DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS.
CEFAS LOWESTOFT LABORATORY, LOWESTOFT, SUFFOLK, ENGLAND.

2003 RESEARCH VESSEL.

REPORT: RV ENDEAVOUR; CRUISE 4B/03.

STAFF:
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E Garnacho
J Jones
W Reynolds
Paul Roberts
K Thomas
S Lincoln; 24th June - 7th July
S Lucas; 7th July - 18th July
B Lyons (Lowestoft); 25th June - 7th July
S Feist (Weymouth); 25th June - 7th July
M Longshaw (Weymouth); 25th June - 7th July
E Naylor (Weymouth); 25th June - 7th July
K Bateman (Weymouth); 7th July - 18th July
J Bignall (Weymouth); 7th July - 18th July
G Stentiford (Weymouth); 7th July to 18th July
Paul Leonard (Defra); 25th - 29th June
Richard Emmerson (Defra); 7th - 8th July

All staff from Burnham Laboratory unless indicated otherwise.

DURATION:
25th June to 18th July 2003.

LOCATION:
North Sea, Irish Sea, Celtic Sea and English Channel.

AIMS:

1. To collect samples of demersal fish for chemical analysis from the North Sea, Eastern English Channel and Irish Sea in support of UK National Marine Monitoring Programme (NMMP).

2. To collect water samples for NMMP biological effects studies and to deploy fractionation / bioassay techniques on water samples from offshore and near shore/estuarine locations.

3. To collect sediment samples for biological effects studies (whole sediment and pore water) at NMMP sites and from additional selected sites as appropriate, e.g. Dogger Bank.

4. To collect fish samples at NMMP sites, for fish disease and genetic toxicological analysis (e.g. DNA adducts).

5. To further investigate the use of appropriate biochemical, cytochemical and other biological techniques in support of NMMP.

6. To sample representative offshore NMMP locations using grab, core, and trawl for trace metal contaminants, PAHs and other organic contaminants (including nonylphenols , flame retardants and HCs) and the benthic fauna.

7. To collect biota for determination of imposex and TBT analysis and sediment for TBT analysis from shipping lanes, anchorages and reference sites in support of OSPAR requirements.

ADDITIONAL AIMS:

8. To make observations on the presence of litter at all NMMP fishing sites and other stations where the Granton trawl is deployed.

NARRATIVE:

RV ENDEAVOUR sailed from Lowestoft on the evening tide of 25th June and overnight steamed to the southern North Sea. On the morning of the 26th June the Granton trawl was shot at the Indefatigable Bank and in the afternoon at Smiths Knoll (Trend site) to collect fish for aim 1. Few fish were caught on the first tow at Smiths Knoll so an alternative tow was fished, yielding sufficient dab and in addition 14 cod for work under aim 5. *ENDEAVOUR* steamed south and on the morning of the 27th June deployed the Granton trawl at Outer Gabbard (NMMP 475). Sufficient numbers of dab were caught for aims 1, 4 and 5. This station was completed by midday. In the afternoon the ship was in position at the Outer Sunk anchorage where a grid of six stations was completed (aim 7) for samples of water, sediment and biota using a Winchester sampler, Day grab and Agassis trawl, respectively. A further grid of six stations was completed in the same manner at the Inner Sunk Anchorage and the Warp Anchorage in the Thames for aims 2 and 7. In the evening, *ENDEAVOUR* sailed to Rye Bay and through the night *en route* sampled at seven stations on a transect through the Dover Straits; water samples were sampled with the Winchester sampler, sediments with a Day grab and biota with the scallop dredge.

On the morning of the 28th June the Granton trawl was deployed on two tows in Rye Bay (NMMP 486) and fish samples taken for aims 1, 4 and 5. *ENDEAVOUR* then steamed for Weymouth and *en route* sampled for water, sediment and biota at the Solent Deep Water Anchorage near Nab Tower. *ENDEAVOUR* berthed on the morning tide in Weymouth Harbour on the 29th of June as a contribution to the Weymouth Fish Fayre and for staff from the CEFAS Weymouth Laboratory to view the ship. Many tourists viewed the ship from the quayside and

approximately half of the Weymouth Laboratory staff were given a guided tour of the ship. On the evening tide, *ENDEAVOUR* sailed for the Celtic Sea and *en route* took samples of water and sediment from the Falmouth Anchorage (aim 7). Several attempts to collect biota were unsuccessful.

On 1st July, *ENDEAVOUR* arrived in Swansea Bay, where a grid of six sediment samples were taken using a Day grab and water samples using a Winchester sampler (aim 7). Attempts to collect biota with the Agassis trawl were unsuccessful. A further grid of nine stations was sampled on the dredged material disposal site for sediment using the Reineck Box corer. Sediment and pore water samples were collected for aims 3 and 5. A churn sample was also taken for aim 2. This work was completed by mid afternoon and *Endeavour* sailed to Carmarthen Bay where the Granton trawl was deployed and fish collected for aims 1, 4 and 5. Overnight *ENDEAVOUR* steamed to the Celtic Deep and on the morning of the 2nd July fish were collected again for aims 1,4 and 5. At the NMMP benthos station, five Day grabs and five Multicore samples were taken within a 200-m bull ring and in addition, benthos was collected with a 2-m wooden beam trawl (aim 6). After completing this work by mid afternoon, *ENDEAVOUR* sailed towards Cardigan Bay and *en route* took samples of water and sediment on a transect out of Milford Haven from the tanker terminal using the ships jet boat (aim 7).

On the 3rd and 4th July *ENDEAVOUR* was in Cardigan Bay and deployed the Granton trawl at three NMMP stations to collect fish for aims 1, 4 and 5. In addition, two tows were also identified and fished to investigate the prevalence and geographical extent of high fish disease observed in Cardigan Bay in previous years. Day grabs were taken at the mid tow positions of each of the tows to collect sediment for contaminant analysis. On the 3rd July a series of five Day grabs were taken in a 200 m bull ring at the Inner Cardigan Bay NMMP benthos station.

Overnight on the 4th July *ENDEAVOUR* sailed to Dundrum Bay and on the morning of the 5th July deployed the Granton trawl to collect fish for aims 1, 4 and 5. This station was completed by mid afternoon and the ship headed for the SE Isle of Man arriving there to start work on the morning of the 6th July. Several tows were needed to collect sufficient fish for aims 1, 4 and 5 and in addition a Day grab was taken from the mid tow position to collect sediment for contaminant analysis. At midday, *ENDEAVOUR* moved to the SE Isle of Man NMMP benthos station where five Day grabs and five Multicore samples were taken within a 200 m bull ring and in addition benthos was collected with a 2 m wooden beam trawl (aim 6). This work was completed by mid afternoon and the ship sailed to the Off Morecambe NMMP station and successfully collected fish using the Granton trawl (aims 1,4 and 5). Overnight *ENDEAVOUR* sailed to Holyhead.

At Holyhead, the jet boat was launched for a changeover of scientific staff. This was completed by mid morning and *ENDEAVOUR* steamed to Red Wharf Bay where the Granton trawl was used to collect fish for aims 1, 4 and 5. This was successfully completed after one tow. Whilst in Red Wharf Bay a grid of six

stations across the anchorage was sampled for water and sediment using the Winchester sampler and Day grab for water and sediment respectively. In addition, the scallop dredge was deployed across the anchorage to collect biota (aim 7). In the late afternoon, *ENDEAVOUR* had moved to Liverpool Bay where plaice, dab, whiting and other commercial species were collected for contaminant analysis for trend and EQS purposes (aim 1).

On the morning of the 8th July fishing commenced at the Liverpool Bay NMMP station and after three tows sufficient fish were collected for aims 1, 4 and 5. *ENDEAVOUR* then moved to the Mersey Bar Anchorage where a series of six Day grabs and Winchester samples for sediment and water were taken for aim 7. The scallop dredge was also deployed across the anchorage to collect biota. Concurrently with this sampling, the jet boat was launched to take water and sediment samples on a transect out from the Mersey for aims 2, 3 and 7. In the evening, a series of five Day grabs were taken within a 200 m bull ring at the Liverpool Bay NMMP benthos station.

The Burbo Bight NMMP station was sampled for fish first thing on the morning of the 9th July, with two tows of the Granton trawl. The ships' jet boat was then launched and three water and sediment samples were taken using a churn, Winchester sampler and hand held Van Veen grab, at three station out from the Dee estuary for aims 2, 3 and 7. At midday *ENDEAVOUR* sailed north and in the evening towed the Granton trawl at the St Bees NMMP station for aims 1, 4 and 5.

Overnight *ENDEAVOUR* sailed to Belfast Lough where the ships' jet boat was deployed to collect samples of water and sediment at ten stations on a transect out from Belfast for aims 2, 3 and 7. This work was successfully completed by midday on the 10th July. *ENDEAVOUR* continued to steam north through the Minches and Pentland Firth to the Central North Sea.

On the 12th July *ENDEAVOUR* arrived on the Dogger Bank at NMMP station 286, West Dogger where the Granton trawl was deployed to catch fish for aims 1, 4 and 5. A Day grab was also deployed to collect sediment from the mid tow position for chemical contaminant analysis. Further NMMP stations were also successfully sampled in the same manner on the 13th July at North Dogger, North East Dogger, and Hospital Ground and on the 14th July at the Silver Pit Off Humber station. No dabs were caught after one tow at the outer Wash NMMP station so this station was aborted. Later on the evening of the 14th July a grid of six stations was sampled for water and sediment across the Humber anchorage using a Winchester sampler and Day grab respectively.

On the morning of the 15th July *ENDEAVOUR* arrived at the Off Flamborough NMMP site (344). The Granton trawl was deployed and after three tows sufficient dab were collected for sampling under aims 1, 4 and 5. A Day grab was also deployed on the mid tow position to collect sediment for chemical contaminants. At midday, sampling was completed and the ship sailed to the Tees Bay Anchorage where in the evening a series of five Day grabs and

Winchester samples for sediment and water respectively were taken. An unsuccessful attempt was made to collect biota from the anchorage using the scallop dredge, 2-m steel beam and Rock dredge. On the second deployment of the 2-m beam the trawl became fast on the bottom and the bridle parted, with the loss of the trawl.

Sampling resumed on the morning of the 16th July when the Granton trawl was deployed at the Tees Bay NMMP station and dab were successfully collected for aims 1, 4 and 5. During the morning the ships' jet boat was used to sample water and sediment at four stations on a transect out from the Tees for aims 2, 3 and 7. This work was completed by midday and *ENDEAVOUR* headed for the Farne Deep. In the evening, the Granton trawl was deployed twice but insufficient dab were caught. However, cod were sampled under aim 5.

Overnight, *ENDEAVOUR* moved to the Amble NMMP station (244) and after three deployments of the Granton trawl sufficient fish were caught for sampling for aims 1, 4 and 5. A Day grab was also deployed on the mid tow position to collect sediment for chemical contaminants. At midday on the 17th July the ship moved to the Tyne Anchorage where a grid of five sediment and water samples were taken for aims 3 and 7. A jet boat deployment for sampling a transect out from the Tyne was aborted due to thick fog. At mid afternoon *ENDEAVOUR* steamed for Lowestoft and docked on the midday tide on 18th July.

RESULTS:

Weather conditions throughout the voyage were very good with the exception of one day as *ENDEAVOUR* steamed through the Minches on its passage to the Central North Sea. Weather at that time was moderate to fresh. On the last working day of the cruise fog reduced visibility to approximately 100 m, but no time was lost due to adverse conditions.

Fishing throughout the voyage was very good. Sufficient fish were obtained at all NMMP sites to fulfil the aims and purposes of the cruise with the exception of the Outer Wash, where fish have been caught in the past but insufficient fish were available at this time. Twenty-six stations were trawled for fish using the Granton trawl. Between one and five deployments of the trawl were needed at each station; on average two to three deployments were necessary and a total of sixty-eight deployments of the trawl were made during the voyage.

Aim 1. Two samples each of twenty-five whole dab were collected from twenty-four NMMP sites. The dab were collected for chemical contaminant analysis for NMMP trend monitoring purposes and where biomarkers and fish disease studies were carried out. Three samples of plaice, whiting and dab in five consecutive length stratified groups were collected for trend purposes from Liverpool Bay. In addition, samples of 25 fish of plaice, whiting, sole and dab of commercial size were collected from Liverpool Bay for EQS performance indicator purposes. Thirty dab in 5 length-stratified groups were collected from

Smiths Knoll for trend monitoring purposes. All samples were frozen and stored at –20^{o}C for analysis at the Burnham Laboratory.

Aim 2. Twenty-five water and sediment samples were collected from coastal and estuarine locations for the analysis of pharmaceutical compounds. The water samples were extracted by solid phase extraction (SPE) immediately upon collection, whilst the sediment samples were frozen at -25°C. The samples will be analysed by liquid chromatography coupled to mass spectrometry for acetyl-sulfamethoxazole, clofibric acid, clotrimazole, dextropropoxyphene, diclofenac, erythromycin, ibuprofen, lofepramine, mefenamic acid, paracetamol, propranolol, sulfamethoxazole, tamoxifen and trimethoprim, upon return to the Burnham Laboratory. At many of the same locations (15), samples were also extracted by large volume SPE in order to provide concentrated extracts for *in vitro* bioassay testing. The extracts will be tested using a battery of bioassays representing different trophic levels and receptor systems.

Aim 3. Twenty-four sediment samples were collected from the mid tow positions of all NMMP fishing stations. The samples were frozen at -20°C for subsequent analysis of chemical contaminants in support of fish chemical contaminant trend monitoring, biomarkers and fish disease monitoring. In addition, thirty-three whole sediment samples and eight pore water samples were taken for ARH receptor screening.

Aim 4: External and internal diseases of dab (*Limanda limanda*) were assessed at the following stations. Figures in parenthesis refer to numbers of dab sampled for histopathology and for external diseases respectively:

Indefatigable Bank (50, 138), Outer Gabbard (0, 27), Rye Bay (50, 240), Carmarthan Bay (50, 126), Celtic Deep (20, 0), Inner Cardigan Bay (50, 203), North Cardigan Bay (50, 0), Roker Park (50, 236), South West Cardigan Bay (50, 0), Dundrum Bay (50, 152), SE Isle of Man (50, 257), Morecambe Bay (50, 236), Red Wharf Bay (50, 222), Liverpool Bay (50, 252), Burbo Bight (50, 225), St. Bee's (50, 128), West Dogger (50, 205), North Dogger (50, 300), North East Dogger (0, 300), Hospital Ground (50, 229), Off Humber Wash (50, 0), Flamborough (50, 207), Off Tees (50, 202), Amble (20, 0).

In total, over 5000 dab were screened for disease. Liver nodules were removed and will be further processed for histological diagnosis of lesion type. In addition, large tumours were excised and frozen for proteomic and genomic assessment of tumour-specific protein and gene mutants.

A number of additional fish species were collected where possible for assessment of pathology and for parasites. These included cod, bass, whiting, haddock, plaice, flounder, lesser spotted dogfish, shad, monkfish, greater weaver fish, five bearded rockling, poor cod, dover sole, turbot, brill, snake blenny, dragonet, red band fish, spurdog, pogge and gurnard. Material from these species will be further analysed at the Weymouth laboratory.

In addition to the fish species listed above, a number of species of crustaceans and molluscs were collected for pathology and parasitology. Molluscs included king scallops, queen scallops, horse mussels, cuttlefish and cockle. Crustaceans included hermit crabs (collected from Outer Sunk, Inner Sunk, Rye Bay, Carmarthan Bay, North Cardigan Bay, Red Wharf Bay, Liverpool Bay, Burbo Bight, St. Bee's, West Dogger, North Dogger, Silver Pit and Off Tees), Norway lobster, pea crab, *Crangon crangon* and *Liocarcinus depurator*. *Crangon crangon* collected from the Wash will be assessed for the *Crangon crangon* bacilliform virus (CcBV) recently described from UK estuarine stocks of this species. Norway lobsters captured from the Silver Pit site exhibited a 1.3 % prevalence of the dinoflagellate parasite *Hematodinium* (number examined = 1868).

Selective samples were collected and preserved for ultrastructural analysis under the scanning and transmission electron microscope. This included samples of *Crangon crangon* for detection of CcBV, samples of Norway lobster for diagnosis of *Hematodinium*, samples of dab testis and cod ovary and testis for detection of apoptotic cell death in spermatogonia and oogonia and samples of liver tumours excised from dab for ultrastructural analysis and application of immuno-gold labelling of tumour-specific proteins.

Aim 5: At each of the twenty four NMMP stations samples were taken for OSPAR JAMP CEMP biological effects monitoring. Ten male and ten female fish were sampled at each site (a total of 480 fish) for biomarkers which include EROD, bile metabolites, DNA adducts, Metallothionein. All samples were frozen in liquid nitrogen for subsequent analysis at the laboratory. Other fish parameters such as weight, length, gonad and liver weight were also recorded along with the collection of otoliths.

In total, 100 cod were sampled for plasma and for histopathology from a number of sites, including Smith's Knoll (13), Outer Gabbard (9), Rye Bay (2), Celtic deep (1), Silver Pit (26), Flamborough (9), Off Tees (4), Farne Deep (12) and Amble (24). The plasma was stored in liquid nitrogen for subsequent analysis of VTG at the laboratory. Other fish parameters such as weight, length, gonad and liver weight were also recorded along with the collection of otoliths.

Aim 6. A grid of 10 Day grabs within a 200 m bullring was successfully collected at each of the following sites, Celtic Deep, Cardigan Bay, SE Isle of Man and Liverpool Bay. Sediment samples were taken for particle size analysis, and chemical analyses of metals and organics. In addition, sediments from the Celtic Deep and SE Isle of Man sites were sieved on-board and all benthos preserved for identification and enumeration on return to the Burnham Laboratory. The 2-m beam trawl was also successfully deployed at each of these two sites and macro benthos preserved for examination on return to the Burnham laboratory. The multicorer was also successfully deployed at the Celtic Deep and SE Isle of Man and meiofauna was collected.

Aim 7. Water samples and sediments were collected for analysis of TBT from sites associated with major shipping activities: Anchorages at Outer and Inner Sunk, Thames Warp, Southampton Water, Falmouth, Swansea, Red Wharf Bay, Burbo Bar, Humber, Tees and Tyne; shipping activities in the Dover Straits, Milford Haven, Mersey, Dee and Belfast Lough. Approximately 80 samples were collected; sediments were frozen onboard and water samples were extracted onboard for subsequent analysis at the laboratory. The samples will be prioritised for analysis with emphasis being placed on sites that have heavy shipping activity such as the Tees anchorage, where 10 large ships were at anchor during the sampling. Collection of whelks and biota from many of the sites was difficult due to the lack of presence of organisms and/or inhospitable substrate for the deployment of gear. Whelks were collected from 15 sites throughout the cruise for the identification of imposex and TBT analysis. In support of this work, samples of hermit crabs taken also for chemical analysis. The samples will be evaluated fully at the Burnham Laboratory.

Additional Aims:

Aim 8. The Granton trawl was deployed at 26 locations during the voyage. A total of 67 tows were made each tow for a distance of c. 2 miles. All items of litter were recorded in terms of type, size etc. Litter was most abundant at North Cardigan Bay and Carmarthen Bay on the west coast of the UK and Rye Bay on the south coast of the UK. Only a few items of litter were found in trawl deployments on the East Coast.

Cetacean sightings:

During the ships passage the following cetaceans were sighted.

30th June 2003, 19:30 hr, 50° 45.95 N : 05° 16.15.00 W
Approx. 30 common dolphins followed the ship for 45 minutes.

2nd July 2003, 10:50 hr, 51° 09.87 N : 05° 44.69 W
Dolphins followed the ship for 30 minutes.

14th July 2003, 04:30 hr, 54° 09.22 N : 02° 40.33 W
Dolphins and Pilot whale observed for 5 minutes.

Acknowledgements:

I would like to acknowledge the active support and help of the ship's officers and crew in completing the above programme of work. In particular thanks to the Captain and Fishing Skipper for their advice and contribution to the work programme.

Two staff from DEFRA, Dr Paul Leonard (Science Directorate) and Dr Richard Emmerson (Marine Waters Division) joined the ship for a short period during the first half of the cruise. Both are project officers for work that was conducted on

the cruise. This provided an excellent opportunity to discuss the work programmes, see the work being conducted and to see first hand the capabilities of the new DEFRA ship.

John Thain (Scientist In Charge)

18th July 2003

SEEN IN DRAFT: Capt. R. McCurry (Master) - initialled

Alex Lincoln (Fishing Skipper) - initialled

Jacqueline Jones (AE002 contract leader) - signed

David Morris (Science Area Head EQ) - signed

DISTRIBUTION:

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RV *CEFAS ENDEAVOUR* Cruise track for cruise 4B 03