FACTORS DETERMINING THE YEAR-CLASS STRENGTH OF NORWEGIAN SPRING SPAWNING HERRING

by

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ABSTRACT

More than 30 years of Russian and Norwegian data on spring-spawning herring larvae along the coast of Norway has been investigated and analyzed together with different environmental parameters and spawning stock size. Quantifiable relations between time series of the yearly abundance of herring larvae, the spawning stock and wind has been found. Together with information on the sea temperature this form the basis for predicting 3 years ahead the strength of the 3 years old herring stock with a preliminary accuracy of about $\pm 3*10^9$ individuals.

INTRODUCTION

In general, recruitment forecasting from larval surveys is not widely employed (Heath 1992). This is partly due to lack of long time series. However, Svendsen *et al.*, (1994) have managed to quantify clear connections between the size of the spawning stock biomass and the environmental conditions during the larval development.

The Institute of Marine Research, Bergen (IMR), has annually since 1948 been sampling fish eggs and larvae at different localities along the Norwegian coast. The sampling during the spring and summer seasons has partly been aimed at the study of single species such as herring and cod. After 1966 a closer sampling grid was introduced from Stad (62°N) to Vestfjorden (68°N), and the sampling in this area in March/April was aimed at the study of the herring larvae only (Fig.1). The objective was to locate spawning grounds and to monitor spawning period, survival and distribution of herring larvae (Bjørke, Fossum and Sætre 1986; Fossum, Bjørke and Sætre 1987 and Sætre, Bjørke and Fossum 1988).

Since 1959, former USSR has annually also been sampling herring larvae outside the Norwegian fishery border at fixed stations along the Norwegian coast (Yudanov 1962; Seliverstov 1974; Krysov, Muchina and Seliverstova 1986 and Krysov and Ergakova 1990).

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A net similar to the modified WP II net has been used (Yudanov 1962). The objective of these investigations was similar to that of the Norwegian investigations. This material presents a rather long time series, and the intention of the present work was to see if this total material can indicate any connection between physical conditions and survival of herring larvae.

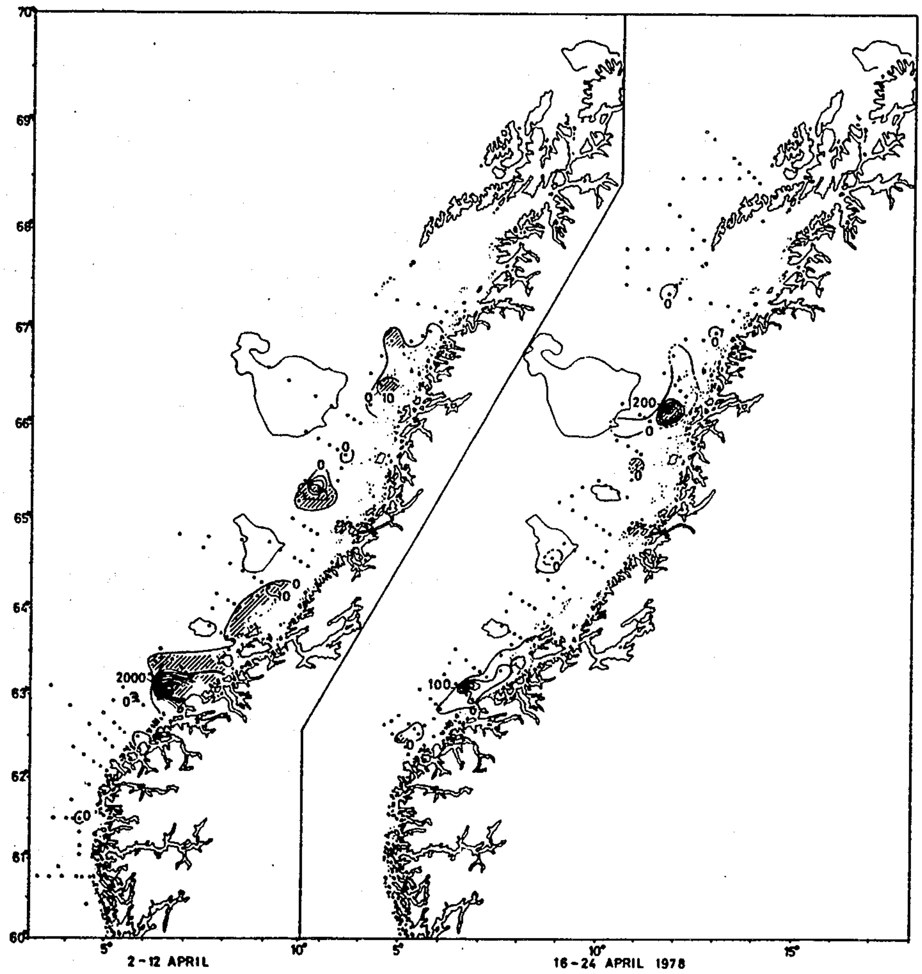

Figure 1. Norwegian stations in 1978. Hatched areas indicate findings of larvae smaller than 9 mm.

BACKGROUND

Hjort (1914) showed that the year-class strength for Atlanto-Scandian herring is established during the early stages of larval life, especially during the transition to mixed feeding. Soleim (1942), conducting investigations under aquarium conditions and at the spawning grounds, found that the survival of larvae depended on the spawning period of zooplankton and the transition of larvae to mixed feeding of copepod eggs and nauplii.

Hjort's hypothesis find some support in recent studies on herring larvae by Moksness and Fossum (1992) and Fossum and Moksness (1993). There seems to be correlations between the temperature in the Atlantic branch of the Norwegian current and the formation of good year-classes of cod, haddock and herring (Sætersdal and Loeng 1987). Ellertsen *et al.* (1990) found that high temperature is a necessity, but not sufficient alone to produce a good year-class of cod. The present authors wanted to study the effect of some physical factors during the period when most of the herring larvae become dependant of external food i. e. in April. These factors were temperature and windstress from different directions.

During the first days of their life, during the yolk-sac stage, the larvae ascend to the surface where sharp fluctuations of temperature and meterological conditions are observed. The hydrographical conditions at the spawning grounds are determined by macroprocesses of atmospheric circulation which affect the heat exchange between the sea and atmosphere and horizontal and vertical transport/mixing of water masses. Abiotic factors have a strong effect both directly and indirectly on the early stages of young fish development. In Atlanto-Scandian herring the effect of abiotic factors is most significant in the embryonic and larval stages, i.e. in the first 2-3 weeks after hatching (Yudanov 1962; Seliverstov and Penin 1969; Seliverstov 1970; Seliverstova 1983 and Krysov and Ergakova 1990).

Marti (1961) noted that, as for cod, abundant year-classes of herring appeared in years with high productive ability of the spawning stock. However, studying the 1959-1992 period, it is clear that among these year-classes only four (1959, 1983, 1991 and 1992) were abundant and only in 1959 the spawning stock was relatively rich (7.5 mill. tonnes).

Marti (1961), Yudanov (1962) and Seliverstov (1971) noted that abundant year-classes did not appear during years of unfavourable physical conditions. Strong year-classes evidently appeared during years with good survival conditions and with a high abundance of breeders.

Krysov and Ergakova (1990) noted that a rise in the heat content of water masses on the spawning grounds and in the routes of herring larval drift and predominance of southwesterly winds determine the appearance of abundant year-classes.

Unfavourable conditions for larval survival is believed to be a short drift into the Norwegian coast where the water temperature is by 1-2°C lower than at the spawning areas over the banks (Seliverstov 1970). The larvae are hence exposed to a limited period of plankton development which could lead to a mismatch between food and larval abundance. By drifting to the north-east the larvae will be brought into conditions of a prolonged spring, which begins in March-April in the southern areas, in April-May in central areas and in June-July in the eastern areas (Pavshtiks 1956). Therefore, it is evident that meterological factors, especially those wind directions transporting the larvae north-eastward should have a positive effect on the development and survival of herring larvae.

Devold (1963) and Røttingen (1992) noted that after 1950 the spawning grounds of herring north of Stad (Figure1) became the most important. According to the data from different scientists mass hatching of herring larvae for the recent 30-35 years was observed in the period from mid-March to mid-April. Therefore the sampling scheme used by the Russians and the Norwegians seems to be suitable for such an investigation.

MATERIAL AND METHODS

Sampling

The Norwegian material has been sampled in March-April with a Gulf III sampler (Zijlstra

1970) and a modified WP II sampler (Anon. 1968) along the Norwegian coast (Figure1). The modification of the WP II consisted of an increase in dimensions of the WP II net to fit a mouth area of 0.5 m^2. Hereafter this net is called the T-80 net. The Gulf III samples were taken in the period 1976-1984 as double oblique hauls from the surface to 60 m depth with a vessel speed of 5 knots and the ship heading towards the next station. Mesh size varied from 500 to 270 micron, most used was nets with 375 micron meshes. The T-80 net was used during the period 1985-1991, and the mesh size was 375 micron. The samples were taken as vertical hauls from 150 m to the surface. In 1976 and 1977 the Norwegian material was preserved in 4% formaldehyde and examined later. During the following years the material was examined fresh. Totally the Norwegian material includes 3704 samples (Appendix I).

The Russian material has been sampled annually in March-April since 1959 at 33-35 fixed stations (Figure 2) along the Norwegian coast with a net similar to the T-80 net (Yudanov 1962). The samples were taken as vertical hauls from 100 m to the surface. During the period 1983-1991 the material was examined fresh. The Russian material includes 1656 samples (Appendix II).

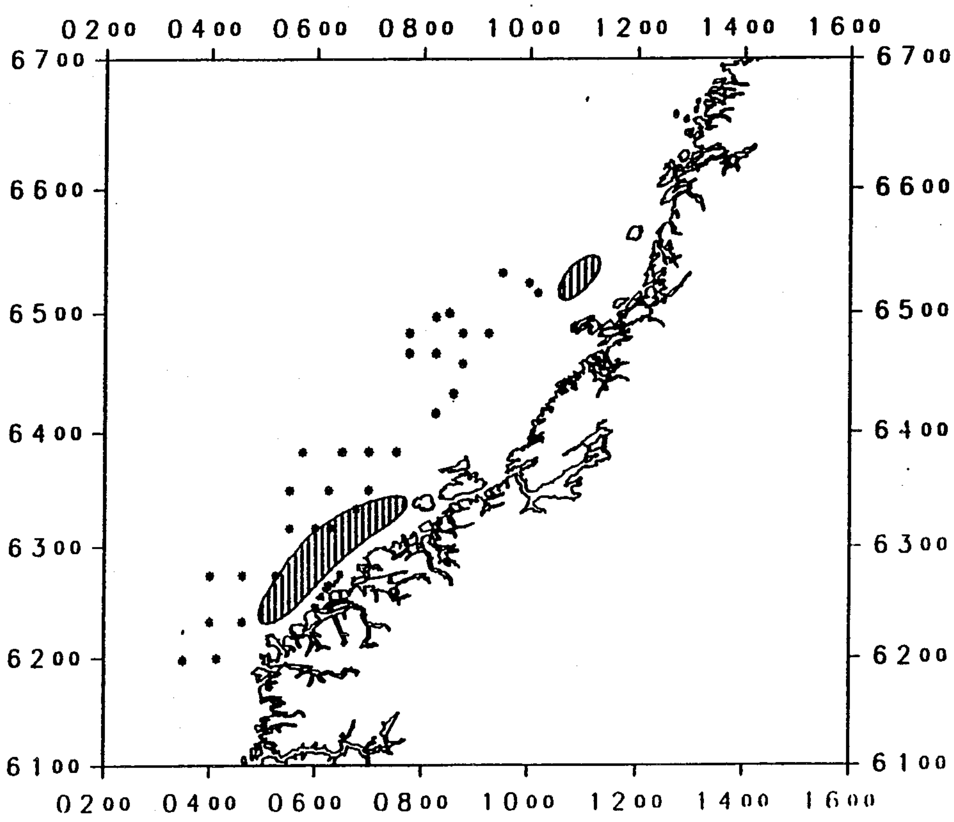

Figure 2. Russian stations in 1973. Hatched areas indicate spawning grounds for herring (Anon. 1993).

Physical variables

Temperature

Daily thermograph data from Hustadvika (Table 1), near Bud (Figure 3), taken from a coastal steamer (Midttun 1975) added with newer data was used in this work. In addition was used temperatures at 20 m depth observed during the Russian larvae surveys and observations from the Kola section. Also average temperature observations from Skrova (Vestfjorden) from 30 to 0 m and 150 to 50 m was used.

Table 1. Mean temperature at Hustadvika and at Russian stations in the Norwegian Sea in April.

Year	Temperature at Hustadvika	Deviation	Russian observations	Deviation
1959	6,8	1,3	6,4	0,2
1960	6,4	0,9		
1961	6	0,5	6,4	0,2
1962	5,4	-0,1	6,4	0,2
1963	5,3	-0,2		
1964	6,1	0,6	7	0,8
1965	5,9	0,4	6,4	0,2
1966	4,1	-1,4	5,2	-1
1967	5,2	-0,3	5,9	-0,3
1968	5,1	-0,4	6	-0,2
1969	4,7	-0,8	6,3	0,1
1970	4,3	-1,2	5,3	-0,9
1971	5,3	-0,2		
1972	5,9	0,4	6,5	0,3
1973	5,9	0,4	6,6	0,4
1974	5,6	0,1	6,1	-0,1
1975	5,9	0,4	6,1	-0,1
1976	5,4	-0,1	6,1	-0,1
1977	5,5	0	6,1	-0,1
1978	5,6	0,1	5,9	-0,3
1979	5	-0,5		
1980	5,1	-0,4	5,8	-0,4
1981	5,3	-0,2		
1982	5,2	-0,3		
1983	6,2	0,7	6,4	0,2
1984	5,3	-0,2	5,8	-0,4
1985	5,1	-0,4	5,8	-0,4
1986	4,6	-0,9	5,8	-0,4
1987	5,3	-0,2	5,9	-0,3
1988	5,4	-0,1	6,2	0
1989	6,1	0,6	6,8	0,6
1990	6	0,5	7	0,8
1991	6	0,5	7,1	0,9
1992	5,9	0,4		
Mean	5,5		6,2	

Wind

These temperature data together with meterological observations from Ona (Figure1), kindly placed to our disposal by The Norwegian Meteorological Institute (DNMI), were used to represent the physical conditions for the herring larvae during their first feeding period. These observations are assumed to represent the shelf area between 62°N and 63°30'N. The directional monthly mean wind stress (Wind (x)) were calculated by using the formula Wind $(x)=f*W^2$, where f is the frequency in percent of observations from a given wind direction $(x^{\pm}15^{\circ})$ and W is the associated mean windspeed in m/sec (Sundby 1982). When the windstress from two directions are used, the sum of the wind stress is applied. However, the winddata for 1963 is missing.

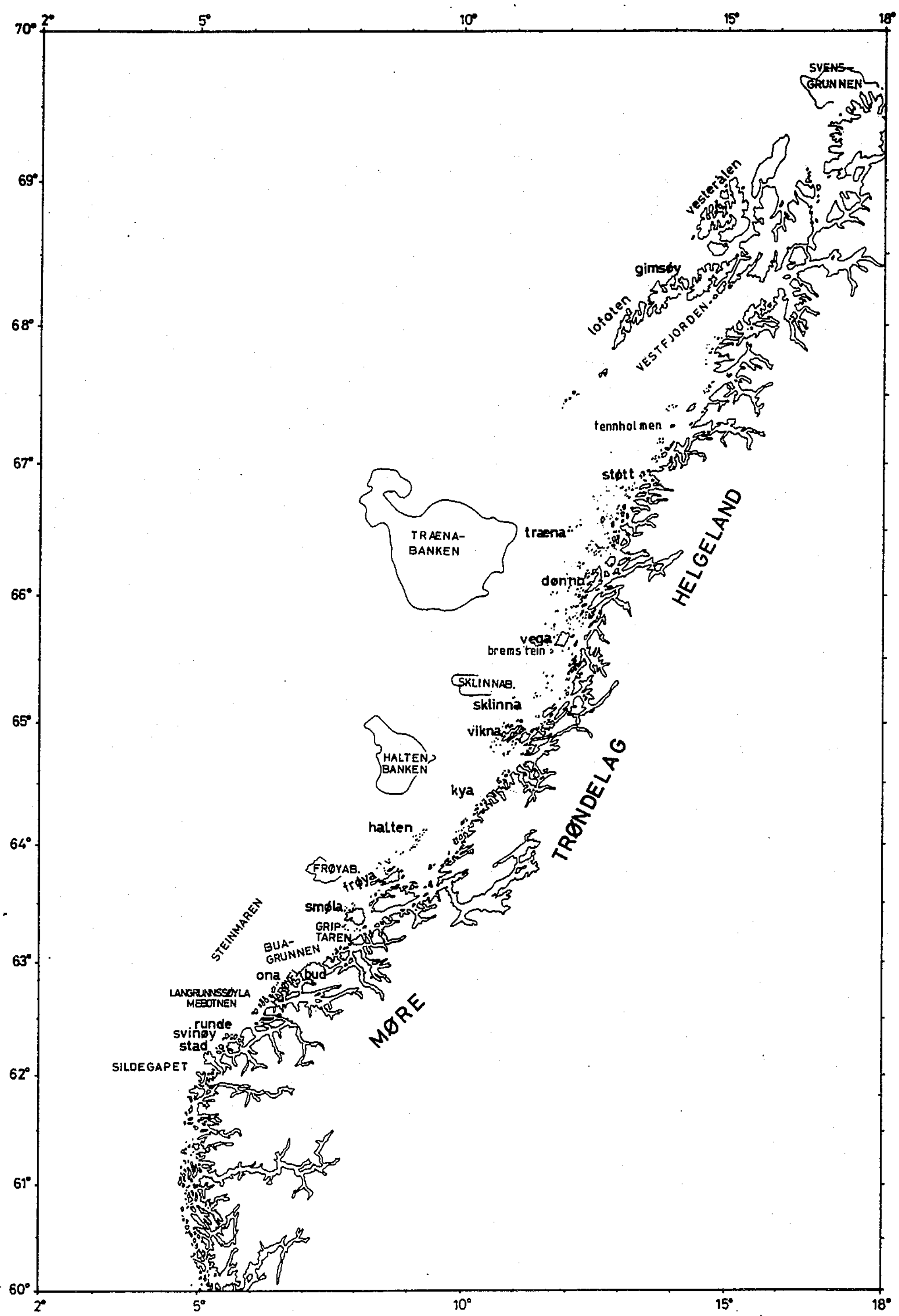

Figure 3. Some of the names used in text.

Biological variables

Larvae index

The herring larvae indices was calculated by a programme by Westgård, Knutsen and Christiansen (1988). The area integrated was between 61°00 and 67°00'N and between 002°00' and 016°00'E. If more than one sample was taken within an area of about one square nautical mile, the average number of larvae per m^2 was calculated. Thus, only one figure represents one year even if the area was sampled more than once (Table 2).

Table 2. Indices and biological and physical variables used in the equations.

Years	Russian index	Norwegian index	Combined index	Temp. Hustad	Wind from 300°	Wind (150-180)°	Age 3 in mill.	Spawning stock in mill. tonnes
1959	2,400	-	2,400	6,8	45	572	21175	6,520
1960	2,900	-	2,900	6,4	899	515	7337	5,310
1961	-	-	-	6,0	205	252	2175	3,930
1962	0,300	-	0,300	5,4	160	190	203	3,130
1963	-	-	-	5,3	-	-	8281	2,450
1964	0,600	-	0,600	6,1	17	421	3832	2,660
1965	0,210	-	0,210	5,9	0	370	107	2,960
1966	0,013	-	0,013	4,1	70	123	230	2,570
1967	0,000	-	0,000	5,2	469	331	21	1,160
1968	0,022	-	0,022	5,1	358	115	10	0,220
1969	0,011	-	0,011	4,7	35	332	513	0,080
1970	0,003	-	0,003	4,3	25	276	7	0,030
1971		-	0,000	5,3	0	217	1	0,009
1972	0,000	-	0,000	5,9	90	123	886	0,002
1973	0,004	-	0,004	5,9	441	374	575	0,100
1974	0,008	-	0,008	5,6	23	51	127	0,120
1975	0,056	-	0,056	5,9	260	356	143	0,120
1976	0,056	0,018	0,056	5,4	101	329	499	0,170
1977	0,029	0,039	0,029	5,5	51	254	324	0,280
1978		0,015	0,015	5,6	70	110	429	0,350
1979		0,077	0,077	5,0	0	315	755	0,380
1980	0,000	0,071	0,000	5,1	276	754	95	0,450
1981		0,007	0,007	5,3	211	312	90	0,470
1982		0,010	0,010	5,2	170	416	232	0,480
1983	0,280	0,074	0,280	6,2	0	352	13478	0,550
1984	0,120	0,190	0,120	5,3	0	354	454	0,580
1985	0,200	0,450	0,200	5,1	0	189	648	0,520
1986	0,072	0,028	0,072	4,6	45	229	96	0,380
1987	0,046	0,230	0,046	5,3	0	163	328	0,730
1988	0,110	0,250	0,110	5,4	114	261	822	2,190
1989	0,340	0,460	0,340	6,1	88	370	8000	2,580
1990	1,000	0,100	1,000	6,0	138	837	8000	2,510
1991	2,600	0,970	2,600	6,0	0	829	10000	2,540
1992		1,700	1,700	5,9	45	570	10000	2,600

Dragesund (1970) suggested that when comparing distribution and abundance of larvae in relation to subsequent year-class strength, those having passed the yolk sac stage (*i.e.* Larvae ≥ 12 mm) should be considered separately. The abundance of these larvae are therefore denoted larvae index, which is believed to reflect the feeding conditions during the early larval stages. The Russian larvae material sampled in 1961 was omitted because the permanent station grid was not sampled and the 1992 material is not worked at present. In 1971 very few larvae were caught during the Norwegian surveys (Dragesund *et al.* 1980) and the index was set at zero.

Spawning stock size and 3-year old herring.

The spawning stock size and number of 3-year old herring is given in Domasnes *et al.* (1993). The recruitment in 1991 and 1992 was estimated as good (Anon. 1993) and the figures as 3 year old is equalled to that of a good year-class (Table 2).

Model

Svendsen *et al.* (1991 and 1994) demonstrated that more than 70% of the year to year recruitment variability of several fish stocks in the North Sea might be explained by an ocean heat parameter and one or two climate/weather parameters representative for the time prior to and/or during the time of larval stages. To find a combination of a few (from many) parameters which could be of main importance for the recruitment success or failure, the authors chose to use a multiple linear regression analysis tool (Wilkinson1989). The physical parameters considered here was the previously mentioned regularly monitored monthly mean sea surface temperature at Hustadvika, ship measured temperatures averaged over different latitudal sectors of the shelf area and monthly mean wind stress from different 30° (or 60°) sectors measured at Ona.

In the present work time series of the following biological variables were taken into consideration (Table 2): Russian larvae index (26 years); Norwegian larvae index (17 years), a combined index (all 31 years), the number of 3-group herring (all years) and the spawning stock size (all years). The statistical analysis gives the coefficients a,b,c.... based on the measured or estimated time series in the equation:

Biological variable = Const. + a(Spawning stock) + b(physical factor$_1$) + c(physical factor$_2$) + d(physical factor$_3$)+......

It must be mentioned that the statistics do not require that these variables are independent. However, a possible presence of autocorrelation in individual timeseries (especially the spawning stock) will somewhat overestimate the statistical significance of the findings. The requirements set for selecting independent variables are that each selected coefficient has to be significantly different from zero, with a 95% confidence level (preferably better), and that the number of variables must be as few as possible (most of the coefficients equal to zero) to reach a total squared multiple correlation coefficient preferably above 0.7. Another important requirement is that the results should be reasonable explained by common oceanographical and biological knowledge. The use of this type of correlation analysis might be discussed. However, knowing that the variability of certain environmental parameters are in general a combined function of several variables, some kind of multivariate analysis is required to estimate the significance of each variable. It is not claimed that the applied statistical method is the best for this purpose.

RESULTS AND DISCUSSION

The monthly mean surface temperatures at Hustadvika and the mean temperature at 25-30 m depth during the Russian surveys in April (1959-91) showed a considerable variation of the hydrographical situations in 1959-1992 (Table 1). For example, 1959,1960,1961,1964,1965, 1972-1975, 1983, 1989-1992 showed variable positive deviation at Hustadvika. In these years, year- classes of high and mean abundance appeared, except for 1961, 1965, and the period 1972-1975. During the period 1970-1975 the stock was nearly depleted, and no abundant year-classes were to be expected. The 1961 year-class was nearly of average strength, but the 1965 year-class was very poor (Table 2). Thus two of ten observations with temperatures higher than the mean fail to produce year-classes of high and mean abundance. However, based on the analysis of the present data, we think that warm conditions in the atmosphere during the hatching period sometimes have a decisive effect on the development and abundance of herring year-classes.

Larvae index

The different larvae indices were run against spawning stock size and the various physical variables. The best results were found in relation to the combined larvae index, where about 70% of the variability is explained simply by the spawning stock and the wind stress in april from 135° to 195° through the equation:

$$\textbf{Mod.Comb.ind.} = -0.509 + 0.315*\text{Sp.st} + 0.145*\text{Wind}(150°-180°)/100$$

$$R^2=0.72\ (0.70),\ \text{St.Err.}=0.44$$

where Comb.ind. is the Russian larvae index or the Norwegian index for years when the Russian index is missing. The squared correlation coefficient R^2 is adjusted (in parenthesis) due to statistical properties of the time series, and St.Err is the associated standard error of estimate. 60% of the variability is caused by the spawning stock size, and 10% by the wind.

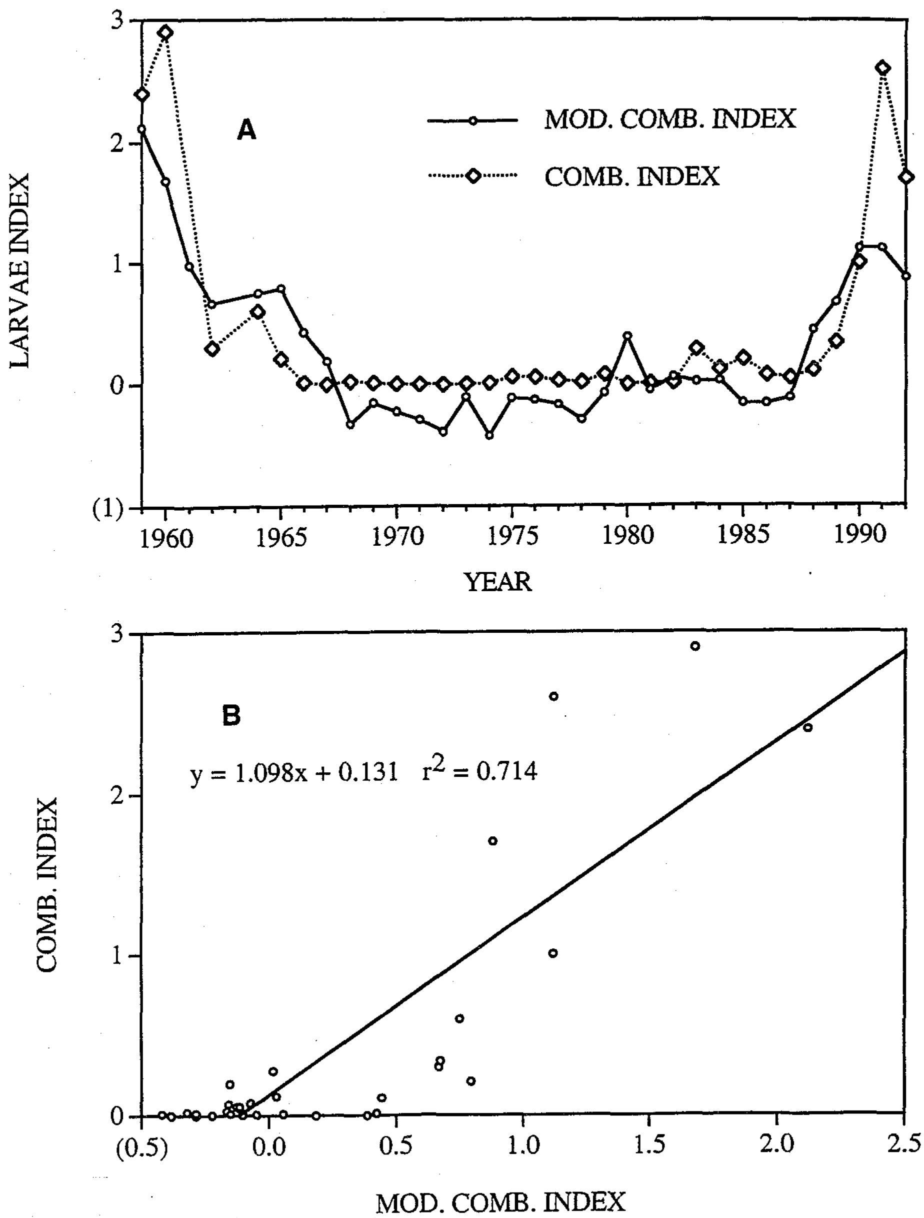

Figure 4. Comparisons (annual time series (A) and sscatter plot (B)) between measurements and empirical model for the abundance of Norwegian spring spawning herring.

This simple empirical model of the combined herring larvae index (Mod.Comb.ind.) and the actual combined index is presented in Figure 4. Clearly some of the variability is picked up, but the high index in 1960 and 1991 is not well simulated. Out of the 32 years with a combined index, only 5 are clearly above the standard error of estimate, and the cluster of all the years with an index close to zero is probably the reason for a relatively higher correlation than expected from just looking at the scatter diagram.

However, the two explainary variables are from a physical and biological point of view very reasonable. Strong and/or persistent winds from south to south-east will indeed favour an effective spread of the larvae northward on the continental shelf in agreement with our hypothesis and earlier postulated by Dragesund (1970). He also found that a widespread distribution of spawning and long duration of the spawning period seemed to give strong year-classes.

Using the same explainary variables for Russian and the Norwegian larvae index separately, gave the following results:

Russian: R^2=0.71 (0.69), St.Err.=0.48

Norwegian: $R^{2=}$0.45 (0.37), St.Err.=0.350

The equations above show that there is little correlation between the Norwegian index and the spawning stock size and wind stress. This is partly due to the fact that the Norwegian index series is much shorter (17 years), during this period the index was only significantly above the standard error of estimate in 1991 and 1992. Since the Russian index time-series is quite similar to the combined time-series, the empirical models for these also come out very similar.

The larvae indices produced above will of course depend on the time of sampling compared to the time of hatching, and for some years the Norwegian index is based only on one ship survey, while the Russian index is in general based on two coverages. In addition Knudsen and Bjørke (in prep.) have shown an avoidance of herring larvae larger than 10mm at daytime when comparing the catch of the T-80 with that of the Gulf sampler. The avoidance increased with larval length. However the sampling has in general been made at the same time of the year during more or less the same light conditions and this fact might have reduced the effect of avoidance. In addition, the sampling with the Gulf III was made from 1976 to 1984 and during this period the size of the spawning stock was rather low. Hence, we prefer to disregard these objections because spawning stock size and wind indices seems to be of major importance in the present material. There is a relatively large difference between the Russian and the Norwegian indices in 1990 and 1991 when the Norwegian estimates are significantly lower than the Russian. In 1990 most of the hatching had taken place in the period just before the survey period, and the samples was dominated by yolksac larvae. In 1991 hatching took place in the middle of March. The survey was carried out 3-4 weeks later, and it is possible that most of the larvae have been advected out of the sampling area (Fossum 1993).

It thus seems that if the larvae indices should be used to predict year-class strength it is important to make two surveys; both perhaps in April. The Russian surveys lasted each 4-5 days (Appendix II) and this sampling strategy seems to be adequate. Most probably indices based on sampling with a Gulf III sampler would fit better than those based on a dip net when the spawning stock is large.

3-group herring

The usefulness of the larvae indices depends on to what degree the amount or survival of larvae has a decisive effect on the year-class strength. This was tested out on the VPA (Virtual Population Analysis) time series for 3-group herring (Dommasnes *et al.* 1993). The resulting empirical model is:

$$\textbf{Mod.Herr.(3)} = \mathbf{-14914.307 + 3854.739*Comb.\ ind.+3116.741*T_{Hust.-7.49\ Wind\ (300°)}}$$

$$\mathbf{R^2=0.73\ (0.70),\ St.Err.=2710}$$

where $T_{Hust.}$ is the previously mentioned sea surface temperature at Hustadvika, and the number of 3-group herring (Herr.(3)) is given in millions of individuals. 56% of the variability is explained by the larvae index, 8% by the temperature and 6% by the wind. The intercomparison of this empirical model and the VPA timeseries is presented in Figure 5, where the time represents the year of birth. Again it is seen that this simple model describes a good part of the variability, but clearly there is an underestimate of the very important and relatively good 1983 year-class.

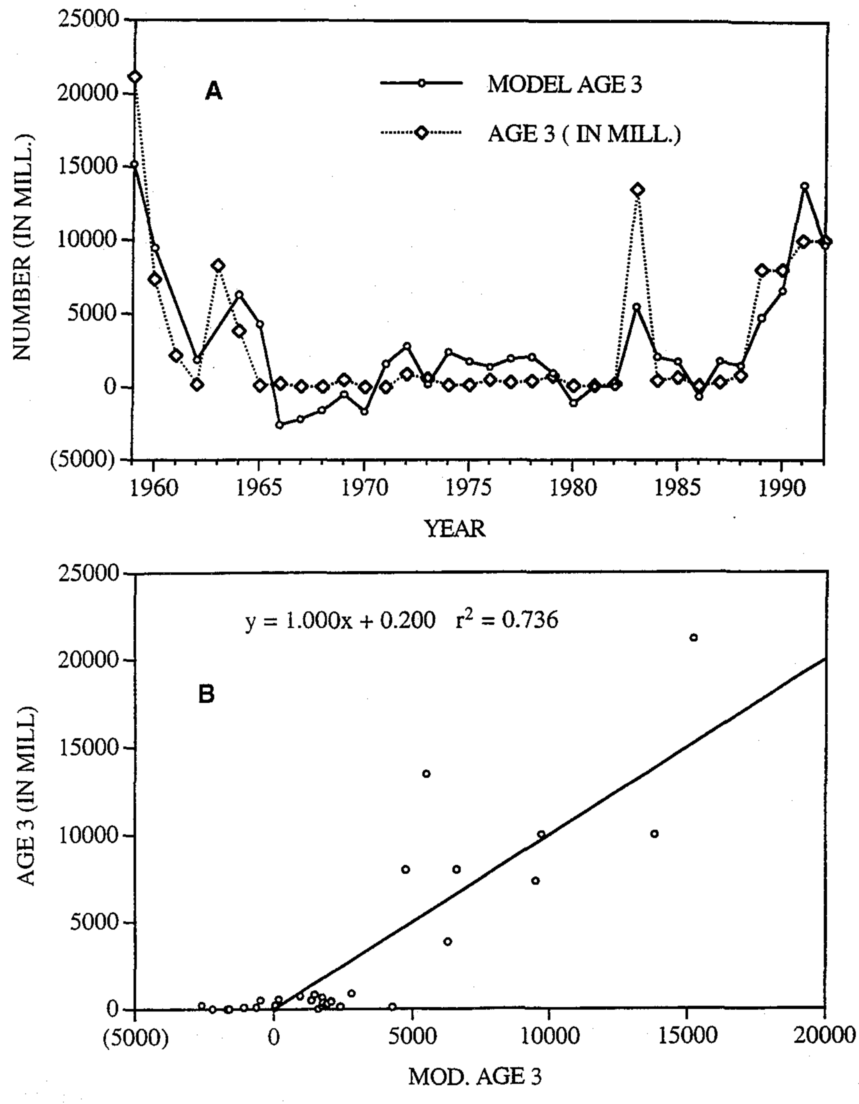

Figure 5. Comparisons (annual time series (A) and scatter plot (B)) between measurements and empirical model for the abundance of 3 year old Norwegian spring spawning herring.

This indicates that probably the measured larvae index for this year is underestimated, probably caused by avoidance of larger larvae. The negative effect of strong and/or persistent winds from northwest is also in agreement with the above hypothesis in the way that it restricts a rapid northeastward spread of larvae. These results indicate a 3 year predictive capability for the year-class strength of 3-group herring through continued monitoring of the larvae index time series, however we feel that more data from years with good recruitment/ strong year-classes is needed to confirm these results.

CONCLUSIONS

This paper clearly demonstrate a quantifiable relation between the abundance of spring spawning herring larvae (above the yolk sack stage) and the combined effect of the spawning stock size and favourable winds from south to southeast. The reason that temperature does not show up as an explainary variable is probably the positive correlation between southerly winds and relatively warm weather leading to relatively high sea temperatures.

The sampling of the larvae should preferably been done twice in April. The Russian surveys lasted each 4-5 days (Appendix 2) and this sampling strategy seems to be adequate. Most probably indices based on sampling with a Gulf III sampler would fit better than those based on a dip net when the spawning stock is increasing.

High abundance of these larvae together with warm ocean climate and reduced northwesterly winds during the early larval stage (April), seems to be the primary factors for producing a good year-class (and vice versa), and these results indicate therefor that the year-class strength (here represented by the number of 3-group herring) can be predicted roughly to within $\pm 3*10^9$ individuals. As in Svendsen *et al.* (1994) this predictive ability should have been tested by hiding some of the data and rerun the statistics. But due to the very few years available with larvae indices significantly above zero, such a test will be postponed until more data are available.

Our preliminary estimate for the numbers of 3 year old herring in 1994 and 1995 is $14*10^9$ and $9*10^9$ respectively, both with an uncertainty of $\pm 3*10^9$ individuals.

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APPENDIX I. Sampling period, number of samples, type of sampler used and main heading of sampling of the Norwegian material. A, B and C indicate coverages of the sampling area.

YEAR	SAMPLING PERIOD	NOS. OF SAMPLES	GEAR	HEADING
1976A	0504 - 1004	60	GULF III	S
1976B	2204 - 3004	74	GULF III	N
1977A	1304 - 2204	129	GULF III	N
1977B	2404 - 2504	14	GULF III	S
1978A	0204 - 1204	125	GULF III	N
1978B	1604 - 2404	126	GULF III	N
1979A	2703 - 0704	146	GULF III	S
1979B	1804 - 2904	148	GULF III	N
1980A	2403 - 3103	103	GULF III	S
1980B	1004 - 2004	148	GULF III	N
1980C	2204 - 2904	125	GULF III	N
1981A	0404 - 1304	100	GULF III	S
1981B	2204 - 2904	145	GULF III	N
1982A	0204 - 0604	59	GULF III	S
1982B	1404 - 2404	103	GULF III	N
1983A	0604 - 0604	10	GULF III	N
1983B	1404 - 2104	103	GULF III	S
1984A	1004 - 1704	113	GULF III	S
1984B	2404 - 3004	95	GULF III	N
1985A	1004 - 1604	128	T-80	S
1985B				
1986A	2903 - 0704	130	T-80	N
1986B	0904 - 1804	166	T-80	S
1987A	2803 - 0704	171	T-80	N
1987B	0904 - 2004	94	T-80	N
1988A	2503 - 0404	173	T-80	N
1988B	1904 - 2604	167	T-80	N
1989A	1903 - 2803	203	T-80	N
1989B	0104 - 1604	244	T-80	N
1990A	3003 - 1004	140	T-80	N
1990B				
1991A	0304 - 1404	120	T-80	N
1991B	0704 - 1304	42	T-80	N/S
1992A	1303 - 0904	118	T-80	N
1992B	1304 - 1704	15	T-80	N/S
Total number of samples		3837		

APPENDIX II. Sampling period, number of samples, type of samplers used and main heading of sampling of the Russian material. A and B indicate coverages of the sampling area.

YEAR	SAMPLING PERIOD	NOS. OF SAMPLES	GEAR	HEADING
1959A	0204 - 0404	7	IKS	N
1959B	1704 - 2004	23	IKS	N
1960A	2703 - 3103	40	IKS	N
1960B			IKS	N
1961A	2403 - 0404	40	IKS	N
1961B	0404 - 2504	49	IKS	N
1962A	0404 - 0704	29	IKS	N
1962B	2204 - 2504	23	IKS	N
1963A				
1963B				
1964A	2003 - 2403	25	IKS	N
1964B	1304 - 1804	24	IKS	N
1965A	2703 - 0204	27	IKS	N
1965B	1404 - 1904	27	IKS	N
1966A	1403 - 2003	26	IKS	N
1966B	0804 - 1304	29	IKS	N
1967A	2003 - 2703	32	IKS	N
1967B	0904 - 1604	31	IKS	N
1968A	1803 - 2303	26	IKS	N
1968B	0804 - 1704	41	IKS	N
1969A	2503 - 0204	37	IKS	N
1969B	0304 - 1504	47	IKS	N
1970A	2003 - 2903	32	IKS	N
1970B	0204 - 0704	28	IKS	N
1971A				
1971B				
1972A	0304 - 1004	30	IKS	N
1972B	1404 - 2204	37	IKS	N
1973A	0804 - 1204	31	IKS	N
1973B	1504 - 2004	31	IKS	N
1974A	0804 - 1304	31	IKS	N
1974B	1704 - 2004	25	IKS	N
1975A	1004 - 1504	25	IKS	N
1975B	1804 - 2204	31	IKS	N
1976A	0504 - 0904	31	IKS	N
1976B	1504 - 1904	31	IKS	N
1977A	0404 - 1004	31	IKS	N
1977B	1504 - 1904	31	IKS	N
1978A				
1978B				
1979A				
1979B				
1980A	0404 - 0904	31	IKS	N
1980B	1104 - 1504	31	IKS	N
1981A				
1981B				
1982A				
1982B				
1983A	1904 - 2404	31	IKS	N
1983B	2604 - 3004	30	IKS	N
1984A	0104 - 0604	31	IKS	N
1984B	1204 - 2004	32	IKS	N
1985A	0104 - 0604	33	IKS	N
1985B	1004 - 1504	33	IKS	N
1986A	0504 - 1104	34	IKS	N
1986B	1704 - 2604	34	IKS	N
1987A	1803 - 2503	43	IKS	N
1987B	0204 - 1004	43	IKS	N
1988A	1104 - 1804	28	IKS	N
1988B	1904 - 2604	30	IKS	N
1989A	2103 - 2503	23	IKS	N
1989B	0704 - 1704	51	IKS	N
1990A	1004 - 1504	30	IKS	N
1991A	2803 - 0304	32	IKS	N
1991B	0504 - 1304	48	IKS	N
Total number of samples		1656		