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ASSESSMENT OF POTENTIAL OIL POLLUTION DAMAGES ON FISH RESOURCES.
SOME EXAMPLES FROM THE AREA OUTSIDE MID-NORWAY.

By

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ABSTRACT

Detailed mapping of fish eggs and larvae both in space and time is essential knowledge when realistic assessments of oil pollution damages to the fish resources are established. The text explain with some examples our attempts to determine how and if pollution from oil fields outside mid-Norway may affect fish stocks.

INTRODUCTION

In 1986 the Norwegian government provided extensive funds for a five-year program to study the distribution of fish eggs and larvae on the continental shelf off Norway north of 62° N (FØYN, 1983). The program was named HELP, Havforskningsinstituttets Egg- og Larve Program, (FOSSUM et al., 1987). The aim of the program is, by mapping the distribution in space (vertical and horizontal) and time of eggs and larvae of the most important fish-species, to have a basis for realistic analysis of the consequences of potential oil pollution damages; (FØYN & BJØRKE, 1986). In addition, the data will also serve as a basis for advice to the authorities, both in the case of an oil pollution accident as well as in helping to smooth the possible conflicts between the fisheries and the oil interests.

We have based our assessments on a worst case philosophy by using the data available. This means that when our knowledge is increased we will never end up with an assessment giving a more serious damage than previously stated.

We have in our previous worst case assessments used the overlapping area between recorded fish eggs and larvae and the area calculated to be covered by oil. The oil coverage have been estimated by using a simple wind driven oil-drift model and by plotting the area within coordinates representing the points of the fastest drifting oil in 15 days. An example of this metode is presented by FØYN & BJØRKE (1986) and is reproduced in Fig. 1.

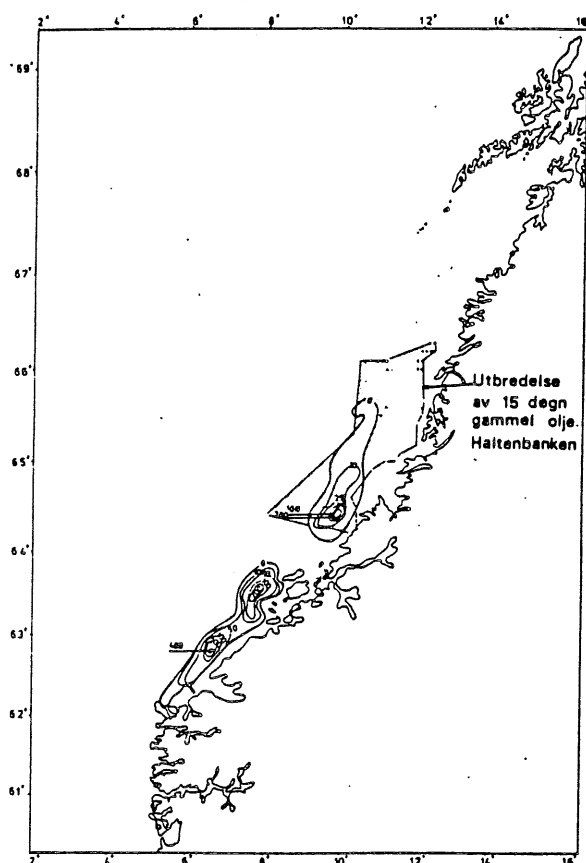


Fig. 1. Herring larvae distribution in April 1976, plotted against 15 days old and younger oil.

As can be seen from Fig.1, about one third of the registered herring larvae are found within the estimated oil covered area. Our worst case estimate of this meant a one third reduction of that particular year class. By using simple one-stock models it is possible to assume the potential loss in tons and even in a today value. Such calculations will only serve to give the dimensions of the potential damage.

ANON (1978) and FØYN & BJØRKE (1986) pointed to the need for better oil-drift models, taking into account the vertical dispersion as well as the evaporation of the spilled oil, and for far more details both vertical and horizontal of fish eggs and larvae. The HELP program has after its two first seasons produced valuable data on vertical distribution as well as a far better resolutions in the horizontal distribution, provided by a dens grid of sampling stations. The work with oil-drift models has accomplished a far better approach to the real events than can be seen from Fig.1. By the courtesy of the norwegian oil company STATOIL we have been provided with an example of an oil distribution from a case study of an oil spill from a proposed oil-pipeline on the shelf off mid-Norway.

MATERIALS AND METHODS

The Institute of Marine Research has since 1948 been sampling fish eggs and larvae at different localities along the Norwegian coast (e.g. WIBORG, 1960; HOGNESTAD, 1969; DRAGESUND, 1970; GJØSÆTER and SÆTRE 1974; ELLERTSEN, SOLEMDAL, STRØMME, SUNDBY, TILSETH, WESTGÅRD and ØIESTAD, 1981; BJØRKE, 1981, 1984; SUNDBY and SOLEMDAL 1984; SUNDBY and BRATLAND 1986). The sampling has taken place during the spring and summer seasons and 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 to Vestfjorden and the sampling was aimed at the study of the herring larvae only. From 1976, due to the plans of moving the oil exploration north of 62° N, it was decided to identify and record all fish eggs and larvae caught with zooplankton gears in the area.

Table 1 shows the recorded number of samples caught with different type of gears. The Bongo 20 cm sampler is described by POSGAY, MARAK and HENNEMUTH (1968), the Clarke-Bumpus sampler by CLARKE and BUMPUS (1950), the Otter Surface Sampler by SAMEOTO and JAROSZYNSKI (1969), the Isaacs-Kidd midwater trawl by ANON. (1977), the Gulf III by ZIJLSTRA (1970), the Juday net by JUDAY (1916), the Egg net by ELLERTSEN, FOSSUM, SOLEMDAL, SUNDBY and TILSETH (1984) and the Mocness sampler by WIEBE, BURT, BOYD and MORTON (1976).

Only fish larvae younger than 6 months are recorded, and standard length is measured to the nearest mm below. The fish eggs are identified when possible and recorded according to easily recognizable stages of development. Unidentifiable eggs are recorded according to diameter and whether or not oil globules are present. Each class interval included eggs within 0.19 mm; for example eggs without oil globules and with diameter from 1.0 to 1.19 are recorded in the same class interval.

Table 1. Total number of samples sampled with different gears recorded up to September 1987.

Bongo- 20 cm	C-B	O.S.S.	IKMT	Pel.- trawl	Gulf- III	Juday- 36 cm	Juday- 80 cm	Egg- net	Moc- ness
154	4250	397	559	1715	4207	4008	486	1871	374

The data are recorded in a data base system developed for the NORD-computer by KVAM DATA. This system makes it possible to choose among any sets of parameters in the data base and list the results. It is, for example, possible to list the number of herring larvae per m² surface smaller than 9 mm caught with Gulf III in March/April from 62° to 64° N during the period 1976-1985. Larvae smaller than 9 mm are newly hatched and the distribution of these indicates spawning areas for the Atlanto-Scandian herring. From this list plots can be made, using a computer programme (WESTGÅRD 1984), and isolines of chosen values can be drawn.

Gadoid eggs without oil globules are almost impossible to distinguish in material from preserved plankton samples except those of Melanogrammus aeglefinus and Gadus morhua which are identifiable in their latest stages of development when the larval pigmentation pattern has become apparent on the embryo (RUSSEL 1976). However, these eggs can be identified by means of isoelectric focusing on fresh material (MORK, SOLEMDAL and SUNDNES 1983). This was done onboard "Odin Finder" during a cruise in the period 17/2-20/4-87. The investigated area was covered four times during this period. Saithe eggs younger than three days were found in areas supposed to be spawning grounds for saithe (ANON 1979).

The scenarios of the fate of an oil spill used in this paper are produced by the Oceanographic Center (OSS) of the SINTEF-group in Norway and provided us by STATOIL. The oil-drift model, DOOSIM, used for making the scenarios presented in Figs. 2 and 3, is developed by OSS. The calculations in the model takes into consideration drift, diffusion, vertical mixing, evaporation, changes in the physical characteristics of the spilled oil, as well as effects of oil-pollution combat devices, dispersion of the oil mixed in the water column and emulsification.

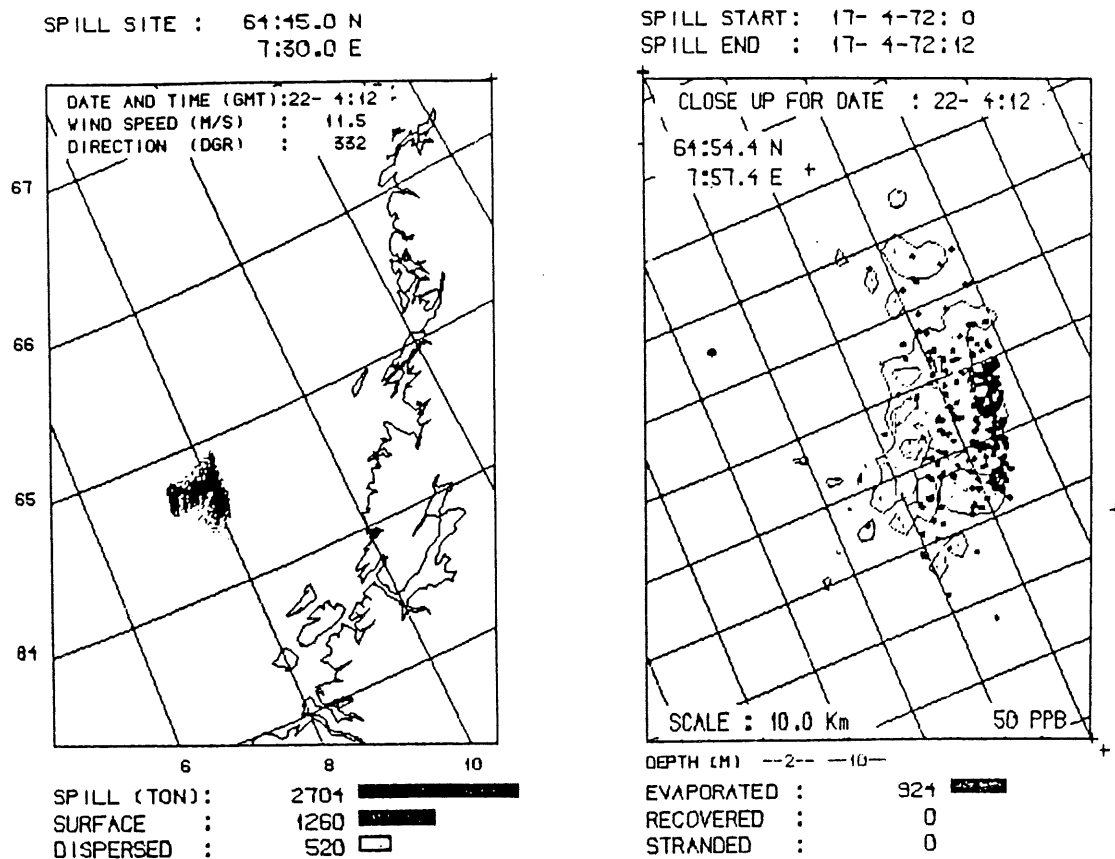


Fig. 2. Scenario of the calculated situation 5 days after the simulated oil spill, by the courtesy of STATOIL, 1987.

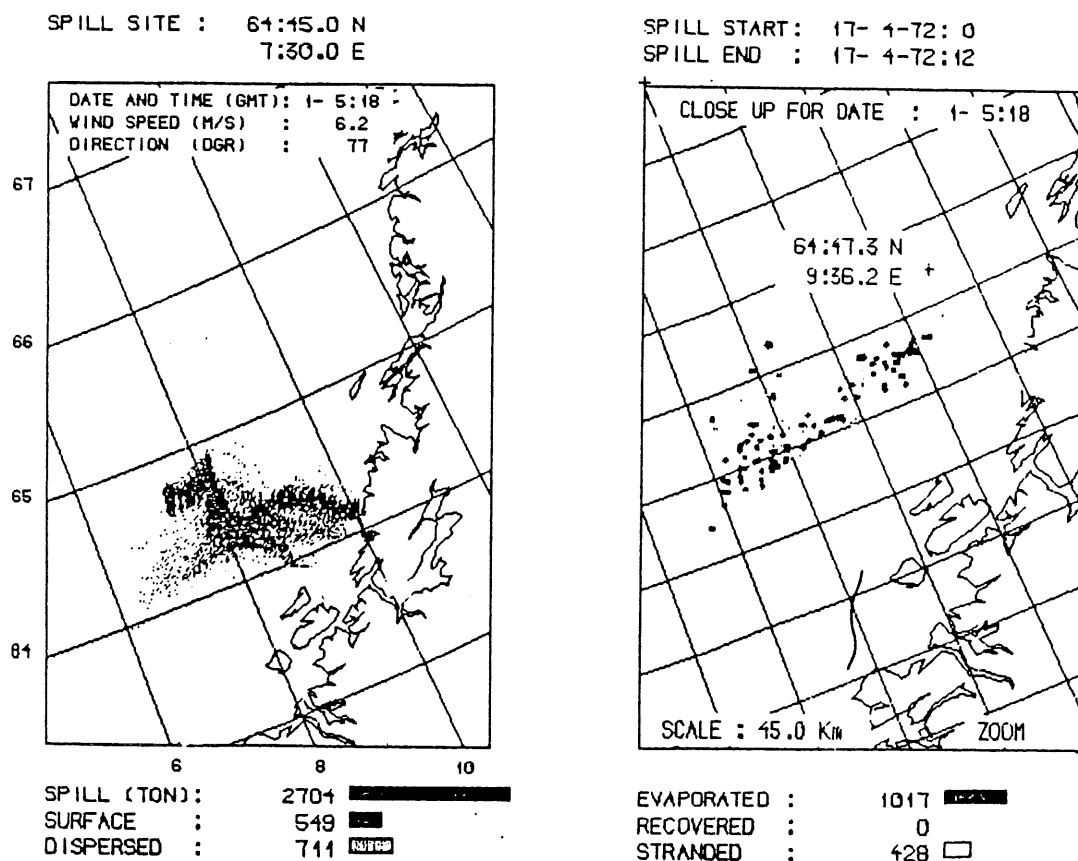


Fig. 3. Scenario of the calculated situation 14 days after the simulated oil spill, by the courtesy of STATOIL, 1987.

DISCUSSION

In making consequence analysis we have based our calculations on the worst case principle. This approach is still valid. But as the modelled examples of the fate of an oil-spill demonstrates, Figs. 2 and 3, the percentage of oil dispersed in the watermass is fairly low. Consequently the overlapping area between oil contaminated water and fish eggs and larvae is far less than what is found by using the maximum surface coverage as presented in Fig. 1. In addition to this, the vertical distribution of eggs and larvae of the various fish species has to be considered. BJØRKE et al. (1986) and FOSSUM et al. (1987) have studied the vertical distribution of herring larvae, they found that the bulk of the herring larvae is found around 50 m depth. Such distributions further reduces the possible conflict area, since the vertical dispersion of oil is limited to the upper 20 - 30 m.

To visualize the more realistic approach to the possible conflict, we have plotted an observed distribution, 17 Feb. - 20 April 1987, of cod and saith eggs and herring larvae, from the area of the oil-spill case study, against the oil-drift scenarios. In Figs. 4, 5 and 6 the distributions of the three species are shown on scenarios from the fifth and the fourteenth day of the oil-spill.

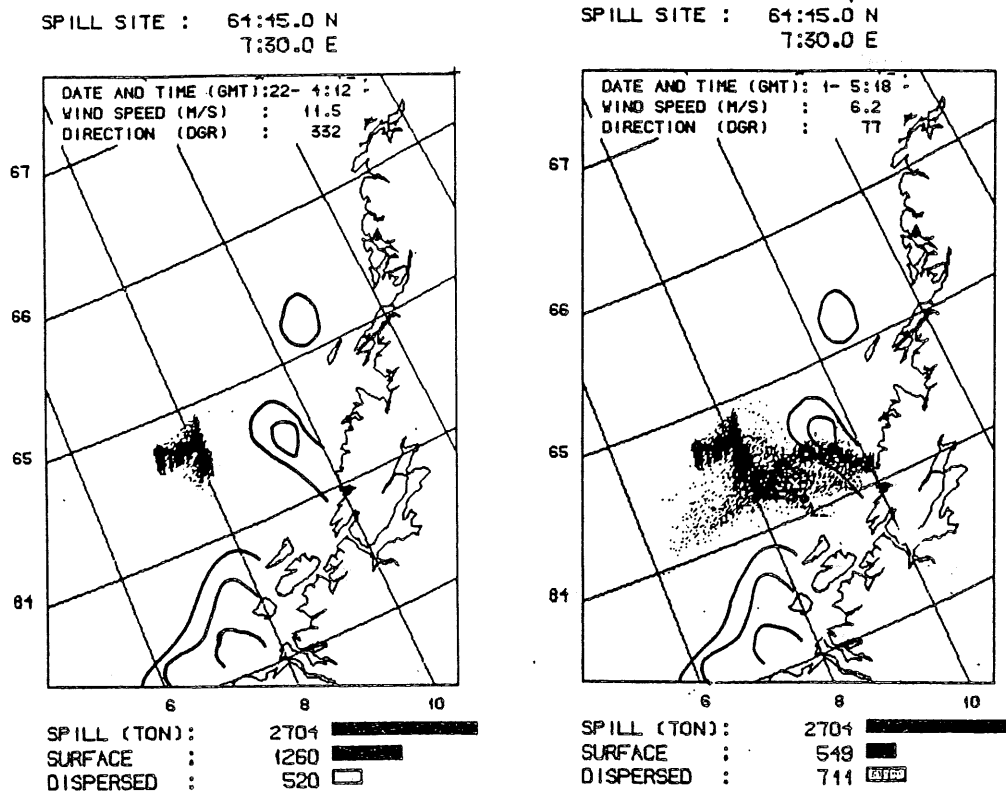


Fig. 4. An example of a possible overlapping of oil and herring larvae from a case study off mid-Norway, day 5 and 14 after the release of oil.

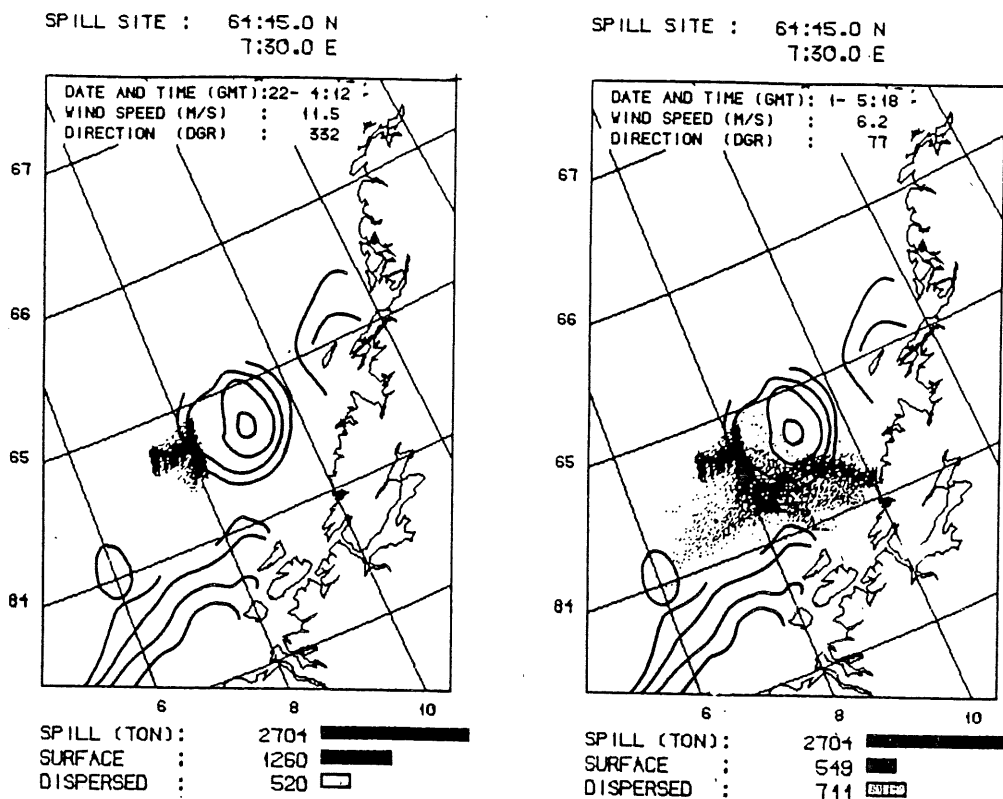


FIG. 5. An example of a possible overlapping of oil and saith eggs from a case study off mid-Norway, day 5 and 14 after the release of oil.

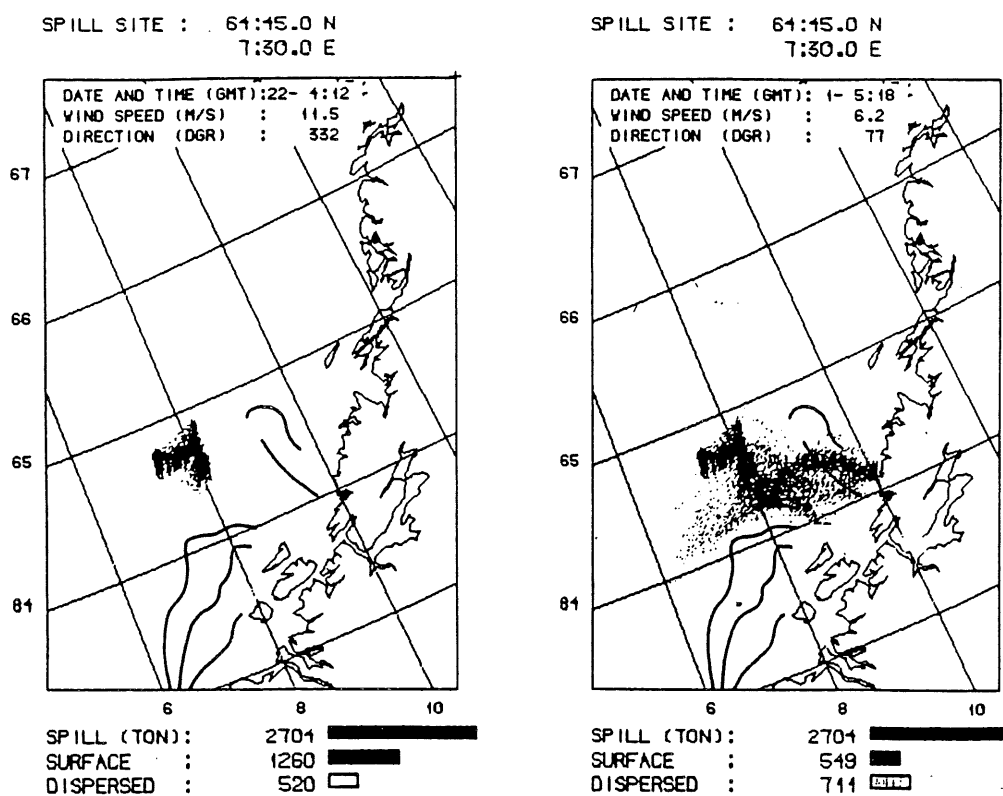


Fig. 6. An example of a possible overlapping of oil and cod eggs from a case study off mid-Norway, day 5 and 14 after the release of oil.

As an example of a realistic event, the distribution of fish eggs and

larvae, presented in Figs. 4, 5 and 6, as well as the modelled oil distribution, may be representative for this area. In the case presented, there is hardly any conflict between an oil spill and fish eggs and larvae. The percentage of the spilled oil dispersed in the watermass, and thereby available as a harmful substance for eggs and larvae, is, as the figures indicates, from 20 to 30. In an oil spill combat the use of chemicals to disperse the oil can alter this percentage close to 100 and thereby enlarge the conflict area considerably. In critical locations where fish eggs and larvae are concentrated the use of chemicals can be crucial for the extent of possible damage to fish eggs and larvae.

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