INTERNATIONAL COUNCIL FOR
THE EXPLORATION OF THE SEA

C.M. 1990/C:22
Hydrography Committee

LONG-TERM CHANGES IN SALINITY DISTRIBUTION IN THE CENTRAL NORTH SEA

by

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Abstract

Annual charts of bottom isohalines in the North Sea in February for the years 1970-1989 have been studied. Gradients of isohalines suggest long-term changes in the strength of the northern Atlantic water inflow. The surface of the area between by the isohalines 34.9 and 35.0‰ and the 0° and 4° East longitude meridionals is proposed as a simple index to describe changes in the strength of this inflow.

Contents

1. Introduction

Long term changes in watercirculation in the North Sea have been supposed to be the cause of recent changes in some fish populations (Van de Kamp 1983, Corten 1986).

Results from hydrographic sampling during the annual International Young Fish Surveys in February 1970-1989 show distinct long-term changes in salinity distributions in the central and northern North Sea. These changes could possible be related to differences in the strength of the Atlantic inflow in the Northern North Sea.

Although the southward extension of certain isohalines in the Central North Sea could give an impression of the strength of the northern inflow of oceanic water the distance between parallel isohalines was thought to give a better result as a stronger inflow is likely to result in a steeper gradient field with southern North Sea water in the Central North Sea.

In this paper no attention is paid to the relative small amount of Atlantic water entering the southern North Sea through the English Channel. Furthermore, this water flows mainly through the eastern coastal areas to the Skagerrak and has little influence on the Central North Sea.

2. Material and Methods

A set of hydrographic data, derived from International Young Fish Surveys in February of the years 1970-1988 was prepared by Reimert and Dooley from the ICES hydrographic office for the 1989 meeting of the ICES Working Group on IYFS. The 1989 data have been published in the serie yearly reports on IYFS (Anon. 1989). From these data, the bottom salinity charts are shown in Figure 1-3.

Only the area between the 0° and 4° longitude meridionals was chosen to look at the salinity gradient field between Atlantic Water and southern North Sea water. Widening this area should give complications with coastal western and eastern North Sea water types. Between these longitudes from Figures 1 - 3 it appears that the isohalines 34.8 till 35.2 are generally fully developed and have a southerly edge. Calculation of the surfaces of the areas enclosed by these isohalines and the 0° and 4° East longitude meridionals was done by cutting this area from Figures 1 - 3 (each year on A-4 format) and weighting the pieces of paper to a 10^{-4} grammes accuracy. This values were multiplied by a factor to get surfaces. Only when, due to gaps in isohalines, less then 30% had to be estimated a calculation was done.

3. Results

Table 1. presents surfaces of the areas enclosed by the 0° and 4° East longitude meridionals and by each of the isohalines 34.8, 34.9, 35.0, 35.1 and 35.2. In the period 1970 - 1989 there was a weak correlation between the surfaces enclosed by the 34.8 - 34.9 isohalines and the 34.9 - 35.0 isohalines (Spearman rank correlation Rs=0.45). Data of surfaces between the 34.9 and 35.0 isohalines for all years were available. Because their mean position seems to fit best as border between North Atlantic water and southern North Sea water, this parameter was chosen as an index for the inflow of North Atlantic water.

The annual values of this index for the years 1970 - 1989 are shown in Figure 4. A small area between both isohalines is supposed to indicate a relatively strong inflow of North Atlantic water. Figure 4. suggests weak inflows in the periods 1977 - 1981 and 1987 - present. The intermediate period is a characterized by a relatively strong inflow.

4. Discussion

The annual salinity gradients found during the IYFS in February suggest a long-term trend. The surface of the area between the 34.9 and 35.0 ‰ isohalines and the 0° and 4° E. longitude meridionals was unusually large in the periods 1977 - 1981 and from 1987 till now, suggesting a weak Atlantic inflow from the north in those periods.

As was stated in the introduction, the distance between parallel isohalines should give a better index of the strength of the northern inflow of Atlantic water then the southward position of a certain isohaline. In Table 1. the latitudes of the estimated centre of gravity of the surface enclosed by the 34.9 and 35.0 isohaline and the 0° and 4° E are given. In the period 1970 - 1989 this latitudes and the belonging surfaces were good correlated (Rs=0.74, Spearman's rank correlation).

Martin et al. (1984) found the wellknown "mid 1970's salinity anomaly" in the Faeroe-Shetland channel from 1975 - 1979 and noticed one year delay of this anomaly towards an area east of the Orkneys. Another year for transport of the water from here to the central North Sea is likely (Zimmerman, 1984). The here observed period of low northern Atlantic inflow in 1977 - 1981 fits remarkably well with the "mid 1970's salinity anomaly", as well as with the expected time of arrival and duration. This coincidence gives support to the idea that the salinity distribution in the Central North Sea is linked to events in the Atlantic ocean and not only to local factors as land runoff, precipitation and evaporation.

Ljøen and Sætre (1987) studied yearly changes in mean temperature and salinity at the latitudes 59° 15'N and 57° N in the North Sea of water with a salinity of > 35 ‰. The material used was derived from a Norwegian standard hydrographic program in the month June of the years 1967-1984. They also found the "mid 1970's salinity anomaly" in the North Sea with a two year delay from the Faeroe Shetland Channel, indicating a long-term change. The anomaly was more pronounced at 59° 15' N than at the 57° N latitude. A separation of the two areas by the east flowing "Dooley current" was suggested. From the salinity distribution in figure 1-3 no such a separation can be seen. This separation could be more a summer phenomenon as in summer this current is found to be more pronounced. From a comparison of summer bottom temperature and salinity distributions in the Northern North Sea for a year with high salinity (1972) and a year with minimum salinity (1978) in the Atlantic water they noticed that the "mid 1970's salinity anomaly" is probably more related to the properties of the inflowing Atlantic water rather than to flux variability. This is not supported by the present study.

Acknowledgement

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SURFACES OF AREAS BETWEEN ISOHALINES

February of year	34.8-34.9 o/oo	34.9-35.0 o/oo	35.0-35.1 o/oo	35.1-35.2 o/oo	latitude of surface between isohalines 34.9-35.0 o/oo
1970	6.3	7.0			56°10'N
1971		4.8	10.1		55°05'N
1972	6.3	4.4	6.7	18.3	55°40'N
1973		4.7	17.3	15.0	54°10'N
1974		7.3	6.7	12.5	55°40'N
1975	4.3	6.2	8.8	23.1	55°20'N
1976	4.2	5.2	9.8	16.7	55°10'N
1977		12.5	7.2		56°00'N
1978	9.7	26.8			58°20'N
1979	3.9	8.0	6.1		57°20'N
1980	5.8	13.8	10.5		57°10'N
1981	8.6	15.9	7.8	8.6	57°00'N
1982	4.1	5.8	12.1	11.2	55°50'N
1983	6.0	6.1	10.4	9.9	55°40'N
1984	7.2	4.8	7.5	11.1	56°05'N
1985	5.3	2.9	3.5	10.4	55°30'N
1986	3.6	6.0	7.7	15.7	56°30'N
1987	7.6	8.5	9.1	8.8	56°00'N
1988	5.7	12.3	6.4	17.7	56°15'N
1989	6.9	13.5	3.2	5.8	56°25'N

Table 1.

Surface of areas enclosed by two successive isohalines (34.8 till 35.2) and the 0° and 4° E. longitude meridionals in 1000 square miles and the latitude of the estimated centre of gravity of the area enclosed by the 34.9 and 35.0 isohalines.

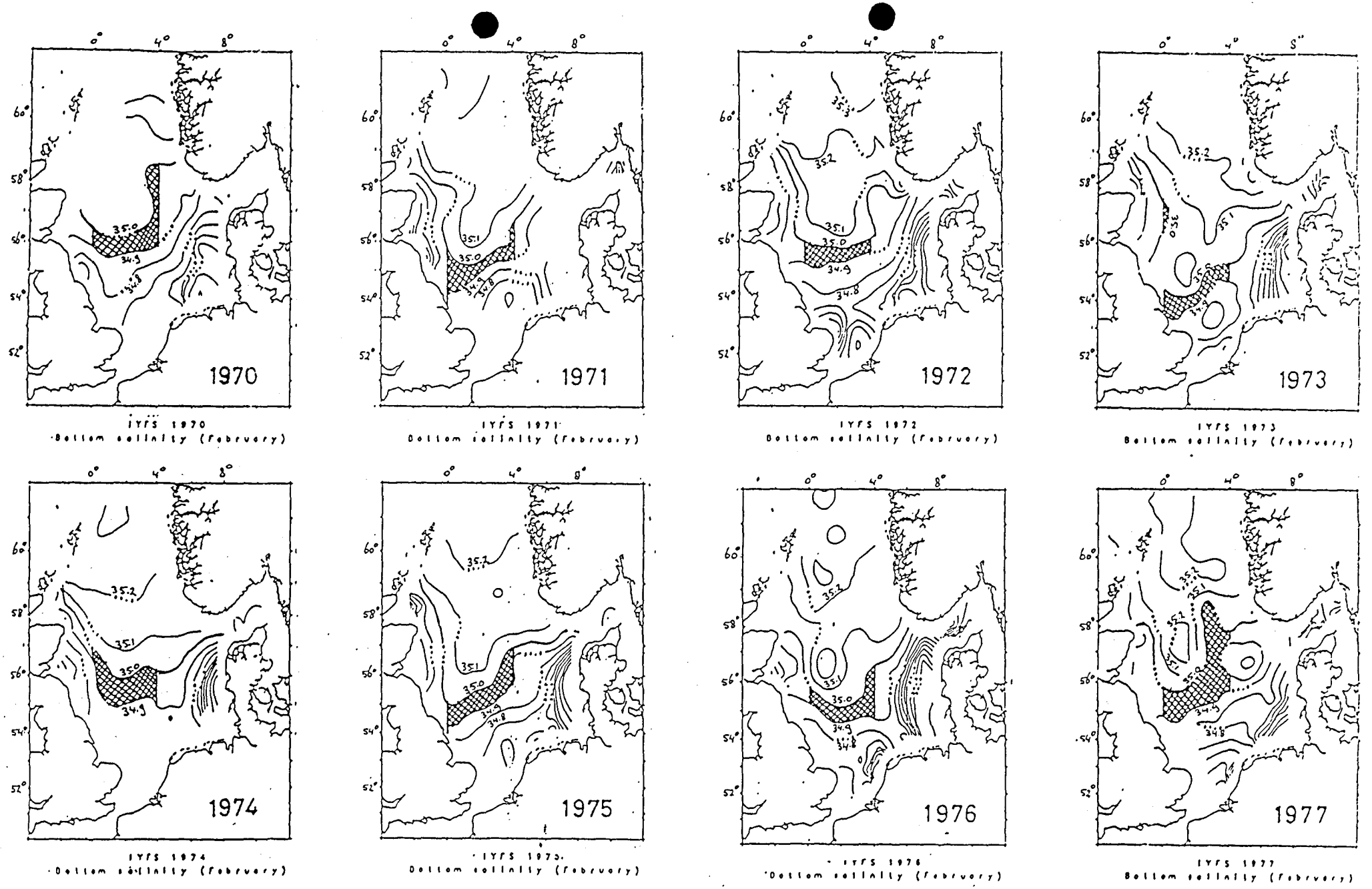

Figure 1. Bottom salinity charts in February 1970 - 1977. Index areas mentioned in the text are shaded
Source : Susanne Reimert & Harry Dooley, ICES Secretariat, 1989.

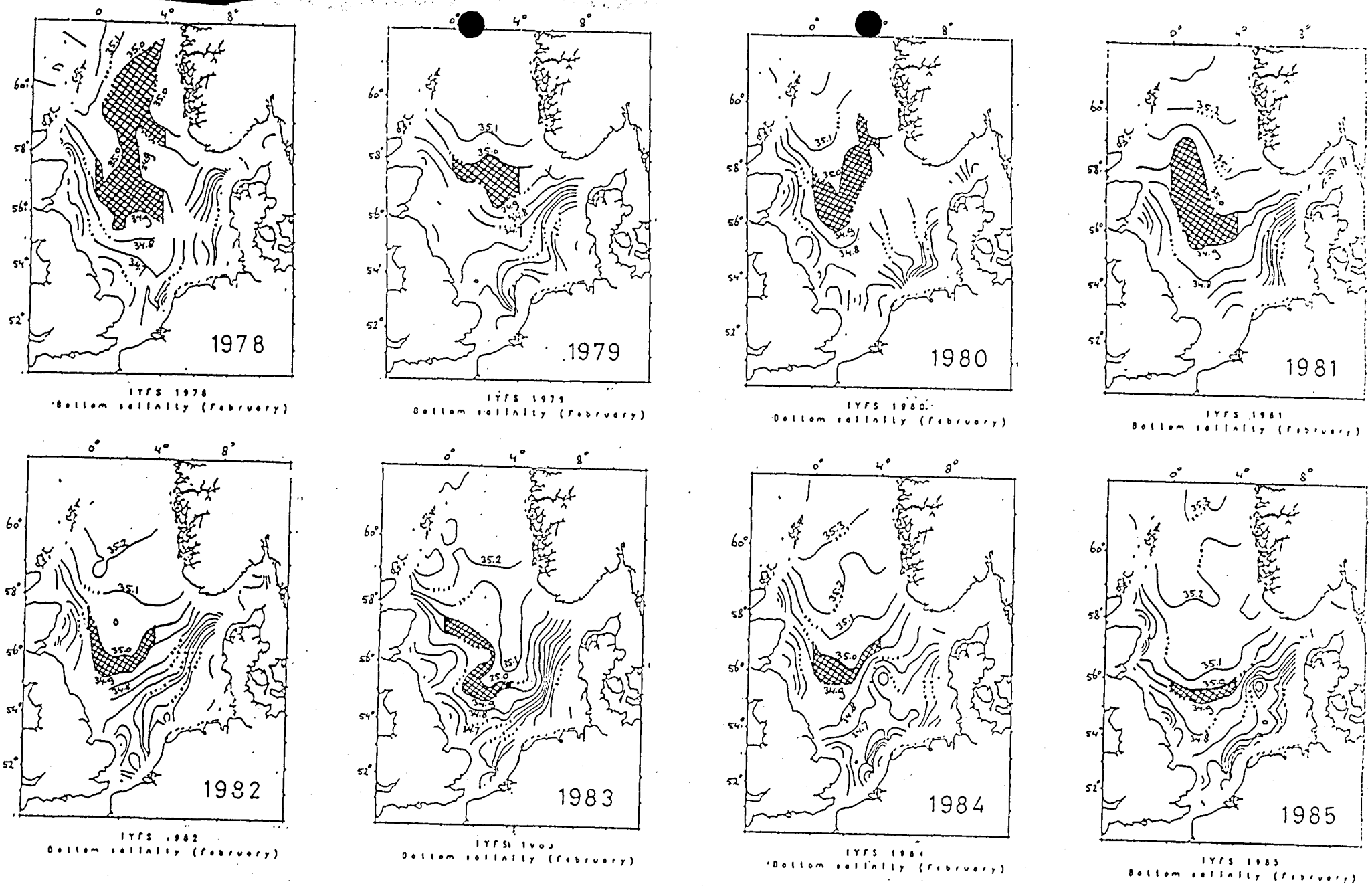

Figure 2. Bottom salinity charts in February 1978 - 1985 Index areas mentioned in the text are shaded
Source : Susanne Reimert & Harry Dooley, ICES Secretariat, 1989.

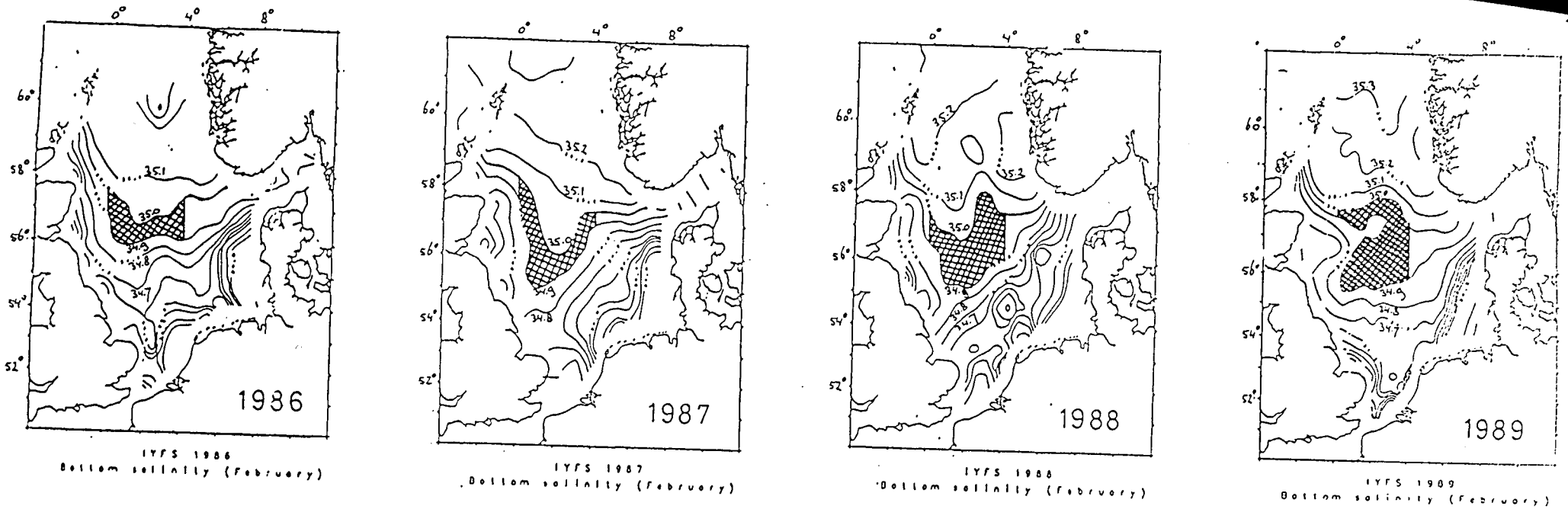

Figure 3. Bottom salinity charts in February 1986 - 1989
Source : Susanne Reimert & Harry Dooley, ICES Secretariat 1989 and ICES C.M.1989/H:54
Index areas mentioned in the text are shaded

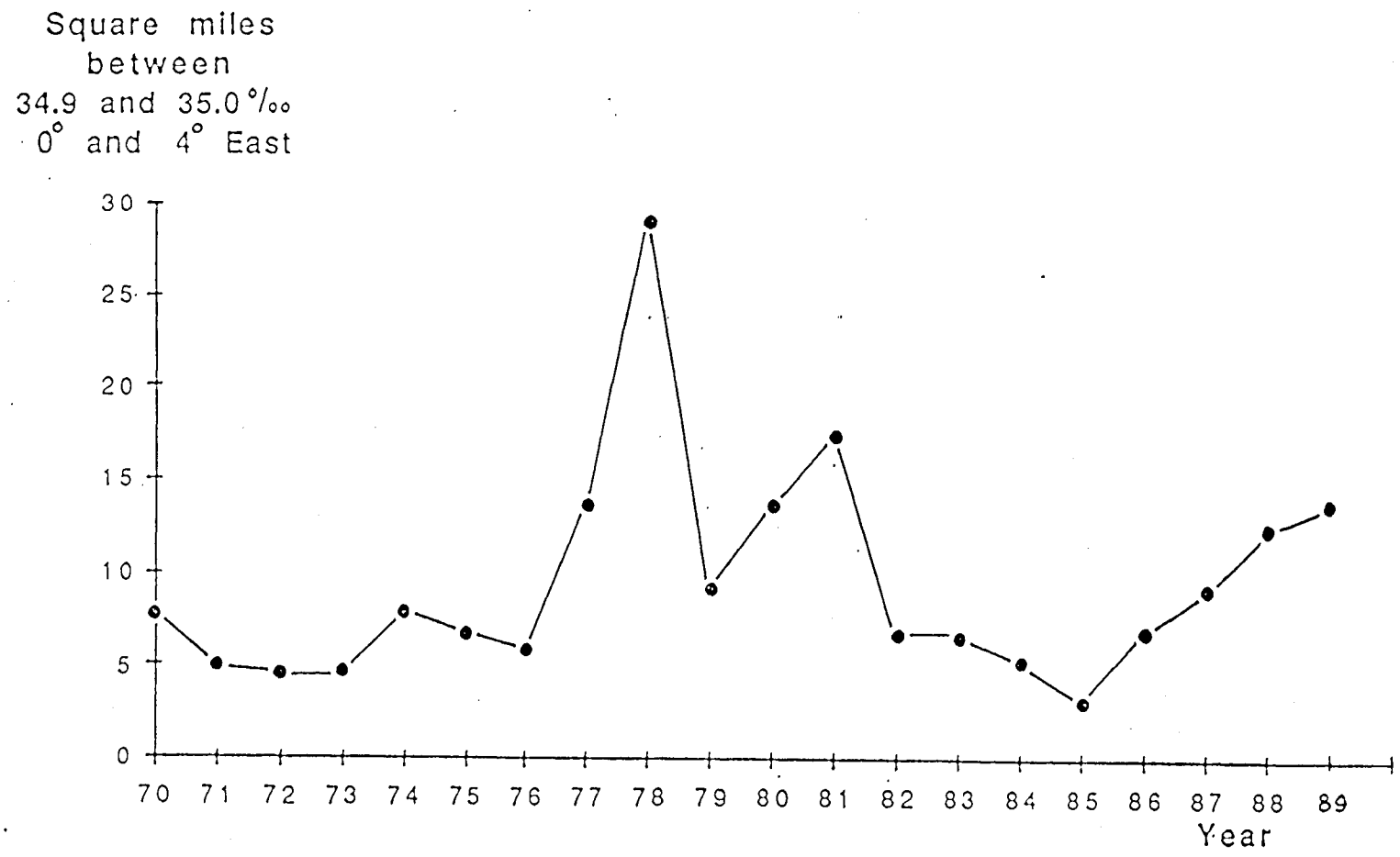

Figure 4. Inflow index of Atlantic Water in the Northern North Sea 1970 - 1989.