

«Cruise report»

RV GO Sars 06.04-19.04.2010

**Distribution and abundance of Norwegian spring spawning
herring larvae on the Norwegian shelf in April 2010**

by

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Objectives

The objectives of this survey were to map the distribution of herring larvae and other fish larvae on the Norwegian shelf and to collect data on hydrography, nutrients, chlorophyll and zooplankton. The data are used to calculate an index of the abundance of herring larvae which is used by the ICES Working Group on Widely Distributed Species (WGWIDE) in the assessment of Norwegian spring spawning herring. The index is used as tuning index for the size of the spawning stock and is part of a time series which started in 1981. An additional objective of the survey was to undertake process studies on herring larvae to map the small scale overlap between the larvae and their prey and predators using the MESSOR (towed Optical counter and plankton sampling) system and macroplankton trawl in selected areas.

Participation

The scientific members during the cruise were:

Jaime Alvarez, Laura Rey, Erling Kåre Stenevik (cruise leader), Bjarte Kvinge, Terje Hovland, Ingve Fjeldstad, Richard Nash (06.04-10.04), Webjørn Melle (06.04-10.04) and Sarah Narkus (guest from University of Hamburg, Germany)

Narrative

Departure from Bergen was delayed while waiting for one crew member to arrive. The vessel left Bergen 06.04 at 23:00. After steaming northwards the first station was undertaken at 61°12N, 3°56E at 08:30 UTC.

Process studies were started 09.04.2010 in the morning on the transect line south of Buagrunn at 62°50 N. The macroplankton trawl was in contact with the bottom on the first haul and was damaged beyond immediate repair, but sampling continued with the MESSOR. After a few hours of sampling the ship was directed to be in Bodø on 15.04.2010 to take part in a press conference. We were also ordered to prioritize the horizontal coverage of the herring larvae in order to produce a larval index. Therefore, the process studies were abandoned and the vessel

headed for Kristiansund so that two members of the scientific team could disembark. The survey continued with increased speed (15 knots instead of 10 knots) on the survey grid in order to get as far north as possible before we had to break off to go to Bodø, where we arrived in the morning on 15.04.2010. The vessel left Bodø the same evening and steamed southward to the transect line at 62°47' to resume the survey. The last station on the survey was taken 19.04.2010 on Malangsgrunnen (69°55'N, 17°54'E) at 10:25 UTC, whereupon the vessel headed for Bergen where we arrived 22nd April at 19:00 UTC. The vessel stopped around 68°26'N 13°47'E for 12 hours to deploy an ROV to search for a piece of equipment that was lost overboard by RV Johan Hjort.

The weather conditions were generally favourable during the survey and a total of 164 larval stations were undertaken in addition to 51 WP II hauls for zooplankton biomass and species composition.

Methods

The cruise tracks with larvae stations are shown in figure 1. CTD casts were taken on each station to collect data on temperature, salinity and oxygen between the surface and 10 m above bottom. If the bottom depth was greater than 500 m, the CTD was lowered to 500 m for the deepest measurement. On every third station, water bottles were used at standard depths to collect data on nutrients over the whole water column and chlorophyll *a* from the surface to 100 m depth.

Fish larvae were sampled with two different nets. During daytime, a Gulf III sampler (375 µm mesh net) was used while during nighttime, a T-80 net (375 µm mesh net) was used. The Gulf III was towed in a double oblique haul down to 75 m depth while the vessel maintained a speed of five knots. The T-80 net was hauled vertically from 150 m depth to the surface while the ship was stationary. Two types of sampling equipment were used because the T-80 underestimates the number of bigger larvae (> 11 mm) larvae during daytime because of avoidance. The Gulf III, however, samples representatively both during daytime and nighttime, but because of the high speed the larvae caught in this net are in a much worse condition. It is therefore sometimes difficult to measure the length of these larvae and to classify them to stages because the gut and yolk sac may be torn off. All herring larvae were counted and a maximum of 50 larvae from each station were staged according to Doyle

(1977) and the standard length was measured. Other larvae were identified as far as possible and their standard length measured. During the survey, samples were preserved for later analyses. A total of 1187 larvae from 69 stations were stored at -80°C for nutritional condition studies and ca. 2000 larvae from 47 stations were fixed in 96% alcohol for otolith microstructure studies. In addition, 189 krill from 18 stations were stored in 96% alcohol for later studies on their stomach contents.

On every third station, a WP II net (180 μm mesh net) was used to sample zooplankton. This net was hauled vertically from 200 m depth to the surface and the sample was split in two. One of the sub-samples was dried for measuring biomass (three size fractions; >2000 , 1000-2000 and 180-1000 μm) and the other preserved in formaldehyde for later analyses of species and stage composition.

Results and Discussion

The number of herring larvae this year was estimated to be $42.7 \cdot 10^{12}$, resulting in a Larvae Production Index (LPI) of 140.2. This is the second lowest number of larvae and larvae production recorded since 2003 when the survey was severely hampered by bad weather (table 1). The weighted mean size of the larvae was 10.6 mm which is the lowest mean size recorded in the time series. Most of the larvae were in first feeding stages (stages 1d and 2a).

As shown in figure 1, herring larvae were observed throughout the sampling area, and zero values were not found either on the northernmost or the southernmost section, although low concentrations (less than 50 larvae m^{-2}) were found on the southernmost survey transect. The offshore extent of the larval distributions were, however, found on all transects. Similar to 2009, in 2010 there was spawning activity (information from the fishery) on the traditional spawning grounds close to Karmøy in the southern part of Norway (around 59°N). This area could, however, not be covered due to time limitation. The highest abundance of herring larvae were found on the Møre spawning grounds.

Acoustic registrations were recorded during the survey and the data was scrutinized using the IMR post-processing acoustic survey package, Large Scale Survey System (LSSS) to major groups (demersal fish, pelagic fish and plankton). However, in the northern part, registrations clearly identified as herring school were observed and in these cases herring was recorded

separately. Since no trawling was performed to obtain species and size composition of the registrations, the data cannot be used to make an abundance estimate. The acoustic data is therefore used only to produce distribution maps of pelagic fish and herring in the survey area in order to study the overlap between these groups and the larval distribution.

Acknowledgements

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References

Doyle, M.J. 1977. A morphological staging system for the larval development of herring, *Clupea harengus* L. *J. mar. biol. Ass. U.K.* 57: 859-867.

Table 1. Total number of herring larvae found on the Norwegian shelf during the period 1981 to 2008 (numbers in 10^{12}). Index 1 is the total number found during the survey while index 2 is the back-calculated number of newly hatched larvae using a 10% daily mortality rate (LPI). The age of the larvae is estimated from the duration of the yolk sac stages and the size of the larvae.

Year	Index 1	Index 2	Year	Index 1	Index 2
1981	0.3		1996	27.7	81.7
1982	0.7		1997	66.6	147.5
1983	2.5		1998	42.4	138.6
1984	1.4		1999	22.5	73.0
1985	2.3		2000	20.8	89.4
1986	1.0		2001	40.7	135.9
1987	1.3	4.0	2002	27.1	138.6
1988	9.2	25.5	2003*	3.5	18.8
1989	13.4	28.7	2004	56.6	215.1
1990	18.3	29.2	2005	73.9	196.7
1991	8.6	23.5	2006	98.9	389.0
1992	6.3	27.8	2007**	90.6	
1993	24.7	78.0	2008	107.9	393.3
1994	19.5	48.6	2009	8.4	53.8
1995	18.2	36.3	2010	42.7	140.2

*Poor weather conditions in 2003, plus survey in late April.

**In 2007 the northern spawning grounds were not covered

Table 2. Fraction of herring larvae in different developmental stages (Doyle, 1977) during the survey.

Stage	1a	1b	1c	1d	2a	2b-2c
Age (days)	0-2	3-5	6-7	8-9	10-24	24+
Fraction (%)	0.03	0.17	3.88	41.29	52.84	1.80

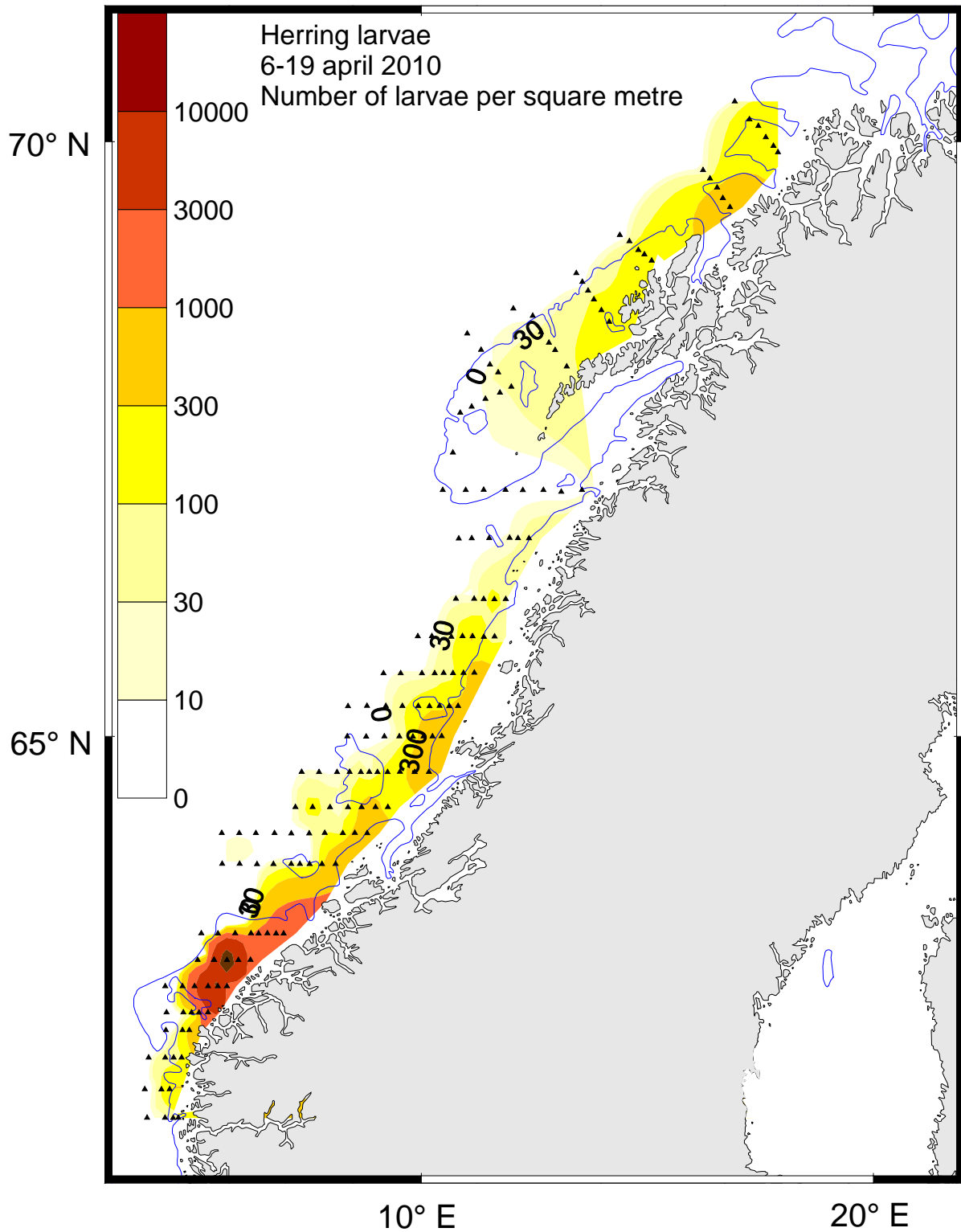


Figure 1. Distribution of herring larvae on the Norwegian shelf in 2010. The larval sampling stations and the 200 m isobath is also shown. Numbers per square metre surface.

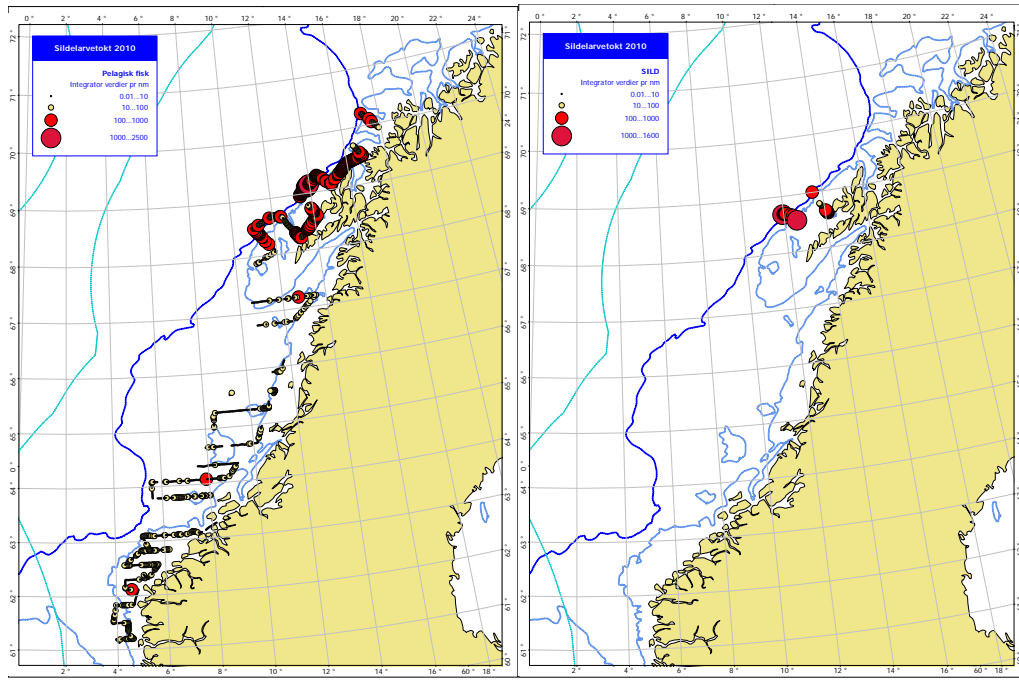


Figure 2. Acoustic S_A values per nautical mile of pelagic fish (left panel) and herring (right panel).