CM 2002/W:01

Jens Eggvin – A Norwegian pioneer in operational oceanography

by

Roald Sætre and Johan Blindheim

ABSTRACT. Jens Eggvin (1899-1989) was employed at the Institute of Marine Research (IMR) in Bergen as head of its physical oceanographic activities in 1933. He followed a Norwegian tradition in relating the physical conditions of the ocean with fisheries. In 1935 he established several fixed hydrographic stations along the Norwegian coast and installed thermographs aboard several regular coastal steamers. In doing so, the entire 2700 km Norwegian of coast was covered by regular observations of the temperature in the surface layer. Later this program was extended to include samples for salinity determination at fixed locations along the coast and also to include a number of shipping routes across the North Sea.. The system of the fixed hydrographic stations were conducted by local observers, usually fishermen, but trained by IMR. This Norwegian Coastal Observing System is still in operation today.

Eggvin was also a pioneer in oceanographic forecasting. An excellent demonstration of the advantage of the new observation system was described in his doctoral thesis “The movement of a cold water front” from 1940. He was able to follow an outbreak of cold water from the Skagerrak and its propagation along the southern Norwegian coast. This work was the basis for later forecasts on cold-water outbreaks and the transporting of harmful algae, both of great importance especially for the fish farmers.

It was early known that the cod in the Lofoten area preferred to spawn in the transition layer between the cold coastal water and the warmer water of Atlantic origin below. The temperature of the transition layer was between 4o and 6o C and the depth of this layer showed great inter-annual variations. These variations influenced fisheries in several ways. Eggvin submitted in many years regular forecasts for the depth of the transition layer before the start of the fisheries.

At the ICES meeting in 1959 Eggvin strongly advocated for “synoptic oceanography” for the benefit of fisheries. “We know that certain hydrographic situations influence the fisheries in various ways. If we can predict such special hydrographic situations, we can expect to be able to assist the fisheries with valuable information, knowing in advance that certain oceanographic conditions affect the fish in such and such a manner that we shall know how the fisheries will turn out” Today, this term is called “Operational Oceanography”. On Eggvin initiative the first ICES pilot project on synoptic oceanography was carried out during the period January- March 1966 with Norway as the lead country.

Introduction

Jens K. Eggvin (1899-1989)(Fig. 1) participated as an assistant in geology during expeditions to Svalbard during the summers 1923-25 and also in the “Norwegia” expedition to the Antarctic 1930-31. He took his cand.real degree at the University of Oslo in physical geography. In those days this subject included disciplines such as meteorology, physical oceanography as well as quaternary geology and Eggvin did his major within this last discipline in 1930. In 1931 the Institute of Marine Research (IMR) in Bergen employed him with the sole responsibility of building up the physical oceanography in relation to fisheries and fisheries research. Eggvin grew up in a small fishing community in Northern Norway and participated in his younger days in the fisheries. He was thus very familiar with life at sea and had a preference for field science. When Eggvin was employed at IMR, physical oceanography was clearly within the scientific interest of the institute but the investigations within fishery biology dominated completely. It was therefore necessary for Eggvin to define the role of the physical oceanography within the IMR's activities. Does physical oceanography have a value of its own or should it only be a supporting discipline for the main issues at the institute? This question often resulted in conflicts with other strong personalities at IMR, who represented the more traditional fishery biology (Schwach, 2000).

Eggvin was undoubtedly, during his activities at IMR to a large extent inspired by Helland-Hansen and Nansen (1909). It seemed justifiable to call this classical work a paradigm shift in oceanography. For the first time they were able to analyse time series on the fluctuations of the Atlantic inflow to the Norwegian Sea and these were coupled with variations in the atmospheric climate in Norway as well as to the ice conditions in the Barents Sea. They also related heat flux variability of the Atlantic inflow with biological consequences, such as the growth conditions of trees and other plants and to the growth, recruitment and distribution of important fish stocks and this pioneered for the more modern fisheries oceanography.

It is expected that variations in the physical conditions of the sea have great influence upon the biological conditions of the various species of fishes living in the sea, and it might therefore also be expected that such variations are the primary cause of the great and hitherto unaccountable fluctuations in the fisheries. It is therefore obvious that it would be of great importance, not only scientifically but also practically, if the relation between the variations in the physical conditions of the sea and the variations in the biological of the various food fishes could be discovered. As our investigations have been carried out on only for such small numbers of years, we have no sufficient observation material for a thorough study of this important question; but the observations at our disposal give, however, some most important results.

"The Norwegian Sea" page 204

In "The Norwegian Sea" Helland-Hansen and Nansen also discuss the possibilities for climate predictions, both in the ocean and in the atmosphere. The apparent propagation time of about two years for a temperature signal to be transported from Western Norway to the Barents Sea indicates a feasibility of giving long-term temperature prognoses for the Barents sea. The observed relationship between the quantity of heat in the Atlantic water off Western Norway in May and the mean air temperature over Norway in the following winter indicates the feasibility of atmospheric climatic predictions. On several later occasions Helland-Hansen and Nansen returned to this problem and stated " *a continued study of these features will hopefully give such results that one later would be able to predict the characteristics of the weather, nor only for the nearest days but for a rather long time – weeks and months ahead."*

Furthermore, Helland-Hansen and Nansen demonstrated the relationship between the mean temperature in the inflowing Atlantic water to the Norwegian Sea and the mean weight of cod roe and liver (cod roe and liver index) from the spawning population during the Lofoten fisheries, as well as up to the time of the Lofoten fishery. High temperatures in the feeding area of the cod are favourable both for the growth and for the development of the sexual organs. Helland-Hansen and Nansen also demonstrated that the outcome of the fishery for sprat and juvenile herring in the Norwegian Coastal areas to a large degree depended on the physical conditions of the Norwegian Coastal Current.

Most likely, the ideas expressed in the work of Helland-Hansen and Nansen (1909) formed the basis for what seemed to be the guiding principle for Eggvin's work at the IMR:

The oceanographic studies at IMR should contribute to explaining the migration and distribution of the commercial fish stocks and to assist in exploring the feasibility for giving prognoses for the fishery following approximately the same pattern as for the weather forecasts.

Eggvin named this field of the oceanography as "oceanographic fisheries research" and internationally it was later referred to as "Fisheries hydrography" or "Fisheries oceanography". He explained oceanic fisheries research in this way:

*Further is it of great importance to investigate how fluctuations in the physical and chemical properties of the sea could influence the occurrence of our useful food fishes. The main task, however, is to find methods to predict how the physical condition of the sea will be in the future. To solve this task, which is of general oceanographic importance, and thereby useful not only for the fisheries but for also for other part of the practical life which is affected by conditions of the ocean, is it necessary to understand the causes of the changes in the oceanographic elements mention above. If these goal is reached, it will be possible to issue forecasts for the coming fishing season and if one know the fluctuations in the condition of the ocean long enough in advance, the forecast can be of great importance for the fishermen preparing for the seasonal fisheries. If these task shall be solved a sufficient observation material is needed.(*Eggvin, 1946)

Operational oceanography

In recent years the term "Operational oceanography" has been widely used. EuroGOOS proposed the following definition which have also been widely accepted within the ICES subsidiary bodies and community:

"Operational oceanography is the activity of routinely making, disseminating, and interpreting measurements of the seas and the atmosphere so as to;

- Provide continuous forecasts of the future conditions of the sea, as far ahead as possible *(Forecasts).*
- Provide the most usefully accurate description of the present state of the sea including living resources *(Nowcast).*
- Assemble climatic long term data sets which will provide data for description of past states, and time series showing trend and changes *(Hindcast).*"

In order to follow up what is believed to be the overall goal of the work of Eggvin as formulated above, his activity could be divided into three phases:

- Establishment of an appropriate Ocean Observing System
- Providing on a regular basis (annually) reports on the status of the physical environment, and on special oceanographic events believed to affect the fisheries *(The diagnostic phase).*
- Explore the feasibility to forecast the impact of the physical environment and oceanographic events on the fisheries *(The prognostic phase).*

Ocean Observing System

On the initiative of Eggvin a network of fixed oceanographic observation stations were established along the Norwegian coast from 1935 and onwards. These stations were located between 2 and 8 nautical miles from the coast and were manned by local observers who were equipped and trained by the staff at IMR (Fig. 2, Table 1). These observers measured the temperature by reversing thermometers and took samples for salinity determinations using Nansen bottles at pre-selected depths, down to 200-300 m. These measurements were supposed to be carried out weekly or every second week throughout the year. The salinity samples were sent to IMR for titration. The observations from some of these fixed stations represents the longest continuous oceanographic time series in the world. What was remarkable was that even during World War II when most other European oceanographic time series were interrupted, the observations at some key stations along the Norwegian coast continued.

Already in the early 1920s sea thermographs were installed on vessels crossing the Pacific and Atlantic Oceans, which gave continuous recordings of temperatures in the upper layer. Due to the lack of oceanographic expertise at the IMR during the 1920s, the biologist Oscar Sund, was at that time in charge of the institute's oceanographic work and also a member of the Hydrography Committee of ICES. On his initiative the Norwegian research vessel "Johan Hjort" was fitted with a sea thermograph in 1924 (Eggvin, 1940). Furthermore, in 1927 Sund initiated a measuring program for surface temperature and salinity along the shipping routes Stavanger – Newcastle and Stavanger – Rotterdam The temperature was directly observed and sea water samples taken for later salinity determination at IMR. In the beginning the observations were taken at equal intervals along the route and later on pre-designated positions. In 1931 a similar program was started on the route from Bergen to Iceland via the Faeroes. During the period 1932 – 34 all these lines were equipped with sea thermographs supplied by Negretti & Zambra of London. The data were reported to ICES Service Hydrographique and how these data should be compiled and distributed was a matter of discussion on several of the ICES meetings during the first part of the 1930s(Anon, 1930,1931, 1932,1933). The thermogrames were re-drawn by the Service Hydrographique and copies were made available on request to the scientific community. Table 2 summarises all of the Norwegian observation lines by ships of opportunity and Fig. 3 shows their positions.

Eggvin continued the work of Oscar Sund and in 1935 he initiated the installation of thermographs in two coastal steamers where the sensor measured the temperature in the cooling water to the engine from an approximate depth of 4 m. These two vessels covered more than 2700 km of coastal stretch between Oslo and Kirkenes near the Russian border 4 – 8 times per month. Fig. 4 shows the first continuous recording of surface temperature along the Norwegian coast and Fig 5 an isoplet diagram 1935–1938 for these coastal observations.

In 1946 a plan to establish 13 ocean weather stations in the North Atlantic was proposed by the International Civil Aviation Organisation ICAO). Norway was to operate one of these in the Nordic Sea, Station M (Mike) and participate in the operation of Station A (Alfa) in the Denmark Strait. Eggvin took an active part in the planning and operation of the oceanographic work from Station M, which resulted in the longest homogeneous deep ocean time series in the world. Eggvin also initiated surface sampling at selected positions en route by the weather ships that facilitated both Stations M and A. For a period, similar sampling was carried out from the passenger ship between Bergen and New York (Table 2).

During the Second World War, observations from the North Sea couldn't be carried out. However, in spite of difficulties the thermograph service along the Norwegian coast continued as before.

Status reports on the physical environment

Oceanographic observations were an integral part of the IMR's investigations during the seasonal fisheries for the Arcto-Norwegian cod off Northern Norway both in winter and spring. Based on these, Eggvin prepared annual reports on the physical conditions of the fishing grounds of the cod and later he also included a similar description of the conditions on the fishing location for the Norwegian spring-spawning herring off central and western Norway. In his descriptions he tried to explore how physical condition influenced the distribution and availability of the fish and these were published in the official Annual Report on Norwegian Fisheries. His first report deals with the winters of 1931 and 1932 (Eggvin, 1932) and this reporting activity was repeated every year for decades (e.g. Eggvin, 1936, 1938).

During the traditional fisheries on the spawning cod population in the Lofoten area a relationship between the sea temperature and the fisheries appear to exist. The first temperature observations in the area were carried out during the Norwegian North Atlantic Expedition in 1878 and regular measurements started the following year. It was soon obvious that the cod preferred to stay in the transition layer between the upper rather cold coastal water and the warmer water of Atlantic origin, where the temperature was between 4o and 6o C. Both the depth and the thickness of the transition layer showed large inter-annual variations, which influenced the distribution and the availability of fish (Fig. 6). As seen the transition layer was significantly deeper and thinner in 1936 than in 1935. Fig. 7 indicates in a conceptual way how the depth and thickness of the transition layer influence the fishery. Knowledge or predictions of these variations would be of vital interest for the fishermen. In general, the transition layer will be deep if the winter is cold and dry, however, it will be shallow during wet and mild winters.

During winter and early spring there is a seasonal fishery for immature cod along the coast of Finnmark in the Barents Sea. This cod follows the capelin on its spawning migration from the northern Barents Sea to the coasts of northern Norway and the Kola Peninsula. In this area the water masses during winter/early spring is approximately vertically homogeneous and the temperature along the coast is mainly determined by the variable inflow of Atlantic water to the Barents Sea. It appears that the fishery mainly takes place in waters of 3o C or colder and the large east/west inter-annual displacement in the position of this isotherm determines where the fishery will take place – a western distribution close to the Norwegian coast or an eastern distribution off the Kola coast (Fig. 8). For smaller boats this could mean win or loose. However, this apparent temperature effect on the fishery is most likely not a direct effect on the cod, but rather that the spawning migration of the capelin is governed by the temperature (Gjøsæter, 1998)

Eggvin(1940) describes a situation from the cold winter of 1937, where he followed an outbreak of cold water and its propagation from the Skagerrak along the coast of southern and western Norway. Blocking and sudden release of the Skagerrak outflow seemed to be a common phenomenon, that is governed by the persistent winds (Aure and Sætre, 1981) During summer, there could be a sudden outbreak of warm water from the Skagerrak as demonstrated in this situation from August 1938 (Fig. 9). It seems as though the northward propagation of the cold-water masses during the winter of 1937 influenced the ongoing herring fishery. When the cold water flushed the traditionally fishing ground the herring disappeared and probably moved farther from the coast and towards deeper waters (Fig. 10). The cold water from the Skagerrak was also a problem for vessels transporting live fish along the coast and owed to the fact that large amounts of fish during these transports were killed by negative seawater temperatures (Eggvin, 1940).

Another effect of cold winters is the great exchange of water masses along the Norwegian coast in 1940(Eggvin, 1943). The extreme cooling of the surface layer during the winter 1940 resulted in the renewing of the bottom and deep water on the shelf area and in the fjords. This situation continued in 1941 and 1942 while in 1943 – 1944 large amounts of relatively warm Atlantic water approached the coast and the oceanographic situation from the last part of the 1930s was restored. It seems that these large physical fluctuations had a pronounced effect on the fisheries, such as the fishery for young herring and also on the depth of the transition layer in the Lofoten area (Eggvin, 1948). The observation system established by Eggvin also facilitated to explain the formation of the deep water of the Norwegian Trench and the Skagerrak. During the summer of 1947 this deep water was approximately 2.5o C colder than in 1946. The reason for this was that during the winter of 1947, heavy and very cold water was formed in the southern North Sea. This cold water over the central and southern North Sea plateau flowed north and was dense enough to replace the deep water of the Norwegian Trench (Eggvin, 1948).

Forecasts

Eggvin's great vision was the struggle for predictions of the physical environment and to be able to give prognoses for the development of the fisheries, especially for the spatial distribution of the fish. His first attempt on forecasts was during the spring cod fishery along the coast of Finmnmark. His theory was that the distribution of fish depends on the temperature conditions in the transition zone between the Atlantic water and the water of Arctic origin off the Finnmark coast (Eggvin, 1936) and later observations seemed to confirm this.

Observations from research cruises and the fixed hydrographic stations in late autumn 1938 and early 1939 showed a strong Atlantic influence of warm water off the northern Norwegian coast. Parts of this water would flow eastward into the Barents Sea along the coast of Finnmark. Based on these observations Eggvin published the following first public oceanographic forecast in January 1939,(Eggvin, 1946), two months before the start of the fishery:

"As conditions in the sea off the north of Norway, and to the south are, at present, it must be expected that the temperature of the deep water will remain relatively high during the spring cod fishery 1939 at East Finnmark which takes place from April to June. Consequently, it will be necessary to go far offshore (northwards) and far to the east in order to arrive at the above mentioned favourable temperature limits. From previous experience there is every reason to believe that there will be little chance for the small vessels to make reasonable catches during the coming spring cod fishery (loddetorsk) off East Finnmark."

This first forecast was a success; both the temperature predictions and the prognoses for the fishery seem to describe the actual situation satisfactory. After this first attempt Eggvin continued to give forecasts for this fishery for years. However, it seems as if no evaluation of their validity and usefulness for the fishermen has been logged.

The other fishery for potential forecasts was the Lofoten cod fishery on the spawning population. The depth of the transition layer would influence both the depth and the distance from the coast of the fishery. If the transition layer was shallow the fisheries will be better in the protected and less exposed eastern part of the Lofoten archipelago and thereby available for smaller and partly open boats. During a deep transition layer situation the fishery will mainly take place at deeper water and in the more distant and exposed western part of Lofoten (Eggvin, 1946).

During the autumn and early winter of 1938/39 it was clear that the t transition layer would be shallow and a forecast for the coming fishery was issued one month before the start of the fishery. The forecast showed to be a correct description of the actual situation. However, Eggvin didn't go public with this forecast but informed only the fishery management authorities and the fishing industry. He continued to do so during the period of World War II and his first public forecast for the Lofoten fishery was given in the late 1940s (Eggvin, 1946). In the following years Eggvin prepared an annual prediction for the depth of the transition layer during the Lofoten fishery (e.g. Eggvin, 1961). Most of the forecasts were published as press releases. His last forecast was issued for the fishery in 1969, that same year he retired (Eggvin, 1969). As for the forecasts for the Finnmark fishery no validation of these predictions have been carried out. They were, however, highly appreciated by fishermen and the fishing industry.

The winter of 1963 was extremely cold in southern Norway and within the North Sea area. The strong cooling of the sea resulted in very low surface temperatures and heavy ice formations in the Baltic, the Kattegat and the Skagerrak (Eggvin, 1963). This cooling formed a cold and dense bottom water mass, which covered most of the shallow North Sea plateau. Based on the experiences from the cold winter of 1947 it was anticipated that this cold water mass would renew the deep and bottom water of the Norwegian Trench and that it would take a rather long time for the temperature to return to more normal values. This prediction came true. The reduction of the temperature in the deeper layer of the Norwegian Trench also had biological implications, such as the availability and distribution of the shrimp (Rasmussen, 1966)

During the winter 1958/59 Eggvin initiated a Norwegian experiment within synoptic oceanography in connection with the investigations on the Norwegian spring-spawning herring (Eggvin, 1959). From a number of observation platforms, such as research vessels, fixed oceanographic stations, light ships and commercial vessels equipped with thermograph, observation were sent telegraphically to IMR where maps of surface temperature were prepared. This feasibility study convinced him of the realism of his vision of rapid exchange of oceanographic observations. On the ICES Statutory Meeting in 1959 he advocated strongly for this idea and as a result the Hydrography Committee established The Sub-Committee for Telegraphic Communication of Oceanographic Observations (Eggvin, 1959). Also several United Nations organisations related to the ocean were positive to the initiative. In his speech to the ICES meeting in 1959 Eggvin said:

We know that certain hydrographic situations influence the fisheries in various ways. If we can predict such special hydrographic situations, we can expect to be able to assist the fisheries with valuable information, knowing in advance that certain oceanographic conditions affect the fish in such and such a manner that we shall know how the fishery will turn out.

On the meeting in 1965 the ICES decided to carry out a pilot project within synoptic fishery oceanography, covering the both Norwegian and the North Seas. The project took place in January – March 1966 with Norway as the lead country (Eggvin, 1966). Observations were received from 8 European countries. IMR prepared oceanographic maps, which were transmitted by faximile, 1 to 4 days after the termination of each 10-days observation period. More elaborated analyses of observations were issued a few days later and distributed by airmail. These also included some cautious forecasts.

The pilot experiment initiated by Eggvin in 1966 was the first ICES activity within what is today called operational oceanography. It demonstrated that it is possible to exchange and process oceanographic observations rapidly and thereby obtain a near-real time picture or a nowcast of the oceanographic conditions. This is necessary for being able to give predictions of the future state of the ocean. The main reason why this pilot experiment was not succeeded by other operational activities was most likely due to lack of interest from potential user groups in the products which was obtained from it. The recent development in instruments, methods and data exchange technology as well as the trend towards an ecological approach to fisheries management opens new possibilities for Eggvin's vision or operational fisheries oceanography. The planned ICES/EuroGOOS North Sea Ecological Pilot Project will probably demonstrate this in a more convincing way.

Jens Eggvin was clearly a pioneer within operational oceanography. Unfortunately, the main part of his work within this field is only published in Norwegian. He very early saw the need to establish observation systems and to carry out regular long-term observations on a routine basis even though such activities had little scientific prestige. As a result, Norway has some of the longest oceanographic time series in the world.

As far back as the early 1930s Eggvin started compiling annual reports on the status of the physical environment and on special oceanographic events, which, were believed to adversely affect the fisheries. In the 1980s or 1990s countries and international organisations acknowledged such activities as important.

The development of larger and better fishing vessels as well as new fishing gear made Eggvin's forecasts for the Lofoten and Finnmark fishery less important for the fishermen today. His activities of oceanographic forecasts based on empirical methods has, however, been followed up by IMR since 1994.

Table 1. Names and years of operations for the fixed hydrographic stations along the Norwegian coast. Fig. 2 shows the position of the observation points

Station name	Years of operation	Numbers of stations up to August 2002
Nordkapp	1955 – 1967	174
Ingøy	1936 – 1944/1967 – present	1180
Eggum	1935 – present	1605
Skrova	1935 – present	2942
Træna	1945 – 1948	53
Ona	1946 – 1954	201
Bud	1971 – present	802
Sognesjøen	1935 – present	1660
Otumnøst/Dale	1950 – 1954	178
Hardangerfjord	1955 – 1958	67
Utsira Ytre/Indre	1942 - present	3345
Lista	1942 – present	1572
Ferder	1964 – 1967	40

Table 2. Observation routes for surface temperature and salinity by Ships of opportunity (Thermograph service). Fig. 3 shows the position of the observation points.

Route no.	Route name	Years of operation
1	Bergen – Kirkenes	1935 – present
2	Bergen – Oslo	1936 – 1990
3	Stavanger – Rotterdam/Amsterdam	1927 – 1939/1953 – 1991
4	Stavanger - Hamburg	1983 - 1988
5	Stavanger – Newcastle	1927 – 1939/1948 – 1980
6	Bergen – Newcastle	1950 – 1979
7	Stavanger – Aberdeen	1991 – present
8	Stavanger – Grimsby	1991 – present
9	Oslo – Newcastle	1966 – 1979
10	Bergen – OWS Mike	1949 – 1981
11a	Bergen – Iceland	1931 – 1940
11b	Bergen – OWS Alfa	1954 – 1974
12	Bergen – New York	1949 – 1966

References

Anon. 1930. Rapports Procés-Verbaux des Reunions, 66: 60 – 69

Anon. 1931. Rapports Procés-Verbaux des Reunions, 74: 66 –71

Anon. 1932. Rapports Procés-Verbaux des Reunions, 81: 66 – 73

Anon. 1933. Rapports Procés-Verbaux des Reunions, 85: 38 – 39

Anon. 1934. Rapports Procés-Verbaux des Reunions, 89: page 22, 37-38

Anon. 1935. Rapports Procés-Verbaux des Reunions, 94: page 68

Aure, J. and Sætre,R. 1981. Wind effects on the Skagerrk outflow. Pp 263 – 294 in R. Sætre and M. Mork (Eds) The Norwegian Coastal Current. Proceedings from the Norwegian Coastal Current Symposium, Geilo,. 9 – 12 September 1980. University of Bergen, 1981.

Eggvin, J. 1932. Vannlagene på fiskefeltet. Årsberetning vedkommende Norges fiskerier, 2: 90-95

Eggvin, J. 1936. Oceanografiske forhold i Nordnorge under lofot- og finnmarksfisket 1936. En foreløbig utredning. Årsberetning vedkommende Norges fiskerier, 2:131-143.

Eggvin, J. 1938. Trekk fra Nord-Norges oceanografi sett i sammenheng med torskefisket. Fiskeridirektoratets Skrifter, Serie Havundersøkelser, 5(7):33-46.

Eggvin, J.1940. The movement of a cold water front. Fiskeridirektoratets Skrifter, Serie Havundersøkelser, 6(5):151pp

Eggvin, J. 1943. The great exchange of water masses along the Norwegian coast, 1940. Rapports Procés-Verbaux des Reunions, 112:49-61.

Eggvin, J. 1946. Den fysiske oseanografi og våre fiskerier. Forskning og Fremsteg; 69-89. Bergen, 1946.

Eggvin, J. 1948. De oseanografiske forhold på Norskekysten i de senere år og deres forhold til fisket. Naturen , 1948, nr. 9: 267-276.

Eggvin, J. 1959. Can the oceanographers work for the fishermen and the fishing industry be intensified by telegraphic distribution of oceanographic observations? Lecture at ICES CM 1959, Unpublished manuscript, 4pp.

Eggvin, J. 1961. Varsel om Lofotfisket 1961. Gitt 23 desember 1960. Årsberetning vedkommende Norges fiskerier, 1959, 5: p. 94.

Eggvin, J. 1963. Tilstanden i havet under den unormale vinteren 1963, Fiskets Gang, 1963: 213 – 220.

Eggvin, J. 1965 The possibilities of forecasting oceanographic conditions in Northwest European waters their significance for fisheries. IAF, Special Publication, 6: 903-907.

Eggvin, J. 1966. Pilot project on rapid utilization of synoptic oceanographic observations. ICES CM 1966, Hydrographic Committee, No 17.

Eggvin, J. 1969. Forutsigelser på oseanografisk grunnlag om Lofotfisket 1969. Unpublished memo, 2pp.

Gjøsæter, H. The population biology and exploitation of capelin (Mallotus villosus) in the Barents Sea. Sarsia, 83: 453 – 496.

Rasmussen, B. 1966. Temperaturforhold og rekefiske i Skagerrak 1962-66.Fiskets Gang, 53:

Schwach, V. 2000. Havet, fisken og vitenskapen. Fra fiskeriundersøkelser til havforskningsinstitutt 1860 – 2000. ISBN 82-7461-051-2. 405 Pp., Oslo.

Sverdrup, H.U. 1952. Havlære. Vanlig havlære. Vannmasser utenfor norskekysten. Fabritius og Sønners Forlag, 109 Pp.

Legend of figures

Fig. 1. Dr. Jens Eggvin (1899 – 1989). Head of the Department of physical oceanography at Institute of Marine Research in Bergen 1931 – 1969.

Fig. 2. Location of the fixed hydrographic coastal stations. The time of operation appear in Table 1.

Fig. 3. The Norwegian lines of surface observations by Ships of opportunity (SOO).The names of the routes and the years of operations appear in Table 2.

Fig. 4. The first continuous record of surface observations along the Norwegian coast 6 – 12 May 1935 (Eggvin, 1940)

Fig. 5. Isoplet diagram for the surface temperature observations from the thermograph service for the years 1935 – 1938 (Eggvin, 1940)

Fig. 6. The transition layer in the Lofoten area in 1935 and 1936. The hatched areas indicate the transition layer where the temperature is 4.5o – 5.5o C (Eggvin, 1946).

Fig. 7,. Conceptual picture of how the depth of the transition layer affects the fishery in the Lofoten area. A) during a deep transition layer. B) during a shallow transition layer. Modified after Sverdrup(1952).

Fig. 8. Bottom temperature off the coast of Finmark, Northern Norway in 1936 and in 1939. (Eggvin, 1946)

Fig. 9. Surface temperature distribution during August 1938. B) 5 – 7 August C) 11 – 14 August and D) 19 – 21 August (Eggvin, 1940).

Fig. 10. Penetration of cold and low salinity water from the Skagerrak along the west coast of Norway and its influence on the distribution of herring. Modified after Sverdrup(1952).

Fig. 11 Observations from the surface layer 12-21 March 1966 during the ICES pilot project (Eggvin, 1966).

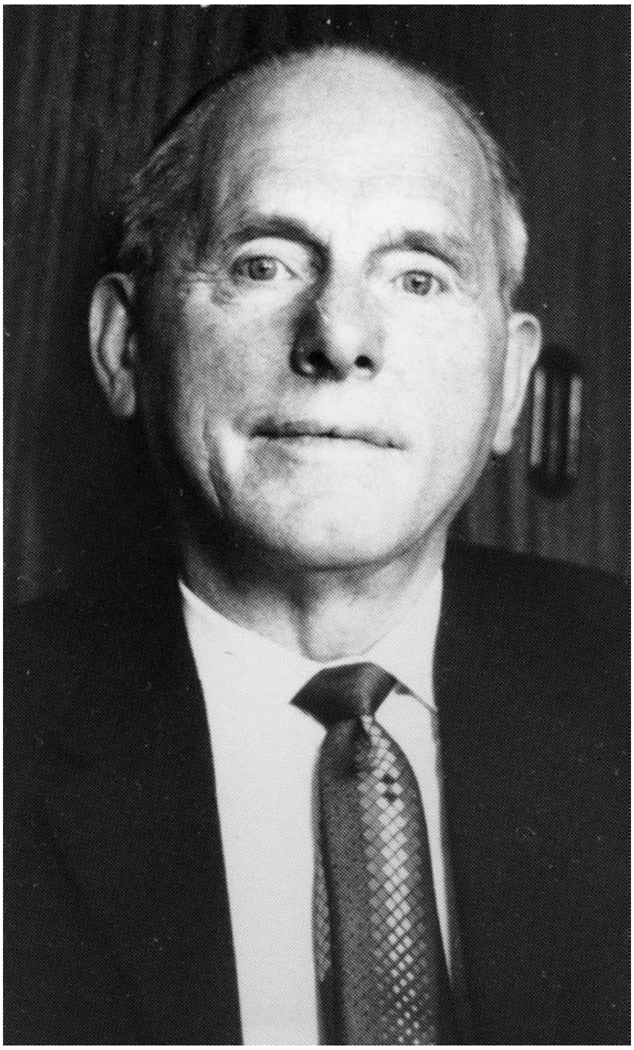


Fig. 1. Dr. Jens Eggvin (1899 – 1989). Head of the Department of physical oceanography at Institute of Marine Research in Bergen 1931 – 1969.

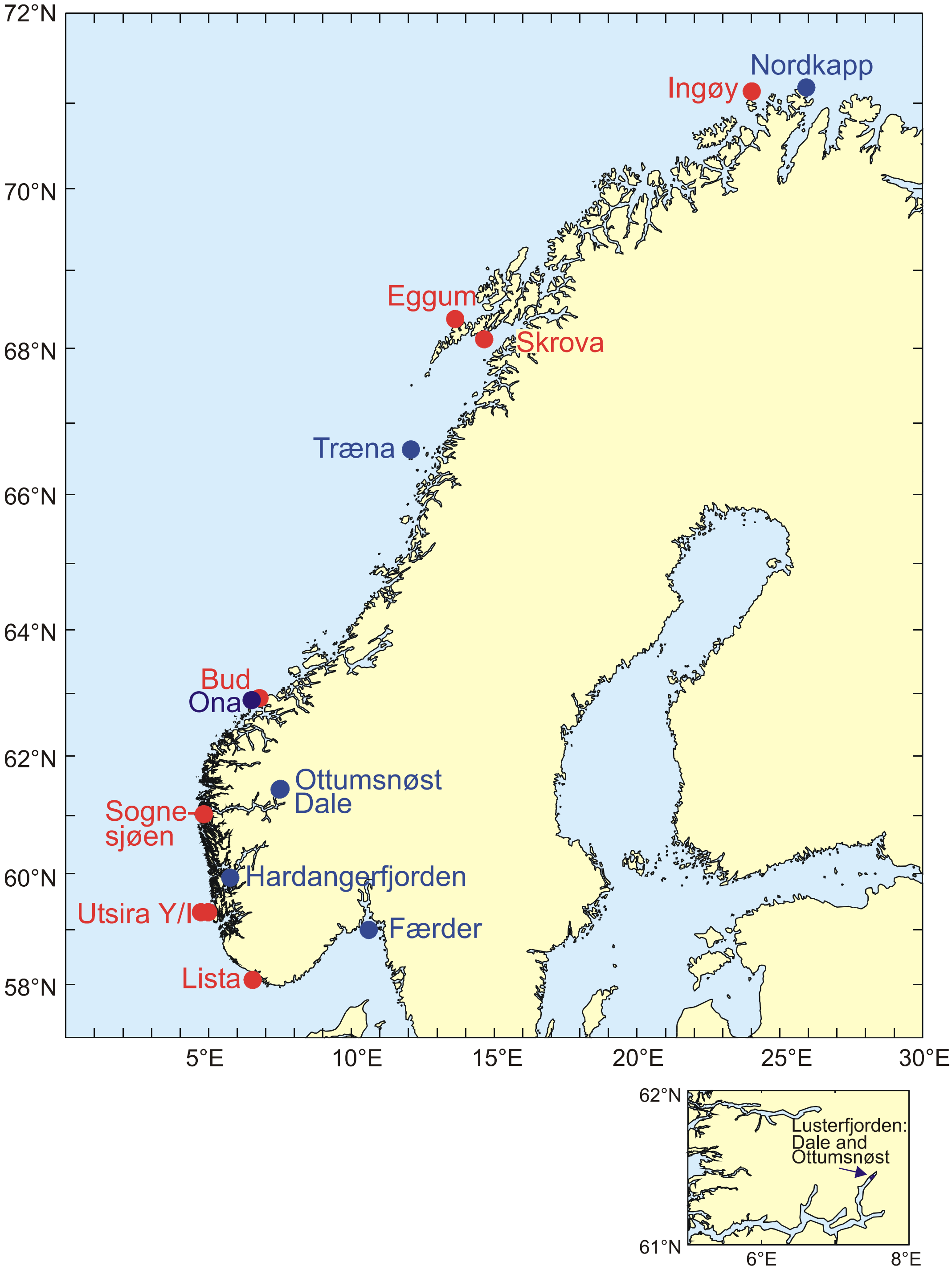


Fig. 2 Location of the fixed hydrographic coastal stations. The time of operation appear in Table 1.

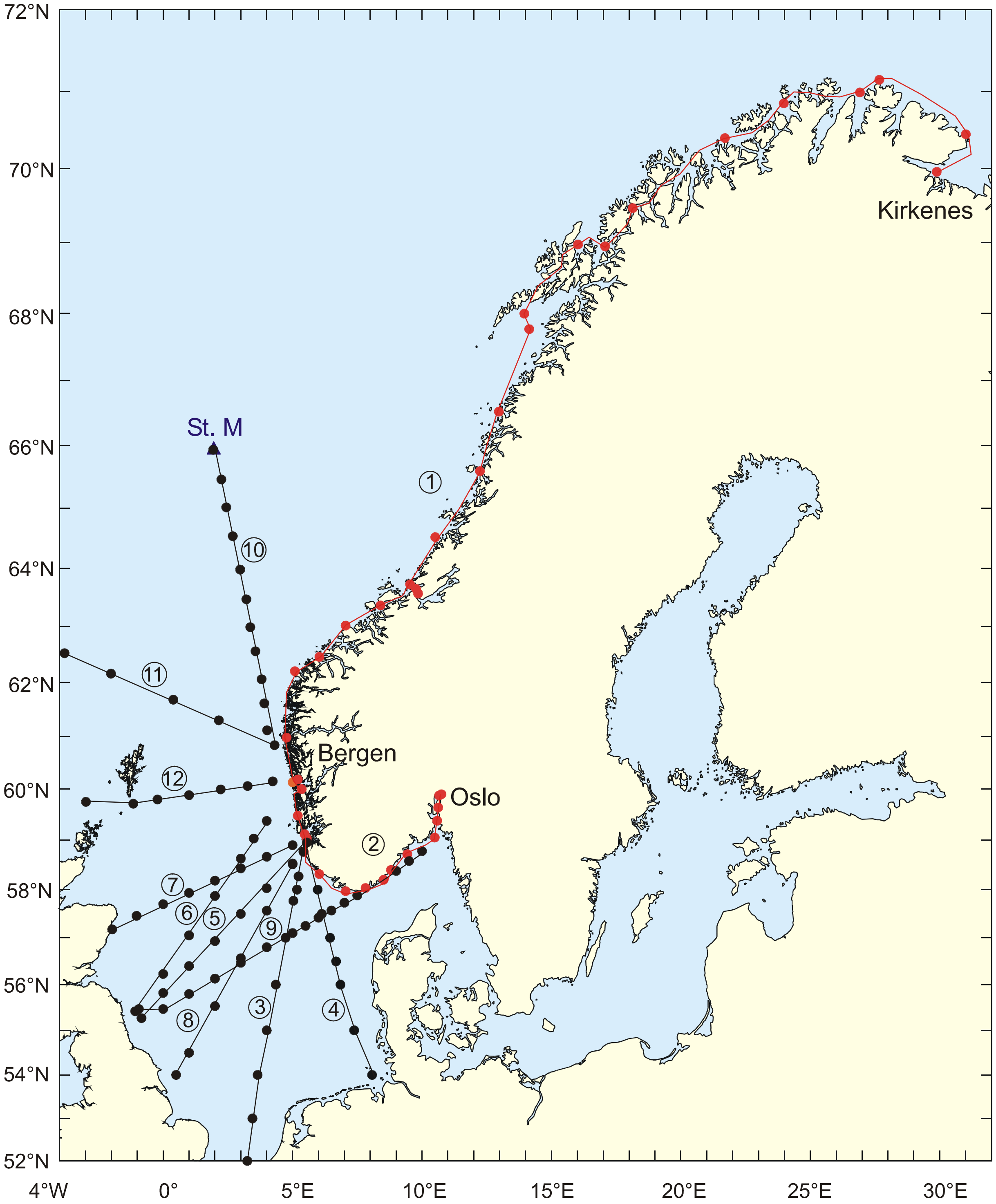


Fig. 3. The Norwegian lines of surface observations by Ships of opportunity (SOO). The names of the routes and years of operations appear in Table 2.

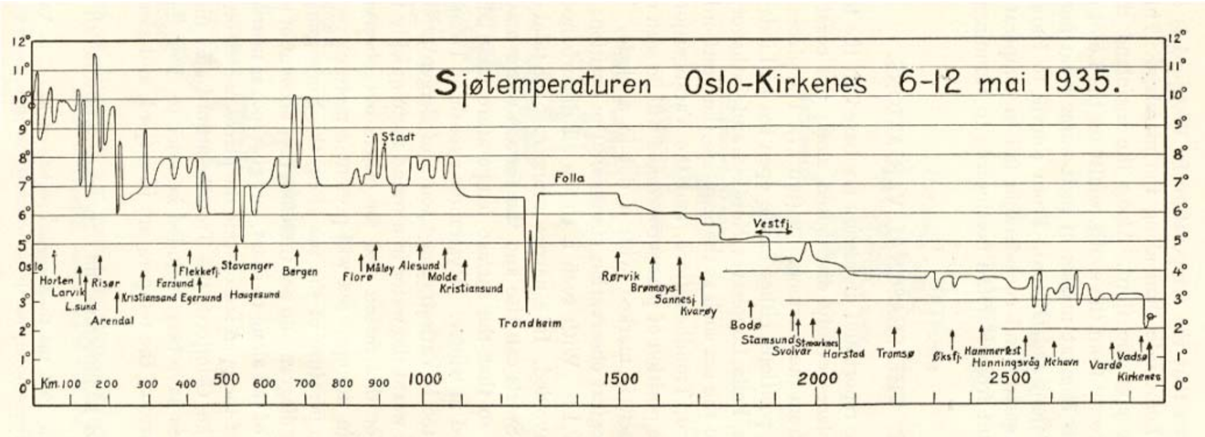


Fig. 4 The first continuous record of surface temperatures along the Norwegian coast 6 – 12 May 1935 (Eggvin, 1940).

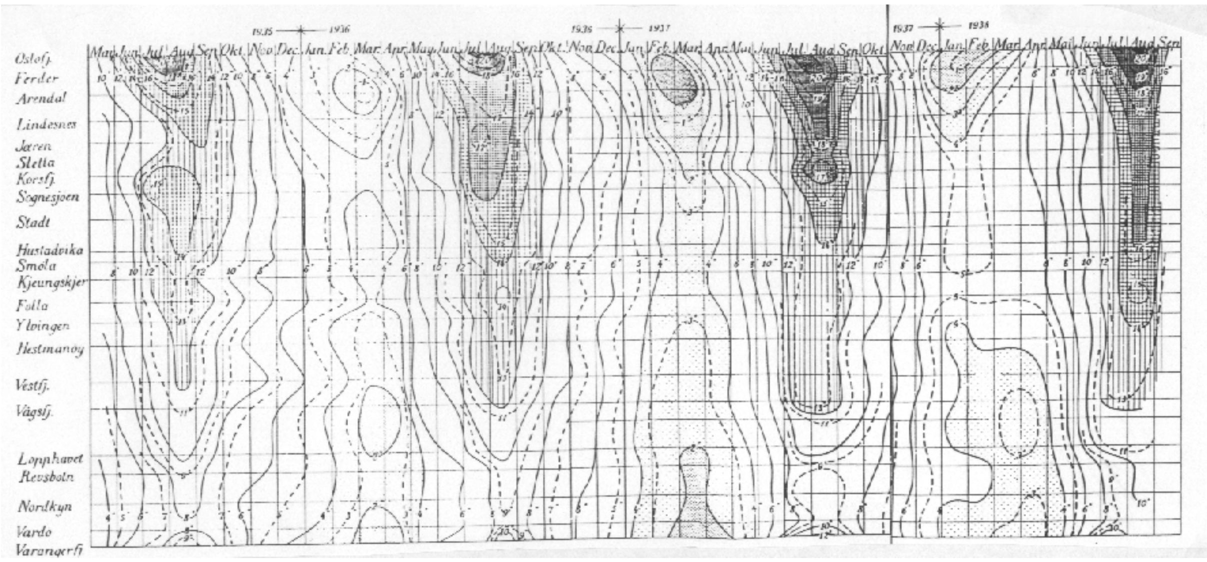


Fig. 5. Isoplet diagram for the surface temperature observations from the thermograph service along the for the years 1935 – 1938 (Eggvin, 1940)

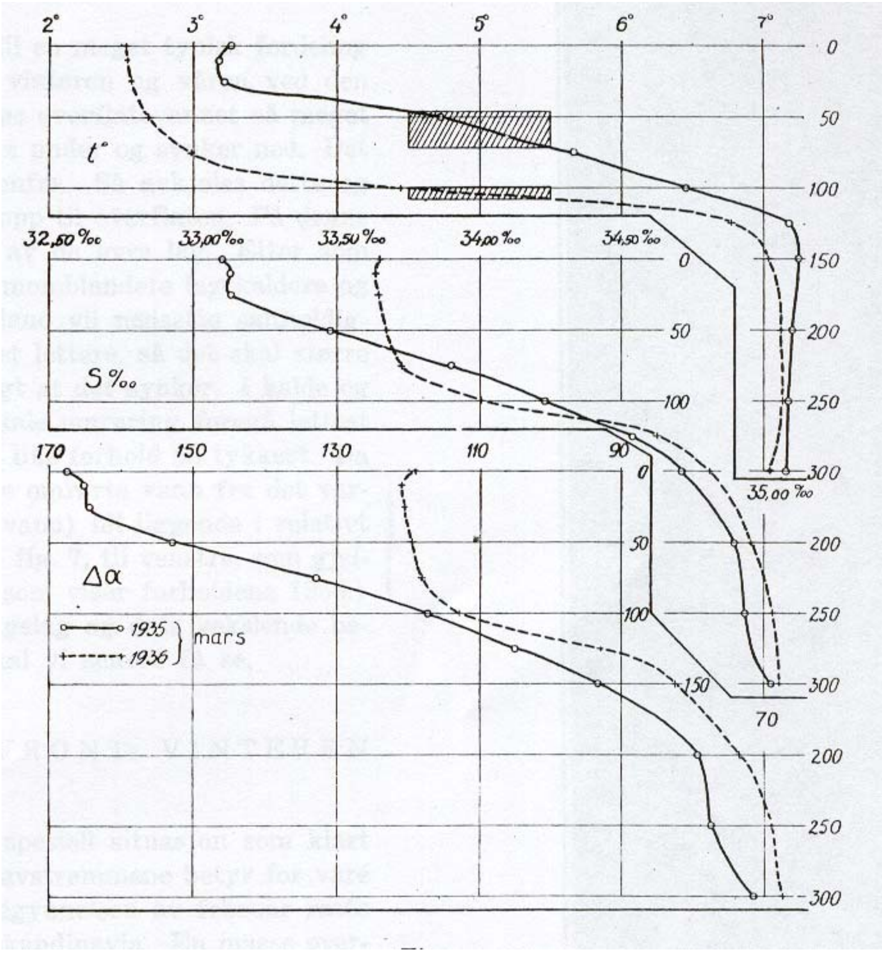
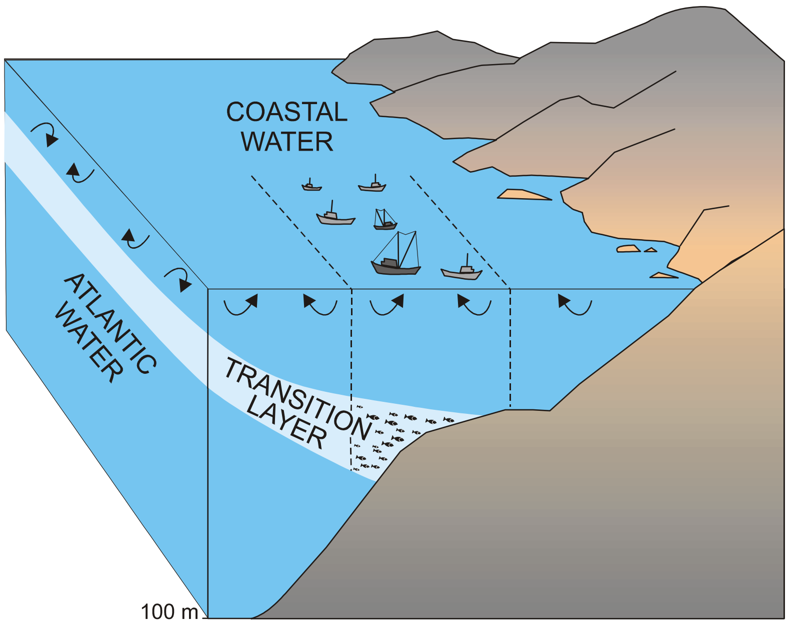


Fig. 6. The transition layer in the Lofoten area in 1935 and 1936. The hatched areas indicate the transition layer where the temperature is 4.5° – 5.5° C (Eggvin, 1946).

A



B

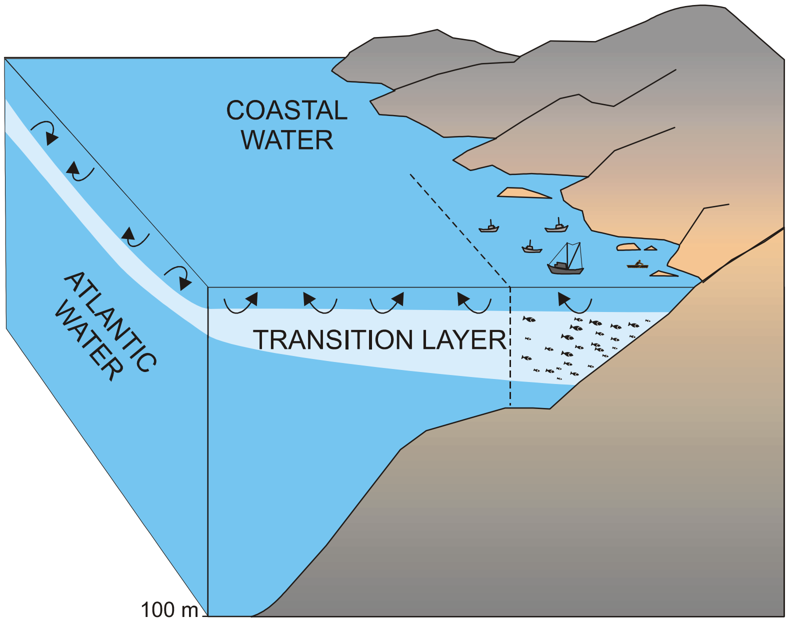


Fig. 7 Conceptual picture of how the depth of the transition layer affects the fishery in the Lofoten area. A) During a deep transition layer. B) During a shallow transition layer. (Modified after Sverdrup, 1955)

.

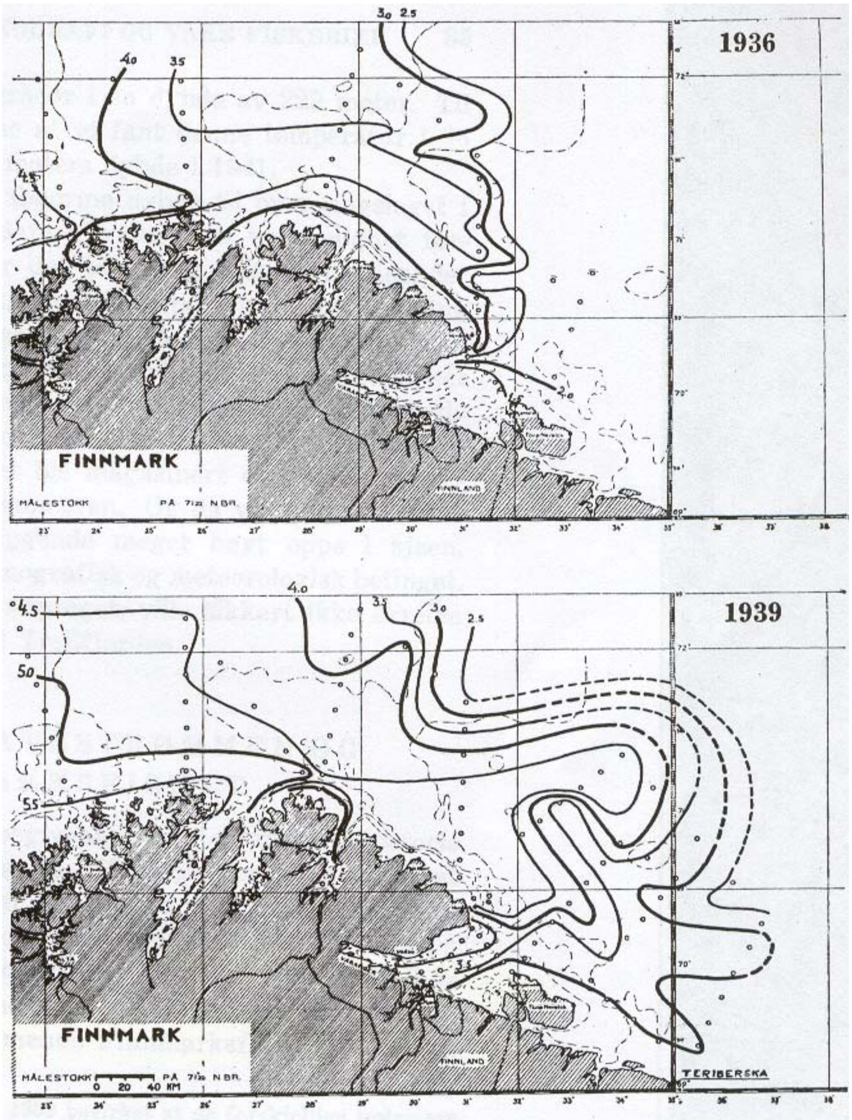


Fig. 8. Bottom temperature of the coast of Finmark, Northern Norway during the spring of 1936 and in 1939 (Eggvin, 1946).

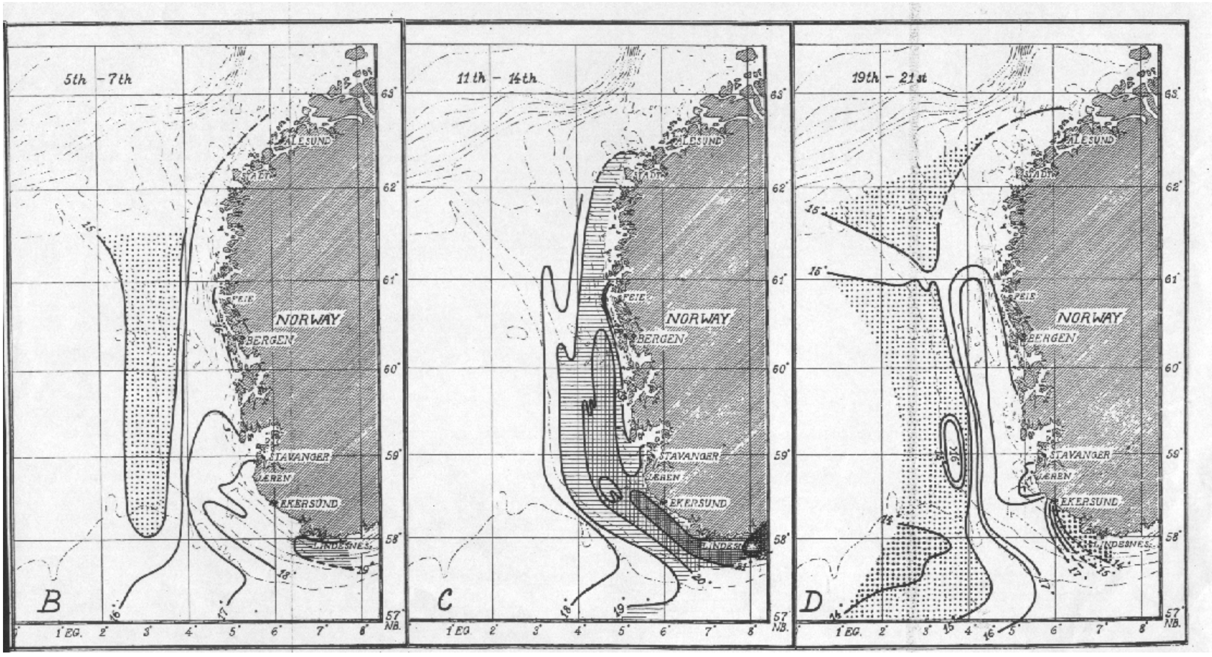


Fig. 9. Surface temperature distribution during August 1938. B) 5 –7 August C) 11 –14 August and D) 19 – 21 August (Eggvin, 1940)

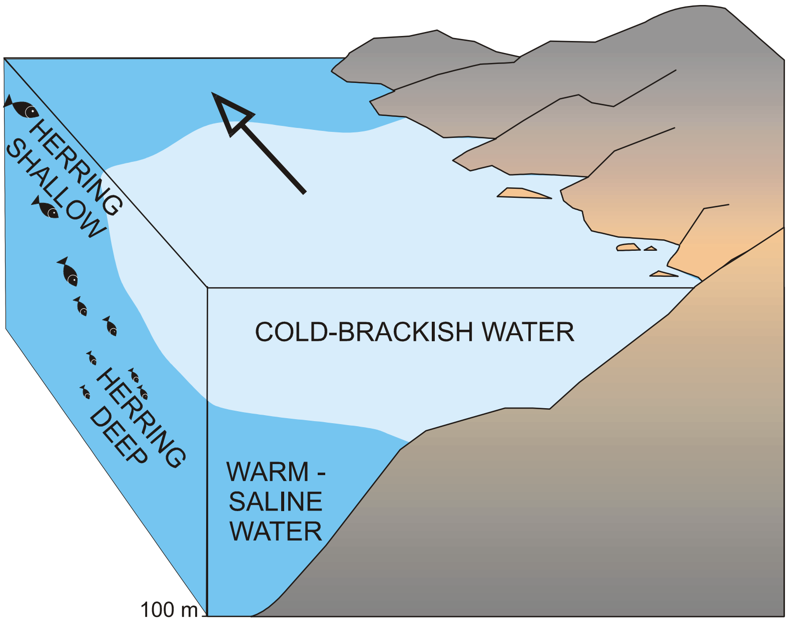


Fig. 10. Penetration of cold and low salinity water from the Skagerrak along the west coast of Norway and its influence on the distribution of herring (Modified after Sverdrup, 1955)

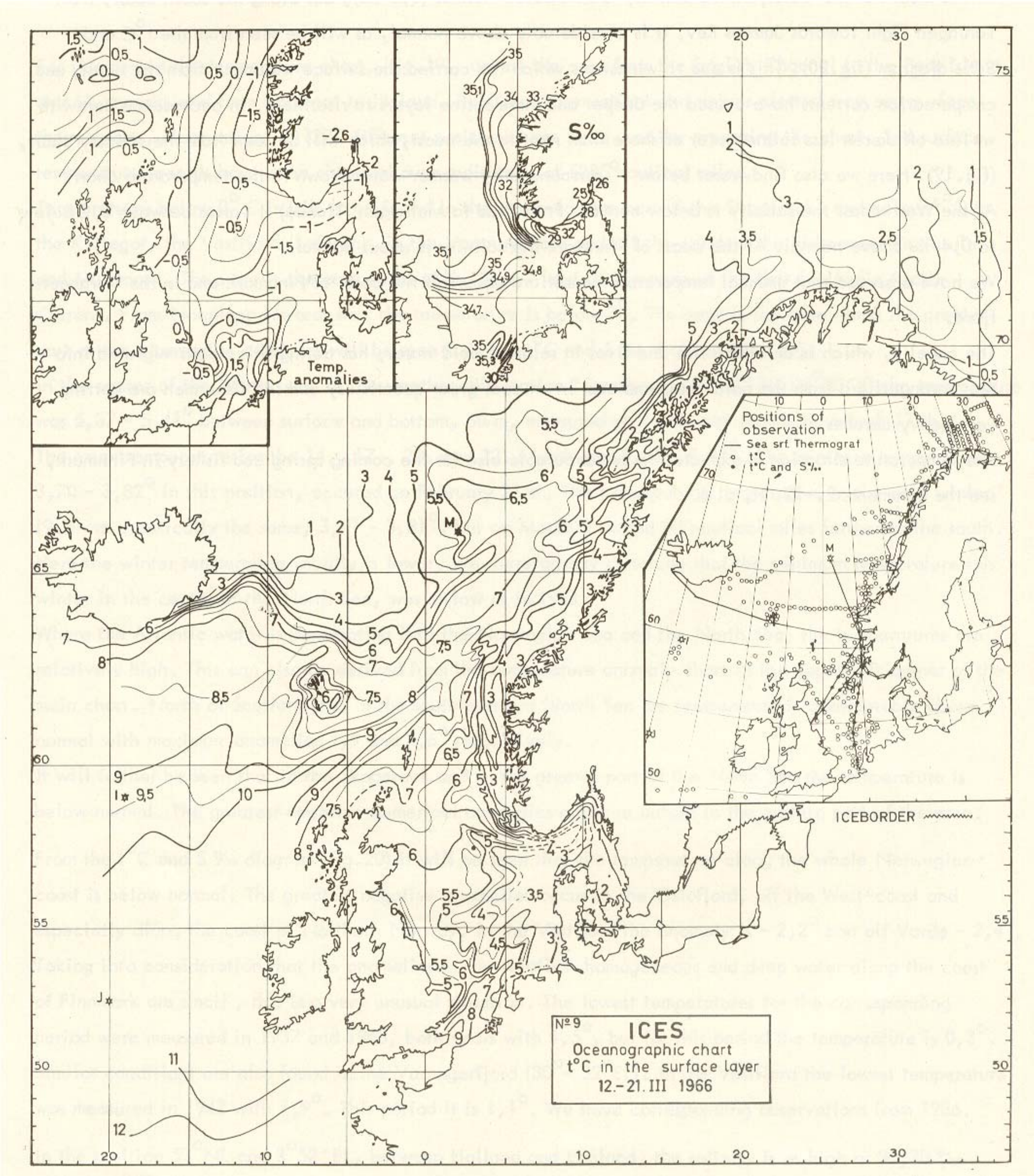


Fig. 11. Temperatures in the surface layer 12 –21 March 1966 during the ICES pilot project (Eggvin, 1966)