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CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE, LOWESTOFT, SUFFOLK, ENGLAND

2001 RESEARCH VESSEL PROGRAMME

REPORT: RV CORYSTES: CRUISE 8

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DURATION: 14 – 29 August

LOCALITY: North Sea

AIMS:

The work is directed toward:

a) A better understanding of the dynamics of the circulation processes of the central North Sea in order to characterise the extent and nature of density driven and seasonal jet-like circulation which acts as a direct and rapid pathway for transport of material. Subsequently, the knowledge will be viewed with respect to concerns that elevated levels of contaminants in the central North Sea have originated in the near coastal regions.
b) Improved knowledge of the processes that determine areas of strong phytoplankton production in the vicinity of the Dogger Bank.
c) A resolution of the processes that influence primary productivity and the distribution and behaviour of particulate matter and nutrients in the southern North Sea. In particular, the interaction between UK and Dutch waters.
d) Additionally, work includes the servicing of moorings in the vicinity of the Outer Gabbard and Thames as part of the National Marine Monitoring Programme.

The main sampling aims of the cruise were:

1. To service moorings deployed in the vicinity of the Outer Gabbard and Thames.
2. To recover seven mooring arrays in the vicinity of the Dogger Bank.
3. Test data storage tags placed on the ADCP mooring frames.
4. Recover free-floating satellite tracked buoys deployed to determine the Lagrangian circulation.
5. Conduct experiments to examine the near-bed cross frontal circulation.
6. To undertake Scanfish and CTD surveys to collect information on the water column structure in relation to nutrient and plankton dynamics.
7. Recover a mooring equiped with sonar in the vicinity of the Indefatigable Bank.

NARRATIVE (all times GMT):

RV CORYSTES sailed at 05:30 for the Smart mooring at the Outer Gabbard (Fig. 1), where on arrival the mooring was serviced and a number of CTD's undertaken for the purpose of calibrating the mooring instrumentation. During this, Dr Weston received news which necessitated him returning ashore, therefore CORYSTES returned to Lowestoft and he was put ashore by searider (~18:00). We then sailed to service the WARP mooring (Fig. 1), a process that included a number of CTD casts for calibration purposes. This was followed by a transect of 4 CTD stations between the Smart Moorings in order to measure primary productivity. The work finished (20:05 15 August) with a number of CTD's at the Gabbard Buoy in order to calibrate the buoy instrumentation.

Subsequently, a series of day grabs were undertaken in the vicinity of the East Anglian 'plume' (Fig. 1) in order to determine the seabed sediment composition. CORYSTES then proceeded to the Dogger Bank to commence a Scanfish line (33; Fig. 2), recovering a 'sonar' mooring on the Indefatigable Bank en route. The Scanfish work commenced at 22:30 16 August, but was rapidly curtailed when the instruments' CPU reset causing the Scanfish to be dragged along the seabed for a short distance. Fortunately, damage was minimal and the fault was eventually diagnosed as a firmware error associated with a piece of equipment being used for the first time. After replacement, the work proceeded without further mishap. Subsequently, three CTD stations (Fig. 1) were occupied along the Scanfish line (Leg 33; Fig. 2) in order to characterise the nutrients status, plankton composition and rate of primary production. It had been the intention to begin the dye release study at this point, however, the forecast was unfavourable and so work proceeded with the recovery of an Argos drifter and a further Scanfish section (Leg 40; Fig. 2). Once completed, we proceeded to the southern most of the CTD stations (09:30 18/08/01). This was followed by an attempt to locate the southern most mooring in the array, the marker toroid from which had previously been landed in Holland. The instrument could not be located acoustically, and we proceeded to the adjacent mooring, the toroid from which was also missing. Nevertheless, the instrument was rapidly located and recovered. This was followed by two further CTD's and the recovery of the northern most mooring, the toroid from which had previously been recovered whilst adrift. Again the instrument package was rapidly located and recovered in failing light (19:30). We then returned to the southern position of the mooring array to undertake a search for the missing instrument. En route, the remaining instrument packages were interrogated in order to determine whether they were still in position. All, but that at position K (Fig. 2) were present. However, only two of the seven marker toroids had survived.

Overnight an acoustic search was conducted for mooring M, without success. Subsequently, three further CTD stations were occupied, before undertaking an acoustic search for mooring K (overnight 19 – 20/8/01). This again proved fruitless, and the search was called off in order to undertake a short Scanfish section (55; Fig 2) in the vicinity of the proposed dye release and a further CTD. What was thought to be the last remaining marker toroid was recovered from the position of mooring J. As this was completed a strong radar contact was observed approximately 2.5 miles away, despite there being no ships in the vicinity. On inspection this proved to be the marker toroid from mooring K. However, on recovery the anchor clump was missing and it was evident that the buoy had been drifting whilst dragging the remains of its mooring wire along the seabed.

Throughout the previous three days the weather was comparatively inclement and unsuitable for conducting a dye release experiment. Fortunately, the forecast brought the prospect of three to four days of reasonably calm weather. Therefore the dye release frame was deployed and the experiment started at 18:25 20/08/01. All went well until approximately 13:30 21/08/01, when contact was lost with the rhodamine patch. Despite following an extensive search pattern for the dye it was not possible to find what we believed to be the original release. However, within approximately 2000 m of the dye release frame significant, but comparatively low concentrations were found. In all probability this was the result of residual discharge from the frame and the experiment was abandoned at 08:30 22/08/01.

Subsequently, the three ADCP moorings at sites H, I & J were recovered followed by the dye release machine. Searches were then conducted for the two missing ADCP rigs at positions K and M. Despite an extensive search with the grapnel that at site K was not located, however, that at site M was recovered at the second attempt (22:00 22/08/01). It had not been possible to communicate with the rig via the acoustic release and there was some evidence of disturbance by fishing activity. In all probability the rig had been turned over at the same time that the marker toroid went missing.

The following day (23/08/01) commenced with the recovery of an ARGOS buoy (04:30) and Scanfish line 79. It had been intended that this be followed by the recovery of the errant marker toroid from mooring G, which was aboard a drilling rig, but this was prevented by thick fog. Consequentially, we continued with Scanfish Leg 80 in the expectation that visibility would improve the next day. Fortunately, conditions were near perfect and following the recovery of two Argos buoys the toroid was towed by searider from the vicinity of the rig and hoisted aboard CORYSTES. Subsequent work was occupied with a combination of Scanfish sections (87, 91, 92, 95 & 96) and Argos buoy recoveries, on occasion having to negotiate considerable concentrations of fishing vessels in foggy conditions. This element of the work was completed north of Denmark at (03:55 27/08/01).

The final part of the cruise was occupied by an uncomfortable return to the Thames in order to calibrate the Smart buoys at the Gabbard and Warp and to collect a large volume water sample at the latter (27/08/01) for subsequent estimation of primary production. En route, sampling was undertaken via the Fast Repetition Rate Fluorometer in order to make estimates of primary production in surface waters between Denmark and the UK. CORYSTES docked at 06:30 29/01/00.

RESULTS (Preliminary):

1) At both Smart moorings a full suite of data was collected. At the more seaward of the two (Gabbard) biological fouling of the instruments was minimal. However, at the Thames mooring fouling continued to be a problem in relation to the determination of chlorophyll, salinity, turbidity and estimation of PAR attenuation coefficient. Full calibration of the sensors and data validation awaits return to the laboratory. Nevertheless, the data can be viewed on the Smart Buoy web site.
2) This objective met with mixed success. Six of the seven ADCP's were recovered, this being the first occasion in six years that we have failed to recover all instruments. However, the marker toroids remained at only two of the sites, perhaps questioning the wisdom of using such buoys for these bottom-mounted instruments. At this stage five have been recovered and it is possible that the remaining two will eventually be found.

Subsequent inspection of the acoustic release at mooring M revealed that it was flooded, the reason for which will be pursued on return to the lab.. Initial inspection of the ADCP data indicates that two of the instruments (moorings G & M) were tipped over. Mooring G at 03:00 7/07/01 (9 days after deployment) and mooring M at 14:00 10/07/01 (13 days after deployment). Only two instruments contained a full data set (moorings I & J), whilst those at moorings H & L will require further assessment to determine whether the records can be retrieved

3) 20 tags were recovered from the mooring frames, which covered a range of depths from 32 - 82 m, a temperature range of approximately 10°C and a varying light climate commensurate with the variation in depth of the moorings. Analysis of the data awaits return to the laboratory, but the deployments should indicate the quality of the tag data and an indication of the evolving near-bed temperature structure. Unfortunately, three tags remain on the missing mooring.
4) Nineteen satellite-tracked drifters had been deployed on the northern flank of the Dogger Bank during CORYSTES 6/01 in order to monitor the Lagrangian circulation. Only nine of the instruments were recovered, six of which were intact. A number are ashore in Denmark and will be returned. Nevertheless, all instruments provided valuable information concerning the residual flow field. The trajectories of the drifters were influenced by several periods of strong winds. However, for the most part the axes of these winds was orientated roughly southwest-northeast, parallel with the overall mean residual flow direction. The drifters moved eastwards towards the Skaggerak at a means speeds of between 3 and 6 km day^{-1} advected with the strong density driven flow associated with the bottom fronts in the region. The most easterly instruments reached the Skaggerak describing the path of a density driven flow that apparently extends continuously from the UK coast.
5) This element of the work was successful, despite losing contact with the dye patch after 21 hours. The evolution of the dye was in contrast to that during CORYSTES 11/00. The patch was rapidly advected away from the sea-bed, a process that appears to be associated with the 'narrowing' of the isopycnal (line of constant density) on which its was released. Again, there was evidence that the dye moved 'up slope' from denser to less dense water. The full potential of the data set will be realised when combined with the observations of nutrients and plankton from the CTD line, the current meter data, larger scale Scanfish data and modelling studies.
6) This objective was met. The mooring section was occupied with CTD's and Scanfish, showing the presence of a strong thermocline and bottom fronts. In contrast to previous years there was a distinct surface mixed layer with a tight thermocline. In the vicinity of the bottom fronts, there was strong near bed phytoplankton production, whilst in deeper water there was a 'thin' layer of intense production associated with the base of the thermocline. The production appears to be largely 'fuelled' by the nutrient rich pool of dense deep water isolated below the summer thermocline following its formation in April/May. The limited series of Scanfish sections provided strong evidence for the movement of fresher water of coastal origin along the northern flank of the Dogger Bank. However, by the Tail End this signal is no longer detectable. Nevertheless, there is strong evidence that flow extends eastwards to the Skaggerak associated with a continuous series of bottom fronts.

Interestingly, preliminary results from the nutrient analysis indicate comparatively high levels of ammonia in the deeper waters under the thermocline, indicative of the decay of

phytoplankton, but also providing an easily utilised food source for new phytoplankton growth at the base of thermocline.

Further analysis of the primary production data in the context of the physical work awaits the return to the laboratory.

7) The mooring at the Indefatigable Bank was recovered successfully. The associated sonar equipment and data storage tag where intact and assessment of the data awaits return to the laboratory.

Overall, the cruise aims were met through the hard work, enthusiasm and good humour of the ships crew and scientific staff. Nevertheless, there were a number of disappointing instrument failures associated with the Scanfish and ADCP's that will require investigation on return to the laboratory.

Juan Brown
(Scientist-in-Charge)
29 August 2001

SEEN IN DRAFT:

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B Salter (Senior Fishing Skipper)

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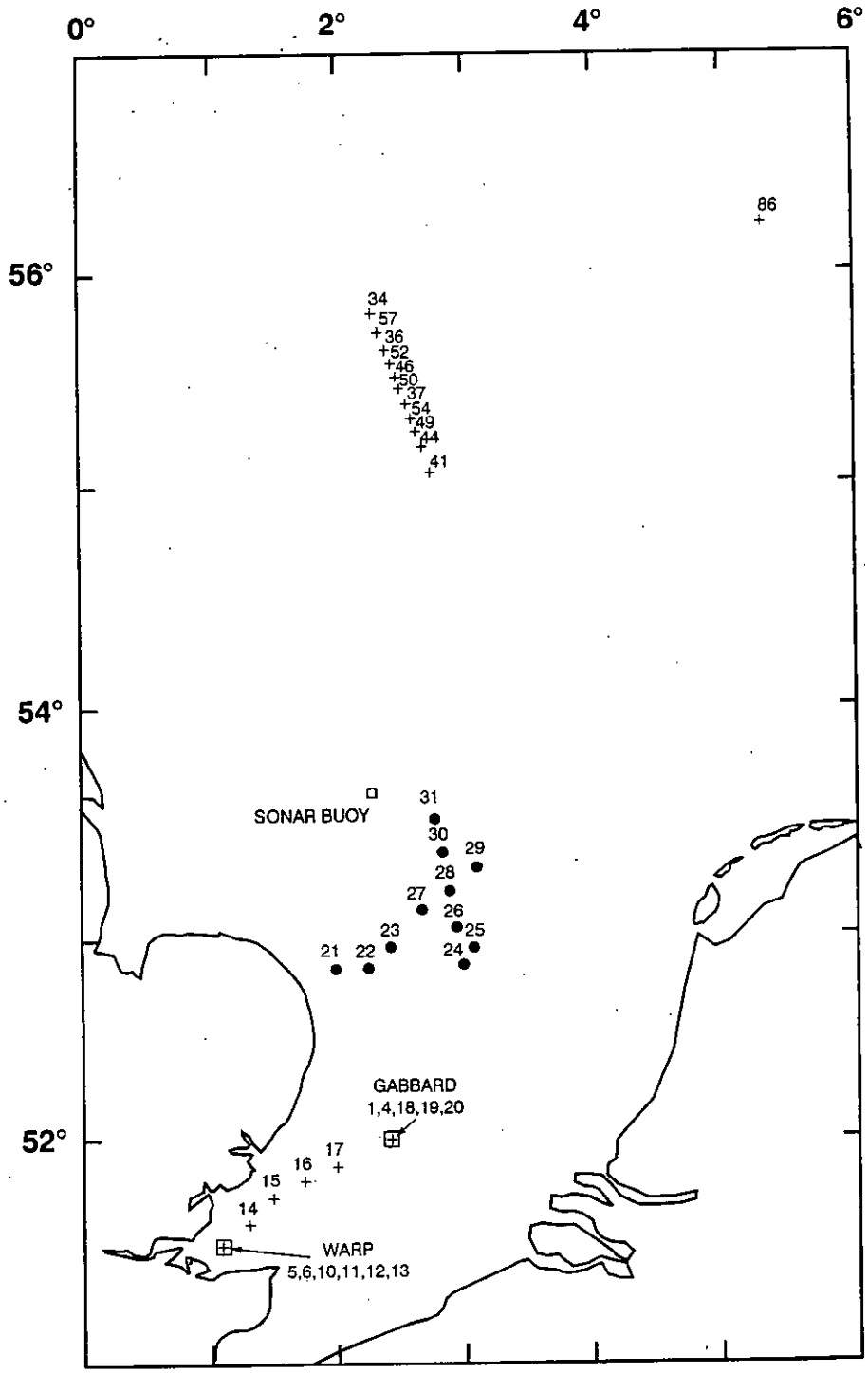

Figure 1. Location of CTD stations (+), grab samples(•) and mooring sites(□)

Jbscanfish

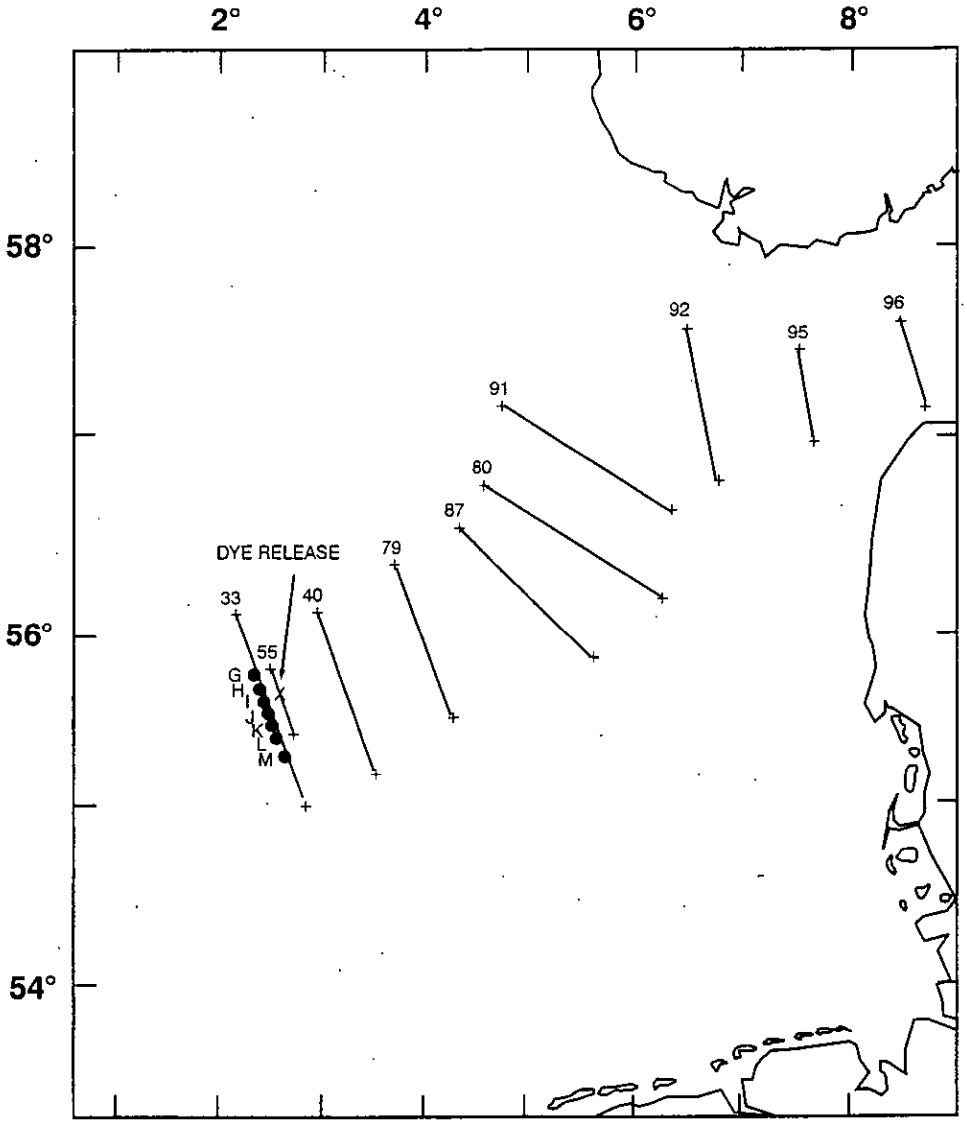

Figure 2. Locations of Scanfish sections, moorings (G-M) and the dye release