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# Survey of chalk cave, cliff, intertidal and subtidal reef biotopes in the Thanet Coast cSAC

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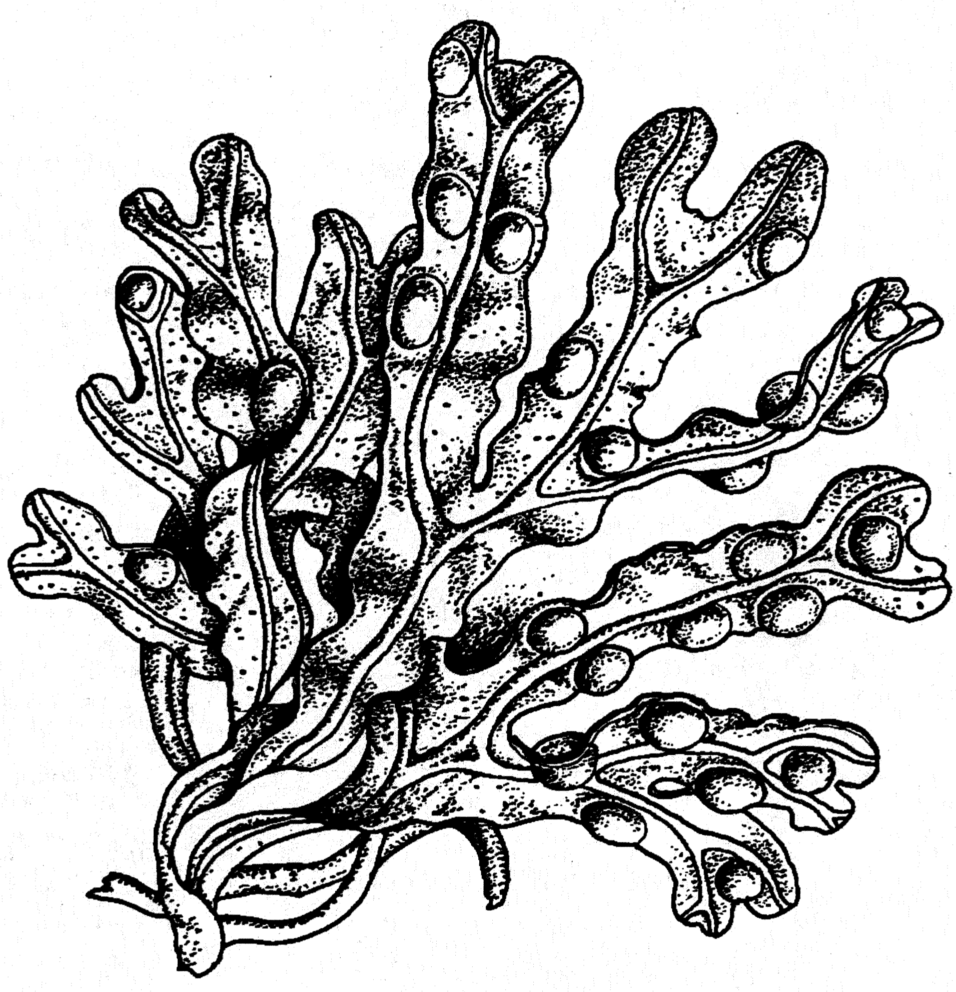

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# Survey of chalk cave, cliff, intertidal and subtidal reef biotopes in the Thanet coast cSAC

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# Contents

## Volume 1

## Submitted seperately

## Volume 2

# Executive Summary


- A survey of chalk cave, cliff, intertidal and subtidal reef biotopes in the Thanet cSAC was undertaken in August and September 1997.
- Phase 1 biotope mapping revealed 37 different intertidal biotopes/ habitats around the coast of Thanet. Aggregate and detailed biotope maps are presented. Two subtidal biotopes associated with chalk reef are described.
- The present survey identified 13 biotopes defined as rare, and four biotopes defined as uncommon in Britain.
- The occurrence of subtidal chalk habitats identified from survey using acoustic methods was confirmed for selected sites by the current diving survey.
- Phase 1/2 surveys at five selected subtidal sites revealed five different biotopes. Site survey maps indicating the occurrence of biotopes are presented.
- The best examples of natural cliff and cave formations and chalk cave and cliff algal communities remained in the Kingsgate area. There had been no loss of habitat since previous surveys.
- Species diversity on Thanet overall is intrinsically low due to the harsh and geologically unique environment.
- Intertidal and subtidal sites on the northeast and east coasts of Thanet supported a greater diversity of biotopes and species. Two sites (Fulsam Rock and Whiteness) were proposed for surveillance.
- Intertidal sites at the western ends of Thanet were strongly influenced by siltation and generally less rich in biotopes and species.
- Phase 2/3 surveys of foreshore reef were undertaken at Fulsam Rock and Whiteness. Both sites contained a good range of biotopes typical of Thanet and chalk shores generally.
- Variants of nationally common biotopes characterised by 'rock-boring' fauna were commonly recorded at intertidal and subtidal levels throughout the cSAC.
- Significant incursions of the invasive alga *Sargassum muticum* were recorded at Fulsam Rock and along the north coast of Thanet to Palm Bay.
- A summer bloom of the green algae *Enteromorpha* and *Ulva* obscuring other biotopes was recorded at Fulsam Rock and elsewhere on Thanet. This may be related to inshore water quality.
- Turbid water conditions with low light penetration are important factors responsible for the limited and specialised subtidal flora and fauna.
- Suggestions are made for monitoring activities likely to cause disturbance to marine communities and to assess maintenance of favourable status.

# 1 Introduction

## 1.1 Background

The Isle of Thanet is a small peninsula and outcrop of chalk rock at the extreme east of Kent in southeastern England (figure 1). A characteristic of chalk coasts, in contrast to many harder rocky coasts of western and northern Britain, is the geomorphological structure in which, because of subaerial and marine erosion, a vertical rocky cliff face abuts an extensive foreshore (a wave-eroded platform) often extending several hundreds of metres seawards. These features are clearly present on Thanet. This is of significance ecologically and biologically in the formation of chalk sea-cave, cliff and reef habitats, and occurrence of associated communities/biotopes. Man's attempts to curb coastal erosion are also of significance in terms of habitat alteration and loss.

In contrast to chalk-shores elsewhere in Britain, the cliffs and foreshore reefs on Thanet are formed of Upper Chalk which is softer and more susceptible to erosion. This soft nature is of significance ecologically for rock-boring biota, a relatively restricted, interesting and unusual feature not evident on harder chalks and limestones (or harder rocks generally), and only seen otherwise in coastal clay and peat.

The Thanet coast has been selected as a candidate Special Area of Conservation (SAC) because of its chalk caves and reef habitat (English Nature 1995); it also holds Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar status. The coast of Thanet is of considerable marine conservation significance, including the pioneering work carried out there by Anand (1937a, b, c) on the taxonomy and ecology of the algae of chalk cliffs (Fowler & Tittley 1993).

Chalk forms only 0.6% of the British coast. Thanet represents 12% of coastal chalk exposure in Europe and 20% of UK coastal chalk, and has the longest continuous stretch of coastal chalk in Britain (English Nature 1995). The Isle of Thanet also has a significant resource of chalk foreshore and subtidal reef creating a range of plant- and animal- characterised biotopes. The greatest proportion of European coastal chalk and many of the best examples of littoral habitats are located on the English coast; Britain therefore has an international responsibility for the conservation of these features (Fowler & Tittley 1993). Only a small proportion of the cliff coastline of Thanet provides suitable habitat for colonisation by cave and cliff inhabiting algae.

Aside from chalk habitats, The Isle of Thanet is also important in a national geographical and biogeographical context; it represents the last significant occurrence of intertidal and subtidal rocky reef on the eastern English coast for three hundred kilometres until the similar chalk headland at Flamborough in Yorkshire (minor outcrops of reef occur in Essex and Norfolk, but in total are less than 3km in extent). Thanet also represents the only major occurrence of rocky reef in the southern North Sea (the continental coast is sedimentary in nature like that of eastern England).

Only 5.9km (out of 23km) of Thanet chalk cave and cliff remain in a natural state (unprotected) and only a small proportion of this supports well-developed cave and cliff communities, and may be deemed threatened in both British and European contexts (Fowler & Tittley 1993). However, surveys of all the chalk cliff and cave areas in England (Tittley 1985, 1988)

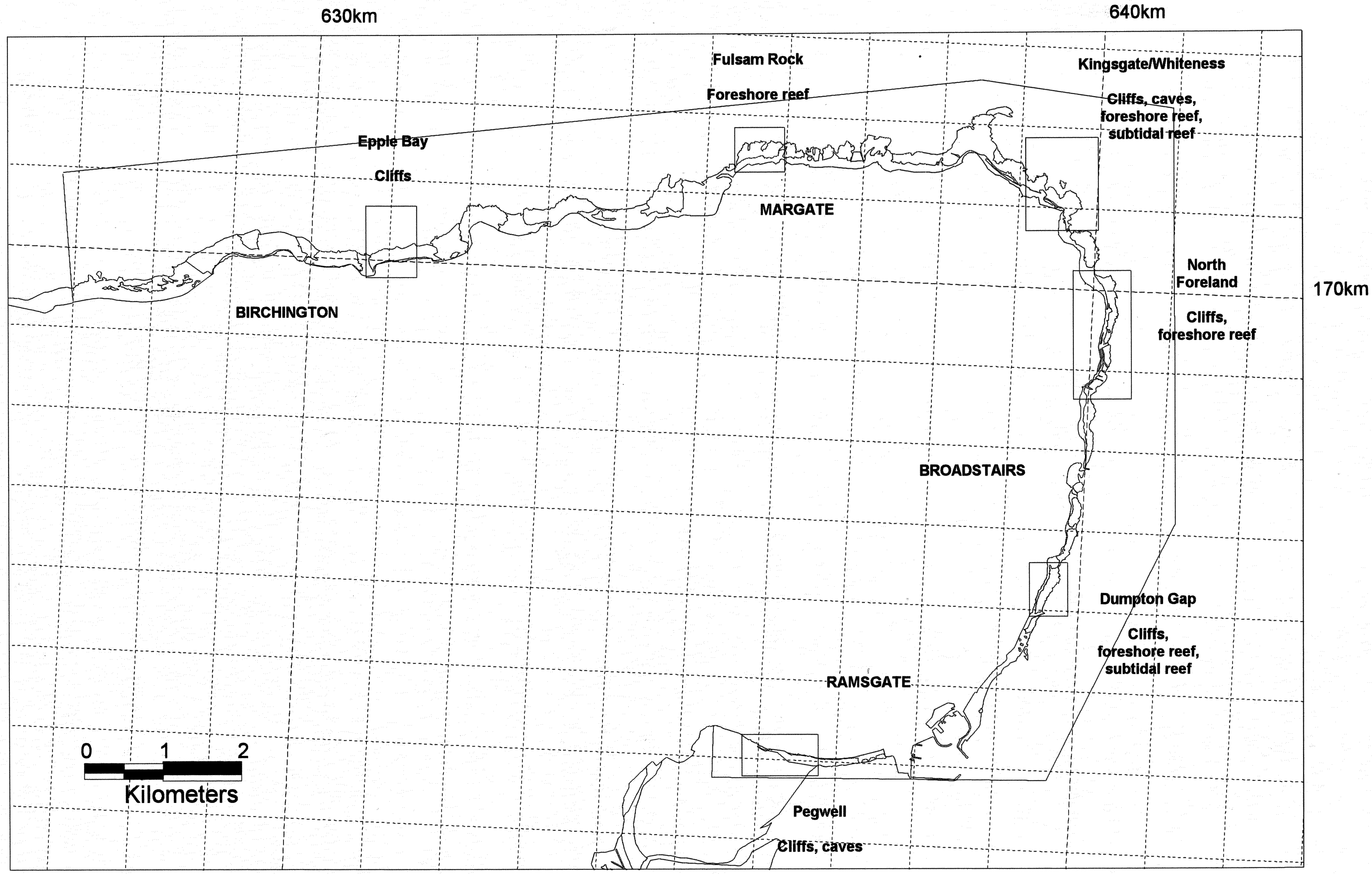


Figure 1 Sites of particular interest in the Thanet candidate SAC

showed the remaining cliffs on Thanet to still have an excellent diversity of species and range of habitats. The area (particularly at Birchington and Ramsgate/ Pegwell, see figure 1) is also of considerable importance as the type locality for genera and species of algae first described by Anand and as the classic locality for studies on the ecology of these communities.

## 1.2 Previous studies

The marine nature conservation importance of British coastal chalk cave and cliff habitats has been fully reviewed by Fowler & Tittley (1993); their extent on Thanet was mapped by Tittley (1985), and the structure and composition of associated algal communities at Thanet sites was analysed by Tittley & Shaw (1980). On Thanet, Tittley (1985) noted that the algal communities were by far the best developed at Epple Bay, from Botany Bay to Kingsgate Bay and at Pegwell Bay. The Epple Bay area represents the last remaining unprotected north-facing cliff coast with good open cliff habitat and communities, and is close to where Anand undertook his pioneer studies.

The foreshore reefs on Thanet have been the subject of study during the past two decades and are relatively well-known (see below); English Nature (1995) note the "...exceptional recorded history and continuity of marine research undertaken here...". A wealth of unpublished manuscript information, literature and specimen records for Thanet, particularly for the marine vegetation, allows the creation of a historical record for the past two centuries (Natural History Museum (NHM) unpublished sources; Price & Tittley 1972).

In addition to the studies of Anand, taxonomic, floristic and distributional information for the algal vegetation of the foreshore around Thanet hv been presented by Price & Tittley (1972) and Tittley & Price (1977). Tittley & Price (1978) presented an ecological assessment of the algal communities and George & Fincham (1989) the macro-invertebrate communities at several Thanet locations. Tittley *et al* (1986) undertook a comprehensive survey of the area for the Nature Conservancy Council and evaluated Thanet sites in the context of southeastern England generally. Fulsam Rock (see figure 1) was identified at this time as the most species-rich site on Thanet with a good range of communities typical of chalk foreshore reef. Tittley & George (unpublished) undertook Phase 2 habitat surveys in 1993 at Fulsam Rock, and also between Botany Bay and Kingsgate Bay (see figure 1) for the Marine Nature Conservation Review (MNCR) of the UK coast. George *et al* (in prep.) have also drafted an overview and biotope classification of chalk coasts in southeastern England, with many references to Thanet, as part of the MNCR.

A brief report on the Pegwell Bay area marine flora and fauna formed part of an environmental impact assessment for the Port Ramsgate terminal extension and road/rail link (Anon. 1986); Bennett (1986) undertook a similar study for NCC concerning nature conservation importance.

The subtidal chalk reefs on Thanet are less well-known; difficult conditions for diving (turbid waters with nil to low visibility, difficult sea and weather conditions) have restricted subtidal surveys. NHM holds late 1960s unpublished information for sublittoral algal flora at Botany 1985, 1988) Bay. Wood (1992) presented a brief account of the sublittoral (animal) biota at Botany Bay. In 1995 the extent of subtidal chalk reef habitats was established by an acoustic habitat mapping survey (Davies 1995). Acoustic data was ground-truthed by diving at 20 sites (Northen, in prep.) and with limited success by video at a number of other sites.

## 1.3 Aims

This report is for two contracted surveys let by English Nature (Survey of intertidal and cave chalk habitats in the Thanet Coast candidate SAC; Diving survey of subtidal biotopes within the Thanet candidate SAC).

In order to assist decision-making and develop a management scheme for the Thanet cSAC it was necessary to obtain further information on the intertidal and subtidal parts of the site. The following aims were identified for the surveys and are listed below. The data collected were used to make a relative conservation assessment, and for recommendations for management and monitoring. In general the level of information required for management is greater than that needed to identify the site as being important for conservation.

**Survey**

- To map location and extent of intertidal reef and cave habitats to biotope level.
- To collect detailed Phase 2/3 information from representative sites to support assessments and future monitoring.
- To use existing information, together with a rapid survey, to map the chalk intertidal habitats.
- To collect data to identify, together with previous ground truth data, the distribution and extent of subtidal chalk habitats.
- To provide detailed information, from subtidal sites surveyed, on the biotopes and species present incorporating data from a separate survey led by the MNCR to investigate further the area around the approach channel to Ramsgate Harbour.

**Management**

- To use the information to provide assessments of management requirements.
- To comment on issues relevant to management (eg changes in water chemistry and physical disturbance).

**Monitoring**

- To provide a baseline for monitoring and to make recommendations (including priority sampling sites) for a future monitoring programme which will report on the condition of habitats and changes from the baseline.

**Conservation**

- To use the information collected to assess the range and variation of biotopes across the candidate SAC, and to provide an assessment of relative conservation value in a local context and comment further on the interests in national context.

# 2 Methods

Previous information from a range of sources was reviewed and collated (see Introduction).

## 2.1 Intertidal field survey

Fieldwork was undertaken in August and September 1997 when day-length and time and height of low tide was most favourable; some winter and spring features of the fauna and flora were therefore not recorded.

### 2.1.1 Phase 1 survey

A phase 1 survey was undertaken which involved mapping intertidal chalk biotopes following the approach set out in *Marine Nature Conservation Review: Rationale and Methods* (Hiscock 1996). Biotopes were identified by direct observations following *Marine biotope classification for Britain and Ireland Volume 1. Littoral biotopes* (Connor *et al* 1997a). Comment is made in the report where biotopes could not be fully matched; we have also identified what we believe to be new biotopes and these are also described in the report.

Biotopes were assessed by walking the entire length of the Thanet coast, traversing the foreshore reef in a 'zig-zag' manner, thereby covering biotopes at all shore levels. The extents of biotopes were defined by eye and outlined on enlarged 1:10000 Ordnance Survey maps. Extensive reference field-notes were also compiled for checking biotope definitions. Biotopes occupying an area of less than 25m$^2$ (eg overhangs and small rockpools) were not mapped but noted as appropriate. Colour photographs of entire foreshore reefs were taken from suitable vantage points, and close-up pictures taken of individual biotopes.

Biological samples were collected in order to check the identity of some less well-known components of the biotopes. Sites identified during the Phase 1 survey as worthy of detailed examination were studied at Phase 2 and Phase 3 level. These were agreed with English Nature to be:

- chalk cave and cliff from Botany Bay to Kingsgate Bay
- foreshore reef at Fulsam Rock, Margate
- foreshore reef at Whiteness between Botany Bay and Whiteness, Kingsgate.

### 2.1.2 Cave and cliff survey

The cave and cliff habitats and communities along the section of coast from Botany Bay to Kingsgate Bay are particularly fine examples, particularly at Kingsgate (figure 3). Their condition was recorded by direct observations and by photography. Tittley (1985) noted that the caves at Kingsgate appeared to be stable and not eroding fast in contrast to those to the west of Ramsgate. The Kingsgate area was therefore reassessed to Phase 2 level because the remaining well-developed habitats and communities were in good condition. The Pegwell section of coast was not reassessed in the present survey.

### 2.1.3 Phase 2 survey

#### Caves and cliffs

Phase 2 studies in chalk caves and on cliff faces involved sampling along a line transect at 0.5m intervals from beach level to as high as could be reached safely. Samples were brought back to the

NHM for detailed identification (phase 3). A photographic record was made at sites investigated. MNCR site and detailed habitat recording forms were completed.

**Foreshore**

Two sites were selected for Phase 2/3 survey: Fulsam Rock and Whiteness. At Fulsam Rock the area selected for phase 2/3 study was located seaward of the first groyne east of Margate Harbour (grid ref. TR354715; figures 1 and 4) and traversed an area of foreshore reef at middle and lower eulittoral levels. A range of habitats and biotopes characteristic of Fulsam Rock was assessed, and included midlittoral rocky reef (MLR), rockpools (Rkp), overhangs (LR.Ov), lower littoral and sublittoral fringe reef (MLR), and shallow sublittoral fringe areas (MIR). Biotope descriptions were prepared for biotopes encountered at six study points at successively lower shore levels in the area. The second area selected for phase 2/3 study was located slightly to the west of Whiteness (towards Botany Bay) at grid ref. TR396700 (figure 5) and traversed an area of reef at middle and lower eulittoral levels. Comprehensive biological collections were made as appropriate for detailed identifications. A full species inventory was prepared for the overall area. MNCR site and detailed habitat recording forms were completed for selected individual biotopes and biotope aggregates (appendix 3).

## 2.2 Subtidal field survey

A review of the acoustic data for Thanet (Davies 1995) was undertaken, particularly in relation to the likely area of chalk, in order to target dive sites for further ground-truthing in 1997. With English Nature's agreement five transect sites were selected for study to give maximum coverage of the range of the chalk habitats identified previously (figure 6). Two of these, at Fulsam Rock and Whiteness, were intended as a continuation of the Phase 2/3 intertidal studies undertaken at these sites.

Subtidal surveying was carried out along these transects from a shore datum established at each coastal location. Adverse weather conditions prevented the fixing of the datum positions during our reconnaissance visit (4 August) so they were marked prior to diving with angle-iron stakes hammered into the seabed above ELWS tide level in order to ensure an overlap with the intertidal investigations.

At each transect site a non-floating reference line tagged with distance markers was laid on a previously calculated compass bearing, approximately at right angles to the coast. The line was laid by dive boat along the inner section of the transect from the shore datum for a distance of 100 metres. The reference line proved invaluable in a zone in which swell and extremely low underwater visibility provided difficult conditions for survey work. It was weighted at intervals and buoyed at distances of 50 and 100 metres from the shore. Stations were investigated at these positions, and at three sites (Epple Bay, Whiteness, and North Foreland) divers swam towards the shore datum from the 50 metre station to determine the seaward extent of the subtidal chalk close inshore.

The stations further offshore, at approximately 250 metres from the datum and at subsequent 250 metre intervals to the seaward boundary of the cSAC, were based on predetermined latitude/longitude positions along the same bearing. These were located during fieldwork using differential GPS.

Dives were carried out by a team of four divers on 12-15 August 1997. In total, 33 stations were investigated, but the number along each transect ranged from four to nine depending on the distance to the boundary of the cSAC. On each dive surveying was undertaken to Phase 2 level using the standard MNCR approach to fieldwork and recording (Hiscock 1996). The biotopes encountered were referenced to the latest MNCR sublittoral biotope manual (Connor *et al* 1997b).

Biological samples were taken for the determination of species for which *in situ* identification was uncertain. Some of these species were identified in the field laboratory and more difficult material was examined by specialists at NHM. A more comprehensive collection of biological material was made for groups of some smaller animals. These specimens were sorted, preserved and labelled for future identification if required.

The maps of the extent of subtidal chalk within the Thanet SAC (Davies 1995) were then reassessed using the data from 1997 in conjunction with existing information. 1997 data includes that from a joint survey of the approaches to Ramsgate harbour undertaken in September led by MNCR.

## 2.3 GIS digital mapping

Biotope maps drafted in the field were brought back to the Museum for checking and to delimit boundaries precisely. These maps were digitized using Mapinfo (English Nature's corporate standard software) in Windows 3.1 compatible format (cf English Nature's Generic specification for mappable digital data).

A baseline map was created using the OS 1:25,000 series for the area, this representing the most recent and consistent publication available. Alignment problems were encountered between the different sheets in the 1:10,000 maps over the same area. Additionally, these maps were revised at different times and thus omitted present coastal features.

Data were used to produce a summary map of the whole intertidal zone of the region. Maps were produced to show the 'higher level' MLR and LS categories using the MNCR standard colours in Connor *et al* (1997a).

Where possible, data were also processed to produce more detailed distributions, again using the standard MNCR colours but with shading and hatching to indicate the different biotopes. It was felt that the data when represented using the MNCR coding system remained difficult to distinguish. A second map was produced with different colours chosen to give a better clarity.

For the subtidal survey, maps were produced to show:

a) the MNCR (1995) survey stations and the biotopes recorded

b) the current survey stations (1997) and the biotopes recorded

c) the position, identity, and MNCR coded colours, of current survey stations (1997) together with those of the MNCR (1995) survey

d) current (1997) and MNCR (1995) survey stations with percentages of exposed chalk

e) all of the above with an overlay of Davies (1995) raster map of areas of similar acoustic characteristics.

The gap between our intertidal and the Davies raster map represented the inshore limit of the 1995 acoustic survey.

In using MapInfo, a number of difficulties were noted which, in some cases, were reported back to manufacturers. The most troublesome of these was the inability of the MapInfo supplied programme to produce accurate grids conforming to the UK Ordnance Survey coordinate system; a consistent displacement to the NE was noted. Other problems were encountered in the colour reproduction available in the printing process, although the on-screen representations were accurate. Colour selection here followed accurately the colour compositions of the Pantone system codes given in Connor *et al* (1997a). It was noted that the RGB annotations given in Connor *et al* (1997a) differed from those of the reference colours quoted. Furthermore, it was noted that in referencing raster image information to the mapping system for comparative purposes, it was the vector image information which became reorientated (cf deformed) to give the correct registration. The adjustment was allowed to persist in A4 maps in the absence of raster data in order to give a consistent appearance.

# 3 Results

This chapter is organised to reflect the two contract surveys let by English Nature. The first part deals with the intertidal survey, the second with the subtidal survey. Within these, descriptions (physical and biological) of the sites investigated in greater (phase 2/3) detail are presented, followed by a list of the biotopes recorded with technical comments on their composition and occurrence in Thanet. Maps showing location of study areas are included with the text; accompanying this report (appendix 2) is a collage of maps showing detailed occurrence and distribution of the main foreshore reef biotopes prepared from the field surveys. Mapped information on subtidal biotopes is included with the text.

The accompanying 1:10000 maps of foreshore reef biotopes comprise two A4 size collage series. The first is coloured according to the MNCR biotope mapping colours (Connor *et al* 1997a); much of the chalk foreshore therefore appears blue (as in figure 2) but with shading overlain to represent the biotopes. In the second series of maps, the colour code representing biotopes has been defined by NHM. Both maps are also supplied separately as A0 size (appendix 6), showing the entire coast of Thanet and its biotopes. The maps are also supplied on disk as digital data (appendix 7).

## 3.1 Intertidal survey

Figure 2 is a summary map of the whole intertidal area. It depicts the occurrence around Thanet of foreshore reef (MLR - see Connor *et al* 1997 for explanation of codes) and littoral sediments (LS), the 'higher levels' in the MNCR biotope classification. These are coloured following the MNCR colour scheme (blue - chalk reef; orange - sandy sediment; olive - muddy sediment). With the exception of Thanet's northwest and southwest extremities it comprises wave-cut platforms (foreshore reef), usually coinciding with higher cliffs and headlands. The latter are separated by sandy areas, coinciding with bays and low cliffs or valleys which descend to sea-level. In many areas a narrow sandy beach separated the cliff from foreshore. As stated elsewhere in this report 75% of the cliff coastline is built over; apart from the harbours at Margate, Broadstairs and Ramsgate, only small areas of foreshore are built over.

The survey recorded open lengths of cliff, caves and other geomorphological formations much as described by Fowler & Tittley (1993). At Botany Bay and Whiteness, as stated previously, the coastline remained more or less in a natural state with well-formed caves and tunnels. Considerable lengths of cliff were protected from the direct effects of the sea by a sandy beach. Small extents of coastal erosion were recorded at Epple Bay, usually at points of weakness where existing sea-wall structures were tied in to the cliffs; small cave-like structures have formed as a consequence. At another site the sea now re-enters a cave behind a length of wall. There has been little change to the chalk coastline between Kingsgate and Broadstairs, and south to Ramsgate. Natural cliff remains discontinuously in contact with the sea but there are no sea-caves. The coastline to the south and west of Ramsgate comprises open cliff and a series of caves. There has been considerable erosion to this section since the survey of the late 1980s with changes in the position and shape of caves. The extent of cliff with algal vegetation is shown in the accompanying collage of maps (appendix 2).

The survey revealed distinct biotopes on the cliffs and foreshore reefs (see accompanying maps in appendix 2). Some areas are bare of fauna and flora (MLR), others in wave-exposed areas are characterised by fauna and a low turf or stunted algae. Foreshores in more sheltered situations were characterised by extensive growths of algae, often as a deep canopy of large

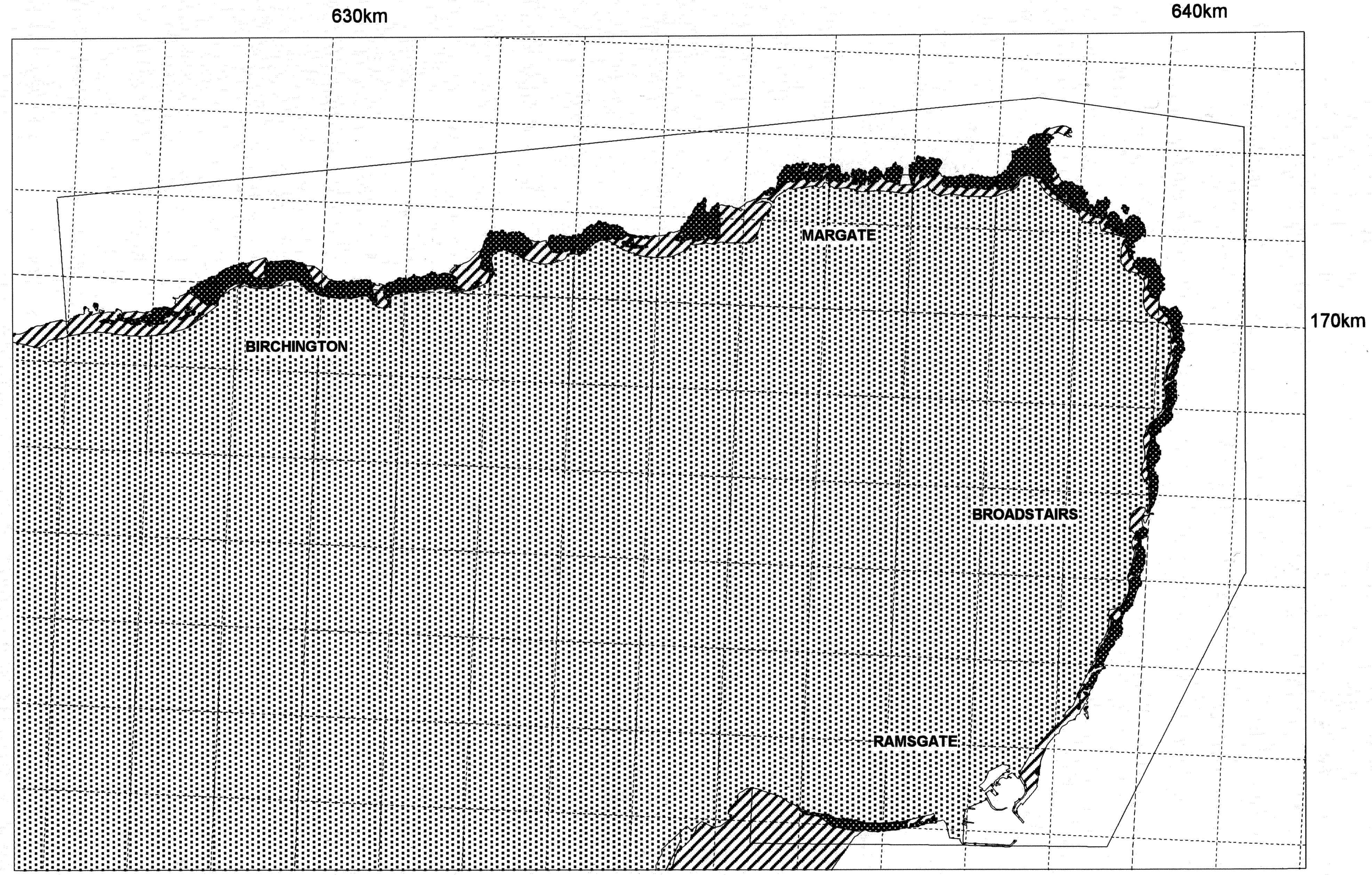


Figure 2. Map showing extent of chalk foreshore reef and the SAC boundary
chalk   Littoral gravels and sands   Littoral muddy sands

brown algae (fucoids and laminarians) over other smaller plants and animals. Other areas of foreshore were covered by extensive mussel beds. The invasive brown alga *Sargassum muticum* is now abundant in pools between Margate and Palm Bay. Chalk foreshore reef of Thanet is characteristically 'bored' by animals; *Polydora* 'borings' appear as fine pores, whilst piddock 'borings' form a honeycomb of large holes which often provide habitat for other small invertebrates. Detailed decriptions of foreshore reef biota at Fulsam Rock and Whiteness are presented below.

### 3.1.1 Description of sites

#### Caves and cliffs

The chalk cave and cliff habitats investigated at Kingsgate (figure 3) and Epple Bay supported communities of algae represented as coloured zones. These comprise:

- bright orange, gelatinous growths of *Chrysotila* spp. at high supralittoral (spray-zone) levels
- brown growths of *Apistonema carterae* at high water spring tide level, just above dense growths of green algae
- bright green growths of *Enteromorpha* and *Rhizoclonium* at 1-2m above beach level to high water spring tide level
- red/dark-red filamentous, filiform growths (various red algae) at the foot of cliffs on open faces
- red velvety growths of *Audouinella purpurea* on shaded cave walls
- golden brown velvety growths of *Pilinia maritima* on cave walls
- green closely adherent (stain-like) growths of *Pseudendoclonium* at high levels on cave walls and ceilings
- blue-green (Cyanobacteria = blue green algae) often gelatinous or filamentous growths on cave walls and ceilings.

The following are the results of the phase 2 survey primarily at Kingsgate but also at Epple Bay.

<u>Study site 1: Botany Bay cliffs</u>

| Height above beach level | Dominant species of zone |
|---|---|
| 3.0m upwards | Black patches - probably a fungus |
| 2.5m+ | *Apistonema carterae** |
| 2.0m+ | *Apistonema carterae** |
| 1.5m+ | *Rhizoclonium riparium* |
| 1.0m+ | *Enteromorpha prolifera* |
| 0.5m+ | *Fucus spiralis* |
| 0.0m+ | Bare abrasion zone |

Other species recorded: *Audouinella purpurea*, *Blidingia minima*, *Phymatolithon lenormandii*, *Pleurocapsa* sp., *Schizothrix mexicana*
* = LR.L Chr biotope component (see also below)

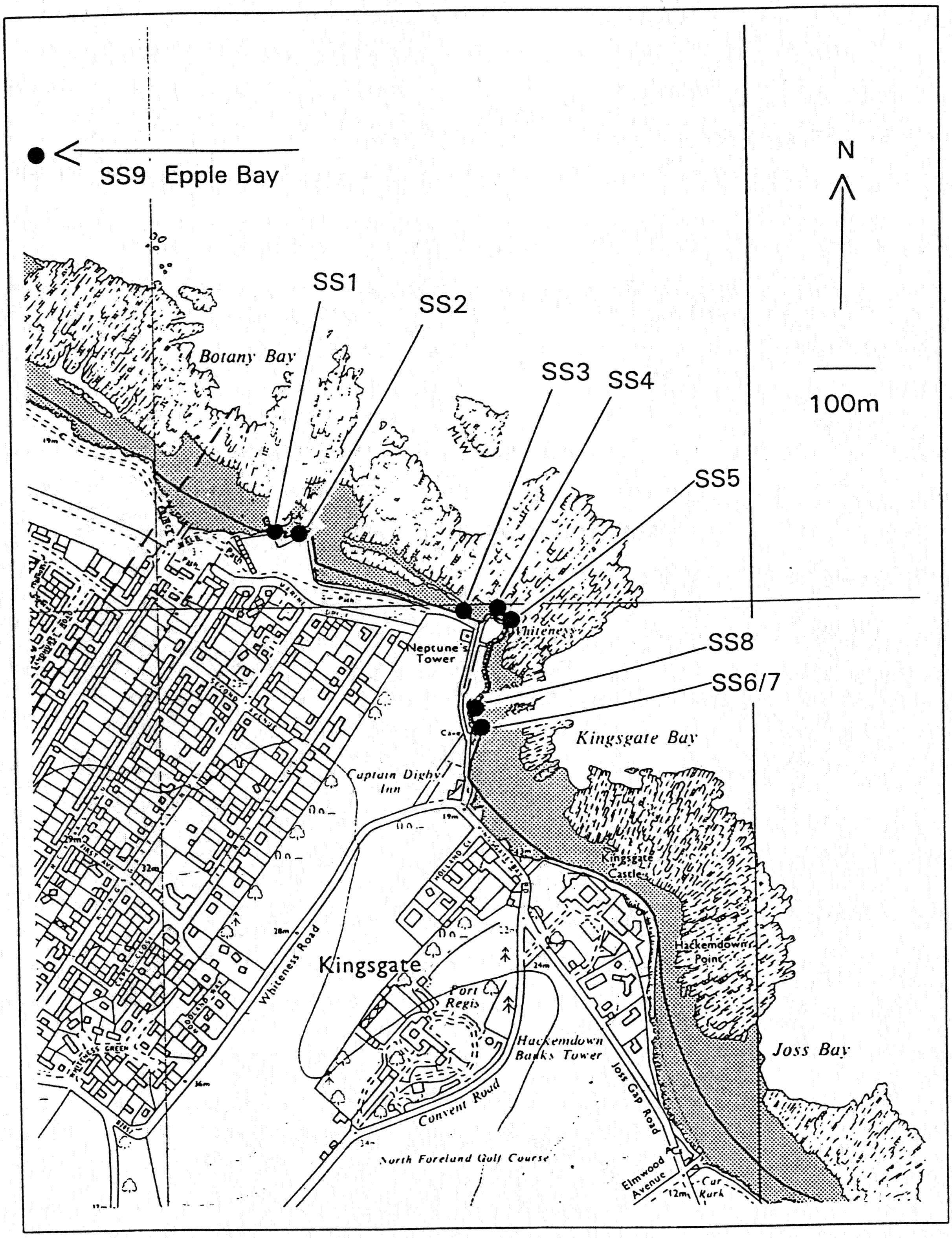


Figure 3. Chalk cave and cliff study sites at Kingsgate (Botany Bay, Whiteness, Kingsgate Bay).

Study site 2: Botany Bay

| | |
|---|---|
| 4.0m upwards | Black patches - probably a fungus |
| 3.5m+ | *Apistonema carterae** |
| 3.0m+ | *Apistonema carterae** |
| 2.5m+ | *Rhizoclonium riparium* |
| 2.0m+ | *Rhizoclonium riparium* |
| 1.5m+ | *Gelidium pusillum*, *Enteromorpha* spp. |
| 1.0m+ | *Gelidium pusillum*, *Enteromorpha* spp. |
| 0.5m+ | *Gelidium pusillum*, *Enteromorpha* spp. |
| 0.0m+ | *Fucus spiralis*, *Enteromorpha* spp. |

Other species recorded: the lichen *Arthropyrenia halodites* between 0 and 1m above beach level.

Study site 3: Cave near Whiteness

Species recorded:

| | |
|---|---|
| Inner cave supralittoral levels: | *Pseudendoclonium submarinum** *Chrysonema littorale**, *Epicladia perforans** |
| Outer cave supralittoral levels: | *Apistonema carterae**, *Enteromorpha prolifera*, *Epicladia perforans**, *Ruttnera litoralis** |
| Outer cave upper midlittoral levels: | *Aglaothamnion hookeri*, *Audouinella purpurea*, *Enteromorpha intestinalis*, *E. prolifera*, *Rhizoclonium riparium* |

Study site 4: Cliffs near Whiteness

Species recorded:

| | |
|---|---|
| Supralittoral levels: | *Apistonema carterae**, *Calothrix* sp.*, *Enteromorpha prolifera*, *Epicladia perforans** |
| High water spring tide level: | *Apistonema carterae**, *Enteromorpha compressa*, *E. intestinalis*, *E. prolifera* |

Study site 5: Whiteness archway

| | |
|---|---|
| 2.5m+ | *Pseudendoclonium submarinum**, *Apistonema carterae** |
| 2.0m+ | *Rhizoclonium riparium* |
| 1.5m+ | *Rhizoclonium riparium* |
| 1.0m+ | *Enteromorpha* spp. |
| 0.5m+ | *Fucus vesiculosus*, red algae |
| 0.0m+ | Abrasion zone with barnacles and limpets |

Study site 6: Kingsgate Bay - narrow cave (north/right side facing in)

| | |
|---|---|
| 2.5m+ | *Pseudendoclonium submarinum** |
| 2.0m+ | *Pseudendoclonium submarinum** |
| 1.5m+ | *Apistonema carterae**, *Epicladia perforans** |
| 1.0m+ | *Apistonema carterae**, *Epicladia perforans**<br>*Enteromorpha prolifera* |
| 0.5m+ | *Apistonema carterae**, *Epicladia perforans**, *Enteromorpha prolifera* |
| 0.0m+ | *Audouinella purpurea*, *Gelidium pusillum* |

Other species recorded: *Rhizoclonium riparium*, *Ruttnera litoralis**, *Schizothrix mexicana**, *Sphacelaria ?nana*

Study site 7: Kingsgate Bay - narrow cave (south/left side facing in)

| | |
|---|---|
| 4.0m+ | *Pseudendoclonium submarinum** |
| 3.5m+ | *Pseudendoclonium submarinum** |
| 3.0m+ | *Audouinella purpurea*, *Pilinia maritima* |
| 2.5m+ | *Audouinella purpurea*, *Pilinia maritima* |
| 2.0m+ | *Audouinella purpurea*, *Pilinia maritima* |
| 1.5m+ | *Audouinella purpurea*, *Pilinia maritima* |
| 1.0m+ | *Audouinella purpurea*, *Pilinia maritima* |
| 0.5m+ | *Audouinella purpurea* |
| 0.0m+ | *Audouinella purpurea* |

Other species recorded: *Enteromorpha prolifera*, *Rhizoclonium riparium*.

Study site 8: Kingsgate Bay - littoral fringe (*Chrysotila*) cave

| | |
|---|---|
| 4.0m+ | *Chrysotila lamellosa** |
| 3.5m+ | *Chrysotila lamellosa** |
| 3.0m+ | *Chrysotila lamellosa** |
| 2.5m+ | *Chrysotila lamellosa** |
| 2.0m+ | *Chrysotila lamellosa** |
| 1.5m+ | *Chrysotila lamellosa** |
| 0.5m+ | *Chrysotila lamellosa** |
| 0.0m+ | *Pseudendoclonium submarinum** |

Other species recorded: *Entophysalis deusta, Eucladium verticillatum* (Bryophyte), *Ruttnera ? maritima**

Study site 9: Epple Bay cliffs

| | |
|---|---|
| 3.0m+ | *Apistonema carterae** |
| 2.5m+ | *Apistonema carterae**, *Rhizoclonium riparium* |
| 2.0m+ | *Apistonema carterae**, *Rhizoclonium riparium* |
| 1.5m+ | *Enteromorpha* spp. |
| 1.0m+ | *Enteromorpha* spp., red algae |
| 0.5m+ | *Enteromorpha* spp., red algae, Fucus sp. |
| 0.0m+ | *Enteromorpha* spp., red algae, Fucus sp. |

Other species recorded: *Aglaothamnion hookeri, Audouinella purpurea, Gelidium pusillum.*

**Foreshore reef**

A general feature of the sea-shore ecology of Thanet is that upper-midlittoral communities tend to be compressed into narrow zones or bands at lower levels on cliff faces to form almost linear features, while lower-midlittoral and sublittoral fringe habitats and communities are often extensive over the foreshore reef. The gradual slope from high to low tide levels seen on sea-shores elsewhere does not occur on Thanet. Possibly as a consequence, chalk shores on Thanet lack the mid- to upper-littoral biotope-characterising (zone-forming) species *Pelvetia canaliculata* and *Ascophyllum nodosum* which are common on sea-shores elsewhere in Britain.

**Fulsam Rock** The site comprises an extensive intertidal foreshore reef which extends approximately 300m from the inshore limit to sublittoral fringe levels (figure 4). As with much of Thanet, the chalk cliffs which back the foreshore have long been occluded by coastal protection, promenade and other structures (NHM holds historical material which indicates that chalk cliffs were formerly in direct contact with the sea). Concurrent with the reconstruction of the sea-wall and change in coastal configuration adjacent to the harbour in

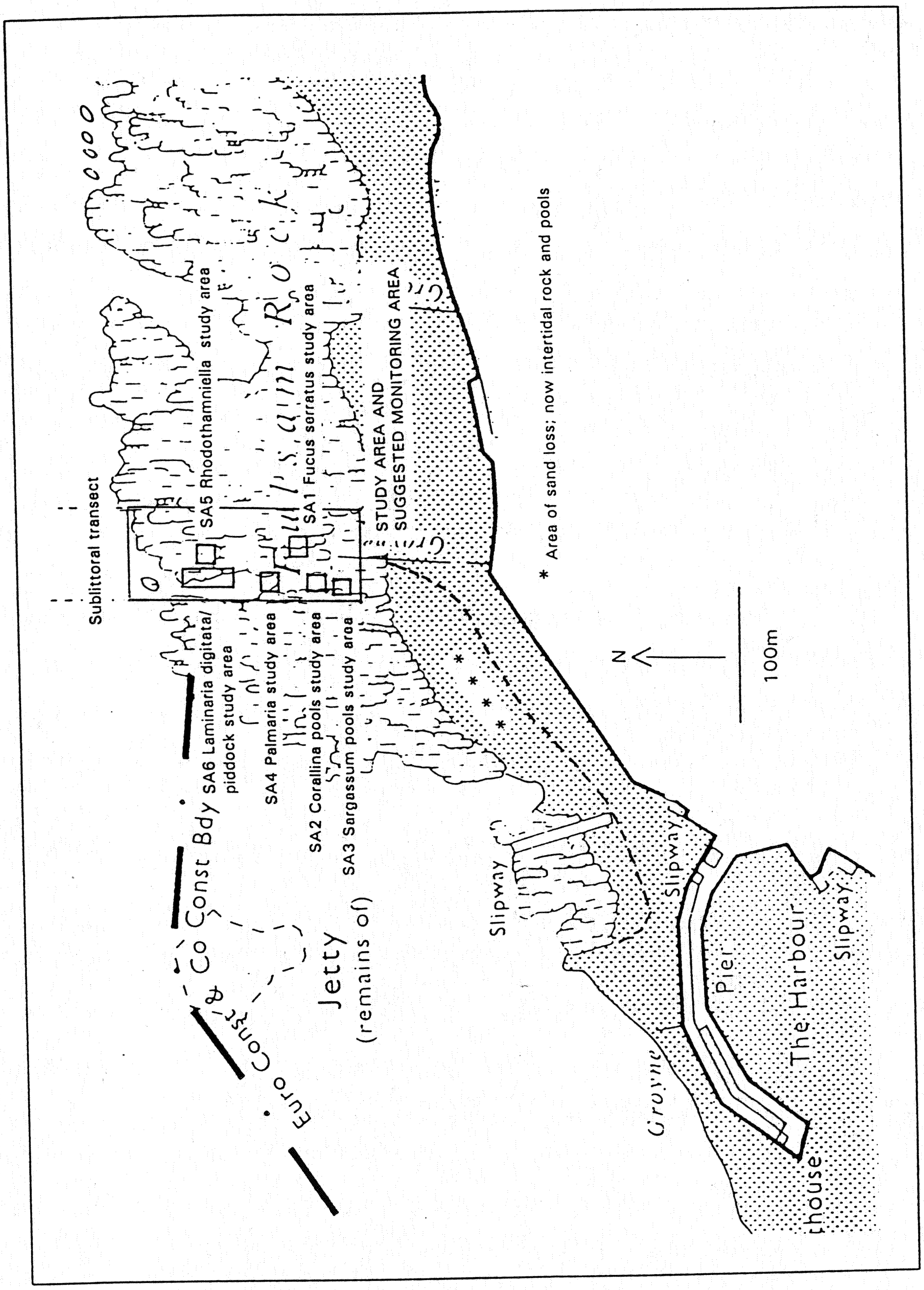


Figure 4. Fulsam Rock phase 2 survey site (study areas indicated).

the 1980s has been the loss of foreshore sandy beach and the exposure of larger areas of intertidal reef than are indicated on the 1: 10000 Ordnance Survey map.

The area for phase 2/3 study was located seaward of the first groyne east of Margate Harbour (grid ref. TR355716; figure 4), and traversed an area of foreshore reef at middle and lower littoral levels. Within this area several small study-areas were investigated in detail, and these formed a discontinuous transect down to sublittoral fringe levels. A range of habitats and biotopes was assessed; these included midlittoral rocky reef (MLR), Rockpools (Rkp) and lower littoral/sublittoral fringe reef and shallow sublittoral areas. A sublittoral transect study site lay adjacent to this area.

In the 1960s, Tittley & Price (NHM - unpublished) prepared an algal inventory for Fulsam Rock and completed an outline map of the principal algal communities for part of the Fulsam Rock area. Tittley *et al* (1986) and Tittley & George (1993 - unpublished data) provided ecological descriptions and MNCR assessement. Fulsam Rock was identified by Tittley *et al* (1986) as probably the best fucoid-covered shore on Thanet with canopy and underflora species well represented. Some rare species were present, but overall species richness was considered to be moderate.

Eight principal biotopes on foreshore reefs have been mapped in the Fulsam Rock area in the present survey. Other biotopes occupying smaller areas were also identified (eg *Corallina* rock pools). The principal biotopes were :

*Enteromorpha*-dominated reef
*Sargassum*-dominated pools and large areas of standing water (described below)
*Fucus serratus*-dominated reef (described below)
*Enteromorpha* on *Rhodothamniella floridula* turf over reef (described below)
*Palmaria*-dominated reef (described below)
Lower shore red algae over reef
*Ulva* on red algal turf over reef
*Laminaria digitata* over piddock-bored reef (described below).

A detailed species inventory was prepared for the site overall and this is presented below together with data from previous surveys (tables 1 and 3). Characterising and associated species for the principal biotopes are described below.

**SA (Study Area) 1 *Fucus serratus* canopy** (MLR.BF FSer)
The study area (SA 1) was located approximately 15m seaward of the navigation marker at the end of the groyne. *Fucus serratus* formed a locally dense canopy which covered chalk bored extensively by *Polydora* and towards the seaward extremity of the biotope also by several species of piddocks in considerable numbers. Adherent growths of the crustose coralline alga *Phymatolithon lenormandii* were a principal underflora component as was the sand-binding polychaete *Sabellaria spinulosa*. Patchy turfs of *Gelidium pusillum*, *Cladophora rupestris*, *Chondrus crispus*, *Cladostephus spongiosus*, *Corallina officinalis*, *Palmaria palmata* (very small plants) and *Ulva lactuca* were also present beneath the fucoid canopy. Several species of winkle (*Littorina littorea*, *L. obtusata*, *L. fabalis*) were seen on the rock surfaces or on the *Fucus* fronds. The crustose red alga *Hildenbrandia rubra* occurred on flints in shallow standing water as did calcareous tubeworms (*Pomatoceros lamarcki*, *P. triqueter*), barnacles (*Semibalanus balanoides*, *Elminius modestus*), the coat-of-mail shell *Lepidochitona cinerea*, and the limpet *Patella vulgata*. The sand-mason worm *Lanice conchilega* occupied sandy niches. The fucoid canopy provided habitats for epiphytes such as the filamentous brown alga *Pilayella littoralis* and various hydroids (particularly *Dynamena pumila*), spirorbid polychaetes (*Spirorbis spirorbis*, *S. corallinae*) and

bryozoans such as *Electra pilosa.* Crevices in the chalk beneath the seaweed canopy concealed sponges (*Halichondria panicea*), many species of errant polychaete and various crabs.

Open areas of chalk reef in the *Fucus serratus* canopy were patchily colonised by *Ulva lactuca, Chondrus crispus, Ceramium deslongchampii, Ceramium nodulosum, Osmundea pinnatifida* and *Polysiphonia fucoides*, species which are common and widely distributed in the Fulsam Rock area. Where turf-forming red algae grew in a mosaic with *Fucus serratus* on piddock- and *Polydora*-bored chalk it created the proposed variant sub-biotope MLR.BF Fser.R.Pid.

There were also open areas in the fucoid canopy where sand and sediment was bound by hummocky turfs of *Rhodothamniella floridula* (see also study area SA5 below); associated with the turf were *Ceramium flabelligerum, C. deslongchampii, Chondrus crispus*, occasional *Dictyota dichotoma, Gelidium pusillum, Halurus flosculosus* and occasional *Palmaria palmata.* Note also that this assemblage grew over piddock-bored rock.

**SA2 *Corallina* pools** (LR.Rkp Cor)
Foreshore reefs at Fulsam Rock and along the entire coast of Thanet bear rock pools of differing shapes, sizes and depths. Only the larger pools have been included in the Phase 1 biotope maps, and none are indicated for the Fulsam Rock area although they were commonly present. The area adjacent to the first groyne had many pools characterised by the coralline red alga *Corallina officinalis*. Such pools commonly contained anemones, hydroids, gastropods, amphipod, isopod and decapod crustaceans as well as the algae *Ceramium nodulosum, Chondrus crispus, Cystoclonium purpureum, Dictyota dichotoma, Fucus serratus, Phymatolithon lenormandii, Sargassum muticum* (juvenile plants), and *Ulva lactuca.* Algal species-richness differed from pool to pool.

**SA3 *Sargassum* pools** (LR.Rkp FK.Sar)
The invasive brown alga *Sargassum muticum* was first detected on the Isle of Thanet at Fulsam Rock in 1987. As the phase 1 biotope survey maps show, the species is now widespread in inshore pools and lagoons at Fulsam Rock. Deep (0.4m) pools in the study area commonly contained extensive *S. muticum* growths with 70-80% and sometimes 100% cover; plants measured 1.5m in length. A few pools contained 100% cover with little or no undergrowth. *Sargassum* has occupied pools which were formerly characterised by bushy growths of *Halidrys siliquosa*; the present survey recorded *Halidrys* as only occasionally present. Also present in the pools were *Chaetomorpha melagonium, Corallina officinalis, Cystoclonium purpureum, Fucus serratus, Laminaria digitata, Palmaria palmata, Polyides rotundus* and *Ulva lactuca. Halurus flosculosus* grew as an epiphyte on *Sargassum.* In terms of their invertebrate content the *Sargassum*-blanketed pools seemed to differ little from those dominated by other algae.

**SA4 *Palmaria*-dominated reef and lagoon areas** (MLR.R Pal)
This is an area of lower littoral reef and sandy-bottomed inlet with shallow standing water seaward of the groyne and marker, generally species-rich and containing several lower littoral biotopes. The margin of the lagoon and shallow standing water supports a dense, in places almost pure, stand of *Palmaria palmata.* Also present at the margins of the lagoon were the algae *Ceramium nodulosum, Chondrus crispus, Corallina officinalis* (abundant), *Cryptopleura ramosa, Dictyota dichotoma, Fucus serratus, Halurus flosculosus, Laminaria digitata, Polysiphonia fucoides, Sargassum muticum* (juvenile) and *Ulva lactuca.* The algae overlie piddock-bored chalk reef.

**SA5 *Rhodothamniella* turf/hummocks** (MLR.Eph Rho)
*Rhodothamniella floridula* turf is widespread over Fulsam Rock; in the study area, a well-formed turf occurred as a fringe along the margins of the lagoon/inlet referred to above. Associated algal species included, *Ceramium nodulosum*, *Chondrus crispus*, *Dictyota dichotoma*, *Halurus flosculosus*, *Osmundea pinnatifida*, *Palmaria palmata*, *Polysiphonia fucoides* and *Ulva lactuca*. As well as piddocks and *Polydora* the *Rhodothamniella* turf concealed the sipunculan *Golfingia minuta*, occasional anemones (*Sagartia troglodytes*), the polychaete *Perinereis cultrifera* amongst others, amphipods, isopods, crabs, the mussel *Mytilus edulis* and brittlestars (*Amphipholis squamata*). The algal assemblage grew over piddock and *Polydora*-bored chalk, with both forming tubes through the *Rhodothamniella* turf.

Elsewhere on Fulsam Rock this biotope was covered by an extensive summer bloom of the green algae *Enteromorpha* spp. and *Ulva lactuca*; thus the usually pink turf of *Rhodothamniella* appeared green in colour.

The biotope MLR.R XR was not studied in detail at Fulsam Rock in the present survey but is a distinct element of lower eulittoral biotopes. The biotope merges with MLR.BF Fser (see above) with the overlap resembling MLR.BF Fser.R and the variants that are characterised by piddock- and *Polydora*-bored rocks (see above).

**SA6 *Laminaria digitata* over piddock-bored chalk reef** (MIR.KR Ldig.Pid)
A distinct biotope characterised by small *Laminaria* plants over piddock-bored chalk. It contains red algal species (*eg Ceramium nodulosum*, *Cryptopleura ramosa*, *Cystoclonium purpureum*, *Halurus flosculosus*, *Membranoptera alata*, *Polysiphonia elongata*, *P. fucoides*, *Plocamium cartilagineum*, *Rhodomela confervoides*, *Rhodymenia holmesii*) largely restricted to lower littoral levels. The biotope extended into shallow subtidal levels; the diving survey revealed a similar gross structure to a few metres depth (see below).

This biotope contained the largest number of invertebrate species, especially sedentary crevice-dwellers. A frequent feature was deep gullies with vertical overhanging walls cut into the chalk platform. The piddocks honeycombing the chalk platform included *Pholas dactylus*, *Barnea candida*, *B. parva* and *Hiatella arctica*. The bivalve *Venerupis saxatilis* was present in the piddock burrows as well as the anemones *Sagartia troglodytes*, the crab *Pilumnus hirtellus* and various errant polychaetes (eg *Harmothoe* spp, *Nereis pelagica*). Old piddock burrows were frequently lined by thin crusts of sponges such as *Halichondria panicea* and *Microciona atrasanguinea* and several species of bryozoan. Dense concentrations of *Polydora* spp occurred in the top centimetre or two of the chalk. Kelp holdfasts were often coated by the sponge *Halichondria panicea* and encrusting bryozoans, and frequented by polychaetes (eg *Harmothoe* spp, *Nereis pelagica*, *Perinereis cultrifera*), amphipods, isopods, crabs and the brittlestars *Amphipholis squamata* and *Ophiothrix fragilis*. Under dark overhangs encrusting sponges (eg *H. panicea*, *Halisarca dujardini*, *Scypha ciliata*), hydroids (eg *Dynamena pumila*, *Eudendrium capillare*, *Plumularia setacea*, *Ventromma halecioides*), bryozoans (eg *Bugula* spp) and ascidians (*Botryllus schlosseri*, *Botrylloides leachi*, *Molgula manhattensis*) were often present. Mobile species such as *Cancer pagurus*, *Porcellana platycheles*, and the starfish *Asterias rubens* were also frequently recorded under overhangs.

**Whiteness - Botany Bay** The foreshore reefs at Botany Bay (Kingsgate) and adjacent reef areas have been surveyed several times. Tittley & Price (1978) reported especially rich marine algal communities at Botany Bay in the late 1960s and early 1970s. The richness of the foreshore reef, together with natural chalk cliff and cave coastline and well-developed communities was important in supporting designation of the area as an SSSI. The Botany Bay foreshore bore an extensive *Fucus* canopy and contrasted with the adjacent Whiteness foreshore reef which was characterised by patchy turfs of *Osmundea pinnatifida* and *Gelidium pusillum*, and also numerous *Corallina* rockpools.

The inshore fucoid canopy at Botany Bay has virtually disappeared and has been replaced by an extensive mussel bed and patchy turf of *Osmundea pinnatifida* and *Gelidium pusillum*. Species diversity may have decreased and the flora, particularly of the inshore reef, appears reduced. Nonetheless the present Phase 1 biotope survey recorded nine major biotopes.

An extensive and dense canopy of *Fucus* covers the foreshore reef between Botany Bay and Whiteness headland (Figure 5), and is representative of many Thanet foreshore reefs. The area was therefore selected for Phase 2/3 assessment; the landward backing of natural chalk cave and cliff was also a Phase 2/3 study site, and a sublittoral study site lay adjacently.

Seven biotopes are described below of which six are shown in the Phase 1 biotope survey maps; those not mapped occupied only a small (surface) area. Species recorded are listed in Tables 2 and 3.

**SA (Study Area) 1 *Fucus vesiculosus* canopy** (MLR.BF FvesB)
Inshore reefs adjacent to the sandy beach supported a canopy of the large brown alga *Fucus vesiculosus*. It was limited in extent and formed an almost linear feature. An understorey comprised chalk-boring blue-green algae (colouring the chalk pale-blue), crustose growths of *Phymatolithon lenormandii* and *Ralfsia* spp., turfy growths of *Gelidium pusillum* and *Enteromorpha* spp.

The beadlet anemone *Actinia equina* was a consistent occupant of this biotope as were various littorinid gastropods (*Littorina littorea, L. fabalis, L. obtusata, L. saxatilis*), the mussel *Mytilus edulis,* the coat-of-mail shell *Lepidochitona cinerea* and *Patella vulgata.* The dogwhelk *Nucella lapillus* was seen browsing on the barnacles *Semibalanus balanoides* and *Elminius modestus*, and the crab *Carcinus maenas* was found frequently on displacing the seaweed canopy, as were other crustaceans such as *Eulimnogammarus obtusatus, Jaera albifrons* and *Idotea granulosa.* The calcareous tubes of the keelworm *Pomatoceros lamarcki* were found embedded or under loose flints, and the green worm *Eulalia viridis* and the ragworm *Perinereis cultrifera* on breaking open the crevices in the chalk. Oligochaetes such as *Clitellio arenarius, Tubificoides benedeni* and *Grania* sp. occurred under stones embedded in muddy sand as did the nemerteans *Lineus ruber* and *L. viridis.* The lugworm *Arenicola marina* was present in patches of open sand.

**SA2 *Enteromorpha-Porphyra* cover** (MLR.Eph EntPor)
Mats of *Enteromorpha* with *Porphyra* covered the inshore fringe of the foreshore reef adjacent to the sandy beach and occupied sandy pools in which the anemone *Actinia equina* and the winkle *Littorina littorea* sometimes occurred. *Fucus vesiculosus* was occasionally present among the mat, as was *Rhodothamniella floridula.*

**SA3 *Fucus serratus* canopy** (MLR.BF Fser)
This fucoid canopy covered large areas of the foreshore reef from the landward fringe to lower littoral shore levels. It covered an understorey of algae and animals comprising many encrusting or crustose species. The crustose coralline *Phymatolithon lenormandii* was the most noticeable underflora species and formed an extensive purple-coloured layer over chalk; the encrusting *Sabellaria spinulosa* was also present together with the crustose brown alga *Ralfsia clavata,* the chalk-boring polychaete *Polydora,* piddocks, and chalk-boring blue-

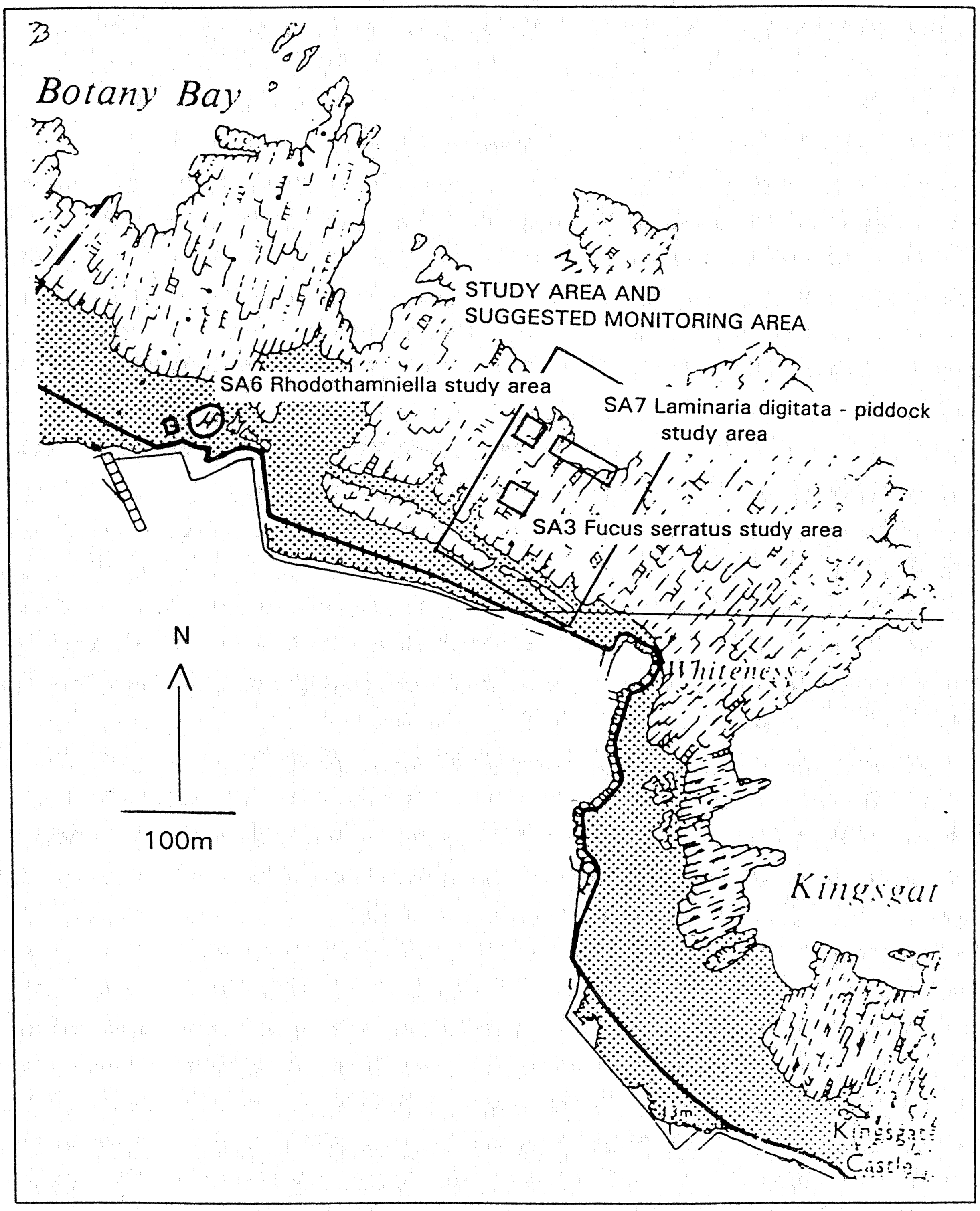


Figure 5. Whiteness phase 2 survey site ( three principal study areas indicated).

green algae. The lichen *Arthropyrenia halodites* was present as occasional pinkish patches. Other underflora species were *Cladophora rupestris, Gelidium pusillum*, and *Membranoptera alata. Patella vulgata* occurred most noticeably on flints; as did the barnacles *Semibalanus balanoides* and *Elminius modestus* and keelworms (*Pomatoceros* spp).

In general the invertebrate fauna found in this biotope at Whiteness was similar to that at Fulsam Rock, although less diverse particularly amongst the polychaete, crustacean, mollusc and bryozoan groups. The explanation is to be sought in the relative lack of deep sheltered overhangs and crevices at this level on the shore and the greater preponderance of sand surging up and down the gullies during the tidal cycle.

Gulley sides and overhangs carried abundant algal and sponge growths comprising: *Cladostephus spongiosus, Cladophora rupestris, Gelidium pusillum, Halichondria panicea, Lomentaria articulata, Phymatolithon lenormandii, Rhodothamniella floridula* and *Ulva lactuca.*

**SA4 *Corallina* rock-pools** (LR.Rkp Cor)
*Corallina* rock-pools were not as common as at Fulsam Rock on the foreshore reef. When present, the biotope comprised a species-rich assemblage of *Chondrus crispus, Cystoclonium purpureum, Dictyota dichotoma, Enteromorpha* spp., *Gelidium pusillum, Halurus equisetifolius, Palmaria palmata, Phymatolithon lenormandii, Rhodomela confervoides* and *Ulva lactuca. Ahnfeltia plicata, Hildenbrandia rubra* and *Ralfsia* spp. were found on flints only.

**SA5 Deep rock pools** (LR.Rkp FK)
Deep pools at lower littoral shore levels, which were present only rarely compared with Fulsam Rock, contained *Fucus serratus, Laminaria digitata, Corallina officinalis, Chondrus crispus, Palmaria palmata, Rhodomela confervoides*, and *Ulva lactuca.*

**SA6 *Rhodothamniella floridula* turf** (MLR.Eph Rho)
*Rhodothamniella* turf was extensive over lower littoral foreshore reefs between the *Fucus serratus* and *Laminaria digitata* biotopes. A variant of this biotope was characterised by an extensive cover of the green algae *Enteromorpha* and *Ulva.*

Constituent algal species of the biotope were: *Ceramium deslongchampii, C. flabelligerum, C. nodulosum, Chondrus crispus, Cladostephus spongiosus, Cladophora rupestris, Cystoclonium purpureum, Dictyota dichotoma, Fucus serratus, Gelidium pusillum, Halurus flosculosus, Lomentaria articulata, Osmundea pinnatifida, Palmaria palmata* and *Porphyra purpurea.* The high diversity of associated algal species suggests overlap with the mixed red algal biotope (MLR.R XR). Small pools/areas of standing water were occasionally present in the turf area and were characterised by the *Corallina* rockpool biotope.

The invertebrates present in the piddock- and *Polydora*- bored chalk beneath the turf and amongst its filaments were similar to those in the same biotope at Fulsam Rock. In this case, however, the Whiteness turf had a greater diversity of species than at Fulsam Rock, possibly reflecting the better development and stability of the turf than at Fulsam where less sand was generally in suspension during the tidal cycle. Species present and not recorded at Fulsam Rock in this biotope included the sponge *Mycale* aff *macilenta,* the anemone *Sagartia troglodytes,* the molluscs *Venerupis saxatilis* and *Petricola pholadiformis* and the pycnogonid *Achelia longipes.*

**SA7 *Laminaria digitata* over piddock-bored chalk reef** (MIR.KR LdigPid).
The sublittoral fringe (and deeper sublittoral areas) of the foreshore reef was characterised by this distinct kelp and piddock-dominated biotope which formed a continuous band from Botany Bay to Whiteness. The density of *Laminaria* plants was 20 - 30 per $m^2$ and plants grew to 1m in length (small in comparison to those on the harder rocky shores of western and northern Britain). Beds of *L.digitata* on Thanet are more extensive than on harder rocky shores elsewhere in Britain where *L. hyperborea* predominates. *Laminaria* stipes carried algal epiphytes, notably *Cystoclonium purpureum* and *Palmaria palmata*. The underflora comprised a scattering of *Palmaria palmata*, patches of *Phymatolithon lenormandii* and tufts of *Polysiphonia fucoides* and was generally poorer in species than the shoreward *Rhodothamniella* biotope. Animals present included *Asterias rubens*, *Lanice conchilega* (especially in accumulations of sediment), various gastropods and crustaceans and *Sabellaria spinulosa* (crust-forming over chalk).

There was a great similarity in faunal composition between this biotope at Whiteness and at Fulsam Rock, with the same species of piddock and *Polydora* honeycombing the chalk beneath the kelp canopy. Empty piddock burrows were often lined by thin films of sponge and colonial ascidians, and crusts of bryozoans, and occupied by the bivalve *Venerupis saxatilis*, some anemones (*Sagartia troglodytes*), crabs and polychaetes. As at Fulsam Rock, kelp holdfasts were a rich source of species of polychaete, amphipods, isopods, crabs, molluscs and bryozoans. Deep crevices and overhangs were less common than at Fulsam and consequently few crevice-loving sponges and hydroids were present. The biotope extended further seawards to shallow subtidal levels.

Table 1. Algal species recorded at Fulsam Rock.

| | 1966/9[1] | | 1986[2] | 1993[3] | | 1997[4] |
|---|---|---|---|---|---|---|
| **Green algae (Chlorophyta)** | | | | | | |
| *Blidingia minima* | | | + | | | |
| *Bryopsis plumosa* | + | | + | | | |
| *Chaetomorpha capillaris* | + | | | | | |
| *Chaetomorpha melagonium* | + | | + | | | |
| *Cladophora rupestris* | + | | + | + | | + |
| *Cladophora sericea* | + | | + | | | |
| *Enteromorpha compressa* | + | | | | | |
| *Enteromorpha intestinalis* | | | + | | | + |
| *Enteromorpha linza* | | | + | | | |
| *Enteromorpha prolifera* | | + | | | + | |
| *Enteromorpha torta* | | | + | | | |
| *Ulva lactuca* | + | | | + | | + |
| **Brown algae (Phaeophyta)** | | | | | | |
| *Cladostephus spongiosus* | + | | + | + | | + |
| *Dictyota dichotoma* | + | | | + | | + |
| *Elachista fucicola* | | | + | | | |
| *Fucus serratus* | + | | + | + | | + |
| *Fucus spiralis* | | | + | + | | |
| *Fucus vesiculosus* | + | | + | | | |
| *Halidrys siliquosa* | + | | + | + | | + |
| *Halopteris scoparia* | + | | + | | | |
| *Laminaria digitata* | + | | + | + | | + |
| *Laminaria saccharina* | + | | + | | | + |
| *Petalonia fascia* | | | + | | | |
| *Pilayella littoralis* | + | | + | | | + |
| *Ralfsia clavata* | | | + | | | |
| *Sargassum muticum* | - | | - | + | | + |
| *Spongonema tomentosum* | | | + | | | |
| **Red algae (Rhodophyta)** | | | | | | |
| *Aglaothamnion hookeri* | | | + | | | |
| *Ahnfeltia plicata* | + | | + | | | |
| *Audouinella purpurea* | | | + | | | |
| *Ceramium deslongchampii* | + | | + | | | + |
| *Ceramium flabelligerum* | + | | | + | | + |
| *Ceramium nodulosum* | + | | + | + | | + |
| *Chondria dasyphylla* | | 80s | | | | |
| *Chondrus crispus* | + | | + | + | | + |
| *Corallina officinalis* | + | | + | | | + |
| *Cryptopleura ramosa* | + | | | + | | + |
| *Cystoclonium purpureum* | + | | + | + | | + |
| *Dumontia contorta* | + | | | | | |
| *Furcellaria fastigiata* | + | | | | | |
| *Gelidium pusillum* | + | | + | + | | |
| *Halurus flosculosus* | + | | | + | | + |

| | | | | |
|---|---|---|---|---|
| *Heterosiphonia plumosa* | | + | | |
| *Hildenbrnadia rubra* | | + | | |
| *Lomentaria articulata* | | + | | |
| *Mastocarpus stellatus* | + | | | |
| *Membranoptera alata* | + | | + | + |
| *Osmundea hybrida* | + | | | |
| *Osmundea pinnatifida* | + | | + | + |
| *Palmaria palmata* | + | + | + | + |
| *Phymatolithon lenormandii* | + | + | | + |
| *Phymatolithon purpureum* | | | + | |
| *Plocamium cartilagineum* | | | + | + |
| *Polyides rotundus* | + | | | |
| *Polysiphonia elongata* | | | | + |
| *Polysiphonia fucoides* | + | + | + | + |
| *Porphyra purpurea* | + | + | | |
| *Rhodomela confervoides* | | | | + |
| *Rhodothamniella floridula* | + | + | + | + |
| *Rhodymenia holmesii* | | | | + |

Data sources

1 = NHM 1960s data
2 = Tittley et al (1986)
3 = MNCR survey (Tittley & George, unpublished)
4 = Present survey

Table 2. Algal species recorded at Botany Bay and Whiteness.

| | 1966/9[1] | | 1986[2] | 1993[3] | 1997[4] |
|---|---|---|---|---|---|
| <u>Green algae (Chlorophyta)</u> | | | | | |
| *Blidingia minima* | + | | + | | |
| *Bryopsis plumosa* | + | | + | | |
| *Chaetomorpha mediterranea* | + | W | | | |
| *Chaetomorpha melagonium* | + | | + | | |
| *Cladophora sericea* | + | W | + | | |
| *Cladophora rupestris* | + | | + | + | + |
| *Codiolum polyrhizum* | | W | | | |
| *Enteromorpha clathrata* | + | | | | |
| *Enteromorpha compressa* | + | | | | + |
| *Enteromorpha intestinalis* | + | | + | | |
| *Enteromorpha linza* | + | | + | | |
| *Enteromorpha prolifera* | + | | + | | |
| *Enteromorpha torta* | | | + | | |
| *Entocladia perforans* | + | | | | |
| *Eugomontia sacculata* | | W | | | |
| *Percursaria percursa* | + | | | | |
| *Pringsheimiella scutata* | + | | | | |
| *Pseudendoclonium submarinum* | | | | + | |
| *Rhizoclonium riparium* | + | | | | |
| *Ulothrix* spp. | + | | | | |
| *Ulva lactuca* | + | | + | + | + |
| *Urospora penicilliformis* | | | + | | |
| <u>Brown algae (Phaeophyta)</u> | | | | | |
| *Acinetospora crinata* | + | | | | |
| *Cladostephus spongiosus* | + | | + | | + |
| *Dictyota dichotoma* | + | | + | + | + |
| *Ectocarpus siliculosus* | + | | + | | |
| *Elachista fucicola* | + | | + | | + |
| *Fucus serratus* | + | | + | + | + |
| *Fucus spiralis* | + | | | | |
| *Fucus vesiculosus* | + | | + | + | + |
| *Giffordia granulosa* | | | + | | |
| *Halidrys siliquosa* | + | | + | + | |
| *Laminaria digitata* | + | | + | + | + |
| *Laminaria saccharina* | + | | + | | + |
| *Myrionema strangulans* | + | | | | |
| *Petalonia fascia* | + | | + | | |
| *Pilayella littoralis* | + | | + | + | |
| *Pilinia maritima* | | | | + | |
| *Ralfsia clavata* | + | | + | | + |
| *Ralfsia verrucosa* | + | | + | | |
| *Sphacelaria fusca* | + | | | | |
| *Sphacelaria nana* | + | | | | |
| *Sphacelaria plumosa* | + | | | | |
| *Taonia atomaria* | + | | | | |

| | | | | | |
|---|---|---|---|---|---|
| *Ulonema rhizophora* | + | | | | |
| <u>Red algae (Rhodophyta)</u> | | | | | |
| *Aglaothamnion hookeri* | + | | + | | |
| *Ahnfeltia plicata* | + | | | + | + |
| *Audouinella daviesii* | | W | | | |
| *Audouinella floridula* | + | | + | + | + |
| *Audouinella purpurea* | + | | | + | |
| *Audouinella secundata* | + | | | | |
| *Audouinella virgatula* | | | + | | |
| *Bangia fuscopurpurea* | + | | | | |
| *Catenella caespitosa* | | | | + | |
| *Ceramium deslongchampii* | + | | + | + | + |
| *Ceramium flabelligerum* | + | W | + | + | + |
| *Ceramium nodulosum* | + | | + | + | + |
| *Chondrus crispus* | + | W | + | + | + |
| *Corallina officinalis* | + | W | + | + | + |
| *Cryptopleura ramosa* | + | | + | | |
| *Cystoclonium purpureum* | + | | + | + | + |
| *Dumontia contorta* | + | W | | + | |
| *Furcellaria fastigiata* | + | W | | | |
| *Gelidium pusillum* | + | | + | + | + |
| *Gracilaria gracilarioides* | + | W | + | | |
| *Halurus flosculosus* | + | W | | + | + |
| *Hildenbrandia rubra* | + | W | + | | + |
| *Hypoglossum hypoglossoides* | + | | | | |
| *Lomentaria articulata* | | W | + | | + |
| *Mastocarpus* stellatus | + | | | | |
| *Membranoptera alata* | + | | | | + |
| *Osmundea hybrida* | + | | + | + | |
| *Osmundea pinnatifida* | + | W | + | + | + |
| *Palmaria palmata* | + | W | + | + | + |
| *Phymatolithon lenormandii* | + | | + | + | + |
| *Phyllophora pseudoceranoides* | + | | | | |
| *Plocamium cartilagineum* | + | | + | | |
| *Polyides rotundus* | + | | | + | |
| *Polysiphonia atlantica* | + | | | | |
| *Polysiphonia fucoides* | + | W | + | + | + |
| *Polysiphonia nigra* | + | | | | + |
| *Porphyra leucosticta* | + | | | | |
| *Porphyra linearis* | + | | | | |
| *Porphyra purpurea* | + | | + | | |
| *Porphyra umbilicalis* | + | W | + | | |
| *Rhodomela confervoides* | + | | | | + |
| *Rhodymenia nicaeensis* | + | | | | |
| <u>Others</u> | | | | | |
| *Athropyrenia halodites* | + | | + | + | + |
| *Apistonema carterae* | | | | + | + |
| *Chrysotila lamellosa* | | | | + | + |
| *Ruttnera litoralis* | | | | | + |

W = Whiteness data
1 = NHM 1960s data
2 = Tittley et al (1986)
3 = MNCR survey (Tittley & George, unpublished)
4 = present survey

Table 3. Fauna recorded at Fulsam Rock and Whiteness.

| | | | Fulsam Rock | | Whiteness | |
|---|---|---|---|---|---|---|
| | | | 1986 | 1997 | 1986 | 1997 |
| PORIFERA | | | | | | |
| *Leucosolenia* | sp.indet. | | - | + | - | + |
| *Scypha* | *ciliata* | (Fabricius, 1780) | + | + | + | - |
| *Grantia* | *compressa* | (Fabricius, 1780) | + | - | + | - |
| *Halichondria* | *panicea* | (Pallas, 1766) | + | + | + | + |
| *Hymeniacidon* | *perleve* | (Montagu, 1818) | + | + | + | + |
| *Mycale* | *aff.macilenta* | (Bowerbank, 1866) | - | - | - | + |
| *Microciona* | *atrasanguinea* | Bowerbank, 1862 | + | + | - | + |
| *Haliclona* | *rava* | (Stephens, 1912) | - | + | - | - |
| *Dysidea* | *fragilis* | (Montagu, 1818) | - | + | - | - |
| *Halisarca* | *dujardini* | Johnston, 1842 | - | + | - | + |
| COELENTERATA | | | | | | |
| *Coryne* | *muscoides* | (Linnaeus) | - | + | - | - |
| *Eudendrium* | *capillare* | Alder, 1857 | - | + | - | - |
| *Nemertesia* | *antennina* | (Linnaeus, 1758) | - | - | + | - |
| *Plumularia* | *setacea* | (Linnaeus, 1758) | - | + | + | + |
| *Ventromma* | *halecioides* | (Alder, 1859) | - | + | + | + |
| *Dynamena* | *pumila* | (Linnaeus, 1758) | + | + | + | + |
| *Sertularella* | *gaudichaudi* | (Lamouroux, 1824) | + | + | - | + |
| *Sertularia* | *argentea* | Linnaeus, 1758 | - | - | - | + |
| *Tridentata* | *distans* | (Lamouroux, 1816) | - | - | - | + |
| *Obelia* | *longissima* | (Pallas, 1766) | + | - | - | - |
| campanulariid | | | - | - | + | - |
| *Actinia* | *equina* | (Linnaeus, 1758) | + | + | + | + |
| *Actinia* | *fragacea* | Tugwell, 1856 | + | + | + | + |
| *Actinia* | *felina* | (Linnaeus, 1761) | + | + | - | + |
| *Metridium* | *senile* | (Linnaeus, 1761) | + | - | + | - |
| *Sagartia* | *elegans* | (Dalyell, 1848) | + | - | + | - |
| *Sagartia* | *troglodytes* | (Price, in Johnston, 1847) | + | + | + | + |
| *Cereus* | *pedunculatus* | (Pennant, 1777) | + | - | - | - |
| PLATYHELMINTHES | | | | | | |
| *Leptoplana* | *tremellaris* | (O.F. Muller, 1774) | - | - | - | + |

| | | | Fulsam Rock | | Whiteness | |
|---|---|---|---|---|---|---|
| | | | 1986 | 1997 | 1986 | 1997 |
| NEMERTEA | | | | | | |
| *Lineus* | *ruber* | (O.F. Muller, 1774) | + | + | + | + |
| *Lineus* | *viridis* | (O.F. Muller, 1774) | - | - | + | + |
| nemertean | | | - | + | - | - |
| NEMATODA | | | | | | |
| nematodes | | | - | + | - | - |
| ENTOPROCTA | | | | | | |
| *Barentsia* | *gracilis* | (M.Sars, 1835) | - | + | - | + |
| *Pedicellina* | *cernua* | (Pallas, 1771) | - | + | - | - |
| SIPUNCULA | | | | | | |
| *Golfingia* | *minuta* | (Keferstein, 1862) | + | + | + | + |
| ANNELIDA | | | | | | |
| | POLYCHAETA | | | | | |
| *Harmothoe* | *extenuata* | (Grube, 1840) | + | + | - | + |
| *Harmothoe* | *fraserthomsoni* | McIntosh, 1897 | + | - | - | - |
| *Harmothoe* | *imbricata* | (Linnaeus, 1767) | - | - | + | - |
| *Harmothoe* | *impar* | (Johnston, 1839) | - | + | - | - |
| *Harmothoe* | sp.indet | | - | + | - | + |
| *Lepidonotus* | *squamatus* | (Linnaeus, 1758) | + | + | + | + |
| *Pholoe* | *inornata* | Johnston, 1839 | - | - | + | - |
| *Pholoe* | *synophthalmica* | Claparede, 1868 | - | + | - | + |
| *Sthenelais* | *boa* | (Johnston, 1833) | - | + | + | + |
| *Eteone* | *flava* | (Fabricius, 1780) | - | + | - | - |
| *Mysta* | *picta* | (Quatrefages, 1866) | - | + | - | - |
| *Eulalia* | *bilineata* | (Johnston, 1840) | - | - | - | + |
| *Eulalia* | *expusilla* | Pleijel, 1987 | - | + | - | - |
| *Eulalia* | *viridis* | (Linnaeus, 1767) | - | + | + | + |
| *Eulalia* | *ornata* | Saint-Joseph, 1888 | - | + | - | + |
| *Eumida* | *sanguinea* | (Oersted, 1843) | - | + | - | + |
| *Phyllodoce* | *maculata* | (Linnaeus, 1767) | - | + | - | - |
| *Glycera* | sp.indet | | - | - | - | + |
| *Kefersteinia* | *cirrata* | (Keferstein, 1863) | - | + | - | + |
| *Syllidia* | *armata* | Quatrefages, 1865 | - | + | - | + |
| *Syllis* | *gracilis* | Grube, 1840 | + | + | + | + |
| *Typosyllis* | *armillaris* | (O.F. Muller, 1771) | - | + | - | + |

| | | | Fulsam Rock 1986 | Fulsam Rock 1997 | Whiteness 1986 | Whiteness 1997 |
|---|---|---|---|---|---|---|
| *Typosyllis* | *hyalina* | (Grube, 1863) | – | + | – | + |
| eusyllinid | | | - | + | - | + |
| *Brania* | *limbata* | (Claparede, 1868) | - | - | - | + |
| *Exogone* | *dispar* | (Webster, 1879) | - | + | - | - |
| *Exogone* | sp.indet | | - | + | - | - |
| *Sphaerosyllis* | *erinaceus* | Claparede, 1863 | - | - | - | + |
| *Sphaerosyllis* | *hystrix* | Claparede, 1863 | - | - | - | + |
| *Autolytus* | sp. indet. | | - | + | - | + |
| *Proceraea* | *picta* | Ehlers, 1864 | - | - | - | + |
| *Nereis* | *pelagica* | (Linnaeus, 1758) | + | + | + | + |
| *Perinereis* | *cultrifera* | (Grube, 1840) | + | + | + | + |
| *Websterinereis* | *glauca* | Pettibone, 1871 | - | + | - | - |
| *Marphysa* | *sanguinea* | (Montagu, 1815) | - | + | - | - |
| *Protodorvillea* | *kefersteini* | (McIntosh, 1869) | - | + | - | - |
| *Aonides* | *oxycephala* | (M. Sars, 1862) | - | + | - | - |
| *Boccardia* | *polybranchia* | (Haswell, 1885) | - | - | - | + |
| *Malacoceros* | *tetracerus* | (Schmarda, 1861) | - | - | - | + |
| *Polydora* | *caeca* | (Oersted, 1843) | - | + | - | + |
| *Polydora* | *caulleryi* | Mesnil, 1897 | - | + | - | + |
| *Polydora* | *ciliata* | (Johnston, 1838) | + | + | + | + |
| *Polydora* | *limicola* | Annekova, 1934 | - | + | - | - |
| *Pygospio* | *elegans* | Claparede, 1863 | - | - | - | + |
| *Cirratulus* | *cirratus* | (O.F. Muller, 1776) | - | - | + | - |
| *Cirriformia* | *tentaculata* | (Montagu, 1808) | + | + | + | + |
| *Dodecaceria* | *concharum* | (Oersted, 1843) | - | + | - | + |
| *Tharyx* | *marioni* | (Saint-Joseph, 1894) | - | + | - | - |
| *Capitella* | *capitata* | (Fabricius, 1780) | - | - | - | + |
| *Capitomastus* | *minimus* | (Langerhans, 1880) | - | + | - | - |
| *Arenicola* | *marina* | (Linnaeus, 1767) | + | + | + | + |
| maldanid | | | - | - | - | + |
| *Nicomache* | *personata* | Johnson, 1901 | - | + | - | - |
| *Nicomache* | *trispinata* | Arwidsson, 1906 | - | + | - | - |
| *Owenia* | *fusiformis* | Chiaje, 1842 | - | - | - | + |
| *Sabellaria* | *spinulosa* | Leuckart, 1849 | + | + | + | + |
| *Amphicteis* | *gunneri* | (M. Sars, 1835) | - | - | - | + |
| *Amphitritides* | *gracilis* | (Grube, 1860) | - | + | - | - |
| *Axionice* | *maculata* | (Dalyell, 1853) | - | + | - | + |
| *Lanice* | *conchilega* | (Pallas, 1766) | + | + | + | + |
| *Neoamphritrite* | *figulus* | (Dalyell, 1853) | - | + | + | - |
| *Nicolea* | *venustula* | (Montagu, 1818) | - | + | - | + |
| *Nicolea* | *zostericola* | (Oersted, 1844) | + | + | - | - |
| *Phisidia* | *aurea* | Southward, 1956 | - | + | - | - |
| *Polycirrus* | sp.indet | | - | + | - | + |

| | | | Fulsam Rock 1986 | Fulsam Rock 1997 | Whiteness 1986 | Whiteness 1997 |
|---|---|---|---|---|---|---|
| *Fabricia* | *sabella* | (Ehrenberg, 1837) | - | - | - | + |
| *Pomatoceros* | *lamarcki* | (Quatrefages, 1865) | + | + | + | + |
| *Pomatoceros* | *triqueter* | (Linnaeus, 1758) | - | + | - | + |
| *Spirorbis* | *corallinae* | de Silva & Knight-Jones, 1962 | - | + | + | + |
| *Spirorbis* | *inornatus* | L'Hardy & Quievreux, 1962 | - | + | - | - |
| *Spirorbis* | *spirorbis* | (Linnaeus, 1758) | + | + | + | + |
| | OLIGOCHAETA | | | | | |
| *Clitellio* | *arenarius* | (O.F.Muller, 1776) | - | - | + | + |
| *Tubificoides* | *benedeni* | (Udekem, 1855) | + | + | + | + |
| *Grania* | sp.indet | | - | - | + | + |
| PYCNOGONIDA | | | | | | |
| *Nymphon* | *brevirostre* | Hodge, 1863 | + | + | + | + |
| *Nymphon* | *gracile* | Leach, 1814 | - | + | - | + |
| *Achelia* | *echinata* | Hodge, 1864 | - | + | - | + |
| *Achelia* | *longipes* | (Hodge, 1864) | - | + | - | + |
| *Endeis* | *spinosa* | (Montagu, 1808) | - | + | - | - |
| *Callipallene* | *brevirostris* | (Johnston, 1837) | - | + | - | + |
| *Anoplodactylus* | *virescens* | (Hodge, 1864) | - | + | - | + |
| *Phoxichilidium* | *femoratum* | (Rathke, 1799) | - | + | - | - |
| CRUSTACEA | | | | | | |
| | CIRRIPEDIA | | | | | |
| *Verruca* | *stroemia* | (O.F. Muller, 1776) | - | + | - | - |
| *Semibalanus* | *balanoides* | (Linnaeus, 1767) | + | + | + | + |
| *Balanus* | *crenatus* | Bruguiere, 1789 | - | + | - | + |
| *Elminius* | *modestus* | Darwin, 1854 | + | + | + | + |
| | AMPHIPODA | | | | | |
| *Apherusa* | *bispinosa* | (Bate, 1856) | + | - | + | - |
| *Apherusa* | *jurinei* | (Milne Edwards, 1830) | - | - | + | - |
| *Calliopius* | *laeviusculus* | (Kroyer, 1838) | - | - | + | + |
| *Talitrus* | *saltator* | (Montagu, 1808) | - | - | + | - |
| *Atylus* | *guttatus* | (Costa, 1851) | + | - | + | - |
| *Atylus* | *swammerdami* | (Milne Edwards, 1830) | + | - | - | - |
| *Dexamine* | *spinosa* | (Montagu, 1813) | - | + | - | + |
| *Dexamine* | *thea* | Boeck, 1861 | + | + | + | + |
| *Tritaeta* | *gibbosa* | (Bate, 1862) | + | + | + | + |
| *Bathyporeia* | *sarsi* | Watkin, 1938 | - | - | + | - |
| *Eulimnogammarus* | *obtusatus* | (Dahl, 1938) | - | - | - | + |

| | | | Fulsam Rock | | Whiteness | |
|---|---|---|---|---|---|---|
| | | | 1986 | 1997 | 1986 | 1997 |
| *Gammarus* | *locusta* | (Linnaeus, 1758) | - | + | + | + |
| *Melita* | *palmata* | (Montagu, 1804) | - | - | - | + |
| *Jassa* | *falcata* | (Montagu, 1808) | + | + | + | + |
| *Jassa* | *marmorata* | S.J. Holmes, 1903 | - | + | - | + |
| *Aora* | *gracilis* | (Bate, 1857) | - | + | - | - |
| *Corophium* | *sextonae* | Crawford, 1937 | - | + | - | + |
| | ISOPODA | | | | | |
| *Cyathura* | *carinata* | (Kroyer, 1847) | - | + | - | + |
| *Jaera* | *albifrons group* | | - | - | + | + |
| *Idotea* | *granulosa* | Rathke, 1843 | + | + | + | + |
| *Idotea* | *pelagica* | Leach, 1815 | - | + | - | - |
| *Zenobiana* | *prismatica* | (Risso, 1826) | - | + | - | - |
| *Ligia* | *oceanica* | (Linnaeus, 1767) | - | - | - | + |
| | DECAPODA | | | | | |
| *Palaemon* | *elegans* | Rathke, 1837 | + | + | + | + |
| *Palaemon* | *serratus* | (Pennant, 1777) | - | + | - | + |
| *Athanus* | *nitescens* | (Leach, 1914) | - | + | - | - |
| *Hippolyte* | *varians* | Leach, 1814 | - | + | - | + |
| *Crangon* | *crangon* | (Linnaeus, 1758) | + | - | + | - |
| *Homarus* | *gammarus* | (Linnaeus, 1758) | - | + | - | - |
| *Pagurus* | *bernhardus* | (Linnaeus, 1758) | - | - | + | + |
| *Pisidia* | *longicornis* | (Linnaeus, 1767) | - | + | + | + |
| *Porcellana* | *platycheles* | (Pennant, 1777) | + | + | + | + |
| *Hyas* | *araneus* | (Linnaeus, 1758) | + | - | - | - |
| *Hyas* | *coarctatus* | Leach, 1815 | + | - | + | - |
| *Cancer* | *pagurus* | Linnaeus, 1758 | + | + | + | + |
| *Carcinus* | *maenas* | (Linnaeus, 1758) | + | + | + | + |
| *Pilumnus* | *hirtellus* | (Linnaeus, 1761) | + | + | + | + |
| INSECTA | | | | | | |
| *Anurida* | *maritima* | (Guerin, 1836) | - | - | + | - |
| MOLLUSCA | | | | | | |
| | POLYPLACOPHORA | | | | | |
| *Lepidochitona* | *cinerea* | (Linnaeus, 1767) | - | + | + | + |
| | GASTROPODA | | | | | |
| *Patella* | *vulgata* | Linnaeus, 1758 | + | + | + | + |

| | | | Fulsam Rock | | Whiteness | |
|---|---|---|---|---|---|---|
| | | | 1986 | 1997 | 1986 | 1997 |
| *Gibbula* | *cineraria* | (Linnaeus, 1758) | + | + | + | + |
| *Lacuna* | *pallidula* | (da Costa, 1778) | + | + | + | + |
| *Littorina* | *littorea* | (Linnaeus, 1758) | + | + | + | + |
| *Littorina* | *fabalis* | Turton, 1825 | + | + | + | + |
| *Littorina* | *obtusata* | (Linnaeus, 1758) | + | + | - | + |
| *Littorina* | *saxatilis* | (Olivi, 1792) | + | + | + | + |
| *Rissoa* | *parva* | (da Costa, 1779) | + | + | + | + |
| *Alvania* | *semistriata* | (Montagu, 1808) | - | + | - | + |
| *Onoba* | *semicostata* | (Montagu, 1803) | - | + | - | - |
| *Cerithiopsis* | *tubercularis* | (Montagu, 1803) | - | + | - | - |
| *Partulida* | *spiralis* | (Montagu, 1803) | - | + | - | - |
| *Brachystomia* | sp.indet | | - | + | - | + |
| *Graphis* | *albida* | (Kanmacher in G.Adams, 1798) | - | + | - | - |
| *Crepidula* | *fornicata* | (Linnaeus, 1758) | - | + | - | - |
| *Nucella* | *lapillus* | (Linnaeus, 1758) | + | + | + | + |
| OPISTHOBRANCHIA | | | | | | |
| *Aeolidia* | *papillosa* | (Linnaeus, 1761) | - | - | + | - |
| | BIVALVIA | | | | | |
| *Mytilus* | *edulis* | Linnaeus, 1758 | + | + | + | + |
| *Abra* | *alba* | W.Wood, 1802 | - | + | - | + |
| *Venerupis* | *saxatilis* | (Fleuriau de Bellevue, 1802) | + | + | + | + |
| *Petricola* | *pholadiformis* | Lamarck, 1818 | - | - | - | + |
| *Sphenia* | *binghami* | Turton, 1822 | - | - | - | + |
| *Hiatella* | *arctica* | (Linnaeus, 1767) | + | + | + | + |
| *Pholas* | *dactylus* | Linnaeus, 1758 | + | + | + | + |
| *Barnea* | *candida* | (Linnaeus, 1758) | + | + | + | + |
| *Barnea* | *parva* | (Pennant, 1777) | + | + | + | + |
| BRYOZOA | | | | | | |
| *Alcyonidium* | *gelatinosum* | (Linnaeus, 1761) | - | + | - | - |
| *Alcyonidium* | *hirsutum* | (Flemming, 1828) | + | + | - | - |
| *Alcyonidium* | *mytili* | Dalyell, 1848 | + | + | + | + |
| *Flustrellidra* | *hispida* | (Fabricius, 1780) | - | + | - | - |
| *Nolella* | *dilatata* | (Hincks, 1860) | - | + | - | - |
| *Nolella* | *pusilla* | (Hincks, 1880) | - | - | - | + |
| *Walkeria* | *uva* | (Linnaeus, 1758) | - | + | - | - |
| *Bowerbankia* | *gracilis* | Leidy, 1855 | - | + | - | + |
| *Cryptosula* | *pallasiana* | (Moll, 1803) | + | + | + | + |

| | | | Fulsam Rock 1986 | 1997 | Whiteness 1986 | 1997 |
|---|---|---|---|---|---|---|
| *Escharella* | *immersa* | (Fleming, 1828) | - | + | - | - |
| *Schizoporella* | *unicornis* | (Johnson in Wood, 1844) | - | + | - | + |
| *Schizomavella* | *auriculata* | (Hassall, 1842) | - | + | - | + |
| *Schizomavella* | *linearis* | (Hassall, 1841) | + | + | + | + |
| *Schizomavella* | *hastata* | (Hincks, 1862) | - | - | - | + |
| *Membranipora* | *membranacea* | (Linnaeus, 1767) | + | + | + | + |
| *Conopeum* | *reticulum* | (Linnaeus, 1767) | + | + | + | + |
| *Electra* | *pilosa* | (Linnaeus, 1767) | + | + | + | + |
| *Callopora* | *lineata* | (Linnaeus, 1767) | - | + | - | + |
| *Scrupocellaria* | *scruposa* | (Linnaeus, 1758) | - | - | - | + |
| *Bicellariella* | *ciliata* | (Linnaeus, 1758) | - | + | - | + |
| *Bugula* | *flabellata* | (Thompson in Gray, 1848) | + | + | + | + |
| *Bugula* | *fulva* | Ryland, 1960 | + | + | - | + |
| *Bugula* | *plumosa* | (Pallas, 1766) | + | + | + | + |
| *Bugula* | *turbinata* | Alder, 1857 | + | + | - | + |
| PHORONIDA | | | | | | |
| phoronid | | | - | + | - | + |
| ECHINODERMATA | | | | | | |
| *Asterias* | *rubens* | Linnaeus, 1758 | + | + | + | + |
| *Ophiothrix* | *fragilis* | (Abildgaard, 1789) | - | + | - | + |
| *Amphipholis* | *squamata* | (Chiaje, 1828) | + | + | + | + |
| *Psammechinus* | *miliaris* | (Gmelin, 1778) | - | - | - | + |
| CHORDATA | | | | | | |
| | ASCIDIACEA | | | | | |
| *Morchellium* | *argus* | (Milne Edwards, 1841) | - | - | + | - |
| *Dendrodoa* | *grossularia* | (van Beneden, 1847) | + | - | - | - |
| *Botryllus* | *schlosseri* | (Pallas, 1776) | + | + | - | - |
| *Botrylloides* | *leachi* | (Savigny, 1816) | + | + | + | + |
| *Molgula* | *manhattensis* | (De Kay, 1843) | + | + | + | + |

| | Fulsam Rock | | Whiteness | |
|---|---|---|---|---|
| | 1986 | 1997 | 1986 | 1997 |
| | 82 | 164 | 92 | 148 |
| Total number of species recorded in 1986 | 108 | | | |
| Total number of species recorded in 1997 | 197 | | | |
| Overall species count | 221 | | | |

### 3.1.2 Intertidal (cave, cliff and foreshore) biotopes: descriptions and comments

In this survey we have identified the following:

- Biotopes that agree with those described by Connor *et al* (1997a).
- Biotopes that are variants of nationally widespread biotopes and which mainly differ in having an abundance of 'rock-boring' animals in the chalk rock substratum. Connor *et al* (1997a) initiated this with the description of MLR.BF Fser.Pid, MLR.R RPid and MIR KR LdigPid biotopes - we have added others. These variants are indicated in the text below with an asterisk *.
- Possible nationally new biotopes.
- Mixed biotopes which could not easily be distinguished apart; some of these will include the 'rock-bored' variants discussed above.

A list of biotopes recorded is given in Table 4 indicating those in Connor *et al* (1997a), variants, new biotopes, and mixed forms.

Some areas of foreshore (rock and sediment) could only be classified to the 'higher' levels of the MNCR biotope classification (MLT; LGS; LMS) as no biota was present or recorded. These are also listed and briefly commented on below. A code is suggested in the text for the possible new biotopes but they are listed under the 'higher level' coding with the annotation 'Code required to indicate:' in square brackets. The biotopes listed below are ordered according to Connor *et al* (1997a). Statements of frequency of occurrence are taken from Connor *et al* (1997a).

The occurrence and distribution of intertidal biotopes (and also 'higher levels') around Thanet is shown in the series of maps in appendix 2. Biotopes (and variants and 'higher levels') are indicated by separate colours/symbols.

**LR.L Chr** Chrysophyceae on vertical upper littoral fringe soft rock. This biotope as defined by Connor *et al* (1997a) probably represents an aggregate of biotopes. Anand (1937a,b,c) described many communities from caves and cliffs and some of these are considered elsewhere in this report. The most obvious biotopes on cliffs and caves were:

- Orange *Chrysotila* growths at supralittoral levels on cliffs and at entrances to caves.
- Brown *Apistonema* growths at littoral fringe levels on cliffs and at entrances to caves.
- Green *Pseudendoclonium* at littoral fringe and supralittoral fringe levels in shaded situations in chalk caves.
- Various Cyanophyta at littoral fringe and supralittoral levels in shaded situations in chalk caves.
- Velvety *Audouinella purpurea* (red) and *Pilinia maritima* (golden brown) mats on cave walls at upper littoral and littoral fringe levels. This assemblage is widespread and common in caves throughout Britain; we suggest it be designated a littoral biotope - **LR.L AudpPilmar**.

LR.L Chr is a rare biotope in Britain.

**MLR** Bare chalk rock without plant or animal cover occurs sporadically around Thanet, mainly in the inshore parts of the foreshore reef/platform and where there is scouring by wave-return from sea-walls. This is a more or less permanent feature in some areas where wave abrasion is severe, but in other areas it can be a transient feature due to sand movements which periodically cover or uncover it.

Table 4. Intertidal biotopes recorded in Thanet

| Biotope code | Listed in Connor *et al* (1997) | Variant biotope | New biotope | Mixed biotope |
|---|---|---|---|---|
| LR.L Chr | + | | | |
| LR.L AudpPilmar | | | + | |
| MLR | + | | | |
| MLR EntUlva.flush | | | + | |
| MIXED MLR EntUlva.flush/ MLR.EntPor | | | | + |
| MIXED MLR.Eph Rho/ Ulva | | | | + |
| MIXED MLR.R XR/ Ulva | | | | + |
| MLR LitPat | | | + | |
| MLR.BF FvesB | + | | | |
| MLR.BF Fser | + | | | |
| MLR.BF Fser.Pid | | + | | |
| MLR.BF Fser.RPid | | + | | |
| MIXED MLR.BF Fser/ MLR.Eph Rho | | | | + |
| MIXED MLR.BF Fser/ MLR.BF Fser.R | | | | + |
| MLR.R XRPid | | + | + | |
| MLR.R PalPid | | + | + | |
| MLR.R Mas | + | | | |
| MLR.R Osm | + | | | |
| MLR.R RPid | + | + | | |
| MLR.Eph Ent | + | | | |
| MLR.Eph EntPor | + | | | |
| MLR.Eph RhoPid | | + | + | |
| MLR.MF | + | | | |
| MLR.MF MytFves | + | | | |
| MLR.Sabspin | | | + | |
| SLR.FX BLitt | + | | | |
| LR.Rkp-no biota | | + | | |
| LR.Rkp G | + | | | |
| LR.Rkp Cor | + | | | |
| LR.Rkp FK | + | | | |
| LR.Rkp FK.Sar | + | | | |
| LR.Rkp SWSed | + | | | |
| LR.Ov SR | + | | | |
| LGS | + | | | |
| LGS.S Lan | + | | | |
| LMS | + | | | |
| MIR.KR Ldig.Pid | + | + | | |
| SIR.K Lsac | + | | | |

**MLR** [Code required to indicate:] Ephemeral *Ulva-Enteromorpha-Chaetomorpha.* In August 1997 extensive areas of foreshore reef appeared green because of a summer flush of *Ulva* and *Enteromorpha* growth (we have used the notation MLR EntUlva.flush). Survey work in September confirmed this to be a temporary phenomenon with less green growth over the foreshore and extensive deposits of drift green algae on beaches (see plates 1 to 4 later in the report).

*Ulva* was dominant in areas which at other times of the year would have been assigned to biotopes such as MLR.R Osm, MLR.R Rho*, MLR.R XR*, MLR.R FserR*, and MLR.EntPor (* = variant biotopes for piddock- and *Polydora-* bored chalk; see introduction to this section of the report and also below).

The following are mixtures of biotopes which could not be distinguished in the field:

MIXED-MLR EntUlva.flush/MLR.EntPor - stands of *Ulva* growing together with *Enteromorpha* and *Porphyra* in sandy areas.

MIXED-MLR. Eph Rho/Ulva - dense stands of *Ulva* over *Rhodothamniella floridula* turfs (see also below).

MIXED-MLR.R XR/Ulva - dense stands of *Ulva* over the biotope of mixed red algae on lower littoral chalk reef.

*Enteromorpha* blooms were also recorded within MLR.Fser (see below); elsewhere *Chaetomorpha mediterranea* blooms were abundantly present in biotopes such as MLR.R Osm and MLR.R XR*. Occasionally *Ulva, Enteromorpha* and *Chaetomorpha* grew together forming a dense green cover.

**MLR** [further coding required to indicate:] Grazed bedrock. Areas of chalk reef where algal growth is scant and where gastropod grazers (eg *Littorina littorea* and *Patella vulgata*) are widespread and common (we have used the notation MLR. LitPat); algal growth is presumably restricted by grazers.

**MLR.BF FvesB** *Fucus vesiculosus* and barnacle mosaics on mid littoral rock. On Thanet chalk reefs the biotope was recorded at lower levels on vertical cliff faces or on the inner (landward) fringes of foreshore platforms. The biotope does not occur extensively, but mainly in areas of moderate wave-exposure at Whiteness. Many of the characterising species listed by Connor *et al* (1997) were present on Thanet. This is a very common biotope in Britain.

**MLR.BF Fser** *Fucus serratus* on mid to lower littoral rock. A widespread biotope at mid to low tide levels in Britain, but on Thanet it occurs on chalk which is usually bored by piddocks and *Polydora*. In some inshore areas these rock-boring animals may be absent, or only *Polydora* present. We encountered two sub- or variant biotopes commonly and these are described below.

**MLR.BF Fser.Pid** *F.serratus* and piddocks on lower littoral soft rock. This biotope is formed by *F. serratus* as a dense canopy over an understorey of small algae on chalk bored by piddocks and *Polydora*. The characterising species, many of which are invertebrates associated with old piddock burrows, are mainly as described in Connor *et al* (1997), although dense *Enteromorpha* growths were associated with it at several localities on Thanet. A rare biotope in Britain.

**MLR.BF Fser.R** [further coding required to indicate:] *F. serratus* and red seaweeds on piddock-bored soft littoral rock. A variant not described in Connor *et al* (1997a) where turf-forming red algae occur in a mosaic with *F. serratus* on piddock- and *Polydora*-bored chalk. The characterising species were mostly as in Connor *et al* (1997a) for MLR.BF Fser.R but exclude

*Himanthalia* (absent in Kent) and *Mastocarpus* (restricted to flint on Thanet). At some locations *Ulva* was commonly associated with this biotope. We suggest the code **MLR.BF Fser.R.Pid*** for this variant. The rock-boring components and associated invertebrate assemblages make this a rare biotope in Britain. It is sporadically present around Thanet at lower littoral levels and may represent an area where MLR.BF Fser.Pid and MLR.R XR* biotopes intergrade.

Both these *Fucus serratus* biotopes sometimes intergrade at lower shore levels into areas dominated by the sand-accumulating *Rhodothamniella floridula* (MLR.Eph Rho*- see below) or by a mix of other red seaweeds (MLR.R XR* - see below).

Areas where we could not distinguish between biotopes are indicated on the Phase 1 biotope maps by a separate colour and designated MIXED - MLR.BF Fser/MLR.R Eph Rho and MIXED - MLR.BF Fser/MLR.BF Fser.R.

**MLR.R XR** [further coding required to indicate:] Mixed red seaweeds on piddock-bored lower littoral rock. This biotope formed a distinct narrow band at lower littoral levels on the foreshore reef of Thanet, just above/inshore of the *Laminaria digitata*/piddock biotope (MIR.KR Ldig.Pid). It is extensive, occurring along much of the Thanet coastline and characterised by algae such as *Ceramium nodulosum* and *Polysiphonia fucoides* (particularly commonly) and also *Chondrus crispus, Cladostephus spongiosus, Corallina officinalis, Dictyota dichotoma* (variety *intricata* was noted in good quantities at Nayland Rock), *Halurus flosculosus, Palmaria palmata* and *Rhodothamniella floridula.* Several species of chalk-boring piddock and *Polydora* were also commonly present. At Botany Bay, *Cladostephus spongiosus* was locally dominant (not listed in Connor *et al* 1997a).

The biotope occurred on piddock- and *Polydora* - bored reef and should be considered a variant (we suggest **MLR.R XR.Pid**). The biotope as present on Thanet is not a good fit with MLR.R XR described by Connor *et al* (1997a. MLR.R XR is a scarce biotope in Britain; the variant we propose, MLR.R XR.Pid, is probably scarcer, reflecting the limited occurrence of chalk and other soft rocks in Britain.

*Chaetomorpha mediterranea* was sometimes noticeably present in the biotope. Where extensive *Ulva* growths were recorded, the gross appearance of the biotope changed from red to green; the green bloom variant is indicated in the Phase 1 biotope maps by a separate colour.

**MLR.R Pal** [further coding required to indicate:] *Palmaria palmata* on lower littoral piddock-bored rock. *Palmaria*-dominated stands over (often piddock- and *Polydora*-bored) chalk reef are widespread but patchy in occurrence around Thanet. The biotope usually occurs at low littoral levels immediately inshore and sometimes overlapping with that defined by *Laminaria digitata.* Characterising species included some of those noted by Connor *et al* (1997a) (but not *Patella ulyssiponensis, Porphyra umbilicalis, Mastocarpus stellatus* and *Verrucaria mucosa*). For reasons outlined previously the biotope is more correctly defined **MLR.R Pal.Pid*** to represent the occurrence of chalk-boring piddocks and associated invertebrate assemblages. This is an uncommon biotope in Britain.

**MLR.R Mas** *Mastocarpus* and *Chondrus* over eulittoral rock. On chalk shores the *Mastocarpus* component of this carragheen moss dominated biotope is absent (it occurs as occasional tufts on flint cobbles); *Chondrus crispus* occurs as locally extensive patches at lower littoral levels just inshore and above *Laminaria digitata* over piddock-bored rock. The biotope on Thanet probably occurs in more sheltered situations than indicated by Connor *et al* (1997a). Characterising species such as *Himanthalia* are absent in Kent but the biotope was otherwise as listed by Connor *et al* (1997a). The biotope contains species also present in MLR.R XR* (as the chalk variant MLR.R XR.Pid). A scarce biotope in Britain.

**MLR.R Osm** *Osmundea pinnatifida* and *Gelidium pusillum* on moderately exposed littoral rocks. The biotope occurs extensively on wave-washed foreshore reefs. An often extensive, open and patchy low-lying turf-forming vegetation of stunted *Osmundea pinnatifida* and *Gelidium pusillum* is common at many locations on Thanet (especially Long Nose Spit, Botany Bay, Whiteness and Hackemdown Point headlands). A local variant is where *Gelidium* is the dominant species. Associated/characterising species include chalk-boring blue-green algae, the crustose brown alga *Ralfsia verrucosa*, the crustose coralline *Phymatolithon lenormandii,* the lichen *Arthropyrenia halodites, Littorina* spp., *Patella vulgata* and *Semibalanus balanoides/Elminius modestus.* Occasional stunted fucoids may be present, and in summer cotton-wool like blooms of the filamentous green alga *Chaetomorpha mediterranea* are associated. The biotope overlaps with MLR.BF Fser where *Osmundea* grows to a larger size. There are many *Corallina* rock pools (LR.Rkp Cor) in the area and *Osmundea hybrida* is frequently seen. This is a scarce biotope in Britain.

**MLR.R RPid** *Ceramium* sp. and piddocks on lower littoral chalk. *Ceramium nodulosum* and *Polysiphonia fucoides* over piddock-bored lower littoral chalk often characterise a lower littoral biotope. These filamentous algae often form a reddish-black mat or turf-like growth. In the absence of piddocks and associated invertebrate assemblage the biotope would be considered MLR.R XR (mixed red algae). Characterising species are as listed by Connor *et al* (1997a). This is a rarely occurring biotope in Britain. Summer blooms of *Ulva* on and among the red algae create a variant of the biotope (see above).

**MLR.Eph Ent** *Enteromorpha* spp. on freshwater-influenced or unstable upper littoral rock. Occasional on inshore chalk reefs in Thanet and defined by Connor *et al* (1997a) as an uncommon biotope in Britain.

**MLR.Eph EntPor** *Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid/lower littoral rock. A widespread and common biotope around the coast of Thanet particularly on inshore margins of the foreshore chalk reefs where chalk rock is overlain by sand. Denser growths of *Enteromorpha* occur in summer at the same time as the summer green algal bloom overlying lower littoral biotopes. Characterising species are broadly as listed in Connor *et al* (1997a). A scarce biotope in Britain.

**MLR.Eph Rho** [further coding required to indicate:] *Rhodothamniella floridula* on piddock-bored lower littoral rock. A distinct and widespread but sporadically occurring biotope in which *Rhodothamniella* forms a hummocky turf by binding sand and silt. On Thanet sand scour is less important than the heavily silt-laden inshore waters which provide the material bound by *Rhodothamniella.* The biotope generally has many red algae present; characterising species on Thanet are as listed by Connor *et al* (1997a). *Rhodothamniella* turfs occur over piddock- and *Polydora*-bored rocks, and tubes formed by these animals perforate the algal turf as do those of the sipunculan *Golfingia minuta.* For this reason we suggest designating a variant or sub- biotope **MLR.Eph Rho.Pid*.**

This biotope often overlaps or merges with MLR.BF Fser biotopes forming a mosaic of hummocky growths in open areas in the *Fucus serratus* canopy (see above). Connor *et al* (1997a) note the occurrence of ephemeral algae (*Enteromorpha, Ulva*); the present survey recorded dense blooms of green algae defined as MIXED-MLR. Eph Rho/Ulva (see above, dense stands of *Ulva* over *Rhodothamniella floridula* turfs). This is an uncommon biotope in Britain (Connor *et al* 1997a).

**MLR.MF** Mussels [and fucoids] on moderately exposed shores. Mussel dominated shores (without an algal cover) occur patchily around Thanet. Near Grenham Bay heavy siltation precluded algal colonisation in a zone in which MLR.MF MytFR would have been expected to occur and consequently was recorded and mapped as MLR.MF. The biotope may be a restricted successional stage of MLR.MF MytFR or MLR.MF MytFves (see below). Where silty or shelly gravel was overlying chalk reef the biotope resembled SLR.MX MytX. This is a scarce biotope in Britain.

**MLR.MF MytFves** *Mytilus edulis* and *Fucus vesiculosus* on moderately exposed midlittoral rock. This biotope occurs sporadically around Thanet, more commonly in the western part of the peninsula. A wet area of the biotope at the western end of Minnis Bay contained *Crepidula fornicata* in considerable numbers; the species is not listed by Connor *et al* (1997a). A variant of the biotope occurred without *Fucus vesiculosus*. A scarce biotope in Britain.

**MLR** [code required to indicate:] *Sabellaria spinulosa*-dominated areas over foreshore chalk at mid to lower littoral levels on moderately wave exposed shores. This proposed biotope (we suggest **MLR.Sabspin**) was detected on the south side of Kingsgate Bay where sand fringes the chalk foreshore reef. The biotope was very rare on Thanet although *Sabellaria spinulosa* is widespread and common (often as an underfauna beneath *Fucus*). *Ulva* and various red algae grew over *S. spinulosa* reefs.

**SLR.FX BLlit** Barnacles and *Littorina littorea* on unstable eulittoral mixed substrata. On Thanet the biotope is formed of flint cobbles upon which occur barnacles (*Semibalanus balanoides, Elminius modestus*) and winkles (*Littorina littorea*). Aggregations of flint cobbles occur mainly at inshore locations over chalk reef or sand, and are sporadic around Thanet as patches of restricted size. The green algae *Enteromorpha* and *Ulva* and occasional fucoids may be associated; the characterising species are mainly as listed in Connor *et al* (1997a). At Dumpton Point embedded flints within chalk rock presented areas for colonisation by *Patella vulgata, Semibalanus balanoides, Elminius modestus* within an overall MLR.Eph EntPor area. This is a rare biotope in Britain.

**LR.Rkp** [code required to indicate no biota] Littoral rockpools [lacking biota]. Rockpools lacking biota are common on the foreshore reef (especially at wave-washed locations) around Thanet. At the scale of study these are too small to be shown in the Phase 1 biotope map.

**LR.Rkp G** Green seaweeds in upper shore rock-pools. Upper shore rock pools are rare in Thanet because upper littoral levels comprise mainly vertical cliff faces or sea-walls. Shallow pools containing principally *Enteromorpha* do occur on inshore reefs (mid-littoral levels) usually in *Enteromorpha*-dominated areas (see above MLR.Eph Ent; MLR.Eph EntPor). Characterising species are as listed by Connor *et al* (1997a). This is a very common biotope in Britain.

**LR.Rkp Cor** *Corallina officinalis* and coralline crusts in shallow littoral rock-pools. This biotope is widespread and common in Thanet but usually too small in area to be shown in the Phase 1 biotope maps at the scale required. They occur both as open habitat or beneath the canopy of *Fucus serratus* and frequently contain prawns and other crustaceans as well as mollusc grazers. At lower littoral levels such rock-pool biotopes are often rich in species, and intergrade with the LR.Rkp FK biotope (see below). Characterising species are as listed by Connor *et al* (1997a), but not *Halidrys siliquosa*. A variant of this biotope occurred to the west of Epple Bay with an extensive mussel bed within the standing water. This is a very common biotope in Britain.

**LR.Rkp FK** Fucoids and kelps in deep littoral rock-pools. Deep rock-pools are not as common in Thanet as LR.Rkp Cor but are nonetheless widespread. They are often rich in prawns and other mobile species as well as attached forms. The characterising species are mainly as listed by Connor *et al* (1997a), but without *Gastroclonium ovatum* and *Himanthalia elongata*. This is a common biotope in Britain.

**LR.Rkp FK.Sar** *Sargassum muticum* in littoral rockpools. *S. muticum* only spread to Thanet in the late 1980s (after the Tittley *et al* 1986 survey) and has colonised mainly inner foreshore reef pools and lagoons from Fulsam Rock to Palm Bay; it is most abundant in shallow to medium depth pools in the Fulsam Rock area. *Sargassum* often formed a blanketing cover allowing little algal growth beneath although crustaceans and grazing molluscs are as common as in LR.Rkp FK. It has occupied habitats where *Halidrys siliquosa* was formerly common and has probably displaced this and other algal species. Characterising species of the biotope on Thanet are mainly those listed by Connor *et al* (1997a). This is a rare biotope in Britain.

**MLR.Rkp SWSed** Seaweeds in sediment-floored eulittoral rockpools. Sandy floored pools and lagoons occur widely but occasionally around Thanet. In contrast to the observations made by Connor *et al* (1997a) such pools on Thanet are not dominated by fucoids and kelps; *Saccorhiza* does not occur in Kent and the sea-grasses *Zostera* spp. and also *Chorda* are not present in Thanet; other characterising species are as listed in Connor *et al* (1997a). Sand-tolerant algae are found at the interface of sediment and chalk reef or flint cobble. This is a common biotope in Britain.

**LR.Ov** Littoral rock - overhangs and caves.

**LR.Ov SR** Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock. Overhanging chalk bedrock occurs commonly as part of the wave-eroded gully systems at lower eulittoral levels. These linear features running at right-angles to the shoreline are common around Thanet but the biotope is best developed on the north coast of Thanet from Margate to Foreness Point and between Foreness Point and Broadstairs. The biotope occupies too small an area to be shown in the Phase 1 biotope survey maps.

Overhanging, vertical and steeply sloping rock-faces are characterised by shade tolerant red algae, sponges, hydroids, bryozoans, and ascidians with species present mainly as listed by Connor *et al* (1997a). This is a common biotope in Britain.

**LGS** Littoral gravels and sand. Sand is deposited widely around the Thanet coast, often as a fringing beach between the foreshore reef and chalk cliffs. The centres of bays contain sand and silt to low water level. There are also small local deposits of sand, shell and gravel over the foreshore reef. Such sandy/gravelly areas provide habitats for polychaetes and other burrowing invertebrates but remain uncolonised by algae.

**LGS.S Lan** Dense *Lanice conchilega* in tide-swept lower shore sand. *Lanice*-dominated sandy areas are common on wave-swept shores on Thanet where sand is trapped between foreshore chalk reefs or at the interfaces of sandy beaches and bays and foreshore reef. The sand mason worm is not featured in many biotope descriptions by Connor *et al* (1997) but in many of ours it was a significant member of the fauna where sand influence was present. The characterising species of the dense *Lanice* biotope are mainly as listed in Connor *et al* (1997a). The biotope is uncommon in Britain.

**LMS** Littoral muddy sands. Littoral muddy sands occur commonly at the western margins of Thanet on both north and south coasts (Minnis and Pegwell Bays). These habitats principally support communities consisting predominantly of polychaetes and bivalves with characterising species as listed by Connor *et al* (1997a). *Zostera noltii* beds are absent on Thanet (but do occur to the west on the North Kent coast). This is a common biotope in the UK.

**MIR.KR LdigPid** *Laminaria digitata* and piddocks on sublittoral fringe soft rock. Much of the sublittoral fringe of the foreshore of Thanet between Margate and Ramsgate is characterised by this biotope; a *Laminaria digitata* canopy covers piddock- and *Polydora*-bored chalk reef. The biotope is rich in invertebrates amongst the kelp holdfasts and in the abandoned borings of piddock which honeycomb the chalk at this shore level. The biotope merges with or forms a mosaic with those of MLR.R XR and MLR.Eph Rho; it extends to subtidal levels. Characterising species are as listed by Connor *et al* (1997b). The biotope is poorly developed or absent west of Margate and Ramsgate. This is a scarce biotope in Britain.

**SIR.K Lsac** *Laminaria saccharina* on very sheltered infralittoral rock. This biotope occurs sporadically on Thanet. Occasional stands grow at sublittoral fringe levels on chalk reef in sheltered areas (eg centres of bays) often at the interface of sand and rock. Our observations concur with those of Connor *et al* (1997b), that the biotope has few associated seaweeds due to siltation or sand movement; *Echinus*, noted as an associated species by Connor *et al* (1997b), is rare on Thanet. Although the biotope is rare on Thanet, it is common elsewhere in Britain.

## 3.2 Subtidal survey

Unlike the intertidal area which was assessed in its entirety, the subtidal area was surveyed at only five restricted locations. However, other subtidal surveys usefully augment our data. An objective of the subtidal survey was to assess the continuity of biotopes/communities from lower littoral levels and to identify the occurrence of exposed chalk rock to the limit of the cSAC. Such areas of chalk were detected thus confirming the results of the habitat survey undertaken by Davies (1995) using acoustic methods. Davies' map of the prediction of the extent of subtidal chalk is reproduced in figure 14. Table 5 attempts to equate Davies' areas of similar acoustic characteristics with his 'biotopes' (extent of chalk).

An additional MNCR led diving survey of the cut channel to Ramsgate harbour was undertaken separately the results of which will be presented in full elsewhere (cf Northen 1997).

The results of the present subtidal survey are presented as (i) a general description of sites investigated and stations studied along each transect line, (ii) description of biotopes recorded at the study stations. These results have also been incorporated into a series of maps which show the survey stations in 1995 and 1997 (figure 6), the extent of exposed chalk rock (figure 8), and biotopes recorded (figures 10 and 12); these data have also been overlain on the acoustic survey map of Davies (1995) (figures 7, 9, 11 and 13). Tables 6 and 7 list the biotopes encountered around Thanet, and the number of species for each site is given to indicate the pattern of subtidal species diversity (in chalk and other habitats) in the cSAC.

For the purpose of data interpretation the dives carried out in August 1997 have been recorded on MNCR forms as five sites and 33 subtidal habitats. Copies of these forms are presented in appendix 4 with summaries of the site and habitat data (generated from the MNCR database) for this survey together with similar summary data for the 1995 MNCR survey and the survey of the Ramsgate harbour approach channel.

### 3.2.1 Description of sites

At all study sites the intertidal chalk reef was continous to shallow sublittoral levels and was usually markedly piddock-bored. Chalk exposures further offshore in deeper water were often sediment-covered. At other locations chalk rock was smooth and scoured. There is therefore variation in the nature of subtidal exposed chalk rock, with that of shallow inshore areas resembling the form of rock at lower littoral levels. Figure 8 shows all survey sites and stations together with the percentage of chalk present at each; these data are overlain on the acoustic map of Davies (1995) (figure 9) which show clearly agreement between the two surveys for the occurrence of subtidal chalk (see table 5 for explanation of colour codes).

**Epple Bay** (site 1; stations 1-8)
The transect at site 1 ran approximately due north, from the shore datum at Epple Bay, for a distance of about 1.3 kms to the boundary of the cSAC. By swimming along the reference line on the inner section of the transect, divers were able to establish the seaward limit of the solitary chalk biotope at this site at a distance of only 35 metres from the shore datum. At this point the substratum became composed entirely of sediment as far as the cSAC's outer limit. Three different sediment types were recognised; these were assigned to 'higher level' categories (cf Connor *et al* 1997b). The first habitat consisted of fine, silty shell sand (CMS) at about 11 metres below chart datum with a limited conspicuous fauna characterised by ophiuroids. Station 7, at 5 metres depth, was silty clay mud (CMU) without any sign of life, and stations 2-6 consisted of mostly barren, clean fine sand (IGS), all at a depth of less than 1

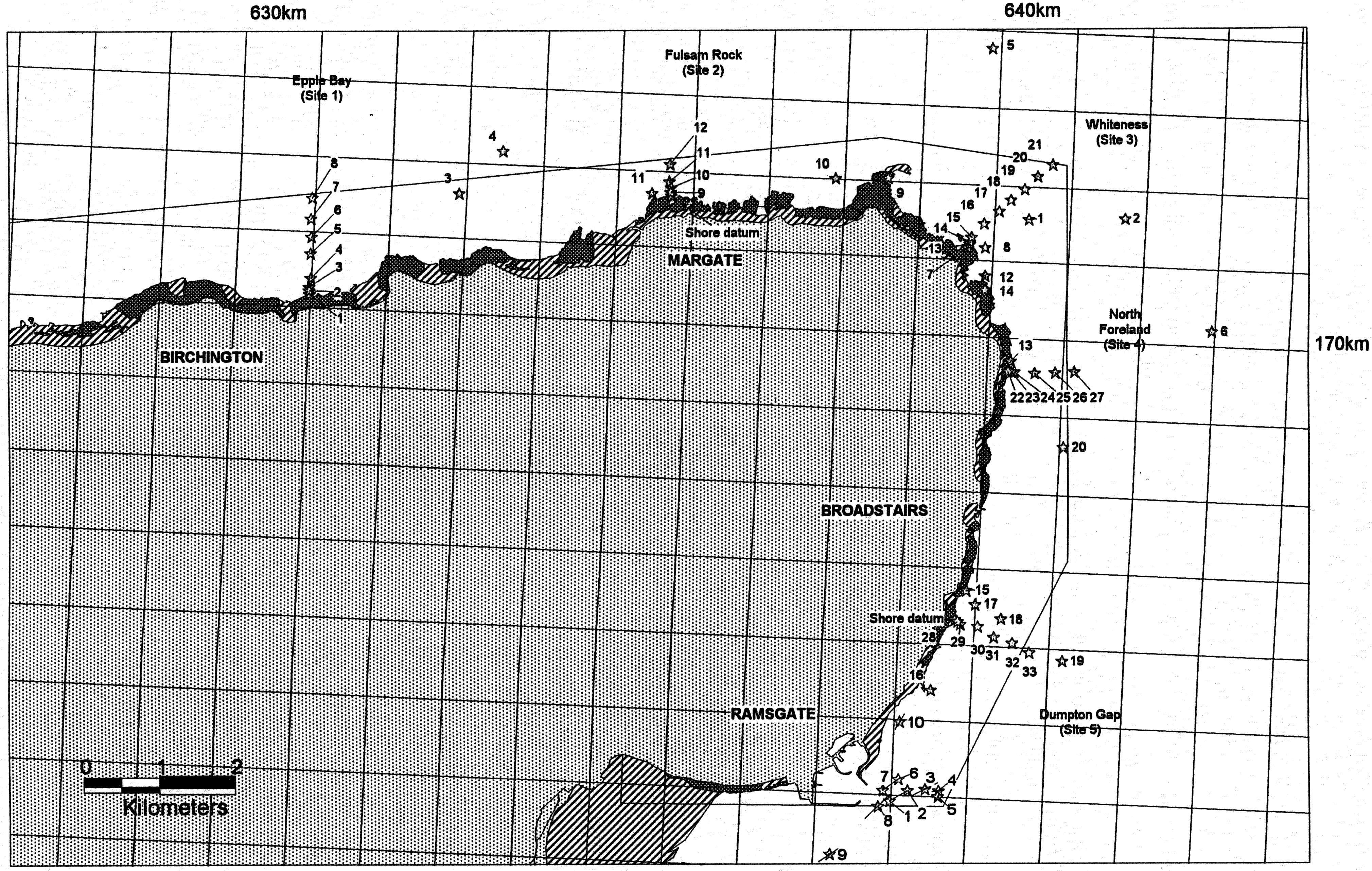


Figure 6. Map showing all survey stations and their MNCR coded colours.
○ 1995 ◇ 1997 ☆ 1997 Drift dives, Ramsgate Harbour Survey

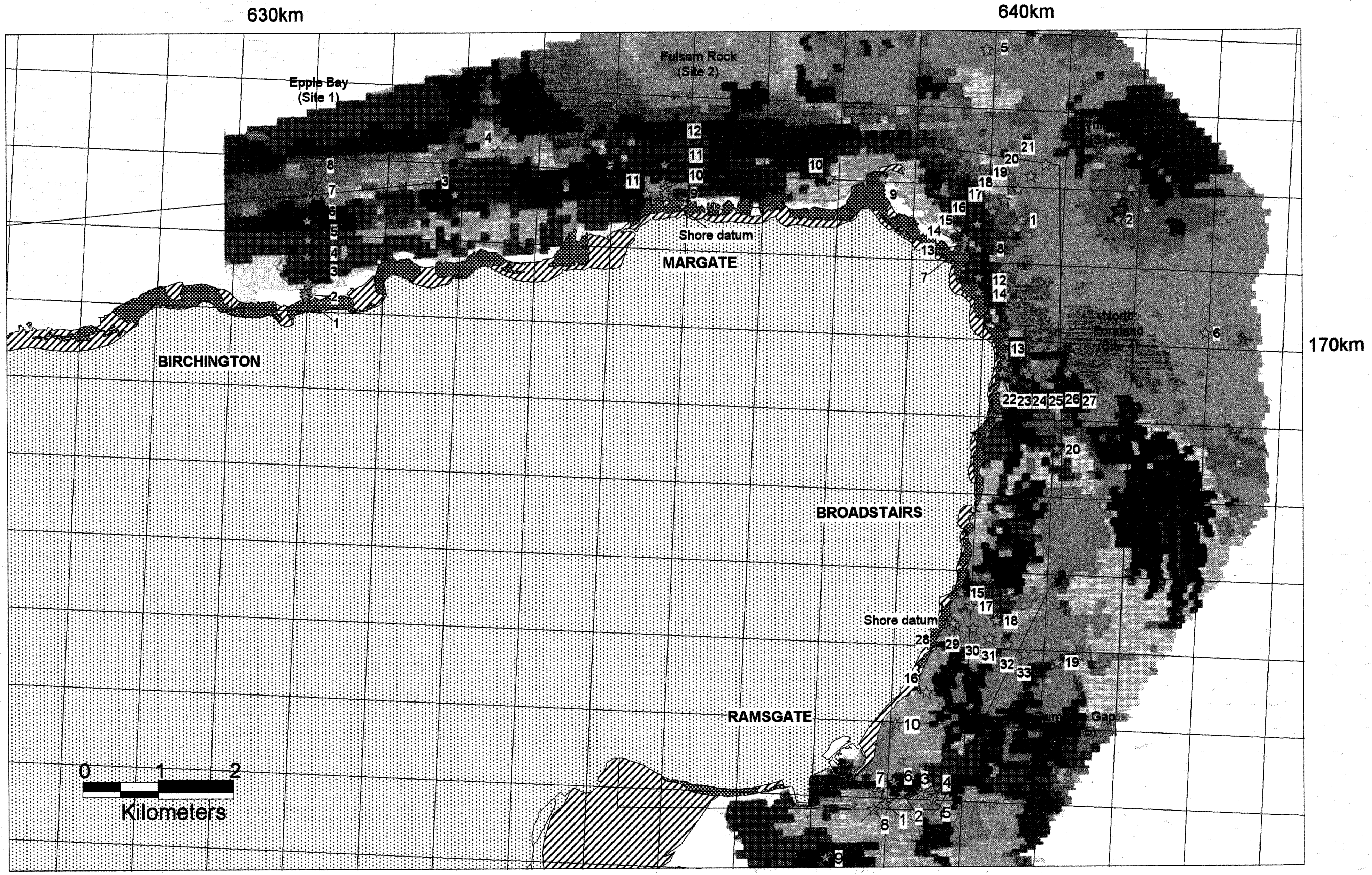


Figure 7. Map showing all survey stations and their MNCR coded colours, overlaying Davies (1995) acoustic data.
○ 1995 ◇ 1997 ☆ 1997 Drift dives, Ramsgate Harbour Survey

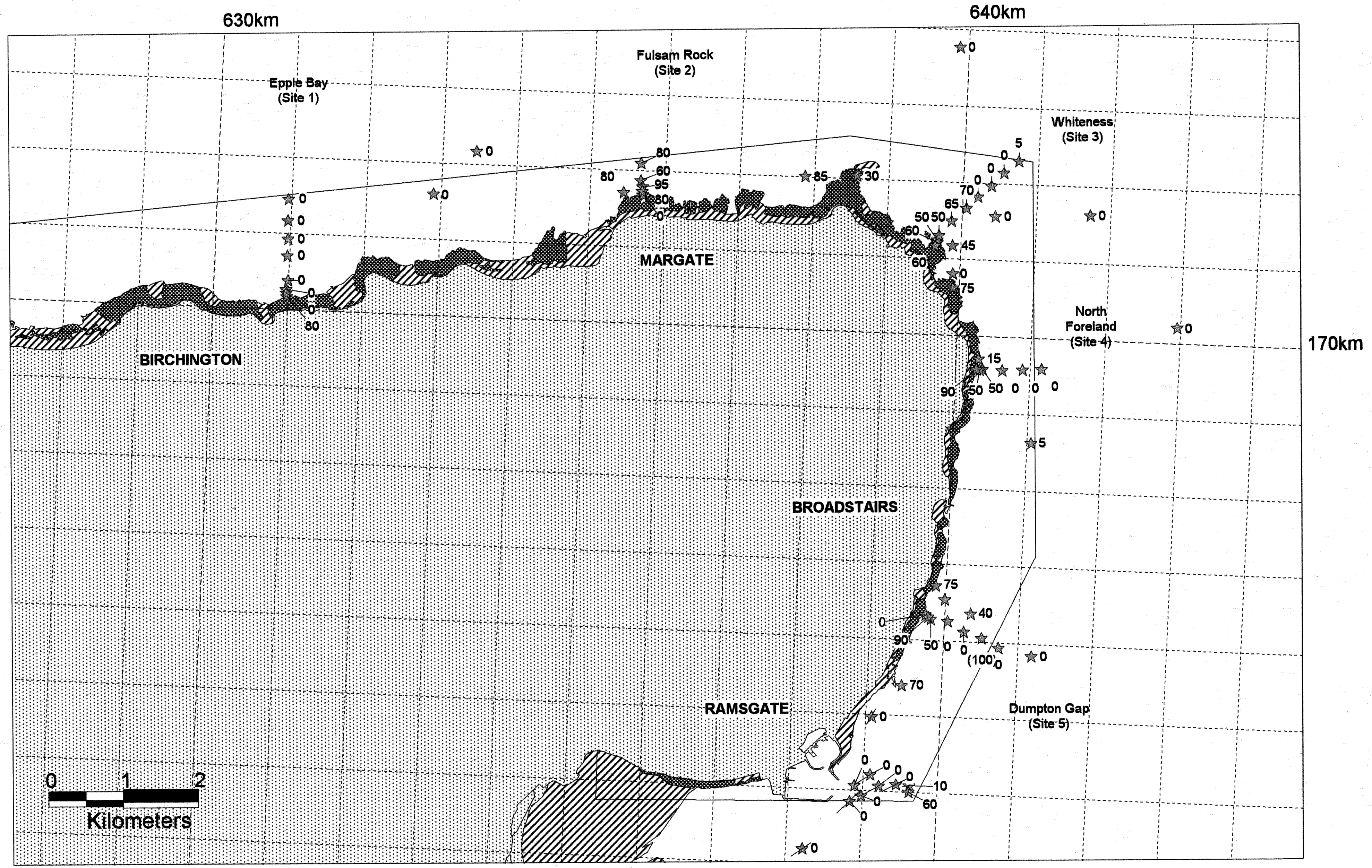


Figure 8. Map showing survey stations together with percentage chalk and MNCR coded colours

○ 1995 ◇ 1997 ☆ 1997 Drift dives, Ramsgate Harbour Survey

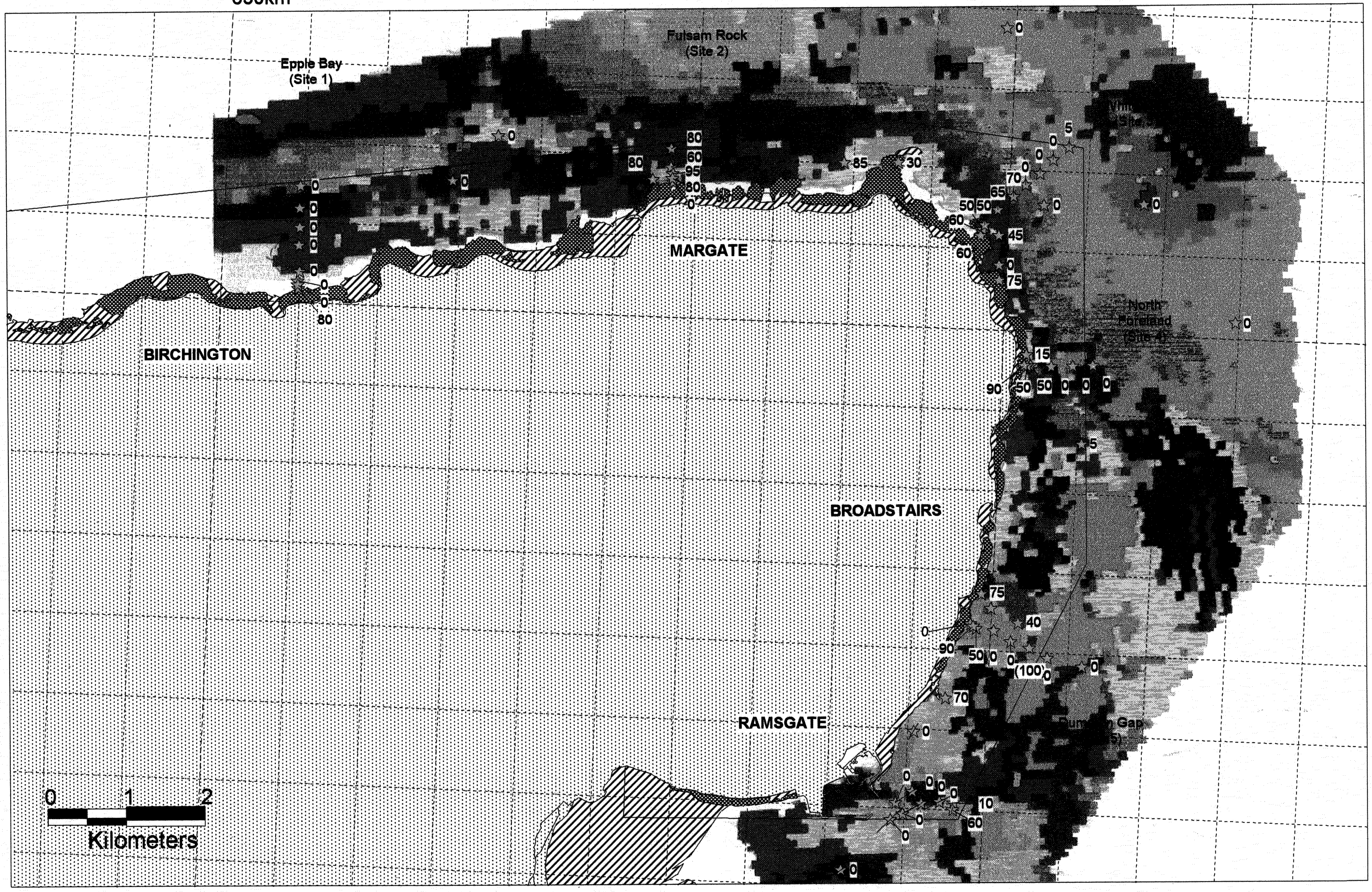


Figure 9. Map showing survey stations together with percentage chalk and MNCR coded colours, overlaying Davies (1995) acoustic data. ○ 1995 ◇ 1997 ☆ 1997 Drift dives, Ramsgate Harbour Survey

metre below chart datum. The habitat CMU occurred in a depth of 5.2m in Thanet instead of the more usual depth range of 15-20m noted in Connor *et al* (1997b) for these muds.

None of these sediment types was recorded elsewhere within the cSAC boundary in 1997 or at any of the dive sites in 1995.

**Fulsam Rock** (site 2; stations 9-12)
The transect from Fulsam Rock also ran due north, for a distance of just under half a kilometre. However, in contrast to site 1 a high proportion of chalk was encountered at each of the four dive locations. Three biotopes were recognised. Piddocks were an important component of the fauna at the inner stations (9-11), which ranged in depth from 0.5 to 3 metres, while the silt-tolerant ascidian *Molgula manhattensis* favoured the very silty conditions at 8 metres depth at station 12 on the edge of the cSAC.

**Whiteness** (site 3; stations 13-21)
The longest transect investigated in this survey ran north-east for a distance of 1.5 kms from Whiteness. The deepest habitats within the cSAC boundary were encountered in around 12 or 13 metres of water in the outer region of this site (stations 18-21), where the mixed substratum seabed was composed of varying proportions of small boulders, cobbles, pebbles, and finer sediments with fairly stable circalittoral tide-swept bryozoan and hydroid communities. The inner series of chalk reef habitats (stations 13-17) were characterised by piddocks, but with bryozoans and hydroids contributing to the biota at station 17 (8 metres depth) and to a lesser extent at station 16 (6 metres). The chalk biotopes at the shallower stations, in about 1-3 metres, were affected by the scouring action of the sand which surrounded the low bedrock outcrops. These supported an impoverished flora and fauna. Bedrock continuous with the intertidal chalk reef was recorded at station 13 at a distance of 35 metres from the shore datum.

**North Foreland** (site 4; stations 22-27)
The transect at this site ran approximately due east for a distance of 0.8 km to just beyond the boundary of the cSAC. The mixed substrata circalittoral habitats at stations 25-27 in depths of 7 or 8 metres contained a higher proportion of sand than the deeper cobble habitats at Whiteness and they supported a biota characteristic of less stable conditions. Chalk bedrock was present beneath the sediment at these stations. The thickness of this covering gradually reduced closer to the shore from 10-20cms at station 27 to around 5-10cms at station 25. The effects of sand scour on the inner part of the transect were particularly marked at this site where very impoverished communities were recorded. The low-lying chalk outcrops at station 24 were bored by piddocks, but in the absence of any significant biota at stations 22 and 23 it was not possible to assign biotopes to them with any degree of accuracy.

**Dumpton Gap** (site 5; stations 28-33)
From Dumpton Gap the transect ran approximately south-east for a distance of one kilometre. The shallow outer stations (30-33) in depths of around 2-5 metres were characterised by *Molgula* 'caps' on cobbles embedded in a sandy matrix. Smooth chalk bedrock was present beneath the covering of sediment at station 32, but chalk was not encountered in the other *Molgula* biotopes. Low profile chalk reef outcrops 100 metres offshore and more-or-less continuous chalk bedrock 50 metres from the shore datum were bored by piddocks in an area where sand scour restricted the biota to upper rock surfaces only. It was noted that the chalk was particularly friable at station 28, which may have prevented its colonisation by kelp plants at this site.

### 3.2.2 Subtidal biotopes: description and comments

Each of the habitats surveyed by diving in 1997 was assigned a biotope category based on the latest MNCR subtidal biotope manual (Connor *et al* 1997b). In some cases broader categories were selected from the hierarchical classification when the data available were insufficient to determine more precise biotopes. Five specific biotopes were identified within the cSAC in August 1997 and these are described below. An additional two biotopes were recorded by the 1995 survey. The occurrence and distribution of subtidal biotopes recorded in the 1995 MNCR survey is shown in figure 10 , and in figure 11 overlain on the acoustic map of Davies (1995). Similar distribution maps for the biotopes recorded in 1997 are shown in figures 12 and 13 respectively. Biotopes are also listed in tables 6 and 7 by stations investigated, with depths, percentage area of open chalk, and number of species recorded (see also table 8 for Ramsgate harbour approach). A full species inventory (with relative abundances) for past and present survey stations is given in table 9.

**MIR.KR Ldig.Pid** *Laminaria digitata* and piddocks on sublittoral fringe soft rock. This biotope was recorded from three locations (stations 1, 9, and 13) at Epple Bay, Fulsam Rock, and Whiteness, respectively. It is known from the intertidal biotope mapping to occur extensively around the Thanet coastline (see appendix 2), but its extension into the shallow infralittoral zone at each of these sites was limited to between 35 and 50 metres from the shore datum positions. The very shallow infralittoral zone was not investigated by the previous diving survey so this biotope was not recorded in 1995.

The extremely turbid water around Thanet has a marked effect on the distribution of kelp in the area. Individual plants are generally small (around 0.75m) and kelp forests are unable to become properly established. At Epple Bay, in the western region of the north coast of Thanet, the sediment load is particularly influenced by the proximity of the Thames estuary. Here, *L.digitata* was recorded as rare, although the chalk was densely colonised by a rich flora dominated by *Halurus flosculosus*, with *Ceramium nodulosum*, *Hypoglossum hypoglossoides*, and *Dictyota dichotoma*. Kelp was recorded as abundant at Fulsam Rock and common at Whiteness, but the underflora was less dense (around 40% cover at each site) than at Epple Bay. At North Foreland kelp was not recorded in the shallow infralittoral zone, possibly because of heavy scouring, and the rock in this zone at Dumpton Gap may have been too friable to support laminarians, although this site was not investigated inshore from the 50 metre station. Nevertheless, MIR.KR Ldig.Pid was recorded on the littoral biotope map at both of these sites.

**MCR.SfR Pid** Piddocks with a sparse associated fauna in upward-facing circalittoral very soft chalk or clay. This biotope was found at nine of the 33 stations investigated in August 1997 and as such was the most frequently encountered biotope. It was also recorded at eight sites in 1995, which was equivalent to just over half of those within the boundary of the cSAC. The biotope also comprised part of the habitats present at a further three sites. Scour tended to restrict the associated fauna in the shallower examples of this biotope, notably at stations 14, 15, and 24 where only six or seven species were recorded. Richer examples occurred where the presence of occasional cobbles and pebbles provided surfaces for colonisation in addition to the bedrock.

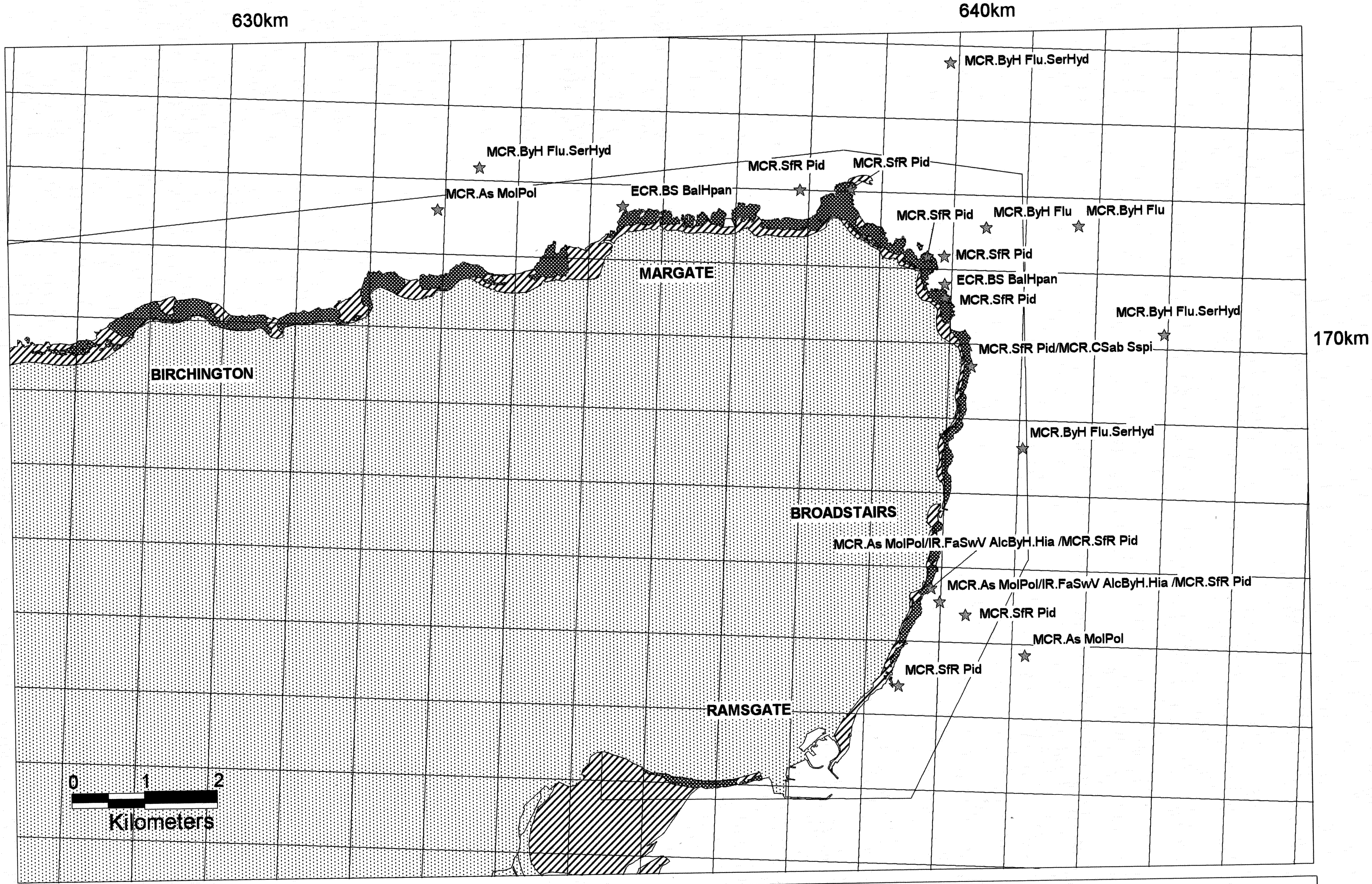


Figure 10. Map showing survey stations in 1995 and the biotopes recorded.

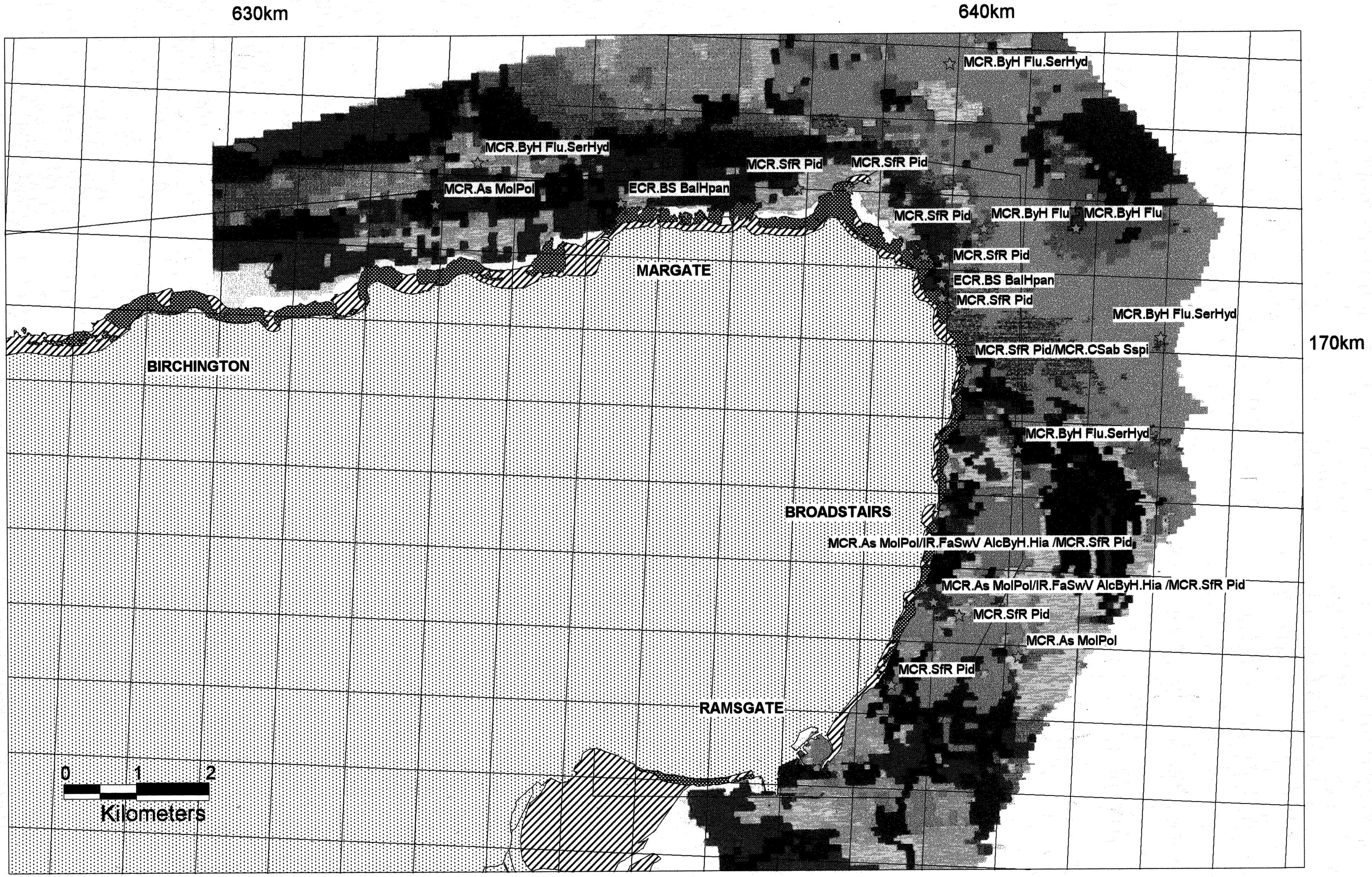


Figure 11. Map showing survey stations in 1995 and the biotopes recorded, overlaying Davies (1995) acoustic data.

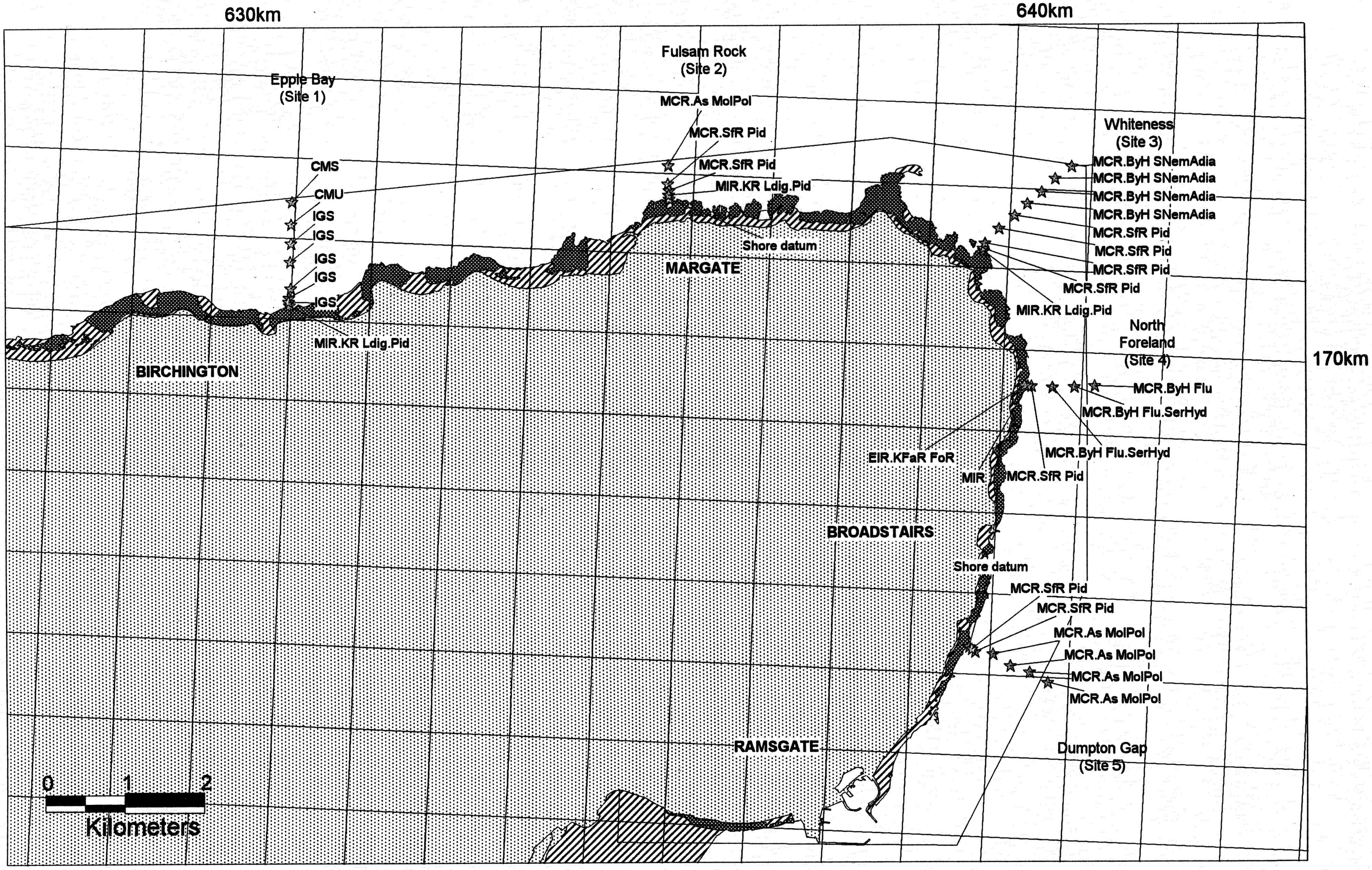


Figure 12. Map showing sublittoral survey stations in Aug 1997 and the biotopes recorded.

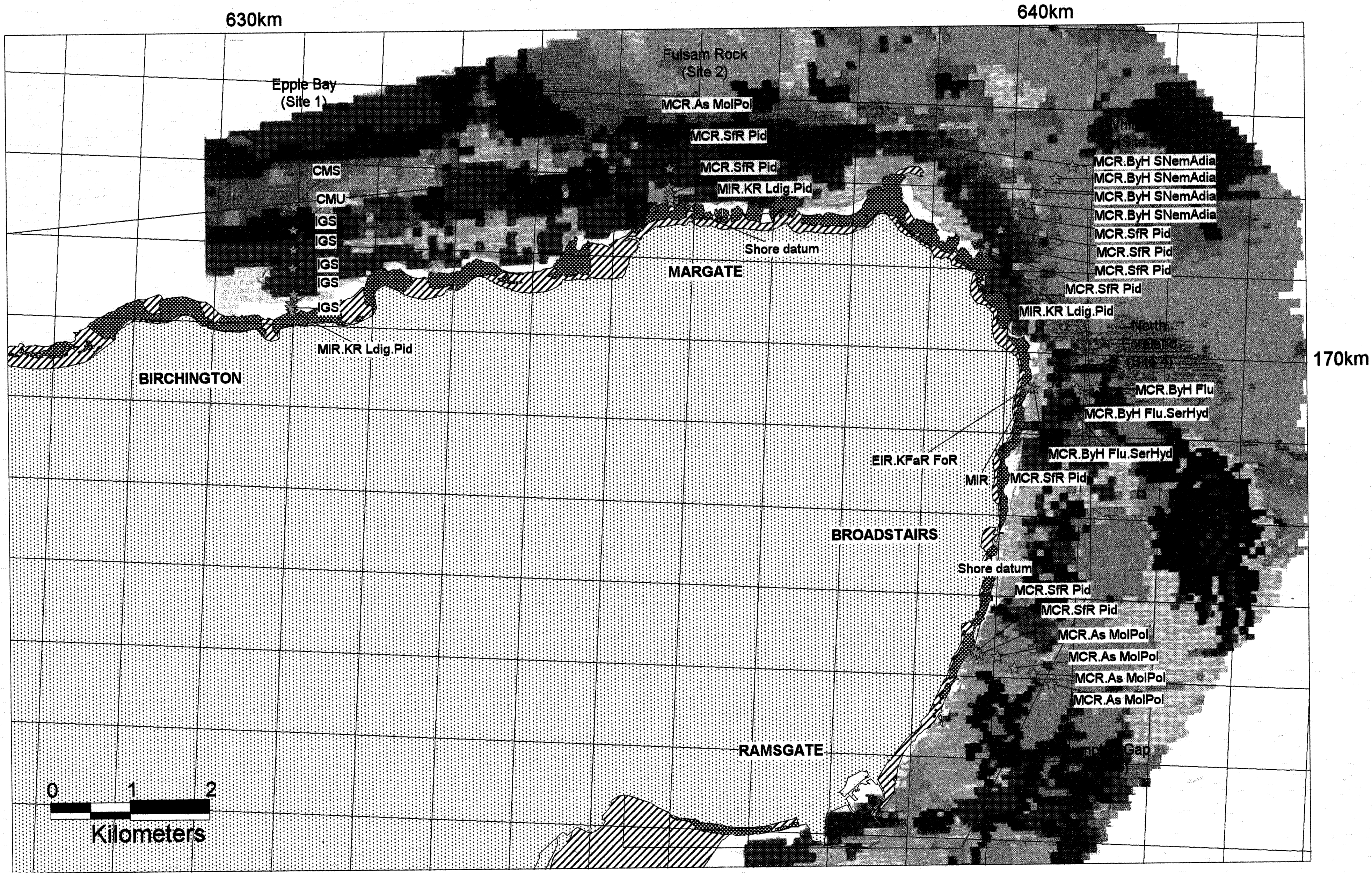


Figure 13. Map showing sublittoral survey stations in Aug 1997 and the biotopes recorded, overlaying Davies (1995) acoustic data.

**MCR.As MolPol** _Molgula manhattensis_ and _Polycarpa_ spp. with erect sponges on tide-swept moderately exposed circalittoral rock. This biotope was the only other one recorded in 1997 which occurred on a circalittoral exposure of chalk reef at Fulsam Rock. It was also recorded on chalk in 1995 at two sites where it formed part of the biotope complexes near Dumpton Gap. On other substrata it was described from four stations off Dumpton Gap in 1997 and from two sites surveyed in 1995. One of these was also offshore from Dumpton Gap, beyond the limit of the cSAC, but demonstrating that a considerable area of seabed was occupied by this biotope in the locality. The other was recorded in the silt-influenced region between Epple Bay and Fulsam Rock, near the boundary of the cSAC. At these other stations the ascidian community occurred on cobble substrata, although bedrock was reported below the sediment in two positions off Dumpton Gap.

In the turbid waters around Thanet, *Molgula* was the only component of the ascidian fauna in this biotope and the sponge fauna was extremely depauperate. In other sectors of the coast much richer species assemblages have been reported for this biotope; the average diversity recorded in Thanet was 25 species. Furthermore, the examples of MCR.As MolPol in Thanet generally occurred in much shallower water than described in the biotope manual by Connor *et al.* The biotope was recorded here from depths of as little as 2.8 metres, although because of high turbidity these habitats were still considered to be within the circalittoral zone. For these reasons it may be appropriate to describe a variant of this biotope based on the communities found in this area.

**MCR.ByH SNemAdia** Sparse sponges, _Nemertesia_ spp., _Alcyonidium diaphanum_ and _Bowerbankia_ spp. on circalittoral mixed substrata. In the four deeper and relatively stable communities off Whiteness the habitats had an affinity to this biotope. *A.diaphanum*, recorded as abundant at each of these four stations, was the dominant bryozoan, and the hydroid *Halecium beanii* was a frequent component of the fauna along with the visually dominant hydroids *Nemertesia antennina* and *Abietinaria abietina*. *H.beanii* was not recorded in 1995, but was found on 15 occasions in August 1997, associated mainly with cobble areas. It was considered to be a characterising species in the fauna of three *Flustra* habitats (stations 25, 26, and 27) off North Foreland. Other species recorded within these communities in 1997, but not in 1995, included *Chartella papyracea*, a foliose bryozoan with a southern distribution, and the branching sponge *Haliclona oculata*, both of which were found at stations 18, 19, and 20. The nudibranch *Acanthodoris pilosa*, recorded as occasional at stations 19, 20, and 21 was also associated with the MCR.By SNemAdia biotope which had a relatively high diversity for the Thanet sites with an average of 30 species. Nevertheless, the number of species recorded at each of these stations decreased towards the shore.

**MCR.ByH FluSerHyd** _Sertularia argentea, S.cupressina_ and _Hydrallmania falcata_ on tide-swept circalittoral cobbles and pebbles. In shallower, less stable conditions the habitats were better fitted to this biotope which was recorded at stations 25 and 26, off North Foreland, in 1997 and was found nearby in 1995. The MNCR survey also found this biotope to be widespread at sites beyond the boundary of the cSAC. In comparison with MCR.SNemAdia, this biotope was much less diverse with an average of only 17 species. The related, broader category of MCR.Flu was recorded for station 27 off North Foreland in 1997; this probably corresponds to the R6.Flu biotope recorded in 1995 in the vicinity of Whiteness.

**ECR.BS BalHpan** _Balanus crenatus, Halichondria panicea_ and _Alcyonidium diaphanum_ on extremely tideswept sheltered circalittoral rock. This barnacle dominated biotope, recorded in shallow sites where small boulders and cobbles were encrusted by *Balanus crenatus*, was detected in 1995 during the MNCR subtidal survey of Thanet at their sites 11 and 12 (figures 6, 10 and 11).

**IR.FaSWV AlcByH.Hia** *Hiatella arctica*, bryozoans and ascidians on vertical infralittoral soft rock. This was one of a mixture of biotopes recorded in 1995 by the MNCR survey at Dumpton Gap (figures 10 and 11); it was associated with MCR.As MolPol and MCR.SfR Pid.

**Other biotopes**

Broad biotope categories were also assigned to the fine sediments which occurred offshore from Epple Bay. An extensive area of shallow "infralittoral gravels and sands" (IGS) encompassed five stations, and "circalittoral muddy sands" (CMS) and "circalittoral muds" (CMU) were each assigned to one station. The CMU biotope occurred in a depth of 5.2 metres in Thanet instead of the more usual depth range of 15-20 metres outlined in Connor *et al* (1995) for these muds.

Table 5. Attempted interpretation of relationship between Davies' figures 7 and 8.

| Figure 7 Acoustic cluster | Figure 8 Biotope | Davies' definition |
|---|---|---|
| **0** | 5} | Stones overlain with sediment |
| | *} | ? Fine sediment |
| **1** | - | Area not surveyed |
| **2** | 4 | Chalk overlain with sediment |
| **3** | 5 | Stones overlain with sediment |
| **4** | * | ?Sediment with stones |
| **5** | *} | ?Fine sediment |
| | 5} | Stones overlain with sediment |
| **6** | 5 | Stones overlain with sediment |
| **7** | 4 | Chalk overlain with sediment |
| **8** | 5 | Stones overlain with sediment |
| **9** | 2 | Circalittoral chalk |
| **10** | 4 | Chalk overlain with sediment |
| **11** | 1 | Infralittoral chalk |
| **12** | 5 | Stones overlain with sediment |
| **13** | * | ?Fine sediment |
| **14** | * | ?Stones and sediment |
| **15** | 1 | Infralittoral chalk |
| **16** | 3 | Tideswept chalk |
| **17** | * | ?Fine sediment |
| | | |
| 11,15 | **1** | Infralittoral chalk |
| 9 | **2** | Circalittoral chalk |
| 16 | **3** | Tideswept chalk |
| 2,7,10 | **4** | Chalk overlain with sediment |
| 0,3,5,6,8,12 | **5** | Stones overlain with sediment |
| 0,5,13,17 | * | ?Fine sediment |
| 4 | * | ?Sediment with stones |
| 14 | * | ?Stones and sediment |

* = not numbered by Davies

Key to Davies' acoustic cluster colour codes (figures 7, 9, 11, 13).

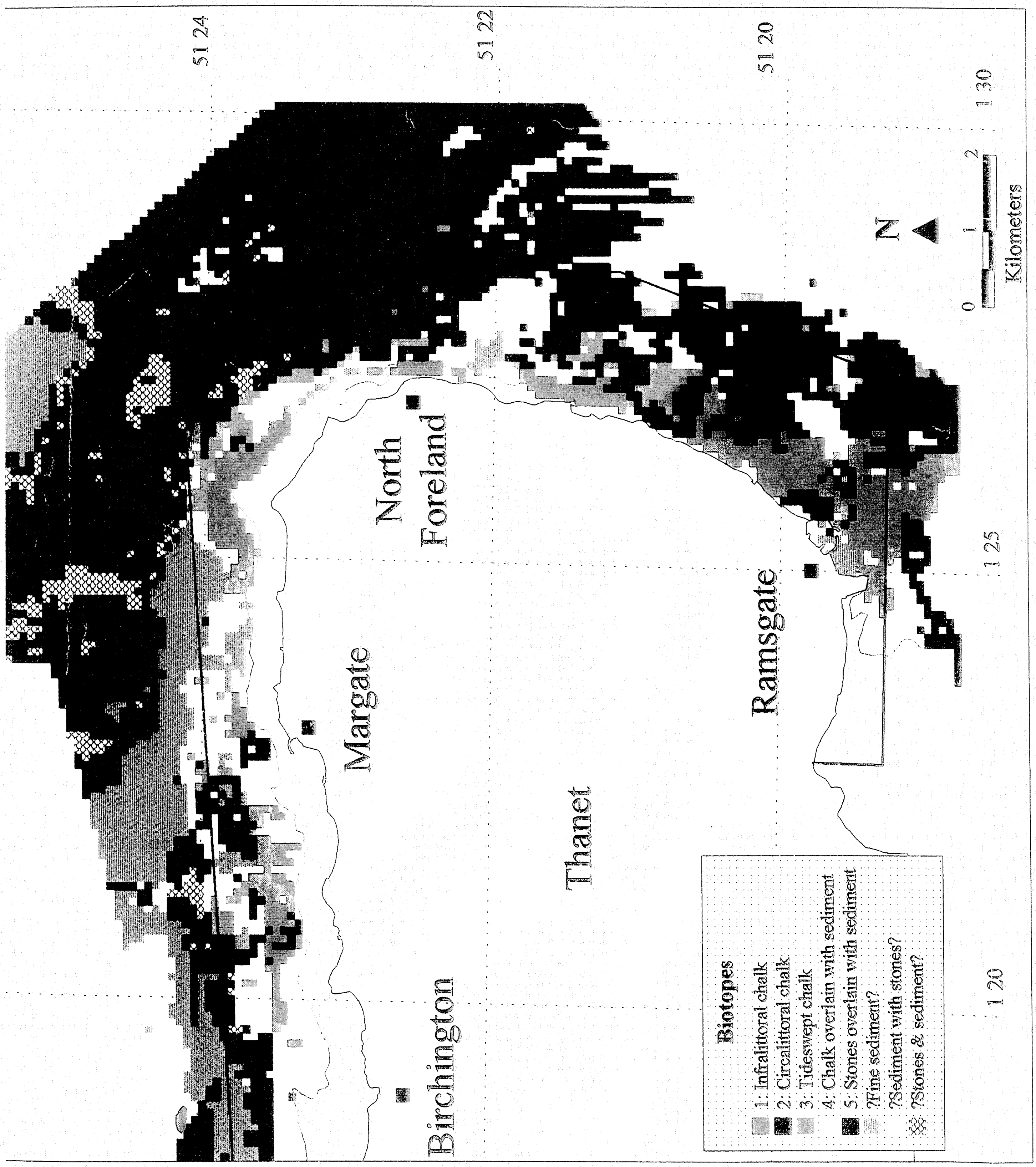


Figure 14. Predicted distribution of 'biotopes' around the Thanet coast (Davies' figure 8).

Table 6. Sublittoral survey stations 1995 (see figure 6 for station locations).

| Dive | Biotopes recorded | No of sp | % cover chalk | Depth |
|---|---|---|---|---|
| 1 | MCR.ByH Flu | 32.00 | 0 | 12.00 |
| 2 | MCR.ByH Flu | 18.00 | 0 | 12.00 |
| 3 | MCR.As MolPol | 15.00 | 0 | 7.00 |
| 4 | MCR.ByH Flu.SerHyd | 14.00 | 0 | 9.00 |
| 5 | MCR.ByH Flu.SerHyd | 18.00 | 0 | 14.00 |
| 6 | MCR.ByH Flu.SerHyd | 26.00 | 0 | 10.00 |
| 7 | MCR.SfR Pid | 41.00 | 60 | 4.00 |
| 8 | MCR.SfR Pid | 18.00 | 45 | 6.00 |
| 9 | MCR.SfR Pid | 27.00 | 30 | 3.00 |
| 10 | MCR.SfR Pid | 35.00 | 85 | 2.00 |
| 11 | ECR.BS BalHpan | 10.00 | 80 | 3.00 |
| 12 | ECR.BS BalHpan | 30.00 | 0 | 3.50 |
| 13 | MCR.SfR Pid/MCR.CSab Sspi | 42.00 | 15 | 3.00 |
| 14 | MCR.SfR Pid | 36.00 | 75 | 2.00 |
| 15 | MCR.As MolPol/IR.FaSwV AlcByH.Hia /MCR.SfR | 38.00 | 75 | 4.50 |
| 16 | MCR.SfR Pid | 32.00 | 70 | 4.00 |
| 17 | MCR.As MolPol/IR.FaSwV AlcByH.Hia /MCR.SfR | 25.00 | 70 | 4.50 |
| 18 | MCR.SfR Pid | 41.00 | 40 | 8.00 |
| 19 | MCR.As MolPol | 27.00 | 0 | 14.00 |
| 20 | MCR.ByH Flu.SerHyd | 10.00 | 5 | 7.50 |

Table 7. Sublittoral survey stations August 1997.

| Station | Locality | Position | Biotopes | No of spl | % cover chalk | Depth |
|---|---|---|---|---|---|---|
| 1 | Epple Bay | Shore Bouy | MIR.KR Ldig.Pid | 42.00 | 80 | 0.00 |
| 2 | Epple Bay | 50m out | IGS | 1.00 | 0 | 0.00 |
| 3 | Epple Bay | 100m out | IGS | 1.00 | 0 | 0.10 |
| 4 | Epple Bay | 5 | IGS | 0.00 | 0 | 0.10 |
| 5 | Epple Bay | 4 | IGS | 1.00 | 0 | 0.60 |
| 6 | Epple Bay | 3 | IGS | 0.00 | 0 | 0.40 |
| 7 | Epple Bay | 2 | CMU | 0.00 | 0 | 5.00 |
| 8 | Epple Bay | 1 | CMS | 8.00 | 0 | 11.00 |
| 9 | Fulsam Rock | 50m | MIR.KR Ldig.Pid | 25.00 | 80 | 1.00 |
| 10 | Fulsam Rock | 100m | MCR.SfR Pid | 36.00 | 95 | 2.00 |
| 11 | Fulsam Rock | 2 | MCR.SfR Pid | 27.00 | 60 | 3.00 |
| 12 | Fulsam Rock | 1 | MCR.As MolPol | 27.00 | 80 | 8.00 |
| Shore datum | Fulsam Rock | Inner Marker M.shore | Shore datum | 34.00 | 0 | 0.00 |
| 13 | Whiteness | Inner Marker M.shore | MIR.KR Ldig.Pid | 31.00 | 60 | 0.00 |
| 14 | Whiteness | 50m | MCR.SfR Pid | 7.00 | 50 | 1.00 |
| 15 | Whiteness | 100m | MCR.SfR Pid | 13.00 | 50 | 3.00 |
| 16 | Whiteness | 6 | MCR.SfR Pid | 46.00 | 65 | 6.00 |
| 17 | Whiteness | 5 | MCR.SfR Pid | 0.00 | 70 | 8.00 |
| 18 | Whiteness | 4 | MCR.ByH SNemAdia | 21.00 | 0 | 13.00 |
| 19 | Whiteness | 3 | MCR.ByH SNemAdia | 19.00 | 0 | 12.00 |
| 20 | Whiteness | 2 | MCR.ByH SNemAdia | 28.00 | 0 | 13.00 |
| 21 | Whiteness | 1 | MCR.ByH SNemAdia | 29.00 | 5 | 13.00 |
| 22 | North Foreland | (inner) | EIR.KFaR FoR | 14.00 | 90 | 0.10 |
| 23 | North Foreland | 50m | MIR | 2.00 | 50 | 0.50 |
| 24 | North Foreland | 100m | MCR.SfR Pid | 6.00 | 50 | 2.00 |
| 25 | North Foreland | 3 | MCR.ByH Flu.SerHyd | 14.00 | 0 | 7.00 |
| 26 | North Foreland | 2 | MCR.ByH Flu.SerHyd | 16.00 | 0 | 8.00 |
| 27 | North Foreland | 1 | MCR.ByH Flu | 18.00 | 0 | 8.00 |
| Shore datum | Dumpton Gap | inner | Shore datum | 0.00 | 0 | 0.00 |
| 28 | Dumpton Gap | middle | MCR.SfR Pid | 32.00 | 90 | 0.10 |
| 29 | Dumpton Gap | outer | MCR.SfR Pid | 18.00 | 50 | 1.00 |
| 30 | Dumpton Gap | 4 | MCR.As MolPol | 23.00 | 0 | 3.00 |
| 31 | Dumpton Gap | 3 | MCR.As MolPol | 21.00 | 0 | 3.00 |
| 32 | Dumpton Gap | 2 | MCR.As MolPol | 29.00 | (100) | 5.00 |
| 33 | Dumpton Gap | 1 | MCR.As MolPol | 30.00 | 0 | 5.00 |

Table 8. Ramsgate harbour approach channel, subtidal survey stations (cf Northen, 1997).

| Transect | Station | Locality | No_of sp | PcntBr | Depth |
|---|---|---|---|---|---|
| 1 | 1.1 | Harbour approach | 23.00 | 0.00 | 3.50 |
| 2 | 1.2 | Harbour approach | 3.00 | 0.00 | 5.50 |
| 3 | 1.3 | Harbour approach | 26.00 | 0.00 | 7.00 |
| 4 | 1.4 | Harbour approach | 16.00 | 10.00 | 9.00 |
| 5 | 1.5 | Harbour approach | 24.00 | 60.00 | 7.50 |
| 6 | 1.6 | Harbour approach | 26.00 | 0.00 | 3.00 |
| 7 | 1.7 | Harbour approach | 2.00 | 0.00 | 5.50 |
| 8 | 1.8 | Harbour approach | 40.00 | 0.00 | 4.50 |
| 9 | 2.1 | Ramsgate Rd, S.of Harbour | 30.00 | 0.00 | 3.50 |
| 10 | 3.1 | Ramsgate Sands N.of Harb. | 20.00 | 0.00 | 2.50 |

Table 9. Species recorded subtidally in the cSAC.

MNCR survey number (MNCR)

| MNCR survey number | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 | 635 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haliphysema tumanowiczi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PORIFERA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leucosolenia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leucosolenia botryoides | O | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - |
| Scypha ciliata | P | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | R | - | - |
| DEMOSPONGIAE | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | P | - | O | - | - |
| Cliona celata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Halichondria bowerbanki | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - |
| Halichondria panicea | - | - | - | - | - | - | F | - | O | O | - | - | - | O | O | O | O | F | - | - |
| Esperiopsis fucorum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Myxilla incrustans | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Microciona atrasanguinea | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Haliclona oculata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Porifera indet crusts | - | - | - | - | - | - | C | - | - | - | - | - | - | - | O | - | - | - | - | - |
| HYDROZOA | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| Ectopleura dumortieri | - | - | - | - | C | C | - | - | - | - | - | - | - | - | - | - | - | - | O | O |
| Tubularia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tubularia indivisa | F | C | O | O | R | C | C | O | F | O | F | F | F | O | O | F | F | O | O | O |
| Eudendrium | - | - | - | O | - | - | O | - | - | - | - | - | - | P | - | O | - | - | R | - |
| Eudendrium capillare | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Eudendrium rameum | O | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydractinia echinata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - |
| Halecium beanii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Halecium halecinum | O | - | - | - | - | O | - | - | - | O | - | - | - | O | R | - | - | R | - | - |
| Halecium lankesteri | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nemertesia antennina | F | - | - | - | - | F | - | O | - | - | - | - | - | - | O | O | O | O | O | - |
| Nemertesia ramosa | - | C | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Plumularia setacea | - | - | - | - | - | - | - | - | - | - | - | - | R | - | O | - | - | - | - | - |
| Abietinaria abietina | R | - | - | - | - | - | - | - | - | - | - | R | - | - | R | - | O | F | O | - |
| Diphasia pinaster | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Diphasia rosacea | O | - | - | - | - | - | O | - | F | - | - | O | O | - | - | - | - | C | O | O |
| Hydrallmania falcata | R | F | - | O | F | - | F | O | - | - | - | O | R | - | - | - | R | O | O | R |
| Sertularella gaudichaudi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sertularella polyzonias | - | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | - | - | - | - |
| Sertularia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sertularia argentea | R | O | - | F | F | O | - | O | F | O | F | O | F | O | F | O | O | O | - | - |
| Sertularia cupressina | - | - | - | - | F | - | F | - | O | - | - | O | - | - | - | - | O | F | F | O |
| Tridentata distans | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Clytia hemisphaerica | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Clytia paulensis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Obelia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - |
| Obelia bidentata | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Obelia dichotoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | - | - |
| Obelia longissima | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Orthopyxis integra | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Alcyonium digitatum | O | C | O | R | R | O | O | O | - | O | - | - | - | - | R | O | R | O | O | - |
| Cerianthus lloydii | - | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Urticina felina | R | F | - | - | O | F | F | F | O | R | - | O | - | O | O | O | R | O | F | R |
| Urticina eques | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Diadumene cincta | - | - | - | - | - | - | C | - | - | - | - | - | O | - | O | - | - | O | - | - |
| Metridium senile | - | - | R | - | - | - | R | O | - | - | - | O | - | - | - | - | - | - | - | - |
| Sagartia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sagartia elegans | - | - | - | - | - | - | - | O | - | C | - | C | F | - | - | O | - | - | - | - |
| Sagartia troglodytes | F | O | O | O | F | C | O | O | A | C | - | - | O | O | O | O | F | F | F | R |
| Cereus pedunculatus | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - |
| NEMERTEA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ENTOPROCTA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| POLYCHAETA | - | - | - | - | F | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - |
| Lepidonotus squamatus | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Polydora | - | - | - | - | - | - | F | - | A | - | C | - | - | - | - | - | F | A | - | - |
| Arenicola marina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sabellaria spinulosa | - | - | P | - | - | - | F | R | - | - | - | O | C | O | O | - | - | R | - | - |
| Terebellidae | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lanice conchilega | - | - | - | - | - | - | - | R | O | O | R | O | F | - | F | O | F | O | O | - |
| Sabella pavonina | O | F | - | - | O | O | O | - | - | - | - | - | - | - | O | R | R | O | R | - |
| Serpulidae | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - |
| Pomatoceros | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pomatoceros triqueter | O | O | O | - | - | O | C | - | F | O | - | O | F | O | F | O | F | O | O | - |
| PYCNOGONIDA | - | - | - | - | - | - | - | - | - | - | - | - | F | - | - | - | - | - | - | - |
| Nymphon brevirostre | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nymphon gracile | - | - | - | P | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Callipallene brevirostris | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pycnogonidae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

MNCR survey number (Ramsgate)

| MNCR survey number | 637 | 637 | 637 | 637 | 637 | 637 | 637 | 637 | 637 | 637 |
|---|---|---|---|---|---|---|---|---|---|---|
| Haliphysema tumanowiczi | O | - | O | - | O | P | - | O | P | P |
| PORIFERA | - | - | R | - | - | - | - | - | - | - |
| Leucosolenia | - | - | - | - | - | - | - | - | - | - |
| Leucosolenia botryoides | - | - | - | - | - | - | - | - | - | - |
| Scypha ciliata | - | - | - | - | R | - | - | - | - | - |
| DEMOSPONGIAE | - | - | - | - | - | - | - | - | - | - |
| Cliona celata | - | - | - | - | - | - | - | - | - | - |
| Halichondria bowerbanki | - | - | - | - | - | - | - | - | - | - |
| Halichondria panicea | O | - | - | - | - | - | - | O | O | - |
| Esperiopsis fucorum | - | - | - | - | - | - | - | O | - | - |
| Myxilla incrustans | - | - | - | - | - | - | - | - | R | - |
| Microciona atrasanguinea | - | - | - | - | - | - | - | - | - | - |
| Haliclona oculata | - | - | - | - | - | - | - | - | O | - |
| Porifera indet crusts | O | - | - | - | - | O | - | R | - | - |
| HYDROZOA | - | - | - | - | - | - | - | - | - | - |
| Ectopleura dumortieri | - | - | - | - | - | - | - | - | - | - |
| Tubularia | R | - | - | - | - | O | - | - | - | - |
| Tubularia indivisa | - | - | - | - | O | - | - | O | O | - |
| Eudendrium | - | - | - | - | - | - | - | - | - | - |
| Eudendrium capillare | - | - | - | - | - | - | - | - | - | - |
| Eudendrium rameum | - | - | - | - | - | - | - | - | - | - |
| Hydractinia echinata | - | - | - | - | - | - | - | - | - | - |
| Halecium beanii | F | - | O | R | - | O | - | O | O | - |
| Halecium halecinum | - | - | - | - | - | - | - | - | - | - |
| Halecium lankesteri | - | - | - | - | - | - | - | - | - | - |
| Nemertesia antennina | O | - | - | - | - | - | - | F | O | - |
| Nemertesia ramosa | - | - | - | - | - | - | - | - | - | - |
| Plumularia setacea | - | - | O | O | F | - | - | R | - | - |
| Abietinaria abietina | - | - | R | - | - | - | - | O | - | - |
| Diphasia pinaster | - | - | - | - | - | - | - | - | - | - |
| Diphasia rosacea | - | - | - | - | - | - | - | - | - | - |
| Hydrallmania falcata | - | - | - | R | R | - | - | R | - | - |
| Sertularella gaudichaudi | F | - | O | O | P | F | - | F | F | P |
| Sertularella polyzonias | - | - | - | - | - | - | - | - | - | - |
| Sertularia | - | - | - | - | - | - | - | - | - | - |
| Sertularia argentea | - | - | - | - | - | O | - | F | - | - |
| Sertularia cupressina | - | - | - | - | - | - | - | - | - | - |
| Tridentata distans | - | - | - | - | C | - | - | F | P | - |
| Clytia hemisphaerica | - | - | - | - | - | - | - | - | - | - |
| Clytia paulensis | - | - | - | - | - | - | - | - | - | - |
| Obelia | - | - | - | - | - | - | - | - | - | - |
| Obelia bidentata | - | - | - | - | - | - | - | - | - | - |
| Obelia dichotoma | - | - | - | - | - | - | - | - | - | - |
| Obelia longissima | - | - | - | - | - | - | - | - | - | - |
| Orthopyxis integra | - | - | - | - | - | - | - | - | - | - |
| Alcyonium digitatum | - | - | - | - | - | - | - | R | O | - |
| Cerianthus lloydii | - | - | - | - | - | - | - | - | - | - |
| Urticina felina | O | - | R | - | - | O | - | F | O | R |
| Urticina eques | - | - | - | - | - | - | - | - | - | - |
| Diadumene cincta | - | - | - | - | - | - | - | - | - | - |
| Metridium senile | - | - | - | - | - | - | - | - | - | - |
| Sagartia | - | - | - | - | - | - | - | - | - | - |
| Sagartia elegans | R | - | - | R | R | O | - | O | P | R |
| Sagartia troglodytes | - | - | - | - | - | - | - | - | - | - |
| Cereus pedunculatus | - | - | - | - | - | - | - | - | - | - |
| NEMERTEA | - | - | - | - | - | - | - | - | - | - |
| ENTOPROCTA | - | - | - | - | - | - | - | - | - | - |
| POLYCHAETA | - | - | - | - | - | - | - | - | - | - |
| Lepidonotus squamatus | - | - | - | - | - | - | - | - | - | - |
| Polydora | - | - | - | - | - | O | - | - | - | - |
| Arenicola marina | - | - | - | - | - | - | - | - | - | - |
| Sabellaria spinulosa | - | - | P | - | - | - | - | F | P | F |
| Terebellidae | - | - | - | - | - | - | - | - | P | - |
| Lanice conchilega | - | - | O | O | P | R | - | - | - | O |
| Sabella pavonina | - | - | - | - | - | - | - | - | O | - |
| Serpulidae | - | - | - | - | - | - | - | - | - | - |
| Pomatoceros | - | - | P | - | - | O | - | F | O | - |
| Pomatoceros triqueter | - | - | - | - | O | - | - | - | - | - |
| PYCNOGONIDA | - | - | O | - | - | - | - | - | - | - |
| Nymphon brevirostre | - | - | - | - | - | - | - | - | - | - |
| Nymphon gracile | - | - | - | - | - | - | - | - | - | - |
| Callipallene brevirostris | - | - | - | - | - | - | - | - | - | - |
| Pycnogonidae | - | - | - | - | F | - | P | - | - | - |

MNCR survey number (NHM)

| MNCR survey number | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 | 695 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haliphysema tumanowiczi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PORIFERA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leucosolenia | R | - | - | - | - | - | - | - | - | - | - | R | - | - | - | P | - | - | - | P | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Leucosolenia botryoides | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Scypha ciliata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DEMOSPONGIAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cliona celata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - |
| Halichondria bowerbanki | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Halichondria panicea | O | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | O | - | O | - | - | R |
| Esperiopsis fucorum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Myxilla incrustans | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Microciona atrasanguinea | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | - | - |
| Haliclona oculata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | F | R | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Porifera indet crusts | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | R | R | - | - | - | O | R | O | - | - | - |
| HYDROZOA | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ectopleura dumortieri | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tubularia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tubularia indivisa | - | - | - | - | - | - | - | - | - | O | R | - | P | - | R | R | - | O | C | - | O | P | - | - | P | O | - | R | O | R | O | - | - |
| Eudendrium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Eudendrium capillare | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R |
| Eudendrium rameum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydractinia echinata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Halecium beanii | - | - | - | - | - | - | - | - | - | O | O | O | - | - | - | O | O | F | F | O | O | - | - | - | O | O | C | - | - | - | O | O | O |
| Halecium halecinum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | O | - | - | - |
| Halecium lankesteri | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nemertesia antennina | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | C | O | C | C | C | C | - | - | - | - | O | - | - | - | O | - | - | O |
| Nemertesia ramosa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Plumularia setacea | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | - | - |
| Abietinaria abietina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | C | C | O | O | - | - | - | - | - | - | - | - | - | - | O | O |
| Diphasia pinaster | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Diphasia rosacea | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydrallmania falcata | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | O |
| Sertularella gaudichaudi | P | - | - | - | - | - | - | - | - | O | O | O | - | - | - | O | - | - | - | - | - | - | - | - | - | - | P | O | - | O | P | O | P |
| Sertularella polyzonias | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sertularia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | R |
| Sertularia argentea | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Sertularia cupressina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tridentata distans | - | - | - | - | - | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | - | - | O | O | P |
| Clytia hemisphaerica | - | - | - | - | - | - | - | - | P | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | P |
| Clytia paulensis | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Obelia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Obelia bidentata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Obelia dichotoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Obelia longissima | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Orthopyxis integra | C | - | - | - | - | - | - | - | C | F | - | - | P | - | - | - | - | - | - | O | - | - | - | - | - | - | - | C | - | - | - | - | - |
| Alcyonium digitatum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | O | ɔ | C | O | O | - | - | - | R | O | - | - | - | - | - | - | - |
| Cerianthus lloydii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Urticina felina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | R | R | - | - | - | - | - | - | - | - | - | - | O | - | O | - |
| Urticina eques | - | - | - | - | - | - | - | - | - | F | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R | - | R |
| Diadumene cincta | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | R |
| Metridium senile | - | - | - | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | R | - | - | - | - | - | - | - | - | - | - | - | - |
| Sagartia | - | - | - | - | - | - | - | - | O | - | R | R | - | - | - | O | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - |
| Sagartia elegans | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | P | - | P | O | - | - | - | - | P | P | P | - | - | O | - | O | - |
| Sagartia troglodytes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cereus pedunculatus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| NEMERTEA | P | - | - | - | - | - | - | - | - | - | - | - | F | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | P | P |
| ENTOPROCTA | - | - | - | - | - | - | - | - | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| POLYCHAETA | P | - | - | - | R | - | - | - | P | P | P | P | P | - | - | P | - | - | - | P | P | - | - | - | - | - | - | P | - | - | - | P | P |
| Lepidonotus squamatus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polydora | F | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Arenicola marina | - | O | O | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sabellaria spinulosa | O | - | - | - | - | - | - | - | - | - | - | - | F | - | - | - | - | - | - | - | - | P | - | - | - | O | - | - | - | - | - | - | - |
| Terebellidae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lanice conchilega | O | - | - | - | - | - | - | O | - | O | A | O | F | O | O | - | O | - | - | O | A | - | - | O | O | P | - | O | O | O | O | O | O |
| Sabella pavonina | - | - | - | - | - | - | - | - | - | - | - | O | - | - | - | C | O | [illegible] | A | C | C | - | - | - | - | - | O | - | - | O | - | O | - |
| Serpulidae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pomatoceros | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | O | O | - | O |
| Pomatoceros triqueter | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PYCNOGONIDA | P | - | - | - | - | - | - | - | P | P | P | - | P | - | - | P | P | - | P | P | P | P | - | - | P | - | P | - | - | - | P | P | P |
| Nymphon brevirostre | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nymphon gracile | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Callipallene brevirostris | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pycnogonidae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Key:

S = superabundant
A = abundant
C = common
F = frequent
0 = occasional
R = rare
P = present
\- = absent

As defined by Hiscock (1996).

| | |
|---|---|
| Verruca stroemia | - - - - - - - - - - - - - - - - - - - - - - - - - P - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Balanus crenatus | - - - - - - F O F O A A C O O O - - - - - - - - - P - - - P O - - - - - - - - - R R - - - - - - - - - - - - - - - - - - - - - |
| Elminius modestus | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| AMPHIPODA | O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - P P P - - P - - P P P A - - P - - A - - P P P |
| Caprellidae | P - - - - - F - - - - - - - - - - - - - - - P O P - - P - - - - - - - - - - - - - P - - - P P P P P P - - - - - - - - - - - P |
| ISOPODA | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - A - - - - - - - - - - - - - - - - - - - - - - - - - |
| Idotea linearis | - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - |
| CARIDEA | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - R R - R - - - - - - - - - - - - |
| Palaemon serratus | - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - |
| Pandalus montagui | O - - - - R - - - R - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O O F - - R - - - |
| Pagurus bernhardus | R O O - O O F - - - - - - - R O - R R - O - R - R O - O O O O - - - - - - O - O O - P - - - - - P - O - - - - - R O - O O O O |
| Galathea | - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Galathea squamifera | - - - - - - - - - R - - - - - - - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Pisidia longicornis | R O O R - P O - R O - O O - O O R O R - O - - - O O - C O - P - - - - - - - - O - - - - - P - - - - - - - - - - P - - - - - - |
| Hyas araneus | - - - - - - - - - - - - - - R O R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Hyas coarctatus | - - - - - R - - - - - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Macropodia | - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Macropodia rostrata | - - - - - - - R - - - - - - - - - - R - - - - - - - - R - - - - - - - - - - - R R O - - - R - - - - - - - - - - R - R - R - R |
| Pirimela denticulata | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R R - - |
| Cancer pagurus | R - - - - - F - O R - O F R F R - O R - - - - - - - - - - - - - - - - - - - R - - - - - - - - - P - - - - - - - - - - - - - - |
| Liocarcinus holsatus | - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - O R R - |
| Necora puber | - - - - - - O R O F - F C R O O R F - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - P - - - - - - - - - - - |
| Carcinus maenas | - - - - - - R - - - - - R R - - R - - - - - R R - O - O - - C - - - - - - - R - - - - - - - - - - - - - - - - - - - R R - - - |
| Pilumnus hirtellus | - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Gibbula cineraria | - - - - - - - - - - - - R - - - - - - - O - R - - - - - P - R - - - - - - - - - - - R R - R - - - - - - - - - - - - - - - R - |
| Calliostoma zizyphinum | - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Littorina littorea | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Hydrobia | - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Rissoa parva | - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Crepidula fornicata | - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| OPISTHOBRANCHIA | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P |
| Tritonia plebeia | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - |
| Dendronotus frondosus | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - |
| Doto | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - |
| Doto pinnatifida | O O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - |
| Acanthodoris pilosa | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - O - - O O O - - - R - - - - R R - - |
| Onchidoris bilamellata | - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Archidoris pseudoargus | - - - - - - - - - - - - - - - - R R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Janolus cristatus | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - R - - - - - - |
| Coryphella browni | F - - - - F - - - R - - R - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Flabellina pedata | - - - - - - - - - - - - - - - - - R R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Cuthona viridis | - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| PELECYPODA | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P |
| Mytilus edulis | R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O - - - - - - - - F - P P - - P - - - P R P - - - - - P - - - O O |
| Chlamys | - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Chlamys varia | - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Pododesmus patelliformis | - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Ensis | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O - - - - - - |
| Venerupis senegalensis | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - |
| Hiatella arctica | - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O - - - - - - - - - - - - - - - - - |
| Pholas dactylus | - - - - - - - O - C - - P - - - - R - - - - - - - - - - - - C - - - - - - - F - F O O O C F C - - - - - - O - - - O O - - - - |
| Barnea | - - - - - - - - - - - - - - - - C F - - - - - - - - - - - - O - - - - - - - - F - - - - - - O - - - - - - - - - - - - - - O - |
| Barnea candida | - - - - - - - - C - - - C O F C - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - |
| Barnea parva | - - - - - - C - A C - - C O F C - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Sepiola atlantica | - - - - - - - - - - - - R - R - - F - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Crisia aculeata | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - |
| Crisia eburnea | O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Alcyonidium diaphanum | F F F F F F F F O R R O O F O F O F O - F O R R O O O O F O - - - - - - - O - O R O - R O A O A A A A - - R C O C - - O O O O |
| Alcyonidium mytili | - - - - - - - - - - - - - - - - - - - - O - R - P F - P P P P - - - - - - - - - P - - - - P - - - - P - - - - - - P - - P - - |
| Vesicularia spinosa | - C - O - R - - - - - - R - - - - - O O - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - R - - - - - R - |
| Escharella immersa | - - - - - - - - - - - - - - - - - - - - P - P - P - - P - P - - - - - - - - - - P - - - - - - - - - - - - - - - - P - - P P - |
| Escharella variolosa | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - |
| Schizomavella linearis | - - - - - - - - - - - - - - - - - - - - - - - - - - - O - P C - - - - - - - - P - - - - - - - - - - - - - - - - - P P P - - - |
| Conopeum reticulum | - - - - - - - - - - - - - - - - - - - - P - P O F F - F P P P - - - - - - - - P P - - - - - P - - - P - - - - P P P P P P P P |
| Electra pilosa | - - - - F - - - C F F - O F - - F O F - - - P - - - - P - P C - - - - - - - O O O - C - - P - - - P P F - - - - - O - - P P P |
| Flustra foliacea | O F O F F O F O - O - O O - O O O O F O F O R R R R - F F - - - - - - - - - - - O O - - - P F C C O O - - - C O C - - O O O O |
| Chartella papyracea | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - O P O - - - - - - - - - - - - - |
| Callopora | - - - - - - - - - - - - - - - - - - - - - - P - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Amphiblestrum auritum | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Callopora dumerilii | - - - - - - - - - - - - - - - - - - - - - - - - - - - P - P - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Callopora lineata | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - - - - - - - - |
| Scrupocellaria reptans | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - |
| Scrupocellaria scruposa | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R P - - - - - - - - - - - - - - - - - - - - |
| Bicellariella ciliata | O - P - - O O - - O - O O - - O - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - P - - - - - - - - - - - - - |
| Bugula flabellata | - - - - - - - - - - - - O - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - P - - - - - |
| Bugula fulva | - - - - - - P - - - - - - - - - - - - - - - - - - - - O - - - - - - - - - - - - R - P - - - - - - - - - - - - - - - - - - - - |
| Bugula plumosa | - - - - - - - - - - - - O - - - - - - - - - - - - O - O O - - - - - - - - - - - - - - - - P - - - R R - - - - P - - - - - - - |
| Bugula turbinata | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - |
| Bryozoa indet crusts | - - P - - O O - - O - O O - O - - O - - F - - - - - - - - - O - - - - - - - - O - - P - - O P P P O O - - - - - P R R - - - - |
| Crossaster papposus | - - - - - - - - - - - - - - - - - - - - - - - - - - - R - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Asterias rubens | C F F R - A F - F F R O F C F F O F C O O O R O O R O C F - - - - - - - - O O O - O - - O O O C C O O - - R O O O O O C - O O |
| OPHIUROIDEA | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - F - - - - - - - - - - - - - - - - O P - - - - - - - - - - - - - - |
| Ophiothrix fragilis | - - - - - - - - - - - - - - - - - - - - - - - - - P - P - - - - - - - - - - - O - R - - - - - - - - O - - - - - - - - - - R - |
| Ophiopholis aculeata | - - - - - - F - - - - - - - - - - O - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - |
| Amphipholis squamata | O O P F P P - - - - - - O - R - - - - - - - - - - - - - P P - - - - - - - - - - P P P - - - - - - O O - - - P - - - - - - O - |
| Ophiura albida | - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - A - - - - - - - - - - - - R - - - - - - - - - - - - |

| | |
|---|---|
| ammechinus miliaris | ----------------------------------------R----RR-R------------R- |
| staplia rosea | ------O--R-OOOOO----------------------------------------------- |
| chidistoma aggregatum | -----------O---------------------------------R----------------- |
| lyclinum aurantium | ------F-OO-OF-O--O---------------------------P----------------- |
| rophora listeri | ---------------------------------------R----------------------- |
| lgula manhattensis | O-CR--OR---OFOC-A-C-F-RRFF-FCF---------P-APOORRPPOO------RRCCCC |
| ngnathus acus | --------------R------------------------------------------------ |
| xocephalus scorpius | -----------R--------------------------------------------------- |
| urulus bubalis | --------------------R------------------------------------------ |
| onus cataphractus | -------------------------------------R------------------------- |
| clopterus lumpus | ------R-------------------------------------------------------- |
| olis gunnellus | ------------R-OR-R--------------------------------------------- |
| llionymus lyra | ----------------------------------------------------------R---- |
| matoschistus | -----------------R-----------------------R----R---------------- |
| euronectidae | -----------------------O--------------------------------------- |
| ythrotrichia carnea | ---------------------------------------------P----------------- |
| lmaria palmata | ------------------------------R-------O------------------------ |
| rallinaceae | ------R-------------------------------------------------------- |
| acilaria gracilis | ----------------------------------------------------R---------- |
| yllophora crispa | ------O-----O--------------------------------------------R----- |
| yllophora pseudoceranoides | --------FO--OF-------------------------------------O----------- |
| ondrus crispus | ------------------------------R-------------------------------- |
| lyides rotundus | -------------O------------------------------------------------- |
| ocamium cartilagineum | --------OF---F---------------RR-------FRRRO-PORRRRRC-----C----- |
| lliblepharis ciliata | ----------------------------R---------------------------------- |
| stoclonium purpureum | ---------------R-------------OC-------PP----------------------- |
| rdylecladia erecta | ---------O-O--------------------------------------------------- |
| odymenia holmesii | --------F-----------------------------R------------------R----- |
| ramium | ----------------------------------------------------------P---- |
| ramium deslongchampii | ----------R---------------------------------------------------- |
| ramium nodulosum | -------------O----------------A-------FP--O-PO----------------- |
| lurus flosculosus | ----------R--O----------------S-------FR--R-P-----RC-----C----- |
| lurus equisetifolius | ---------------------------------------------P----------------- |
| yptopleura ramosa | --------FO-----------------------------P----------------------- |
| lesseria sanguinea | --------OO---O------------------------R------------------------ |
| ypoglossum hypoglossoides | --------OO---O----------------C-------RR--FOOPR-P--O------O---- |
| mbranoptera alata | ---------------------------------------P----------------------- |
| lysiphonia | ----------------------------------------------------------O---- |
| lysiphonia elongata | --------------------------------------RP----P------------------ |
| lysiphonia nigra | --------O---OF----------------------------O--------------C----- |
| lysiphonia fucoides | ------------------------------P--------R--O-P------O----------- |
| odomela confervoides | -------------O----------------O-------FP--COP------P-R----O---- |
| rionema corunnae | ------------------------------P-------------------------------- |
| ictyota dichotoma | ------------------------------C-------R------------------------ |
| aminaria digitata | ------------------------------R-------A---C-------------------- |
| nteromorpha | ---------------O---------------------------------P------------- |
| nteromorpha intestinalis | ---------------------------------------------P----------------- |
| lva | ---------------O--------------R-------------------------------- |
| lva lactuca | --------------------------------------R------P----------------- |
| haetomorpha mediterranea | ---------------------------------------P-----P----------------- |
| ladophora | ---------------------------------------------P----------------- |
| ryopsis plumosa | ------R--R---O------------------------------------------------- |

# 4 Discussion

## 4.1 Caves and cliffs

### 4.1.1 Interpretation of the results

The data obtained in the present survey show a good range of cliff and cave algal species present on the chalk cliffs and in caves at Epple Bay, Botany Bay and Kingsgate Bay. The most diverse habitat areas are at Kingsgate and as a consequence a well-developed cave flora is present. Four cave formations are of particular importance; that on the north-facing coast to the west of Whiteness shows a good range of communities inhabiting dark shaded conditions. The tunnel at Whiteness has fewer 'Chrysophyceae' but supports communities typical of more open wave-washed conditions. The deep tunnel-like cave in Kingsgate Bay has one of the best ranges of cave algal communities on Thanet with 'Chrysophyceae' and other communities on the outer insolated walls; differing 'Chrysophyceae', green algal, and blue-green algal communities occurred on cave walls and ceilings. Communities characteristic of caves generally (*Audouinella purpurea, Pilinia maritima*) were abundant on lateral walls. The balance of species present varied according to light levels (insolation/shading), tidal penetration, wave wash and spray, and percolating fresh water. Preliminary transect studies on opposite walls revealed the differences in community structure. The '*Chrysotila*' cave adjacent to the previous cave was particularly interesting in that it is situated for the most part above high water spring tide level; this allowed access to communities otherwise high on cliffs and on the ceilings of caves. The flora was dominated by bright orange growths of *Chrysotila lamellosa*; the species occurs sporadically around the coast of Thanet on open, usually shaded north-facing cliffs (it is well developed in a gully formation at Botany Bay and also on open cliff faces east of the stack, at spray zone [supralittoral] levels). Another interesting feature in the '*Chrysotila*' cave was the moss *Eucladium verticillatum* which had not previously been recorded, and was not recognised until a covering layer of blue-green algae was removed. This indicated the importance of humidity in the cave, low light levels, and a low salinity environment (mosses rarely come into direct contact with sea water). Percolating fresh water is probably important in maintaining these communities.

At all sites several species of marine/maritime fungi were observed on and among cave and cliff algal growths; they took the form of grey-black, often discoid, growths on open cliff faces, or white-grey discoid growths over orange *Chrysotila* in the entrances of caves. The marine lichen *Arthropyrenia halodites* is a common feature on chalk foreshores, chalk cliffs to high water spring tide level and at the mouths of caves. The species is characterised by pinkish discoid growths with black spots representing the reproductive apothecia. It also occurs on barnacles and limpets, but grows to a much larger size on softer chalk rock. It is an important feature of chalk cliff communities and its occurrence appears to exert an antibiotic effect on fast-growing green algae preventing overgrowth by *Rhizoclonium* and *Enteromorpha*. It was seemingly overlooked by Anand in his pioneer cliff algal studies.

### 4.1.2 Limitations of the data

The principal limitations of the data relate firstly to the taxonomy of these haptophyte and chrysophyte algae. Our taxonomic understanding was initiated by Anand (1937a) and revised subsequently (see Parke & Dixon 1976); the geographically wider appraisal of these algae and the communities they form (Tittley 1985, 1988) identified taxonomic problems which require resolution. The second main limitation relates to thoroughness of sampling. While these communities have been studied on several occasions, the more thorough the study the more these rare and unusual microscopic algae are detected, ie they are easily overlooked. The present study, with careful sampling from the caves in the Kingsgate area, revealed species rarely found (eg *Ruttnera litoralis*).

### 4.1.3 Implications for further work

The chalk cave and cliff coastline and associated biota have been relatively well studied during the past two decades; intensive surveys have been undertaken but at only irregular intervals. The monitoring scheme outlined below, if applied, would enable surveys and appraisals at differing degrees of detail to take place at regular intervals. The current biotope classification has a single biotope (LR.L Chr) for chalk caves and cliffs. From our experience this represents an aggregate of differing communities/biotopes. We suggest further work (as a 'one-off' study) to reclassify the communities described by Anand along the lines of the current biotope classification; this may require description of new biotopes. Our proposal for an *Audouinella purpurea/Pilinia maritima* cave biotope (widespread in the UK and further afield) is an example.

### 4.1.4 Management and monitoring issues

Successful management of these nationally and internationally important biotopes will be assisted by monitoring programmes directed at either recording the maintenance of flora, fauna, communities and biotopes, or anthropogenic potentially damaging (or disturbing) activities (PDAs) likely to affect fauna and flora. However, the difficulty of accurately monitoring changes in species abundance to detect variation from a favourable status was tested and discussed at workshops for the purpose (Worsfold & Dyer, 1997).

An important management aim is to maintain as much open (unprotected) cliff and cave as possible and thereby maintain the cave and cliff communities.

Another aim would be to monitor coastal engineering works likely to affect sand deposition and beach level, as beaches isolate cliffs from direct contact with the sea.

We suggest that the minimum monitoring effort required to determine favourable conservation status would be an annual 'skilled eye' appraisal. A Phase 1 survey would be sufficient to identify gross changes (natural and anthropogenic) in cliff and cave biotopes, habitats and broad communities; the approach to such a survey is given below.

Because of the site's national and international importance we also suggest a detailed audit every five or six years. This would deliver a comprehensive species inventory with information on rare species, occurrence and distribution of communities sufficient to identify less obvious changes or deterioration to cliff and cave communities. We suggest a quantitative ecological approach evaluating communities within cave systems and cliff faces. This detailed monitoring exercise is proposed to accommodate the requirement to report a 'favourably-maintained' site status to the EU every six years, and to obtain a clearer understanding of how the cliff and cave ecosystems function, and their responses to natural dynamic events such as erosion, climate and sea-level change. A comprehensive baseline will have been created against which the impact of a disaster event (eg oil-spill) could be assessed (see below).

Annual surveillance

<u>Phase 1</u> skilled-eye appraisal and photographic record, undertaken annually by walking the complete length of natural coastline on Thanet. The survey will audit coastal geomorphological features and associated biota to:

- confirm the remaining extent of natural cliff
- assess impact of any agreed repair or alteration to existing coastal protection structures
- maintain an inventory (number and identify) and photographic record of caves, tunnels, arches and deep gullies noting in particular:
    - loss of caves and cave-like formations

- creation of new cave-like structures
- changes in form or shape of structures

- assess the extent of cliff and cave communities (LR.L Chr and others) by noting coloured growths ie
  - bright orange (gelatinous) growths (*Chrysotila*) at high supralittoral (spray zone) levels
  - brown growths (*Apistonema*) at high water spring tide level and just above (above dense growths of green algae)
  - bright green growths (*Enteromorpha, Rhizoclonium*) at 1-2m above beach level to high water spring tide level
  - red/dark red filamentous, filiform growths (various red algae) at the foot of cliffs on open faces
  - red velvety growths (*Audouinella purpurea*) on shaded cave walls
  - golden brown velvety growths (*Pilinia maritima*) on cave walls
  - green closely adherent (stain-like) growths (*Pseudendoclonium*) at high levels on cave walls and ceilings
  - blue-green (Cyanobacteria = blue-green algae) often gelatinous or filamentous growths on cave walls and ceilings.

Five/six yearly surveillance

A survey to map in detail communities on cliffs and in caves at key sites (eg Botany Bay, Whiteness, Ramsgate/Pegwell Bay, and Epple Bay) using precise quantitative, transect and quadrat methods. This would involve study at points within a cave system and along lengths of open cliff (see above).

## 4.2 Intertidal reef

### 4.2.1 Interpretation of the results

Thanet foreshores support a range of biotopes typical of chalk reefs; as stated previously biotopes obvious elsewhere in Britain (*Pelvetia*, *Ascophyllum*) are absent. Because of the overall shape of the shore the *Fucus spiralis* biotope is restricted to a narrow linear feature at the base of the chalk cliffs, and the *Fucus vesiculosus* biotope forms only a narrow or linear band on the inner platform/reef. Much of the intertidal supports biotopes characterised by *Fucus serratus* and by red-algal asemblages. An important feature of chalk-shores is the extensively piddock- and *Polydora*-bored chalk rock. Overhang biotopes, often dominated by invertebrates, were well represented at both Fulsam Rock and Whiteness at lower shore levels. Whiteness foreshore reef had not been colonised by the invasive *Sargassum muticum*.

The biotopes mapped at Fulsam Rock during the present survey corresponded well with the outline map of algal communities produced by Tittley & Price (NHM - unpublished; 1960s). There were three significant differences:

1. exposure of larger areas of inshore reef following loss of sandy beach
2. aggressive colonisation by the alien *Sargassum muticum* changing the nature of rockpool biotopes
3. extensive cover of green algae (*Enteromorpha* spp. and *Ulva*) overlying other biotopes/ communities.

Algal diversity at Fulsam Rock has remained constant with 36 - 40 species recorded during the various surveys (a smaller number was noted in 1993 when the focus was on MNCR rocky shore and not detailed species recording). Comparable data are not available for Whiteness. A larger number of invertebrates was recorded at Fulsam Rock (164) and Whiteness (148) in the present survey than in 1986 (82 and 92 respectively).

The uncovering of more inshore reef at Fulsam Rock has created additional pool/lagoon habitat much of which has been occupied by *Sargassum*. Aggressive colonisation by *Sargassum* since 1986 has probably changed the balance of algal species present in the rock-pool biotopes although it appears not to deleteriously affect animal assemblages. *Sargassum* has spread along the north coast of Thanet to Palm Bay; it does not occur east and south of Foreness Point or to the west of Margate.

We were surprised at the extent of *Enteromorpha/Ulva* cover over rocks (especially in the August survey) and other biotopes at Fulsam Rock and elsewhere on Thanet (see above). We believe this to be evidence of a 'green-tide' phenomenon (plates 1 - 4). *Enteromorpha* spp. and *Ulva* are natural components of the marine flora of Thanet. Tittley & Price (NHM unpublished data - 1960s) recorded belts or zones of *Enteromorpha* at sites around Thanet including Fulsam Rock. They were seen to form a seasonal flush of growth. Fletcher (1974) recorded an *Ulva* problem in the summer period in Kent with unprecedented deposits on holiday beaches in Thanet. An extensive cover of green algae (*Enteromorpha* spp., *Ulva*) was not seen at Whiteness. This may be in part because the green algae were at their maximum in August when the survey commenced and the study at Fulsam Rock undertaken, and had declined by September when the study was concluded. However large quantities of green algae were recorded in September as deep deposits of driftweed on nearby beaches at Kingsgate (plates 3 and 4). The problem is widely recognised; for example, Anon (1997) refers to EU and UK Government requirements for Thames Water plc to remove phosphate from sewage effluents discharged into waters deemed to be sensitive to eutrophication.

Blooms of green algae may result from high nitrate and phosphate levels in sea-water. Price & Tittley (1987), in connection with nuisance seaweed occurrence at Worthing, Sussex, commented on the extent to which weed growth is dependent upon the inputs of nutrient from the Worthing and other nearby sewage outfalls. They noted that it is unlikely that any seaweeds were wholly dependent on the input of nutrients from outfalls and other sources. It has long been known that there exists local correlation of sewage pollution with, for example, extensive *Ulva* and *Enteromorpha* problems (Cotton 1911; Burrows 1971). However Cotton (1911) showed clearly that *Ulva* can occur in great quantity on shores where there is no pollution by sewage, for instance, it can be particularly common in 'natural pollution' areas where there is drainage from rotting piles of seaweed. Experimental work (Letts & Richards 1911; Wilkinson 1964) has shown that *Ulva* responds to the presence of sewage in a number of ways, usually resulting in growth of plants with a higher than normal nitrogen and organic sulphur content. Fletcher (1974) speculated that the large quantities of drift *Ulva* may have been indirectly related to local sewage discharges. Nuisance blooms of green algae have been recorded at several sites around the British Isles (Langstone Harbour, Dublin Bay, Ythan Estuary) and are currently the subject of detailed investigation.

Plate 1. Green algal growth over foreshore reef at Palm Bay.

Plate 2. Green algal growth over foreshore reef near Foreness Point.

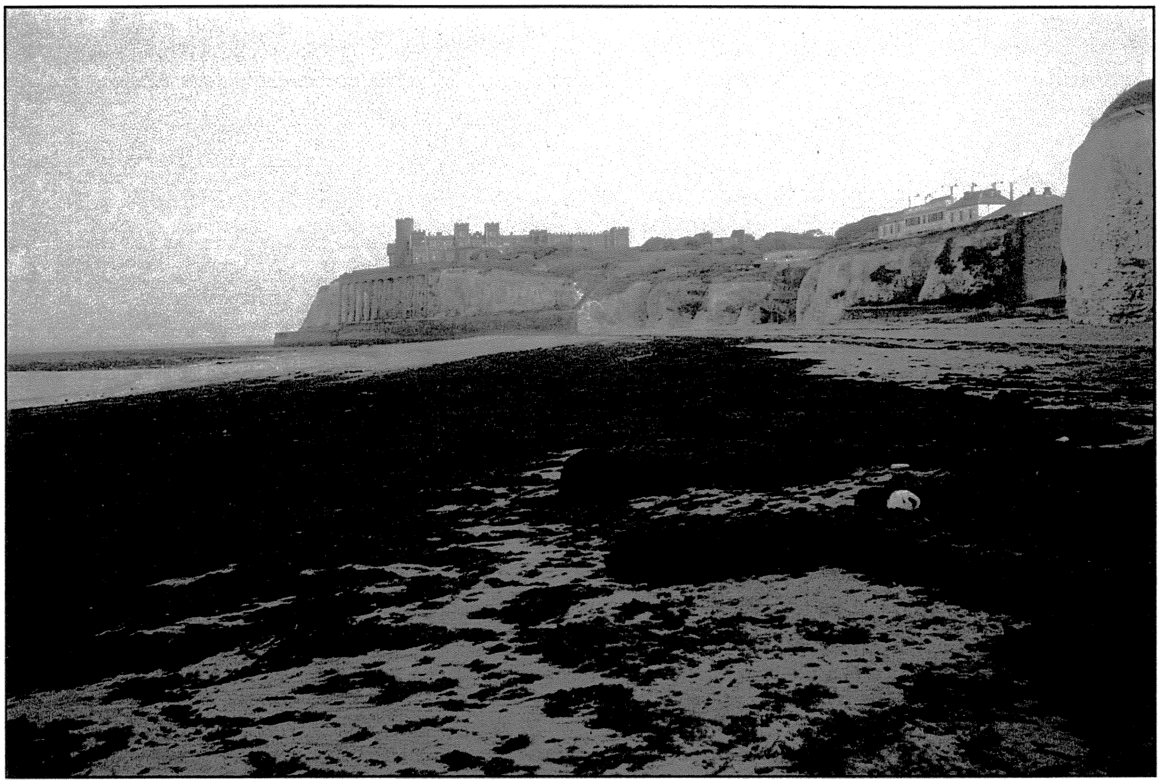

Plate 3. Driftweed of mainly green algae on beach at Kingsgate Bay.

Plate 4. Driftweed of mainly green algae in cave at Kingsgate.

### 4.2.2 Limitations of the data

The present evaluation of the major biotopes has been thorough, although those occupying a very small area (eg overhang biotopes) may have been overlooked in the Phase 1 mapping survey. Most biotopes are characterised by the dominant vegetation, there being only few biotopes characterised by sedentary animals (eg *Mytilus*, *Semibalanus*, *Sabellaria* and *Lanice* dominated communities). Grazed bedrock is a possible biotope characterised by mobile animals. It is also possible that in the course of a rapid biotope survey such as this one, the less obvious, and especially the mobile animal components may be overlooked. The Phase 2 survey covered restricted biotopes in more detail. Species diversity assessment remains incomplete and requires further study. Good historical and more recent past data are available which allow the present studies to be placed in a temporal context.

### 4.2.3 Implications for further work

As indicated elsewhere in this report although Fulsam Rock has been studied on several occasions previously, study periods have been limited in extent and to a particular season of the year. Further short studies to complete a full assessment of plant and animal diversity are recommended. This information forms an important baseline against which future changes in the site's biodiversity can be assessed.

We also recommend studies to evaluate the effect on plant and animal communities of the spread of *Sargassum muticum*; this could involve an experimental approach involving clearance of *S. muticum*. Such work would contribute important information towards site management.

The 'green-tide' phenomenon requires further evaluation involving both *in situ* and *ex situ* (laboratory) studies. Additional information on this phenomenon is currently being made available through new research. This is one of the monitoring studies (see below) that should initially be undertaken seasonally, and then annually until the patterns (if any - this may be a stochastic event) are evident. The study should involve *in situ* quantitative evaluation in terms of green algal production (biomass) per unit area per unit time. Competitive or blanketing effects also require evaluation.

### 4.2.4 Management and monitoring issues

An important aspect of foreshore reef management in the Thanet cSAC will be the maintenance of intertidal reef biotopes/communities at a favourable status. Approaches to identify changes from such a status are considered by Worsfold & Dyer (1997).

Water quality is probably one of the most important factors governing species occurrence and community structure on Thanet. The response of algae to soluble components of sewage discharge has been discussed previously; the high productivity of *Enteromorpha*, *Ulva* and perhaps also *Chaetomorpha* may be a response to high nutrient levels in the Thames Estuary and southern North Sea. An important management aim would be to monitor inshore water quality.

The sea-water here is extremely turbid containing large quantities of suspended particles and this has a profound effect on especially the subtidal marine flora. This discharge of sediment to the North Sea from the Thames estuary complex is a natural phenomenon and is augmented by fine chalk particles from the surrounding rock. There is no evidence that the sediment loading of inshore waters has changed but visibility in the water column can be easily measured.

Other solid matter can enter the water column from sewage discharge; it has been shown elsewhere that filter-feeders (especially *Mytilus*) can increase in numbers at the expense of flora (Wilkinson *et al* 1989). A management aim could be to monitor sewage discharges in relation to adjacent biota.

Thanet lies close to major shipping lanes and could suffer a catastrophic event such as an oil spill; these have affected the Thanet coast previously (Tittley, 1972). It is important therefore to have a reliable baseline of taxonomic and ecological information in order to assess damage.

Thanet is a popular leisure resort with large numbers of people spending time on the sea-shore. Some sea-shore biota is sensitive to physical disturbance (stone turning, trampling etc) and an important management task would be to identify any such disturbance and assess the risk and scale of damage to sea-shore communities.

The foreshores of Thanet are also locally popular with fishermen who collect crabs, winkles and crustacea on a small scale; the effects of these activities on such local animal populations are not known.

Occasional extreme climatic events such as the freezing of inshore seas around the Thanet coast (see Plates 5 and 6) will have a dramatic impact on eulittoral and shallow infralittoral biota (species and communities/ biotopes). To speculate, the projected sea-level rise of 0.5m-1m during the next 100 years (through global warming) will also have a profound impact on the gently sloping littoral biotopes of Thanet. Increased average sea-temperatures may have an effect on species occurrence and diversity. These changes alone are good reasons for developing monitoring programmes but the present work is directed towards the present features of the cSAC. However, there is a need to know much more about the short- and long-term stability of marine biotopes in order to develop appropriate management programmes.

We suggest the following strategy to address surveillance and monitoring for management purposes. An annual Phase 1 ('skilled-eye') surveillance is the minimum to achieve basic information on change to the main communities, occurrence of nuisance growths, and status/audit of *Sargassum* spread around Thanet. It would note the occurrence of key biotopes (eg *Fucus* canopy, *Laminaria* canopy, red-algal turf) and their extent in order to identify any major change. The survey should ideally cover the entire cSAC, and be undertaken in the winter period when green algal growth is at a minimum.

We also suggest detailed surveillance at five or six yearly intervals to coincide with reporting maintenance of favourable status to the EU. This appraisal would include diversity and community structure (Phase 3) studies embracing a full species inventory, assessment of abundance and ecological survey. Changes in area of biotopes would be incorporated into the GIS digital mapping database which have been initiated by this study. Such surveillance would take place at the sites of investigation in the present survey and thereby contribute to temporal comparison (see below).

Plate 5. Frozen sea at Minnis Bay, 1963.

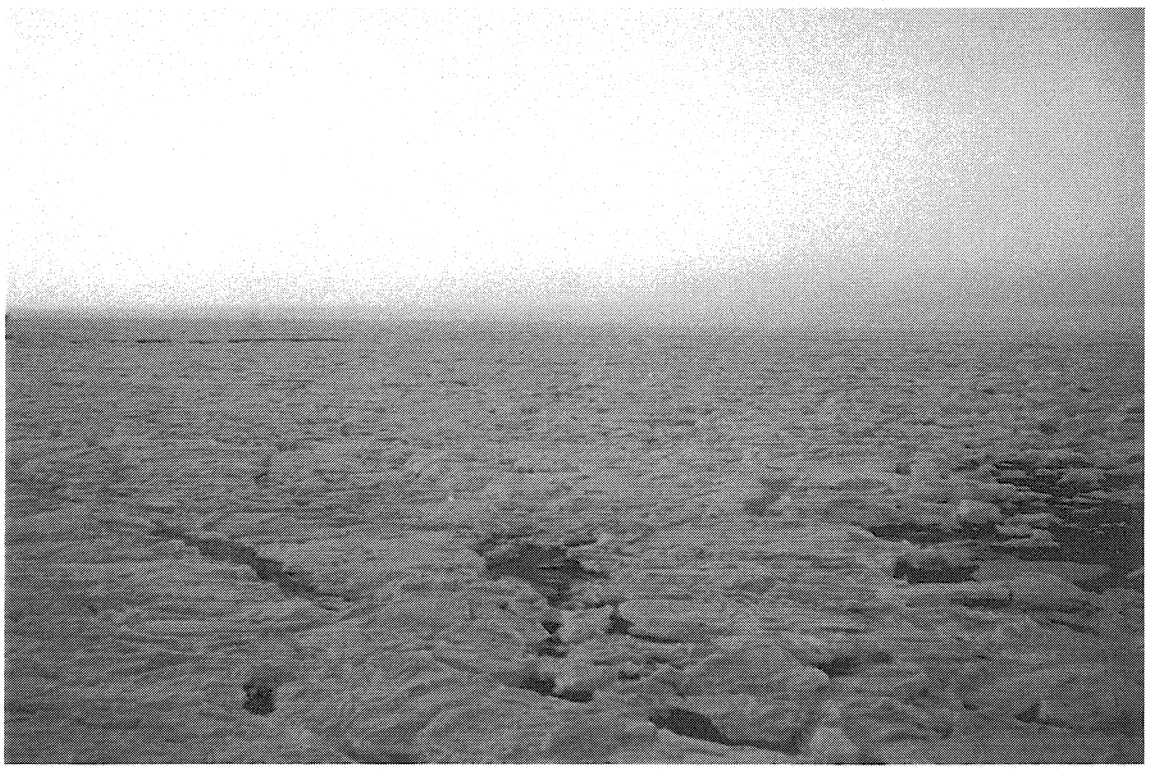

Plate 6. Frozen sea, view from Minnis Bay, 1963.

Regular monitoring of chalk shores in North Norfolk (George *et al* 1997) has revealed much information on change in seashore communities. Gross features such as *Fucus* canopy have remained stable while other communities underwent greater change with a large annual turnover of species. Regular monitoring also revealed blooms of interesting and unusual species in Norfolk. Such long-term data collection creates a better baseline and understanding of variation (for example, changes in diversity with time). However, any monitoring programme for Thanet also needs to pick up impacts.

## 4.3 Subtidal reef

### 4.3.1 Interpretation of the results

**Distribution and extent of subtidal chalk habitats**

In 1995 acoustic tracking data were interpolated to produce a mosaic of seabed areas with similar acoustic characteristics based on a cluster analysis (figure 7 in Davies 1995). In order for this information to be of value it was necessary to relate it to biological data from direct observations. Ideally the full range of acoustic data should be thoroughly sampled and this is normally achieved mainly with video cameras. However, inclement weather posed a number of problems to the survey and consequently data analysis was incomplete. One of the aims of the 1997 study was to provide further information for this analysis. In 1995 the restricted ground-truth data was used with the acoustic information to determine five main 'biotopes' which were defined largely on the basis of physical parameters (Davies' figure 8, reproduced as figure 14 in this report). The 'biotopes' referred to by Davies are essentially habitat types corresponding more with the 'higher level' classification of Connor *et al* (1997b).

An unsatisfactory method had to be used for the secondary analysis in which overlap was found when allocating the limited range of 'biotopes' to the acoustic clusters. The limitations of the resultant predicted distribution of 'biotopes' were stressed by Davies. Nevertheless, the mapping did produce an approximate indication of the extent of subtidal chalk; reassuringly, some of these areas of chalk habitat identified by acoustic methods were confirmed by subsequent diving surveys (figures 8 and 9), ie the predicted distribution of subtidal chalk from Davies (1995) is further supported by the present survey.

When attempts were made to superimpose the MNCR biotope categories on the predicted distribution of chalk habitat, as many as six, but normally three or four, different biotopes occurred within each of the Davies 'higher level' categories (his 'biotopes') as can be seen in table 10. The same MNCR biotopes also occurred in different Davies' 'higher level' categories ('biotopes') see table 10. For example, MCR.As MolPol, which occurred both on chalk and cobble substrata, was found in three different chalk Davies' 'higher level' categories ('biotopes'), but was not found in any areas of stones and sediment (Davies' 'biotope' 5), its main substratum type (see table 10). It is, of course, possible in such a dynamic environment that the nature of the bottom substratum had altered between the acoustic survey and later ground-truthing.

An attempt to relate the MNCR biotopes recorded in the recent surveys to the distribution of acoustic clusters directly was inconclusive because several biotopes could be associated with a particular cluster (see figures 11 and 13). This analysis was limited by the constraints of the present survey in which only a small number of acoustic clusters could be ground-truthed. Further confirmation of the predicted extent of subtidal chalk and associated biotopes from the acoustic survey will only be possible by further diving surveys. Ground

Table 10. Relationship of Davies' 'biotopes' to diver-derived MNCR biotopes.

| Davies' 'biotope' | MNCR biotope | 1995 sites | 1997 station |
|---|---|---|---|
| 1. Infralittoral chalk | EIR.KFaRFor | | 22 |
| | MIR | | 23 |
| | ECR.BS BalHpan | 11 | |
| | MCR.SfR Pid | 10,16,18 | 10,11,24 |
| 2. Circalittoral chalk | IR.FaSwV AlcByH.Hia | 15 | |
| | MCR.ByH Flu SerHyd | | 25,26 |
| | MCR.As MolPol | 15,19 | 30,31,32,33 |
| | MCR.SfR Pid | 15 | 28,29 |
| 3. Tideswept chalk | IR.FaSwV AlcByH.Hia | 17 | |
| | MCR.AsMolPol | 17 | |
| | MCR.SfR Pid | 17 | |
| 4. Chalk overlain with sand | MCR.ByH FluSerHyd | 20 | |
| | MCR.As MolPol | 3 | 12 |
| | MCR.SfR Pid | 8 | 16 |
| 5. Stones overlain with sediment | MCR.ByH SNemAdia | | 19,20,21 |
| | MCR.ByH Flu | 1 | 27 |
| | MCR.ByH FluSerHyd | 4,5,6 | |
| | MCR.SfR Pid | | 17 |
| | CMS | | 8 |
| | CMU | | 7 |
| ? Sediment with stones | ECR.BS BalHpan | 12 | |
| | MIR.KR Ldig.Pid | | 9 |
| | MCR.ByH Flu | 2 | |
| | MCR.SfR Pid | | 14,15 |
| | IGS | | 4,5,6 |
| ? Stones and sediment | MCR.ByH SNemAdia | | 18 |
| Littoral/infralittoral fringe chalk | MCR.KR Ldig.Pid | | 13 |
| | MCR.SfR Pid | 7,9,13,14 | |

truthing of sea-floor type ('higher level' [habitat] *sensu* Connor *et al* 1997b, ie sediment, cobble, bedrock) can be extensively and inexpensively undertaken by systematically dragging a weighted line over the sea-bed from a boat; different types of resistance will be felt according to substratum type).

There is now sufficient information to suggest that the principal biotopes associated with sublittoral chalk exposures are widespread in the cSAC and suitable sites can be selected for monitoring their condition within the cSAC.

**Description of biological features**

Two hundred and twenty-six animal taxa, including 175 identified to species, have been recorded sublittorally around Thanet. The records from 1995 and 1997 (giving abundances) are shown in the species/site matrix presented in table 8. Two additional algae (*Erythroglossum laciniatum* and *Corallina officinalis*), from NHM unpublished data, and five animal species comprising the snakelocks anemone *Anemonia viridis*, the lobster *Homarus gammarus*, a spiny spider crab *Maja squinado*, the sand gaper *Mya arenaria*, and a dab *Limanda limanda* (Wood 1992) were reported from subtidal surveys in 1970 and 1985, respectively. The species total would undoubtedly be increased by identification of preserved specimens and by further diving surveys as well as by sampling the infauna. Nevertheless, the biological diversity is considered to be low, with an average of only 24 species per site, primarily because of the harsh ambient environment, including exteme sea-water temperatures, water movement from storms and currents, high water turbidity, siltation, and unusual geology of the area. In the tide-swept sublittoral environment off Thanet scour is another factor affecting the biota. This was evident at many sites from the dominance by species capable of withstanding these conditions. The more diverse biotopes tended to occur in deeper habitats below the additional influence of wave surge.

High turbidity also has a pronounced effect on the sublittoral zonation around Thanet. Its influence on the distribution of kelp has already been mentioned and the occurrence of other algae is similarly affected. Low light penetration severely restricts the depth at which even red seaweeds can survive so that in quite shallow water these plants are only rarely recorded, and those which do occur tend to be scour-tolerant species such as *Plocamium cartilagineum* and *Hypoglossum hypoglossoides*. In the highly stressed environment of the cut channel to Ramsgate harbour no algae were found. In general, depths below two to three metres were considered to be in the circalittoral zone, where fauna is the dominant component of the biota. Since the shallow habitats above this level were affected by wave action which causes heavy scouring, the communities in the infralittoral zone tended to be characteristically species-poor.

In an area where biological zonation is so condensed it is often very difficult to differentiate between the upper and lower infralittoral, and sublittoral fringe zones. In these very shallow regions the MIR.KR Ldig.Pid biotope, characterised by a dense algal cover, predominated where continuous chalk bedrock existed. More isolated chalk outcrops were surrounded by sand and greatly affected by scouring.

Piddocks were found to be present in all biological zones where chalk reefs were visible. Exposures of the very soft Thanet chalk in deeper water were still influenced by tidal scouring and as a result the surface of the chalk was often smooth. Few species directly colonised the bedrock, but those capable of boring into the substratum are those which are scarce in harder rocky environments elsewhere. These included five piddock species (*Pholas dactylus, Hiatella arctica, Petricola pholadiformis*, *Barnea candida,* and *B.parva*) and the burrowing bristleworms *Polydora* spp. Other polychaetes such as *Lanice conchilega* and small *Sabella pavonina* and the anemones *Sagartia spp.* occupied old piddock holes which had become filled with sediment. The majority of the associated biota in these habitats, however, tended to colonise other harder surfaces where they were available. In most cases these were provided by flints forming small boulders, cobbles, and pebbles overlying the chalk or embedded in a sandy matrix where the bedrock substratum was absent or overlain by sediment.

The most frequently encountered piddock species, *Pholas dactylus*, was found on 25% of dives and the two *Barnea* species were each found on around 10% of dives. The smaller *Hiatella arctica*, which has a preference for steep or vertical rock faces, was found at only two sites.

The most commonly occurring species in Thanet was the erect bryozoan *Alcyonidium diaphanum*, recorded subtidally from 78% of dives, with *Asterias rubens* seen on 75% of dives. Other frequently encountered species included *Flustra foliacea* (63%), *Tubularia indivisa* (60%), *Lanice conchilega* and *Molgula manhattensis* (57% each), *Pagurus bernhardus* (48%), and *Urticina felina* (43%). However, the abundance at which each of these was recorded was only 'occasional' and around 65% of the species in Thanet were only reported as either 'present' or 'rare'.

Of the species of interest in the sublittoral zone in Thanet, a few are worthy of mention. Two small specimens of aff. *Clytia paulensis* found on *Bugula* spp. are probably the first records of this hydroid from Kent, representing its easternmost limit of distribution. However, because of its small size it may have been easily overlooked in other localities. The anemone *Urticina eques* was recorded on three occasions. This species is known from Norfolk and from further north on the east coast of Britain, so the specimens found in Thanet may represent its southernmost record. A single specimen of *Tritonia plebeia* was found off Whiteness in 1997. This opisthobranch mollusc is normally associated with clearer offshore waters so its appearance in Thanet, where it was probably feeding on *Alcyonium digitatum*, is unusual. *Psammechinus miliaris*, commonly known as the shore sea urchin, is typical of sheltered boulder shores (Picton 1993) where it may grow to 5 cms in diameter. Sublittorally its occurrence is more sporadic and it has a preference for sheltered or slightly brackish sites. In Thanet the much smaller specimens, all about 1 cm in diameter, were found on the undersides of cobbles and pebbles. The occurrences of the above species were all isolated and it is not thought that special conservation measures are merited for them here.

### 4.3.2 Limitations of the data

Some of the difficulties experienced in mapping the predicted distribution of 'biotopes' and in reconciling these with the biotopes described in the MNCR classification have been outlined above. A further difficulty arose in attempting to plot the 1995 survey sites, which had not been recorded using differential GPS, on a digitised map of greater accuracy. For example, there is some disparity in the positions of four MCR.KR Pid biotopes from that survey which appear to have been recorded from within the littoral zone. Interpretation of biotope distribution maps should therefore be treated with caution.

Because the sites surveyed in 1995 were not fixed using differential GPS, and even for those investigated in 1997 when this accuracy was obtained, it would be very difficult to revisit the precise location of previous dives where such poor underwater visibility prevails. The future approach to monitoring may therefore involve a different sampling strategy. The current data provide a basis for assessing gross trends in change.

Over 200 taxa were recorded by the diving surveys in 1995 and 1997, but significant species differences between the two years are apparent. Thirty-eight species reported in 1995 were not encountered in 1997 and 68 found in 1997 had not been seen in 1995. Only 37% of the biota was common to both survey years. There are a number of possible explanations for this variation. The greater algal diversity recorded in 1997 is not too surprising since sites were investigated closer inshore than they had been in 1995, and for some other groups the identifications were taken to different levels by the two surveys. In the very poor visibility experienced by divers it is possible that some species which were present may have been overlooked; natural patchiness in species distribution is a frequent occurrence in the marine environment.

Seasonal and longer-term temporal variation are other likely contributory factors to which consideration should be given in designing an appropriate monitoring strategy. None of the sites surveyed in 1995 was revisited in 1997 so temporal comparisons could not be drawn. George *et al* (1995) have demonstrated for communities in Norfolk, which are similar to those occurring around Thanet, that an annual turnover in species of over 30% can be expected. It is therefore important to gain an understanding of the natural fluctuations in the populations and communities forming the Thanet biotopes before judgements on the effects of any anthropogenic changes to the environment can be made.

### 4.3.3 Management and monitoring issues

At present potentially disturbing or damaging activities in the subtidal environment are unclear to us. Activities such as trawling and dredging likely to cause physical disturbance are not undertaken within the cSAC. Sewage disposal into the sea may effect communities near the discharge point, but long-sea outfalls now discharge beyond the boundary of the cSAC. As noted above, Thanet lies close to major shipping routes and could suffer a catastrophic event such as an oil-spill with potential for damaging sea-bed communities of plants and animals.

As for caves, cliffs and foreshore reefs, an important management aim for subtidal reefs will be to maintain 'favourable status'. Recent surveys have provided information (on habitats, biotopes, and species) which helps define 'favourable status'. All recent surveys have identified subtidal chalk exposures in various forms near to Foreness Point, North Foreland, Broadstairs and Dumpton Gap. One or more of these areas could be selected as a study area to assess 'favourable status'.

We suggest detailed surveillance along the lines of the present survey, every five or six years to accommodate the requirement to report a 'favourably maintained' site status to the EU. This would deliver an assessment of the principal chalk biotopes, and a basis for comparison with the present survey results to detect any gross changes in their local occurrence and distribution. Compilation of a detailed species inventory would allow assessment of changes in diversity.

The subtidal area round Thanet presents a difficult environment to work in. Remote sensing has had limited success and information is best obtained by SCUBA diving but diving at shallow subtidal fringe levels is particularly difficult and study there is better undertaken from the foreshore reef.

Further surveys would be desirable to assess more precisely the nature and extent of subtidal biotopes and also natural change in populations and communities with time (see above), accepting that we understand the distribution of the broader habitat of subtidal chalk.

## 4.4 Analysis of relative conservation importance

### 4.4.1 General observations

The Introduction to this report drew attention to the importance of Thanet because of:

- Its coastal geology, only 0.6% of the British coast is of chalk, and Thanet represents a significant proportion of coastal chalk exposure in Europe (12%) and in Britain (20%), and has the longest continuous stretch of coastal chalk in Britain.

- Its unusual nature among coastal chalk exposures. The caves, cliffs and reef are of Upper Chalk which is softer than other types of chalk and more easily eroded.

- Its geomorphology, and significance in habitat formation and ecology (cf Fowler & Tittley 1993 who also noted that the remaining lengths of chalk cliff exhibited an excellent range of habitats and communities).

- Its geographical position as the only major rocky outcrop in the southern North Sea.

Thanet, however, is located in a harsh marine environment:

- The surrounding sea-water is extremely turbid, a feature of the southern North Sea generally but with increased sediment load because of its location at the mouth of the Thames estuary complex.

- Sea-water temperatures in the North Sea are more extreme than those on the west coast of Britain (higher in summer, lower in winter). This wide amplitude of temperature may present upper and/or lower lethal limits preventing survival and growth of species.

- Thanet lies in a densely populated region of England and is an urban centre; it is adjacent to extensive agricultural areas. These features may affect inshore water quality.

### 4.4.2 Conservation importance of the biota

The marine fauna and flora of Thanet, particularly that of the foreshore and subtidal reef, comprises species and communities tolerant of the conditions described above.

Specialist species such as the 'Chrysophyceae' algae (*sensu* Anand, 1937a) inhabit caves and cliffs. Others such as the 'boring' animals species only occur in soft rocks such as chalk (also clay and peat).

Thanet is important as a location for scarce species, such as those forming the distinct chalk cave and cliff communities, which occur rarely in Britain. Thanet is the only known location for some of these species. A vascular plant *Limonium binervosum* ssp *cantianum* believed to be endemic to north east Kent also occurs on the chalk cliffs at supralittoral (spray zone) levels (see appendix 1).

Tittley *et al* (1986) were requested by NCC to rank in importance intertidal chalk and sandstone shores investigated in Kent and Sussex. This was done subjectively on the basis of species richness, habitat availability, and overall ecology (presence of communities and their structure and content). Fulsam Rock, Thanet, was listed seventh out of eleven sites. However, all comparative sites lay to the west of Thanet in less harsh and extreme environments.

**4.4.3 Conservation criteria**

Criteria (listed against bullet points below, cf Hiscock 1996) identified for the assessment of nature conservation importance of an area, are:

- Species richness

Some areas, sites, habitats and their communities are intrinsically more species-rich than others, so comparisons are only valid between examples of the same type of area or habitat and their communities (Nature Conservancy Council (1989) internal document: *Guidelines for selection of biological SSSIs*). Coastal chalk reef is an example of a habitat with intrinsically low species diversity. The diversity on Thanet reflects a harsh and geologically unusual environment with, in many cases, resilient and opportunistic species characterising its biota. The algal flora is enhanced by the spasmodic occurrence of ephemeral species, and the unique chalk cave and cliff assemblages. In general the east coast of England is less rich in species than the west coast and the south of Britain is richer than the north. Thanet's geographical position precludes the occurrence of species characteristic of the extremes (warm south-west, cold north) of the British marine fauna and flora. However, Thanet is probably the richest natural site in the southern North Sea despite the harsh environmental parameters of the area.

- Representativeness

The Thanet cSAC has a good representation of the biotopes that occur on chalk shores in Britain. The absence of some otherwise widespread and common biotopes on non-chalk rocky shores is of scientific interest. As stated above, the biotopes present are those tolerant of the harsh and geologically unusual environment of the area.

- Naturalness

Large areas of foreshore and subtidal reef remain in an apparent natural state. However, this and previous surveys have identified some loss of natural features, principally the loss of natural chalk cave/cliff habitat; the 25% of cliff which remains in a natural state is of the utmost importance. Sea-walls also cause a zone of scour on the chalk reef in front of them. Another loss of natural feature is the occurrence of the invasive *Sargassum muticum* now present along 2km (Margate to Palm Bay) of the 23km of Thanet coast. A possible change in inshore water quality may have encouraged excessive growth of *Enteromorpha* and *Ulva*.

- Biotope rarity

The present survey has identified 14 biotopes (see below) defined as rare in Britain (Connor *et al* 1997a, b), and four as uncommon in Britain. Biotopes in Thanet differ by the unusual chalk-boring fauna creating relatively rare and restricted local or chalk variants of otherwise common and widespread biotopes. Of these, five occur commonly and two abundantly in Thanet. Chalk cliff biotopes are rare.

- Biotope richness

We have recorded over 40 biotopes around the coast of Thanet. However there are difficulties in making comparisons with locations elsewhere because comparative inform-ation is not available on the same basis as the current survey.

- Species rarity

Present and past surveys have revealed local rarities on Thanet. For the reasons stated above it is unlikely that there would be national rarities in Thanet; notable exceptions to this are the chalk cliff algae.

Two additional parameters used to evaluate sites but not considered by Hiscock (1996) are:

- Recorded history

The site is of considerable historic scientific interest with information in older publications, and museum specimens for the area going back almost two centuries. For the marine flora a good baseline of information has been established during the past three decades (see Introduction). The site is also of considerable scientific interest since it is the type locality for one genus and six species of chalk cave and cliff algae. Thanet was the first place in Britain where chalk cliff algae were studied; this work took place in the 1930s. It has been built on over subsequent years by the Natural History Museum in particular (see Introduction).

- Size

The Thanet coast comprises 12% of the coastal chalk exposure in Europe and 20% of coastal chalk in the UK. The intertidal chalk reef comprises approximately 252ha (41% of the total) of foreshore and the unprotected portion of cliff extends for 6km. Of the other areas of chalk reef this comprises the largest continuous area in the UK.

Three of several other possible factors influence the relative conservation importance of the Thanet cSAC, and of sites within the cSAC:

- Integrity

As stated in the Introduction, chalk coasts are characterised by cliff (and associated geomorphological formations), foreshore and subtidal reef (wave-cut platform). Sites within Thanet such as at Kingsgate, North Foreland, Dumpton and Pegwell are especially important in that the coastal ecosystem comprising cliff, foreshore and subtidal reef remains entire. However, the surrounding human/urban, and marine environments strongly influence the integrity of these areas and the Thanet cSAC as a whole.

- Dependency on ecological processes

Subaerial and marine erosion are the natural processes that have formed the range of coastal and marine habitats on Thanet. It is important to ensure that these processes continue in order to maintain key communities and biotopes.

- Irreplaceability

Thanet is the only coastal area in Britain comprising an extensive exposure of upper chalk at sea-level. Its associated features such as caves and cliffs, and perforated (bored) rocks may be deemed unique in that they do not exist in the same form elsewhere.

### 4.4.4 Thanet cSAC sites of particular interest

Although in the Thanet cSAC areas of particular interest (cf figure 1) include those where chalk caves, cliffs, foreshore and subtidal reef form an entire unit, the extent of coastal protection around Thanet limits the number of such sites (see above). But there are sites with sea-wall structures that support a good range of foreshore and subtidal biotopes and species. Using the criteria outlined above we identified two sites of particular interest within the cSAC, and with English Nature's agreement, these sites were selected for Phase 2/3 survey. They are also proposed for future surveillance and monitoring.

Kingsgate Bay - Botany Bay: a relatively pristine area (possibly affected by sewage discharge) selected because of

- an excellent range of chalk cave and cliff habitats and species
- diversity of intertidal biotopes/ habitats and communities
- diversity of subtidal species
- relative isolation.

Fulsam Rock: identified as being the most species-rich area on Thanet with an excellent range of foreshore reef and shallow subtidal reef biotopes, but suffering the effects of

- sea-wall construction
- invasive *Sargassum*
- excessive green algal growth
- proximity to a major tourist resort (Margate) with ensuing trampling and disturbance.

### 4.4.5 Conservation importance of Thanet biotopes

As stated previously chalk shores on Thanet are characterised by the absence of some otherwise common biotopes. There are rare and unusual biotopes or variants of nationally widespread biotopes; the prime examples are those biotopes where the chalk-boring piddock and *Polydora* are abundant. We have also recorded other biotopes for the first time on Thanet, such as that characterised by encrusting *Sabellaria spinulosa*. The proposed cave biotope characterised by *Audouinella purpurea* and *Pilinia maritma* we know to be widespread in Britain but it has probably been overlooked in the national biotope classification. Two biotopes associated with subtidal chalk reefs (MIR.KR Ldig.Pid and MCR.SfR Pid) are known to be scarce in Britain (Connor *et al* 1997b), so they are of national conservation importance. In the Thanet area they occur around the majority of the coastline.

The following table lists biotopes, recorded around Thanet, by frequency of occurrence in Britain (cf Connor *et al* 1997a, b).

| Biotope | Occurrence nationally | Occurrence on Thanet | |
|---|---|---|---|
| LR.L Chr | rare | occasional | |
| LR.L AudpPilmar* | occasional | rare | |
| MLR | ? | occasional | |
| MLR EntUlva.flush* | ? | common | ? seasonal |
| MIXED MLR EntUlva.flush/ MLR.EntPor* | ? | common | ? seasonal |
| MIXED MLR.Eph Rho/ Ulva* | ? | common | ? seasonal |
| MIXED MLR.R XR/ Ulva* | ? | common | ? seasonal |
| MLR LitPat* | ? | common | |
| MLR.BF FvesB | common | occasional | |
| MLR.BF Fser | common | occasional | |
| MLR.BF Fser.Pid | rare | abundant | |
| MLR.BF Fser.RPid* | rare | common | |
| MIXED MLR.BF Fser/ MLR Eph Rho? | | common | |
| MIXED MLR.BF Fser/ MLR.BF FserR | ? | common | |
| MLR.R XRPid* | rare | common | |

| | | |
|---|---|---|
| MLR.R PalPid* | rare | occasional |
| MLR.R Mas | rare | occasional |
| MLR.R Osm | rare | common |
| MLR.R Rpid | rare | common |
| MLR.Eph Ent | uncommon | occasional |
| MLR.Eph EntPor | rare | common |
| MLR.Eph RhoPid* | uncommon | common |
| MLR.MF | rare | occasional |
| MLR.MF MytFves | rare | occasional |
| MLR.Sabspin* | unrecorded | rare |
| SLR.FX Blitt | rare | occasional |
| LR.Rkp-no biota* | ? | common |
| LR.Rkp G | common | rare |
| LR.Rkp Cor | common | abundant |
| LR.Rkp FK | common | uncommon |
| LR.Rkp FK.Sar | uncommon | rare |
| LR.Rkp SWSed | common | occasional |
| LR.Ov SR | common | common |
| LGS | ? | common |
| LGS.S Lan | uncommon | common |
| LMS | common | uncommon |
| MIR.KR LdigPid | rare | abundant |
| SIR.K Lac | common | rare |
| IR.FaSWV AlcByH.Hia | widespread | ?rare |
| ECR.BS BalHPan | rare | ?rare |
| MCR.ByH SNemAdia | ?uncommon | ?rare |
| MCR.ByH FluSerHyd | widespread | ?rare |
| MCR.As MolPol | widespread | locally common |
| MCR.SfR Pid | scarce | common |

* = undescribed biotope

The biotopes/communities recorded during the present survey differ little from those recorded in previous studies. They are typical of chalk reefs in Britain and many will be encountered on chalk foreshores in Sussex and Hampshire.

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# Appendix 1

## Other features of note around Thanet

### Birds

The Thanet coast is also a European Community 'Special Protection Area' (SPA) (Birds Directive 1979). It supports wintering waders that feed on the resources of the foreshore reef exposed at low tide; there are internationally important numbers of Grey Plover, Ringed Plover and Sanderling (Griffiths 1992). The Purple Sandpiper seems to be dependent on food amongst the rocks; Turnstone feeds mainly on the rocks but also wherever rotting seaweed occurs. Griffiths (1992) reports that Sanderling and Dunlin have declined mainly in the north east of Thanet while at more westerly areas, such as Minnis Bay, they have held firm or increased. Griffiths notes that it is perhaps significant that long sea outfalls have replaced the former very short sewage outfalls in north-east Thanet (at Foreness and Broadstairs) since 1987. Dunlin and Sanderling may be more dependent on small filter-feeding invertebrates that benefit from sewage as a basis to the food chain, while Turnstone may be less vulnerable because of their ability to feed on invertebrates abundant in rotting seaweed. The apparent correlation between sewage discharge, abundance of filter-feeding invertebrates, and occurrence of birds was also noted previously by Henderson (1988). Mussel-dominated areas are less interesting marine-biologically than the algal-covered rocky reefs (see elsewhere in this report), but both are important to the bird populations.

The Fulmar (*Fulmaris glacialis*), a pelagic species which breeds colonially on coastal cliffs but which spends much of the year at sea, has expanded its breeding range in Europe (Keith & Gooders 1990). It has spread to the cliffs of Thanet where there is now a population (Henderson 1988). They occur at high (supralittoral) levels on the cliffs, at and above the highest levels of the orange alga *Chrysotila*. Their presence adds to the biological importance of the Thanet chalk cliffs. Cliff 'management' activities such as 'scarping' (rounding-off the upper parts of cliffs from the horizontal) degrade the habitat with possible disturbance to Fulmars and should be avoided.

### Rock sea lavender *Limonium binervosum* (G.E.Sm.) C.E.Salmon

The genus *Limonium* (Sea Lavenders) is common in coastal and saltmarsh habitats in the British Isles. Some of the member species are of restricted occurrence and rare in Britain, the Channel Isles and Northwest Europe generally. *Limonium binervosum* is referred to in the literature by most workers as a species-aggregate. Stace (1997) showed that its constituent species and subspecies are difficult to distinguish. *L. binervosum* (*sensu strictu*) occurs only in eastern England and northwestern France (Stace, 1997); Philp (1982) gives a distribution map of the species which shows it to occur predominantly on chalk cliffs between Folkestone and Deal, and on Thanet, and notes also its occurrence at the foot of cliffs. A significant proportion of the species proper occurs in eastern England and on Thanet.

Stace (1997) identified two subspecies of *L. binervosum*. Subspecies *binervosum* grows on chalk cliffs and in some saltmarshes of East Sussex and southeast Kent only. Subspecies *cantianum* Ingr. occurs on chalk cliffs, and in some saltmarshes, of northeast Kent including Thanet, and is considered to be endemic to the area. *L. binervosum* ssp. *cantianum* occurs at supralittoral levels, at and above the height of the orange alga *Chrysotila*. The occurrence of this subspecies on Thanet further supports the national importance of Thanet chalk cliff as a habitat, which should be maintained in as natural a state as possible.

We recommend further study on the ecology of the subspecies and also further taxonomic evaluation (possibly employing molecular techniques) to confirm its precise taxonomic and biogeographical status. Site management should ensure maintenance of populations.

Another interesting Thanet chalk-cliff species is the Hoary Stock *Mathiola incana* (L.) R.Br., a relative rarity in Kent described by Stace as possibly native to sea-cliffs in southern England. Others of local importance and interest include the Cabbage *Brassica oleracea* L. and Rock Samphire *Crithmum maritimum* L.

## Sediment-cobble habitats

The present survey has by requirement of English Nature focused on chalk cliffs, foreshore chalk reefs and subtidal chalk reefs. We draw attention in the aggregate biotope maps to the extent of intertidal and subtidal sediment biotopes. Such habitats/biotopes contain communities of invertebrates both macrofauna and meiofauna. Studies elsewhere have shown the latter to be useful indicators of environmental quality. The subtidal survey has identified animal communities characterising biotopes in cobble and sediment areas which are an important component of the area's total biota and biodiversity.

## Man-made habitats

A variety of man-made structures has been built around the coast of Thanet and provides habitats for marine plants and animals. Many bear communities different from those in natural habitats (Tittley & Shaw 1980) but most of which are not of exceptional interest. However, there are structures which support interesting and unusual species; Tittley & Shaw (1980) drew attention to the occurrence of the alga *Pleurocladia lacustris* A.Braun, a species lost from chalk cliffs and caves, on the limestone outer harbour wall at Margate. The inner harbour at Ramsgate contains algal species such as *Antithamnion cruciatum* (C.Agardh) Naegeli and *Desmarestia viridis* O.F.Muller which are only known in Kent from this location. While coastal structures can correctly be perceived as contributing to the degradation of natural habitats, paradoxically they also contribute habitat diversity.