will increase. The effects for salmon is unknown, but the issue should be examined more closely, as this may increase mortality of salmon at sea.

Acknowledgements
We greatly appreciate the enthusiasm and innovative spirit of Mr. Gunnar Bakke, IMR, and the "B- crew " on board the R/V "Johan Hjort" both during the development of the fishing gear and the test fishing.

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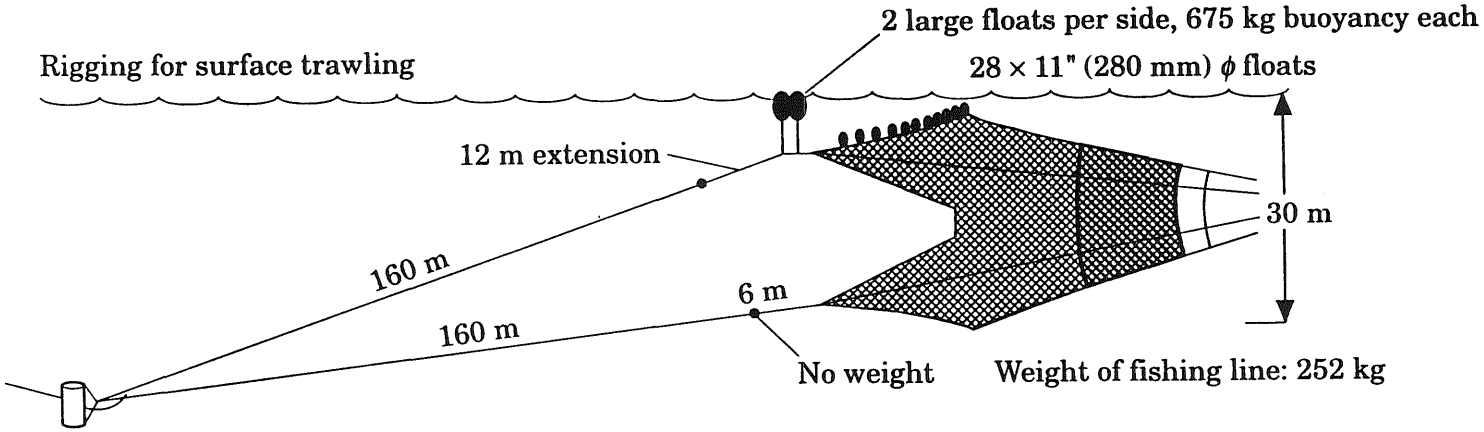

Fig. 1. Rigging of the Åkra trawl for near- surface sampling (Valdemarsen and Misund 1995). On the R/V Johan Hjort in 1995 the trawl was operated with Tybo Røn multipurpose trawl doors and by slightly turning or «zig- zagging» the vessel to keep the trawl out of the propeller wake.

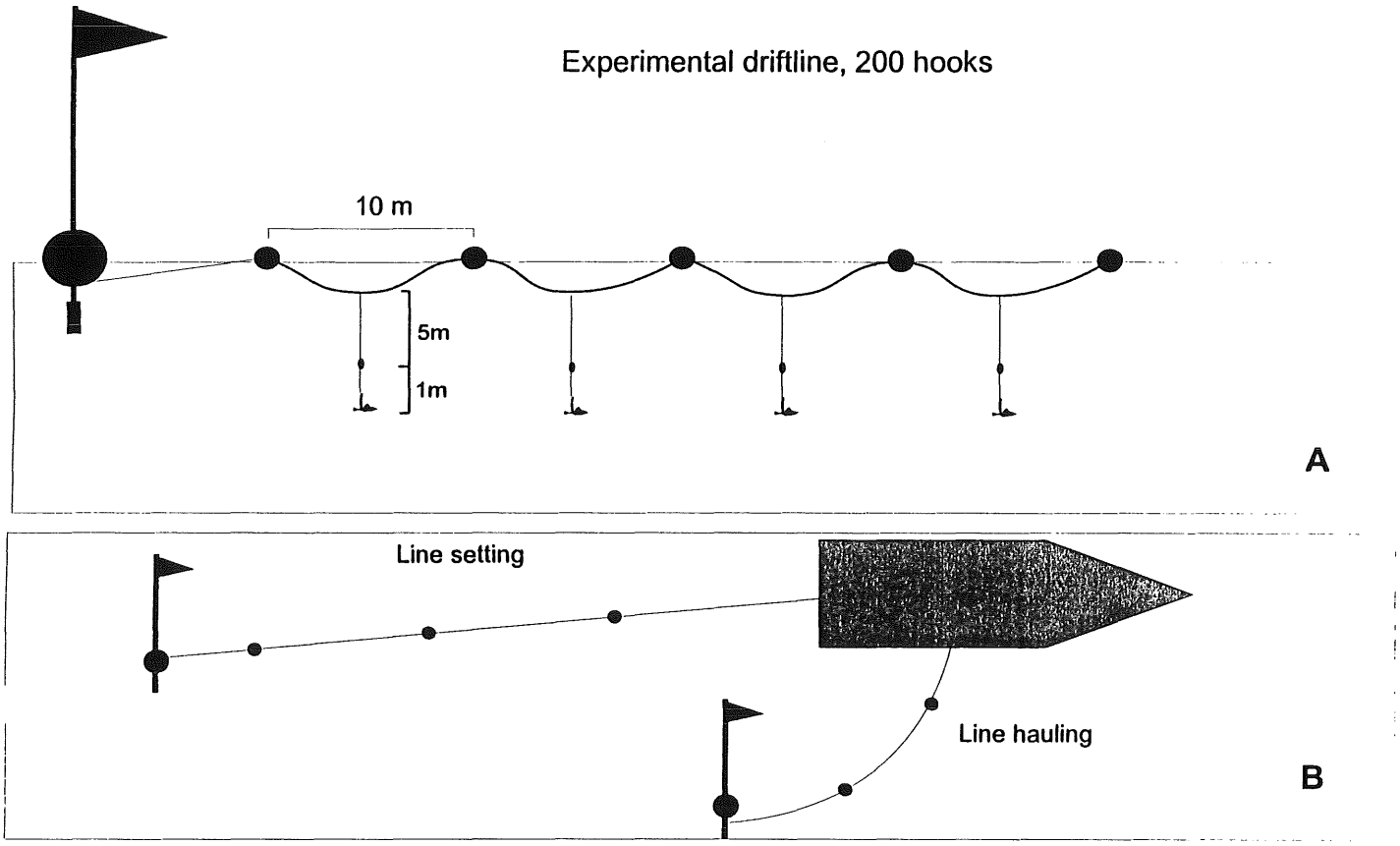

Fig. 2. A) Salmon drift line Faroese model, R/V Johan Hjort, July 1995
B) Line setting from trawl port, Hauling from starboard side

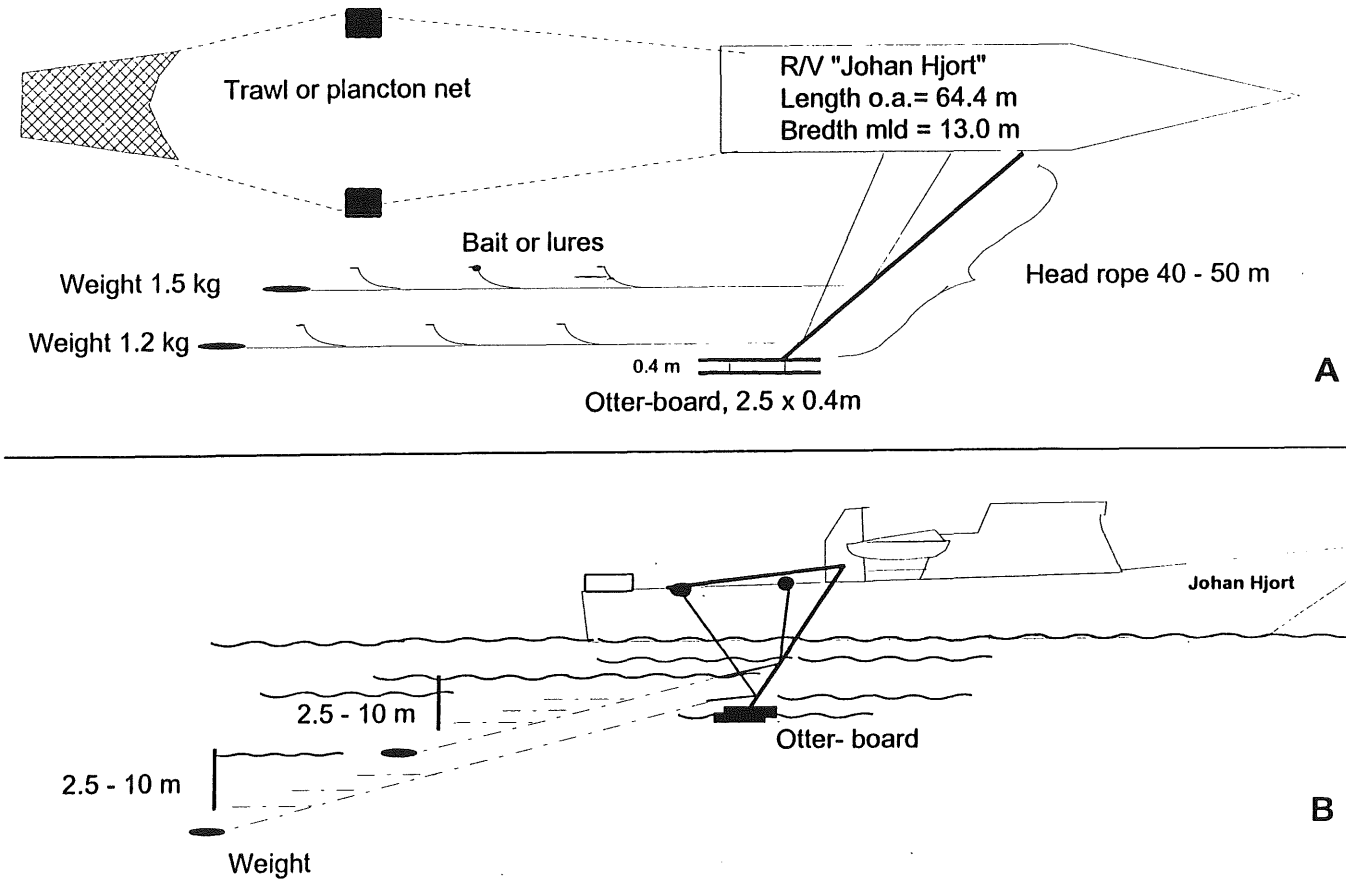

Fig.3. Otter- board trolling for salmon from the R/V Johan Hjort. A) Viewed from above; B) Side view

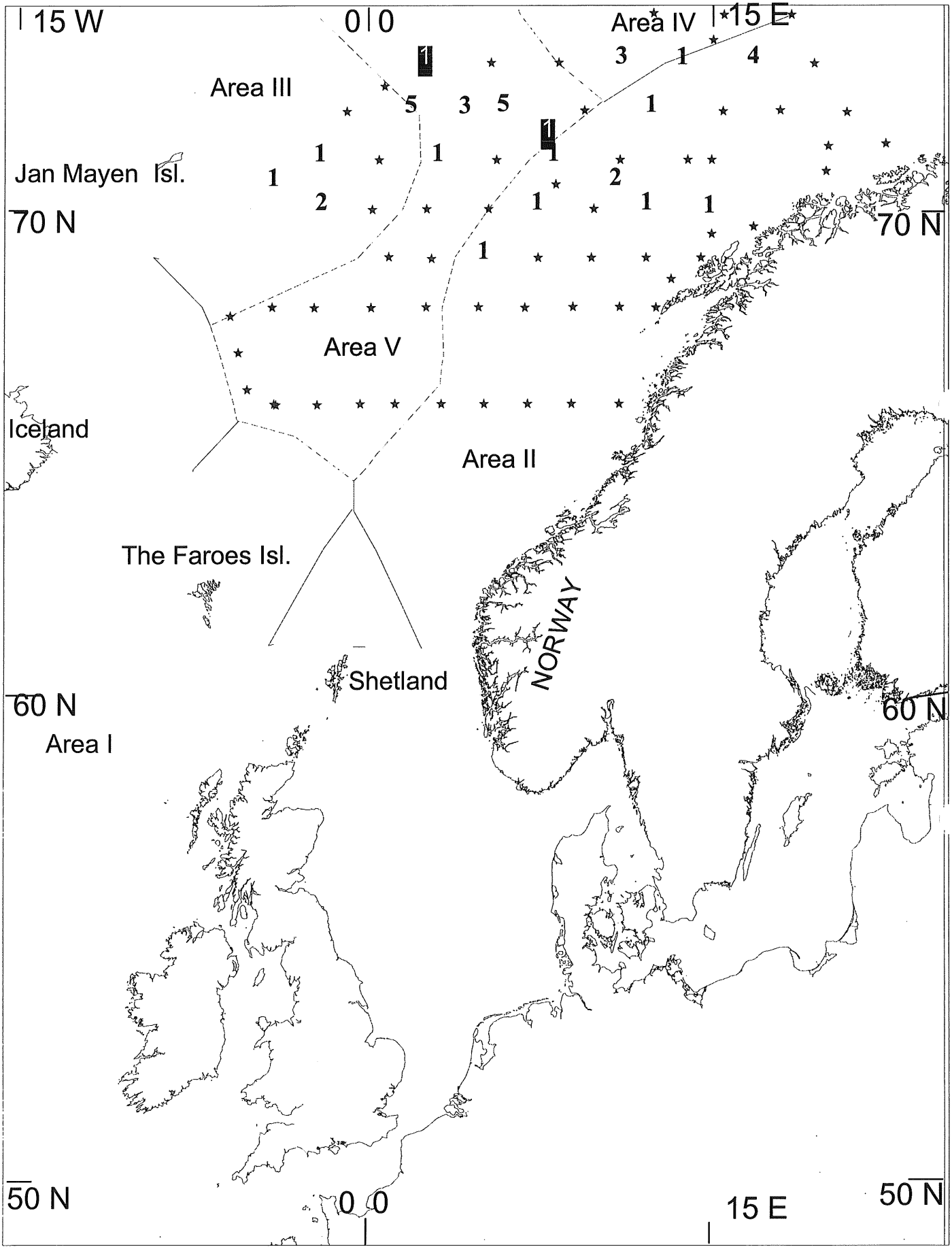

Fig.4. Pairtrawl catches in the Norwegian Sea in 1991. Surface hauls without salmon shown as stars. Postsmolt catches shown in black numbers, while 1-SW salmon are shown as white on black. Hyphenated line delineates international waters. Area codes refer to Table 3.

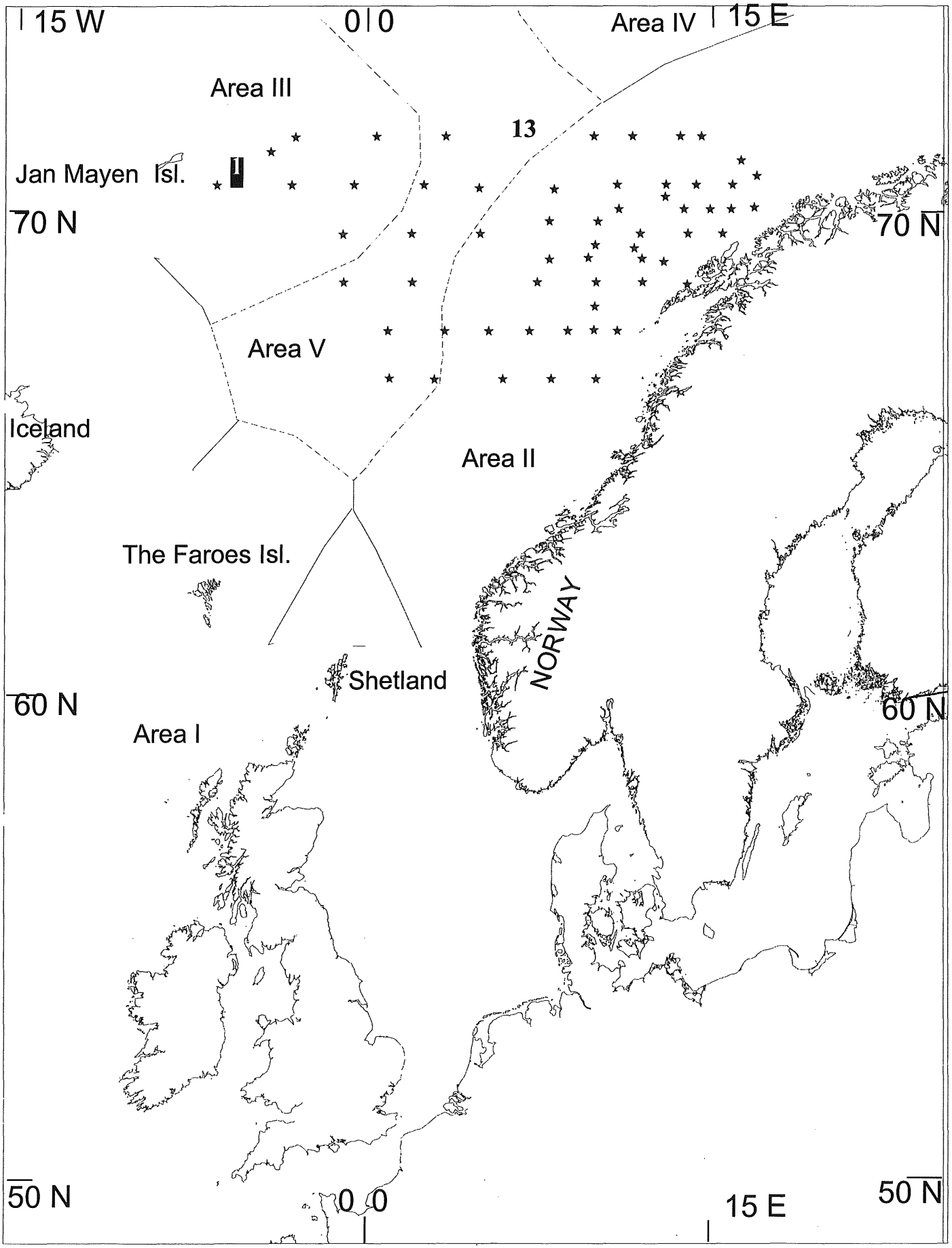

Fig. 5. Numbers of postsmolts and 1-SW salmon in surface trawl hauls (one boat trawl) in 1993. Legends as in Fig. 4.

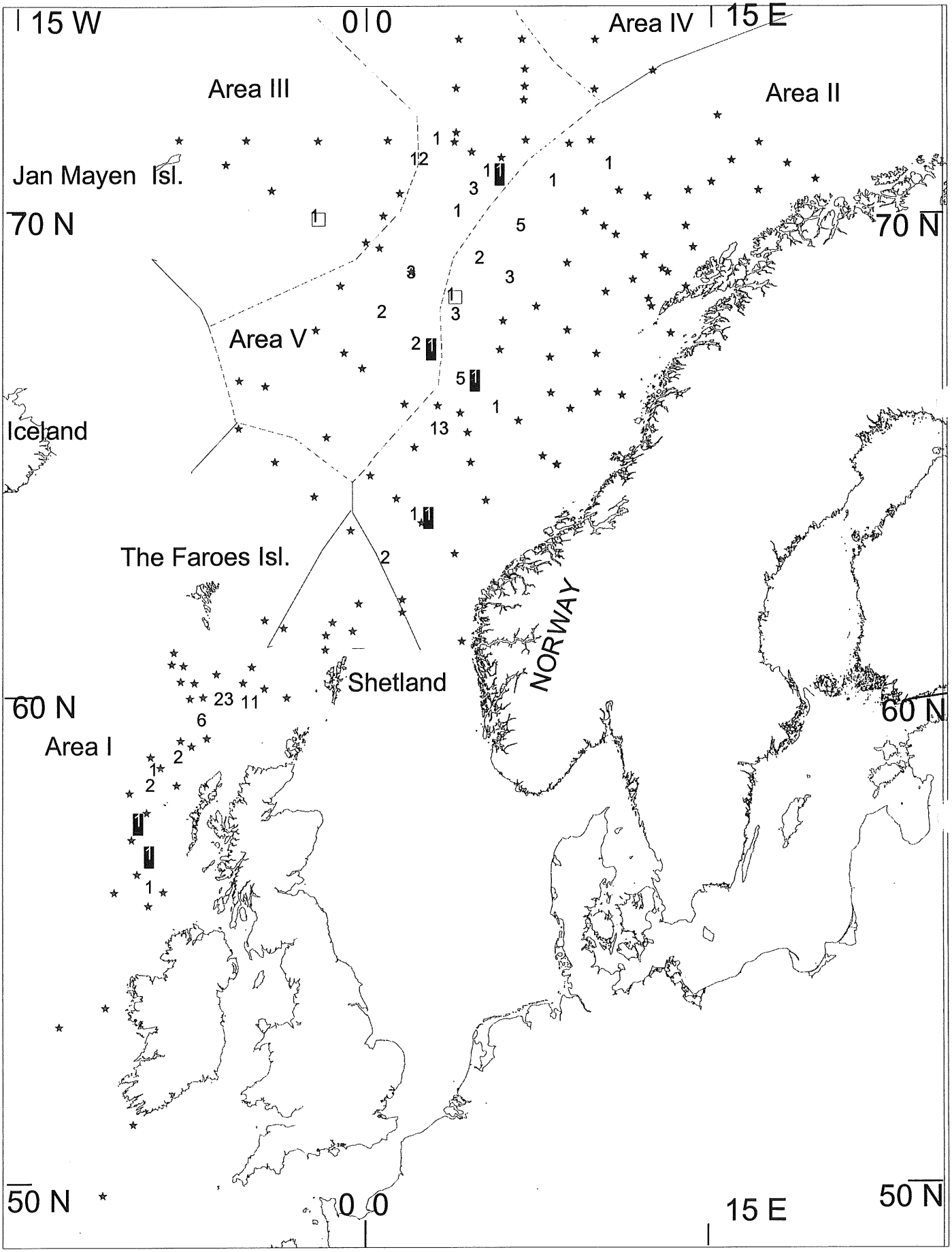

Fig. 6. Numbers of postsmolts and 1-SW salmon in surface trawl hauls (one boat trawl) in 1995. Legends: [1] = Smolts caught in August; Catches North of 60 N made in July; Catches south of 60 N were made in June. Other legends as in Fig. 4.