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RECRUITMENT OF COD (*GADUS MORHUA*), WHITING (*MERLANGIUS MERLANGUS*) AND POLLACK (*POLLACHIUS POLLACHIUS*) IN THE RISØR AREA ON THE NORWEGIAN SKAGERRAK COAST 1945 TO 1985

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ABSTRACT

Gjøsæter, J. and Danielssen, D.S. 1990. Recruitment of cod (*Gadus morhua*), whiting (*Merlangius merlangus*) and pollack (*Pollachius pollachius*) in the Risør area on the Norwegian Skagerrak Coast 1945 to 1985. Flødevigen rapportser. 1, 1990: 11-31.

0-group gadoids and other fishes from the shallow water zone were sampled with a beach seine at 22 fixed localities in the Risør area at the Norwegian Skagerrak coast. A series of 41 years (1945 - 85) has been analysed.

Cod, whiting and pollack showed great variation in 0-group abundance, but no consistent trend over the period studied. There was a slight positive correlation between 0-group abundance of cod and pollack. Whiting showed no correlation to the others.

There was a good correlation between the 0- and 1-group cod of the same year-class in the beach seine in the area. The catches of 0- and 1-group cod showed also a good correlation to the whole Norwegian Skagerrak coast, and two very good year-classes never followed each other.

The Risør area was divided into six subareas, and the abundance in these subareas was closely correlated for cod and pollack, but only weakly for whiting.

Cod and whiting were most abundant in protected areas, while pollack was most abundant at exposed stations. All species generally had an increase in mean length at increased exposure.

There was no correlation between size and abundance, although the five smallest year-classes of cod and pollack had a lower mean size than average.

There was no correlation between the abundance of any of the gadoids and of the other species studied.

INTRODUCTION

Off the Skagerrak coast, O-group cod (*Gadus morhua*) spend their first summer and autumn in shallow waters (Dahl 1906, Tveite 1971,

1984). The 0-groups of other gadids such as whiting (*Merlangius merlangus*), pollack (*Pollachius pollachius*) and sometimes saithe (*Pollachius virens*), are also common there, as are juveniles and adults of a number of non-commercial shallow water fishes. In addition to these, I-group cod are often found in the same area (i.e. Gjøsæter et al. 1989).

The cod generally settle in shallow water in May or June, when they are about 3 - 5 cm long. During autumn, usually in October - November, they leave the shallow areas and descend to deeper water where the temperature is higher (Dahl 1906).

Tveite (1971) has shown that there is a close correlation between the number of O-group caught in the littoral zone during autumn and subsequent abundance of that year-class along the Norwegian Skagerrak coast. Similar observations have been made in other areas (Hylen og Dragesund 1973, Randa 1984). Therefore, at least some of the factors regulating the year-class strength must act during the planktonic stages of the cod larvae or during the period of settlement in the littoral zone.

Tagging experiments have revealed that the cod off the Skagerrak coast form many local aggregations with little migratory exchange (Løversen 1946, Danielssen 1969, Danielssen in prep.).
The objective of the present paper is to describe the abundance and distribution of juvenile gadids in shallow waters in the Risør area, and their relationship to each other and to the environment.

Since cod is the most important commercial species, the main emphasise is put on this species, while whiting and pollack are dealt with more briefly.

MATERIALS AND METHODS

Samples of young fish were collected in the Risør area on the Norwegian Skagerrak coast during the period 1945 to 1985 using a beach seine.

Before 1961 a seine made of cotton twine was used for sampling. It was 38.0 m long and 3.8 m deep, and the stretched mesh size was 14 mm. From 1962 a nylon seine of the same size and construction was used. No comparative experiments with the two seines were performed, but as no significant change in number per seine haul and no apparent difference in length distribution of the fish caught in the two seines was found

in the years immediately after 1961, the seines were considered to have the same fishing power (Tveite 1971, 1984).

The stations were surveyed at the same time each autumn and the same sampling sites were used throughout. The seine was never operated by an entirely new crew in two successive years, which ensured consistency in the sampling protocol. The area and the subareas are shown in Fig. 1 and Table 1.

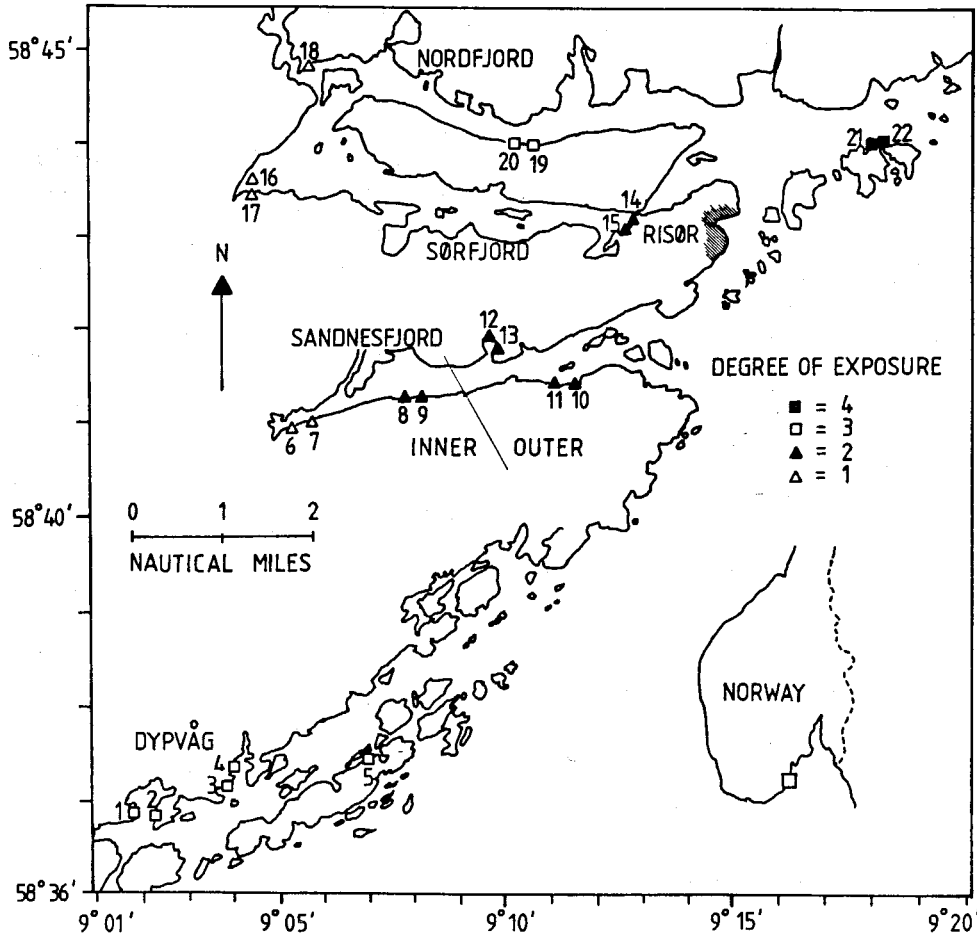

Fig. 1. The area surveyed, showing beach seine stations and their degree of exposure on a scale from 1 to 4 where 4 is the most exposed. The subareas are also indicated.

Table 1

Subareas sampled during the beach seine survays. The positions of the stations are shown in Fig. 1.

Area	Stations
Dybvåg	1 - 5
Inner Sandnesfjord	6 - 9
Outer Sandnesfjord	10 - 13
Sørfjord	14 - 17
Nordfjord	18 - 20
Risør	21 - 22

In each catch the fish were identified to species. Numbers and lengths of cod, whiting and pollack were recorded. Other fish species were classified only as absent (0), present (1) and abundant (2).

The temperatures used are monthly averages of daily temperature records at 1 m depth measured at the Flødevigen Biological Station near Arendal.

Statistical analyses of the data utilised the methods described by Zar (1974) and Siegel (1956), using the computer programs StatView and StatWorks.

RESULTS

Annual variation in abundance

General trends

During the period of 1945 - 1985 the annual average number of cod caught per haul varied between 0.5 and 38 with a mean of 10.5. There was no trend in the abundance through this period (Spearman's rank correlation, $r = 0.212$, $N=41$, $P > 0.05$) (Fig. 2).

The annual average number of whiting caught per haul varied between 2.3 and 150.9 with a mean of 37.2 (Fig. 2). There was no trend in the abundance through this period (Spearman's rank correlation, $r = 0.007$. $N=41$, $P >> 0.05$).

For pollack, the annual average number caught per haul varied between 0.5 and 46.7 with a mean of 8.2 (Fig. 2). There was no trend in the abundance through this period (Spearman's rank correlation, $r = -0.258$. $N=41$, $P > 0.05$). The five strongest (in descending order) and the five

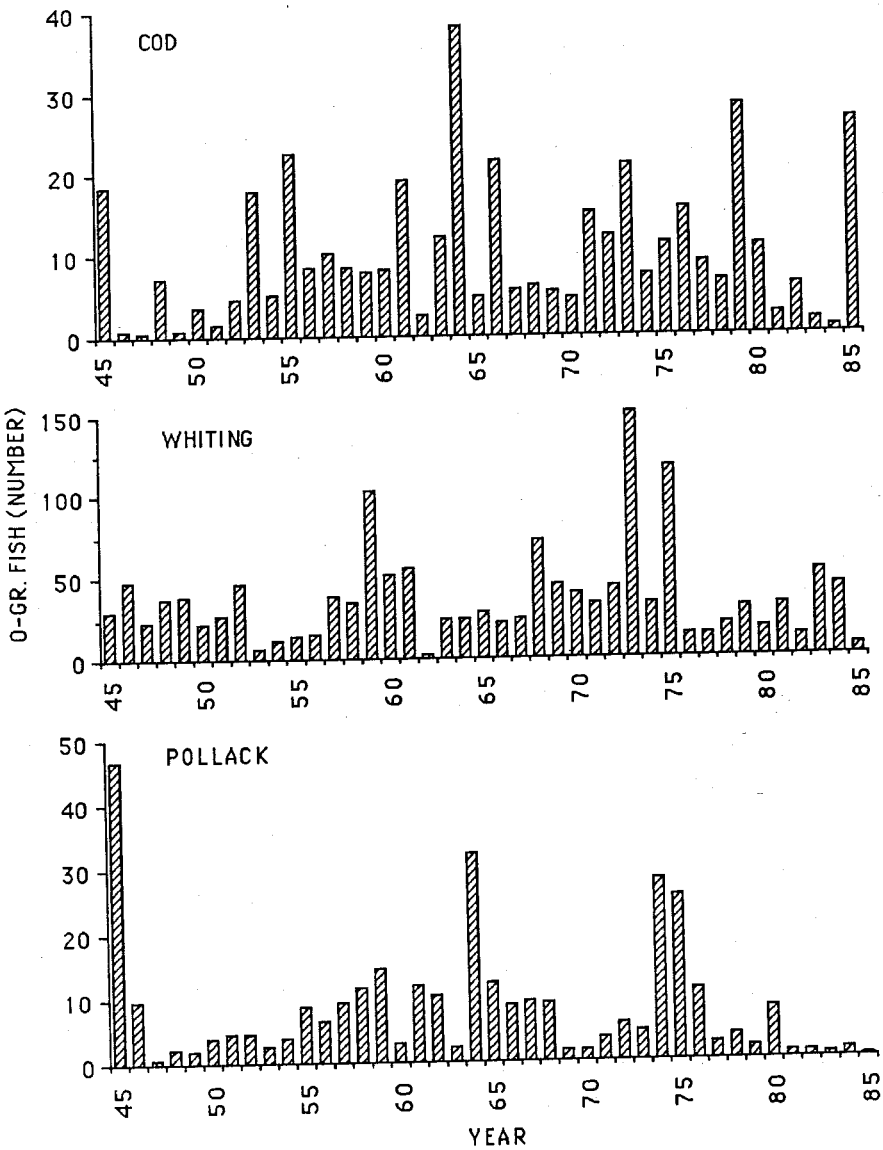

Fig. 2. Annual mean catch of O-group cod, whiting and pollack caught by beach seine from the whole Risør area.

weakest (in ascending order) year-classes of the three species are shown in Table 2.

The ratio between the strongest and the weakest year-class observed was 73, 65 and 103 for cod, whiting and pollack respectively.

Table 2

The five strongest (in descending order) and the five weakest (in ascending order) year-classes of cod, whiting and pollack.

	Cod	Whiting	Pollack
Strongest	1964	1973	1945
year-classes	1979	1975	1964
	1985	1959	1974
	1955	1968	1975
	1966	1961	1959
Weakest	1947	1962	1985
year-classes	1946	1985	1947
	1984	1953	1983
	1949	1954	1981
	1951	1982	1982

Trends in subareas

Analysing the abundance in the subareas (see Fig. 1) separately showed that there was a significant increasing trend of 0-group cod in Sørfjorden (Table 3). In Dybvåg there was an apparent decrease in number of 0-group cod, but the trend was not significant (Table 3). Pollack showed a significant decreasing trend in Dybvåg. In the other areas no trend in the abundance of 0-group cod could be found.

Since data from Dybvåg were only available after 1961, a separate analysis was run including only data after this year. This procedure made all the correlations non-significant.

Table 3

Results of the Spearman's rank analyses of the correlation between number of O-group cod and time. Data from Dybvåg from 1962 - 1985. All other areas 1945 - 1985. Significance: P<0.05; *.

Area	Spearman's rank		
	Cod	Whiting	Pollack
Dybvåg	-0.31	-0.01	-0,48*
Inner Sandnesfjord	0.06	-0.20	-0.24
Outer Sandnesfjord	-0.03	-0.14	-0.22
Sørfjord	0.37*	0.14	-0.14
Nordfjord	0.16	0.03	-0.03
Risør	0.01	0.01	-0.19
Total	0.06	0.01	-0.19

Correlation between the Risør area and the whole Skagerrak coast.

An analysis of the relationship between average number of 0-group cod per haul in the Risør area and on the whole Skagerrak coast, revealed a close correlation (Spearman's rank correlation, r = 0.65. N=41, P < 0.01, Fig. 3). A comparable correlation was found between number of I-group cod in the Risør area and on the whole Skagerrak coast (Spearman's rank correlation, r = 0.60. N=41, P < 0.01, Fig. 4).

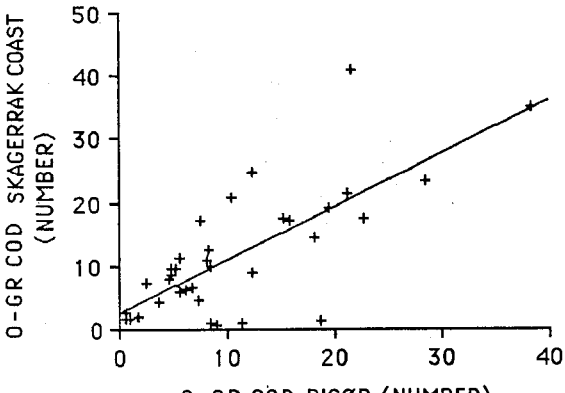

Fig. 3. Relationship between average number of 0-group cod per haul in the Risør area and on the whole Skagerrak coast in the same year. The line indicate a least square regression.

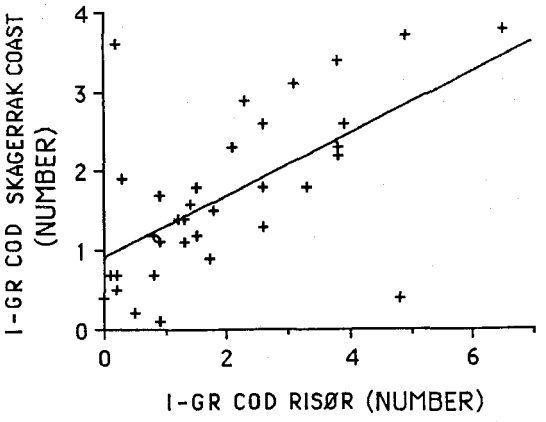

Fig. 4. Relationship between average number of I-group cod per haul in the Risør area and on the whole Skagerrak coast in the same year. The line indicates a least square regression.

Similar analyses were conducted for pollack and whiting (Fig. 5 and 6). For pollack there was a very close correlation between numbers caught in the Risør area and number caught off the whole Skagerrak coast in the same year (Spearman's rank correlation, $r = 0.89$. $N=41$, $P < 0.01$, Fig. 5). The correlation was weaker for whiting , but still significant (Spearman's rank correlation, $r = 0.62$. $N=41$, $P < 0.01$, Fig. 6).

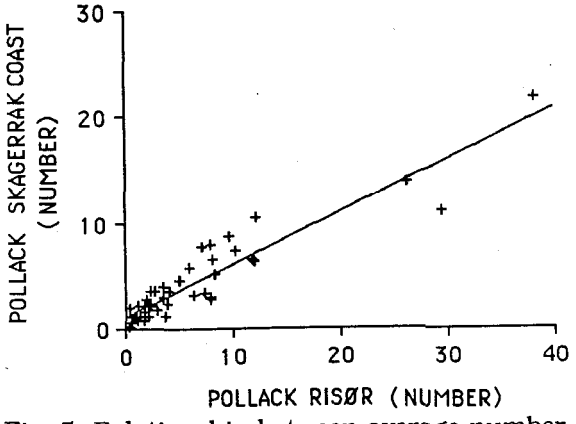

Fig. 5. Relationship between average number of 0-group pollack per haul in the Risør area and on the whole Skagerrak coast in the same year. The line indicates a least square regression.

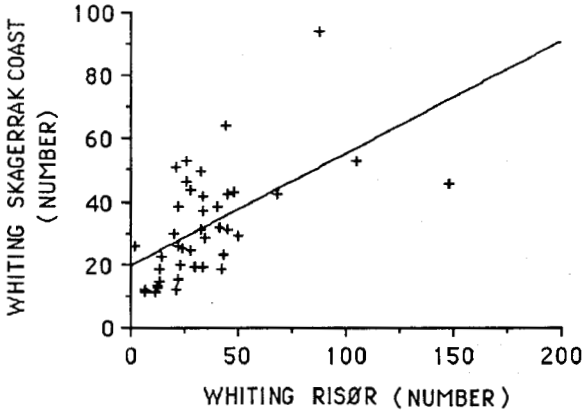

Fig. 6. Relationship between average number of 0-group whiting per haul in the Risør area and on the whole Skagerrak coast in the same year. The line indicates a least square regression.

Number of 0-group cod and successive number of I-group.

There was a significant correlation between the number of 0-group cod caught in the beach seine in one year and the number of I-group cod caught the next year (Spearman's rank correlation, $r = 0.67$. $N=40$, $P < 0.01$, Fig. 7). The I-group of whiting and pollack were rarely caught in beach seine.

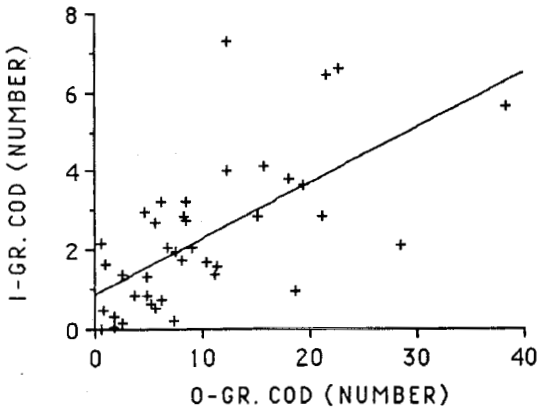

Fig. 7. The relationship between average number of 0-group cod caught in the beach seine one year and the number of I-group cod caught the next year. The line indicates a least square regression.

O-group abundance, length and temperature.

No significant correlation could be found between the number of 0-group cod caught and the monthly mean temperature during spring and summer. Neither was the size of the 0-group cod related to temperature. Similar analyses were conducted for whiting and pollack, and for those species too,there was no correlation between number or size and average temperature (Table 4).

Table 4

Correlation coefficients between numbers and length of O-group cod, whiting and pollack and monthly mean temperature at 1 m depth off Flødevigen. Significance: P < 0.05; *, P < 0.01; **.

	Number			Length		
Month	Cod	Whiting	Pollack	Cod	Whiting	Pollack
March	0.01	0.27**	0.08	0.06	0.00	0.03
April	-0.01	0.13*	0.13*	0.01	0.00	0.02
May	-0.10*	0.04	0.01	-0.01	-0.04	0.00
June	0.00	-0.02	-0.06	-0.02	-0.01	-0.02
July	-0.01	0.05	0.01	-0.04	-0.01	0.05
August	-0.01	0.04	0.01	-0.01	-0.03	-0.04
Sept.	-0.06	0.09	0.04	0.00	-0.01	0.00

Distribution

Variation in abundance between stations

The average number of 0-group cod caught per haul at each station studied during the period 1945 - 1985, varied from 2.0 (st. 21) to 40.6 (st. 6)(Fig. 8). The variance for cod was closely related to the mean i.e. stations with high mean number also had a high variance. (Spearman's rank correlation, $r = 0.937$, N=22, P> 0.01). Therefore, stations with a low mean gave relatively few fishes also in good years, while the good stations gave very high numbers in good years.

There was no significant relation between the average number of 0-group and I-group found at any one station (Fig. 9) (Spearman's rank correlation, $r = 0.167$, N=22, $P > 0.05$).

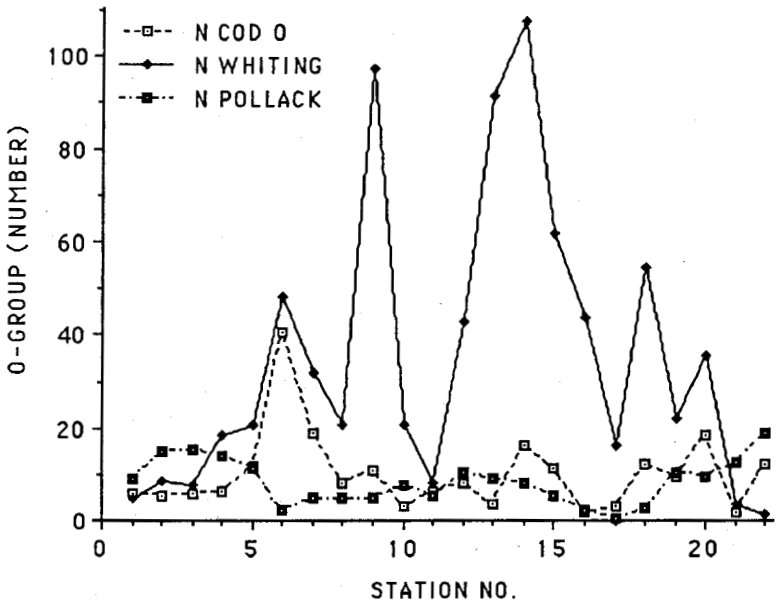

Fig. 8. Average number of 0-group cod, whiting and pollack at the stations in the Risør area. For location of the stations see Fig 1.

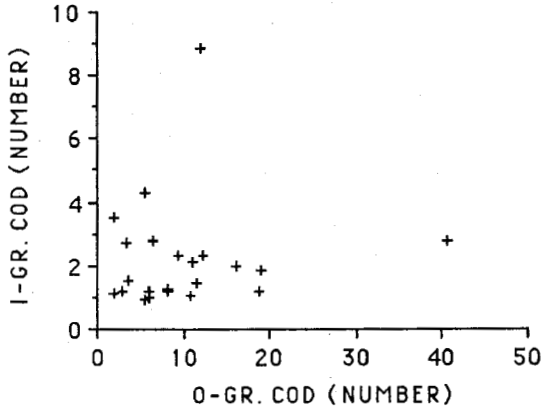

Fig. 9. Relation between the average number of 0-group cod and 1-group cod at the 22 stations in the Risør area.

The average number of 0-group whiting caught per haul at the stations studied varied from 2.7 (st. 22) to 107.7 (st. 14) (Fig. 8). For pollack the respective numbers were 0.7 (st. 17) and 19.1 (st. 22) (Fig. 8). I-group whiting and pollack were, as earlier mentioned rarely caught in the beach seine.

Distribution in subareas

The number of 0-group cod taken in different subareas in the same year generally shows a high correlation (Table 5). Dybvåg and Sørfjord seem to be slightly different from each other, and so are Sørfjord and outer Sandnesfjord and Sørfjord and Risør. For Dybvåg it should also be noted that the series for this area is much shorter than in the other areas.

For whiting there was hardly any correlation between most areas, and only few significant values were found (Table 6). For pollack, on the other hand, the significance of the correlation between the areas was high, indicating that the abundance in all the areas were closely related to each other (Table 7).

Table 5

Correlation between number of 0-group cod in the different areas during 1945 - 85. (Data from Dybvåg, 1962 - 1985.) The values given are Spearman's rank correlation coefficients. Significance: $P<0.05$; *, $P<0.01$;**.

	Inner Sandnes-fjord	Outer Sandnes-fjord	Sør-fjord	Nord-fjord	Risør
Dybvåg	0.44*	0.56**	0.20	0.40*	0.79**
Inner Sandnes-fjord		0.66**	0.33*	0.42**	0.47**
Outer Sandnes-fjord			0.20	0.47**	0.71**
Sørfjord				0.57**	0.15
Nordfjord					0.45**

Table 6

Correlation between number of 0-group whiting in the different areas during 1945 - 85. (Data from Dybvåg, 1962 - 1985.) The values given are Spearman's rank correlation coefficients. Significance: P<0.05; *, P<0.01 **.

	Inner Sandnes-fjord	Outer Sandnes-fjord	Sør-fjord	Nord-fjord	Risør
Dybvåg	0.26	-0.13	0.39	0.15	0.64**
Inner Sandnes-fjord		0.19	0.24	0.36*	0.20
Outer Sandnes-fjord			0.07	0.09	-0.10
Sørfjord				0.15	0.40*
Nordfjord					0.14

Table 7

Correlation between number of 0-group pollack in the different areas during 1945 - 85. (Data from Dybvåg, 1962 - 1985.) The values given are Spearman's rank correlation coefficients. Significance: P<0.05; *, P<0.01;**.

	Inner Sandnes-fjord	Outer Sandnes-fjord	Sør-fjord	Nord-fjord	Risør
Dybvåg	0.86**	0.62**	0.72**	0.85**	0.79**
Inner Sandnes-fjord		0.55**	0.58**	0.70**	0.54**
Outer Sandnes-fjorden			0.42*	0.61**	0.59**
Sørfjord				0.66**	0.36*
Nordfjord					0.72**

Fish abundance and degree of exposure

The exposure was classified from 1 to 4 where 1 is well protected bays and 4 is in the open skerries. Two stations (82 hauls) were classified as 4, nine stations (294 hauls) as 3, six stations (252 hauls) as 2, and five stations (195 hauls) as 1 (see Fig 1).

The number of cod per haul was highest at exposure 1 and decreased gradually towards the most exposed areas (Fig. 10). Whiting were most abundant at exposure 2, while pollack was most abundant at the most exposed areas (4), decreasing gradually towards more sheltered areas. For 0-group cod, whiting and pollack the exposure had a significant influence

on the number of fish per haul (Kruskal-Wallis test, H = 20.9, 146.5 and 121.5 respectively, v = 3, $p < 0.001$).
For older cod the abundance was highest in the most exposed areas (H = 7.3, $p \approx 0.07$) (Fig. 11).

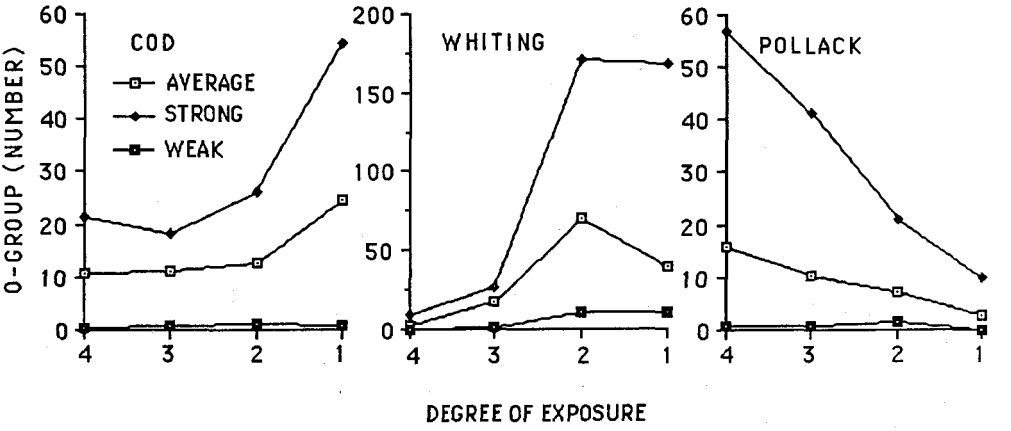

Fig. 10. The relationship between exposure and number of 0-group cod, whiting and pollack of the 5 strongest and the 5 weakest year-classes caught in the beach seine. 4 is most exposed, 1 most sheltered, average, is the mean of all year-classes, strong, and weak, are average of the five strongest and five weakest year-classes respectively.

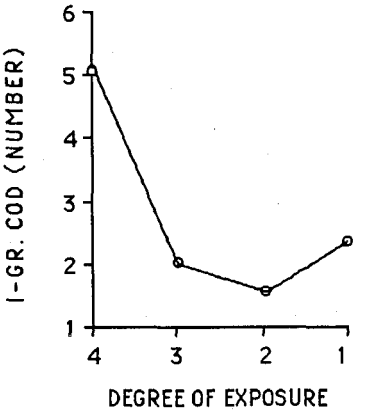

Fig. 11. The relationship between exposure and number of I-group cod caught in the beach seine. 4 is most exposed, 1 most sheltered.

Fish length also varied with exposure (Fig. 12). The mean length of the 0-group was largest at the more exposed stations for all species, and the differences were statistically significant (Kruskal-Wallis test, H = 104.2, 36.7 and 45.6 respectively, v = 3, $p < 0.001$). The whiting had the largest mean length, and the cod the smallest in all areas.

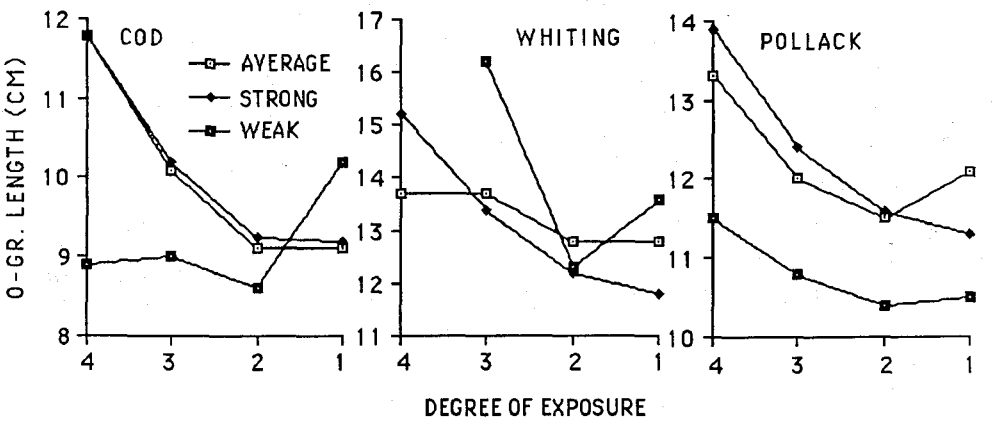

Fig. 12. The relationship between exposure and size of 0-group cod, whiting and pollack. 4 is most exposed, 1 most sheltered. Average is the mean of all year-classes, strong and weak are average of the five strongest and five weakest year-classes respectively.

The relationship between exposure and number and size of 0-group fish of the 5 strongest and the 5 weakest year-classes caught in the beach seine were analysed separately (Fig. 10 and 12). For all species the difference between the areas became more pronounced for large year-classes. A progressively higher percentage of the fish were found in the most preffered area for cod (exposure 1) and pollack (exposure 4). For whiting the largest relative increase in number was found in the most sheltered areas, although the average yearclass was most abundant at degree of exposure 2.

The mean size of an average and a big year class was rather similar for cod and pollack (Fig. 12) A small year- class of these species in most cases had a lower mean length. The number of fish measured during the years with weak year- classes were however low, and the differences may not be real. The length of whiting did not show the same picture.

Relationships and interactions

Size and Abundance

There was no correlation between the number of 0-group cod caught at a station, and the size of the cod at the same station (Spearman's rank correlation, $r = 0.054$, $N=598$, $P > 0,05$). The correlation between number of cod caught one year and the mean length of that year-class was also analysed, and found to be not significant (Spearman's rank correlation, $r = -0.038$, $N=41$, $P > 0,05$), although the 5 weakest year-classes proved to have a lower mean size than the average.

For whiting and pollack too, the correlation between number caught one year and the mean length of that year-class was analysed, and found to be not significant (Spearman's rank correlation, $r = -0.193$, $N=41$, $P > 0,05$ and $R = 0.218$, $N=41$, $P > 0,05$ respectively).

Relation between number of cod, whiting and pollack

There is no significant correlation between the number of 0-group cod and whiting caught at a particular station (Spearman's rank correlation, $r = 0.417$, $N=22$, $P \approx 0.05$). Analysing the annual mean numbers, there were no correlations between the abundance of 0-group cod and 0-group whiting (Spearman's rank correlation, $r = -0.152$, $N=41$, $P > 0,05$).

A similar analysis of the relation between annual mean number of cod and pollack gave a slight, but not significant correlation (Spearman's rank correlation, $r = 0.286$, $N=41$ $P > 0,05$). There was no correlation between whiting and pollack (Spearman's rank correlation, $r = 0.121$, $N=41$ $P > 0,05$).

Relation between size of cod, whiting and pollack

There was a week, but significant correlation between the annual mean size of 0-group cod and whiting in the same haul (Spearman's rank correlation, $r = 0.337$, $N = 41$, $0.05 > P > 0,02$) and between 0-group cod and pollack (Spearman's rank correlation, $r = 0.299$, $N = 41$, $0.05 > P > 0,025$) while no such correlation was found between whiting and pollack (Spearman's rank correlation, $r = 0.082$, $N = 41$, $P > 0,05$).

Cod and other species

The annual mean number of 0-group cod showed no significant relation to the abundance indices of any of the non-gadid species caught (Table 8).

Table 8

Spearman rank correlations ,r, between annual mean number of 0-group cod and abundance indices of other species (N = 41).

Species		r	P
Goldsinny wrasse	*Ctenolabrus rupestris*	0.072	>0.50
Other labridae	*Labridae*	-0.017	>0.50
Gobidae	*Gobidae*	-0.001	>0.50
Stickleback	*Gasterosteus aculeatus*	0.307	0.10>P>0.05
Flounder	*Platichthys flesus* (L.)	0.309	0.10>P>0.05
Herring	*Clupea harengus* L.	0.063	>0.50
Sprat	*Sprattus sprattus*	-0.305	0.10>P>0.05
Mackerel	*Scomber scombrus* L.	-0.188	0.50>P>0.20
Sand eel	*Ammodytes lancea* Yar	-0.255	0.20>P>0.10
Pipe fish	*Siphonostoma typhle*	-0.044	>0.50
Other fish		-0.13	0.50>P>0.20
Crab	*Carcinus meanas*	-0.203	0.50>P>0.20

Similar analyses were conducted between length of cod and the abundance indices of the other species. No significant correlation was found.

DISCUSSION

Catches of 0-group cod by beach seine along the Norwegian Skagerrak coast in the autumn have been compared with trap catches of older fish of the same year-classes, and found to give a resonably good estimate of year-class strength (Tveite 1971). The present investigation showed that there was a good correlation between the 0- and I-group cod of the same year-class in the beach seine, which support the previous findings. A considerable part of the I-group cod was still in the shallow near-shore waters in the autumn, which is also found by Pihl (1982) for the Swedish Skagerrak coast.

Beach seine catches of 0- and 1-group cod in the Risør area showed a good correlation with the whole Norwegian Skagerrak coast. The year-

class strength in this area may, therefore, be used as an indication of year-class strength along the whole coast. Tveite (1984) came to the same general conclusion although he found some differences between fjords and open coastal areas. He also showed that the inner Oslofjord and the Langesund area showed a decreasing trend in cod abundance, probably due to direct or indirect effects of pollution.

The mean number of 0-group cod in beach seine catches, therefore reflects the relative year-class strength in the area in the period 1945-1985. Great variations from year to year were present, but no trend was evident during the period. Although no significant correlation was found between the recruitment in two consecutive years, it seemed, however, that two very good year-classes never followed each other. This was also shown by Pihl and Ulmestrand (1988), and is possibly due to sharing of habitat and competition between 0- and I-group cod, and that I-group cod prey on the younger fish (Gjøsæter 1988).

Two of the best year-classes during the whole period were those of1979 and 1985 and very good year-classes were also observed in the Skagerrak and Kattegat area during those years(Anon, 1988. Pihl and Ulmestrand, 1988). The cod in the Skagerrak and the Kattegat are supposed to belong to two different stocks (Anon, 1989), and are also different from the cod on the Norwegian Skagerrak coast (Ruud, 1939. Løversen, 1946. Danielssen, 1969). In addition to a possible predation pressure on 0-group cod, there are probably environmental factors that control the recruitment of year-classes even if there are separate stocks involved.

There was a close correlation between the 0-group pollack in the Risør area and along the whole Skagerrak coast and for whiting there was also a good correlation, but not as good as for the two other species. These correlations indicate that similar factors may determine the year-class strength all along the coast.

For whiting and pollack there is no data to show that the abundance of 0-groups reflects the recruitment to the adult stock. There is no commercial fishery for these species in the area and the older year-classes of these species are not caught in significant numbers by beach seining.

For none of the species studied was there any trend in their abundance over time. This was also generally the case when the Risør area was separated into subareas, although there were indications of an increase in the number of cod in the Sørfjord and a decrease in number

of pollack in Dybvåg. This may suggest that there has been no large changes in the environment during the period studied, or that any changes have not influenced the recruitment of these species. Further, it indicates that there has not been a decline in the spawning stock size large enough to give recruitment failure.

All species showed a high variability between years and between stations. Between years cod varied by a factor of 70, pollack by a factor of 102 and whiting by a factor of 65. Between stations the factors were 21, 28 and 73 for cod, pollack and whiting respectively. The great spatial variation in whiting was also reflected in a low correlation in abundance between subareas, and lower correlation between the Risør area and the whole Skagerrak coast than for the other species.

The number of 0-group cod per haul declined from the sheltered to the exposed stations, while the average length of the 0-group increased in the same direction. Simultaneously the number of I-group cod per haul increased from the sheltered to the exposed stations. This may indicate a migration towards the exposed areas, or an increasing growth and survival in that direction, but the data for I-group cod is very scarce.

There are indications that the whiting prefer less exposed areas than cod, while pollack prefer more exposed areas. On the British North Sea coast, Riley and Parnell (1984) found that cod were more abundant in inshore waters with low salinity than whiting, but this contrasts with our observations. That pollack preferred more exposed areas than cod was also observed on the coast of mid Norway (Godø et al. 1989). Whiting was less abundant in that area, most of them being observed in inshore waters.

No positive correlation was observed between the abundance of the three species. This may indicate that different factors determine their year-class strength, but possibly more likely that the difference in spawning time between the species make them subjects to different environmental conditions, during the pelagic stages.

Years of relatively high water temperature tended to give better year-classes than cold years in the Lofoten area (Ellertsen et al. 1987), while no clear trend was observed in the Risør area for any of the species studied. Neither was there a correlation between temperature and growth. This suggests that factors other than temperature determine the survival and growth of the juveniles. Stability of the water-masses which influences food availability seem to be an important factor for cod recruitment in both areas (Tilseth 1984, Johannessen and Tveite 1989).

No correlation was observed between the number of 0-group cod, whiting or pollack and their average size. This may suggest either that there is no common carrying capacity for these species (i.e. little inter-specific competition) or that the eventual carrying capacity for the 0-group of these species has not been trespassed during the period studied. Individuals from the poorest year-classes were smaller than average and large year-classes, which suggest that a year producing a large year-class also produce enough food for them while very low year-classes may lack food due to poor production.

No correlation was found between potential prey species and size or abundance of the three gadids studies. However, in Masfjorden, western Norway, Fosså (1989 a, b) showed that there was a correlation between production of an important prey item, the gobid, *Gobiculus flavescens*, and 0-group cod. This could be caused by his different approach as Fosså measured production over a period of time while our data give standing stock and length at one specific time only.

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