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The Propagation of Cod *Gadus morhua* L.

0-GROUP COD INVESTIGATIONS ON THE NORWEGIAN SKAGERRAK COAST

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ABSTRACT

Tveite, S., 1984. 0-group cod investigations on the Norwegian Skagerrak coast. In: E. Dahl, D.S. Danielssen, E. Moksness and P. Solemdal (Editors), The Propagation of Cod *Gadus morhua* L. Flødevigen rapportser., 1, 1984: 581-590.

Since 1917 0-group cod have been sampled by beach seine along the Norwegian Skagerrak coast. The average number of 0-group per haul is found to give a relatively reliable estimate of yearclass strength.

There was a period of relatively low abundance in all areas from 1930 to 1950. The best period for the open areas on the south coast was from 1950 to 1970, while in more landlocked areas the abundance was highest before 1930 and after 1970. In the Langesund area and inner parts of the Oslofjord there has been a general decline since 1950, at least partly caused by environmental changes due to pollution.

INTRODUCTION

From 1903 through 1905 G.M. Dannevig (1906) and K. Dahl (1906) used beach seines for estimating the yearclass strength of cod. The investigations were performed in order to prove or disprove any beneficial effect of liberated yolk sac cod larvae. They reached different conclusions based on the same material.

Alf Dannevig (1921) was of the opinion that longer series of

data were necessary before a firm conclusion could be drawn. A new series of beach seine hauls at different locations along the Skagerrak coast was therefore started in 1917, performed annually and is still continuing.

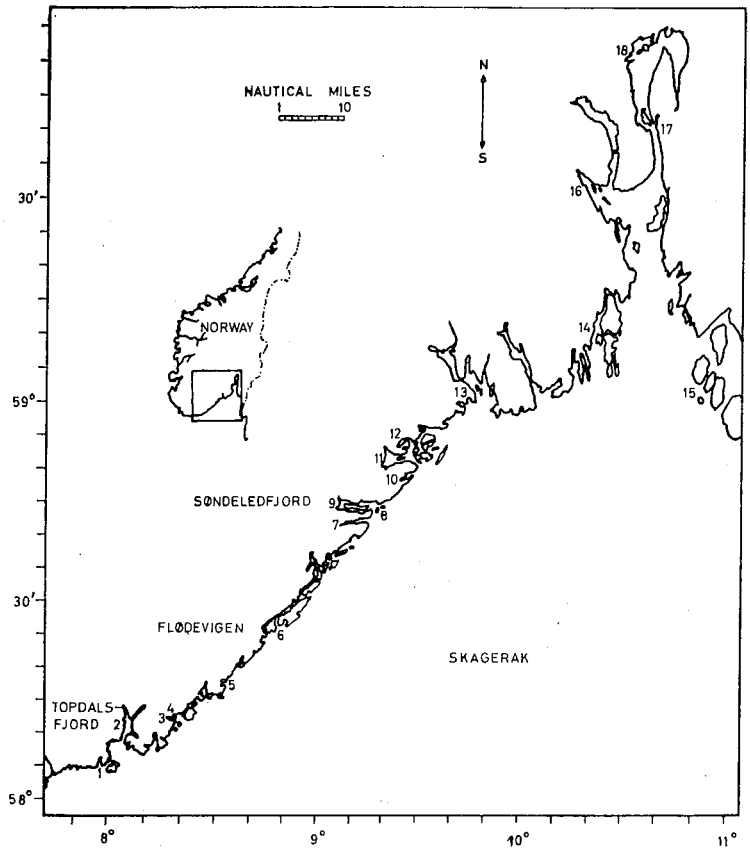

Fig. 1. Districts investigated 1)Torvefjord, 2) Topdalsfjord, 3) Steindalsfjord, 4) Vestre Vallesvær, 5) Bufjord, 6) Fløde-vigen, 7) Sandnesfjord, 8) Søndeledfjord, 9) Risør Skerries, 10) Støleфjord, 11) Kilsfjord, 12) Soppekilen, 13) Langesund, 14) Vrengen-Tjøme, 15) Hvaler, 16) Holmestrand, 17) Drøbak 18) Nærsnes-Bygdøy.

G. Dannevig (1963) used parts of the material for the original purpose. He showed that in the Oslofjord area there seemed to be a correlation between liberation of cod larvae and the number of 0-group cod. However, when using all the data available, artificial propagation could not be significantly separated from other sources of variation (Tveite, 1971). It was also shown that number of 0-group cod in the seine hauls gives a relatively good measure of subsequent yearclass strength (Tveite, l.c.).

In this paper the more longterm trends will be considered.

MATERIALS AND METHODS

The seine hauls are performed during September-October. The total area covered is split into 18 districts as shown in Fig. 1. In each district there are two to nine localities for operating the seine.

In districts 1 to 12 the sampling has been carried out since 1917. In district 13 (the Langesund area) the investigations started in 1953 and in the remaining districts (Oslofjord) in 1936. The results from 1917-1919 are omitted since many of the hauls had not yet found their permanent position. During the war 1940-1944 only the hauls in Flødevigen were worked. Only localities sampled over the entire period are considered here.

The hauls are taken at the exact same localities and cover the same bottom area each year. During the 66 years, only two persons have been in charge of the investigations on the cruises. The hauls are taken during daytime. The greatest depth of the different hauls varies from 3 to 15 m. There is hardly any tide in the area. Up to 1961, seines made of cotton were used. They were 38 m long and 3.8 m deep, the mesh size was 14 mm stretched mesh. From 1962 nylon seines of the same size and construction have been used. No comparative experiments with

the two types have been performed, but no change in length distribution of the fish was discovered. The seines were therefore considered to have the same selectivity.

In each haul the number of each fish species is counted. The commercial species cod, pollack (*Pollachius pollachius* (L.)), whiting (*Merlangius merlangus* (L.)) and coalfish (*Pollachius virens* (L.)) are measured for length. In this paper only results on cod are presented. Since 0-group cod might sometimes be difficult to separate from the I-group cod, some otoliths have occasionally been sampled.

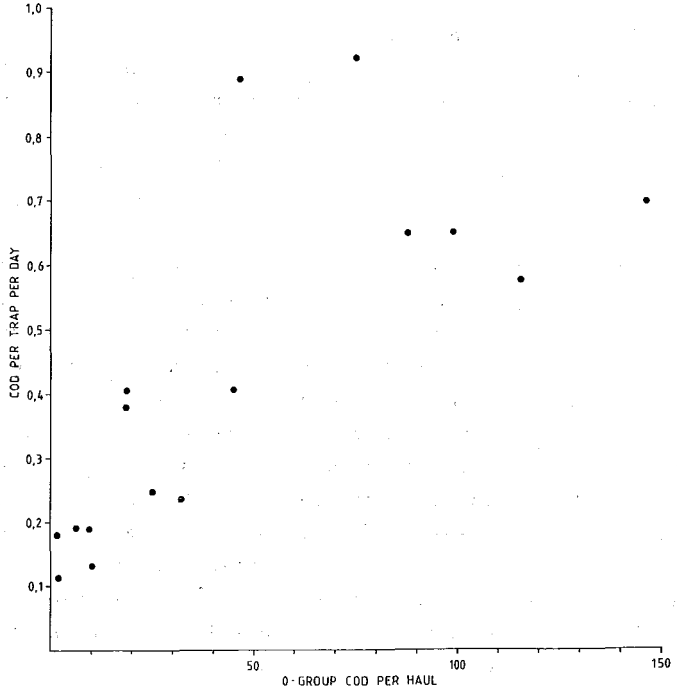

Fig. 2. Catches of 1922-1937 yearclasses as 0-group in four beach seine hauls compared with catches of I-IV group in traps in Topdalsfjord (r = 0.78).

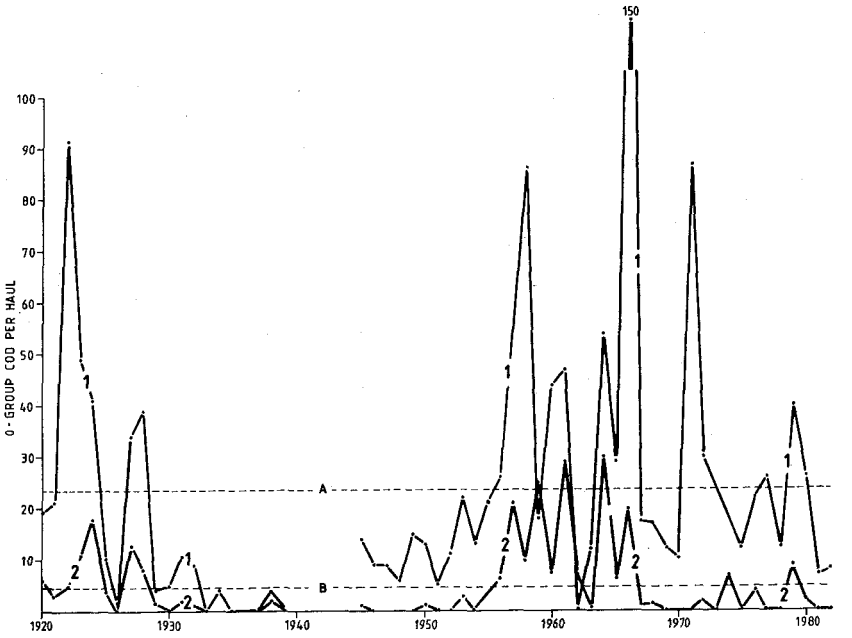

Fig. 3. Comparison of two "rich" hauls (1) and two "poor" hauls (2) in Steindalsfjord. A average for 1, B average for 2.

RESULTS AND DISCUSSION

Dahl (1906) and Dannevig (1906) simply assumed that the strength of a yearclass was determined at the 0-group stage and that the number of cod per haul was a reliable measure of the abundance of the 0-group. Dannevig (1963) showed the good relationship between the 0-group and the I-group cod caught in the seine the following year. Tveite (1971) showed a statistically significant correlation between 0-group per seine haul and the later catches of the yearclass in traps as I-IV group cod. An example of the correlation is here shown in Fig. 2. The basic assumption is therefore supported by observations.

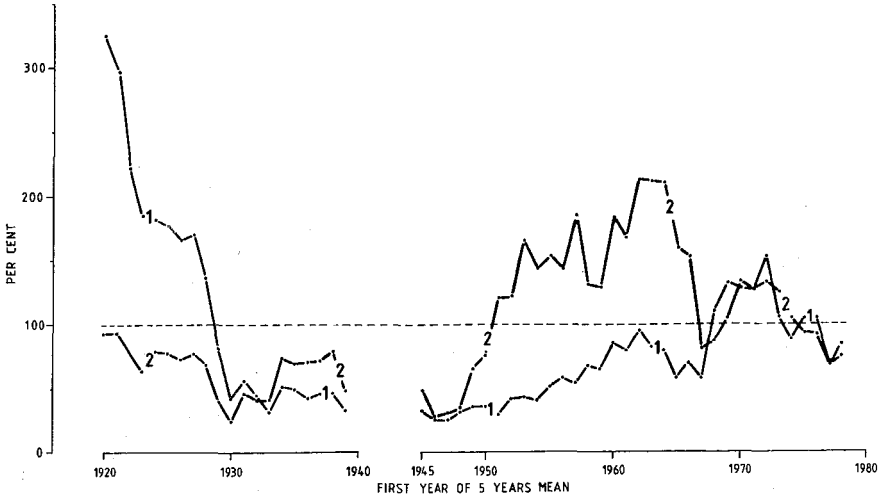

Fig. 4. Five year moving average of percent of average cod per haul for 1920-1982. 1: three landlocked fjords: Topdalsfjord (2) Søndeledfjord (8) and Kilsfjord (11). 2: four more open: Torvefjord (1), Bufjord (5), Flødevigen (6) and Risør Skerries (9).

The average number of cod per haul differs between localities. For example, of four localities in Steindalsfjord (district 3) the same two usually give higher numbers of 0-group cod than the two others (Fig. 3). The fluctuations follow the same pattern ($r = 0.55$), but the absolute differences are big. This shows that new localities should not be used in calculations without compensating for the average level of cod per seine haul for that locality.

The nearly tideless sea in this area might make it more suitable for the beach seine method than areas with big tidal differences. Most of the hauls are more than 5 m deep. This reduces possible effects of variations in the distribution of young cod due to differences in the light conditions.

The long term trends are shown in Fig. 4, 5 and 6. In Fig.

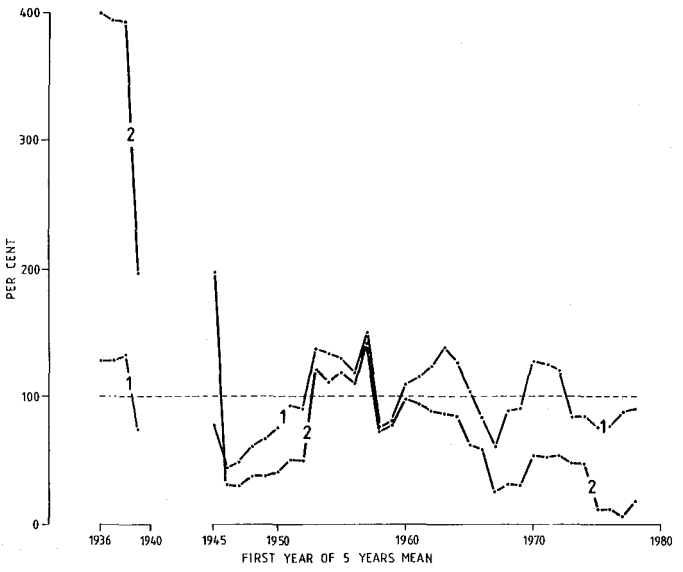

Fig. 5. Five year moving average of percent of average cod per haul for 1936-1982. 1: Outer areas of Oslofjord: Vrengen-Tjøme (14) and Hvaler (15). 2: Inner areas: Holmestrand (16), Drøbak (17) and Nærsnes-Bygdøy (18).

4 the more landlocked fiords south of the Langesund area are compared with the more open ones. The rapid decrease during the 1920's in the landlocked areas has been correlated with the disappearance of *Zostra marina* L. However, the falling trend started long before the extinction of the eel grass,which was mainly observed in 1933 (Dannevig, 1954). From tagging experiments and age-composition of trap-caught cod, it might be concluded that the exploitation rate was quite high before 1940. However, there is no significant explanation for the smaller yearclasses from 1930 onwards (Dannevig, 1954). After 1944 there are no data available to show any changes in exploitation rate.

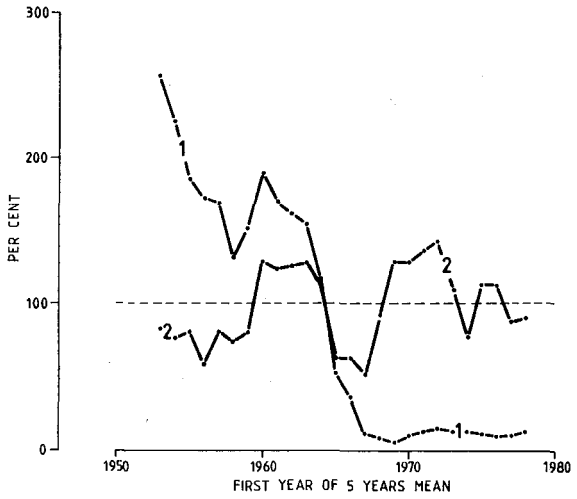

Fig. 6. Five year moving average of percent of average cod per haul for 1953-1982. 1: The Langesund area (13), 2: Stølefjord (10), Kilsfjord (11), Sandnesfjord (7), Søndeledfjord (8) and Risør Skerries (9).

After 1950 there has been a gradual improvement in the landlocked areas on the southern part of the coast. This is in contrast to the inner Oslofjord (districts 16-18) and the Langesund (district 13) area, where there has been a gradual deterioration during the last 25 years (Fig. 5 and Fig. 6).

Rueness (1973) and Bokn and Lein (1978) have described changes in the algal flora in the Oslofjord. A more rough picture of the situation in the Langesund area, based on descriptions of the bottom conditions given every year for each haul, is shown in Fig. 7. During the sixties the eel grass (*Zostra marina* L.) disappeared and the green algae *Ulva lactuca* L. became a dominant species. This was most probably caused by changes in the pollution to the area (Bokn, 1979). Simultaneously the abundance of 0-group cod was drastically reduced (Fig. 6). Whether this reduction is caused directly by pollution, for instance on the larval stage, or indirectly through

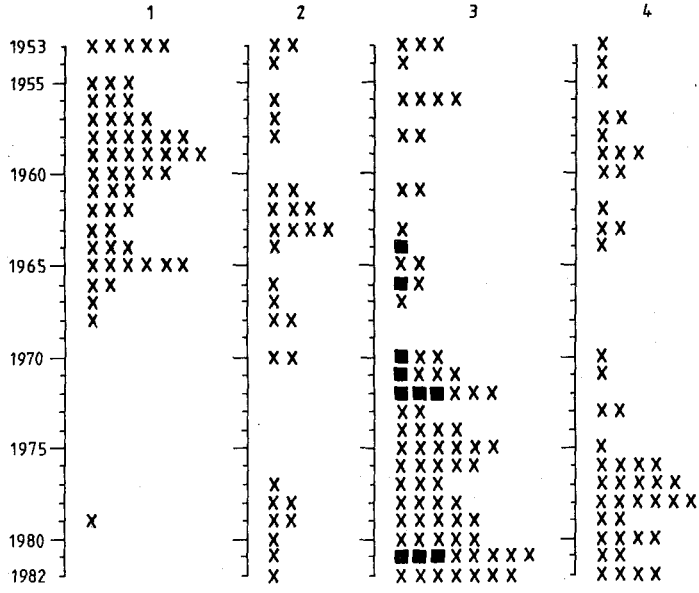

Fig. 7. Observations of bottom conditions at the nine localities in the Langesund area. Based on descriptions given for each haul every year.
1. Eel grass (*Zostra marina*)
2. Brown algae
3. Green algae (mostly *Ulva lactuca*)
4. Blue mussels
X: Observed in a haul
■: So much that it made sampling of fish difficult or impossible.

the deterioration of the littoral zone as a habitat for 0-group cod, is not known. However, the trends in these areas are so clearly different from the trends in less polluted areas that pollution must be considered as the original reason for reduced recruitment.

In the Holmestrand (district 16) area a similar development has taken place without the obvious changes in the bottom flora. In some of the other areas in the Oslofjord the trend is the same, although some rich yearclasses have occurred in between the poor ones also during the later years.

CONCLUSION

At an age of six months the abundance of cod measured by the beach seine method can be used to predict the abundance of the yearclass recruiting later to the fishery along the Norwegian Skagerrak coast.

For the Langesund area and the inner parts of the Oslofjord, pollution has directly or indirectly had a negative effect on recruitment. In the rest of the areas investigated no such effect can be traced.

REFERENCES

Bokn, T., 1979. Klasser av fastsittende alger brukt som indikator på eutrofiering i estuarine og marine vannmasser. Norsk Inst. Vannforsk., årbok 1978: 53-59.

Bokn, T. and Lein, T.E., 1978. Long term changes in fucoid associations of the inner Oslofjord, Norway. Norw. J. Bot. 25: 9-14.

Dahl, K., 1906. Undersøgelser over nytten af torskeudklækning i Østlandske fjorde. Norges Fiskerier Aarsber., 1906: 1-97.

Dannevig, G.M., 1906. Undersøgelser over nytten af torskeudklækning i Østlandske fjorde. Norges Fiskerier Aarsber., 1906: 101-121.

Dannevig, A., 1921. Foreløbig meddelselse om undersøkelser vedkommende aarsyngel av torskefisk i strandregionen paa Sørlandet, særlig i forbindelse med udslipning av torskeyngel. Norges Fiskerier Aarsber., 1919: 258-293.

Dannevig, A., 1954. The littoral cod of the Norwegian Skagerrak coast. Rapp. P.-v. Réun. Cons. Int. Explor. Mer, 136: 7-14.

Dannevig, G., 1963. Artificial progapation of cod. Some results of the liberation of larvae. FiskDir. Skr. Ser. HavUnders., 13: 73-79.

Rueness, J., 1973. Pollution effects on littoral algal communities in the inner Oslofjord, with special reference to *Ascophyllum nodosum*. Helgoländer wiss. Meeresunters., 24: 446-454.

Tveite, S., 1971. Fluctuations in yearclass strength of cod and pollack in southeastern Norwegian coastal waters during 1920-1969. FiskDir. Skr. Ser. HavUnders., 16: 65-76.