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National Marine Baseline Survey 1995

Littoral Cell 5
Selsey Bill to Portland Bill

ENVIRONMENT AGENCY

Report NC/MAR/016 Part 7 of 17
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Foreword

In recent years we have carried out National Baseline Surveys of the coastal zone which have involved analysis of samples taken at specific locations in coastal waters around England and Wales for a wide range of determinants. These data have been supplemented by further continuous analysis from the Coastal Survey Vessels and by spatial data from airborne remote sensing operations.

The dissemination of information from these data in an easily digestible form has proved to be a difficult task. To try to overcome this problem the data for the 1995 surveys have been distilled into a summary for each littoral cell.

The information in these summaries is meant to reflect the main features of the littoral cell. More extensive data as well as data collected in previous surveys are held at the National Centre and can be made available on request.

David Palmer

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MANAGER, NATIONAL CENTRE

Introduction

The object of this report is to present an overview of the results of the four 1995 surveys in a compact form. The report is accompanied by the full laboratory analysis results and a catalogue of image data stored on CD-ROM and video. In total there are seventeen parts to the report, and those parts included in this pack are listed at the end of this section.

The coastline has been divided into coastal cells, known as littoral cells using the procedure developed by HR Wallingford (Motyka and Brampton, Report SR 328, January 1993). A map of the divisions between these cells is shown in Figure (i). The rationale of these cells means that any changes within a cell should not affect adjacent cells. In addition each cell has a significantly different character to adjacent cells, in terms of geology or biology. The divisions were defined principally for coastal defence construction, but the position of boundaries have implications on water quality variations. For example, effects from effluent outfalls should not be transferred across boundaries.

The water chemistry results for each cell have been reviewed for each season. In particular the nutrient results have been investigated for high concentrations in Summer which may be linked to anthropogenic sources, and which may result in eutrophic waters. In parallel with this the chlorophyll-*a* concentrations have been studied for any increases which are linked to high nutrient values, by two techniques. Firstly, the individual samples have been investigated, and secondly, maps of the entire coastal zone have been produced to allow spatial estimates of eutrophic waters to be made.

The absolute concentration of chlorophyll-*a* is compared with a concentration of 10 µg/l. This is the level suggested as representative of a bloom event by the Department of the Environment in their document "Criteria and Procedures for Identifying Sensitive Areas and Less Sensitive Areas" which was produced as a response to the EC Urban Waste Water Treatment Directive. Although this level signifies the presence of a phytoplankton bloom, it must be associated with other indicators to show that waters are effected by eutrophication.

Dissolved metals concentrations have been investigated in terms of their relation to the Environmental Quality Standard (EQS) levels. These levels are established in response to the EC Dangerous Substances Directive. The definition of the EQS level is as an annual mean. This has been calculated for any sites in which an individual sample exceeds the EQS. Organic contaminants have also been compared with EQS levels where they exist.

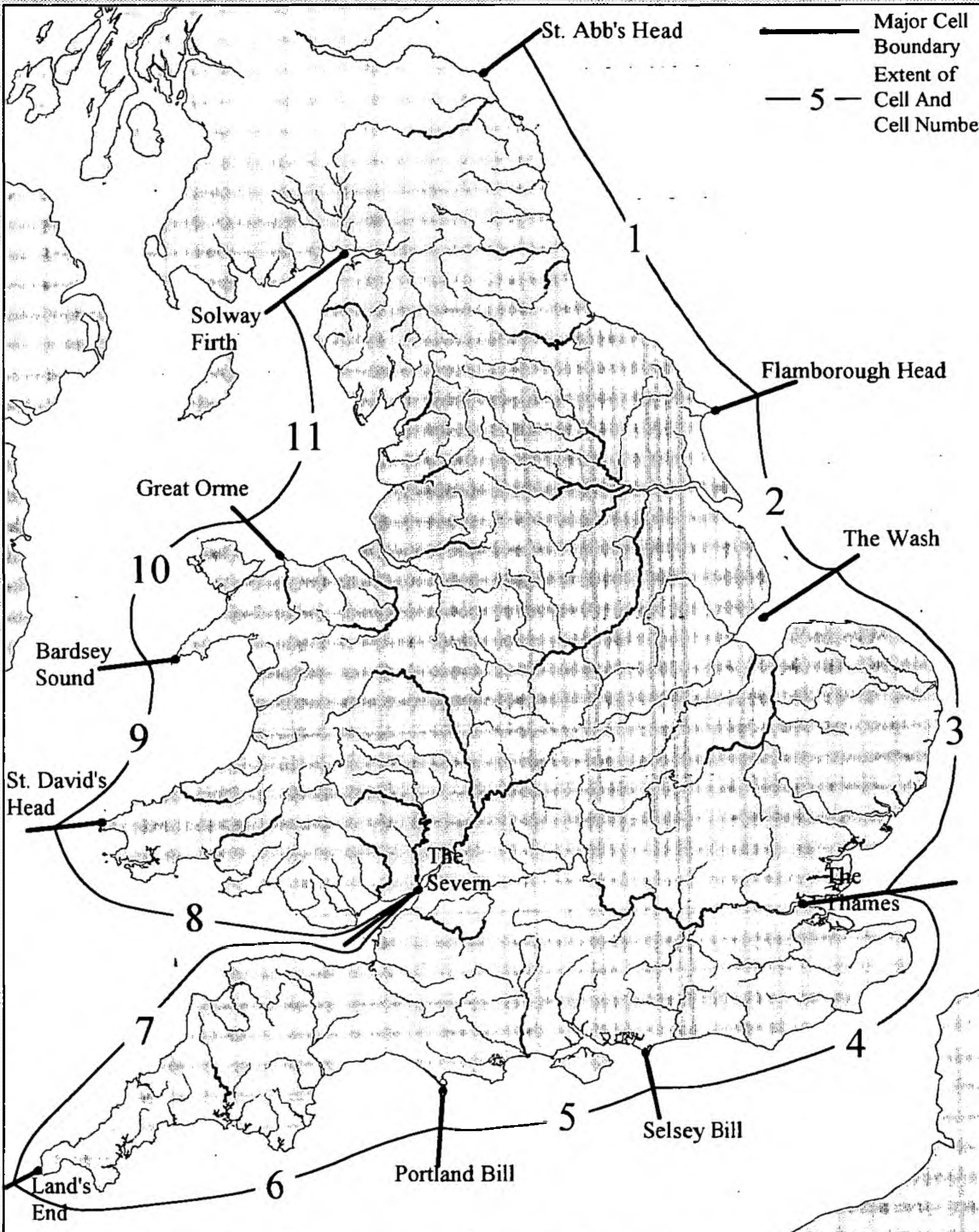
Consideration has been given to the position of the baseline sampling sites in relation to estuaries or major oceanographic features.

The image data and underway data have been investigated for major oceanographic features and changes in water quality. These may be manifested in the image data in two ways. Features are seen in the CASI imagery if they result in an alteration in the ocean colour signal. This usually requires a change in the amount of light scattered or absorbed by particles in the water column. Features such as estuarine plumes have higher particulate matter loading which increases the ocean colour sighal. Phytoplankton blooms increase the absorption of light in selected wavebands and moreover result in fluorescence being detected in other wavebands. Some features do not record a CASI signal but have a difference in water temperature. The thermal video systems used in the baseline survey record only the surface temperature of the water, but clearly show features such as effluent discharges and outfalls from power station cooling systems, in addition to river plumes.

The underway data illustrates changes in temperature, salinity, dissolved oxygen, transmission and fluorescence. The longitudinal profiles from the underway systems have been investigated for major changes which may be associated with estuarine inputs or fronts between different water bodies. Data from the Skalar continuous monitoring nutrient analyser have been investigated to determine the geographical extent of elevated samples in the laboratory analyses.

Summaries have been produced for each littoral cell which provide a statement on the water quality of the region recorded by the baseline survey. The key local oceanographic features are also summarised.

Figure i. The Major Littoral Cells of England and Wales, After Motyka and Brampton; 1993.



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

Littoral Cell 5: Portland Bill to Selsey Bill

Executive Summary

This littoral cell stretches from Portland Bill to Selsey Bill, and includes the major estuary of Southampton Water and the Solent.

No sites exceeded defined Environmental Quality Standards for metals or organic compounds. Highest concentrations of metals were generally found in the most highly industrialised area in the cell within Southampton Water. Nutrient samples showed a seasonal cycle, with higher concentrations in Winter. Only one sampling point showed an elevated concentration in Summer, which is Dockhead, close to the sewage treatment works in Southampton Docks.

Spatial chlorophyll-*a* concentrations determined both from the CASI imagery and from the continuous track fluorimeter were less than 6 µg/l throughout the region in Summer, indicating that this region was not subject to eutrophication at the time of the Summer survey.

The presence of the Isle of Wight and major headlands such as Selsey Bill and Portland Bill have the major effect on the division of water bodies and oceanographic processes within the cell. The formation of headland gyres, longshore drift and the presence of mobile sand and shingle banks are all noted within the imagery and underway data of this cell.

1. Introduction

This littoral cell stretches from Portland Bill in the West to Selsey Bill in the East, and data from around both these headlands will be included in this discussion. This constitutes approximately 1680 km^2 within the coastal zone for which the Environment Agency has responsibility for controlled waters, of which 400 km^2 are estuarine waters. This is illustrated in Figure 1.

During 1995 data collection was carried out jointly between Vigilance and Sea Vigil, with surveys being carried out in early Spring (April), late Spring (May), Summer (July) and Autumn (September). Data were collected from aircraft in July and September.

2. Water chemistry results

2.1 Background

In total there are thirteen laboratory sampling sites within this littoral cell, with a greater density of sampling points around the more highly populated areas of the Solent and Southampton Water (see Figure 1). This increased density of sampling allows inclusion of the National Marine Monitoring Plan sites within the estuary.

2.2 Nutrients and chlorophyll-*a*

2.2.1 Total Oxidised Nitrogen (TON)

TON concentrations were highest in early Spring, with a maximum of 1697 µg/l N at Dockhead (68.3). High concentrations were also recorded in Autumn, for example 1103 µg/l N again at Dockhead (68.3). During late Spring and Summer maximum concentrations of 425 µg/l N and 429 µg/l N respectively were again recorded at this site.

2.2.2 Silicate

Silicate concentrations showed a clear seasonal and geographical pattern. In early Spring, the maximum concentration was recorded at Dockhead (68.3) equal to 735 µg/l Si. In late Spring and Summer the laboratory minimum reporting value (MRV) of 1 µg/l Si was seldom exceeded, except by sites within Southampton Water. Concentrations were higher again in Autumn, with a maximum of 337 µg/l Si at Dockhead (68.3).

2.2.3 Orthophosphate

Orthophosphate concentrations showed a similar seasonal and geographical cycle. The maximum concentration of 51 µg/l P was again found in early Spring at Dockhead (68.3). In late Spring concentrations were generally below 25 µg/l P, with similar concentrations in Summer, except at sites in Southampton Water. Autumn concentrations were higher once more, with a maximum of 45 µg/l P at Dockhead (68.3).

2.2.4 Total Ammoniacal Nitrogen (Ammonia)

During early Spring, ammonia concentrations were higher than anywhere else on the coastline of England and Wales, with a maximum of 292 µg/l at Dockhead (68.3). Concentrations in late Spring, Summer and Autumn were all low, but with the maximum concentrations again being recorded at Dockhead (68.3).

2.2.5 Nitrite

Nitrite concentrations were generally low for this littoral cell in early Spring, late Spring and Summer. In Autumn, exceptionally high concentrations were recorded at Dockhead (68.3) equal to 354 µg/l N, and Calshot (68.2) equal to 152 µg/l N.

2.2.6 Chlorophyll-a

Chlorophyll-*a* concentrations showed a seasonal cycle, with highest concentrations in late Spring, reaching a peak of 9.37 µg/l at the Needles (70). Sites outside the Solent showed very low results all year round, generally below 2 µg/l. The Dockhead sampling site (68.3), however, where nutrients are highest, showed high levels of chlorophyll-*a* in Summer equal to 6.47 µg/l.

2.2.7 Nutrients/chlorophyll-a Summary
Nutrients results were in all cases greatest during the early Spring survey, although the peak of nutrients was probably not measured, due to the survey being carried out in April when concentrations are not usually maximum. Certain baseline sampling points showed elevated levels during all seasons, particularly Dockhead (68.3) in Southampton Water. This is probably due to the location of the baseline sampling site close to the sewage treatment works. This pattern was repeated for silicate, orthophosphate, ammonia and nitrite concentrations. Other sites within Southampton Water and the Solent also showed elevated concentrations.

Elevated chlorophyll-*a* concentrations were also found at Dockhead (68.3), which may be artificially induced by the input of nutrients at Dockhead from the sewage treatment works. The concentration recorded is however not in excess of 10 µg/l, which indicates the presence of a phytoplankton bloom.

2.3 Suspended solids

Suspended solids concentrations for this littoral cell were geographically variable. Highest concentrations were seen in the Solent and Southampton Water during early Spring, with a maximum of 14 mg/l at East Brambles (68.1). In Autumn the highest concentrations were recorded between Hengistbury Head (71) and Weymouth Bay (73), with a maximum concentration of 8 mg/l at Hengistbury Head (71). In late Spring and Summer all concentrations were low, with many sites below the laboratory MRV of 3 mg/l.

2.4 Metals

2.4.1 Total Mercury
Concentrations of total mercury were generally low, but with higher concentrations during the Autumn survey. The maximum concentration recorded was 0.215 µg/l Hg at Calshot (68.2). This compares with an EQS level of 0.3 µg/l Hg.

2.4.2 Dissolved Cadmium
Dissolved cadmium concentrations seldom exceeded MRV of 0.042 µg/l Cd. The maximum concentration recorded was 0.919 µg/l Cd at Nab Tower (67) in Summer.

2.4.3 Dissolved Copper
Dissolved copper concentrations were generally low, with many samples below the laboratory MRV of 0.55 µg/l Cu. There was a clear geographical dependence, with highest concentrations within Southampton Water and the Solent. For example a maximum concentration of 1.31 µg/l Cu at Calshot (67) in Summer, which compares with an EQS level of 5 µg/l Cu.

2.4.4 Dissolved Lead
Dissolved lead concentrations for this littoral cell were low in all four surveys, seldom exceeding the laboratory MRV of 0.024 µg/l Pb. The maximum concentration was 0.93 µg/l Pb, recorded at Nab Tower (67) in late Spring, compared with an EQS level of 25 µg/l Pb.

2.4.5 Dissolved Arsenic
No samples exceeded the laboratory MRV of 2 μg/l As in any of the four surveys.

2.4.6 Dissolved Zinc
Dissolved zinc concentrations were generally in excess of the laboratory MRV of 2 μg/l Zn. The maximum concentration recorded was 16.4 μg/l Zn at St. Catherine's (69) in Autumn.

2.4.7 Dissolved Chromium
Dissolved chromium concentrations showed a random geographical distribution and generally low concentrations. The maximum concentration recorded was 2.42 μg/l Cr at West Princessa (68.4), in Autumn, compared with an EQS level of 15 μg/l Cr.

2.4.8 Dissolved Nickel
Dissolved nickel concentrations generally exceeded the laboratory MRV of 0.058 μg/l Ni, although the concentrations were geographically random. The concentrations are low with respect to the EQS level of 30 μg/l Ni, with concentrations typically less than 1 μg/l.

2.4.9 Metals Summary
No samples exceeded the EQS levels for any of the metals measured. Most dissolved metal concentrations showed a geographical dependence with the highest concentrations in the Solent and Southampton Water.

2.5 Organic Determinands

Samples were analysed for trace organic determinands at four sites within this cell at Selsey Bill (66), Calshot (68.2), Hengistbury Head (71) and Anvil Point (72). 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.

During the Spring, Summer and Autumn surveys no sites recorded concentrations above the minimum reporting value of 0.001 μg/l. In early Spring each site recorded a result for α-HCH and γ-HCH. However, the concentration of total HCH was only approximately 10% of the EQS level of 0.02 μg/l.

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. The chlorophyll-*a* concentration was low throughout the cell, being consistently between 2 and 4 μg/l, except close to Poole Bay where concentrations decrease to less than 2 μg/l. These concentrations are as anticipated for the summer season for the majority of this cell. Laboratory samples showed higher concentrations within Southampton Water, however no image data was available here for the determination of the FLH. This is due to a statistically poor calibration caused by a time lapse in the collection of boat and aircraft data.

Figure 3 shows the continuous track boat fluorimeter data for this cell, which has been calibrated using the laboratory samples. This map shows the same concentrations as the FLH results, except for two regions. Firstly, the fluorimeter derived chlorophyll-*a* shows more detail off Portland Bill, which is probably due to the variability in the position of the front off Portland Bill. A variation in the position of this feature between collection of boat and aircraft data would mean that the feature would be smoothed out by the calibration procedure. Secondly, the fluorimeter results show higher concentrations up to 6 µg/l in Southampton Water which was not seen in the FLH data due to the reasons described above.

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 are 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 will provide an overview of the results for this section of coastline. The areas are as follows.

1. Portland Bill and Harbour
2. Kimmeridge Bay
3. Poole Harbour and Studland Point
4. The Needles to St Catherine's Point
5. Fawley Refinery
6. East Solent and Southampton Water
7. Selsey Bill

4.1 Portland Bill and Harbour

CASI imagery from Portland Bill collected during 1995 shows a complex arrangement of water bodies in both July and September. On a large scale, the Bill acts as a boundary between lower reflectance water, signifying clearer water to the West within Lyme Bay, and higher reflectance to the East in Weymouth Bay. In addition, the imagery shows the position of a gyre off the headland. In Plate 1(i), the gyre is located offshore, with the position being closer to shore in Plate 1(ii).

Laboratory samples show low results for suspended solids at 105°C for all samples along this area of coast, with results less than 2 mg/l during the July and September surveys. Chlorophyll-*a* samples again show very low concentrations at all points along this coast. The front off Portland Bill is thus between two water bodies of broadly similar characteristics.

Other laboratory samples show that metal concentrations are low along this section of coast, with only copper, zinc and lead showing results above the MRV. None of these results exceed 50% of their respective EQS values. Measurements for organic compounds have not been taken close to Portland Bill. Nutrient results show that this area has low concentrations relative to surroundings, but with the anticipated seasonal effects causing highest results during the winter survey.

The underway data records the position of the front off Portland Bill on all occasions, with a drop in transmission towards the east. Temperature measurements show a slightly lower temperature to the west of the headland, although the difference is very small. Thermal video imagery from July and September does not record any marked feature here.

Thermal video imagery shows great variability around Portland Harbour (Plate 1(iii)). Ships tracks are clearly seen across the July image, which was taken on an extremely calm day. These tracks show that the depth of the surface layer is less than 3 m. The heating is due to a seasonal thermocline having developed, with little diurnal warming due to the time of the image at 09:30 GMT.

In addition, there is an eddy to the south of the most southerly breakwater, extending approximately 2 km down the coastline. This feature is not clear on the CASI imagery, which suggests that it is either a purely surface feature, as the thermal system records information from only the top few micrometers of the sea surface, or a feature which does not have a marked difference in the ocean colour signal. The source of the feature is seen to be from Portland Harbour, which would have a warmer temperature due to entrapment. During Winter this water would have a higher suspended solids loading. However, low riverine runoff in Summer would account for the low variation in ocean colour signal.

4.2 Kimmeridge Bay

Imagery revealed the presence of longshore drift of suspended particulate matter from Winspit on St Aldhelm's Head eastward towards Durlston Head. This is seen most clearly on the thermal imagery from July 1995 as shown in Plate 2, where the area of warmer water extends approximately 1 km offshore.

The underway data does not indicate any variation in transmission along this section of coastline during the July survey. In September, however, a clear drop in transmission is noted to the East of St Aldhelm's Head which indicates the presence of higher suspended solids, but there is no corresponding increase in temperature. Laboratory samples are not gathered within the region under consideration, with the nearest sampling point being to the west of the headland. The thermal imagery shows however that there is a considerable flow of warmer water along this coast. There are a number of streams in this region which would output warmer water, which might then pool in the shallow ledges along this coast.

4.3 Poole Harbour and Studland Point

Sandbanks within Poole Harbour are clearly visible on all CASI imagery and thermal video imagery collected during 1995. However, this is not specifically part of the baseline survey. One key feature within the coastal zone is Hook Sand which lies between the main shipping channel and the north side of Poole Bay. This may be seen on CASI imagery from July 1995 (Plate 3(i)), but is less clearly visible in September, due to tidal state. This bank divides the flow of water from Poole Bay with the main stream flowing to the south but with a part moving along the coast to the north. Low water quality has been recorded within Poole Bay in the past. Thus the flow of water from the bay along the coast may have potential implications on the water quality of this coast.

Outflow of water high in suspended solids is seen in CASI imagery of July, extending southwards towards Studland Point where it appears to be deflected north and offshore. The thermal video imagery shows this more clearly, with the water from within Poole Bay being distinctly warmer (Plate 3(ii)). This water hugs the coast until it reaches Studland Point where it is deflected and forms an eddy structure off the headland. This eddy has been documented previously and causes a distinct front between warmer water to the north of the headland and colder water to the south.

Underway data from July shows the presence of a thermal anomaly within this region, with an increase of approximately 1.5°C associated with a dip in transmission and an increase in chlorophyll-*a* fluorescence. The geographical position of the anomaly is located away from that seen in the thermal imagery, which may be explained by the differing state of the tide.

Laboratory samples are recorded at Hengistbury Head to the east of Studland and at Anvil Point to the south. These two sites have similar levels of most determinands, with lower concentrations of winter nutrients at the more offshore position of Anvil Point. The structures discussed above would have no implications on the baseline sampling measurements as they are on a relatively local scale.

4.4 The Needles to St Catherine's Point

The front caused by the presence of the shingles bank in the mouth of the West Solent is shown on CASI data and thermal imagery from both 1995 surveys. The eastern edge of the Shingles Bank is marked by a clear difference between water higher in suspended particulate load to the south east as apposed to the lower concentration seen to the north west. This signifies the outflow of higher suspended solids water from the Solent on the south side of the Shingles Bank.

Underway data shows the presence of this frontal structure off the Needles in all four surveys. In Winter, the area to the south of the Shingles Bank is of higher temperature and chlorophyll-*a* and lower transmission and dissolved oxygen concentration as shown in Figure 4. Although this is the survey in which results are most clearly seen, the situation is repeated in each of the other surveys. In each there is a decrease in salinity which shows that this is the outflow of fresher water from the Solent and its associated rivers, which is supported by the timing of surveys close to low water.

Laboratory samples show the Needles sampling point to have high concentrations of chlorophyll-*a* and mercury relative to surrounding waters, which is explained by the location of this sampling point within the plume of material from the Solent. In particular, chlorophyll-*a* concentrations are high, which corresponds with the high fluorimeter measurement from the Towfish. In Spring the concentration of mercury at this point is the highest in the region, but is still only 10% of the EQS level.

To the south of the Needles there is a front running parallel to the coast on the southern side of the Isle of Wight, which has both a thermal and a colour signature. Inshore waters are higher in suspended particulate load and warmer. Clearer colder water is located offshore. This feature is not shown in the underway data as the vessel track does not traverse it.

Sediment transport patterns are seen off St Catherine's Point on the southern tip of the Isle of Wight in both CASI and thermal imagery. A plume of sediment extends from the headland eastward in the July imagery. Further imagery from September confirms the presence of this plume, with turbulence in one image resulting in white capping around the headland.

The high suspended sediment concentrations close to the coast are due to erosion of the cliffs on the southern side of the Isle of Wight. Thus, CASI imagery may be used to show where transport of eroded sediments is high.

Underway data from this region shows generally lower transmission, but with no major features, due to the vessel not traversing the high sediment region. Laboratory results show high concentrations of suspended solids in Winter, although the results from the other campaigns are not exceptional. The sampling point is located on the edge of the plume as seen in the imagery, and may on some occasions be sampling in the clearer offshore waters. Results for dissolved metals and nutrients are similar to surrounding sampling sites.

4.5 Fawley refinery

Thermal video imagery shows a large outflow of warmer than ambient temperature water from Fawley refinery on Southampton Water in September 1995 (Plate 4). The imagery shows a flow of warmer water both to the north and the south, due to a reversal in tidal flow 30 minutes prior to the image collection.

The imagery also shows a minor warm outfall to the south of the southern jetty. Ship tracks are seen, where the passage of the vessel has stirred up warmer water from beneath the surface.

The effects of this thermal variation on the ecology of the region can not be assessed from the baseline data. This would require further local investigation if the warmer water were thought to be a potential problem.

4.6 East Solent and Southampton Water

The East Solent shows high local variability in colour signal from the CASI in all imagery which is caused by the high variability in suspended sediment load within this region. Areas of deeper clear water are visible around Portsmouth Harbour, with SPM increasing on passage up the East Solent towards Southampton.

Underway data from the area shows similar results in all four surveys, as shown in Figure 5. Temperature increases up the Solent towards Southampton, with a corresponding decrease in transmission, representing higher suspended particulate matter loading. Salinity decreases towards Southampton also, due to the inputs of freshwater from the Rivers Test, Itchen and other associated rivers. Between the baseline sampling points at East Brambles and Calshot a clear structure is seen in July, with a similar but smaller scale structure seen in September. There is a distinct increase in fluorescence accompanied by a decrease in transmission, which signifies the presence of a phytoplankton bloom. This would not generally be expected in July, and might therefore warrant further investigation.

One major feature seen in this region is the sandbank known as Ryde Sand, which has a clear signal in the CASI imagery in both July and September as shown in Plate 5. The more elevated area to the west of the sandbank is clear in both images as an arc shape. In the September image the bank appears to be larger. Consultation of the tidal states shows that they are very similar in the two images, and therefore the difference is probably caused by differing weather conditions. In September, the weather is more turbulent which causes stirring up of bottom sediment.

Laboratory samples in this region show the anticipated higher concentrations of metals and nutrients at the upper end of Southampton Water, at the Dockhead sampling site. This sampling site records the highest nutrient levels for the entire cell at Dockhead, which is close to a major sewage treatment works. There are also enhanced concentrations of chlorophyll-*a* found in this region in Summer, which may be linked to the increased nutrient availability. The chlorophyll-*a* concentration does not exceed the level proposed by the Department of the Environment as being significant for the identification of areas subject to eutrophication.

Underway nutrient data from the Skalar system are shown in Figures 6 - 9. The scales used to plot the data are based on the values for all surveys at all geographical locations, to allow national comparisons to be made.

The figures illustrate the high nutrient values at the upper end of Southampton Water. In Winter the extremely high concentrations of TON, ammonia and phosphate approximately extend to Calshot. In addition, there is an area of elevated ammonia concentration greater than 40 μg/l N around the Needles which represents the outflow of water from the West Solent. In Spring phosphate concentrations are generally much lower, although there is still an elevated concentration at Dockhead. Ammonia and TON concentrations are also lower. Silicate concentrations are very high for this season, with the maximum concentrations recorded at Dockhead greater than 800 μg/l N. In Summer, the upper part of Southampton Water shows high concentrations of all nutrients, particularly silicate, with a maximum between 300 and 400 μg/l Si, and ammonia, with a maximum greater than

100 μg/l N.

The continuous monitoring nutrient analyser allows the geographical extent of the effects of the Dockhead sewage treatment works to be established. In Winter the high nutrient concentrations clearly extend the length of Southampton Water, with a more localised effect in Spring, with high TON and silicate concentrations only as far south as the Hamble Estuary, and phosphate constrained to the top of Southampton Water. Similarly in Summer elevated concentrations are found only in the upper part of Southampton Water. In Autumn the effects are most widespread, in particular in the silicate and ammonia concentrations, with concentrations of ammonia greater than 80 μg/l N extending into the East Solent.

4.7 Selsev Bill

The major physical feature seen in imagery of Selsey Bill and Chichester Harbour is the presence of sandbanks, both at the mouth of the harbour and around the headland. The low light levels in imagery from late afternoon in October reveals the presence of sandbanks at harbour mouths most clearly.

Around Selsey Bill it is possible to distinguish a number of submerged sandbanks, but more clearly an emergent feature is seen in imagery from both July and September. Plate 6 shows the image from September 21st 1995, which illustrates this feature most clearly, as a white emergent elbow of material extending approximately 0.5 km offshore. This structure is probably the shingle bank Kirk Arrow Spit known locally as Cack Hard, which although not marked on the Admiralty charts, is included in recent navigational advice. This should, however, be emergent only at Low Water Spring tides, whereas all the imagery from last year was recorded within one day of Neaps. Further investigation would therefore be required to establish whether this area of shingle has grown noticeably. Development of additional bathymetry would result in the deflection of low quality waters from the Solent and Portsmouth harbours offshore at this point.

Deeper water is located immediately to the west of Selsey Bill, which appears clear in imagery. This is associated with an area of high transmission values from the underway data which is noted in each of the surveys but is most apparent in July. This region also has an increased temperature during all surveys. To the west of this feature the transmission then begins a gradual increase towards the Solent where higher levels of suspended solids are seen.

5. Conclusions

In general, the water quality of this section of coastline is high, with no laboratory samples exceeding the defined EQS levels for dissolved metals and organic determinands. High nutrient values are seen within Southampton Water throughout the year, which is anticipated in this estuarine environment close to a large conurbation.

The spatial chlorophyll-*a* data measured by both the Fluorescence Line Height technique and using the continuous track fluorimeter shows that the chlorophyll-*a* concentration during Summer 1995 was less than 6 µg/l during the period of overflights. Thus no coastal areas are subject to the effects of eutrophication as defined by the Department of the Environment Methodology for Identifying Sensitive Areas.

The major factor determining the position of water bodies of differing characteristics is the presence of the Isle of Wight at the centre of the littoral cell, and on a smaller scale by the presence of headlands such as Selsey Bill, Portland Bill and Studland Point. Bathymetric features such as sandbanks and saltmarshes are also of importance in defining this coastline and may warrant further investigation as repetitive imagery shows seasonal differences as well as departures from the mapped extent.

The CASI imagery does not reveal any major sea outfalls within this region. This is because the majority of outfalls are into the more turbid coastal area, and are thus difficult to distinguish. In contrast a number of major outfalls are located outside the limit of the imagery, particularly within the East Solent. Thermal imagery shows an outfall at Lee-on-Solent, and from Fawley oil refinery.

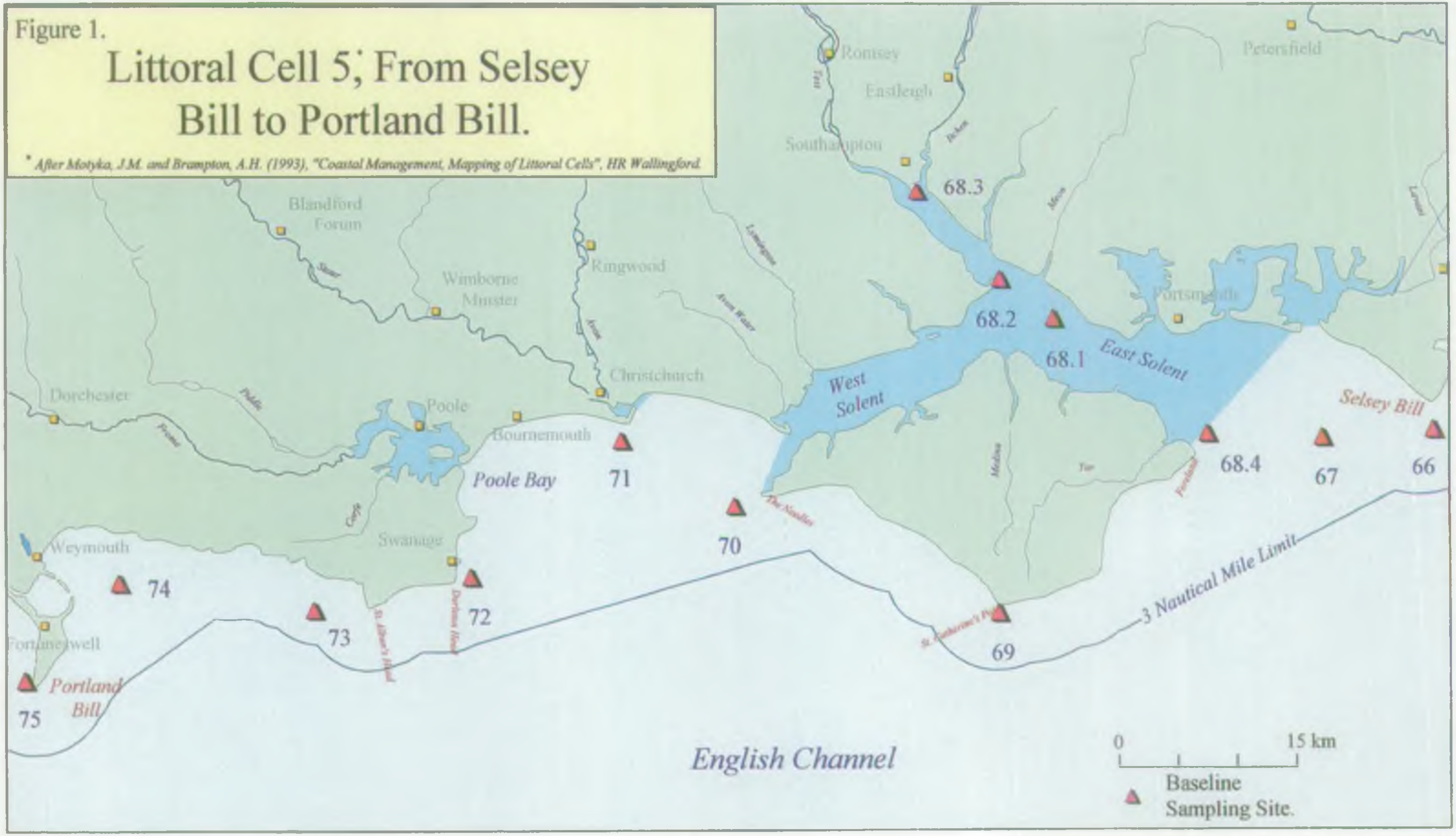


Figure 1.

Littoral Cell 5*; From Selsey Bill to Portland Bill.

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

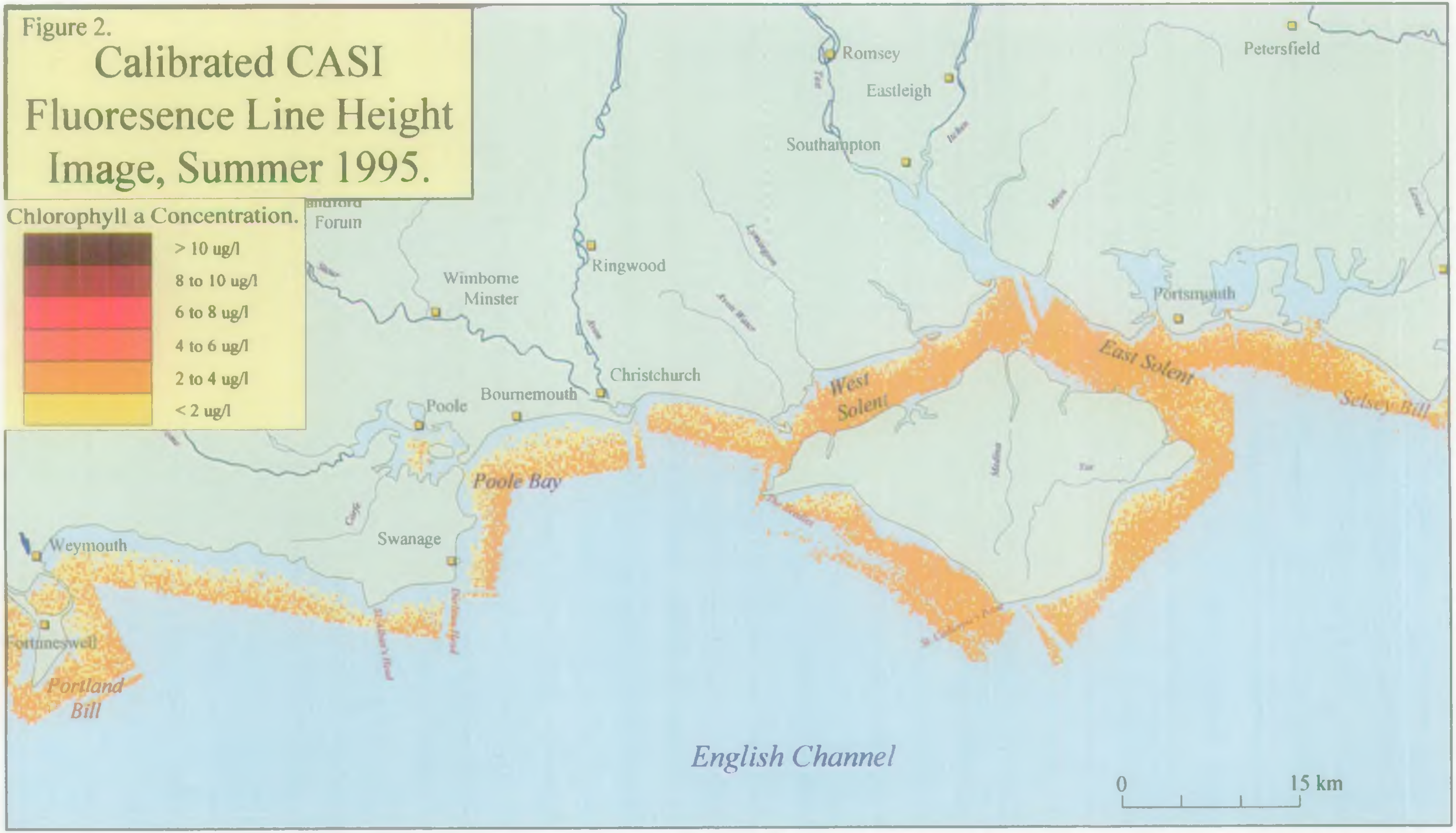


Figure 2.
Calibrated CASI Fluoresence Line Height Image, Summer 1995.

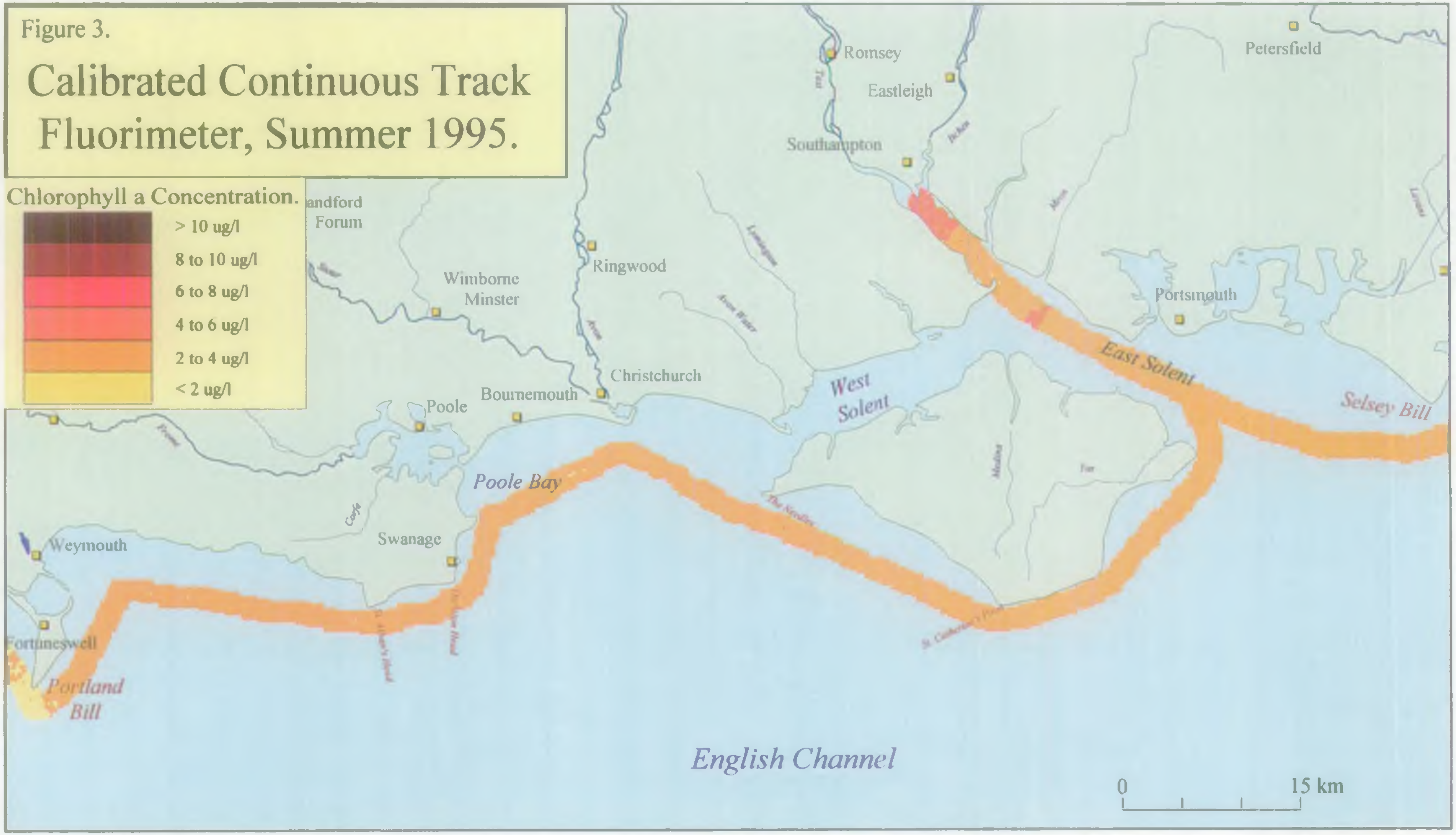
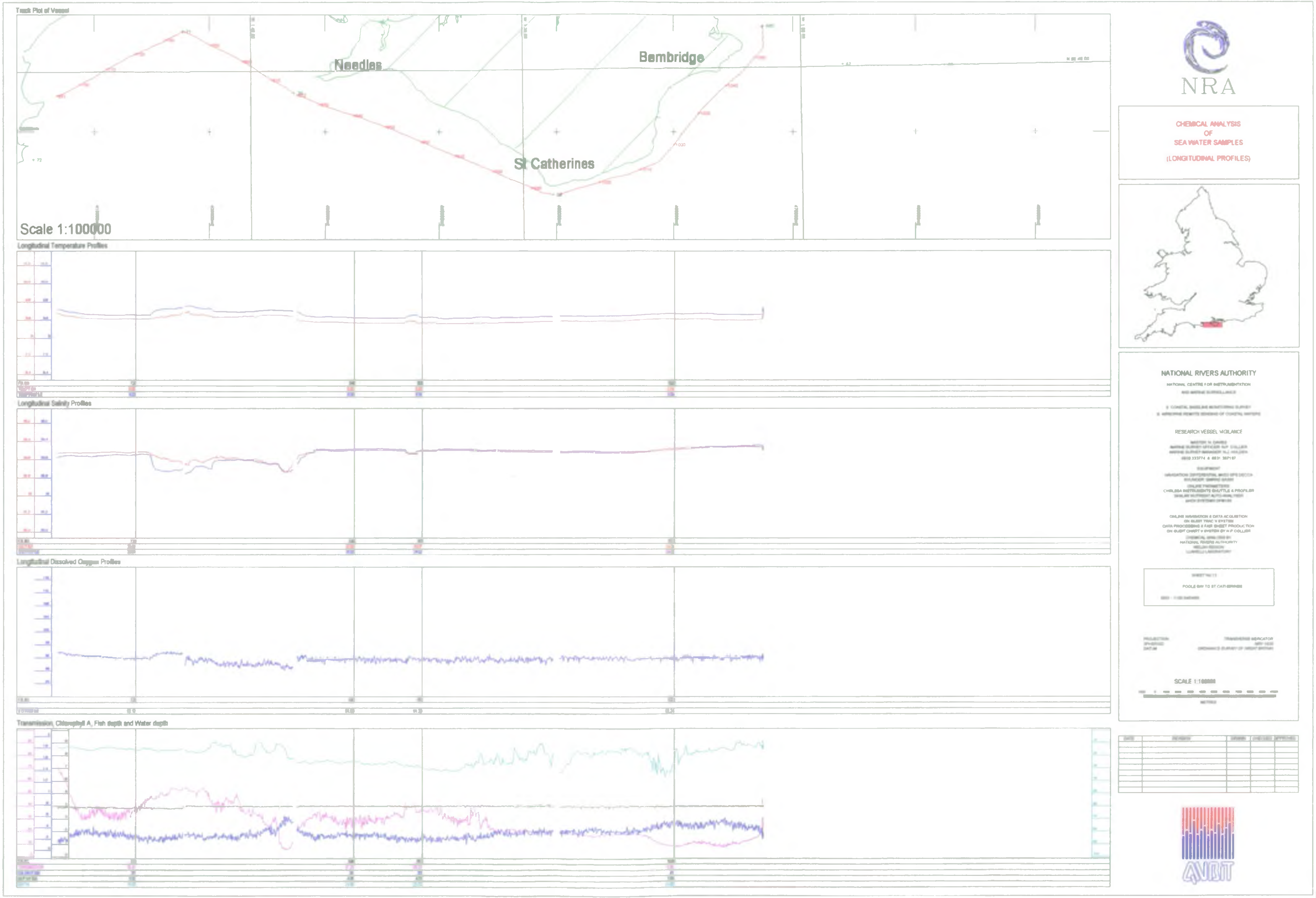


Figure 3.

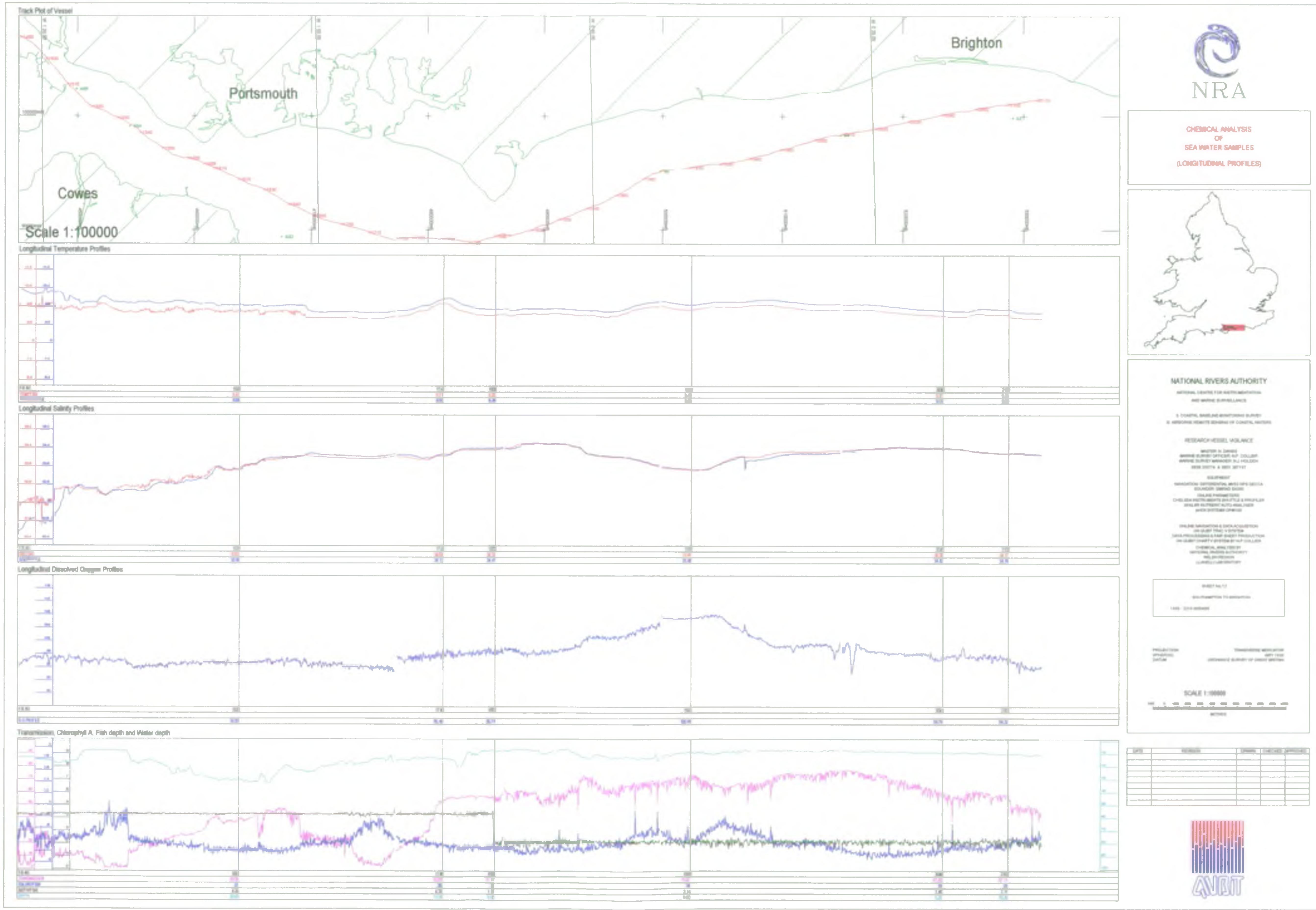
Calibrated Continuous Track Fluorimeter, Summer 1995.

Figure 4



Track Plot of Vessel
Needles
Bembridge
St Catherines
Scale 1:100000
Longitudinal Temperature Profiles
Longitudinal Salinity Profiles
Longitudinal Dissolved Oxygen Profiles
Transmission, Chlorophyll A, Fish depth and Water depth
NRA
CHEMICAL ANALYSIS
OF
SEA WATER SAMPLES
(LONGITUDINAL PROFILES)
NATIONAL RIVERS AUTHORITY
RESEARCH VESSEL VIGILANCE
SCALE 1:100000

Figure 5



Track Plot of Vessel
Portsmouth
Brighton
Cowes
Scale 1:100000
Longitudinal Temperature Profiles
Longitudinal Salinity Profiles
Longitudinal Dissolved Oxygen Profiles
Transmission, Chlorophyll A, Fish depth and Water depth
NRA
CHEMICAL ANALYSIS
OF
SEA WATER SAMPLES
(LONGITUDINAL PROFILES)
NATIONAL RIVERS AUTHORITY
RESEARCH VESSEL VIGILANCE

Figure 6.

Skalar Nutrient Data from the Solent - Isle of Wight Area, Winter 1995.

Figure 7.

Skalar Nutrient Data from the Solent - Isle of Wight Area, Spring 1995.

Figure 8.

Skalar Nutrient Data from the Solent - Isle of Wight Area, Summer 1995.

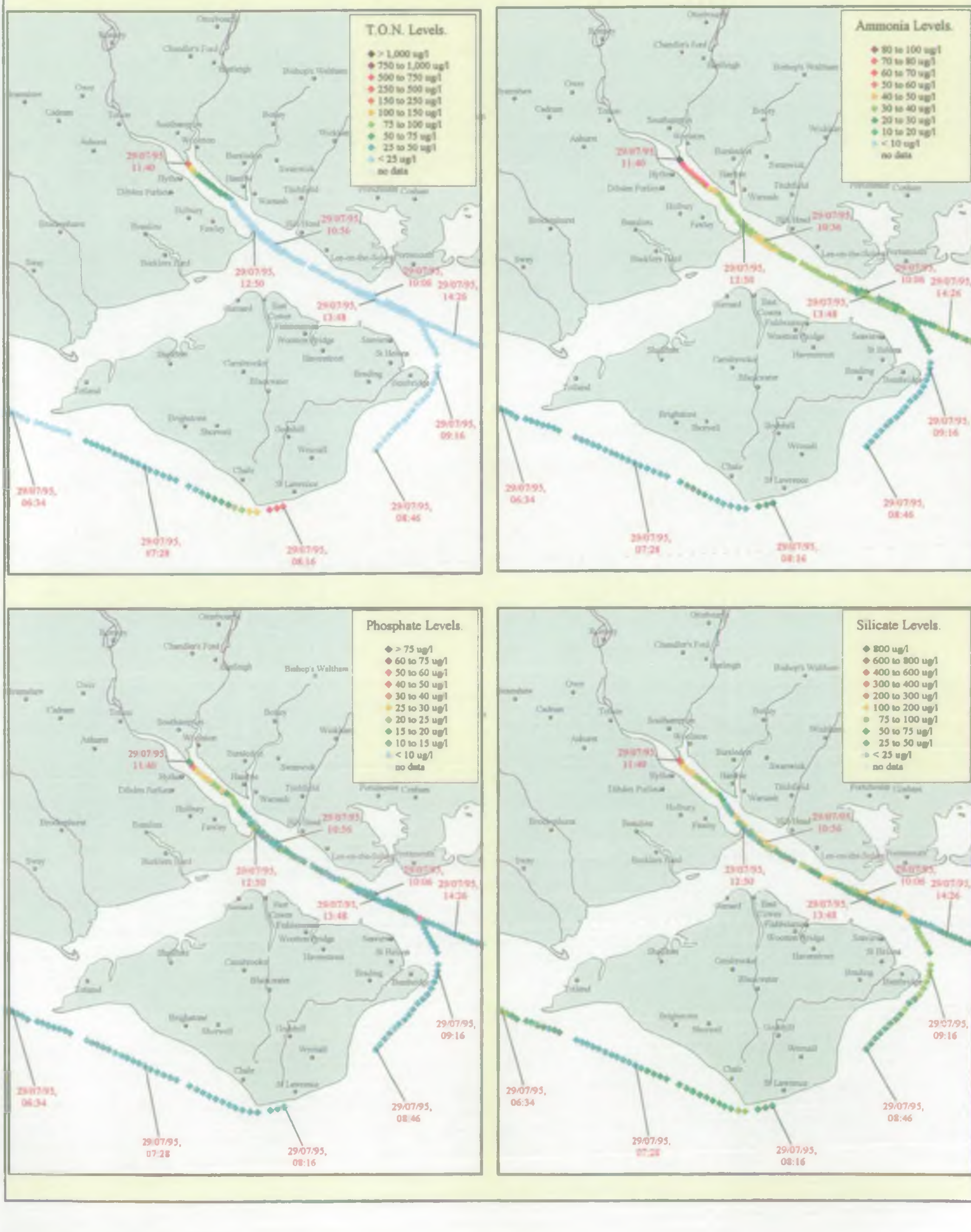


Figure 9.

Skalar Nutrient Data from the Solent - Isle of Wight Area, Autumn 1995.

(i) CASI colour composite image showing a higher reflectance region offshore, 31st July 1995

(ii) CASI colour composite image showing the beginning of a front off Portland Bill headland 24th July 1995

(iii) Thermal video image of Portland Harbour 31st July 1995

Plate 1: Portland Bill and Harbour

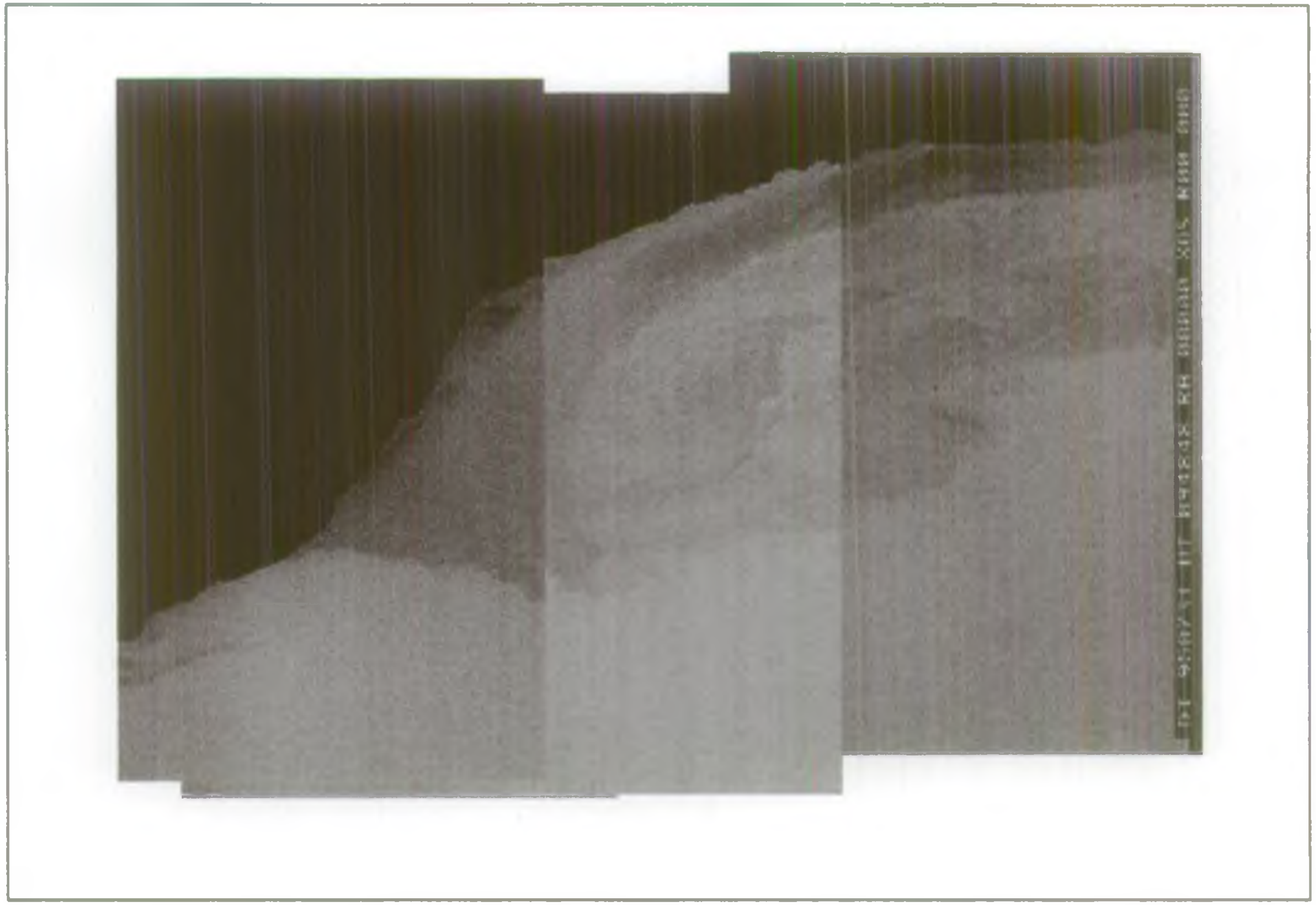
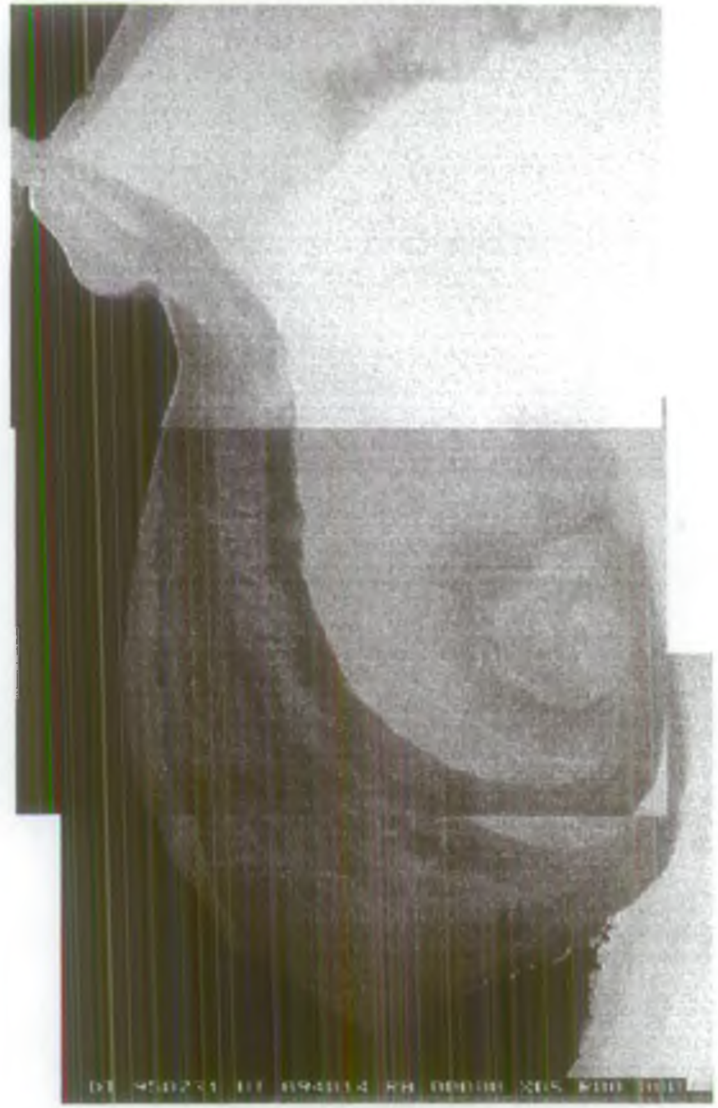


Plate 2: Kimmeridge Bay
Thermal video image composite, 31st July 1995

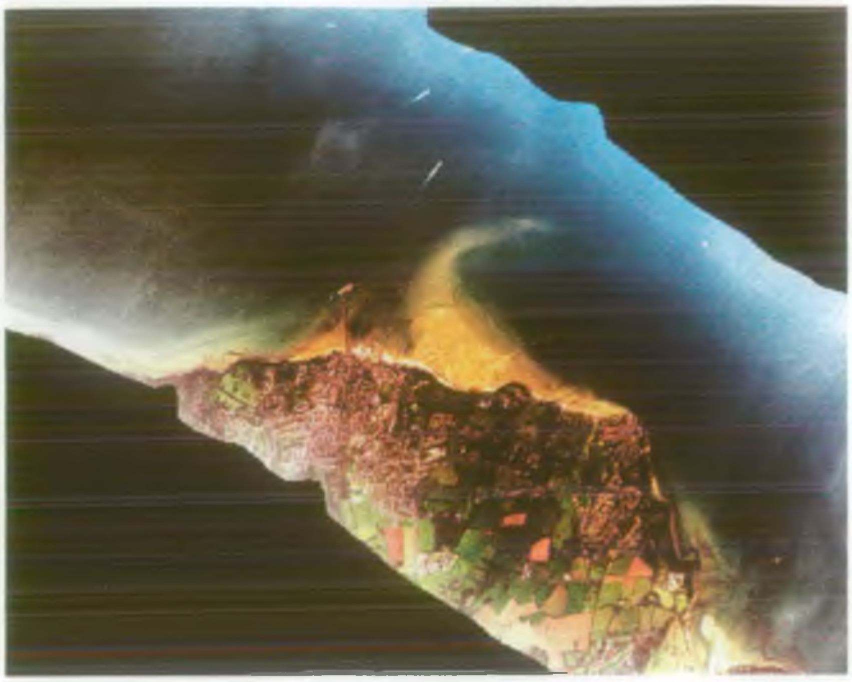
(i) CASI enhanced true colour composite image of Studland Point and Poole Harbour entrance 31st July 1995



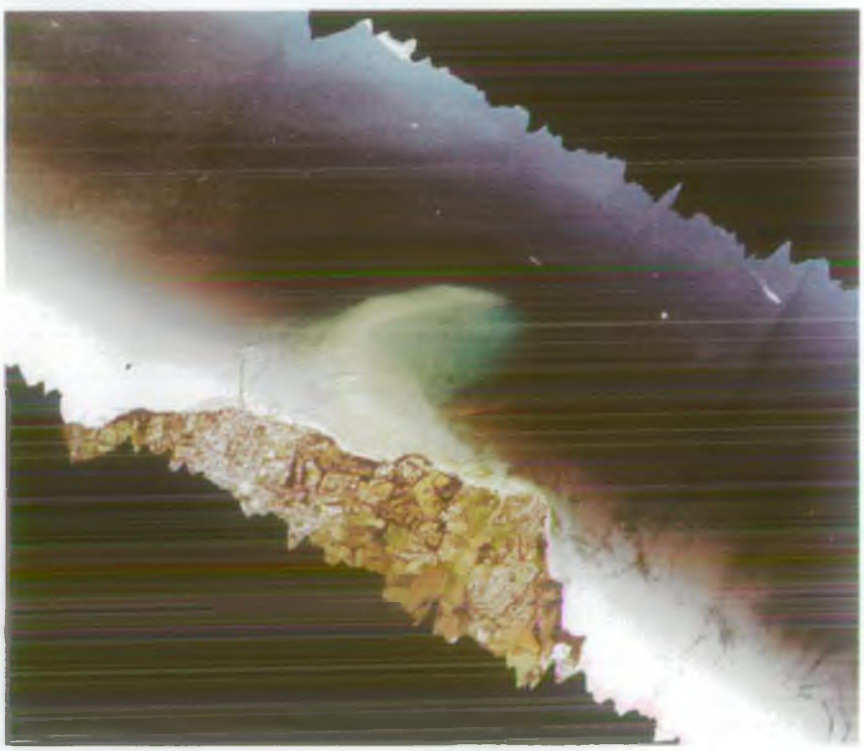
(ii) Thermal video image of Studland Point and Poole Harbour entrance, 31st July 1995

Plate 3: Studland Point and Poole Harbour

Plate 4: Fawley oil refinery outfall
Thermal video composite image
25th September 1995, 09:27 GMT



(i) 20th July 1995



(ii) 21st September 1995

Plate 5: Ryde Sands, East Solent

CASI enhanced true colour composite images showing variability in the East Solent and the presence of Ryde Sand

Plate 6: Kirk Arrow Spit, off Selsey Bill

CASI enhanced true colour composite image showing the presence of Kirk Arrow Spit