EA-NCEDS BOX 3

National Marine Baseline Survey 1995

Littoral Cell 4
The Thames to Selsey Bill

ENVIRONMENT AGENCY

Report NC/MAR/016 Part 6 of 17

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Littoral Cell 4: The Thames to Selsey Bill

Executive Summary

Water quality data within this cell showed a clear geographical pattern with higher concentrations of nutrients and dissolved metals being found at those sites on the northern Kent coast towards the Thames Estuary. There were some exceptions, for example silicate showed highest concentrations around Bexhill and Beachy Head in Sussex. The Newhaven sampling site recorded a chlorophyll-*a* concentration representative of bloom conditions in Summer. Although high nutrient concentrations were recorded in Summer, the area showed elevated nutrient concentrations at other seasons.

Spatial chlorophyll-*a* results showed that there was a distinct boundary between those waters under the influence of the Thames Estuary and those influenced by English Channel effects, with the Thames recording higher chlorophyll-*a* concentrations. In addition there was a further area of high chlorophyll-*a* concentration around Newhaven, which indicated the presence of a phytoplankton bloom.

Sediment transport patterns within the Thames Estuary were revealed in the CASI data. Headlands such as Dungeness and Beachy Head act to produce eddy formations and apparent barriers to flow. The effects of tidal state on results from laboratory analysis of water samples from close to Dover and Folkestone harbours was also illustrated in the CASI data. The effect of the Dungeness power station outfall could be seen in the thermal video imagery.

1. Introduction

This littoral cell extends from the Thames Estuary to Selsey Bill in Sussex. This constitutes approximately 2000 km^2 within the coastal zone for which the Environment Agency has responsibility for controlled waters, of which 390 km^2 are estuarine waters. This includes all of the Thames Estuary as the littoral cell boundary does not extend offshore. Figure 1 illustrates the area and the position of baseline sampling sites. Residual littoral flow is to the West along the northern Kent coast, and towards the East on the southern coast of Sussex and Kent. The west coast of Kent shows a low southwards drift due to interruption of flow by headlands.

Underway data and water samples for laboratory analysis of chemical determinands were collected in early Spring (April), late Spring (May), Summer (July) and Autumn (September), by Sea Vigil, Vigilance and Water Guardian, depending on survey. Airborne data collection was carried out in July and September using the CASI ocean colour sensor and a thermal video system.

2. Water chemistry results

2.1 Background

There are a total of sixteen baseline sampling sites within this littoral cell, extending from the Medway Buoy to Selsey Bill. These are illustrated in Figure 1. The major variations in water quality are a result of the presence of the Thames Estuary to the north of the cell.

2.2 Nutrients and chlorophyll-*a*

2.2.1 Total Oxidised Nitrogen (TON)

TON concentrations showed both a seasonal cycle, with highest values in early Spring, and lowest values in late Spring, and a geographical pattern, with the highest concentrations consistently found around the Medway Buoy (51). In early Spring the maximum TON concentration is 1131 µg/l N at the Medway Buoy (51), with high concentrations also at Newhaven (62) equal to 606 µg/l N. In Autumn results are variable for the entire cell, with a range of concentrations from 1630 µg/l N at East Margate (53) to 127 µg/l N at East Brake Buoy (54).

2.2.2 Silicate

Silicate concentrations showed a similar seasonal cycle, but with a very different geographical pattern. In this case the maximum values were consistently found on the Sussex coast: in early Spring at Beachy Head (61) equal to 158 µg/l Si, in late Spring at Newhaven (62) equal to 27 µg/l Si and in Summer at Bexhill (60) equal to 11 µg/l Si. In Autumn the results were again more variable, with a maximum concentration of 205 µg/l Si at East Brake Buoy (54) in Kent.

2.2.3 Orthophosphate

Orthophosphate concentrations in the Thames Estuary were high throughout the four seasons, for example 80 µg/l P at Medway Buoy (51) in Summer, but showed a seasonal cycle away from this estuarine influence, with highest concentrations in early Spring and lowest in Summer. In addition, a strong geographical pattern was seen, with highest concentrations always found in the Thames.

2.2.4 Total Ammoniacal Nitrogen (Ammonia)

Ammonia concentrations showed a seasonal cycle during Spring and Summer, although no results were available in Autumn. Geographically there were two areas which showed the highest concentrations: those sites under the influence of the Thames, and the region around Newhaven (62). The early Spring concentration at Newhaven (62) was 150 µg/l N, with other sites generally less than 100 µg/l N. In late Spring the peak concentration was recorded at Medway Buoy (51) equal to 47 µg/l N.

2.2.5 Nitrite

Nitrite concentrations were generally low for this littoral cell and showed little seasonal cycle or geographical pattern. In early Spring the maximum occurred at Newhaven (62) equal to 6.2 µg/l N. In Summer the maximum concentration was seen at Medway Buoy (51) equal to 80 µg/l N. In Autumn, the concentrations which were high and variable, were checked by the laboratory due to their extreme variability. The laboratory was unable to repeat the analysis but concluded that the results were analytically correct.

2.2.6 Chlorophyll-a
Chlorophyll-*a* concentrations for this littoral cell were high. In early Spring the national survey maximum was recorded at Goodwin Fork Buoy (55), equal to 10.93 µg/l. Many neighbouring sites were above 5 µg/l. In late Spring, concentrations were again high with a maximum of 14.1 µg/l at East Brake Buoy (54). The south coast, around Newhaven (62), showed abnormally high concentrations during Summer, with a result of 16.07 µg/l at Newhaven (62). The baseline sample from Shiveringsand Buoy (52) was also in excess of 10 µg/l. No autumnal bloom was seen, with concentrations in the Autumn survey generally between 2 and 4 µg/l.

2.2.7 Nutrients/Chlorophyll-a Summary
Nutrient concentrations showed both a seasonal and geographical pattern, although exceptions did occur. In the Thames Estuary, nutrient concentrations were elevated at all seasons, which reflected the magnitude of this nutrient source. The Sussex coast showed high chlorophyll-*a* concentrations in Summer, and did not record high nutrient concentrations. This region may benefit from further investigation, as the chlorophyll-*a* concentrations suggest that it is potentially subject to eutrophication. The high concentrations of chlorophyll-*a* recorded in the early Spring survey probably reflect the date of data collection, on the 7th April, when the Spring bloom in phytoplankton would have started. Concentrations of this magnitude are not exceptional for April in the Dover Straits region.

2.3 Suspended solids

Suspended solids concentrations were very low in the early Spring survey, with only the Thames Estuary sites recording concentrations in excess of 3 mg/l. These relatively low levels were due to the date of data collection, as by April the riverine runoff would have been decreasing. As expected, the late Spring and Summer concentrations were also generally below 3 mg/l. In Autumn concentrations are higher, with a maximum concentration at Shiveringsand Buoy (52) equal to 32 mg/l. This reflected the stormy weather at this time resulting in increased riverine input and agitation of sediments.

2.4 Metals

2.4.1 Total Mercury
Total mercury concentrations for this cell were low, with many sites not exceeding the laboratory minimum reporting value (MRV) of 0.008 µg/l Hg. The sample from Middleton-on-Sea (65) in Summer, recorded a concentration of 0.183 µg/l Hg, which is greater than 50% of the EQS level of 0.3 µg/l Hg.

2.4.2 Dissolved Cadmium
Dissolved cadmium concentrations were low for this littoral cell, with many sites recording concentrations less than the laboratory MRV of 0.042 µg/l Cd. Only one site, South Foreland, recorded a concentration greater than 10% of the EQS, equal to 0.636 µg/l Cd.

2.4.3 Dissolved Copper
Dissolved copper concentrations showed a clear geographical pattern at all seasons, with highest concentrations always found towards the Thames estuary. Concentrations were

not, however, high in comparison with the EQS level of 5 µg/l Cu. In Winter the maximum concentration was 0.96 µg/l Cu at East Brake Buoy (54). The Spring survey recorded the highest concentrations with a maximum of 1.76 µg/l Cu at Medway Buoy (51), which also recorded the highest concentration in Summer, equal to 1.22 µg/l Cu. In Autumn the maximum of 1.26 µg/l Cu was located further to the south at East Margate (53).

2.4.4 Dissolved Lead
Dissolved lead concentrations were low throughout the four surveys. The maximum concentration was found in Spring at the Medway Buoy (51) equal to 0.24 µg/l Pb, compared to an EQS level of 25 µg/l Pb.

2.4.5 Dissolved Arsenic
No samples showed concentrations of dissolved arsenic above the Minimum Reporting Value (MRV) of 2 µg/l As.

2.4.6 Dissolved Zinc
Dissolved zinc concentrations showed a variable geographical distribution, with maxima in early Spring and Autumn at the Medway Buoy (51). In late Spring and Summer concentrations were highest at Brighton (63) and Bexhill (60) respectively. The maximum concentration recorded throughout the four surveys was 10.9 µg/l Zn compared with an EQS value of
40 µg/l Zn.

2.4.7 Dissolved Chromium
Dissolved chromium concentrations were generally low and geographically variable, seldom exceeding the MRV of 0.35 µg/l Cr. The sample at Goodwin Fork Buoy (55) in late Spring, however, shows the maximum concentration for this survey, equal to 4.79 µg/l Cr, compared with an EQS level of 15 µg/l Cr.

2.4.8 Dissolved Nickel
Dissolved nickel concentrations showed low concentrations throughout the four surveys, seldom exceeding the MRV of 0.058 µg/l Ni. The maximum concentration was found at East Margate (53) in Autumn equal to 1.79 µg/l Ni.

2.4.9 Metals Summary
Metals concentrations in this littoral cell were generally low. Some dissolved metals concentrations showed a geographical pattern, with highest concentrations found in those sites under the influence of the Thames, which is the major estuarine source in this cell. No sites recorded any concentrations in excess of the EQS levels.

2.5 Organic contaminants

Water samples were analysed for twenty three trace organic determinands at four baseline sites within this littoral cell, at Medway Buoy (51), South Foreland (56), Beachy Head (61) and Selsey Bill (66). Only γ-HCH and α-HCH gave positive analyses. The other 22 determinands were not detected at their laboratory MRVs of 0.001 µg/l for the entire survey.

In early Spring, all sites record concentrations for α-HCH and γ-HCH. The maximum concentration for total HCH is 0.003 μg/l compared with an EQS value of 0.02 μg/l. In late Spring, Beachy Head (61) and Selsey recorded (66) concentrations of γ-HCH above the MRV. In Summer γ-HCH concentrations above the MRV were found at all sites. In Autumn only Medway Buoy (51) and South Foreland (56) showed γ-HCH concentrations above the MRV. This region has high concentrations of γ-HCH relative to national averages and may benefit from local investigations to establish the source.

3. Spatial chlorophyll-*a* results

The CASI imagery has been used in combination with the laboratory baseline samples and the underway fluorimeter to produce maps of chlorophyll-*a* concentration of the coastal zone. The technique used involves calculation of the Fluorescence Line Height (FLH) of the imagery and correlation of the three measuring techniques.

Figure 2 shows the chlorophyll-*a* concentration during Summer 1995 for this littoral cell, as derived from the FLH technique. Chlorophyll-*a* concentrations between 4 and 8 μg/l were found from the Thames Estuary to Pegwell Bay, where concentrations then dropped to between 2 and 6 μg/l. A further decrease in concentration was noted around Selsey Bill, with the Bognor Regis area recording concentrations less than 2 μg/l. There are no areas in excess of 10 μg/l.

Figure 3 shows the chlorophyll-*a* concentration determined from calibration of the underway fluorimeter for the Summer survey. This map shows a higher level of variability due an artifact of the FLH technique which results in some smoothing of high and low concentrations. The Thames Estuary shows the same high concentrations, with a boundary again occurring at Pegwell Bay. This marks the limit of influence of the Thames, which was also seen in the laboratory results. Concentrations in this region exceed 10 μg/l in some cases, which may signify that this area is subject to the effects of eutrophication.

This map also shows a high chlorophyll-*a* concentration between Beachy Head and Worthing, which was not noted in the FLH imagery. Concentrations up to 10 μg/l were found, which is unusually high for July. This is due to a time differential between the aircraft and vessel surveys. This region is associated with high nutrient concentrations, and as such this region may be subject to the effects of eutrophication.

Integration of the two techniques described above allows a spatial picture of the variation in chlorophyll-*a* concentration to be drawn. This is advantageous in the assessment of areas which are potentially subject to eutrophication, as the full geographical extent of high chlorophyll-*a* regions may be shown.

4. Local oceanographic descriptions

Underway measurements have been investigated in order to show which areas within this littoral cell show most variability in the underway parameters measured, namely temperature, salinity, fluorescence, transmission and dissolved oxygen. In addition the imagery has been studied for variation in ocean colour signal and temperature signal, or where discrete bathymetric and oceanographic features were visible during either July or September.

These areas will be discussed in more detail below, in terms of results from remote sensing imagery, laboratory sampling and underway measurements. This is to provide an overview of the results for this section of coastline. The areas selected are as follows.

1. Isle of Sheppey
2. Ramsgate sandbanks
3. Dover and Folkestone harbours
4. Phytoplankton bloom off Newhaven
5. Dungeness power station outfall
6. Sediment transport around Dungeness

4.1 Isle of Sheppey

CASI imagery of the Isle of Sheppey in the outer Thames estuary shows interesting sediment patterns in September.

Variation in suspended particulate matter concentration is seen in the CASI imagery due to the increased scattering of sunlight which causes a higher ocean colour signal. Imagery from the two surveys is shown in Plate 1. The first image collected at 16:18 GMT on the 1st August shows low concentrations of suspended sediment, with a homogeneous ocean colour signal. Some flow patterns are still apparent, with a general flow to the east. The imagery from the 23rd September 1995, shown in Plate 1(ii) shows much higher suspended sediment concentrations, with the sediment being shown as brightly coloured regions, as the particulates cause enhanced scattering of sunlight.

The tidal streams on 1st August show a strong flow to the east out of the Thames Estuary. The sediment concentration measured by Sea Vigil on the 30th July, two days previously was less than 3 mg/l. Sediment concentrations were low for this region during July and August due to the very dry weather conditions. By contrast the concentrations recorded on the 10th September were between 23 and 32 mg/l for this region. The tidal streams are more complex with slack water to the north of the Isle of Sheppey. Flow to the west of the island is towards the west and that to the east is directed to the north east. There is thus a divergence of water at this point, which is shown in the imagery as the clearer water.

4.2 Ramsgate sandbanks

An offshore flightline is flown with the CASI off Ramsgate as this is an area where phytoplankton blooms are abundant. The baseline data does not record the presence of any bloom activity in 1995. One of the flightlines, however, illustrates the potential of the CASI imagery for mapping of bathymetric features as shown in Plate 2.

The image taken in July clearly shows the presence of large sandbanks. These are not emergent, and it is the ability of CASI to integrate the surface layer in clear water conditions that allows them to be distinguished in the imagery. These sandbanks are well established and are not particularly mobile. In areas of greater mobility CASI data may be used to map the positions as an aid to navigation, with the variable resolution of the CASI allowing smaller bathymetric features to be mapped if required.

4.3 Dover and Folkestone harbours

The water around Dover and Folkestone has the greatest shipping density seen in the coastal waters of England and Wales. Thermal video imagery of this region reflects this activity with the tracks of vessels shown as lines of cooler water which has been mixed from lower in the water column by the passage of the vessel. This is most pronounced in July, when the difference in temperature between surface and bottom waters is greatest (see Plate 3).

Close to the harbour entrance, in the area marked X, the water is well mixed due to intensive vessel activity. Further offshore, in the area marked Y, the region shows some stratification, with the lower waters being clearly cooler than those at the surface.. The surface warming is probably a seasonal effect as the data were collected early in the morning when diurnal heating would not have caused such a marked effect.

CASI data from this region in both July and September shows the flow of suspended particulate matter along this section of coast (see Plate 4). In Plate 4(i) the flow is towards the south-west, with water from Dover harbour being deflected offshore . There is however a minor flow directed towards the coast which may have water quality implications. In Plate 4(ii) there is a general flow to the north-east, with apparently clear water situated close to the coast. The image in Plate 4(iii) shows no clear sediment flow direction, with simply higher suspended loading offshore.

The flow direction in these three images is directly linked to the tidal flow at the time of measurement. In the first image there is a strong south-westerly tidal stream, with the tidal stream in the second image being strongly to the north-east. The third image was taken at slack water, which explains the apparent lack of sediment flow.

The tidal state at which samples are taken would thus greatly affect the water quality results from the two local baseline sampling sites at South Foreland (56) and Sandgate Bay (57) (see Plate 4). The South Foreland (56) site would fall under the influence of the flow from Dover harbour when the tidal stream is to the north-east, and the site at Sandgate Bay (57) would be under the affect of the flow from Folkestone harbour when the flow is to the south-west.

The first scenario is seen in the results of laboratory analysis from Autumn 1995, taken at 14:00 GMT on the 10th September. The tidal stream at this time is strongly to the north-east. Measurements for suspended solids at the South Foreland (56) site show a concentration of 18 mg/l compared to a concentration of less than 3 mg/l at the Sandgate Bay (57) site. In addition all nutrient concentrations are higher at the South Foreland (56) site. Thus this site is clearly within the influence of the plume from Dover harbour.

4.4 Phytoplankton bloom off Newhaven

Results from the laboratory analysis of water samples for chlorophyll-*a* show the presence of a phytoplankton bloom off Newhaven in July. The chlorophyll-*a* concentration at this site was 16.07 µg/l, which exceeds the limit suggested by the Department of the Environment to be indicative of the presence of a bloom.

By observation of the underway fluorimeter data from Water Guardian it is possible to see that the bloom extends from the Newhaven (62) baseline sampling site to a point just to the East of the Brighton (63) sampling site (see Figure 4). The Brighton (63) sampling site also showed a slightly elevated chlorophyll-*a* concentration of 3.97 µg/l. The underway data also shows an increase in dissolved oxygen concentration. No variation in temperature is seen.

This phytoplankton bloom is of exceptional concentration for 30th July in this region. Laboratory analysis showed nutrient concentrations at this sampling site to be similar to neighbouring sites, and comparable with national figures during this survey. This region does, however, show high nitrite and ammonia results during other surveys, indicating the presence of a nutrient source in the region.

Skalar continuous monitoring nutrient data from this region is shown in Figures 5 - 8. The scales for these plots are derived from national average figures to allow seasonal and national comparisons. In Summer, when chlorophyll-*a* concentrations at Newhaven were high, the nutrient concentrations were generally low compared to national averages. In Spring this region recorded high concentrations of nutrients, in particular phosphate, with concentrations in excess of 75 µg/l P.

Thus although the nutrient concentrations at the time of the bloom were low, there is clearly a source of nutrients within this region. The concentrations may have decreased due to uptake by phytoplankton in the development of the bloom. This region may benefit from local investigation of the potential nutrient sources.

4.5 Dungeness power station outfall

Thermal imagery shows the presence of the Dungeness power station outfall. The water used for cooling within the power station is pumped out at a warmer temperature than the surrounding waters. This is clearly seen in the image data where warmer water is shown darker (see Plate 5).

In the image from 20th of July, the tidal stream is directed to the west and this is seen in the imagery with the plume being directed to the west along the coast. In the image from July 21st and both of the September images, the tidal stream direction is to the east and this is shown in the position of the plume directed to the east. Neither of the September images show the plume to effect the water to the east of the headland. However, in the July image the effect does seem to pass around the headland.

In Plate 6 (i), the contrast in the imagery is highest, allowing the presence of two individual outfalls to be seen. The images from July (Plate 5(i) and 5(ii)) appear to show three separate outfall sources. This suggests that differing numbers of outlets may be used depending on the amount of discharge required.

The relevance of this imagery is the extent to which cooling water from the power stations effects the temperature of the surrounding waters. The thermal video imagery is not calibrated for absolute temperatures and as such the temperature at any particular point on the coastline may not be stated. However, the imagery seems to suggest that when the tidal flow is to the east the effects are generally over a short distance, with no warming around the coastline to the north of the headland. There is some sign of warming to the east of the headland in the image from 21st of July, but this effect does not appear to be directed towards the coast. When the tidal stream is to the west, however, the effects are more widespread with warming up to 6 km alongshore.

Warmer water from this outfall has potential implications on the ecology of the surrounding area. The thermal video system records the surface temperature only, and as such the magnitude of the effect may not be fully assessed by this technique.

At all states of the tide this plume suggests a coastal flow of water in this region with no immediate offshore exchange. This has implications on the transfer of pollutants from any effluent sources within this region and should be considered when positioning outfalls.

4.6 Sediment flow around Dungeness headland

CASI data shows flow of suspended particulate matter around the Dungeness headland (see Plate 7). In the first image from July 20th the tidal stream is directed to the west. There is no apparent flow of sediment around the headland, with the highest concentrations seen to be constrained close to the coast to the east of the headland. The headland is acting as a barrier to the continued westerly flow of suspended matter. In the second figure, there is a strong tidal flow to the east along this coast, which is shown in the position of the sediment plume which is being deflected around the headland and then to the north. The plume is partially deflected offshore at this point. This is probably due to the presence of slightly slacker water within the lee of the headland. The final image shows slack water conditions, with sediment being held in small scale features around the headland. This image also shows breaking waves on the beach to the north of the headland, which may be caused by the strong onshore wind recorded at this time.

The baseline sampling site at Dungeness is to the east of the headland. The results from this site were not exceptional compared to neighbouring sites for any of the four baseline surveys, indicating that the water quality within this region was good. The sediment flow patterns may, however, have implications for the transport of sediment in this region and the build up of sand bars and other coastal morphology.

5. Conclusions

This littoral cell showed a great variation in water quality between the Thames Estuary baseline sampling sites and the sites along the coast of Kent and Sussex during the 1995 survey. The Thames Estuary sites showed high concentrations of nutrients, some metals and suspended solids, with this influence extending to East Margate (53). The Sussex coast showed elevated nutrient levels, particularly silicate, with a maximum concentration at Bexhill (60).

No dissolved metals concentrations exceeded the EQS levels. A high concentration of 4.79 µg/l of dissolved chromium was found at Goodwin Fork Buoy (55) which is to the south of the usual limit of the Thames influence.

Imagery of the region shows great variability in sediment transport patterns, which are seem to mainly obey the tidal stream direction. In addition, the main transport direction along the south coast is seen to be to the east which is the direction of residual littoral flow. The most dramatic sediment patterns are seen around the Isle of Sheppey, with headlands such as Beachy Head and Dungeness resulting in the formation of eddy structures.

The outfall of warmer water from Dungeness power station is the most marked feature seen in the thermal video imagery. This outfall is seen to have greatest effect on the surrounding waters when the tidal stream is directed towards the west. Moreover the imagery illustrates the major flow direction to be along the coast as apposed to offshore which may have implications on the positioning of effluent outfalls.

Both underway fluorimeter data and laboratory analysis recorded the presence of a phytoplankton bloom off Newhaven in Summer. Although this bloom was not associated with elevated nutrient concentrations at the time of survey, the area did record high ammonia and nitrite concentrations at other seasons indicating a nutrient source in this region, and this region may benefit from local investigation of the potential source.

Figure 1.

Littoral Cell 4*, From The Thames to Selsey Bill.

* *After Motyka, J.M. and Brampton, A.H. (1993), "Coastal Management, Mapping of Littoral Cells", HR Wallingford*

Figure 2.

Calibrated CASI Fluoresence Line Height Image, Summer 1995.

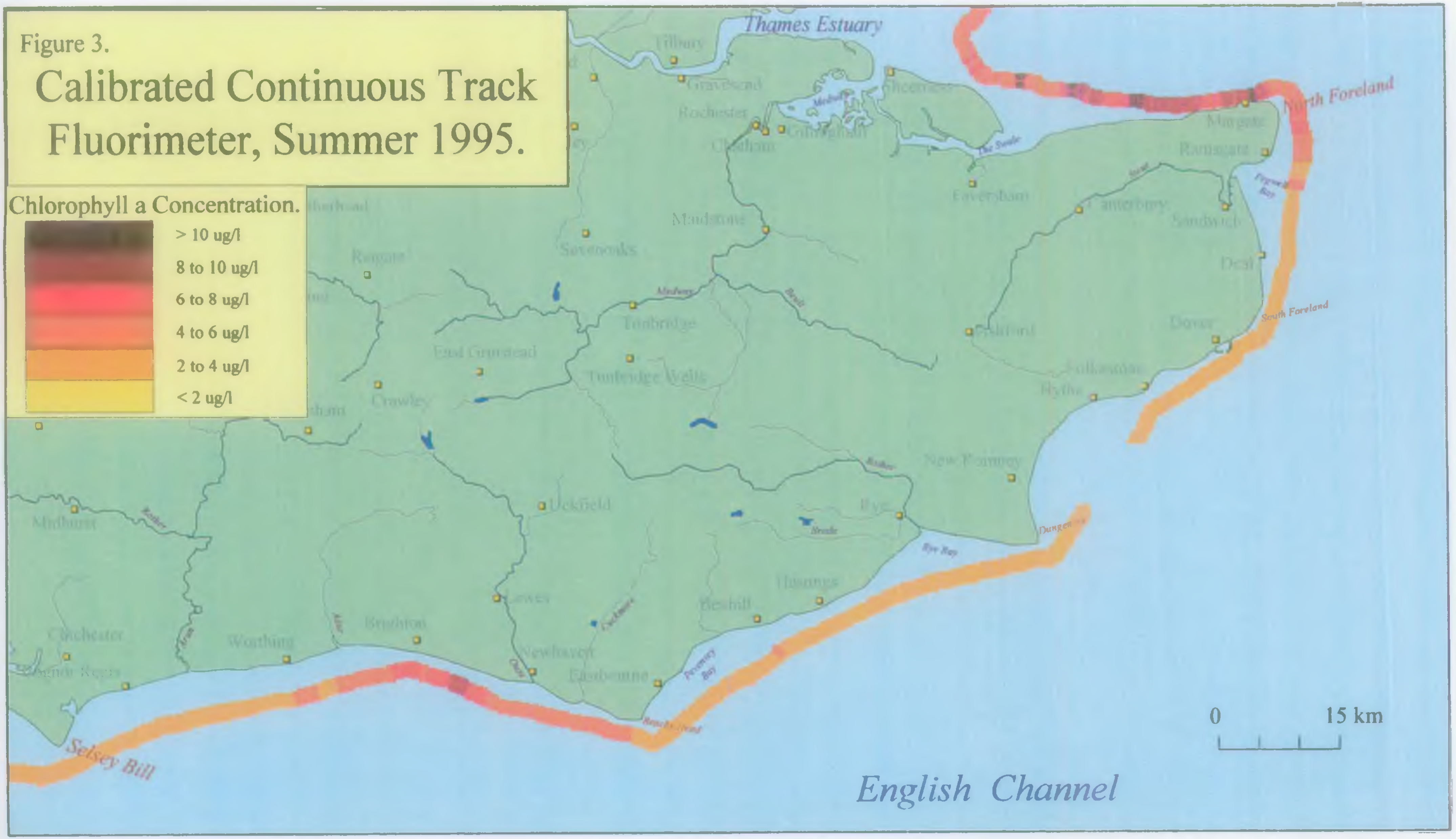

Figure 3.
Calibrated Continuous Track Fluorimeter, Summer 1995.

Figure 4

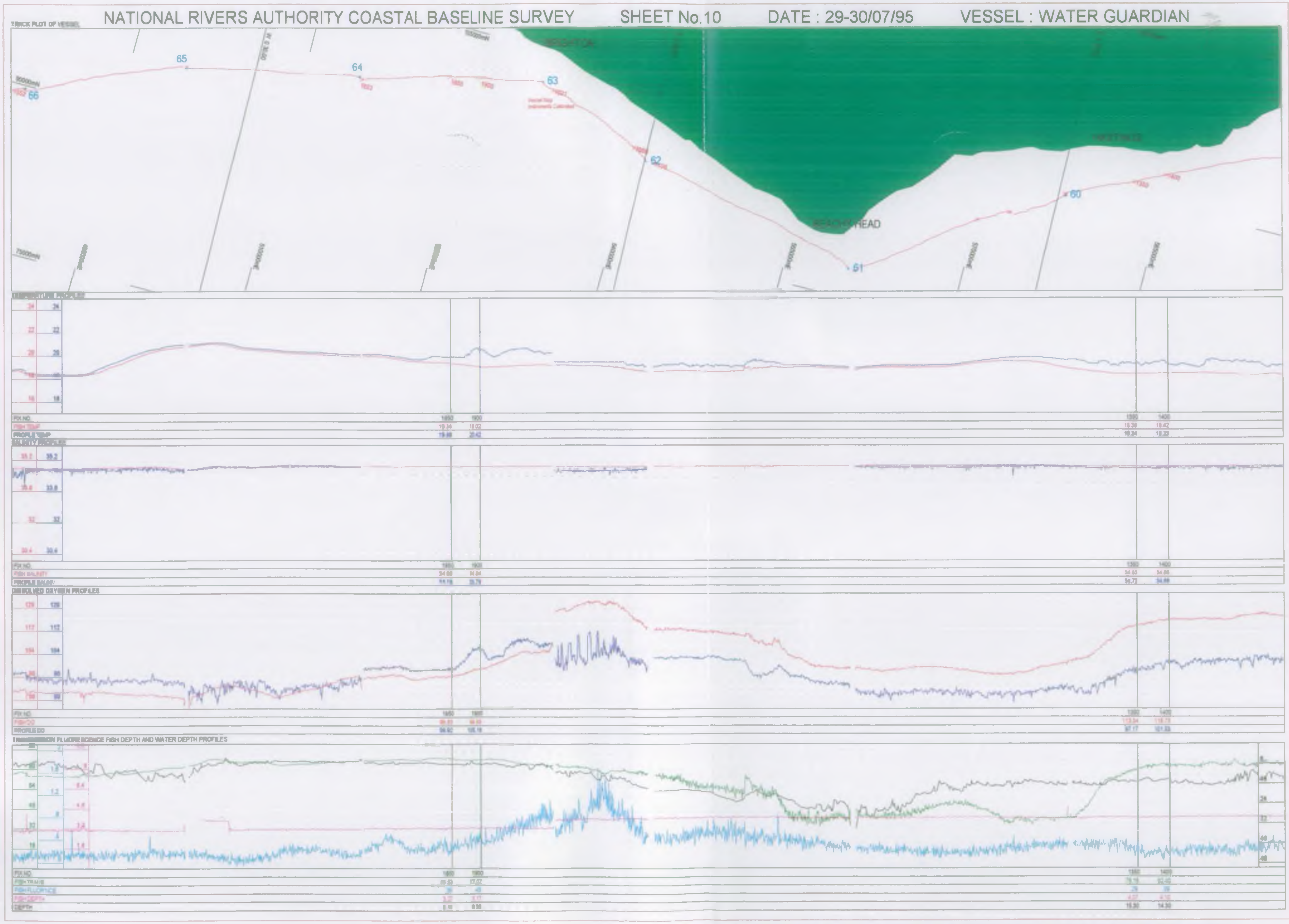

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Figure 5.

Skalar Nutrient Data from Brighton to Hastings, Winter 1995.

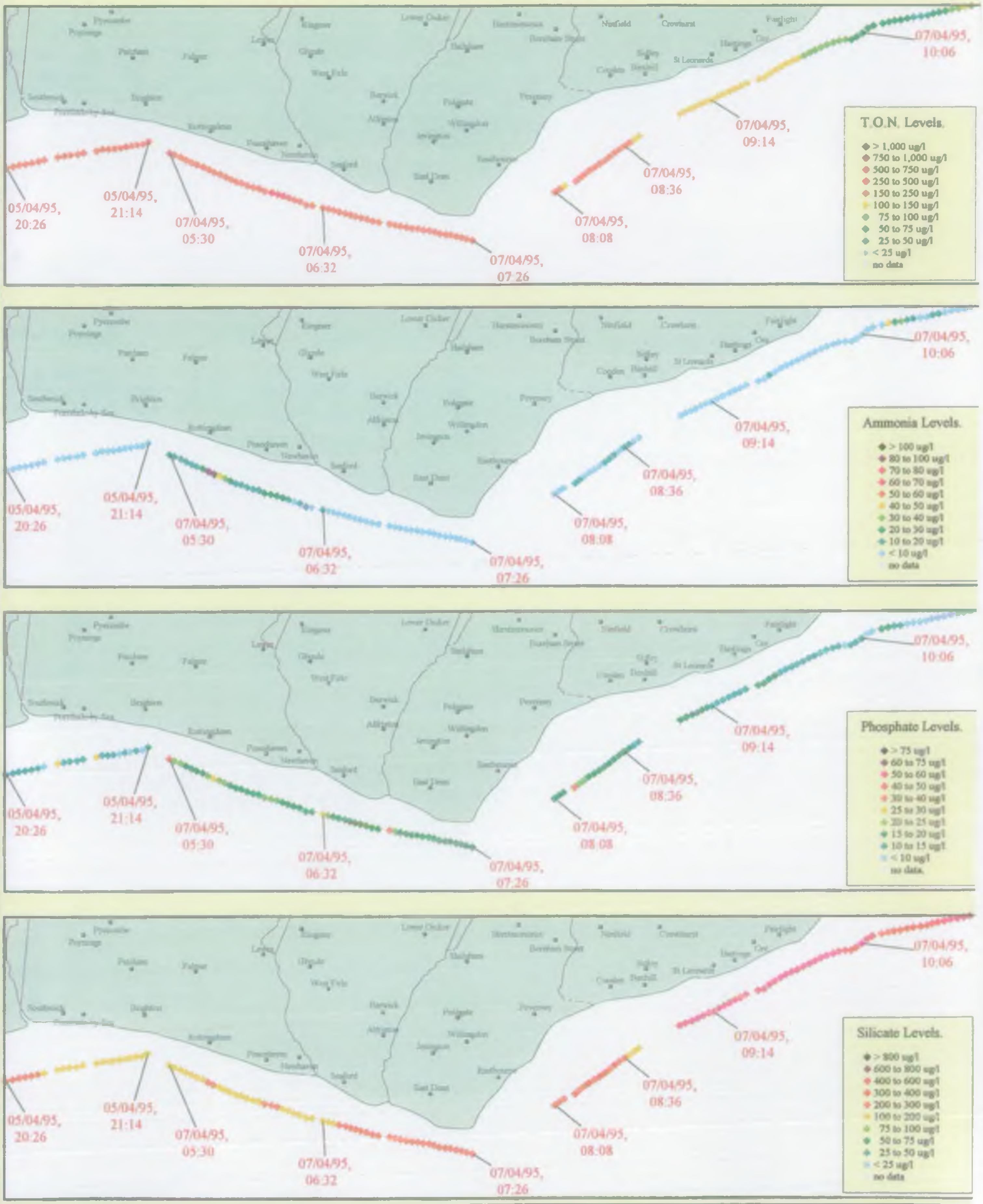


Figure 6.

Skalar Nutrient Data from Brighton to Hastings, Spring 1995.

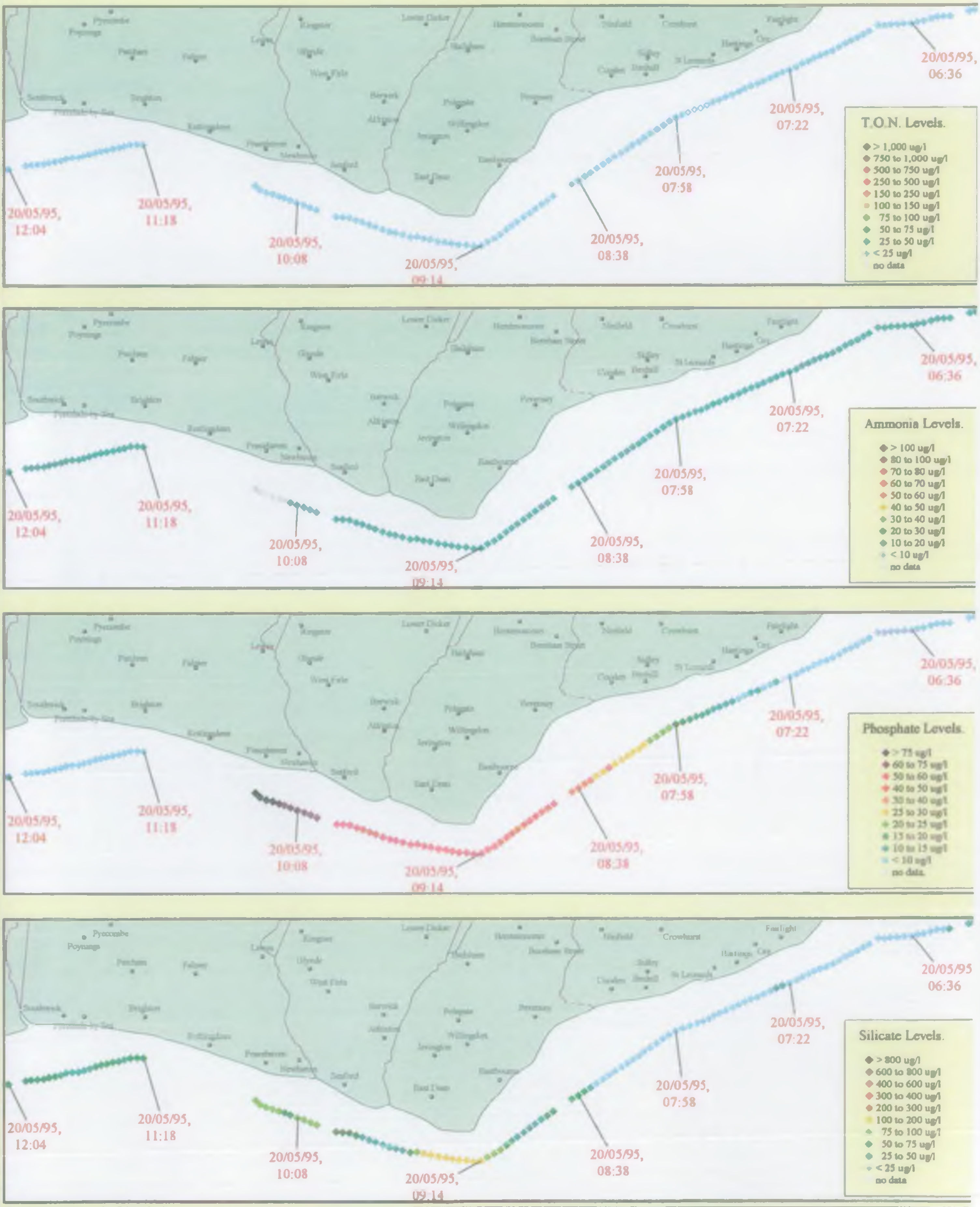


Figure 7.

Skalar Nutrient Data from Brighton to Hastings, Summer 1995.

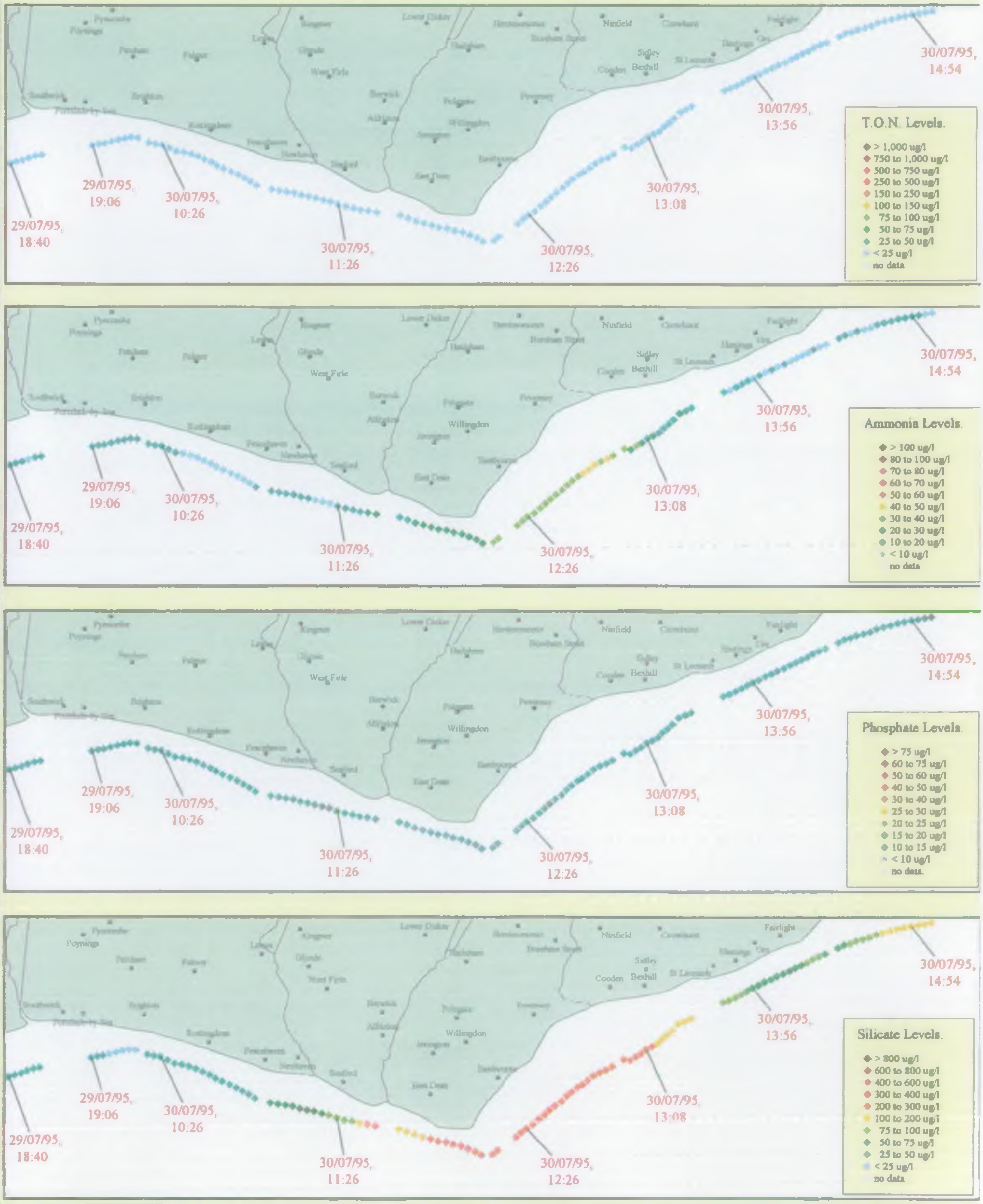
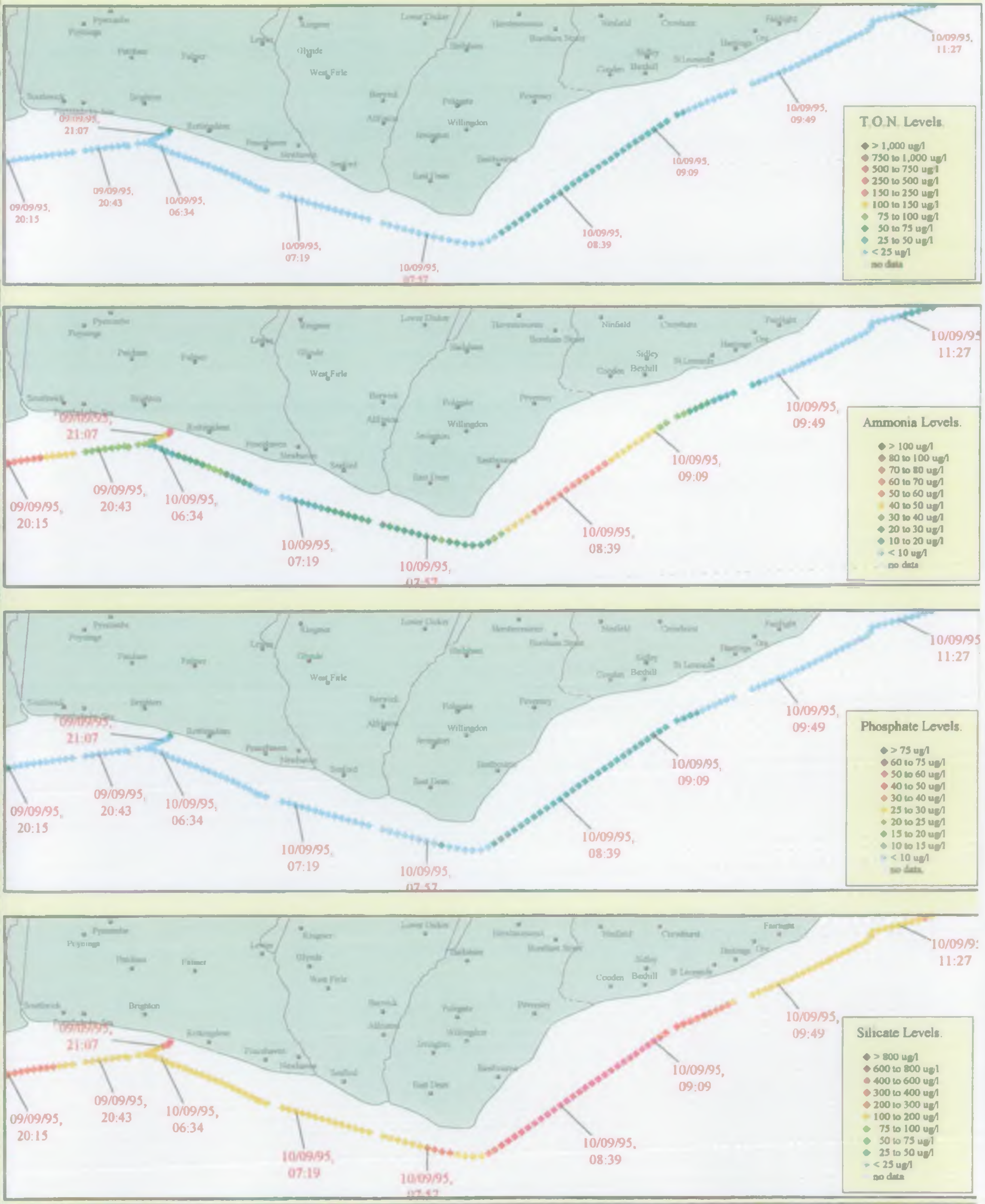
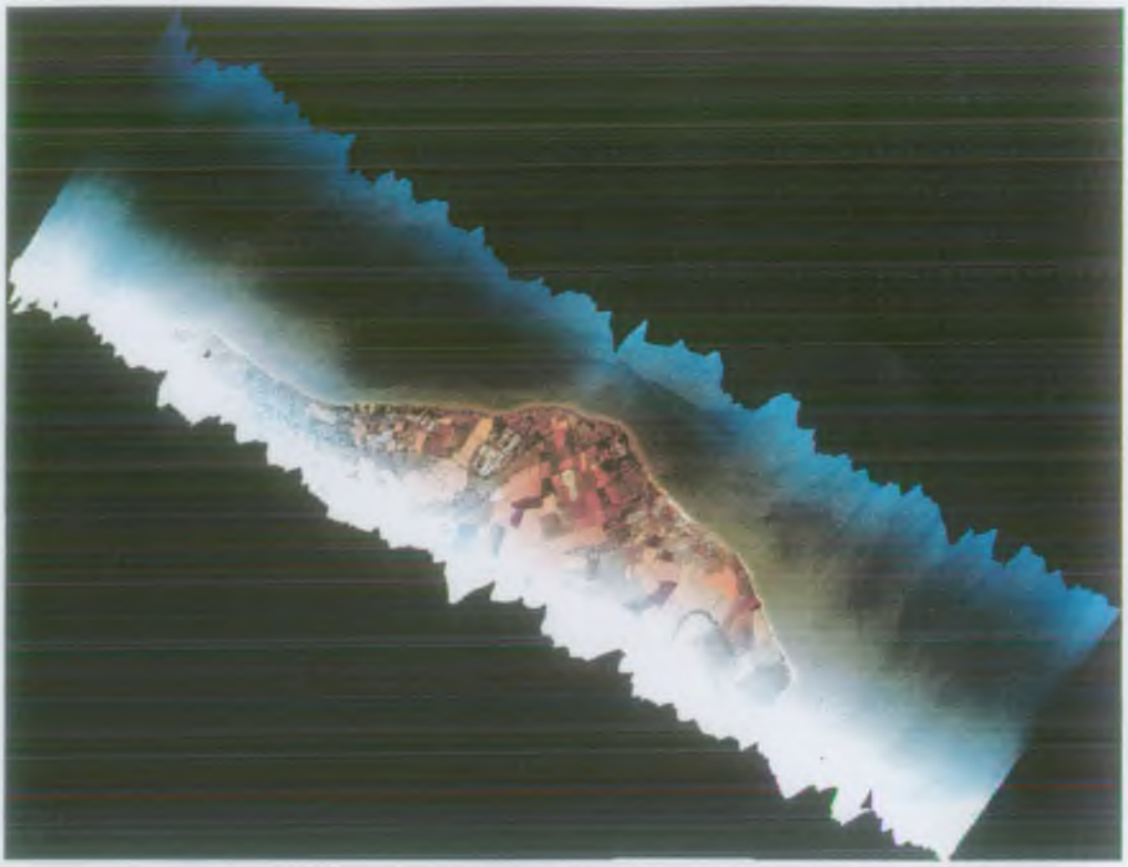


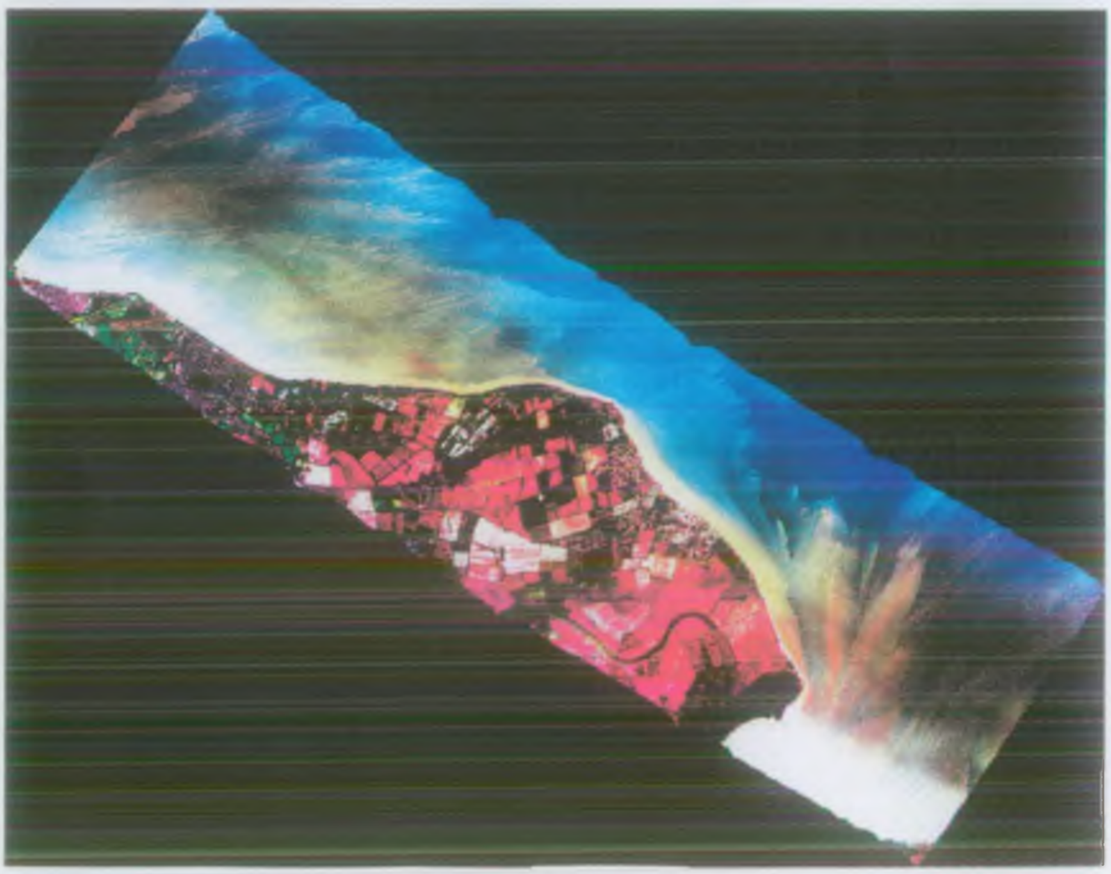
Figure 8.

Skalar Nutrient Data from Brighton to Hastings, Autumn 1995.



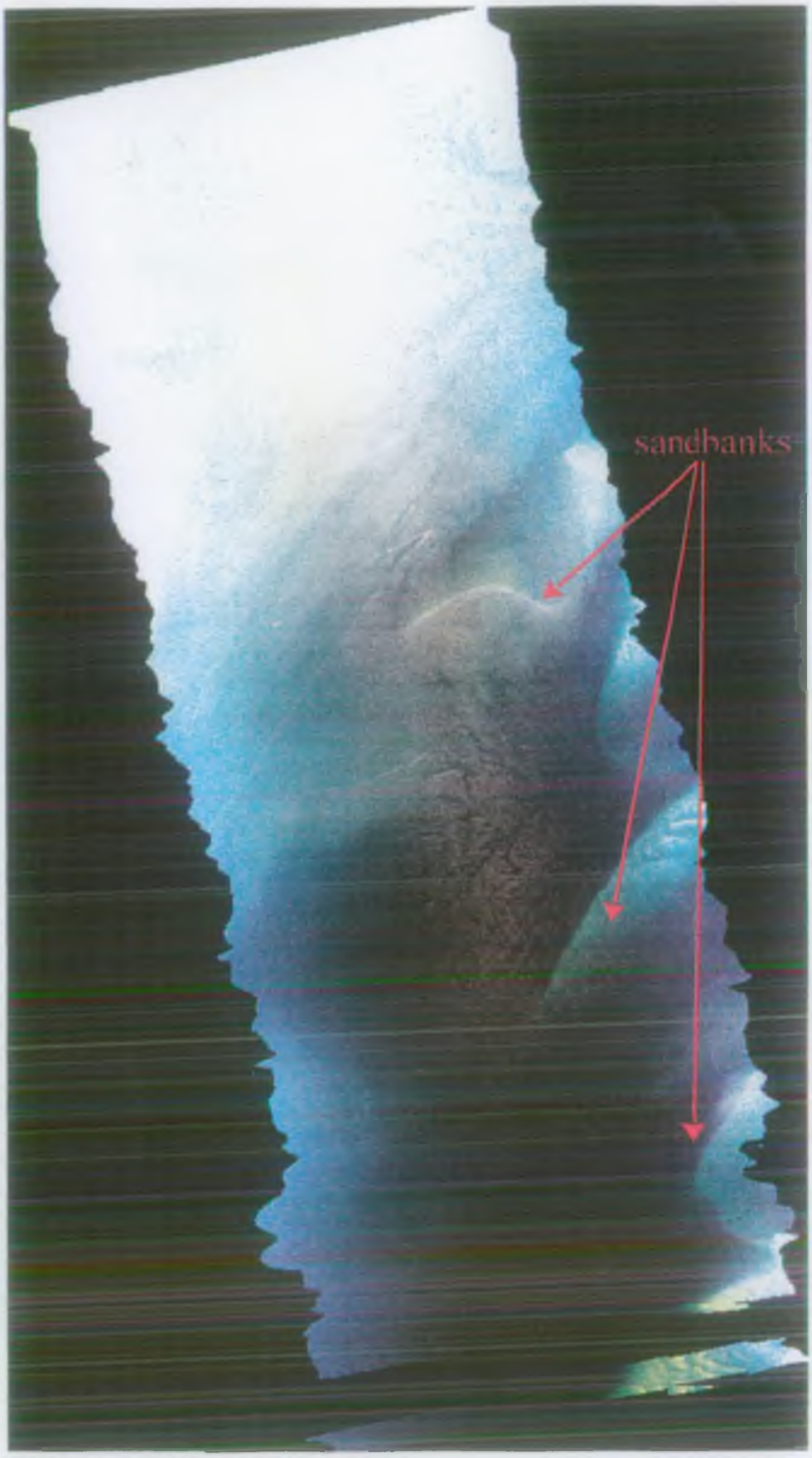


(i) 1st August 1995, 16:18 GMT



(ii) 23rd September 1995, 10:47 GMT

Plate 1: Isle of Sheppey, Thames Estuary
CASI enhanced true colour composite images



20th July 1995,10:09 GMT

Plate 2: Ramsgate
CASI enhanced true colour composite images

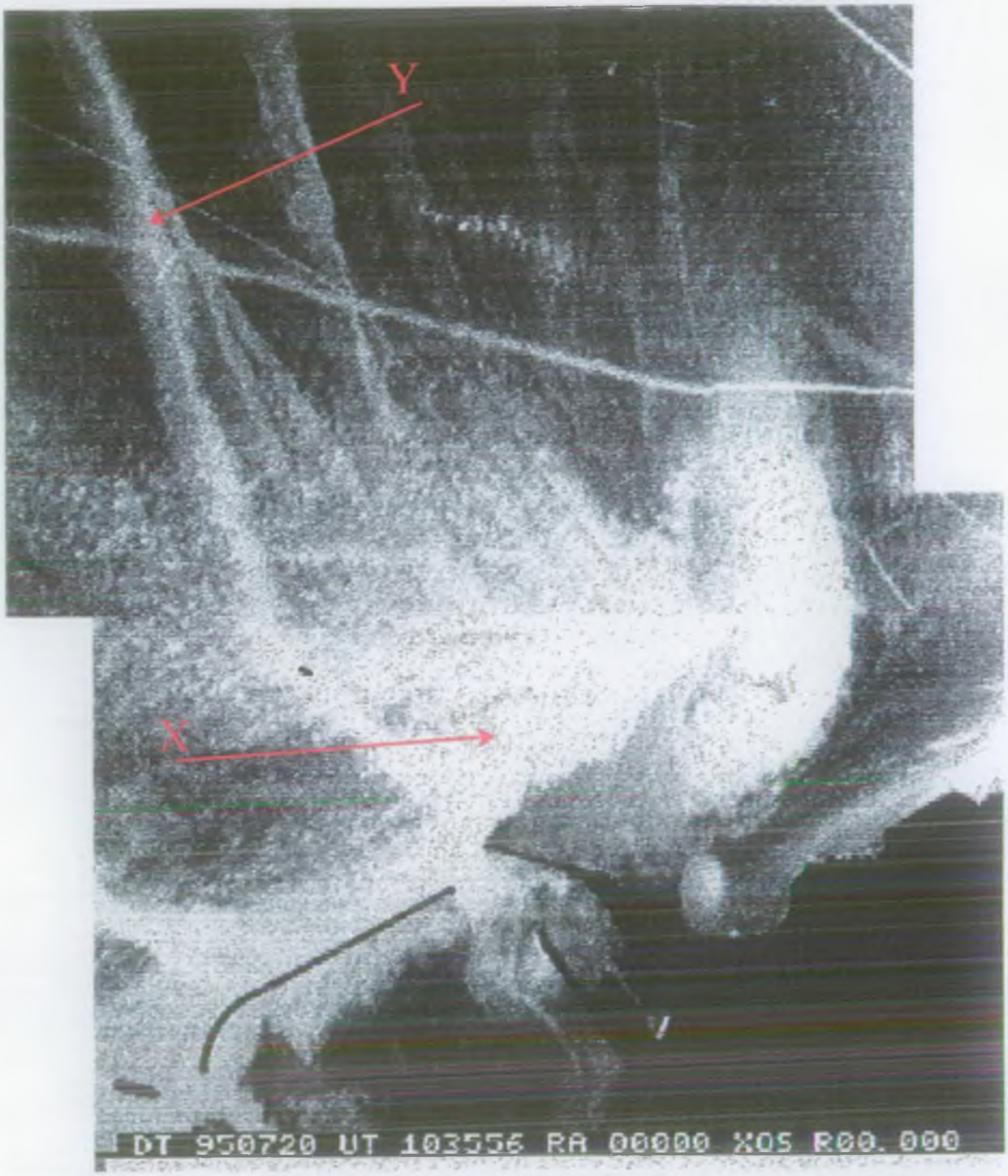
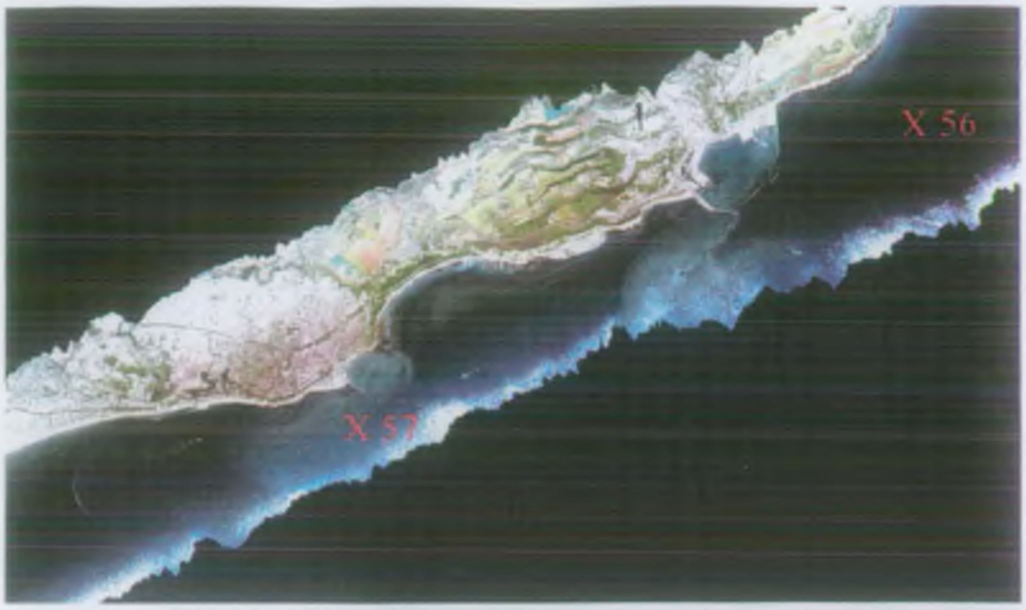
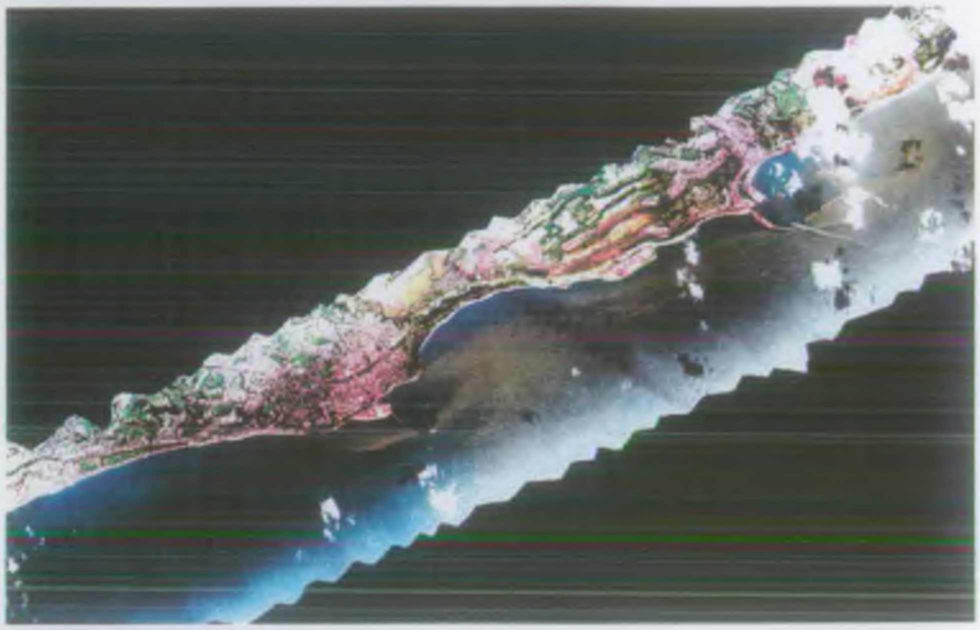


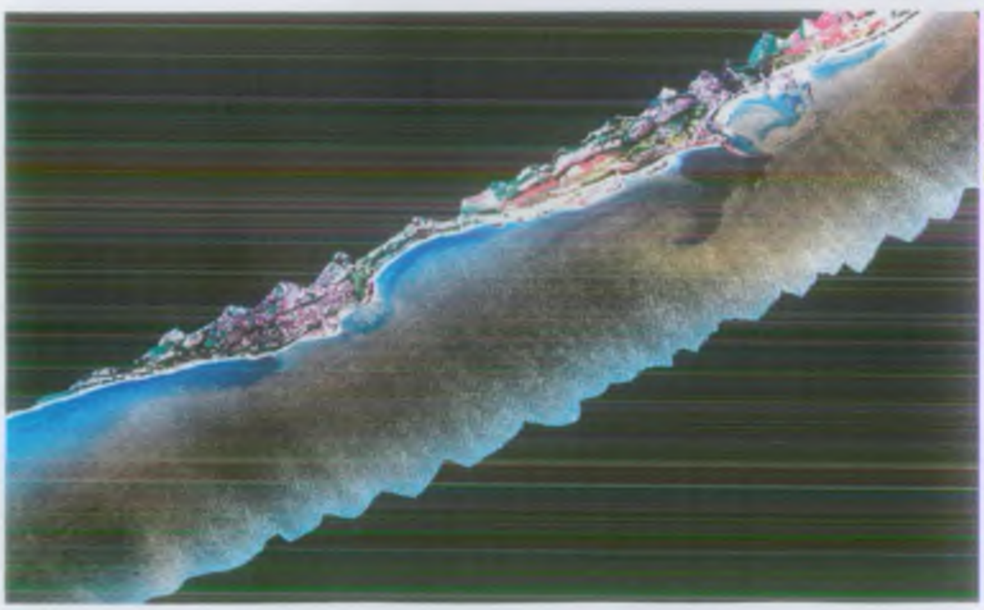
Plate 3: Dover harbour
Thermal video image composite
20th July 1995, 10:35 GMT



20th July 1995
10:38 GMT

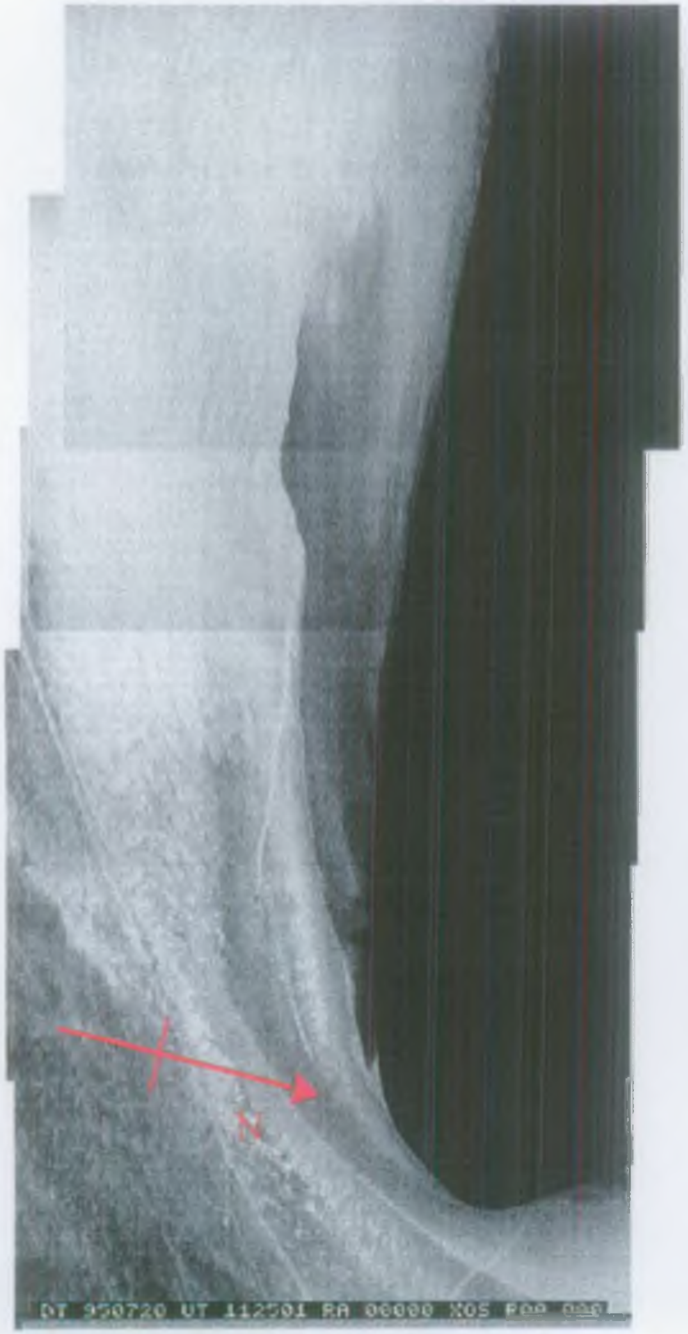
23rd September 1995
11:30 GMT



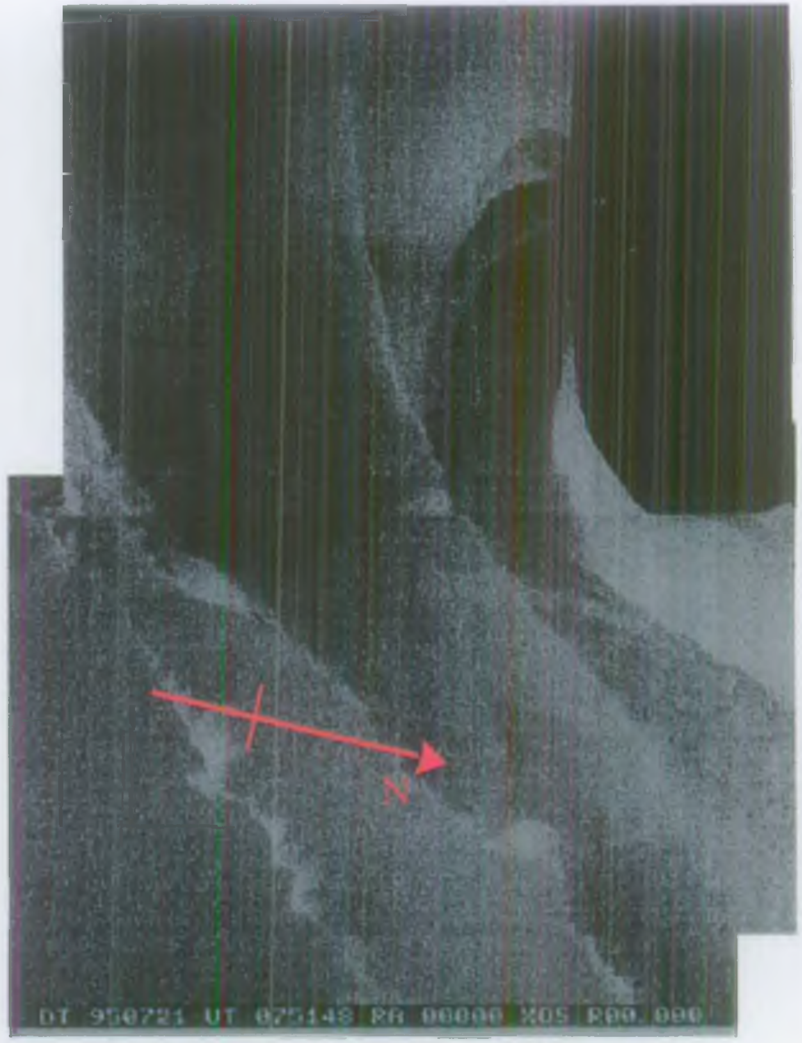


25th September 1995
08:38 GMT

Plate 4: Dover and Folkestone harbours
CASI enhanced true colour composite images



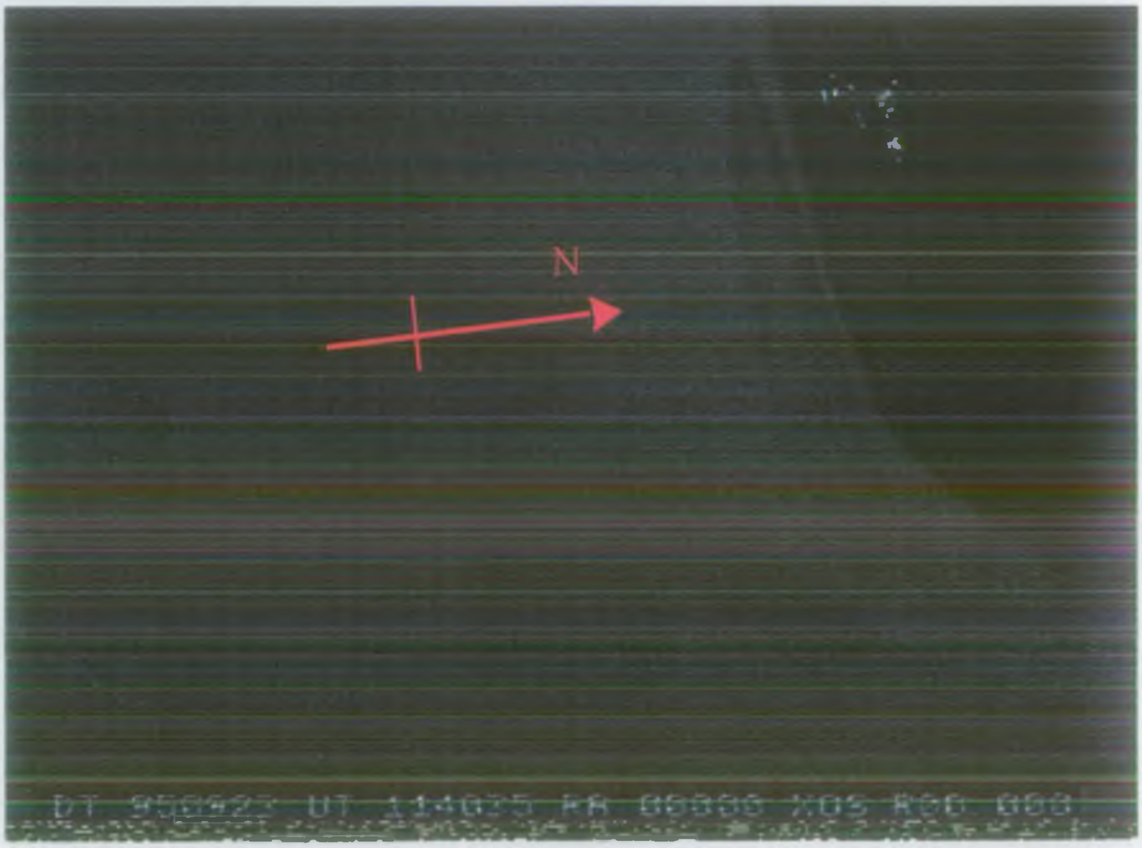
20th July 1995, 11:25 GMT



21st July 1995, 07:51 GMT

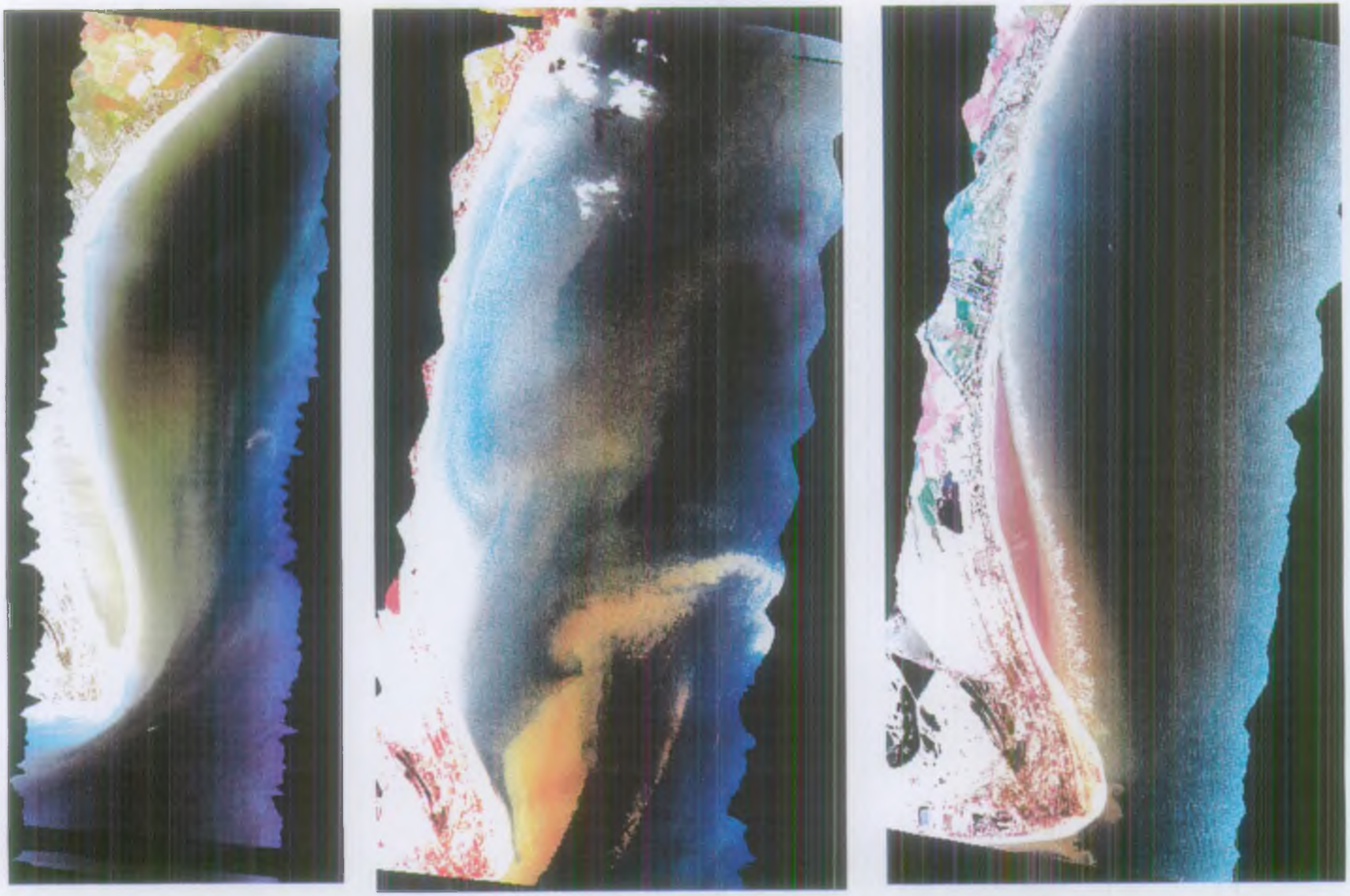
Plate 5: Dungeness power station outfall
Thermal video image composites, July

(i) 23rd September 1995, 11:40 GMT



(ii) 25th September 1995, 08:50 GMT

Plate 6: Dungeness power station outfall
Thermal video composite images, September



20th July 1995
11:14 GMT

23rd September 1995
11:37 GMT

25th September 1995
08:48 GMT

Plate 7: Dungeness headland
CASI enhanced true colour composite images