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FRV *Clupea*

Cruise 0698C

REPORT

14-30 April 1998

Ports

Loading:	Fraserburgh
Unloading:	Fraserburgh
Working:	Leith, 21-22, 24-25 and 27-28 April

Personnel

D Saward	SSO	14-30 April (in charge)
J McKie	HSO	14-30 April
Ms L Goodwin	SO	14-30 April
D Moore	SSO	14-28 April
C Shand	HSO	14-25 April
P Copland	HSO	21-25 April
M Burns	SO	25-28 April
A Beaton	AO	26-27 April (shore-based)
Ms E Souter	AO	26-27 April (shore-based)

Fishing Gear: None

Objectives

1. To undertake grab surveys to collect seabed sediment samples from the Bell Rock and St Abb's Head sewage sludge disposal sites, and from areas adjacent to both sites, for microbiological analysis on FRV *Clupea*, and for physical, chemical and biological analyses in the Marine Laboratory, Aberdeen (MLA).

2. To undertake Agassiz trawl surveys to collect benthic epifauna samples from the areas outlined above, for identification and enumeration of the predominant species and items of litter on FRV *Clupea*.

3. To undertake underwater television surveys to investigate the benthic epifauna in the areas outlined above, for identification and enumeration of the predominant species in MLA.

4. To map the seabed bathymetry and sediment types in the Middle Bank area of the Firth of Forth, using RoxAnn©.

5. To undertake a side-scan sonar survey in the Middle Bank area, to determine the nature and distribution of significant seabed features (eg natural outcrops of rock).

6. To undertake a transmissometer survey in the Middle Bank area, to investigate the levels of turbidity in the water column.

7. To collect seawater samples from the Middle Bank area, for measurement of suspended solids levels and phytoplankton analysis in MLA.

8. To undertake grab and corer surveys to collect seabed sediment samples from the Middle Bank area, for physical, chemical and biological analyses in MLA.

9. To undertake an Agassiz trawl survey to collect benthic epifauna samples from the Middle Bank area, for identification and enumeration of the predominant species on FRV *Clupea*.

10. To undertake an underwater television survey to investigate the benthic epifauna in the Middle Bank area, for identification and enumeration of the predominant species in MLA.

Out-turn Days Per Project: 17 days. BEA1 (AEO2n).

Narrative

Scientific equipment was loaded and set up at Fraserburgh on 9 April, at the end of FRV *Clupea* Cruise 0598C. Scientific staff joined the vessel at 1045 hours on 14 April, and completed the setting up of scientific equipment. Departure from Fraserburgh was delayed until 1415 hours, to await the delivery of microbiological culture media. The vessel then proceeded to an anchorage off Arbroath. The vessel remained at anchor from 2245 hours on 14 April until 0700 hours on 15 April, and then proceeded to the Bell Rock survey area to undertake the grab sampling outlined in Objective 1. The grab sampling was commenced at 0815 hours and was completed at 1815 hours. The underwater television survey was then commenced, as outlined in Objective 3. Survey operations were suspended at 1945 hours, following failure of the underwater television system, and the vessel proceeded to an anchorage off East Haven (Arbroath). The vessel remained at anchor from 2115 hours on 15 April until 0715 hours on 16 April. During transit to the anchorage, and whilst at anchor, the fault in the underwater television system was investigated and the seabed sediment samples were processed for enumeration of faecal coliforms and faecal streptococci. On leaving the anchorage, the vessel returned to the Bell Rock survey area to commence the Agassiz trawl survey outlined in Objective 2. During transit to the survey area, the fault in the underwater television system was repaired. The Agassiz trawl survey was commenced at 0830 hours but had to be suspended at 1030 hours because of rapidly deteriorating weather conditions. The vessel then proceeded to shelter in Largo Bay, and remained at anchor from 1430 hours on 16 April until 0745 hours on 17 April. On leaving Largo Bay, the vessel proceeded to Fife Ness to investigate sea conditions outside the Firth of Forth. Conditions were unsuitable for survey operations, so the vessel re-entered the Firth of Forth and proceeded to the Middle Bank survey area to commence the grab sampling outlined in Objective 8. The grab sampling was commenced at 1145 hours and was completed at 1800 hours. The vessel then proceeded to an area off Kirkcaldy, to undertake limited echo-sounder and grab surveys to confirm whether the area was suitable for RoxAnn© calibration trials. The limited surveys were completed at 1900 hours and the vessel returned to Largo Bay. The vessel remained at anchor from 2145 hours on 17 April until 0715 hours on 18 April. On leaving Largo Bay, the vessel returned to the Bell Rock survey area to complete the Agassiz trawl and underwater television surveys outlined in Objectives 2 and 3. The Agassiz trawl survey was resumed at 1000 hours and was completed at 1345 hours. The underwater television survey was resumed immediately and was terminated at 2000 hours. The vessel then proceeded to an anchorage off May Island, and remained there from 2200 hours on 18 April until 0745 hours on 19 April. On leaving the anchorage, the vessel proceeded to the

St Abb's Head survey area to undertake the grab sampling outlined in Objective 1. The grab sampling was commenced at 0930 hours and was completed at 1930 hours. The vessel then proceeded to the Bubbly Buss anchorage, and remained there from 2130 hours on 19 April until 0700 hours on 20 April. During transit to the anchorage, and whilst at anchor, the seabed sediment samples were processed for enumeration of faecal coliforms and faecal streptococci. On leaving the anchorage, the vessel returned to the St Abb's Head survey area to commence the Agassiz trawl and underwater television surveys outlined in Objectives 2 and 3. The underwater television survey was commenced at 0930 hours and was completed at 1815 hours. The Agassiz trawl survey was commenced immediately and was suspended at 1945 hours. The vessel then proceeded to an anchorage in Windyraw Cove (Pease Bay), and remained there from 2045 hours on 20 April until 0800 hours on 21 April. On leaving the anchorage, the vessel returned to the St Abb's Head survey area to complete the Agassiz trawl survey outlined in Objective 2. The Agassiz trawl survey was resumed at 0900 hours and was completed at 1315 hours. Upon completion of the Bell Rock and St Abb's Head survey programmes, the vessel proceeded to Leith to allow P Copland to join the vessel. The vessel docked at Leith at 1730 hours on 21 April, and P Copland joined the vessel immediately. Whilst in Leith, the equipment used to process samples for the enumeration of faecal coliforms and faecal streptococci was unloaded to be transported back to Aberdeen, and the RoxAnn© and side-scan sonar transducers were set up for deployment on a boom attached to the starboard side of the vessel. The vessel remained at Leith until 1100 hours on 22 April, and then proceeded to an area off Kirkcaldy to undertake RoxAnn© calibration trials. The calibration trials were commenced at 1230 hours and were completed at 1330 hours. The vessel then returned to the Middle Bank survey area to undertake underwater television visibility trials. The visibility trials were commenced at 1400 hours and were suspended at 1430 hours. The RoxAnn© and side-scan sonar surveys were then commenced, as outlined in Objectives 4 and 5. During the RoxAnn© and side-scan sonar surveys, the colour underwater television camera was exchanged for a monochrome camera to improve the resolution, and survey operations were suspended at 2030 hours to resume the visibility trials using the monochrome system. The visibility trials were completed at 2045 hours and the vessel proceeded to the Leith Roads small vessel anchorage. The vessel remained at anchor from 2100 hours on 22 April until 0800 hours on 23 April, and then returned to the Middle Bank survey area to commence the underwater television survey outlined in Objective 10; and to resume the RoxAnn© and side-scan sonar surveys. The underwater television survey was commenced at 0800 hours and was suspended at 1320 hours. The RoxAnn© and side-scan sonar surveys were commenced immediately and were suspended at 2145 hours. The vessel then returned to the Leith Roads small vessel anchorage, and remained there from 2200 hours on 23 April until 0800 hours on 24 April. On leaving the anchorage, the vessel returned to the Middle Bank survey area to complete the underwater television, RoxAnn© and side-scan sonar surveys. The underwater television survey was resumed at 0815 hours and was completed at 1030 hours. The RoxAnn© and side-scan sonar surveys were resumed immediately and were completed at 1645 hours. The vessel then proceeded to Leith, to allow P Copland and C Shand to disembark, and to allow M Burns to join the vessel. The vessel docked at Leith at 1800 hours on 24 April, and remained there until 0845 hours on 25 April. Whilst in Leith, the underwater television, RoxAnn© and side-scan sonar equipment was demobilised. P Copland and C Shand disembarked at 0815 hours on 25 April, and M Burns joined the vessel at 0830 hours. The vessel then returned to the Middle Bank survey area to undertake Craib corer trials; and to commence the transmissometer, water sampling and Agassiz trawl surveys outlined in Objectives 6, 7 and 9. The Craib corer trials were commenced at 0915 hours and were terminated at 1015 hours. One sample was obtained, but the corer was very unreliable. The transmissometer and water sampling surveys were commenced immediately and were suspended at 1930 hours. The Agassiz trawl survey was commenced immediately and was suspended at 2030 hours to return to the Leith Roads small vessel anchorage. Whilst at anchor, the Agassiz trawl samples were sorted. The vessel remained at anchor from 2100 hours on 25 April until 0800 hours on 26 April, and then returned

to the Middle Bank survey area to commence the Craib corer sampling outlined in Objective 8; to complete the transmissometer and water sampling surveys; and to undertake gravity corer trials. The Craib corer sampling was commenced at 0830 hours but had to be terminated at 0900 hours because the sea bed was unsuitable for the sampling gear. A Beaton and B Souter joined the vessel by Pilot Cutter at 0900 hours. Supplementary grab sampling was then commenced (replacing the Craib corer sampling), to collect seabed sediment samples for phytoplankton cyst enumeration. The supplementary grab sampling was completed at 1115 hours, and the transmissometer and water sampling surveys were resumed. Survey operations were suspended between 1530 hours and 1645 hours to undertake the gravity corer trials. A Beaton and B Souter disembarked by Pilot Cutter at 2000 hours. The transmissometer and water sampling surveys were completed at 2015 hours and the vessel returned to the Leith Roads small vessel anchorage. The vessel remained at anchor from 2030 hours on 26 April until 0800 hours on 27 April, and then returned to the Middle Bank survey area to complete the Agassiz trawl survey. The trawl survey was resumed at 0815 hours. A Beaton and B Souter joined the vessel by Pilot Cutter at 0930 hours. The Agassiz trawl survey was completed at 1600 hours and the samples were sorted during passage into Leith. The vessel docked at Leith at 1645 hours on 27 April, and remained there until 0900 hours on 28 April. A Beaton and B Souter disembarked at 1830 hours on 27 April, and D Moore and M Burns disembarked at 0830 hours on 28 April. Upon leaving Leith, the vessel returned to the Middle Bank survey area to undertake further grab sampling and gravity corer sampling, as outlined in Objective 8. The grab sampling was commenced at 1000 hours and was completed at 1130 hours. The gravity corer sampling was commenced at 1200 hours and was completed at 1645 hours. Upon completion of the Middle Bank survey programme, the vessel returned to an anchorage in Largo Bay, and remained there from 1800 hours on 28 April until 0200 hours on 29 April. The vessel then departed the Firth of Forth to return to Fraserburgh. The vessel docked at Fraserburgh at 1330 hours on 29 April, and scientific equipment was demobilised. Unloading was completed at 1030 hours on 30 April, and scientific staff disembarked at 1045 hours to return to Aberdeen.

Results

1. Grab sampling for physical, chemical and microbiological analyses was undertaken at a total of 29 sampling stations in the vicinity of the Bell Rock sewage sludge disposal site, and at one sampling station in an adjacent control area. Thirty-five Day grab deployments were made, and 30 seabed sediment samples collected.

a. All of the seabed sediment samples were sub-sampled for microbiological analysis. Sub-samples were removed from the surface of the sediment using a sterile spatula. The sub-samples were processed on FRV *Clupea*, and faecal coliforms and streptococci enumerated. Processed material was stored in a refrigerator, for enumeration of *Clostridium perfringens* spores in MLA. Faecal coliforms were detected in one of the 30 sediment samples (one colony). It was noted that very few non-target micro-organisms were present on the culture plates. Faecal streptococci were not detected in any of the samples, and it was noted that there were no non-target micro-organisms present on the culture plates. The single positive faecal coliform sample was collected from an area at the western limit of the sewage sludge disposal site. However, it is considered unlikely that the contamination was related to sewage sludge disposal operations as the Bell Rock site had not been used for sewage sludge dumping since October 1997.

b. All of the seabed sediment samples were sub-sampled for particle size and heavy metal analyses. Thirty core sub-samples were taken for particle size analysis; and 30 surface

scoop sub-samples were taken for heavy metal analysis. The sub-samples were deep frozen for analysis in MLA.

2. Grab sampling for macrobenthos infauna analyses was undertaken at a total of nine of the grab sampling stations in the vicinity of the Bell Rock sewage sludge disposal site. Thirty three Day grab deployments were made, and 27 samples collected (three samples at each sampling station). The samples were washed through a 0.5 mm mesh sieve. The macrobenthos infauna remaining in the sieves were transferred to sample buckets and fixed in a 10% solution of formalin in sea water. The samples were then stored for analysis in MLA.

3. One Agassiz trawl of approximately 15 minutes duration was undertaken in the vicinity of each of the nine Bell Rock stations sampled for macrobenthos infauna analyses and at the adjacent control sampling station. The epifauna present in the trawls were identified and enumerated on FRV *Clupea*. The litter present in the trawls was identified and enumerated. Very few commercially exploited organisms were caught in the trawls, and it was not possible to obtain sub-samples for chemical analysis in MLA.

4. One towed sledge underwater television transect of approximately 30 minutes duration was undertaken in the vicinity of eight of the nine Bell Rock stations sampled for macrobenthos infauna analyses. A log of observations was made during the course of each transect, and the tape records were retained for analysis in MLA. There was insufficient time to undertake transects at the other station sampled for macrobenthos infauna analysis or at the adjacent control sampling station.

5. Grab sampling for physical, chemical and microbiological analyses was undertaken at a total of 29 sampling stations in the vicinity of the St Abb's Head sewage sludge disposal site, and at one sampling station in an adjacent control area. Thirty-five Day grab deployments were made, and 30 seabed sediment samples collected.

a. All of the seabed sediment samples were sub-sampled for microbiological analysis. Sub-samples were removed from the surface of the sediment using a sterile spatula. The sub-samples were processed on FRV *Clupea*, and faecal coliforms and streptococci enumerated. Processed material was stored in a refrigerator, for enumeration of *Clostridium perfringens* spores in MLA. Faecal coliforms were detected in one of the 30 sediment samples (one colony). It was noted that large numbers of non-target micro-organisms were present on the culture plates used for enumeration of samples collected at the St Abb's Head sewage sludge disposal site. Faecal streptococci were detected in 21 of the sediment samples, and it was noted that there were no non-target micro-organisms present on the culture plates. The single positive faecal coliform sample was collected from the adjacent control area, and it is considered unlikely that the contamination was related to sewage sludge disposal operations. Eighteen of the positive faecal streptococci samples were collected from sampling stations located within the sewage sludge disposal site. Faecal streptococci were not detected in the sample collected from the adjacent control area. The levels of faecal streptococci were low in 19 of the 21 positive samples, and intermediate in the remaining two samples. The intermediate concentrations were detected in samples collected within one mile of the centre of the sewage sludge disposal site. The failure to detect faecal coliforms in the sediment samples collected at the St Abb's Head sewage sludge disposal site was unusual as the site was currently being used for sewage sludge dumping operations. It is possible that the media had been prepared incorrectly, or that it had been contaminated prior to use. However this seems unlikely, as one coliform colony was noted in the sample collected from the adjacent control area; selected duplicate samples

incubated using a alternative medium also failed to detect faecal coliforms; and large numbers of non-target micro-organisms were noted on the culture plates. It is also possible that the faecal coliforms associated with the sewage sludge had "died-off" more rapidly than is normally cited (4-5 days), as there had been no sewage sludge dumping operations during the three days prior to the seabed sediment sampling. Whilst this also seems unlikely, as one would not expect total mortality within such a short and finite period, it is probably the only plausible explanation for the data.

b. All of the seabed sediment samples were sub-sampled for particle size and heavy metal analyses. Thirty core sub-samples were taken for particle size analysis; and 30 surface scoop sub-samples were taken for heavy metal analysis. The sub-samples were deep frozen for analysis in MLA.

6. Grab sampling for macrobenthos infauna analyses was undertaken at a total of nine of the grab sampling stations in the vicinity of the St Abb's Head sewage sludge disposal site. Twenty-eight Day grab deployments were made, and 27 samples collected (three samples at each sampling station). The samples were washed through a 0.5 mm mesh sieve. The macrobenthos infauna remaining in the sieves were transferred to sample buckets and fixed in a 10% solution of formalin in sea water. The samples were then stored for analysis in MLA.

7. One Agassiz trawl of approximately 15 minutes duration was undertaken in the vicinity of each of the nine St Abb's Head stations sampled for macrobenthos infauna analyses and at the adjacent control sampling station. The epifauna present in the trawls were identified and enumerated on FRV *Clupea*. The litter present in the trawls was identified and enumerated. Organisms that could not be identified on FRV *Clupea* were transferred to sample jars and fixed in a 10% solution of formalin in sea water. The organisms were then stored for identification in MLA. Very few commercially exploited organisms were caught in the trawls, and it was not possible to obtain sub-samples for chemical analysis in MLA.

8. One towed sledge underwater television transect of approximately 30 minutes duration was undertaken in the vicinity of each of the nine St Abb's Head stations sampled for macrobenthos infauna analyses and at the adjacent control sampling station. A log of observations was made during the course of each transect, and the tape records were retained for analysis in MLA.

9. A RoxAnn© survey was completed at the Middle Bank survey area. Maps of seabed bathymetry and sediment type were produced to support the sampling programme. The maps will be refined in MLA, incorporating tidal corrections (obtained from Forth Ports plc), sediment descriptions and particle size analysis data.

10. A side-scan sonar survey was completed at the Middle Bank survey area. The side-scan sonar data will be processed in MLA, and combined with the RoxAnn© survey data to produce a map detailing the nature of the sea bed and the distribution of significant seabed features. The map will then be further refined to incorporate the biological data obtained during the grab sampling and the Agassiz trawl and underwater television surveys.

11. Vertical transmissometer deployments were undertaken at a total of 17 sampling stations in the Middle Bank survey area. A minimum of four deployments were made at each sampling station. During each deployment, transmission data (descent and ascent) were logged against water depth. The transmission data will be calibrated in MLA using

suspended solids measurements, and transmission and suspended solids profiles prepared to characterise the water column.

12. Seawater sampling was undertaken at eight of the 17 Middle Bank transmissometer sampling stations. Twenty two rosette water sampler (Rosie) deployments were undertaken. Wherever possible, duplicate seawater samples were collected at three depths during each deployment, near-surface (-1 metre), mid-water and near-bottom (+2 metres above the sea bed). Fifty-seven duplicate seawater samples were collected for suspended solids measurements. The duplicate samples were pooled, and 500 ml sub-samples were filtered on FRV *Clupea* for measurement of suspended solid levels in MLA. Eleven duplicate seawater samples were collected for phytoplankton screening. The duplicate samples were pooled, and one litre sub-samples preserved with Lugol's solution. The preserved sub-samples were then stored in the dark in insulated containers, prior to analysis in MLA.

13. Grab sampling for physical and chemical analyses was undertaken at a total of 53 sampling stations in the Middle Bank survey area. (The sampling stations included the 17 transmissometer sampling stations). Fifty-three Day grab deployments were made, and 53 seabed sediment samples collected. All of the seabed sediment samples were sub-sampled for particle size and heavy metal analyses. The seabed sediment samples collected at the locations of the eight water sampling stations were also sub-sampled for PCB analysis. Fifty-three core sub-samples were taken for particle size analysis; 53 surface scoop sub-samples were taken for heavy metal analysis; and eight surface scoop sub-samples were taken for PCB analysis. The sub-samples were deep frozen for analysis in MLA.

14. Grab sampling for plankton cyst enumeration was undertaken at the eight seawater sampling stations in the Middle Bank survey area. Nine Day grab deployments were made, and eight seabed sediment samples collected. Duplicate core sub-samples were taken from each grab sample. The cores were separated into three depth zones, surface to -1 cm, -1 to -3 cm and -3 to -5 cm, and the duplicate depth zones were pooled in a sample jar. The samples were then covered with filtered sea water and stored in the dark in insulated containers, prior to analysis in MLA.

15. Gravity corer sampling to determine the depth of any superficial silt or clay deposits (dredging over-burden) was undertaken at the 17 combined transmissometer and grab sampling stations in the Middle Bank survey area. Twenty-two gravity corer deployments were made, and 17 core samples collected. All of the core samples were described and measured, and the depths of any superficial silt or clay deposits determined. Reasonable length cores (approximately 50 cm) were obtained in areas where the sediment was predominantly mud, with only moderate amounts of shell debris. Smaller cores were obtained in areas where the sediment was more sandy, and contained large amounts of shell debris. The depth of the over-burden in the areas identified for potential aggregate extraction appeared to be between 10 and 50 cm. The quality of the underlying sand and shell deposits was variable, and some of the deposits appeared to contain significant quantities of fines. Sub-samples were collected from each core for particle size analysis, to confirm the proportion of fines. A total of 30 sub-samples were deep frozen for particle size analysis in MLA.

16. One Agassiz trawl of approximately 15 minutes duration, and 15 trawls of approximately 10 minutes duration, were undertaken in the Middle Bank survey area. The 16 trawls included coverage in the vicinity of 14 of the 17 combined transmissometer and grab sampling stations. The epifauna present in the trawls were identified and enumerated

on FRV *Clupea*. Significant debris present in the trawls was identified and enumerated. Organisms that could not be identified on FRV *Clupea* were transferred to sample jars and fixed in a 10% solution of formalin in sea water. The organisms were then stored for identification in MLA.

17. Eleven towed sledge underwater television transects of approximately 30 minutes duration were undertaken in the Middle Bank survey area. The 11 transects included coverage in the vicinity of all 17 combined transmissometer and grab sampling stations. A log of observations was made during the course of each transect, and the tape records were retained for analysis in MLA.

Derek Saward
19 May 1998

Seen in draft: A Simpson, OIC

FRV *Clupea*, Cruise 0698C

Figure 1 Locations of survey areas

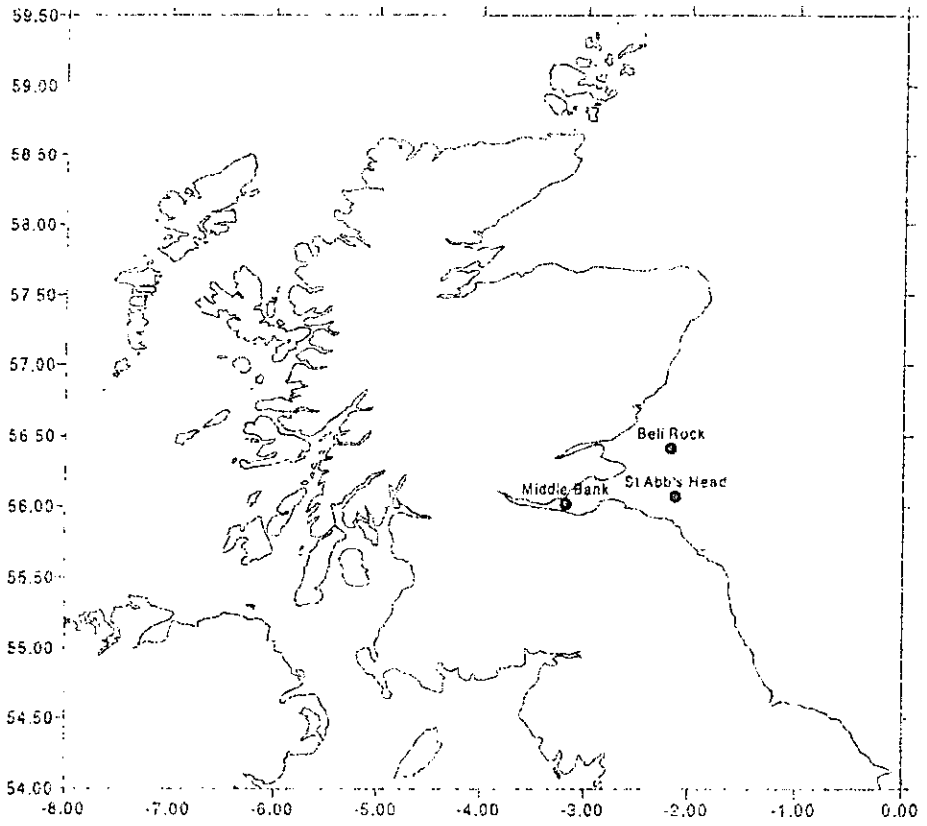
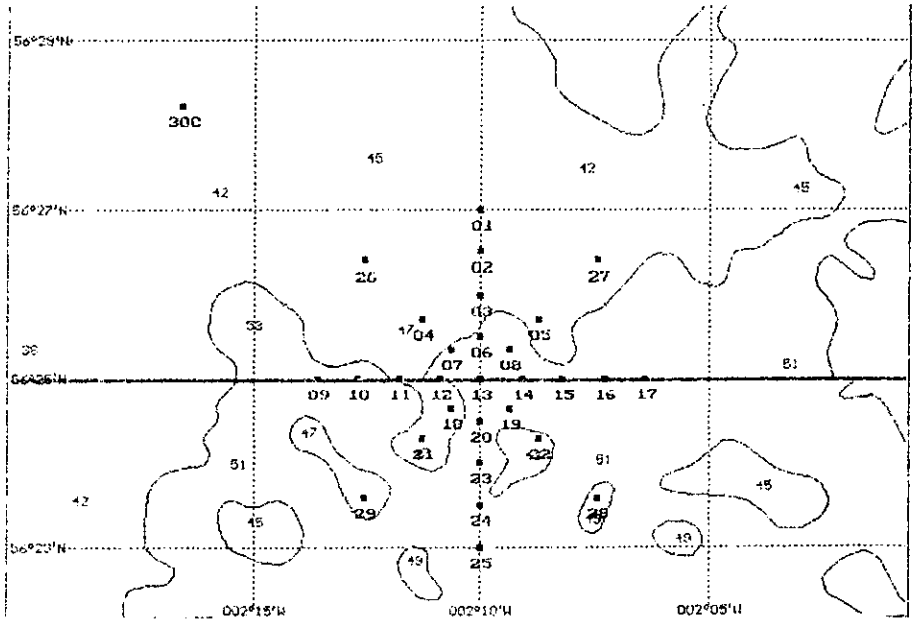
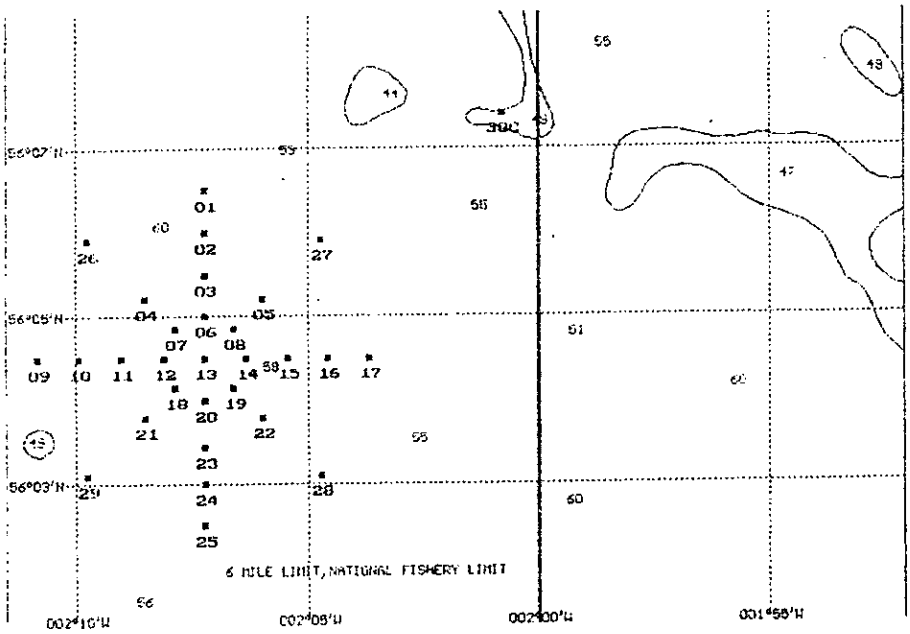


Figure 2 Sampling grid, Bell Rock sewage sludge disposal site



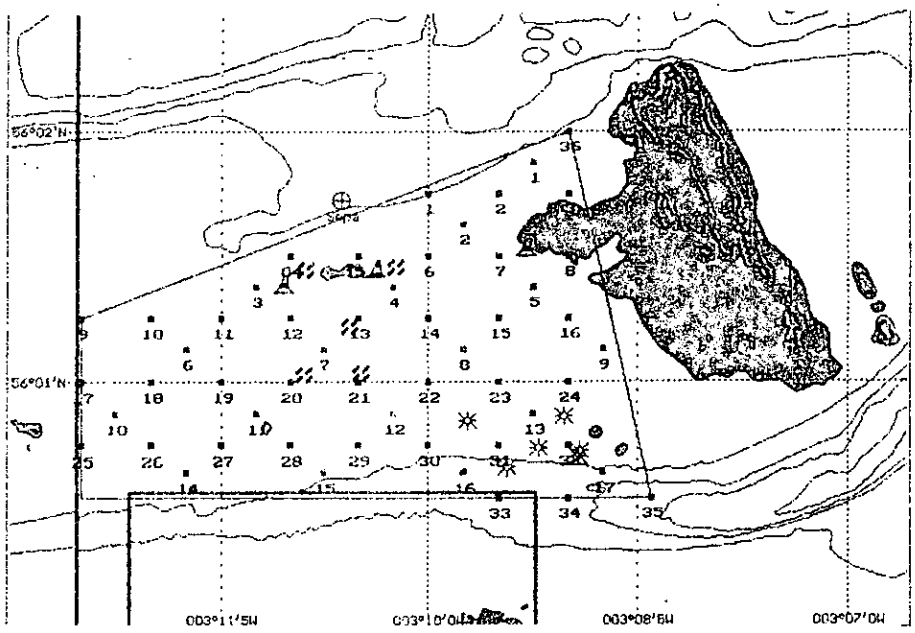
30C - control sampling site

Figure 3 Sampling grid, St Abb's Head sewage sludge disposal site



30C - control sampling site

Figure 4 Sampling grid, Middle Bank survey area



Sepa - location of Scottish Environment Protection Agency sub-surface mooring