

**FLAMBOROUGH HEAD  
SUBLITTORAL MONITORING  
2002**

**REPORT**

**Christine Howson, Tom Mercer and Francis Bunker**

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**FLAMBOROUGH HEAD SUBLITTORAL MONITORING**

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**Client**

English Nature  
Northminster House  
PETERBOROUGH  
PE1 1UA

**Nominated Officer**

Eleanor Hill  
Tel. 01733 455461

**Contractor**

Aquatic Survey & Monitoring Ltd.  
Rowangate  
5 Whitfield Brow  
Bollihope  
Frosterley  
Co. Durham  
DL13 2SZ

**Primary Author**

Christine Howson  
Tel. 01875 613256

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## **Data storage and display**

### **Data**

All of the data collected during this survey have been stored in the following formats:

- Excel spreadsheets;
- Marine Recorder;
- MapInfo GIS;
- Original raw data sheets.

These are kept by English Nature

### **Other end products:**

- Animal voucher specimens – these are lodged with the Marine Invertebrate section of the National Museum of Scotland, Chambers Street, Edinburgh;
- Algal specimens – these are lodged with the Royal Botanic Gardens Edinburgh;
- 35 mm transparencies – a CD is held by English Nature. C.M. Howson has the original transparencies which are available for loan;
- Hand-held video tapes, Digital and VHS format. These are held by English Nature North & East Yorkshire Area Team;
- Drop-down video tapes, Hi8, digital (some drops only) and VHS format. These are held by English Nature North & East Yorkshire Area Team.

All of the above are available for reference or loan upon request to English Nature.

## Synopsis

Flamborough Head on the Yorkshire coast was nominated as a candidate Special Area of Conservation (cSAC) to the European Commission in 1996 (Joint Nature Conservation Committee 1995). Its submerged chalk reefs, an unusual habitat in the British Isles, extend up to 6 km offshore. This survey was commissioned to look at the extent and diversity of the infralittoral and circalittoral biotopes on the submerged chalk reefs around Flamborough Head and to initiate a repeatable monitoring programme, against which the condition of the site can be measured in the future. It forms part of a larger programme to monitor specific features of all the sublittoral marine SACs in England.

This project was designed to enable the condition of the Flamborough Head cSAC to be assessed against the targets for the features listed in the table below. This required both diving fieldwork and the use of remote video to establish a baseline of information against which the site condition could be assessed in the future and which could also be used in a comparison with extant data sets such as those collected by the MNCR. The methods used broadly followed those outlined in the Procedural Guidelines in the Marine Monitoring Handbook (Davies *et al.* 2001; <http://www.jncc.gov.uk/marine/mmh/overview.htm>). Field work for this project was carried out during 2001 and 2002. The data collected have been used to establish a quantitative baseline of information for the site. In addition, comparisons were made between the data from 2001/2002 and data acquired in the course of various surveys since 1987.

### Features of Flamborough Head cSAC selected for site condition monitoring

Feature	Species/ biotopes	Target
Kelp forest communities & Subtidal faunal turf communities	Kelp forest communities & Circalittoral communities	No decrease in distribution and range of biotopes from baseline.
Kelp forest communities	Kelp forest communities	Algal species composition: no significant deviation from baseline.
Kelp forest communities	<i>Ptilota gunneri</i> ; <i>Odonthalia dentata</i> ; <i>Calliblepharis ciliata</i> ; <i>Halurus equisetifolius</i> ; <i>Taonia atomaria</i>	Presence and abundance of these species should not deviate significantly from baseline.
Subtidal faunal turf communities	Flu.Flu; StoPaur; AlcByH.Hia	Species composition: no significant deviation from baseline.
Subtidal faunal turf communities	<i>Archidistoma aggregatum</i> ; <i>Polymastia boletiformis</i> ; <i>Thuiaria thuja</i>	Presence and abundance of these species should not deviate significantly from baseline.

## Summary of the major conclusions

### **Kelp forest communities & Circalittoral communities: No decrease in distribution and range of biotopes from baseline.**

- The video survey carried out in 2001/02 found a very similar range of biotopes to earlier surveys. Taking into account differences in the survey techniques, the distribution of biotopes was broadly similar between surveys.
- 67% of the circalittoral biotopes recorded by the MNCR were found during the present survey; some apparent differences may be due to differences in interpretation of the biotope classification.
- Some apparently real differences include beds of the mussel *Mytilus edulis* (MytHAs), which was recorded over a much wider area in 2001/2002 than in earlier years.
- In general, the biotope distributions have been very consistent over the 15 years from 1987.

**Kelp forest communities: No significant deviation of algal species composition from baseline.**

- A comparison of data from the 2002 survey with data from 1987 and 1993, using species' presence/absence, appears to show that there has been no major change in the algal species composition of the kelp forest communities (Lhyp.Ft; Lhyp.Pk) since 1987.
- A similar comparison of data from the mixed kelp communities on scoured rock and cobble (XKScrR) showed considerable variability between all the sites over the years. However, there does not appear to have been any major change in the algal species composition of these communities since 1987. More detailed analysis of data of similar structure to the 2002 dataset would be required to answer this question with more confidence.

**Kelp forest communities: Presence and abundance of selected key species should not deviate significantly from baseline.**

- Of the five algal species selected for inclusion in this study (see table above) one, *Halurus equisetifolius*, was not found in the historical records from the site nor recorded during the present surveys and so was ignored.
- A comparison of the records of the remaining four species with those from earlier surveys showed that there has been no significant change in the distribution of any of the four species between 1987 and 2001/2002.

**Subtidal faunal turf communities (Flu.Flu, StoPaur, AlcByH.Hia): No significant deviation of species composition from baseline.**

- Detailed sampling in 2002 at locations where StoPaur had been recorded by earlier surveys led to a slightly different interpretation of the classification and the following *Circolittoral faunal turf* biotopes were identified and sampled: StoPaur; Flu.HByS; SNemAdia.
- Differences in sampling techniques between 2002 and earlier surveys combined with the different interpretation of the biotope classification hindered meaningful comparisons with historical data. A visual comparison of the species lists suggested that there has been no major change in the dominant species but this conclusion should be regarded as provisional.
- The offshore *Flustra*-dominated Flu.Flu could not be sampled due to difficult sea conditions. This biotope should perhaps be excluded from future monitoring surveys.
- The infralittoral faunal turf AlcByH.Hia was found to be widely distributed on the north coast but the broken nature of the habitat on small vertical walls meant that there were no continuous large areas of the biotope. This produced a high degree of variation within the species composition of the quadrats. It was concluded that, if this biotope was to be included in future quantitative monitoring work, a much larger number of quadrats and sites should be sampled.
- The variability observed in the 2002 data from AlcByH.Hia was also reflected in the earlier work and it was not possible to draw any meaningful conclusions from comparisons of presence/absence information. An inspection of the species lists suggested that there has been no major change in the dominant species, but more detailed analysis is required before any firm conclusions can be made.

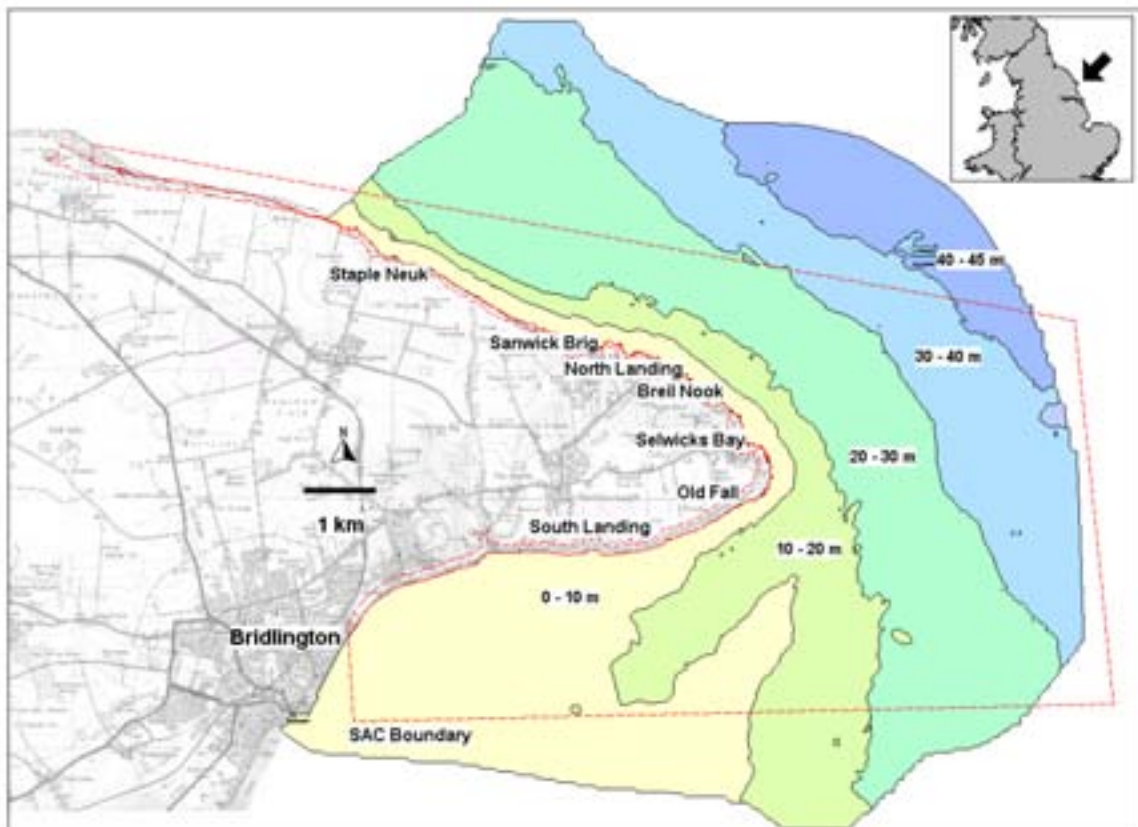
**Subtidal faunal turf communities: Presence and abundance of selected key species should not deviate significantly from baseline.**

- Records of the presence of the three animal species selected for study (see table above) on both the video tapes and in the diving results were compared with earlier data.
- The results show that there has been no significant decrease within the SAC in the distribution of any of the three species between 1987 and 2001/2002.
- Two of the species, the hydroid *Thuiaria thuja* and the ascidian *Archidistoma aggregatum* may have increased their range within the site.
- *A. aggregatum* continues to be abundant within the site but there is not enough information to assess accurately any changes in abundance of any of the species.

## 1 Introduction

Flamborough Head on the Yorkshire coast was nominated as a candidate Special Area of Conservation (cSAC) to the European Commission in 1996 for its vegetated sea cliffs, intertidal and submerged reefs and sea caves (Joint Nature Conservation Committee 1995). Its spectacular cliffs and rocky shores, which represent almost 10% of all European coastal chalk, are riddled with sea caves whilst submerged chalk reefs, an unusual habitat in the British Isles, extend up to 6 km offshore. Under the terms of the Habitats Directive (Council of European Communities 1992) the UK is required to report at intervals on the condition of its marine SACs. Information on the distribution and extent of the features within the site is an essential pre-requisite for both effective management and assessment of the condition of the site. This survey was commissioned to look at the extent and diversity of the infralittoral and circalittoral biotopes on the submerged chalk reefs around Flamborough Head and to initiate a repeatable monitoring programme, against which the condition can be measured in the future. It forms part of a larger programme to monitor specific features of all the sublittoral marine SACs in England.

**Figure 1** Location of the survey area



Flamborough Head presents a challenging environment for marine biological work. The chalk, wave-cut platforms in the sublittoral zone are dissected, particularly on the north coast, by deep gullies with outcrops projecting above the level of the platform. The coast is exposed with strong tides off the head itself and the combination of wave action and chalk means that the water is generally very turbid, particularly in shallow water. There are relatively few surface features to aid in site relocation. This environment presents some difficulties in terms of access to shallow inshore water, particularly on the north coast, where the water turbidity means that underwater rocks or obstructions are difficult to see. Onshore wave action in these conditions also presents difficulties for manoeuvring boats safely.

## 2 Objectives

This project was designed to enable the condition of the Flamborough Head cSAC (Figure 1) to be assessed against the targets for the features listed in Table 1. The objectives for this sublittoral field programme were to establish a methodology for sampling the sublittoral features of the site

- 1) that could be repeated in the future;
- 2) that would produce a robust data set to enable comparisons to be made between data collected at different visits.

This required both diving fieldwork and the use of remote video to establish a baseline of information against which the site condition could be assessed in the future and which could also be used in a comparison with extant data sets such as those collected by the MNCR.

**Table 1** Features of Flamborough Head cSAC selected for site condition monitoring

Feature	Species/ biotopes	Target
Kelp forest communities & Subtidal faunal turf communities	Kelp forest communities & Circalittoral communities	No decrease in distribution and range of biotopes from baseline.
Kelp forest communities	Kelp forest communities	Algal species composition: no significant deviation from baseline.
Kelp forest communities	<i>Ptilota gunneri</i> ; <i>Odonthalia dentata</i> ; <i>Calliblepharis ciliata</i> ; <i>Halurus equisetifolius</i> ; <i>Taonia atomaria</i>	Presence and abundance of these species should not deviate significantly from baseline.
Subtidal faunal turf communities	Flu.Flu; StoPaur; AlcByH.Hia	Species composition: no significant deviation from baseline.
Subtidal faunal turf communities	<i>Archidistoma aggregatum</i> ; <i>Polymastia boletiformis</i> ; <i>Thuiaria thuja</i>	Presence and abundance of these species should not deviate significantly from baseline.

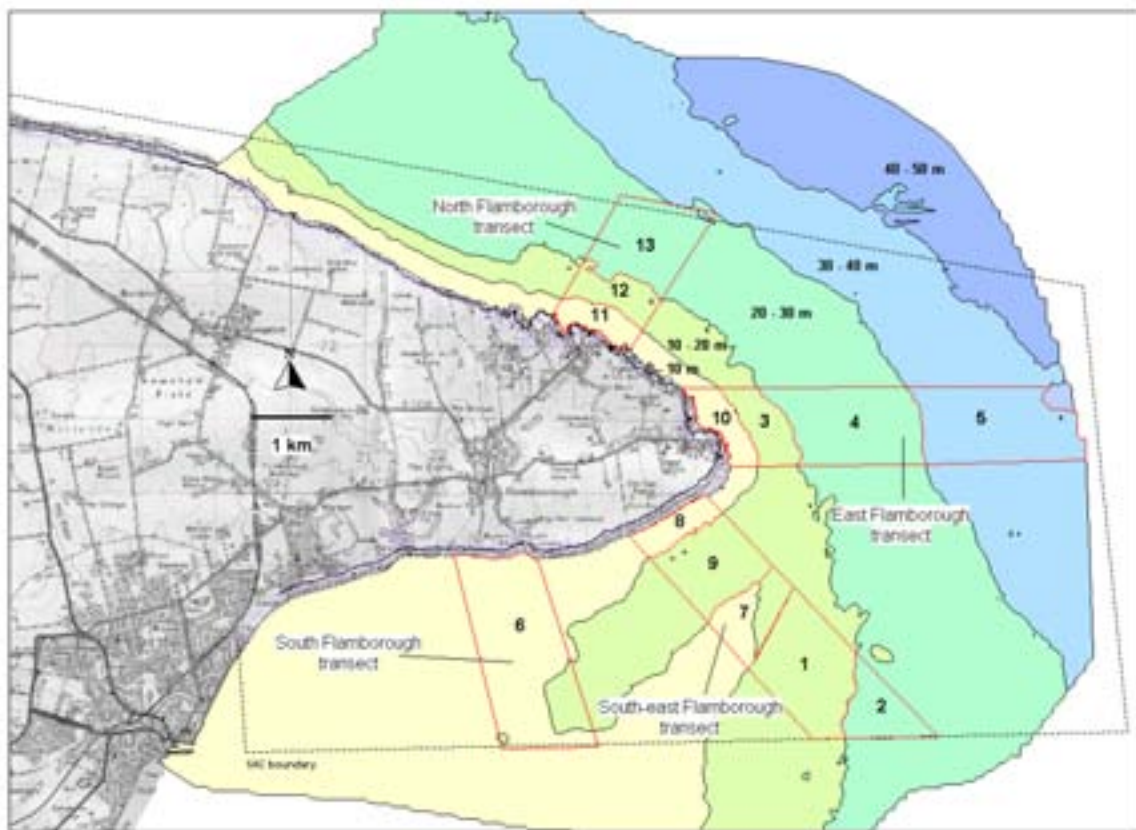
## 3 Methods

### 3.1 Assessment of range of biotopes and their distribution using remote video

**Feature:** Kelp forest communities and sublittoral faunal turf communities  
**Target:** No decrease in distribution and range of biotopes from baseline.

Biotope complement and the distribution of biotopes across the site were assessed using a drop-down video to sample four block transects around the headland (Figure 2). These transects were selected on the basis of previous surveys to encompass the range of known biotopes. They were divided into depth bands, each of which was sampled using a drop-down video deployed at a series of randomly located positions. The main aim of this exercise was to identify the biotope at each position, and so the camera was kept on the seabed until it was judged that there was enough footage to enable the biotope to be identified, a duration of 2 to 3 minutes. If the seabed was mixed, the tows were generally longer within the safe limits of the operating conditions. These methods are described in detail in Appendix 1 and only an outline summary is included here.

**Figure 2** Location of video transects and numbered sampling blocks; these equate to depth bands



The field work was begun on the 7<sup>th</sup> and 8<sup>th</sup> September 2001 by Dr R Foster-Smith of SeaMap at Newcastle University assisted by Christine Howson of ASML. Bad weather meant that only part of the survey was carried out at this time and it was finally completed on 12<sup>th</sup> and 13<sup>th</sup> September 2002. The survey vessel ‘Mariner’, run by Seastar Surveys, was used for this work in 2001, working from Bridlington Harbour. In 2002 the local survey vessel ‘Striker’ was used.

### 3.2 Assessment of species composition of selected biotopes using diving

**Feature:** Kelp forest communities  
**Target:** Algal species composition: no significant deviation from baseline.

**Feature:** Subtidal faunal turf communities - Flu.Flu; StoPaur; AlcByH.Hia  
**Target:** Species composition: no significant deviation from baseline.

A number of kelp forest and circalittoral faunal turf communities were chosen for study which were considered to be representative of the major biotopes present in the area. These were selected by a combination of an inspection of earlier survey records and the results of the 2001 video survey. Diving was used to establish the species’ complement of these communities and the abundance of their constituent species. The difficult tidal conditions and generally poor underwater visibility around Flamborough Head dictated to some extent the sites selected for monitoring and influenced the methods used underwater. The approach to the quantitative monitoring adopted for this project was one of stratified random sampling in which the target biotope acts as the stratified element of the sampling programme, and is sampled using quadrats positioned randomly along a transect. These methods and biotope-specific variations are described in detail in Appendix 2.

This detailed quantitative work was supported by semi-quantitative Phase II surveys of the target biotopes which provided a broader contextual description to complement the smaller scale quadrat studies. In addition, each transect was either videoed using hand-held digital video or photographed with a 35 mm camera to provide a permanent visual record of the biotope appearance. In some cases there was a combination of both video and photography, depending upon the logistics of personnel and underwater conditions on the day.

Following the data analysis, local biotope descriptions were compiled for each biotope surveyed (see Appendix 6). These were intended to fulfil the target of defining the species composition of the various biotopes present. In order to provide an assessment of whether the species composition showed any significant deviation from earlier data, the results were compared with data collected during MNCR Phase II surveys. The results of this are described in Section 5.

### 3.3 Assessment of presence of selected algal species using diving

**Feature:** Kelp forest communities  
**Target:** Presence and abundance of selected species should not deviate significantly from baseline.

#### Selected species

- *Ptilota gunneri*;
- *Odonthalia dentata*;
- *Calliblepharis ciliata*;
- *Halurus equisetifolius*;
- *Taonia atomaria*

The presence and semi-quantitative abundance of these five algal species was recorded by the divers at sites where a Phase II reconnaissance was carried out or where quadrat work was undertaken. No additional sites were dived solely for this purpose.

### 3.4 Diving safety and logistics

The diving fieldwork was carried out by a team of four divers over a period of two separate weeks of neap tides in 2002, 19<sup>th</sup> – 22<sup>nd</sup> May and 18<sup>th</sup> – 23<sup>rd</sup> June. The local survey vessel ‘Striker’, based in Bridlington, was used as a diving platform. All of the diving was carried out in accordance with the Approved Code of Practice for scientific diving projects (Health and Safety Commission 1998). The divers were all qualified according to the relevant 1997 HSE regulations and used air with standard SCUBA equipment.

Diving was planned for slack water where this could be determined (Table 2) although slack water was influenced strongly by the wind strength and direction, with very little slack water following a period of strong easterlies and significantly longer slacks during the calm weather of the second week of diving. The times shown in Table 2 are the times when diving was possible at these sites; it is likely that there are other periods of slack water, particularly around low water. Relatively little diving was done at low water because Bridlington Harbour dries and access is limited around low water. Divers remained in contact with each other underwater in conditions of poor visibility by using a buddy line. One of each pair carried a Surface Marker Buoy (SMB) and the other diver had a delayed SMB for use in case of separation.

**Table 2** Estimated times of slack water at the dive sites around Flamborough Head.

Site	High water slack	Low water slack
South Landing (Sites 1, 2, 8, 16)	HW to HW + 1 hr 30 mins	LW – 1 hr to LW + 1 hr
Offshore South Landing (Site 9)	HW – 2 hrs to HW + 30 mins	Not known
Old Fall (Sites 5, 11)	HW – 1 hr 35 min to HW – 45 min (Slight tide running) No slack on HW	LW + 3 hrs to ?
Breil Nook Circalittoral (Site 4)	HW to HW + 1 hr 30 mins	LW – 2 hrs to ?LW
Breil Nook Infralittoral (Site 3)	Generally slack	Generally slack
Breil Nook offshore (Site 14)	No slack found	No slack found
North coast inshore (Sites 15, 10, 6, 7, 13)	Generally slack	Generally slack
Sanwick Brig Circalittoral (Site 12)	HW + 1 hr to HW + 2 hr	Not known

### 3.5 Photography and video

The majority of the biotopes were videoed with a hand-held digital video and lights (Sony VX1000 3CCD). 35 mm macro photographs using a housed Nikon F50 with 60 mm lens were taken of a representative range of species at several of the sites. Underwater visibility and light conditions were generally too poor to allow wide-angle photography.

### 3.6 Data handling and analysis

#### 3.6.1 Video data analysis

An initial assessment of the biotopes found on each tow, based on the species visible and the seabed type, was made during the course of the field work. Following the field survey, the video tapes were viewed more thoroughly and biotopes assigned to each tow. Approximately 40% of the tows were then reviewed by a second worker to ensure accuracy and consistency of biotope identification. The sites selected for review included examples of each biotope identified and a number of sites where there was a query over the classification. The results and comments from both workers were taken into account to make a final decision on biotope allocation.

In addition to this work, video tapes from a broad scale survey of Flamborough Head carried out in 1994 (Davies & Sotheran, 1995) were reviewed and biotopes assigned according to the current national classification (Connor *et al.*, 1997). This project had been carried out before the present classification system was in use and life forms rather than biotopes had originally been assigned to the data, making direct comparison with the present work difficult.

Analysis of the quadrat data collected by the divers (see Section 5) enabled better recognition of a number of the biotopes present in the area and in particular the separation of SNemAdia, Flu.HByS and StoPaur. Where appropriate, the biotope descriptions compiled from the divers' data were used to assist in classifying the video drops. No statistical analysis of the video results was deemed relevant.

### 3.6.2 Quadrat data handling and analysis

The methods used for data analysis, including the treatment of the data before analysis, are described in detail in Appendix 3 and only an outline summary is included here. The comparison with earlier data is discussed in Section 5.

Following the field work, all the specimens collected, including those in the suction samples, were identified and added to the species data sets as *Present* unless there was additional abundance information available. All the Phase II and quadrat data were entered into Excel spreadsheets and Marine Recorder.

The data collected were divided into the following groups for analysis:

- Circalittoral rock and cobble – sites 4, 9, 11, 12;
- Infralittoral rock and kelp – sites 3, 13, 15;
- Infralittoral boulder/cobble and kelp – sites 8, 14;
- Gully walls – sites 6, 10.

The quadrat data were analysed using the PRIMER 5 statistical package to address the following questions:

- Which species characterised each biotope sampled in 2002?
- How similar were the data for a biotope which occurred at more than one site?
- Could the data be used to separate closely related biotopes or was there too much overlap in the dominant species?
- Did the quadrats collected from one site by different divers comprise a coherent data set or were there major differences between workers?

Cluster analysis and ordination were the major tools used to provide a visual assessment of the similarity of and differences between the various sites and to check for outlying quadrats. The species responsible for the similarities and differences between the resultant clusters were identified and this information was used to assist in drawing up descriptions of the biotopes.

### 3.6.3 Biotope descriptions

The results from the quadrat analyses, when combined with the qualitative suction samples and the Phase II records, enabled the individual biotopes to be distinguished and National Biotope Codes were assigned (Connor *et al.* 1997). Local biotope descriptions for Flamborough Head were then written which made use of all the different levels of information that had been collected during the survey. The lists of characterising species were compiled from the results of the data analyses combined with the Phase II observations.

### 3.6.4 Comparison with historical data

Several descriptive surveys have been carried out around Flamborough Head since 1987 (Table 3). The biotope and species data available from these surveys were used in a number of ways to compare with the results from the present survey in an attempt to assess whether the following monitoring targets for the kelp forest and subtidal faunal turf communities had been achieved:-

- No decrease in distribution and range of biotopes from baseline.
- Species composition of community: no significant deviation from baseline.
- Presence and abundance of selected algal species should not deviate significantly from baseline

**Biotope distribution**

Biotope distributions were compared visually on maps, firstly using the comparable video data from 1994, 2001 and 2002 (Section 4.3) and then using all the available data since 1987 (Section 6.1).

**Species composition**

Earlier data detailing the species composition of the various biotopes are contained in the 1987 and 1993 surveys, both of which were carried out at Phase 11 level with species recorded as semi-quantitative abundances. In order to make comparisons with the quantitative monitoring data, all of the relevant information was converted to Presence/Absence and cluster analyses and ordinations were carried out, as described in Appendix 3. A visual comparison was also made of the lists of dominant species recorded in the various surveys.

**Selected algal species presence and abundance**

Records of the key algal species were extracted from the database and mapped with records from the present survey for a visual comparison of distribution. No statistical analyses of abundance were carried out.

**Table 3** Surveys used for comparison of biotope and species data.

Year of survey	Survey title	Organisation	Survey type	Reference
1987	Flamborough Headland; sublittoral survey	NCC	Diving	Wood (1988)
1993	MNCR sublittoral survey from Saltburn to Flamborough Head	MNCR	Diving	Brazier <i>et al.</i> (1998)
1994	Mapping the distribution of biotopes at Flamborough Head	EN/Biomar	Acoustic/ Remote Video	Davies & Sotheran (1995)
2001	Flamborough Head sublittoral monitoring; video surveys	EN/ASML	Remote Video	Present report
2002	Flamborough Head sublittoral monitoring; diving surveys	EN/ASML	Diving	Present report

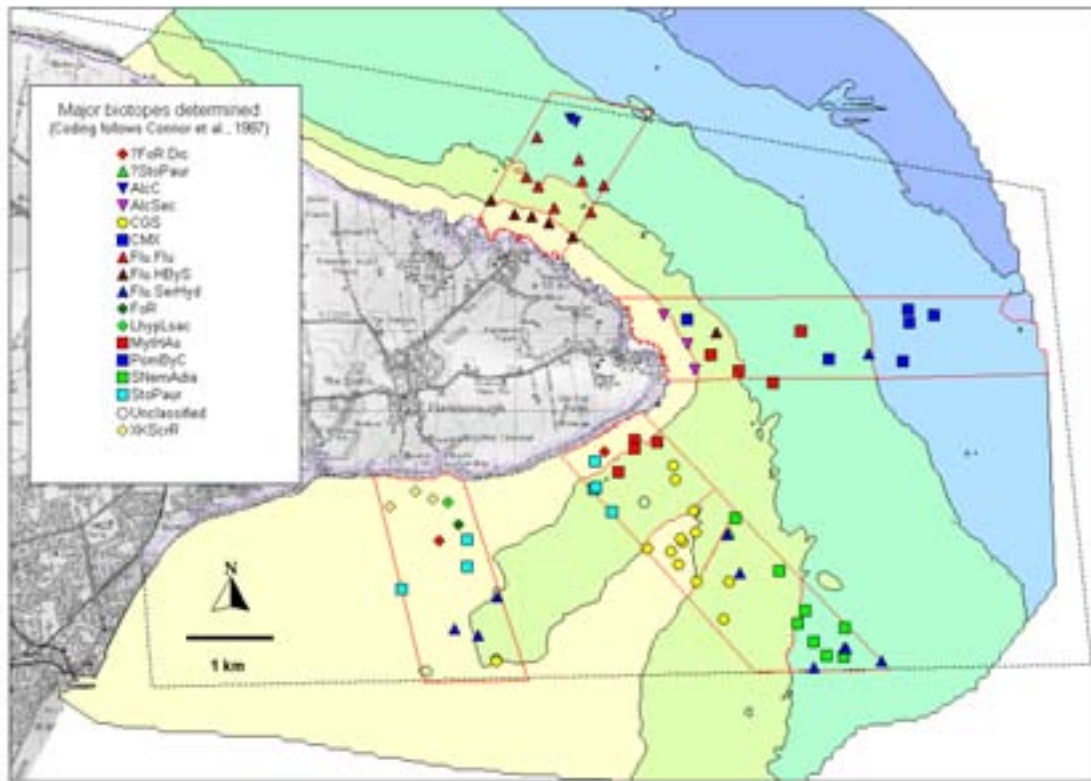
**4 Results of video survey**

**4.1 Video survey**

Video drops were made at 85 sites in the 4 sampling transects. 79 successful tows, with an average length of 67.2 m, were made. 14 individual biotopes and 4 mixtures of biotopes were recorded and Figure 3 shows the location of the drops and the biotope distribution. Appendix 4 summarises the data collected.

Rough sea conditions, strong tides and rugged underwater terrain limited the use of the video on parts of the east transect; in particular the survey of Block 5, the outermost part of the east transect and the deepest part of the survey, was not completed. Additional video drops above the initial target number were made in several of the sample blocks, partly because time was available whilst some areas were inaccessible due to heavy seas and partly to investigate the sample effort required in surveys of this nature. This is discussed further below. The last three drops in block 6 were not random but were selected to record the transition from infralittoral to circalittoral.

**Figure 3** Location of video sample drops in 2001/2002 and the biotopes recorded



## 4.2 Assessment of range of biotopes and their distribution using remote video

**Feature:** Kelp forest communities and subtidal faunal turf communities  
**Target:** No decrease in distribution and range of biotopes from baseline.

The initial purpose of the video survey was to identify the biotopes present around the headland and to assess the distribution and abundance of the kelp forest and subtidal faunal turf communities. Table 4 lists the biotopes recorded by the video work in 2001/2002 and in 1994, with a brief description of each biotope. The results discussed here are supplemented where relevant with observations made by the divers.

From an inspection of Figure 3 and Table 4 it can be seen that the sublittoral reefs around the headland are a mixture of bedrock, boulder and cobble, with an extensive area of cobble off the south coast. There is a large area of sand known as Smithic Sand in the centre of the south-east transect; the scour that this creates influences the reef biotopes bordering it.

### 4.2.1 Kelp-dominated biotopes

Kelp-dominated infralittoral biotopes were only recorded from the inshore part of the southern transect, with an upper circalittoral biotope containing significant amounts of red algae also found on the southern transect. As sampling in very shallow water with the video was difficult, the infralittoral zone was almost certainly under-represented in the 2001/2 survey. The infralittoral biotopes recorded were characteristic of the scoured, unstable substratum with mixed kelp species and foliose algae dominant (XKScrR) with more kelp on the more stable areas of larger boulders and bedrock (LhypLsac). An upper circalittoral biotope with dense growth of foliose red and brown algae (FoR)

was found on bedrock and boulders beyond the lower limit of the kelp; this appeared to grade into the more cobbly XKScrR.

#### 4.2.2 Subtidal faunal turf biotopes

Circalittoral reef biotopes with faunal turf were found on three main types of substratum: bedrock platform and gullies, mostly on the north coast; broken bedrock, boulder and cobble, found inshore on the south coast and inshore on the headland; cobbles, which covered a large area of the south coast.

The main features of the composition and distribution of the circalittoral biotopes recorded by the 2001/2 video survey are highlighted below:

##### Bedrock and boulder

- The circalittoral faunal turf biotopes were dominated by the large conspicuous species *Flustra foliacea* and *Alcyonium digitatum*. These two species were characteristic of all the most abundant circalittoral biotopes in the area (Appendix Table 4.1).
- Bedrock with dense *Flustra foliacea* (Flu.Flu) and bryozoan/hydroid turf (Flu.HByS) dominated the north coast, with *Flustra* more abundant offshore.
- Inshore of the dense *Flustra*, the bedrock platforms were covered with an extensive turf of bryozoans, hydroids and ascidians, with patchy *Flustra* and *Alcyonium* (Flu.HByS).
- Bedrock in the strong tides of the inshore rock beneath the Head supported abundant *Alcyonium digitatum* with some bryozoan/hydroid turf (AlcSec).
- StoPaur, which is characterised by a mixture of ascidians, hydroids and *Flustra*, was most widespread on the inshore broken rock and boulder areas of the south coast.

##### Cobble

- The extensive areas of cobble on the south coast supported three main biotopes. These were related to differing degrees of scour.
- The most scoured, with clean chalk cobbles and small boulders on mobile sand, and very little epifauna (PomByC), was only found at three sites in 2001/2. These were adjacent to sediment areas, with one site on the edge of Smithic Sand.
- Slightly less scoured cobbles with a mixture of clean cobbles, some development of hydroids and turf species and often abundant *Lanice conchilega* (Flu.SerHyd) occurred around the edges of Smithic Sand and also further offshore, towards the outer limit of the cobbles.
- The most stable of the cobble biotopes had considerable development of hydroid and bryozoan turf, particularly on the more stable boulders, and fewer bare cobbles than the other two biotopes (SNemAdia). This occurred on the outer part of the south-east transect, between two areas of the more scoured Flu.SerHyd.
- These three cobble biotopes graded into each other and separation of them using the video footage was difficult and a matter of individual judgement.
- Extensive mats of mussels *Mytilus edulis* were abundant on mixed rock and sand off the headland, and on the inshore part of the south-east transect (MytHAs). It is possible that *Modiolus* was present further offshore on the headland; although the animals themselves could not be distinguished on the video tapes, there were dead shells present and the associated community suggested that there were mussels stabilising the sediments. As neither worker could find live mussels on the tapes, a mixed sediment biotope was assigned to these sites (CMX).

#### 4.2.3 Sediments

The area known as Smithic Sand comprises an extensive area of mobile, rippled, coarse sand with little associated epifauna. The presence of large areas of mobile sand has a considerable influence on the composition and distribution of the adjacent reef communities.

### 4.3 Comparison with other broad scale surveys

The biotopes identified from the 2001/02 video survey were compared with the re-worked results from a biotope mapping exercise around Flamborough Head in 1994 carried out by Davies & Sotheran (1995) (Figure 4; Appendix Table 4.2;). The 1994 survey had a greater spread of sites across the whole of the reef area but there were relatively few sites in some of the transect blocks. The quality of the pictures was on the whole better in the earlier survey, a result of clearer water conditions, and there was greater coverage of the infralittoral zone.

Despite the problems of direct comparison between different surveys, a number of relevant points emerge and are discussed below with reference to the monitoring targets.

#### 4.3.1 Range of biotopes present

Similar biotopes were found on both surveys. The 1994 survey found more infralittoral biotopes but this was a factor of a greater inshore sampling effort on that survey, and in fact these biotopes were found by the diving survey. A mixed sediment biotope was recorded in 2001/02 on the outer part of the eastern transect in an area where no video samples were taken on the 1994 survey.

#### 4.3.2 Distribution of biotopes

Figures 3 and 4 show the distribution of biotopes indicated by the two surveys. These surveys were designed for different purposes. The earlier video survey acted as ground validation for a broad scale acoustic survey whilst for the more recent work the four transects were intended to sample the majority of the biotopes recorded but not the whole area. There were no 1994 video drops in the area of the southern transect and there were no drops in 2001/02 in the north west of the site, which is mostly sediment. Despite these differences in coverage, there was enough overlap to make some general observations about the comparative distribution of biotopes in the two surveys.

#### Kelp-dominated biotopes

- There was a better coverage of the infralittoral zone by the Davies & Sotheran survey than the more recent one. However, both surveys had generally similar results with red algal-dominated bedrock and kelp forests within the 10 m depth contour.
- Both surveys found mixed, scoured substrata with abundant foliose algae and kelps on the more stable boulders (XKScrR) along the south coast of the site, with any differences in distribution attributable to differences in sampling approach.
- Davies & Sotheran drop 101 is probably in the wrong position as it shows kelp forest in the centre of the 10 – 20 m zone off the Head.

#### Subtidal faunal turf biotopes

- Dense *Flustra foliacea* (Flu.Flu) was found in the same area in both surveys, on the north coast bedrock platforms between depths of approximately 10 m and 25 m.
- Along the north coast, the bryozoan/hydroid turf with *Flustra* and *Alcyonium* (Flu.HByS) was found inshore from the dense *Flustra*, on bedrock around the 10 m depth contour, in both surveys. There were other records of the biotope slightly further offshore on the Head, with one record in the 2001/02 transect and several from the earlier survey.
- The cobble biotopes showed a broadly similar distribution in both surveys, with the most scoured cobbles (PomByC) generally nearest the sandy areas, the next most scoured (Flu.SerHyd) adjacent to the PomByC and in deeper water towards the outer parts of the reef and the most stable cobbles (SNemAdia) in between.
- Differences observed in the distribution of these cobble biotopes is probably due in part to difficulties in separating such closely related biotopes on only limited video evidence and in part to likely changes in the distribution of the very mobile sand.
- Mussels *Mytilus edulis* were found in a similar area to the east of the Head in both surveys. The more recent survey found a second area of mussels on the inshore part of the south-

eastern transect. Whilst this area was not picked up on the earlier video survey, mussels were found to be extremely abundant on lower shore rock all around the head during intertidal surveys in 1999 and 2000 (Howson 2000 & 2001).

- Biotopes dominated by *Alcyonium digitatum* were found immediately below the Head and on offshore rock on the north coast during the 2001/02 survey. Sites in this inshore area on the earlier survey were classified as Flu.HByS. There were no equivalent offshore drops for comparison.

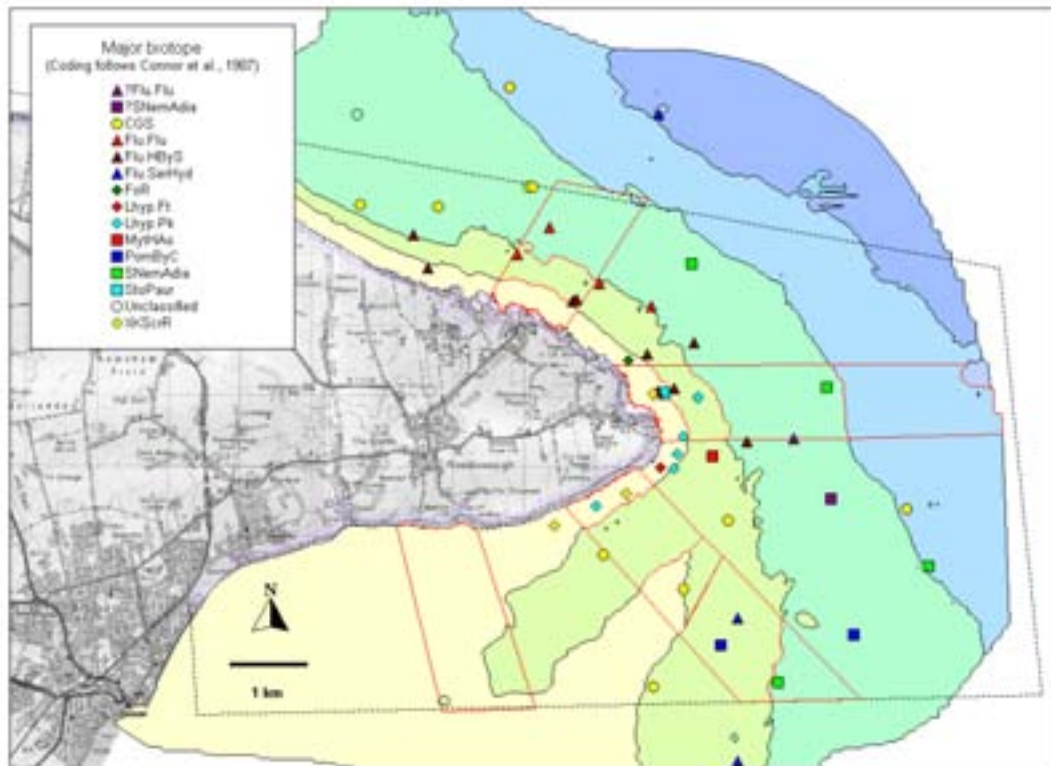
### Sediments

- The two surveys found a broadly similar extent of sand around Smithic Sand; as this sand is highly mobile, it is probable that there are no constant boundaries for this area. Possible differences in the distribution of adjacent, scoured biotopes may be caused by seasonal movement of the sand.
- There were no video drops beyond the 30 m contour to the east of the Head on the Davies & Sotheran video to provide a comparison with the mixed sediment biotope recorded in 2001/01. It is possible that the horse mussel *Modiolus* was present in this area but the quality of the video did not enable this to be established for certain.

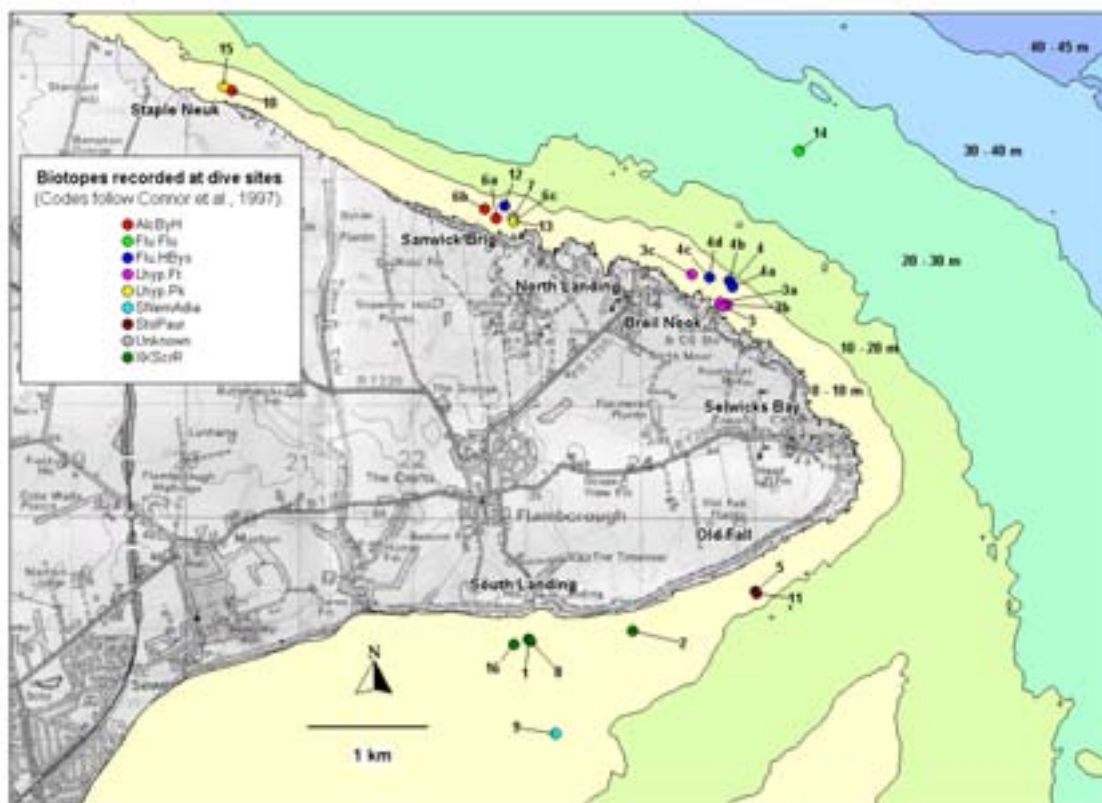
#### 4.3.3 Conclusions of video work

The video survey carried out in 2001/02 found a very similar range of biotopes to the earlier Davies & Sotheran (1995) survey. Taking into account differences in the survey techniques, the distribution of biotopes was broadly similar between the two surveys, with only very minor differences.

**Figure 4** Location of Davies & Sotheran (1995) video drops showing the major biotope recorded at each site.



**Figure 5** Location of dive sites, coded by biotope sampled



## 5 Results of diving survey

### 5.1 Diving survey

Dives were carried out at 16 sites with quadrat data collected at 11 of these. A summary of these dives and the data collected is given in Appendix Table 4.3. Figure 5 shows the location of the dive sites and the biotopes sampled.

To address the targets of *Biotope species composition: no significant deviation from baseline*, three main questions were asked of the data:

- Did the methods used produce a robust data set for each biotope, with high levels of similarity between quadrats?
- Which species and habitat attributes characterised each biotope?
- What were the differences between the data collected in earlier MNCR surveys and the data from 2002?

Some results of the multivariate analyses are included in Appendix 5. For each group of related biotopes, the cluster analysis and MDS plot are shown to illustrate the separation of individual biotopes. Selected species are highlighted on a series of MDS plots to illustrate their relative importance in the ordination. These analyses were repeated for individual biotopes to check the similarity of the various quadrats and results are shown for each biotope.

Local biotope descriptions are given in Appendix 6 for those biotopes where detailed quadrat information was collected. These are derived from the results of the multivariate analyses and the Phase II survey forms and encompass the characteristic species and habitat features. A number of other biotopes were recorded, either on reconnaissance dives or from the video drops, but there was not enough information available to write detailed descriptions of these. A short description of each is given at the end of Appendix 6.

Comparisons with earlier data are made following each habitat analysis below and are discussed in Section 6.

### 5.2 Assessment of species composition of kelp forest communities using diving

**Feature:** Kelp forest communities  
**Target:** Algal species composition: no significant deviation from baseline.

Quadrat data were only collected from *Laminaria hyperborea* kelp forest (Lhyp.Ft) and park (Lhyp.Pk) on the north coast, with two sites visited for kelp park (Sites 13 & 15) and one site, which covered a wide area around Breil Nook, for kelp forest (Site 3). Two infralittoral cobble sites on the south coast (Sites 8 & 14) which were classified as XKScrR are included in the *Kelp forest communities* feature. As these sites were very different from the kelp forest and park on rock, the cobble data were analysed separately. The species composition of these biotopes is described in detail in the biotope descriptions given in Appendix 6.

#### 5.2.1 Infralittoral rock – *Laminaria hyperborea* forest and park (Lhyp.Ft; Lhyp.Pk)

The initial analysis of the quadrats for sites 3, 13 and 15 showed that:-

- The data split clearly into two main clusters distinguishing the kelp forest and park, with one kelp park quadrat (13.16) separating at a high level from the remainder (Appendix 5.1). This was the only quadrat to be dominated by ‘unidentified brown fluff’, probably an Ectocarpaceae. There were relatively few other species in this quadrat.
- The kelp forest clearly had far more mature *Laminaria hyperborea* plants than the kelp park.

- *Plocamium cartilagineum* was the dominant understorey species in both forest and park.
- There were clear differences between the understorey flora in the forest and the park with examples including the following:-
  - *Delesseria sanguinea* was abundant in the kelp park but scarce in the forest whereas *Callophyllis laciniata* was abundant in the forest but virtually absent from the park.
  - Two green algae were conspicuous; *Chaetomorpha melagonium* was common in the kelp forest and *Bryopsis plumosa* in the park, but each species was absent from the other biotope.
  - *Corallina officinalis* was common in the kelp forest and at site 15 in the park, but was scarce at site 13.

Each biotope cluster was then analysed separately with the following results:-

#### **Lhyp.Ft**

- There was high average similarity between the quadrats of 67%.
- A group of five quadrats that split from the others had more kelp plants and therefore less of an understorey than the other quadrats.

#### **Lhyp.Pk**

- There was high average similarity between the quadrats of 60%.
- Two quadrats at site 13 that were different from the others were dominated by *Hypoglossum hypoglossoides*.
- *Delesseria sanguinea* was one of the dominant understorey species but this was more common at Site 13 than Site 15.
- Coralline crusts were a feature of a group of quadrats at Site 15.
- Silt and scour tolerant species such as *Phyllophora pseudoceranoides* and *Rhodomela confervoides* were important features of this biotope.

### **5.2.2 Infralittoral cobble – Mixed kelps and scour-tolerant algae (XKScrR)**

The Primer analyses for sites 8 and 14 highlighted the following:

- The data split broadly, but not entirely, into the two separate sites, Site 8 and Site 14, showing that there was a difference between the two sites; these were represented by two major clusters in the data, with average similarities of approximately 50%.
- One quadrat (8.2) was very different from the others. The main features separating this were a high abundance of *Laminaria saccharina* sporelings and the presence of *Desmarestia aculeata*, both of which would shade out a proportion of the smaller foliose algae. Both of these species also featured at Site 14, but with a lower abundance.
- Site 8 had a higher abundance of adult kelp plants, coralline crusts, *Delesseria sanguinea* and *Plocamium cartilagineum* than Site 14.
- The brown alga *Taonia atomaria* was present in many of the quadrats at both sites, albeit in low abundance.

### **5.2.3 Comparison with earlier data**

In an attempt to assess whether the target of *Algal species composition: no significant deviation from baseline* had been met in the kelp forest communities, a comparison was made with data from the 1987 NCC survey (Wood 1988) and the 1993 MNCR survey (Brazier *et al.* 1998). These data are at Phase 11 level with species recorded as semi-quantitative abundances and so comparisons of species' presence/absence were made.

#### **Kelp forest and park (Lhyp.Ft, Lhyp.Pk)**

Data for both the kelp forest and park were included in the same Primer analyses. The results showed the following:

- The data split into one group which included both of the 2002 sites with sites from both 1987 and 2002 at an average similarity of approximately 62 %, a small group of 3 sites from 1987 with a similarity of 57 % and the remaining sites which showed no clear relationship to the others.
- There was no clear split between kelp forest and kelp park in the data.
- The cluster with the 2002 sites included sites scattered all along the north coast of Flamborough Head.
- The sites in this cluster had the greatest diversity of foliose algae, with the species listed in Table 5 most frequently recorded.
- There was a noticeably greater diversity of smaller and less conspicuous species such as *Erythrodermis traillii* and *Bryopsis plumosa* in the 2002 cluster. This may reflect a difference in the detail of recording.

**Table 5** Results from cluster analysis of algal presence/absence data from kelp forest and park in 1987, 1993 and 2002. Table shows the species selected by SIMPER for Cluster 3 in Appendix 5.10 as contributing most to the similarity of the group. Average similarity of cluster 61.28 %. Sites included in this cluster: 2002.Ft (3); 2002.Pk (13 & 15); 1987 (145.17; 38); 1993 (400.56;58;60;65)

Species	Contribution to similarity shown as cumulative percentage
<i>Phycodrys rubens</i>	7.64
<i>Phyllophora crispa</i>	15.29
<i>Delesseria sanguinea</i>	22.93
<i>Laminaria hyperborea</i>	30.58
<i>Plocamium cartilagineum</i>	36.54
<i>Hypoglossum hypoglossoides</i>	42.51
<i>Bryopsis plumosa</i>	48.33
Corallinaceae indet.	54.15
<i>Corallina officinalis</i>	59.93
<i>Membranoptera alata</i>	64.64
<i>Dilsea carnosa</i>	69.28
<i>Dictyota dichotoma</i>	73.73

This was a fairly crude comparison which only highlighted those species most often recorded, taking no account of the relative abundance of the species. However, it does appear to show that there has been no major change in the algal species composition of the kelp forest communities since 1987.

#### **Mixed kelps and scour-tolerant algae (XKScrR)**

A similar analysis was carried out for the algal communities on the less stable cobble and boulder areas of the south coast of the Head. The following points emerged:

- There was a relatively low level of similarity within these sites, with the two most similar being Sites 14 and 8 from 2002; these sites had separated clearly on the more detailed quadrat analysis.
- Two sites from 1987 clustered with Sites 2002.8 and 2002.14 at a similarity level of approximately 46 %. These 4 sites were all in the vicinity of South Landing.
- Site 38 from 1987 was clearly different from the rest in the cluster analysis; this was the only site in the immediate vicinity of the Head, where the habitat conditions are likely to be very different.

- The relatively low similarity within this biotope probably reflects differences in detail of recording and small differences in species composition rather than any major change. Two sites from 2002 where, due to the tidal conditions, only superficial Phase II recording was carried out without detailed quadrat work, clustered with a 1987 record rather than the other 2002 sites. The SIMPER results showed that large, conspicuous species were responsible for the similarity within this cluster whereas there was a greater diversity of foliose algae which contributed to the similarity within the South Landing cluster. Table 6 shows the main species which determined this cluster.

**Table 6** Results from cluster analysis of algal presence/absence data from mixed kelp and scour-tolerant algal sites in 1987, 1993 and 2002. Table shows the species selected by SIMPER for Cluster 4 in Appendix 5.11 as contributing most to the similarity of the group. Average similarity of cluster 46.34 %. Sites included in this cluster: 2002.8, 16; 1987.54, 58.

Species	Contribution to similarity shown as cumulative percentage
<i>Rhodomela confervoides</i>	12.55
<i>Hypoglossum hypoglossoides</i>	25.09
<i>Laminaria saccharina</i>	37.64
<i>Delesseria sanguinea</i>	50.18
<i>Brongniartella byssoides</i>	62.73
<i>Polysiphonia stricta</i>	68.22
<i>Cystoclonium purpureum</i>	73.70
<i>Calliblepharis ciliata</i>	79.18
<i>Taonia atomaria</i>	84.56

As with the kelp forest, this was a fairly crude comparison which took no account of the relative abundance of the species. There seems to be considerable variability between all the sites over the years but it does not appear that there has been a major change in the algal species composition of these communities since 1987. More detailed analysis of data of similar structure to the 2002 dataset would be required to answer this question with more confidence.

### 5.3 Assessment of species composition of subtidal faunal turf communities using diving

**Feature:** Subtidal faunal turf communities - Flu.Flu; StoPaur; AlcByH.Hia  
**Target:** Species composition: no significant deviation from baseline.

Quadrat data were collected from subtidal faunal turf communities on circalittoral rock and cobble sites on both the north and south coasts. Four of these sites were from the circalittoral zone (Sites 4, 9, 11, 12) and two were from vertical chalk within the infralittoral zone (Sites 6 & 10). These sites were separated into the shallow vertical rock and the deeper circalittoral zone for analysis. The species composition of the biotopes identified is described in detail in the biotope descriptions given in Appendix 6.

#### 5.3.1 Faunal turf on circalittoral rock and boulder

The analysis showed an initial split between the north coast (Sites 4 & 12) and south coast (Sites 9 & 11) data and a further split into the four sites surveyed Appendix 5.6). More detailed analysis and inspection of the data showed the following:

- The north coast sites were predominantly bedrock with some boulder;
- The south coast sites were a mixture of rock, boulder and cobble, with more cobble further offshore;

- Site 9, which was predominantly cobble, was characterised by *Alcyonidium diaphanum*, hydroids particularly *Halecium halecinum* and *Nemertesia antennina*, crisiid turf and the polychaete *Lanice conchilega* rather than *Flustra foliacea* and *Alcyonium digitatum*. This was classified as **SNemAdia**.
- Site 11, also on the south coast, consisted of mixed rock and boulder. It was characterised by an abundance of the ascidians *Archidistoma aggregatum* and *Polyclinum aurantium*, hydroids including *Halecium halecinum* and *Nemertesia antennina*, *Alcyonidium diaphanum* and the ascidian *Clavelina lepadiformis*. This was classified as **StoPaur**.
- Sites 12 and 4 on the north coast consisted primarily of bedrock. Both were characterised by *Alcyonium digitatum*, *Flustra foliacea*, crisiid turf with *Bicellariella ciliata* and large numbers of *Asterias rubens*. Although there were differences between the two sites, these were felt to reflect the patchiness of the biotope rather than separate biotopes. Both were classified as **Flu.HByS**.

When the data set for each biotope was examined alone, the following emerged:

#### **Flu.HByS**

- There was an average similarity between the two sites of approximately 40%, with a much higher similarity within each site.
- A group of quadrats that split from the main Site 4 cluster was characterised by a higher abundance of *Archidistoma aggregatum*.
- Site 4 generally had more crisiid turf and hydroids than Site 12.
- *Flustra foliacea* was particularly abundant at Site 12.

#### **StoPaur**

- There was an average similarity between the quadrats of 56 %.
- Two quadrats that split from the main cluster at a fairly high level had a greater abundance of *Sabellaria spinulosa*.

#### **SNemAdia**

- There was an average similarity between the quadrats of 50%.
- Three quadrats that split from the main cluster at a fairly high level had a greater abundance of *Flustra foliacea* and *Nemertesia antennina* and less crisiid turf than in the other quadrats.

### **5.3.2 Comparison with earlier data**

In an attempt to assess whether the target of *Species composition: no significant deviation from baseline* had been met in these subtidal faunal turf communities, a comparison was made with data from the 1987 NCC survey (Wood 1988) and the 1993 MNCR survey (Brazier *et al.* 1998). These data are at Phase 11 level with species recorded as semi-quantitative abundances and so comparisons of species' presence/absence were made. It was found that it was not possible to make a meaningful comparison using the techniques available in Primer for a number of reasons. First of all, the division of biotopes in the 2002 data set was slightly different to the earlier data sets and this meant that a direct comparison of the species composition of individual biotopes was not possible. Secondly, when all of the circalittoral biotope data were combined, the different sampling methods used in 2002, including the collection of suction scrapes, which produced more detailed species lists than in earlier surveys, resulted in the 2002 sites separating almost completely from the other sites. This was not helped by the small number of samples in 2002 compared to earlier surveys and the relative coarseness of the presence/absence data. A visual comparison of the species lists suggests that there is no major change in the dominant species.

### **5.3.3 Faunal turf on infralittoral vertical chalk**

Two inshore sites in the bedrock gullies of the north coast were surveyed (Sites 6 & 10), both of which were classified as **AlcByH.Hia**. As these sites were very different from others surveyed, these data were analysed alone. The Primer analyses highlighted the following:

- The two sites clustered together, with five outlying quadrats.
- There is a relatively low average similarity within the main cluster of about 37%.
- The main species characterising the major cluster were the animals *Halichondria panicea*, *Hiatella arctica*, *Sabellaria spinulosa*, crisiid turf and the algae *Schottera nicaeensis* and *Plocamium cartilagineum*.
- Quadrats 10.1, 2, 3 and 4 had no *H. arctica* or *S. nicaeensis* but *Ophiactis ballii* and *Balanus crenatus* were common.
- Quadrats 10.7 and 10.8 had little *Sabellaria spinulosa* and crisiid turf, with few foliose algae. *Clathrina coriacea* and jassid amphipods were common.

#### 5.3.4 Comparison with earlier data

In an attempt to assess whether the target of *Species composition: no significant deviation from baseline* had been met in these subtidal faunal turf communities, a comparison was made with data from the 1987 NCC survey (Wood 1988) and the 1993 MNCR survey (Brazier *et al.* 1998). These data are at Phase 11 level with species recorded as semi-quantitative abundances and so comparisons of species' presence/absence were made. It was found that the variability observed in the 2002 data was also reflected in the earlier work and so it was not possible to draw any meaningful conclusions from these comparisons of presence/absence information. As with the circalittoral faunal turf biotopes, a visual inspection of the species lists suggests that there is no major change in the dominant species, but more detailed analysis is required before any firm conclusions can be made.

#### 5.4 Distribution of selected algal and faunal turf species

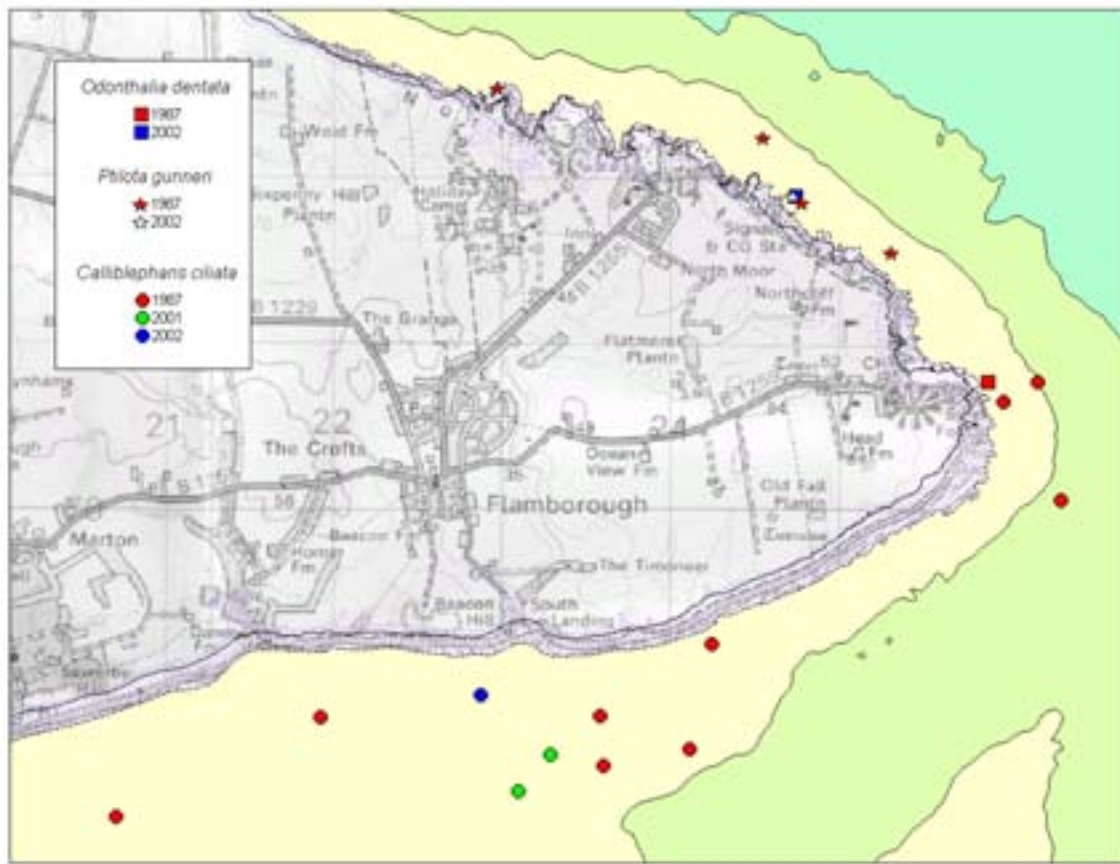
<b>Features:</b>	Kelp forest communities; Subtidal faunal turf communities
<b>Target:</b>	Presence and abundance of selected species should not deviate significantly from baseline.

##### 5.4.1 Key algal species

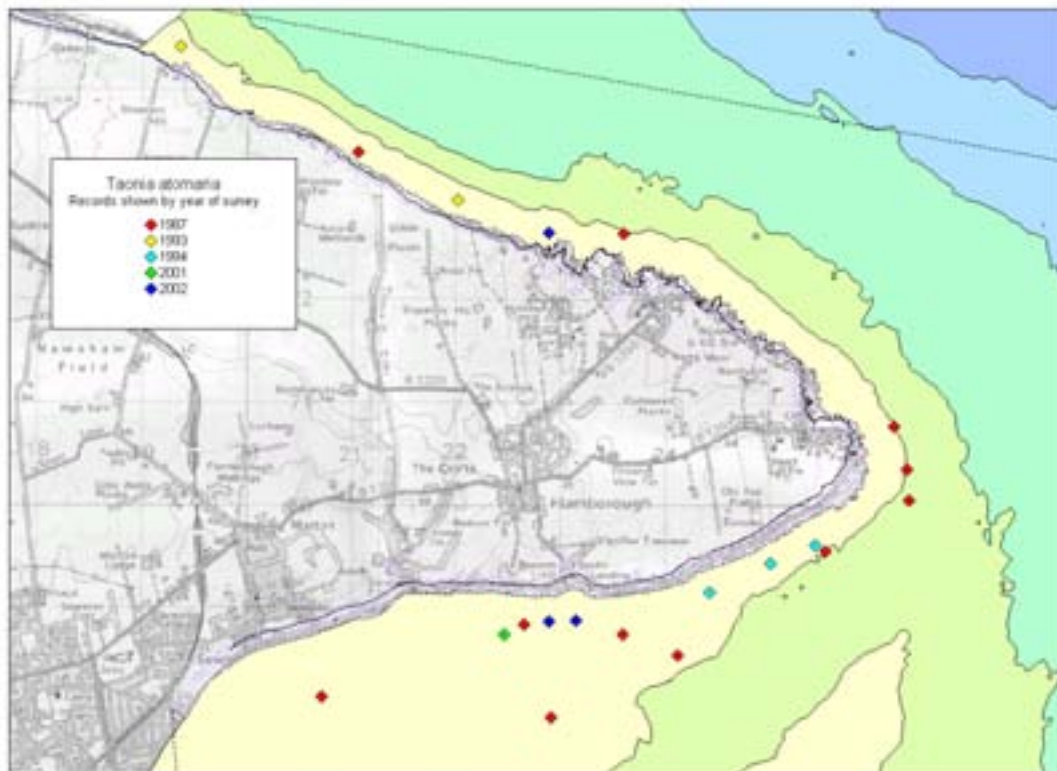
###### Selected kelp forest algae

- *Ptilota gunneri*;
- *Odonthalia dentata*;
- *Calliblepharis ciliata*;
- *Halurus equisetifolius*;
- *Taonia atomaria*.

**Figure 6** Distribution of records of selected algal species around the headland from 1987 to 2002



**Figure 7** Distribution of records of *Taonia atomaria* around the headland from 1987 to 2002



One of the five algal species selected for survey, *Halurus equisetifolius*, was not found in the historical records from the site and was not recorded during the present surveys and so this species was ignored. Records of the remaining four species were compared with those from earlier surveys and the results are shown in Figures 6 and 7, with the surveys included listed in Table 3. *Taonia atomaria*, the most common of the four species around the Head, has a southern and western distribution, and is at or approaching its north eastern limit in the area of Flamborough Head. During the inspection of the 1994 video survey tapes, large plants of *Taonia* were seen to be very abundant at at least one of the sites on the south of the Head; no similar abundance was noted in any of the other surveys. *Calliblepharis ciliata* which is more widespread on the west of the British Isles than *Taonia* was not found on the north side of the Head in any of the surveys. The remaining two species, *Odonthalia dentata* and *Ptilota plumosa*, are at the southern limit of their distribution in this area and have not been found on the south side of the Head. These results support the suggestion that the Flamborough Front, which forms in the area during the summer months (Pingree & Griffiths 1978; Brazier *et al.* 1996), acts as a barrier to the distribution of some species approaching their geographical limits. Although the spread of sites included in the present survey was much narrower than in the earlier 1987 and 1993 diving surveys, and no account has been taken of time of year, the results show that there has been no significant change in the distribution of any of the four species between 1987 and 2001/2002. No additional information was collected on the abundance of these species, other than the quadrat records, so it is not possible to comment on any changes or otherwise in their abundance.

#### 5.4.2 Key faunal turf species

##### Selected faunal turf species

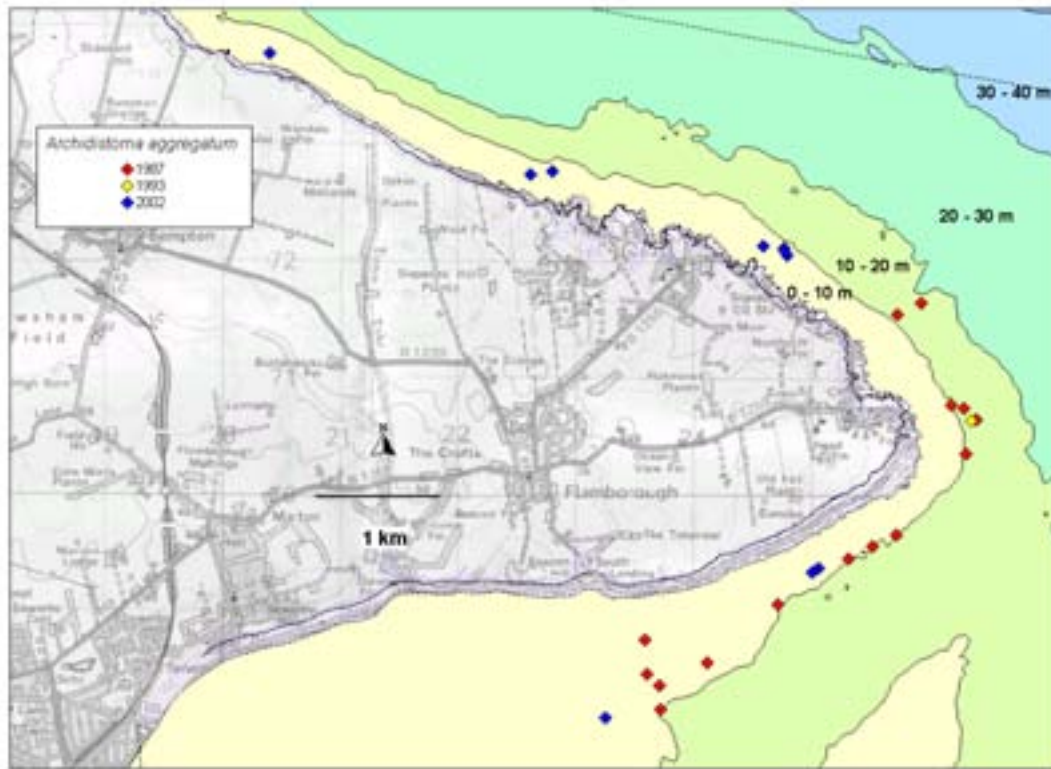
- *Archidistoma aggregatum* (an ascidian)
- *Polymastia boletiformis* (a sponge)
- *Thuiaria thuja* ( bottlebrush hydroid)

Part of the original survey plan was that the faunal turf species should be recorded from the video drops. In the event, the underwater conditions meant that the quality of the video was such that these species could not be recorded reliably. However, the three species were all encountered incidentally either on the video tapes or by the divers and these records are compared with those from earlier surveys on Figures 8 to 10. As with the algal species, these maps enable the distribution of the species over the fifteen year period to be assessed, but it is not possible to assess any changes in abundance.

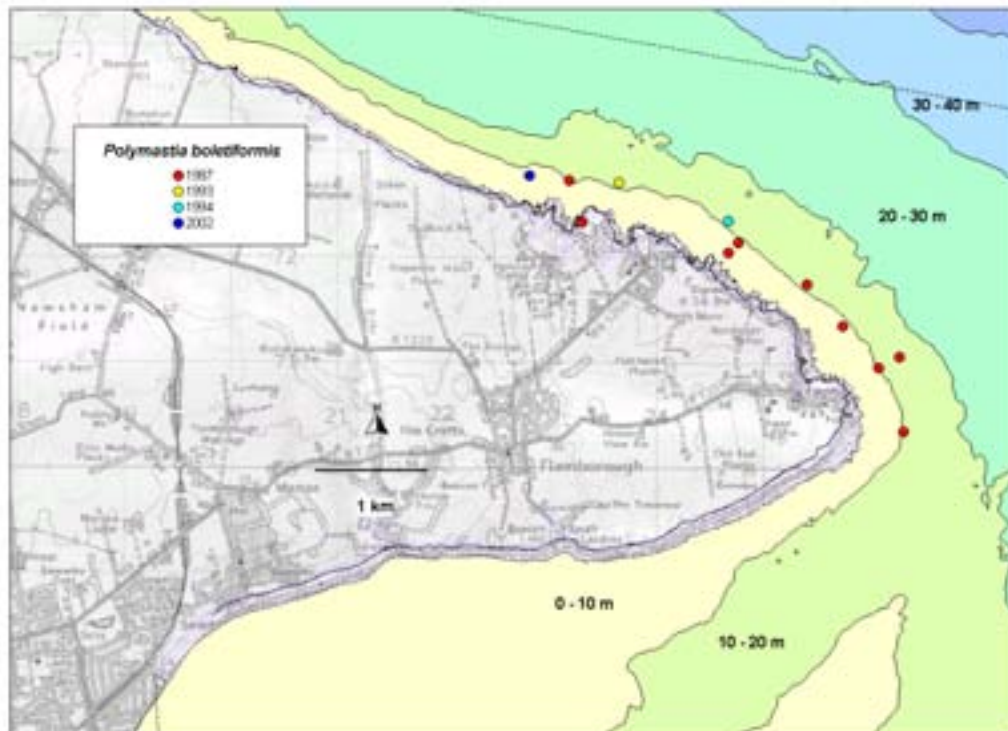
The hydroid *Thuiaria thuja* is a northern species, at its southern limit of distribution at Flamborough Head. Previous records of the hydroid extended as far south as Flamborough Head itself. In 2001 and 2002 the hydroid was seen on the video at sites on both sides of the head, suggesting that its range has certainly not decreased and that it may now extend slightly further south than previously. In contrast, the southern species of ascidian was found at sites all around the headland in 2002, extending its previously recorded distribution within the SAC, and it was generally abundant where it was found. *Polymastia boletiformis* was the least frequently recorded of the three species in 2002 but the two records of this sponge were at the north western and south eastern limits of its previously recorded distribution.

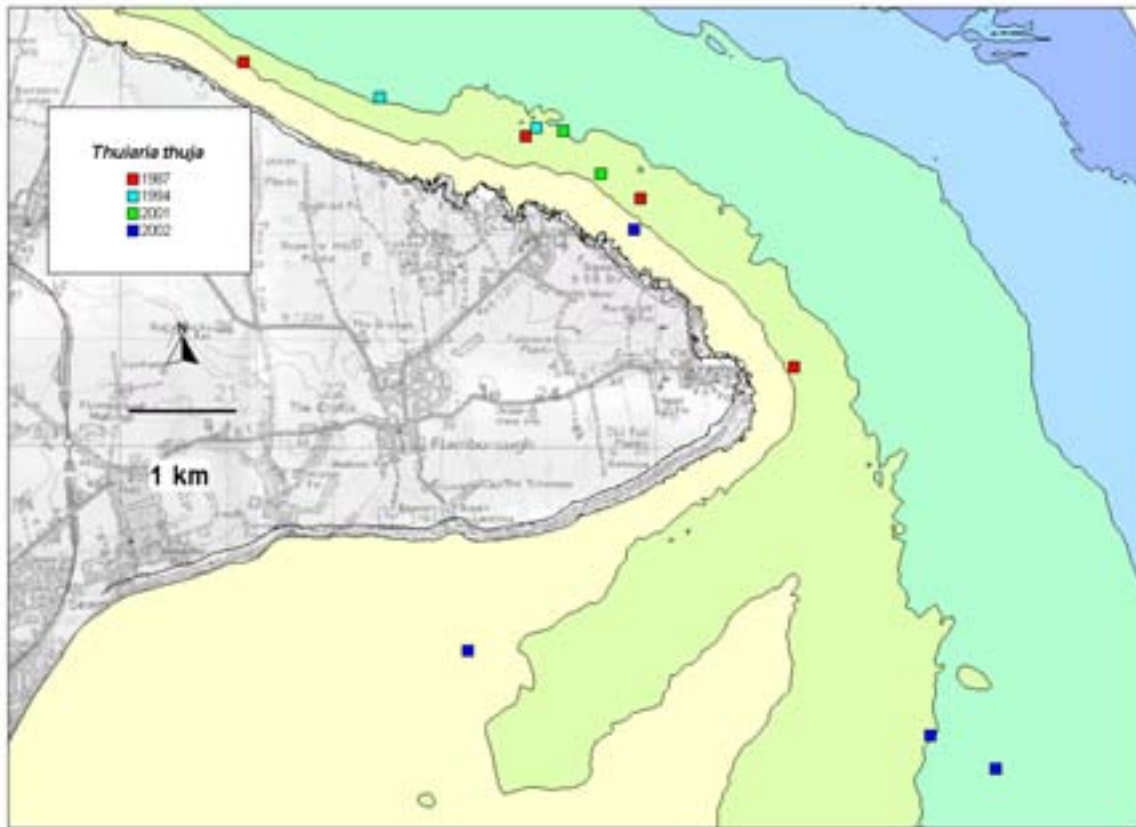
These results show that there has been no significant decrease within the SAC in the distribution of any of the three species between 1987 and 2001/2002, and that two of the species, the hydroid *Thuiaria thuja* and the ascidian *Archidistoma aggregatum* may have increased their range within the site. *A. aggregatum* continues to be abundant within the site but there is not enough information to assess accurately any changes in abundance of any of the species.

**Figure 8** Distribution of records of *Archidistoma aggregatum* around the headland from 1987 to 2002



**Figure 9** Distribution of records of *Polymastia boletiformis* around the headland from 1987 to 2002



**Figure 10** Distribution of records of *Thuiaria thuja* around the headland from 1987 to 2002

## 6 Discussion

### 6.1 Comparison with historical data

#### 6.1.1 Biotope and species distribution

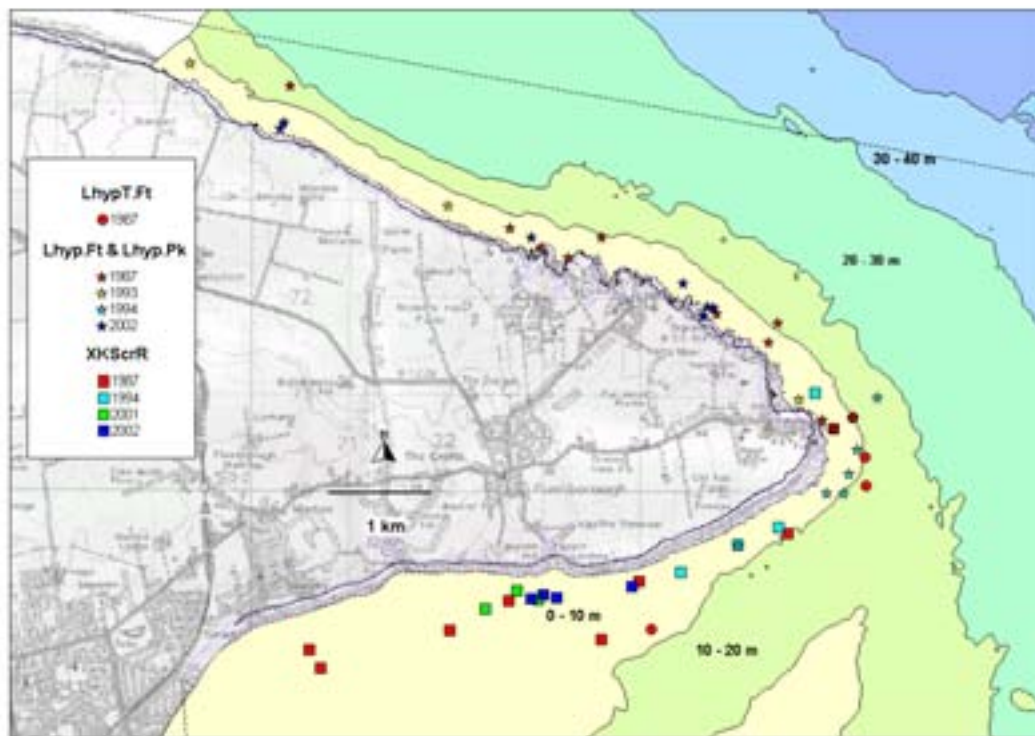
The results from the video and diving surveys carried out in 2001 and 2002 were compared with earlier data in a number of ways. A comparison of the distribution of selected key algal and faunal turf species is described above in Section 5.4 and a comparison of video survey results is given in Section 4.3. This process was taken further by comparing the biotope distributions of all the data from the relevant surveys carried out since 1987 (see Tables 7 and 8). These are illustrated in Figures 11 to 14. In general, the biotope distributions have been very consistent over the 15 years from 1987. There was reasonably good correspondence between the major circalittoral rock biotopes, with 67% of the circalittoral biotopes recorded previously being found during the present survey. There are some differences apparent, but some of these may be due to differences in interpretation of the biotope classification. In particular, the more recent surveys have classed the inshore circalittoral rock as Flu.HByS and mixed rock and boulder as StoPaur whilst the earlier surveys applied StoPaur more widely. Five biotopes recorded by the present survey had not been recorded by the MNCR (Table 7). Two of these (SNemAdia and Flu.HByS) were identified from the detailed quadrat data and suction samples. 4 of the 5, including SNemAdia and Flu.HByS, were assigned to the re-worked Biomar video drops.

Rock covered by the tubes of the worm *Polydora* (Pol in Brazier *et al.* 1998) was recorded during the diving work in 2002 but was not separated from Flu.HByS. Other differences can be accounted for by the use of different survey methods and the levels of data obtained. For example, it is not always easy to separate different types of *Laminaria hyperborea* forest using remote video and this would certainly account for observed differences around the headland (Figure 11) where tide-swept forests

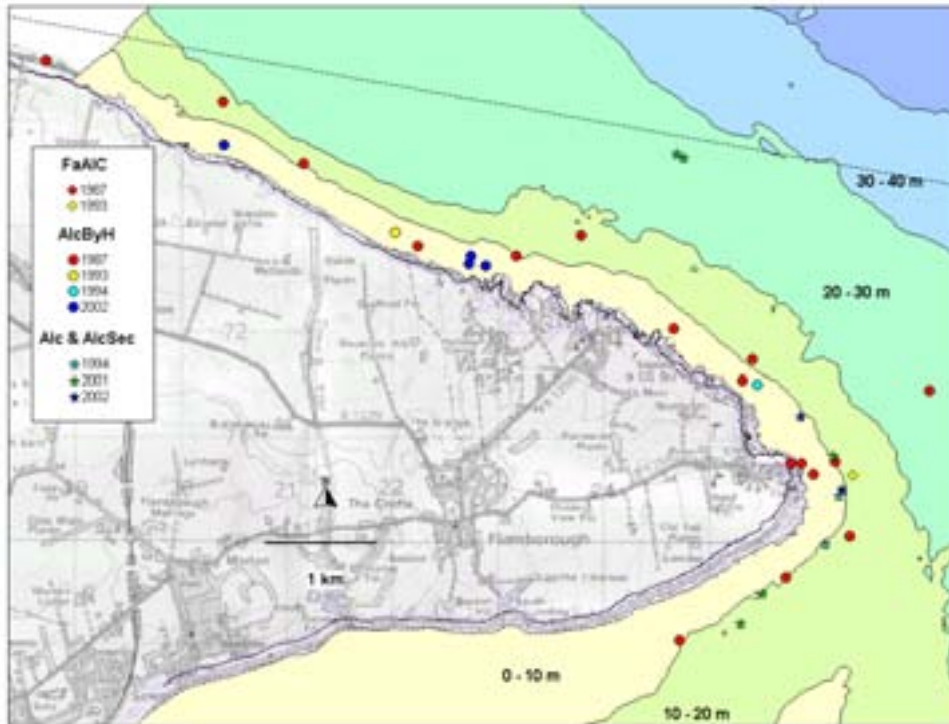
were separated by the divers in the 1987 data but the more recent video lumped all the *L.hyperborea* forests together.

There are a few apparently real differences. The mussel *Mytilus edulis* (MytHAs) was recorded over a much wider area in 2001/2002 than in earlier years (Figure 14); there was enough sampling in these areas on earlier surveys to have identified the wider presence of this biotope. Beds of the brittlestar *Ophiothrix fragilis* (Oph) were found in 1987 but not on subsequent surveys. Both of these biotopes can be transient, with the highly mobile beds of brittlestars moving on and mussel beds changing in size in response to predation.

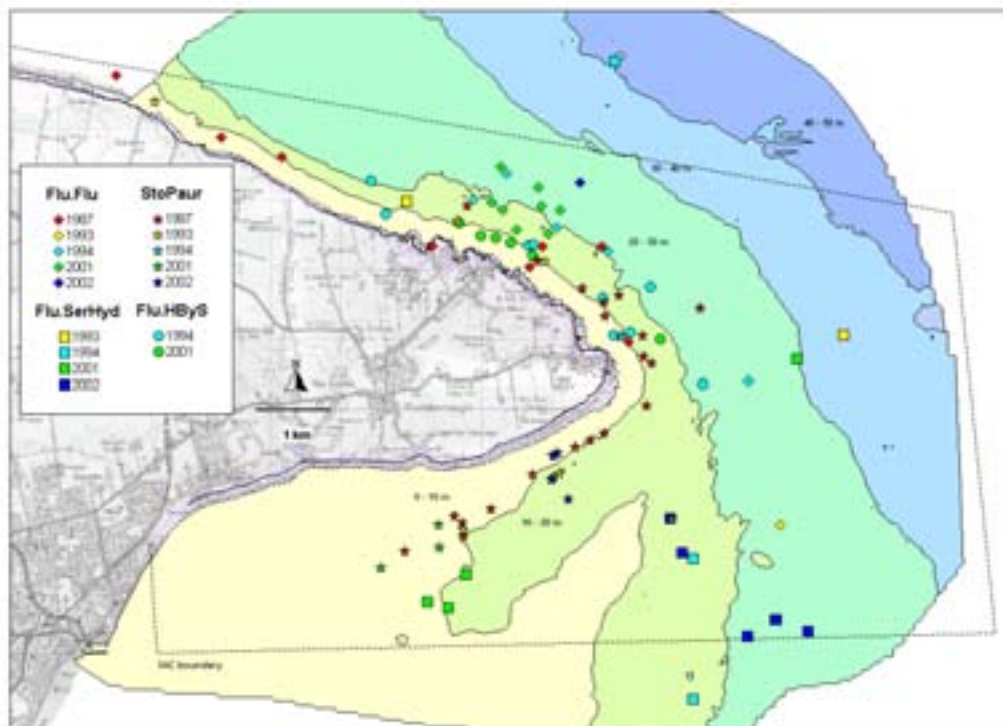
**Figure 11** Distribution of records of infralittoral biotopes from 1987 to 2002.



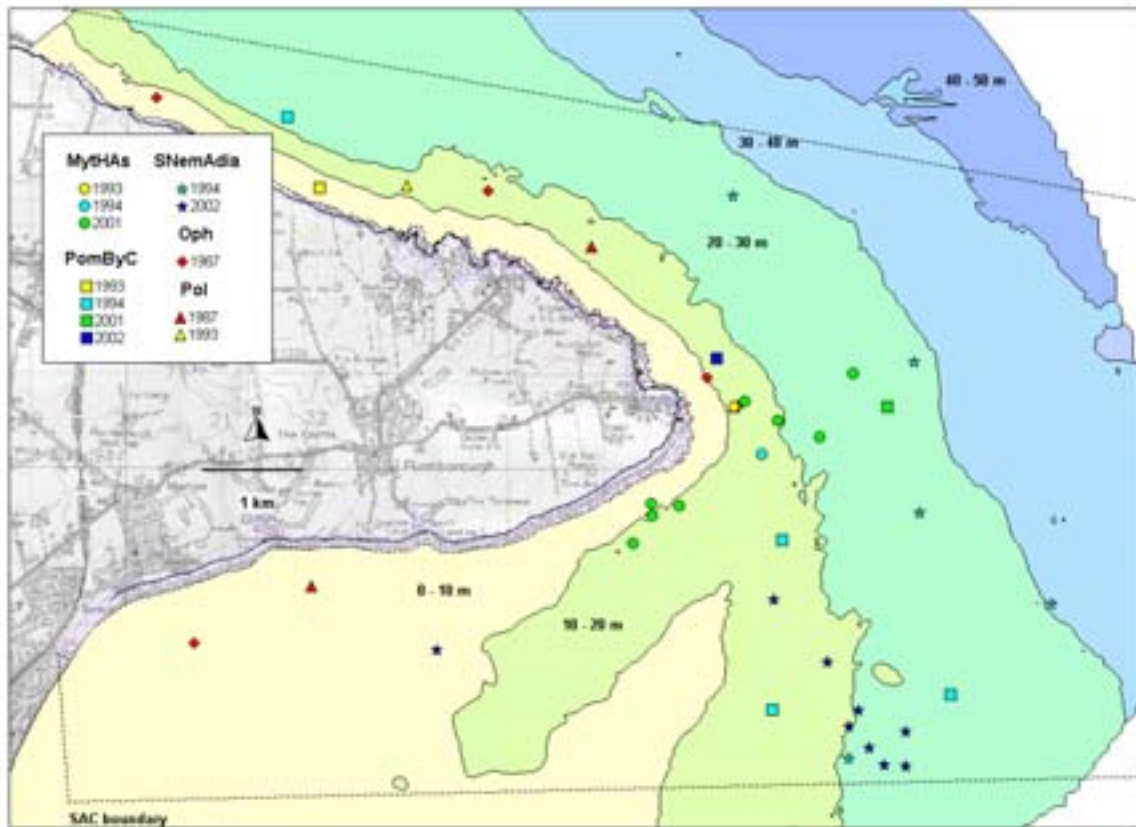
**Figure 12** Distribution of records of circalittoral biotopes from 1987 to 2002.



**Figure 13** Distribution of records of *Flustra*-dominated biotopes from 1987 to 2002.



**Figure 14** Distribution of records of circalittoral biotopes on mixed substrata from 1987 to 2002.



### 6.1.2 Biotope composition

The monitoring target for several of the SAC features is that the species composition of the biotope should not deviate significantly from the baseline. Whilst the present survey establishes a quantitative baseline for several of the biotopes present around Flamborough Head, it was pertinent to compare the data collected with the previous baseline of existing historical data. These data sets differ in that the MNCR and NCC data sets consist of semi-quantitative data collected from a large number of sites around the headland whilst the present data set contains detailed quantitative data from a very few sites. These differences and the differences in biotope classification discussed above made comparisons between the circalittoral faunal turf community records difficult and no meaningful conclusions could be drawn. However, it did prove possible to make a comparison between the various algal data sets from the kelp forest and park and, to a lesser extent, the mixed kelps and scour-tolerant algae. The results suggested that there had been no major changes in the species composition of these biotopes between 1987 and 2002. As the analyses only used presence/absence data, much more detailed analysis than was carried out would be needed to establish whether there were identifiable changes in the relative abundance of any species or in the overall species diversity of the sites.

**Table 7** Infralittoral and circalittoral biotopes recorded from video survey in 2001 and 2002 compared with earlier data. Infaunal biotopes which could not have been recorded by the video technique have been excluded. The Biomar tapes were re-worked and biotopes assigned for the present report.

Video survey 2002	MNCR biotopes	Biomar survey	Comments
CGS	IGS	CGS	Possibly equivalent
?ModMx	ModMx	-	
MytHAs	MytHAs	MytHAs	
PomByC	-	PomByC	
Flu.Flu	Flu.Flu	Flu.Flu	
Flu.SerHyd	Flu.SerHyd	Flu.SerHyd	
StoPaur	StoPaur	StoPaur	
FoR.Dic	FoR	FoR	Probably equivalent
XKScrR	XKScrR	XKScrR	
AlcC	-	AlcC	
AlcSec	-	AlcSec	
LhypLsac	-	-	
SNemAdia	-	SNemAdia	
Flu.HByS	-	Flu.HByS	
-	FaAIC	-	
-	Oph	-	No <i>Ophiothrix</i> seen on videos
-	Pol	-	<i>Polydora</i> would be difficult to see on video in the poor conditions. Dense <i>Polydora</i> was recorded by the divers in 2002 but not separated from StoPaur
-	SspiMx	-	<i>Sabellaria</i> was found in several biotopes by 2002 divers; this biotope may have been present but difficult to identify on video
-	Urt.Urt	-	Likely to be a sub-biotope around the edges of Flu.SerHyd; unlikely to find this on the video
-	IMX	-	
-	EphR	-	Infralittoral biotopes were poorly sampled in 2001/02 as working in shallow water was very difficult
-	Ldig.Ldig	-	
-	Lhyp.Ft	Lhyp.Ft	
-	Lhyp.Pk	Lhyp.Pk	
-	LhypFa	-	
-	LhypR.Pk	-	
-	LhypT.Ft	-	
-	AlcByH.Hia	AlcByH	

**Table 8** Summary of biotopes recorded from video survey in 2001/02 compared with earlier data

Biotope groups	MNCR	Biomar video	Video survey
Total no biotopes (including mosaics)	30	19	18
<b>Of these:</b>			
Infaunal	4	0	0
General sediment	2	1	1
Shallow vertical	5	1	0
Infralittoral other	9	4	3
Circalittoral rock or mixed	10	9	10
Mosaics	0	4	4

## 6.2 Comments on methods used

### 6.2.1 Sample density of video drops

An estimate was made prior to the survey of the number of samples that would be needed to cover the area adequately. This was based largely on survey intensity employed in video surveys in similar areas such as the SeaMap survey of Flamborough Head (Davies & Sotheran 1995) and elsewhere. In other surveys, however, the video has generally been used as a ground validation tool for broad scale acoustic mapping of the seabed. For monitoring work such as that reported here, there is likely to be a more specific target to be measured. In this instance the target is that there should be no decrease in the distribution and range of kelp forest and faunal turf biotopes from the baseline (Table 1).

Moore & Bunker (2001), in a reassessment of video tapes from a number of Scottish surveys, outlined a suggested approach to sampling using remote video. They recommended that sample size should be determined by continuing to survey sites from each zone until

- i) no additional biotopes have been found for the zone in the last 3 surveyed sites; and
- ii) at least 4 times as many sites as there are biotopes in the zone have been surveyed.

An inspection of the order in which biotopes were recorded during this survey shows that new biotopes were still being recorded in most of the blocks after the planned number of drops was completed. Sample effort should be related to the heterogeneity of the seabed whilst giving enough sample points to enable some statistical analysis. Table 9 shows the minimum number of drops that would be needed in each sample block if this survey protocol were to be adopted, and shows that overall the survey effort would need to be almost doubled. The first of the two Moore & Bunker targets was met in 9 of the sample blocks and both were met in 4 blocks. It is clearly easier to achieve the first than the second. Even if the different blocks were combined into depth bands (Table 10), the sampling effort would need to have been increased by about 20 % to 105 drops. The 2001/02 survey averaged 1 drop every 0.19 km<sup>2</sup> (area 15.02/sample size 80). On the Moore & Bunker estimates, a minimum of 1 drop every 0.12 km<sup>2</sup> (15.02/130) would be required. This was almost achieved in the 10 – 20 m depth band but was not met in any of the other bands.

There are no similar survey data available for the site to enable a direct comparison to be made between two data sets. However, if the data from a survey such as this are to be used as statistical indicators of the relative abundance of each biotope, more data points would be required for each biotope. In order to carry out an approach to sampling such as this successfully, it would be necessary to identify the biotopes at least provisionally in the field. Around Flamborough, several of the biotopes were very similar to each other and a decision on the classification was only made after viewing the tapes carefully, analysing the data from the divers and comparing the relevant biotope descriptions in the manual. However, a provisional biotope identification would certainly have been possible in the field and should be considered for future surveys.

The visual rather than statistical comparison that was made with the Davies & Sotheran (1995) data showed that the biotopes recorded and their distributions in 2002 were broadly similar to those of the earlier survey. If a visual, rather than statistical comparison is deemed a sufficient measurement for the monitoring target, the sample density achieved was adequate. The costs and time involved in almost doubling the sampling effort are unlikely to be warranted.

**Table 9** Planned and actual video sampling effort related to the number of biotopes recorded in each sample block

No. of drops	Cumulative number of biotopes recorded												
	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8	Block 9	Block 10	Block 11	Block 12	Block 13
Depth band	0-10	20-30	10-20	20-30	>30	0-10	0-10	0-10	10-20	0-10	0-10	10-20	20-30
1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	1	1	2	1	2	1	2	2	1	1	1	1
3	2	1	1	3		2	2	2	2	2	1	1	1
4	2	1	2	4		3	3	2	2	2	1	1	2
5	2	1		4		3	4	3	2		1		2
6	2	1				3	4	3	2				2
7	2					3	4	3					
8	2					3	4						
9	2					4							
10						4							
11						5							
12						6							
13						6							
14						6							
Total no. drops	9	6	4	5	2	14	8	7	6	4	5	4	6
Total no. biotopes	2	1	2	4	1	6	4	3	2	2	1	1	2
Target no. drops	4	2	2	5	5	9	2	3	3	3	3	2	4
Area of block (km <sup>2</sup> )	1.71	0.71	0.59	1.8	2	3.06	0.74	0.42	1.18	0.47	0.4	0.54	1.4
Area : no. drops	0.19	0.12	0.15	0.36	1.00	0.31	0.09	0.06	0.17	0.12	0.08	0.14	0.23
Minimum no. drops required after Moore & Bunker (2001)	8	4	8	16	?	24	26	12	8	8	4	4	8
Planned survey completed?	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
No additional biotopes in last 3 drops?	Y	Y	N	N	N	Y	Y	Y	Y	N	Y	Y	Y
4 times as many sites as biotopes?	Y	Y	N	N	N	N	N	N	N	N	Y	Y	N
3 times as many sites as biotopes?	Y	Y	N	N	N	N	N	N	Y	N	Y	Y	Y
2 times as many sites as biotopes?	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y

**Table 10** Actual video sampling effort related to the number of biotopes recorded in each depth zone

Depth Band	No. drops	No. biotopes	Area (km <sup>2</sup> )	Area : no. drops
0 - 10 m	26	9	5.09	0.20
10 - 20 m	32	8	4.02	0.13
20 - 30 m	18	8	3.91	0.22
> 30 m	5	1	2	0.40

### 6.2.2 Diving field methods

The basic method of quantitative sampling by means of random quadrats located within a biotope was trialled extensively in Loch Maddy during the development of monitoring methods for the Life project (Howson & Davison 1999). This method is relatively easy to deploy and has none of the expensive maintenance costs associated with permanent fixed stations. The robustness and repeatability of the technique has been questioned and was addressed to some extent by Howson & Davison (1999). This cannot be fully addressed in this survey until the work is repeated. However, a number of points have emerged from the field work and data analyses:

- The use of a small team of 4 people, all of whom are experienced biologists working together on a number of related projects has proved invaluable. The quality and consistency of the data collected are much higher than in earlier projects, with very little processing of the data in Excel prior to analysis required.
- This consistency has been helped by the development of detailed survey protocols (Appendix 2), and good pre-dive briefings which ensure that all the team are aware of the procedures to be followed when recording.
- The introduction of a reconnaissance dive and specimen work-up period and the resultant ability to produce a targeted species check list considerably improved the standard of species recording.
- The suction samples and scrapes carried out in 2002 enabled detailed species lists for the bryozoan and hydroid turfs to be compiled and helped considerably in separating the biotopes.
- Data have been entered into Excel spreadsheets by the individual fieldworker during the evening following the dive. This has also helped in improving consistency between workers as queries and anomalies have been resolved during the survey.
- Sea conditions prevented sampling of the deeper offshore rock with dense *Flustra foliacea* (Flu.Flu).

### 6.2.3 Analysis of quadrat data

- The cluster analyses have generally shown fairly high similarity within data sets. Where the similarities have been lower, this has been due to patchiness within the biotope which was observed by the surveyors in the field.
- Smaller quadrats were used for sampling the faunal turf on the gully walls (AlcByH.Hia), a biotope where similarities were particularly low. This biotope was observed to be very patchy and it may be that, with the smaller quadrats, more samples should have been taken to account for this patchiness.
- Where one or a few quadrats separate from the main clusters at a low similarity, this can generally be explained by the abundance or the absence of one particular species. Unless a different biotope has been inadvertently sampled, such as a single large stable boulder on a cobble plain, these differences are facets of the environment that should be sampled. However providing there are enough samples, single odd quadrats can and should be left out of an analysis to improve the robustness of the data set.

## 6.3 General comments on the nature conservation interest of the area

Earlier surveys of this area highlighted the conservation interest of the species-rich communities in the strong tides around the head, both on the wave-cut chalk platforms of the north coast and the more mobile chalk cobbles of the south coast. Although only relatively few sites were visited during the present project, the findings have reinforced this opinion. The faunal turf covering the chalk platforms proved to be particularly rich with a great diversity of hydroids, bryozoans and ascidians tangled together. This included several species which are uncommon elsewhere, notably the ascidian *Archidistoma aggregatum*, which was abundant and the small hydroids *Sertularella tenella* and *Tridentata distans* which were present within the turf. A very low level of grazing combined with the strong tides and the calcareous substratum would seem to have allowed this particularly rich turf to

develop. There are similar *Flustra*-dominated communities elsewhere on the east coast but none has the diverse combination of species found at Flamborough Head.

Also of interest are the infralittoral and circalittoral cobble communities of the south coast and further offshore on the north. The circalittoral cobbles have similar communities to the rock although they are differentiated by the presence of species characteristic of scour and the unstable substratum. These communities also range from those closest to the sand, where the cobbles are mostly bare chalk, to the rich communities further offshore which support a hydroid and faunal turf with species such as *Archidistoma aggregatum* and the polychaete *Sabellaria spinulosa* common. In the infralittoral zone, the abundance of the brown alga *Taonia atomaria* is of note as this species is approaching the northern limit of its range at Flamborough Head.

## 7 Conclusions

### 7.1 Project objectives

This project was designed to enable the condition of the Flamborough Head cSAC to be assessed against the targets for the features listed in Table 1.

The objectives for the field programme were to establish a methodology for sampling the subtidal features of the site

- 1) that could be repeated in the future;
- 2) that would produce a robust data set to enable comparisons to be made between data collected at different visits.

The data collected have been used in two ways:

- 1) To establish a baseline of information against which the site condition can be assessed in the future;
- 2) To consider the present condition of the site when compared with historical data.

The conclusions of this work are summarised below.

### 7.2 Field survey methods

#### 7.2.1 Video work

- The approach adopted for this survey, involving sampling at random positions within transects divided into blocks by depth, proved straightforward to operate.
- The survey was not completed due to poor weather conditions. The infralittoral zone, which is very shallow, was difficult to sample, particularly around the headland and on the north coast, as the seabed is very rugged and there are strong tides close inshore. However, the majority of the rocky circalittoral biotopes recorded by previous surveys were found during this video survey.
- Visual inspection of the data when compared with other data sets suggests that the level of sampling carried out was adequate for the purpose and that any statistical benefits that would be gained by extending the survey as recommended by Moore & Bunker (2001) would not be warranted.

#### 7.2.2 Diving work

- Seven biotopes were sampled effectively by diving.
- Tidal conditions influenced the site selection and prohibited the survey of the circalittoral Flu.Flu biotope. Underwater visibility and swell were major limiting factors; an effective repeat survey could only be attempted in excellent sea conditions.
- The use of a small team of biologists experienced in this type of work proved to be a major factor in collecting data sets that were consistent and robust.

- There was a good correspondence with data collected on earlier surveys. However, the biotope classification of the circalittoral sites differed between the present survey and earlier work, partly due to the enhanced ability to analyse the quantitative data that these techniques allow. Previous surveys used purely semi-quantitative methods.
- Local biotope descriptions have been compiled for the seven biotopes which were sampled in detail.

### 7.3 Monitoring targets

#### 7.3.1 Kelp forest communities & Circalittoral communities: No decrease in distribution and range of biotopes from baseline.

- The video survey carried out in 2001/02 found a very similar range of biotopes to the earlier Davies & Sotheran (1995) survey. Taking into account differences in the survey techniques, the distribution of biotopes was broadly similar between the two surveys, with only very minor differences.
- When compared with earlier MNCR diving surveys, 67% of the circalittoral biotopes recorded previously were found during the present survey.
- Some apparent differences may be due to differences in interpretation of the biotope classification.
- Five biotopes recorded by the present survey had not been recorded by the MNCR. Two of these (SNemAdia and Flu.HByS) were identified using the detailed quadrat data and suction samples collected by the divers and the codes were subsequently assigned to some of the video data.
- Some apparently real differences include beds of the mussel *Mytilus edulis* (MytHAs), which was recorded over a much wider area in 2001/2002 than in earlier years; there was enough sampling in these areas on earlier surveys to have identified the wider presence of this biotope. Beds of the brittlestar *Ophiothrix fragilis* (Oph) were found in 1987 but not on subsequent surveys. Both of these biotopes can be transient, with the highly mobile beds of brittlestars moving on and mussel beds changing in size in response to predation.
- In general, the biotope distributions have been very consistent over the 15 years from 1987.

#### 7.3.2 Kelp forest communities: No significant deviation of algal species composition from baseline.

- A comparison of data from the 2002 survey with data from 1987 and 1993, using presence/absence of individual species, only highlighted those species most often recorded and took no account of the relative abundance of the species. However, this does appear to show that there has been no major change in the algal species composition of the kelp forest communities (Lhyp.Ft; Lhyp.Pk) since 1987.
- A similar comparison of data from the mixed kelp communities on scoured rock and cobble (XKScrR) showed considerable variability between all the sites over the years. However, there does not appear to have been any major change in the algal species composition of these communities since 1987. More detailed analysis of data of similar structure to the 2002 dataset would be required to answer this question with more confidence.

#### 7.3.3 Kelp forest communities: Presence and abundance of selected key species should not deviate significantly from baseline.

- Five algal species were selected for inclusion in this study (*Ptilota gunneri*; *Odonthalia dentata*; *Calliblepharis ciliata*; *Halurus equisetifolius*; *Taonia atomaria*). One of these, *Halurus equisetifolius*, was not found in the historical records from the site nor recorded during the present surveys and so was ignored.
- A comparison of the records of the remaining four species with those from earlier surveys showed that there has been no significant change in the distribution of any of the four species between 1987 and 2001/2002.

- No additional information was collected on the abundance of these species, other than the quadrat records, so it is not possible to comment on any changes or otherwise in their abundance.

#### **7.3.4 Subtidal faunal turf communities (Flu.Flu, StoPaur, AlcByH.Hia): No significant deviation of species composition from baseline.**

- Detailed sampling in 2002 on sites where StoPaur had been recorded by earlier surveys led to a slightly different interpretation of the classification and the following Circalittoral faunal turf biotopes were identified and sampled: StoPaur; Flu.HByS; SNemAdia.
- Differences in sampling techniques between 2002 and earlier surveys combined with the different interpretation of the biotope classification hindered meaningful comparisons with historical data. A visual comparison of the species lists suggested that there has been no major change in the dominant species but this conclusion should be regarded as provisional.
- The offshore *Flustra* dominated Flu.Flu could not be sampled due to difficult sea conditions. This biotope should perhaps be excluded from future repeat surveys.
- The infralittoral faunal turf AlcByH.Hia was found to be widely distributed on the north coast but the broken nature of the habitat on small vertical walls meant that there were no continuous large areas of the biotope. This produced a high degree of variation within the species composition of the quadrats. It was concluded that, if this biotope was to be included in future quantitative monitoring work, a much larger number of quadrats and sites should be sampled.
- It was found that the variability observed in the 2002 data from AlcByH.Hia was also reflected in the earlier work and so it was not possible to draw any meaningful conclusions from comparisons of presence/absence information. A visual inspection of the species lists suggested that there has been no major change in the dominant species, but more detailed analysis is required before any firm conclusions can be made.

#### **7.3.5 Subtidal faunal turf communities: Presence and abundance of selected key species should not deviate significantly from baseline.**

- Three animal species were selected for inclusion in this study (*Archidistoma aggregatum*; *Polymastia boletiformis*; *Thuiaria thuja*). The original approach envisaged of measuring the abundance of these species on the video tapes was not practical. Records of the presence of the 3 species on both the video tapes and in the diving results were compared with earlier data.
- The results show that there has been no significant decrease within the SAC in the distribution of any of the three species between 1987 and 2001/2002.
- Two of the species, the hydroid *Thuiaria thuja* and the ascidian *Archidistoma aggregatum* may have increased their range within the site.
- *A. aggregatum* continues to be abundant within the site but there is not enough information to assess accurately any changes in abundance of any of the species.

## **8 References**

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## Appendix 1

### Drop-down video survey methods

This appendix details the procedures followed for the video survey at Flamborough Head in 2001 and 2002.

#### Survey plan

The contract required the biotope complement and distribution of biotopes across the site to be assessed using a drop-down video to sample four block transects around the headland. These transects were selected on the basis of previous surveys to encompass the range of known biotopes. They were divided into depth bands, each of which was to be sampled at a series of randomly located positions.

**Appendix Table 1.1** Number of 100 m video transects per depth block proposed and achieved

Transect no.	Transect location	Depth bands	Approx. area (km <sup>2</sup> )	No tows	
				Target	Achieved
1	Northern transect	0 -10 m	0.5	3	5
		10 – 20 m	0.6	2	4
		20 – 30 m	1.3	4	6
2	Head	0 -10 m	0.8	3	4
		10 – 20 m	0.6	2	4
		20 – 30 m	1.7	5	5
		>30 m	2.3	5	2
3	South east	0 -10 m inshore	0.8	3	7
		10 – 20 m inshore	1.1	3	6
		0 -10 m offshore	0.7	2	8
		10 – 20 m offshore	1.6	4	9
		20 – 30 m	0.4	2	6
4	Southern transect	0 -10 m	3	9	14
		<b>Total</b>	<b>15.4</b>	<b>47</b>	<b>80</b>
<b>Total area and number of tows per depth band</b>					
		0 -10 m	5.8	20	
		10 – 20 m	3.9	11	
		20 – 30 m	3.4	11	
		>30 m	2.3	5	

The four block transects sampled are shown in Figure 2 in the main body of the report. These were divided into 5 blocks of varying sizes in the 0 – 10 m band, 4 at 10 –20 m, 3 at 20 –30 m and 1 deeper than 30 m (Appendix Table 1.1). The entire southern transect was shallower than 10 m and there were two 10 m areas separated by a deeper area in the adjacent transect. It was difficult to assess the heterogeneity of the area and hence the number of samples needed prior to the survey. As suggested in the procedural guidelines (Holt & Sanderson, 2001; see <http://www.jncc.gov.uk/marine/mmh/overview.htm>), video tows of 100 m length would be recorded at a series of randomly located positions within these depth bands. The minimum number of samples proposed prior to the survey is shown in Appendix Table 1.1; it was proposed that additional samples would be taken if the seabed was very heterogeneous. The number of tows suggested was roughly related to the area covered by each depth band as shown at the bottom of the table. An additional tow was included for the 0 –10 m zone on the north coast as this zone was less well represented on the north coast

than the south by the transects. In the event, more drops than planned were carried out; this is discussed in the report.

### **Sampling procedure**

A set of random positions within each survey block was generated prior to the survey. These provided sample stations which were sampled in numerical sequence to ensure that the positions remained random. If for some reason a station could not be sampled effectively, for example due to the strength of the tide or poor visibility at the seabed, the video was dropped at the next station in the numerical sequence. It was intended that each tow should be approximately 100 m in length and the camera was allowed to drift along the seabed for between 2 and 5 minutes to achieve this. The environmental conditions prevailing during the survey determined to a large extent the duration of each drop, as weather and sea conditions were poor, there was generally low underwater visibility and, in some parts of the site, the terrain was very rugged with deep rock gullies which threatened to snag the camera system. In these situations, the camera was kept on the seabed until it was judged that there was enough footage to enable the biotope to be identified. If the seabed was mixed, the tows were generally longer within the safe limits of the operating conditions.

### **Data analysis**

Whilst the video tows were underway, notes were made from the television screen by one of the biologists on the species visible and the seabed type. This enabled an initial assessment of the biotopes present. Subsequent analysis of the tapes involved reviewing each tow more thoroughly to identify as many species as possible and to produce a more detailed description of the seabed. Intermediate level MNCR survey forms were completed with as much information as possible, including depth and position. The forms were then inspected and biotopes assigned to each site. In a number of cases, the low level of information retrievable from the tapes meant that the site could fit into any one of several biotopes. In these cases, the nearest fit from the data compiled in the area summary (Brazier *et al.* 1998) was used. If this was not possible, then the biotope was assigned to a higher level in the classification. This happened with the sandy sites where very few animals were seen and the sites were classified as CGS (Circalittoral gravels and sands). Mixtures of biotopes were recorded at a few sites where there was no clear spatial division between the biotopes present.

Following the diving survey in 2002, analysis of the quadrat data collected by the divers (see Report Sections 3.6 and 5) enabled a better identification of a number of the biotopes present in the area and in particular the separation of SNemAdia, Flu.HByS and StoPaur. Where appropriate, these biotope identifications were used to reassess those identified from the video drops and a number of the video drops were reclassified. The results of the video work were entered into an Excel spreadsheet and *Marine Recorder*. No statistical analysis of the video results was deemed relevant.

Approximately 40 % of the tows were reviewed by a second ASML biologist to ensure accuracy and consistency of biotope identification. The sites selected for review included examples of each biotope identified and a number of sites where there was a query over the classification.

### **Video equipment**

The video system used consisted of a Sony Hi8 video camera housed in a SeaPro housing, mounted in a stainless steel cage with *RoHo* video lights fitted. This was linked via a co-axial umbilical strengthened by polypropylene rope to a surface TV unit, enabling real-time video to be viewed on the surface during operations. The camera recorded the video footage. A digital recording was made on the surface for a proportion of the drops but this system only worked for part of the time. An echo sounder on the camera frame and a surface GPS input enabled depth and positions to be recorded directly onto the video tape in the camera. GPS positions were also logged continuously by the boat's navigation system on the survey vessel 'Mariner' (Seastar Surveys) which was used for this work in 2001. This facility was not available on the boat used in 2002, the local survey vessel 'Striker'.

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## **Appendix 2**

### **Sampling methods used for diving work, and recording protocols for monitoring quadrats**

#### **Contents:**

- Diving survey methods
- Recording protocols
- Biotope-specific variations
- Species proformas (Font and table size have been reduced for this report.)

## Diving survey methods

The contract required monitoring by divers of the kelp forest and subtidal faunal turf communities, with the aim of establishing the species' complement of these communities and the abundance of the constituent species. It was intended that this work should broadly follow the approach outlined in Procedural Guideline 3-7 (Murray 2001; see <http://www.jncc.gov.uk/marine/mmh/overview.htm>)

The biotopes selected for quantitative monitoring were chosen to be representative of the major biotopes present in the area, and were selected by a combination of an inspection of earlier survey records and the results of the 2001 video survey. The difficult tidal conditions and generally poor underwater visibility around Flamborough Head dictated to some extent the sites selected for monitoring and influenced the methods used underwater. The approach to the quantitative monitoring adopted for this project was one of stratified random sampling in which the target biotope acts as the stratified element of the sampling programme, and is sampled using quadrats positioned randomly along a transect. The methods used are described below, followed by detailed protocols for each group of biotopes sampled. These protocols were adapted where necessary to the prevailing underwater conditions and these biotope-specific variations are also described.

## Generalised quadrat sampling methods

For each biotope, a site was selected where it was considered that the target biotope was likely to be present. One pair of divers then carried out a reconnaissance dive, establishing which part of the site was most suitable for a transect, gathering enough information to complete a Phase II survey and collecting specimens for identification prior to the quadrat work. These specimens enabled all the divers to familiarise themselves with the species they were likely to find in the quadrats and a species proforma was then drawn up for the site as a checklist for quadrat recording. At this stage, a decision was made as to which species would be counted in the quadrats and which would be recorded as percentage cover. These were put in separate sections on the checklist, and biotope and site specific proformas were printed on waterproof paper on a daily basis as required. These are included with the survey protocols in this appendix..

Following the site reconnaissance, a shotline was placed at the GPS position felt to be most suitable for survey. Once underwater, the divers were able to move the shotline if necessary to an area of level seabed within the target biotope, avoiding areas of boulders if possible. A tape measure was then laid and attached to a stabilising lead line running out from the base of the shotline along the seabed to a distance of 10 m, keeping the tape within the biotope. A second lead line was laid next to the tape; this served as a safety line to which each diver attached themselves with an individual lanyard, enabling both divers to remain in physical contact with each other and the shotline. Each diver was equipped with a species proforma attached to a slate, a set of random positions for a given side of the tape and a quadrat of a size appropriate to the biotope.

The quadrats used in most cases were 0.25 m<sup>2</sup>; some were divided by lines into a grid of 25 squares, each with an area of 100 cm<sup>2</sup>. representing 4% of the quadrat area. This size of quadrat was selected as it had been found to be a manageable size for working with underwater and it was of a scale appropriate to most of the biotopes. The smaller squares could be used for counts of small and very numerous species. The divers placed the quadrats at the predetermined positions and recorded the abundance of all the species present, either as counts or as percentage cover. A minimum of 10 quadrats were sampled with more if time allowed.

## References

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## FLAMBOROUGH HEAD MONITORING PROTOCOL

### Kelp forest algal communities – Lhyp.Ft; Lhyp.Pk; XKScrR

#### Quadrat size:

- ❖ 0.25 m<sup>2</sup>

#### Quadrat number:

- ❖ At least 10 quadrats

#### Quadrat structure:

- ❖ Quadrats should be 3-sided and marked on each side at 10 cm intervals

#### Transect length:

- ❖ 10 m

#### Transect position:

- ❖ Transect to be placed within one biotope, on reasonably level, uniform seabed, along pre-selected depth contour;

#### Quadrat positions:

- ❖ Pre-determined random positions;
- ❖ Adjacent quadrats should not overlap and so positions should be selected to ensure this; move to the next random number in the sequence if one will overlap with an earlier position;
- ❖ Both sides of the line can be used; the two sides should be clearly identified for example as Left or Right, with left being the side on the left when viewed from the origin.
- ❖ T or B should also be selected at random.
- ❖ Lower (if above the line) or upper (if below the line) left hand corner of the quadrat should be placed at the chosen position, and the quadrat side lying along the line.

#### Species recording:

- ❖ Record only the algae, not the animals!
- ❖ The percentage cover of each species present on the seabed within the quadrat should be recorded.
- ❖ Kelp epiphytes should not be included.
- ❖ A 10 x 10 cm square is equivalent to 4% cover
- ❖ Total % cover may be greater than 100% if species are lying over each other.
- ❖ If a plant is lying partly in and partly out of the quadrat, only the part within the quadrat should be recorded.
- ❖ Anything less than 0.5% or any other variation should be recorded as 0.25 so analysis by PRIMER can be carried out. This will often apply to small, sparsely distributed species where a percentage cannot be estimated effectively.
- ❖ Both **mature canopy and understory kelp plants** should be **counted**, but these categories should be recorded separately as *Laminaria hyperborea* (mature) and *Laminaria hyperborea* (medium).
- ❖ **Kelp sporelings** should be assessed as **percentage cover**.
- ❖ Remember to check for encrusting species – these may be partly covered by silt. If the species cannot be separated, or identified accurately, they should be recorded as *Coralline crusts*, *dark red algal crusts*, *brown algal crusts*.
- ❖ It is useful to make accompanying notes, such as 'Present as small, scattered sporelings'.
- ❖ Plants should be recorded to species level where possible. If the identity of a plant is uncertain, a specimen should be collected.
- ❖ It is preferable that specimens can be attributed to a particular quadrat following a dive, to minimize confusion, unless the species is a common one across the transect.

#### Substratum:

- ❖ The percentage cover of each of the major substrata within the quadrat must be recorded.

**Familiarization:**

- ❖ Half a day should be spent on familiarization dives in the biotope, with collections of specimens made for identification.
- ❖ The remainder of the day should be spent with the whole team working up the specimens to ensure familiarity and consistent identification, particularly of the common species.
- ❖ A collection of the algae should be made for future reference. This can be a combination of pressed and pickled specimens, but pressed specimens are better for showing other divers what a particular species looks like.

**Check lists:**

- ❖ A checklist of the species likely to be found on the kelp forest transects should be compiled from the familiarization work and pre-existing survey lists.
- ❖ This should be put together the evening before the quadrat dives and copies printed onto waterproof paper for use underwater.

**Phase II survey:**

- ❖ A Phase II survey of the biotope in which the transect has been placed should be carried out in conjunction with the quadrat work.

**Photography:**

- ❖ A photographic record should be made of the communities and individual species. This can be 35 mm still photographs, digital photography, video footage or any combination.

**Specimen curation:**

- ❖ A reference collection should be made for use on future surveys.
- ❖ Specimens must be preserved and labelled during the following evening to prevent a build up of specimens and consequent confusion.
- ❖ A voucher collection of taxonomically challenging species must be collated after the survey has finished.
- ❖ Survey teams must have dilute, buffered formaldehyde and 70% Industrial Methylated Spirits available on site.

## **Habitat-specific variations for kelp forest monitoring**

### **MIR.XKScrR**

- The seabed in this biotope consisted of mixed boulders, cobbles and sand, with different species on the stable boulders compared to the more mobile cobbles. The transect line was not used due to the strong tides and the divers selected areas of cobbles for their quadrats, avoiding the larger boulders.
- 4-sided gridded quadrats were used.
- Kelp plants were divided into mature plants and medium sized plants, both of which were counted, and sporelings which were recorded as percentage cover.
- All other algae were recorded as percentage cover; no animals were recorded.

### **MIR.Lhyp.Ft**

- There was often a heavy swell and dense kelp in the very shallow water, precluding the use of tapes and ground lines. As the biotope was very uniform, the divers simply placed their quadrats where they were able to find suitable level rock within the kelp forest.
- Non-gridded quadrats were used with one side that could be removed to allow the quadrat to be fitted around the kelp plants.
- Kelp plants were divided into mature plants and medium sized plants, both of which were counted, and sporelings which were recorded as percentage cover.
- All other algae were recorded as percentage cover; no animals were recorded.

### **MIR.Lhyp.Pk**

- The bedrock in this zone was very broken by gullies into flat-topped pillars and small platforms. There was not enough continuous bedrock to lay a transect, so the divers moved from one suitable patch of bedrock to the next.
- Non-gridded quadrats were used with one side that could be removed to allow the quadrat to be fitted around the kelp plants.
- Kelp plants were divided into mature plants and medium sized plants, both of which were counted, and sporelings which were recorded as percentage cover.
- All other algae were recorded as percentage cover; no animals were recorded.

**Flamborough Head SAC sublittoral monitoring, 2002: Lhyp.Ft/Pk, 10m transect, 0.25m<sup>2</sup> quadrats Site:**

**Surveyor:** ..... **Date:** ..... **Time at start:**.....

**Position:**..... **Depth at start:**.....

**Substratum:**..... **Transect:** .....

**Recording conditions: OK?** ..... **Transect side (L/R):**.....

<b>Quadrat position:</b>						<b>Quadrat position:</b>					
<b>Time start</b>											
<b>Count</b>											
Laminaria hyperbo											
<b>% cover</b>											
Coralline crusts											
Dark red alg crusts											
Brown algal crusts											
Kelp sporelings											
Brongniartella byss											
Bryopsis plumosa											
Ceramium											
Chondrus crispus											
Corallina officinalis											
Cryptopleura ramo											
Delesseria sanguis											
Dictyota dichotoma											
Dilsea carnosus											
Erythrodermis traill											
Furcellaria lumbric											
Hypoglossum hypo											
Lithothamnion glac											
Lomentaria orcade											
Membranoptera al											
Palmaria palmata											
Phycodrys rubens											
Phyllophora crispa											
Phylloph pseudoce											
Plocamium cartilag											
Polysiphonia strict											
Ptilota gunneri											
Rhodomela confer											
Ulva											



## FLAMBOROUGH HEAD MONITORING PROTOCOL

### Circalittoral rock communities - Flu.Flu; Flu.HByS; StoPaur; SNemAdia

#### Quadrat size:

- ❖ 0.25 m<sup>2</sup>

#### Quadrat number:

- ❖ At least 10 quadrats

#### Quadrat structure:

- ❖ Quadrats should be 4-sided and sub-divided into 25 grid squares, 10 x 10 cm

#### Transect length:

- ❖ 10 m

#### Transect position:

- ❖ Transect to be placed within one biotope, on reasonably level, uniform seabed, along pre-selected depth contour;

#### Quadrat positions:

- ❖ Pre-determined random positions;
- ❖ Adjacent quadrats should not overlap and so positions should be selected to ensure this; move to the next random number in the sequence if one will overlap with an earlier position;
- ❖ Both sides of the line can be used; the two sides should be clearly identified for example as Top or Bottom, with Top being the shallower side of the line.
- ❖ T or B should also be selected at random.
- ❖ Lower (if above the line) or upper (if below the line) left hand corner of the quadrat should be placed at the chosen position, and the quadrat laid along the line.

#### Species recording:

- ❖ Record both algae and animals.
- ❖ The following should be recorded as percentage cover of each species present within the quadrat: algae; animals forming crusts, mats or turf; very abundant sessile animals such as barnacles or *Pomatoceros*.
- ❖ Animal species which should be recorded as % cover will be selected during the familiarization survey and identified as such on the survey checklists.
- ❖ Other animals should be counted, recording the number of individuals of each species in the whole quadrat.
- ❖ Fish and other highly motile animals such as shrimps should be excluded from the quadrat monitoring; their abundance for the biotope can be assessed as part of the Phase II survey.
- ❖ Very numerous small species such as small gastropods should be ignored or recorded as Present (0.25 % - see below); how they are to be treated must be agreed during the initial familiarisation day and shown on the checklists.
- ❖ It is important that all surveyors record at the same taxonomic level, even if they are able to separate species in the field which others find difficult. These taxonomic levels will be agreed beforehand.
- ❖ Groups that are difficult to identify reliably in situ may be recorded at a higher level than species. These will be highlighted during the familiarization work beforehand and shown on the checklist.
- ❖ Species hiding in crevices or under cobbles should be ignored; only the species conspicuous on the surface should be recorded.
  
- ❖ A 10 x 10 cm square is equivalent to 4% cover
- ❖ Total % cover may be greater than 100% if species are lying over each other.
- ❖ If a plant or encrusting/colonial/mat-form animal is lying partly in and partly out of the quadrat, only the part within the quadrat should be recorded.

- ❖ Anything less than 0.5% or any other variation should be recorded as 0.25 % so analysis by PRIMER can be carried out. This will often apply to small, sparsely distributed species where a percentage cannot be estimated effectively.
- ❖ It is useful to make accompanying notes, such as '*Present as small, scattered sporelings*' or '*numerous small patches on maerl branches*'.
- ❖ Remember to check for encrusting algal species – these may be partly covered by silt. If the species cannot be separated, or identified accurately, they should be recorded as *Coralline crusts, dark red algal crusts, brown algal crusts*.
- ❖ Everything should be recorded to species level where possible, unless agreed otherwise beforehand. If the identity of something is uncertain, a specimen should be collected.
- ❖ It is preferable that specimens can be attributed to a particular quadrat following a dive, to minimize confusion, unless the species is a common one across the transect.

**Substratum:**

- ❖ The percentage cover of each of the major substrata within the quadrat must be recorded.

**Familiarization:**

- ❖ Half a day should be spent on familiarization dives in the biotope, with collections of specimens made for identification.
- ❖ The remainder of the day should be spent with the whole team working up the specimens to ensure familiarity and consistent identification, particularly of the common species.
- ❖ A collection of both algae and animals should be made for future reference. This can be a combination of pressed and pickled specimens, but pressed algal and hydroid specimens are easiest for showing other divers what a particular species looks like.

**Check lists:**

- ❖ A checklist of the species likely to be found on the sediment transects should be compiled from the familiarization work and pre-existing survey lists.
- ❖ This should indicate animals that are to be recorded at a higher taxonomic level than species.
- ❖ This should be put together the evening before the quadrat dives and copies printed onto waterproof paper for use underwater.

**Phase II survey:**

- ❖ A Phase II survey of the biotope in which the transect has been placed should be carried out in conjunction with the quadrat work.

**Photography:**

- ❖ A photographic record should be made of the communities and individual species. This can be 35 mm still photographs, digital photography, video footage or any combination.

**Specimen curation:**

- ❖ A reference collection should be made for use on future surveys.
- ❖ Specimens must be preserved and labelled during the following evening to prevent a build up of specimens and consequent confusion.
- ❖ A voucher collection of taxonomically challenging species must be collated after the survey has finished.
- ❖ Survey teams must have dilute, buffered formaldehyde and 70% Industrial Methylated Spirits available on site.

## **Habitat-specific variations for faunal turf monitoring**

### **MCR.Flu.HBvS**

#### **MCR.StoPaur**

- Demanding diving conditions in the circalittoral (strong tides and poor visibility) precluded the use of ropes on the seabed; the divers remained in contact with a buddy line.
- The seabed consisted of an open rock platform. Without the ground lines the quadrats were positioned either by swimming a certain number of fin strokes or hovering above the seabed and dropping the quadrat with eyes closed.
- The contents of four quadrats within a biotope were collected using a scraper and suction sampler for detailed analysis of the species present in the turf.

### **MCR.SNemAdia**

- The seabed in this biotope consisted of mixed boulders, cobbles and sand, with different species on the stable boulders compared to the more mobile cobbles. The transect line was not used due to the strong tides and the divers selected areas of cobbles for their quadrats, avoiding the larger boulders.
- The contents of 4 quadrats were collected using a scraper and suction sampler for detailed analysis of the species present in the turf.

### **MCR.Flu.Flu**

- This biotope was not sampled due to strong tides and zero visibility on the seabed at the site selected for survey.



## FLAMBOROUGH HEAD MONITORING PROTOCOL

### Vertical rock communities – AlcByH.Hia

#### Quadrat size:

- ❖ 30 x 30 cm (approx. 0.1 m<sup>2</sup>)

#### Quadrat number:

- ❖ At least 12 quadrats

#### Quadrat structure:

- ❖ Quadrats should be 4-sided and sub-divided into 20 grid squares,

#### Transect length:

- ❖ No transect used

#### Quadrat positions:

- ❖ As the habitat is broken into small areas (gully walls) the surveyors should move from one area of suitable size and uniformity to the next.
- ❖ Adjacent quadrats should not overlap.
- ❖ Elasticised bungees can be used to hang the quadrats from kelp plants higher on the rock.

#### Species recording:

- ❖ Record both algae and animals.
- ❖ The following should be recorded as percentage cover of each species present within the quadrat: algae; animals forming crusts, mats or turf; very abundant sessile animals such as barnacles or *Pomatoceros*.
- ❖ Animal species which should be recorded as % cover will be selected during the familiarization survey and identified as such on the survey checklists.
- ❖ Other animals should be counted, recording the number of individuals of each species in the whole quadrat.
- ❖ Fish and other highly motile animals such as shrimps should be excluded from the quadrat monitoring; their abundance for the biotope can be assessed as part of the Phase II survey.
- ❖ Very numerous small species such as small gastropods should be ignored or recorded as Present (0.25 % - see below); how they are to be treated must be agreed during the initial familiarisation day and shown on the checklists.
- ❖ It is important that all surveyors record at the same taxonomic level, even if they are able to separate species in the field which others find difficult. These taxonomic levels will be agreed beforehand.
- ❖ Groups that are difficult to identify reliably in situ may be recorded at a higher level than species. These will be highlighted during the familiarization work beforehand and shown on the checklist.
- ❖ Species hiding in crevices or under cobbles should be ignored; only the species conspicuous on the surface should be recorded.
  
- ❖ Total % cover may be greater than 100% if species are lying over each other.
- ❖ If a plant or encrusting/colonial/mat-form animal is lying partly in and partly out of the quadrat, only the part within the quadrat should be recorded.
- ❖ Anything less than 0.5% or any other variation should be recorded as 0.25 % so analysis by PRIMER can be carried out. This will often apply to small, sparsely distributed species where a percentage cannot be estimated effectively.
- ❖ It is useful to make accompanying notes, such as '*Present as small, scattered sporelings*' or '*numerous small patches on maerl branches*'.
- ❖ Remember to check for encrusting algal species – these may be partly covered by silt. If the species cannot be separated, or identified accurately, they should be recorded as *Coralline crusts, dark red algal crusts, brown algal crusts*.
- ❖ Everything should be recorded to species level where possible, unless agreed otherwise beforehand. If the identity of something is uncertain, a specimen should be collected.

- ❖ It is preferable that specimens can be attributed to a particular quadrat following a dive, to minimize confusion, unless the species is a common one across the transect.

**Sample collection**

- ❖ The contents of 4 quadrats should be collected using a scraper and suction sampler for detailed analysis of the species present in the turf.

**Substratum:**

- ❖ The percentage cover of each of the major substrata within the quadrat must be recorded.

**Familiarization:**

- ❖ Half a day should be spent on familiarization dives in the biotope, with collections of specimens made for identification.
- ❖ The remainder of the day should be spent with the whole team working up the specimens to ensure familiarity and consistent identification, particularly of the common species.
- ❖ A collection of both algae and animals should be made for future reference. This can be a combination of pressed and pickled specimens, but pressed algal and hydroid specimens are easiest for showing other divers what a particular species looks like.

**Check lists:**

- ❖ A checklist of the species likely to be found on the sediment transects should be compiled from the familiarization work and pre-existing survey lists.
- ❖ This should indicate animals that are to be recorded at a higher taxonomic level than species.
- ❖ This should be put together the evening before the quadrat dives and copies printed onto waterproof paper for use underwater.

**Phase II survey:**

- ❖ A Phase II survey of the biotope in which the transect has been placed should be carried out in conjunction with the quadrat work.

**Photography:**

- ❖ A photographic record should be made of the communities and individual species. This can be 35 mm still photographs, digital photography, video footage or any combination.

**Specimen curation:**

- ❖ A reference collection should be made for use on future surveys.
- ❖ Specimens must be preserved and labelled during the following evening to prevent a build up of specimens and consequent confusion.
- ❖ A voucher collection of taxonomically challenging species must be collated after the survey has finished.
- ❖ Survey teams must have dilute, buffered formaldehyde and 70% Industrial Methylated Spirits available on site.

**Flamborough Head SAC sublittoral monitoring, 2002: AlcByH, random 0.1m<sup>2</sup> quadrats Site:**

**Surveyor:** ..... **Date:** ..... **Time at start:**.....  
**Position:**..... **Depth at start:**.....  
**Substratum:**..... **Transect:** .....  
**Recording conditions: OK?** ..... **Transect side (L/R):**.....

<b>Quadrat position:</b>						<b>Quadrat position:</b>					
<b>Time start</b>											
<b>Count</b>											
Cancer pagurus											
Necora puber											
Sagartia elegans											
Urticina felina											
Hiatella arctica											
Ophiactis ballii											
Grantia compressa											
Dyopedos whips											
<b>% cover</b>											
Alcyonium digitatu											
Aplidium punctum											
Asciidiella scabra											
Bicellariella ciliata											
Botrylloides leachii											
Clathrina coriacea											
Corallina officinalis											
Coralline crusts											
Crisiidae turf											
Dark red crusts											
Delesseria sanguin											
Dendrodoa grossul											
Diphasia rosacea											
Halichondria panic											
Heterosiphonia plu											
Hypoglossum hypo											
Leucosolenia com											
Myxilla incrustans											
Phycodrys rubens											
Phyllophora pseud											
Plocamium cartilag											
Polyclinum auranti											
Sabellaria spinulos											
Schottera niccaens											
Scrupocellaria sp.											

## Appendix 3

### Data handling and analysis

#### Specimens

Upon return to the laboratory, the constituent species of the suction samples were identified. The replicate samples from a site were combined and a species list drawn up. No attempt was made to quantify the abundance of individual species although a note was made if a particular species dominated the sample. These species have been added to the Phase II data as *Present*. Specimens that were collected individually during the survey were also identified and added to the appropriate data sheet. Curated specimens have been lodged with the National Museum of Scotland.

#### Data handling and storage

The data collected from the quadrats were treated in a number of ways before statistical analysis. Each worker entered their own data into the a *Microsoft Excel* spreadsheet during the evening following the dive. This, combined with some on-site specimen identification, meant that many of the anomalies that have arisen on other similar surveys between different workers could be sorted out immediately. Consequently any remaining inconsistencies were few and easily rectified. For example, if one person had recorded *Pomatoceros* sp. and another *Pomatoceros triqueter*, these were combined as *Pomatoceros* sp. Duplicate species were also combined. Any records of *Present* were changed to 0.25 and any question marks addressed, generally by removing the record unless there was an obvious answer. Any species for which there were no records were removed and finally, all blank cells were replaced by 0. All of the Phase II data and the quadrat data were later entered into *Marine Recorder* for storage.

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#### Quadrat data analysis

The quadrat data were analysed using the PRIMER 5 statistical package to address the following questions:

- Did the quadrats collected from one site by different divers comprise a coherent data set or were there major differences between workers?
- How similar were the data for a biotope which occurred at more than one site?
- Could the data be used to separate closely related biotopes or was there too much overlap in the dominant species?
- Which species characterised each biotope sampled in 2002?

These questions were approached by combining data from similar sites for initial cluster analysis and ordination and then looking at the species responsible for the similarities and differences between the resultant clusters. The data were analysed in the following groups:

- Circalittoral rock and cobble – sites 4, 9, 11, 12;
- Infralittoral rock and kelp – sites 3, 13, 15;
- Infralittoral boulder/cobble and kelp – sites 8, 14;
- Gully walls – sites 6, 10.

The data were standardised to take account of the combination of abundance measures (percentage cover and counts) at any one site and a fourth root transformation was applied. The data transformation is important on this type of data where there are a few very common species and many rare ones, as it weights the rare and common species and allows all species present to have some contribution to the similarities (Gauch 1982; Sokal & Rohlf 1981). A similarity matrix was then calculated for each data group using the *Bray-Curtis similarity coefficient*.

The following analyses were then carried out:

- Cluster analysis;
- Multi-dimensional scaling (MDS), an ordination technique;

These provided a visual assessment of the similarity of and differences between the various sites and identified outlying quadrats.

- SIMPER (similarity percentages) showed which species were primarily responsible for the different groups identified by the clustering and MDS;
- ANOSIM (analysis of similarity), a multivariate technique which compared the sites statistically.

### **Biotope descriptions**

The results from the quadrat analyses, when combined with the qualitative suction samples and the Phase II records, enabled the individual biotopes to be distinguished and National biotope codes were assigned (Connor *et al.* 1997). Local biotope descriptions for Flamborough Head were then written which made use of all the different levels of information that had been collected during the survey. The lists of characterising species included in these descriptions were compiled from the combined results of the SIMPER analyses and the Phase II observations.

### **References**

- Gauch, H.G. jr. 1982. *Multivariate analysis in community ecology*. Cambridge, Cambridge University Press.
- Sokal, R.R. & Rohlf, F.J. 1981. *Biometry. The principles and practice of statistics in biological research*. 2<sup>nd</sup> edition. New York, W.H. Freeman & Co.

## **Appendix 4**

### **Video and dive site locations and associated data**

- Appendix 4.1** Summary of video drops and data collected during 2001 – 2002 monitoring survey of Flamborough Head
- Appendix 4.2** Summary of video drops and data collected during 1994 broad scale mapping of Flamborough Head (Davies & Sotheran 1995). Tapes were reviewed and biotopes assigned as part of the present exercise.
- Appendix 4.3** Summary of sites dived and data collected during 2002 monitoring survey of Flamborough Head

**Appendix 4.1 Summary of video drops and data collected during 2001 – 2002 monitoring survey of Flamborough Head**

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotopes	Length of tow (m)
13/09/02	1	1/1	8:46:00	54.089833 <sup>0</sup> N	0.0666667 <sup>0</sup> W	13.1 - 16	Coarse sand and gravel with sand waves. Dead <i>Mytilus</i> shells common. No animals seen other than a few sand eels.	CGS	119.84
12/09/02	1	1/2	14:49:00	54.084833 <sup>0</sup> N	0.0545 <sup>0</sup> W	19.50	Cobbles, boulders and gravel with <i>Flustra</i> , hydroids including <i>Halecium halecinum</i> , <i>Abietinaria</i> , <i>Tubularia indivisa</i> , <i>Thuiaria thuja</i> ; <i>Alcyonidium</i> , <i>Urticina</i> , <i>Liocarcinus</i> , <i>Taurulus</i> , <i>Nemertesia antennina</i> , <i>Balanus balanus</i> , <i>Asterias rubens</i> . Some turf.	SNemAdia	56.65
13/09/02	1	1/3	8:57:00	54.090833 <sup>0</sup> N	0.0645 <sup>0</sup> W	17.40	Fairly clean, bare cobbles with <i>Pomatoceros</i> , rare <i>Flustra</i> , <i>Crossaster</i> , <i>Cancer</i> .	SNemAdia	119.40
12/09/02	1	1/4	14:40:00	54.081 <sup>0</sup> N	0.0495 <sup>0</sup> W	20.80	Cobbles and boulders with <i>Flustra</i> , <i>Hydrallmania falcata</i> , scruffy hydroids, <i>Henricia</i> , <i>Urticina</i> and <i>Alcyonidium</i> . Some gravel patches.	SNemAdia	59.69
13/09/02	1	1/5	9:18:00	54.086333 <sup>0</sup> N	0.0528333 <sup>0</sup> W	19.90	Cobble, gravel and boulders with <i>Flustra</i> . <i>Alcyonidium</i> , <i>Haliclona</i> , <i>Asterias</i> , <i>Henricia</i> , <i>Urticina</i> , <i>Polymastia boletiformis</i> , <i>Crossaster</i> , <i>Polyclinum aurantium</i> , <i>Halecium halecinum</i> , <i>Sertularia argentea</i> , <i>Haliclona oculata</i> , fish indet.	SNemAdia	119.40
13/09/02	1	1/6	9:05:00	54.0855 <sup>0</sup> N	0.0681667 <sup>0</sup> W	17.80	Coarse sand and gravel waves with cobbles in the troughs and occasional boulders. Very little on gravel. <i>Alcyonidium</i> and <i>Flustra</i> dominant on boulders. Other species include <i>Hydrallmania</i> , <i>Sertularia argentea</i> , <i>Abietinaria abietina</i> , <i>Ascidia mentula</i> , <i>Halichondria panicea</i> , <i>Polymastia mamillaris</i> .	CGS/SNemAdia	98.77
13/09/02	1	1/7	9:28:00	54.082667 <sup>0</sup> N	0.0516667 <sup>0</sup> W	21.00	Cobbles with <i>Flustra</i> , <i>Urticina</i> and <i>Pomatoceros</i> . Also present <i>Abietinaria</i> , <i>Alcyonidium</i> , small ascidians. Some big boulders.	SNemAdia	107.48
13/09/02	1	1/8	9:51:00	54.097167 <sup>0</sup> N	0.0645 <sup>0</sup> W	16.70	Boulders and cobbles with <i>Flustra</i> , <i>Asterias</i> , <i>Alcyonidium</i> , <i>Halichondria panicea</i> , <i>Haliclona oculata</i> , <i>Callionymus</i> , hydroid/ascidian turf, <i>Rhizocaulus verticillatus</i> , <i>Pomatoceros</i> , <i>Urticina</i> . Good picture with slack water.	SNemAdia	21.71
13/09/02	1	1/9	9:40:00	54.091 <sup>0</sup> N	0.057 <sup>0</sup> W	18.60	Boulders and possibly bedrock forming ridges with cobbles between these. Dense <i>Flustra</i> on boulders and cobbles. <i>Pomatoceros</i> , hydroids, <i>Abietinaria</i> , <i>Tubularia indivisa</i> , <i>Halichondria panicea</i> , <i>Alcyonidium</i> , <i>Asterias</i> , <i>Urticina</i> , <i>Polyclinum aurantium</i> , ascidian/hydroid turf.	SNemAdia	98.20
12/09/02	2	2/1	10:35:00	54.080833 <sup>0</sup> N	0.0463333 <sup>0</sup> W	21.80	Chalk boulders and cobbles with some flat bedrock. <i>Flustra</i> , <i>Nemertesia ramosa</i> and <i>N. antennina</i> , <i>Sertularia argentea</i> , <i>Abietinaria</i> , <i>Urticina eques</i> , bryozoan/ascidian turf. Most <i>Flustra</i> on the larger boulders. Very silty with poor visibility.	SNemAdia	74.17

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotopes	Length of tow (m)
12/09/02	2	2/2	10:55:00	54.079667 <sup>0</sup> N	0.0521667 <sup>0</sup> W	20.50	Fairly clean cobbles, pebbles and gravel with a few boulders; patch of bedrock towards end of sequence. Some <i>Pomatoceros</i> and sparse <i>Flustra</i> , with more on boulders. <i>Callionymus lyra</i> , <i>Asterias</i> , <i>Haliclona oculata</i> , some patches ascidian/bryozoan turf including <i>Polyclinum aurantium</i> .	SNemAdia	59.71
12/09/02	2	2/3	11:00:00	54.081833 <sup>0</sup> N	0.0461667 <sup>0</sup> W	21.50	Stretch of fairly clean cobbles, pebbles and gravel with <i>Pomatoceros</i> . Boulders with <i>Flustra</i> and some <i>Alcyonium</i> and <i>Tubularia</i> . Very poor visibility - camera streamed out behind boat. Very little seen on this sequence.	SNemAdia	107.52
12/09/02	2	2/4	14:00:01	54.081833 <sup>0</sup> N	0.0458333 <sup>0</sup> W	21.60	Cobbles, many with little animal cover, with <i>Flustra</i> , <i>Pomatoceros</i> , <i>Thuiaria</i> , <i>Nemertesia</i> , <i>Halecium halecinum</i> , <i>Urticina eques</i> , <i>Haliclona oculata</i> .	SNemAdia	149.92
12/09/02	2	2/5	14:12:00	54.084167 <sup>0</sup> N	0.0458333 <sup>0</sup> W	21.5 - 23.2	Cobbles with <i>Flustra</i> , <i>Pomatoceros</i> , <i>Alcyonidium</i> , <i>Alcyonium digitatum</i> , <i>Sertularia argentea</i> , <i>Urticina eques</i> , <i>Asterias rubens</i> . Patches of ascidian/bryozoan turf. Many bare cobbles and gravel patches. Camera travelling very fast.	SNemAdia	74.84
12/09/02	2	2/6	14:26:00	54.080167 <sup>0</sup> N	0.0395 <sup>0</sup> W	22.60	Cobbles with <i>Flustra</i> , <i>Nemertesia</i> , <i>Alcyonidium</i> , <i>Tubularia indivisa</i> , <i>Halecium halecinum</i> , <i>Henricia</i> , <i>Pomatoceros</i> . Many bare cobbles.	SNemAdia	74.85
07/09/01	3	3/1	13 19 50	54.114055 <sup>0</sup> N	0.061535 <sup>0</sup> W	20.90	Flat smooth rock with sand patches and cobbles. Abundant <i>Mytilus</i> & <i>Asterias</i> , with lots of dead shells. <i>Pecten</i> , <i>Flustra</i> , <i>Liocarcinus</i> .	MytHAs	82.95
07/09/01	3	3/2	13 27 47	54.116017 <sup>0</sup> N	0.06656 <sup>0</sup> W	16.8 - 18.25	Low lying rock ridges with mussels & <i>Asterias</i> both abundant. Several <i>Cancer</i> seen & clumps of hydroids. <i>Alcyonidium</i> , <i>Crossaster</i> . Lots of dead shells.	MytHAs	50.85
07/09/01	3	3/3	13 44 40	54.1125 <sup>0</sup> N	0.0553333 <sup>0</sup> W	23.6 - 24.2	Plain of muddy sediment, silty rock and cobbles; dead <i>Mytilus</i> shells common; some live Mussels, <i>Asterias</i> . Obvious fauna very sparse. Visibility very bad & camera moving fast. Pots approaching	MytHAs	53.21
07/09/01	3	3/4	13 34 48	54.118617 <sup>0</sup> N	0.0652317 <sup>0</sup> W	20.05	Rock platform and cobbles dominated by a mixture of <i>Flustra</i> and hydroid/bryozoan turf. Few <i>Alcyonium</i> . <i>Asterias</i> was common - mussels not obvious, but possibly present judging by number of starfish. <i>Asterias</i> , <i>Cancer</i> , <i>Flustra</i> , <i>Henricia</i> , <i>Abietinaria</i> . Pot line – video up	Flu.HByS	48.23
07/09/01	4	4/1	13 54 29	54.115047 <sup>0</sup> N	0.0446733 <sup>0</sup> W	28.95	Plain of muddy cobbles, pebbles & small boulders with patches of bedrock. Very silty. Fauna sparse with some <i>Flustra</i> (not much), <i>Pomatoceros</i> , <i>Urticina eques</i> & <i>Echinus</i> .	PomByC	89.83
07/09/01	4	4/2	14 14 17	54.115603 <sup>0</sup> N	0.037235 <sup>0</sup> W	30.20	Plain of muddy cobbles with some small boulders or bedrock outcrops, very silty. <i>Flustra</i> , <i>Haliclona</i> , <i>Crossaster</i> , patches of hydroid/bryozoan turf ( <i>Eucratea/Sertularia</i> ), <i>Urticina</i> . Fauna generally sparse.	Flu.SerHyd	80.60

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotopes	Length of tow (m)
07/09/01	4	4/3	14 33 09	54.120605 <sup>0</sup> N	0.02922 <sup>0</sup> W	35.32	Plain of muddy shell gravel and cobbles, with large dead shells, including many <i>Modiolus</i> shells. Uncertain whether live <i>Modiolus</i> was present. <i>Echinus</i> , <i>Urticina</i> , <i>Liocarcinus</i> , clumps of hydroids including <i>Sertularia argentea</i> , <i>Abietinaria</i> , prawns, spider crab.	?ModMx	78.78
07/09/01	4	4/4	14 04 20	54.118385 <sup>0</sup> N	0.04946 <sup>0</sup> W	27.20	Plain of muddy cobbles and sand with <i>Mytilus</i> , <i>Asterias</i> & <i>Crossaster</i> . Occasional large boulder or bedrock outcrop with patches of <i>Flustra</i> .	MytHAs	73.62
07/09/01	4	4/5	14 23 20	54.114667 <sup>0</sup> N	0.0310383 <sup>0</sup> W	35.82	Plain of muddy shell gravel and cobbles, with large dead shells. <i>Asterias</i> , <i>Pagurus</i> , <i>Pomatoceros</i> . Little obvious life. Possibly <i>Modiolus</i> , but difficult to make out in poor visibility.	?ModMx	57.19
07/09/01	5	5/1	14 46 09	54.119102 <sup>0</sup> N	0.0291217 <sup>0</sup> W	34.43	Plain of muddy shell gravel and cobbles, with occasional patches of large boulders. Dead shells include <i>Modiolus</i> - possibly also live <i>Modiolus</i> , but this was unclear. Shell gravel has sparse hydroids. <i>Urticina eques</i> , sparse <i>Flustra</i> on boulders, hydroids, <i>Liocarcinus</i> , <i>Echinus</i> . Video brought up because of boulders.	?ModMx	61.14
07/09/01	5	5/2	14 53 55	54.119878 <sup>0</sup> N	0.0245217 <sup>0</sup> W	37.3 - 39.1	Muddy shell gravel, cobbles and occasional boulders. Fauna fairly sparse. Patches of hydroids, occasional <i>Urticina eques</i> , <i>Liocarcinus</i> , <i>Echinus</i> , <i>Asterias</i> , <i>Crossaster</i> . Dead <i>Modiolus</i> present - possibly also live ones? This was unclear. Flat battery.	?ModMx	47.69
07/09/01	5	5/3					Too rough		
07/09/01	5	5/4					Too rough		
07/09/01	5	5/5					Too rough		
08/09/01	6	6/1	09 57 00	54.090007 <sup>0</sup> N	0.1274867 <sup>0</sup> W	6.96	Rugged, fairly low-lying bedrock interspersed with cobble & small boulder areas. Covered with mixture of <i>Flustra</i> , <i>Alcyonium</i> & hydroid turf with different species dominating different areas. Camera moving very fast so identifications difficult. Large clumps of <i>Nemertesia</i> frequent.	StoPaur	135.89
08/09/01	6	6/10	12 53 50	54.081628 <sup>0</sup> N	0.1110067 <sup>0</sup> W	10.53	Coarse rippled sand with rock outcrops & boulders. Small rock ledges just visible under sand. <i>Alcyonium</i> & hydroid turf on rock; little on sand. Flat battery.	CGS	31.57
08/09/01	6	6/10	13 56	54.0815 <sup>0</sup> N	0.111 <sup>0</sup> W	11.68	Coarse rippled sand with some mud. Very little hard substratum. Sandeels, <i>Lanice</i>	CGS	34.15
08/09/01	6	6/11	10 46 26	54.095522 <sup>0</sup> N	0.1198633 <sup>0</sup> W	4.5 - 5.5	Mixed bedrock, boulders and cobbles with mixed hydroid turf and red algae. Patches of <i>Flustra</i> on bedrock outcrops. Fairly rich-looking community. <i>Calliblepharis</i> , <i>Nemertesia</i> , <i>Flustra</i> , <i>Liocarcinus</i> , hydroids	?FoR.Dic or ?StoPaur	74.30

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotores	Length of tow (m)
08/09/01	6	6/12	13 18 59	54.1 <sup>0</sup> N	0.1176667 <sup>0</sup> W	3.8 - 4	Dense kelp forest on cobble & boulder (bedrock, if present, not visible beneath kelp canopy). Kelps mixture of <i>Laminaria hyperborea</i> and <i>L. saccharina</i> , with red algae, <i>Delesseria</i> , <i>Dictyota</i> , <i>Ulva</i> and <i>Laminaria</i> sporelings common on cobbles.	LhypLsac	37.41
08/09/01	6	6/13	13 30 50	54.0955 <sup>0</sup> N	0.1146667 <sup>0</sup> W	7.9 - 8.5	Mixture of cobbles, boulders & coarse sand covered with a hydroid community of various species, mostly <i>Nemertesia</i> , <i>Sertularia</i> , <i>Abietinaria</i> & <i>Halecium halecinum</i> . <i>Urticina</i> ; sparse red algae; some <i>Flustra</i> on larger boulders.	StoPaur	32.17
08/09/01	6	6/14	13 39 10	54.097333 <sup>0</sup> N	0.116 <sup>0</sup> W	6.1 - 6.3	Plain of boulders, cobbles and coarse sand covered with foliose red & brown algae, hydroids & some <i>Flustra</i> . Rich-looking site. <i>Nemertesia</i> , <i>Sertularia argentea</i> , lots of <i>Calliblepharis</i> .	StoPaur	26.19
08/09/01	6	6/2	10 19 34	54.10125 <sup>0</sup> N	0.1234333 <sup>0</sup> W	1.30	Dense <i>L hyperborea</i> forest on bedrock and cobble with considerable amounts of <i>L. saccharina</i> & <i>Desmarestia aculeata</i> . Clumps of red algae, including <i>Dilsea</i> , & <i>Ulva</i> common.	XKScrR	71.47
08/09/01	6	6/4	10 26 40	54.100328 <sup>0</sup> N	0.120355 <sup>0</sup> W	1.70	Dense forest of mixed kelps on boulders and cobble, predominantly <i>L. saccharina</i> with <i>L hyperborea</i> . Red algae and kelp sporelings frequent. <i>Dilsea</i> , <i>Ulva</i> , <i>Delesseria</i> .	XKScrR	65.51
08/09/01	6	6/5	12 43 41	54.084513 <sup>0</sup> N	0.1140033 <sup>0</sup> W	9.98	Muddy sediment plain with <i>Lanice</i> & some <i>Mytilus</i> , with cobbles, bedrock outcrops & boulders. These have a silty hydroid turf, <i>Flustra</i> & <i>Alcyonium</i> . Low-lying bedrock at the sediment plain level has abundant <i>Alcyonidium</i> . Shell debris ( <i>Mytilus</i> ) present.	SNemAdia/MytH As	85.56
08/09/01	6	6/6	12 34 30	54.085333 <sup>0</sup> N	0.1183333 <sup>0</sup> W	9.73	Muddy sand plain with occasional boulders, rock outcrops and cobbles. <i>Lanice</i> common on sediment, <i>Alcyonium</i> & <i>Flustra</i> on rocky bits with silty hydroids ( <i>Sertularia/Hydrallmania</i> ). <i>Alcyonidium</i> common on low sediment-covered rock.	SNemAdia	85.58
08/09/01	6	6/7	10 53 40	54.0925 <sup>0</sup> N	0.115 <sup>0</sup> W	7.6 - 8.6	Coarse sandy gravel with muddy fraction overlying rock, with larger boulders/rock outcrops protruding. <i>Alcyonidium</i> & hydroids on sandy rock, <i>Flustra</i> and/or <i>A. digitatum</i> dominating outcrops. <i>Nemertesia</i> frequent.	StoPaur	91.31
08/09/01	6	6/8	10 36 44	54.099667 <sup>0</sup> N	0.1285 <sup>0</sup> W	3.50	Cobble plain dominated by patchy <i>L. saccharina</i> with dense red algae. <i>Dictyota</i> , <i>Ulva</i> , <i>Desmarestia</i> . Occasional <i>L. hyperborea</i> plants. Few animals. Very murky	XKScrR	52.87
08/09/01	6	6/9	12 20 28	54.088833 <sup>0</sup> N	0.1098333 <sup>0</sup> W	10.9 - 11.1	Muddy sand plain with occasional cobbles, possibly with bedrock projecting through/underlying sediment. <i>Lanice</i> (?or perhaps <i>Sabellaria</i> ?) abundant. Scattered <i>Urticina eques</i> and some scruffy hydroids ( <i>Sertularia/Hydrallmania</i> ) occasional. Dead <i>Mytilus</i> shells & frequent <i>Asterias</i> - possibly some live mussels?	SNemAdia	83.26
07/09/01	7	7/1	12 07 50	54.094667 <sup>0</sup> N	0.0745 <sup>0</sup> W	8.13	Coarse sand with large ripples. No animals seen.	CGS	0.00

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotopes	Length of tow (m)
13/09/02	7	7/1	10:01:00	54.095 <sup>0</sup> N	0.0748333 <sup>0</sup> W	7.70	Coarse sand waves and ripples with <i>Asterias</i> . Slack water	CGS	18.57
07/09/01	7	7/2	12 16	54.095417 <sup>0</sup> N	0.0658867 <sup>0</sup> W	15.5 - 16	Cobble plain with pebbles and occasional small rock ledges; <i>Flustra</i> on ledges. Small clumps of hydroids. Cobbles mostly bare apart from <i>Pomatoceros</i> .	?StoPaur	49.42
13/09/02	7	7/2	10:11:00	54.095333 <sup>0</sup> N	0.0663333 <sup>0</sup> W	16.30	Fairly bare cobble and sand. <i>Pomatoceros</i> , occasional <i>Flustra</i> , <i>Alcyonidium</i> , hydroids, <i>Abietinaria abietina</i> , <i>Asterias</i> , <i>Nemertesia</i> .	SNemAdia	95.07
13/09/02	7	7/3	10:22:00	54.092 <sup>0</sup> N	0.0756667 <sup>0</sup> W	5.1 - 6.4	Coarse sand waves with <i>Mytilus</i> shells. Fish indet.	CGS	64.45
13/09/02	7	7/4	10:29:00	54.095667 <sup>0</sup> N	0.072 <sup>0</sup> W	10.40	Coarse sand waves with <i>Mytilus</i> shells.	CGS	57.37
13/09/02	7	7/5	10:43:00	54.09 <sup>0</sup> N	0.0725 <sup>0</sup> W	11.40	Coarse sand waves with <i>Mytilus</i> shells.	CGS	28.57
13/09/02	7	7/6	10:50:00	54.0935 <sup>0</sup> N	0.0768333 <sup>0</sup> W	6.70	Coarse sand with <i>Mytilus</i> shells and sand eels	CGS	57.41
08/09/01	8	8/1	11 22 40	54.106533 <sup>0</sup> N	0.0820817 <sup>0</sup> W	8.60	Bedrock, small boulders and muddy sand covered with dense <i>Mytilus edulis</i> and lots of <i>Asterias</i> . Scattered clumps of <i>Nemertesia</i> , sparse <i>Flustra</i> (particularly on bedrock) & red algae.	MytHAs	110.69
08/09/01	8	8/11	14 44 22	54.104167 <sup>0</sup> N	0.0896667 <sup>0</sup> W	9.00	Plain of boulders, cobbles & sandy gravel covered with <i>Flustra</i> & hydroids, particularly <i>Nemertesia</i> , & sparse small red algae.	StoPaur	68.58
08/09/01	8	8/12	14 52 13	54.105333 <sup>0</sup> N	0.0878333 <sup>0</sup> W	7.80	Boulders with <i>Flustra</i> , red algae, hydroids. Ridges of rock or boulders with cobbles & gravel between. Very murky so difficult to identify anything. Stopped tow	StoPaur	38.68
08/09/01	8	8/2	11 30 13	54.1055 <sup>0</sup> N	0.0821667 <sup>0</sup> W	9.00	Bedrock ridge with plain of ?rock, sand & cobbles adjacent. Ridge dominated by <i>Alcyonium</i> with some <i>Flustra</i> . Plain completely covered by <i>Mytilus</i> with lots of <i>Asterias</i> . Clumps of <i>Nemertesia</i> frequent.	AlcSec/MytHAs	92.51
08/09/01	8	8/3	11 52 34	54.102833 <sup>0</sup> N	0.0855 <sup>0</sup> W	10.10	Bedrock ridges dropping to sand/cobble/rock plain. Rock covered with <i>Flustra</i> , <i>Nemertesia</i> & <i>Alcyonium</i> . Sand covered with dense mussels becoming more abundant further away from rock.	AlcSec/MytHAs	117.54
08/09/01	8	8/4	11 37 19	54.106293 <sup>0</sup> N	0.077885 <sup>0</sup> W	9.9 - 12.1	Undulating seabed completely covered by <i>Mytilus</i> and <i>Asterias</i> with patches of <i>Flustra</i> and scattered clumps of <i>A. digitatum</i> ,	MytHAs	108.17
08/09/01	8	8/8	14 22 35	54.101167 <sup>0</sup> N	0.09 <sup>0</sup> W	11.60	Plain of low rock ledges covered by coarse sand with scattered cobbles. No bare rock visible. <i>Flustra</i> , <i>Nemertesia</i> , <i>Alcyonidium</i> , <i>Alcyonium</i> attached to rock. Very little on sand itself. <i>Asterias</i> . Hooked pot line	StoPaur	27.64

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotores	Length of tow (m)
13/09/02	9	9/1	11:34:00	54.101 <sup>0</sup> N	0.0903333 <sup>0</sup> W	9.70	Scattered large boulders on coarse sand. Very little on the sand, although <i>Alcyonidium</i> growing through from rocks beneath. Boulders covered with <i>Flustra</i> and ascidian/hydroid turf. <i>Nemertesia antennina</i> , <i>Urticina eques</i> , <i>Alcyonium digitatum</i> .	StoPaur	65.73
13/09/02	9	9/2	10:56:00	54.094 <sup>0</sup> N	0.0811667 <sup>0</sup> W	8.90	Sand with poor visibility	CGS	57.12
13/09/02	9	9/3	11:06:00	54.098167 <sup>0</sup> N	0.0721667 <sup>0</sup> W	9.30	Sand with poor visibility	CGS	57.12
13/09/02	9	9/4	11:12:00	54.101833 <sup>0</sup> N	0.075 <sup>0</sup> W	13.30	Sand - heavy swell	CGS	94.23
13/09/02	9	9/5	11:19:00	54.1035 <sup>0</sup> N	0.0751667 <sup>0</sup> W	14.80	Clean gravel with pebbles and small scoured boulders. Swell.	CGS	78.32
13/09/02	9	9/6	11:44:00	54.098333 <sup>0</sup> N	0.0873333 <sup>0</sup> W	11.20	Boulders and rock with sand, much covering areas of flat rock, with abundant <i>Alcyonium diaphanum</i> and hydroid/bryozoan/ascidian turf. <i>Nemertesia</i> was common, <i>Flustra</i> present. <i>Alcyonium digitatum</i> , <i>Urticina eques</i> , <i>Asterias rubens</i> , <i>Cancer pagurus</i> , <i>Haliclona oculata</i> . More <i>Nemertesia</i> and less <i>Flustra</i> than cobble/sand sites in outer blocks & deeper water.	StoPaur	103.18
13/09/02	9	9/7	13:13:00	54.099333 <sup>0</sup> N	0.0811667 <sup>0</sup> W	14.00	No picture - no board - no lights.		78.32
13/09/02	10	10/10	12:40:00	54.120167 <sup>0</sup> N	0.0703333 <sup>0</sup> W	16.20	Scoured, bare rock, boulders and cobbles covered with <i>Pomatoceros</i> . Poor picture.	PomByC	28.56
13/09/02	10	10/4	12:31:00	54.114333 <sup>0</sup> N	0.0698333 <sup>0</sup> W	6.90	Bedrock and boulders with short bryozoan/hydroid turf and sparse <i>Alcyonium digitatum</i> . <i>Delesseria sanguinea</i> frequent. <i>Alcyonium diaphanum</i> , <i>Asterias rubens</i> , <i>Tubularia indivisa</i> . Camera lights erratic and visibility poor.	AlcSec	28.56
13/09/02	10	10/7	12:47:00	54.120667 <sup>0</sup> N	0.0748333 <sup>0</sup> W	7.55	Rock gullies with very dense short bryozoan turf and common <i>Alcyonium digitatum</i> . Sponges, <i>Asterias</i> , <i>Delesseria</i> , other red algae, <i>Nemertesia antennina</i> (sparse), <i>Alcyonium diaphanum</i> .	AlcSec	18.57
07/09/01	10	10/9	16 11 46	54.117247 <sup>0</sup> N	0.0707167 <sup>0</sup> W		Tide too strong 3.3 knots. Big bedrock gullies with dense <i>Alcyonium</i> .	AlcSec	171.78
07/09/01	11	11/1	12 43	54.13 <sup>0</sup> N	0.0905383 <sup>0</sup> W	9.3 - 12.3	Big rock ridges and gullies with <i>A. digitatum</i> dominant on silty rocky, but patches of <i>Flustra</i> still common. Several <i>Asterias</i> . Sparse red algae & frequent hydroid turf. Ledges and overhangs frequent.	Flu.HByS	23.88
07/09/01	11	11/3	12 51	54.1325 <sup>0</sup> N	0.0978333 <sup>0</sup> W	8.50	Big rock ridges and gullies with <i>A. digitatum</i> & hydroids dominant, hydroids mostly <i>Abietinaria</i> . Small amounts of <i>Flustra</i> .	Flu.HByS	66.72
07/09/01	11	11/6	10 59 09	54.132833 <sup>0</sup> N	0.101 <sup>0</sup> W	3.6 - 4.3	Big rock ridges with small clumps of <i>Alcyonium</i> , and dense turf of heavily encrusted red algae. Species not easy to identify on film. Camera moving very fast so difficult to identify. Very short tow.	Flu.HByS	30.47

Date	Video block	Video drop	Time in	Latitude in	Longitude in	Depth (m bcd)	Notes	Biotopes	Length of tow (m)
07/09/01	11	11/8	12 56 50	54.131733 <sup>0</sup> N	0.0948167 <sup>0</sup> W	9 - 11.8	Big rock ridges and gullies, with coarse sand in gully floors. <i>A. digitatum</i> & hydroid/bryozoan turf dominant, hydroids mostly <i>Nemertesia</i> & <i>Abietinaria</i> . Small amounts of <i>Flustra</i> .	Flu.HByS	73.35
07/09/01	11	11/9	10 50 22	54.134477 <sup>0</sup> N	0.1052333 <sup>0</sup> W	8.1 - 12.5	Big rock ridges with some patches of <i>Alcyonium</i> , some of <i>Flustra</i> . Hydroid turf generally common - several species, but not easy to identify on film. Lots of overhangs. Site very silty. <i>Flustra</i> , <i>A. digitatum</i> , <i>Nemertesia</i> , <i>Halecium</i> , <i>Alcyonidium</i> , hydroids.	Flu.HByS	77.63
07/09/01	12	12/1	10:29:00	54.137167 <sup>0</sup> N	0.0981667 <sup>0</sup> W	18.10	Silty rock ridges dominated by <i>Flustra</i> with clumps of <i>A. digitatum</i> . <i>Alcyonidium</i> , <i>Thuiaria</i> , <i>Urticina</i> , <i>Haliclona</i> . Sparser faunal cover than 12.2.	Flu.Flu	33.43
07/09/01	12	12/2	10:17:24	54.133433 <sup>0</sup> N	0.093495 <sup>0</sup> W	16.70	Rock ledges, ridges & gullies. Some hydroid turf. Clumps of <i>Alcyonium</i> and patches of <i>Pomatoceros</i> but mostly dominated by <i>Flustra</i> . <i>Thuiaria</i> , <i>Abietinaria</i> , <i>Alcyonidium</i> , <i>Cancer</i> . More hydroids than earlier drops.	Flu.Flu	84.18
07/09/01	12	12/3	10:08:15	54.132833 <sup>0</sup> N	0.0868483 <sup>0</sup> W	15.1 - 16.9	Silty rock dominated by <i>Flustra</i> with patches of <i>A. digitatum</i> . <i>Cancer</i>	Flu.Flu	39.40
07/09/01	12	12/4	10 35 42	54.136018 <sup>0</sup> N	0.0960967 <sup>0</sup> W	18.20	Silty bedrock ridges with abundant <i>Flustra</i> (but less than 12.2) and <i>A. digitatum</i> . A few patches of hydroids. Several shrimps. <i>Necora puber</i>	Flu.Flu	73.97
07/09/01	13	13/1	8:50:09	54.13893 <sup>0</sup> N	0.0881283 <sup>0</sup> W	21.00	Silty rock ledges with muddy, shelly sediment between ridges. Large patches of <i>Flustra</i> , clumps of <i>Alcyonium</i> and scattered hydroids.	Flu.Flu	123.91
07/09/01	13	13/2	9:06:36	54.141667 <sup>0</sup> N	0.0956667 <sup>0</sup> W	22.00	Rock ledges & silty boulders with patchy <i>Flustra</i> and <i>A. digitatum</i>	Flu.Flu	40.21
07/09/01	13	13/3	9:49:00	54.13585 <sup>0</sup> N	0.08408 <sup>0</sup> W	19.70	Silty rock ridges, boulders and some cobbles. <i>Flustra</i> abundant, <i>Alcyonium</i> common. <i>Pomatoceros</i> and pink crusts visible through silt.	Flu.Flu	6.99
07/09/01	13	13/4 (1)	10:19:00	54.143667 <sup>0</sup> N	0.0891667 <sup>0</sup> W	22.00	Rock and boulders with sparse <i>Alcyonium</i> and sand. Water very murky so little visible.	AlcC	37.75
07/09/01	13	13/4 (2)	9:26:42	54.143333 <sup>0</sup> N	0.0881667 <sup>0</sup> W	24.65	Sand with large boulders. Whiting. Visibility very low so little identifiable.	AlcC/CMS	34.95
07/09/01	13	13/5	9:38:17	54.144167 <sup>0</sup> N	0.0745 <sup>0</sup> W	29.8 - 30.3	Nothing visible		8.39
07/09/01	13	13/6	9:57:46	54.136433 <sup>0</sup> N	0.0879 <sup>0</sup> W	19.20	Silty rock ledges and patches of muddy sand. <i>Flustra</i> and <i>A. digitatum</i> present but visibility very low so few species seen.	Flu.Flu	61.14

## Appendix 4.2 Summary of video drops and data collected during 1994 broad scale mapping of Flamborough Head (Davies & Sotheran, 1995).

Tapes were reviewed and biotopes assigned as part of the present exercise.

Date	Site no	Latitude	Longitude	Biotope	Notes
1994	220	54.113 <sup>0</sup> N	0.047554 <sup>0</sup> W	?Flu.Flu	Silty boulder, cobble, bedrock with <i>Flustra</i> common, hyd/bry turf, <i>Asterias</i> ; <i>Urticina felina</i> ; <i>Urticina eques</i> ; <i>Bugula plumosa</i> . Flu.Flu? Substratum quite broken. Very little <i>A digitatum</i>
1994	301	54.1051 <sup>0</sup> N	0.040945 <sup>0</sup> W	?SNemAdia	Very silty cobble & boulder with <i>Pomatoceros</i> , sparse <i>Flustra</i> & hydroids; vis poor;
1994	115	54.1439 <sup>0</sup> N	0.117326 <sup>0</sup> W	CGS	V silty; <i>Asterias</i> ; seabed not visible not clear whether rock or sand.
1994	307	54.0816 <sup>0</sup> N	0.080659 <sup>0</sup> W	CGS	Rippled sand
1994	305	54.094 <sup>0</sup> N	0.072832 <sup>0</sup> W	CGS	Clean sand waves
1994	119	54.159 <sup>0</sup> N	0.10035 <sup>0</sup> W	CGS	Shelly sand
1994	112	54.1461 <sup>0</sup> N	0.098266 <sup>0</sup> W	CGS	V silty; sand; poor vis; pot line. Fauna looks sparse
1994	113	54.1461 <sup>0</sup> N	0.0973 <sup>0</sup> W	CGS	Poor vis; V silty; sand?
1994	213	54.0987 <sup>0</sup> N	0.088842 <sup>0</sup> W	CGS; Flu.SerHyd	Sand with scattered boulders; cobbles scoured clean; sparse <i>Flustra</i> and hydroids on more stable boulders; <i>Urticina</i> ; fairly barren; highly mobile & scoured
1994	302	54.1035 <sup>0</sup> N	0.025252 <sup>0</sup> W	CGS; Flu.SerHyd	Pebble & muddy shell gravel; occ clumps of hydroids on scarce boulders; <i>Urticina eques</i> ; occ boulders; poor vis
1994	117	54.1444 <sup>0</sup> N	0.133378 <sup>0</sup> W	CGS; PomByC	Bad vis; rippled sand with rock outcrops & cobble; <i>Lanice</i> present
1994	304	54.1027 <sup>0</sup> N	0.062456 <sup>0</sup> W	CGS; PomByC	Sand & shell debris; patches of scoured, clean boulders; <i>Asterias</i>
1994	106	54.1303 <sup>0</sup> N	0.074881 <sup>0</sup> W	Flu.Flu	Silty bedrock ledges; <i>Flustra</i> abundant; patchy ascidian/bryozoan/hydroid turf; <i>A digitatum</i> ; <i>Asterias</i>
1994	111	54.1408 <sup>0</sup> N	0.0946 <sup>0</sup> W	Flu.Flu	V silty bedrock, <i>Flustra</i> ; sparse <i>Alcyonium digitatum</i> ; <i>Henricia</i> ; <i>Asterias</i> ; <i>Echinus</i> ; patches of turf & patches of bare, silty rock; <i>Urticina eques</i> ; <i>Crossaster</i> ; bad vis.
1994	107	54.1335 <sup>0</sup> N	0.085207 <sup>0</sup> W	Flu.Flu	Silty undulating broken bedrock; <i>Flustra</i> A; <i>Alcyonidium</i> ; turf; <i>Asterias</i> ; <i>Urticina</i> ; <i>Pomatoceros</i> ; <i>Echinus</i> ; <i>Haliclona oculata</i> ; sparse <i>A digitatum</i> ;
1994	110	54.1375 <sup>0</sup> N	0.101775 <sup>0</sup> W	Flu.Flu	Silty bedrock, boulders & cobble with <i>Flustra</i> ; <i>Pomatoceros</i> ; patchy turf; sparse <i>A digitatum</i> ; <i>Asterias</i> ; <i>Echinus</i> ; <i>Halecium</i> ; <i>Thuiaria</i> large patch; <i>A diaphanum</i>
1994	102	54.1194 <sup>0</sup> N	0.074903 <sup>0</sup> W	Flu.HByS	Flat silty bedrock ledges & cobbles; <i>Crossaster</i> ; <i>Flustra</i> Common; bryozoan turf Abundant; <i>Henricia</i> ; sparse <i>Alcyonium digitatum</i> ; <i>Asterias</i> .
1994	103	54.1255 <sup>0</sup> N	0.066556 <sup>0</sup> W	Flu.HByS	Flat silty bedrock ledges & cobbles; <i>Flustra</i> ; <i>Pomatoceros</i> ; <i>Sabellaria</i> ; <i>Abietinaria</i> ; sparse <i>Alcyonium digitatum</i> ; ascidian/bryozoan/hydroid turf; <i>Scypha</i> ; <i>Alcyonidium</i> ; <i>Crossaster</i>
1994	105	54.1242 <sup>0</sup> N	0.076565 <sup>0</sup> W	Flu.HByS	Silty bedrock ledges; scattered common <i>A digitatum</i> ; ascidian/bryozoan/hydroid turf Abundant; <i>Alcyonidium</i> ; more <i>A digitatum</i> than <i>Flustra</i> ; <i>Henricia</i> ; <i>Asterias</i> ; <i>Abietinaria</i> ; <i>Flustra</i> ;
1994	114	54.136 <sup>0</sup> N	0.120436 <sup>0</sup> W	Flu.HByS	Bedrock ridges; ?mussels; <i>Asterias</i> ; <i>Flustra</i> & turf; <i>Pomatoceros</i> ; <i>A diaphanum</i> ; sparse <i>A digitatum</i> ;
1994	216	54.1197 <sup>0</sup> N	0.071457 <sup>0</sup> W	Flu.HByS	Silty bedrock gullies with hydroid/bryozoan turf, ascidians, abundant <i>Flustra</i> , sparse <i>Alcyonium</i> ; turf abundant
1994	219	54.1127 <sup>0</sup> N	0.057246 <sup>0</sup> W	Flu.HByS	Mixed bedrock & cobble; <i>Asterias</i> ; sparse hydroids; silty; <i>Asterias</i> ; <i>Crossaster</i> ; occ. <i>Nemertesia</i> ; occ. <i>Flustra</i> ;

Date	Site no	Latitude	Longitude	Biotope	Notes
1994	109	54.1313 <sup>0</sup> N	0.091124 <sup>0</sup> W	Flu.HByS; AlcC	Bedrock ridges with turf & <i>Alcyonium</i> ; <i>Flustra</i> ; <i>Henricia</i> ; <i>Alcyonidium</i> ; <i>Nemertesia antennina</i> ; <i>Polymastia boletiformis</i> ; <i>Tubularia</i> ;
1994	108	54.1315 <sup>0</sup> N	0.090224 <sup>0</sup> W	Flu.HByS; AlcSec	Silty bedrock with some bare cobbles. Started on <i>Flustra</i> moved onto dense <i>Alcyonium</i> ; <i>Flustra</i> ; turf; ? <i>Sabellaria</i> ; <i>Pomatoceros</i> ; <i>Crossaster</i> ; <i>Tubularia</i> ; <i>Asterias</i> ; <i>Halecium</i> ;
1994	116	54.1404 <sup>0</sup> N	0.122901 <sup>0</sup> W	Flu.HByS; CGS	Bedrock with <i>Flustra</i> & sparse <i>Alcyonium digitatum</i> ; <i>Thuiaria</i> ; Silty rock & boulder ledges; Not much turf; then moved onto sand with boulders on sand & some ; rock coming through; rock very bored; <i>Ophiopholis</i> ? brittle stars; <i>Ophiura ophiura</i> ; <i>Alcyonium diaphanum</i> ; <i>Asterias</i> ; fish (mullet?); plaice;
1994	201	54.155 <sup>0</sup> N	0.070171 <sup>0</sup> W	Flu.SerHyd	Muddy pebbles, cobbles, shelly sand; <i>Urticina eques</i> ; hermit; <i>Asterias</i> ; sparse hydroids; <i>Thyone</i>
1994	204	54.0717 <sup>0</sup> N	0.064632 <sup>0</sup> W	Flu.SerHyd	Muddy sand with rock outcrops & pebbles; <i>Lanice</i> abundant; <i>Urticina eques</i> ; <i>Asterias</i> ; <i>Cancer</i> ; <i>Pholis</i> ; <i>Callionymus</i> . Not much cobble/turf
1994	306	54.0901 <sup>0</sup> N	0.062198 <sup>0</sup> W	Flu.SerHyd; PomByC	Boulders & cobbles; fairly clean; <i>Crossaster</i> ; <i>Asterias</i> ; Pagurid; occ. patches of hydroids; <i>Pomatoceros</i> ; <i>Urticina eques</i> ; <i>Cancer</i> ; barnacles
1994	104	54.1235 <sup>0</sup> N	0.080432 <sup>0</sup> W	FoR; AlcByH	Started on red algae (mostly <i>Delesseria</i> ); finished on rich animal turf. Walls with dense turf & few algae. Flat silty bedrock; red algae; hydroid/bryozoan turf; <i>Henricia</i> ; <i>Delesseria</i> A; <i>Flustra</i> ; <i>Tubularia</i> ; <i>Polyclinum</i> ; gullies & walls; <i>Asterias</i> ; <i>Aplidium</i> ; <i>Hypoglossum</i> ;
1994	209	54.1097 <sup>0</sup> N	0.07549 <sup>0</sup> W	Lhyp.Ft	<i>L hyperborea</i> ; <i>Palmaria</i> ; bedrock ledges & small gullies
1994	214	54.1114 <sup>0</sup> N	0.071839 <sup>0</sup> W	Lhyp.Pk	<i>Laminaria hyperborea</i> ; red algae; <i>Plocamium</i> abundant; bedrock platform & walls with sand & cobbles in gully floors; mixed other algae;
1994	101	54.1185 <sup>0</sup> N	0.066668 <sup>0</sup> W	Lhyp.Pk	<i>L hyperborea</i> ; red algae; <i>Dictyota</i> ; bryozoans
1994	208	54.1096 <sup>0</sup> N	0.07284 <sup>0</sup> W	Lhyp.Pk; AlcByH	Boulders & bedrock ledges with <i>Laminaria hyperborea</i> park & dense algae; <i>Dictyota</i> ; <i>Delesseria</i> ; animals on verticals inc <i>Alcyonium digitatum</i> ; <i>Urticina felina</i> in gullies; <i>Brongiartella</i> ; cobbles & sand on gully floors;
1994	203	54.1137 <sup>0</sup> N	0.07039 <sup>0</sup> W	Lhyp.Pk; AlcByH	Bedrock ledges and small vertical walls with dense algae and sparse <i>L hyperborea</i> , animal turf on walls; <i>Dictyota</i> ; <i>Delesseria</i> ; <i>Desmarestia viridis</i> ; <i>Asterias</i> ; <i>Leucosolenia</i> ;
1994	211	54.105 <sup>0</sup> N	0.089567 <sup>0</sup> W	Lhyp.Pk; XKScrR; CGS	Rippled sand; then cobble/bedrock with luxuriant growth of <i>Ulva</i> , <i>Dictyota</i> ; <i>Taonia</i> ; <i>Desmarestia</i> sp; <i>Phycodrys</i> ; various red algae; kelps on larger boulder and on bedrock at end of drop. Some <i>L saccharina</i> earlier.
1994	218	54.111 <sup>0</sup> N	0.064556 <sup>0</sup> W	MytHAs	<i>Mytilus</i> bed, 100 % cover; <i>Asterias</i> ; sparse <i>Flustra</i> ; <i>Cancer</i> ; plaice; bedrock & cobbles;
1994	206	54.0866 <sup>0</sup> N	0.065991 <sup>0</sup> W	PomByC	Pebble & cobble , clean, with occasional boulders with sparse <i>Flustra</i> ; occ. Patches of <i>Sabellaria</i>
1994	207	54.0875 <sup>0</sup> N	0.038488 <sup>0</sup> W	PomByC	Clean cobble & pebble with occ. Hydroids; <i>Flustra</i> on larger boulders; <i>Urticina eques</i> ;
1994	205	54.0817 <sup>0</sup> N	0.054906 <sup>0</sup> W	SNemAdia	Cobbles and boulders with <i>Sabellaria</i> common; <i>Flustra</i> ; patchy hydroids; <i>Urticina felina</i> ; <i>Urticina eques</i> ; <i>Crossaster</i> ; <i>Asterias</i> ;
1994	202	54.1357 <sup>0</sup> N	0.065821 <sup>0</sup> W	SNemAdia	Muddy sand with rock outcrops & pebbles; <i>Asterias</i> ; <i>Flustra</i> ; patches of hydroids/bryozoans;
1994	221	54.1193 <sup>0</sup> N	0.039861 <sup>0</sup> W	SNemAdia	Boulder & cobble & sand; <i>Echinus</i> ; <i>Asterias</i> ; patchy turf; <i>Flustra</i> ; <i>Tubularia</i> ; <i>Crossaster</i> ; lots of <i>Cancer</i> & <i>Asterias</i> ; ? <i>Mytilus</i> ?; <i>Sabellaria</i> ; <i>Haliclona oculata</i>
1994	303	54.096 <sup>0</sup> N	0.021702 <sup>0</sup> W	SNemAdia	Boulders & bedrock/cobbles/pebbles; silty hydroids; <i>Pomatoceros</i> ; sparse <i>Flustra</i> ;

Date	Site no	Latitude	Longitude	Biotope	Notes
1994	217	54.1192 <sup>0</sup> N	0.07349 <sup>0</sup> W	StoPaur; FoR	Bedrock & some cobbles with mixed algae, ascidian/hydroid turf, <i>Flustra</i> ; <i>Polyclinum</i> ; <i>Aplidium</i> ; <i>Alcyonidium diaphanum</i> ; <i>Henricia</i> ; <i>Asterias</i> ; <i>Haliclona oculata</i> ; <i>Delesseria</i> ; <i>Dictyota</i> ; coralline crusts; <i>Pomatoceros</i> ; <i>Hypoglossum</i> ;
1994	210	54.1065 <sup>0</sup> N	0.083099 <sup>0</sup> W	XKScrR	Foliose algae on level seabed; ( <i>Dictyota</i> )/?large <i>Taonia</i> ? dominant ; mixed rock, boulder, cobble, sand; <i>Asterias</i> ; small red algae; <i>Bugula plumosa</i> ; no kelp seen
1994	212	54.1026 <sup>0</sup> N	0.098501 <sup>0</sup> W	XKScrR	Cobble, boulder & sand with luxuriant foliose algae; <i>Ulva</i> ; <i>Laminaria hyperborea</i> ; <i>Dictyota</i> ; <i>Urticina felina</i> ; red algae; <i>Desmarestia aculeata</i> ; <i>Delesseria</i> ; <i>Brongniartella</i> ; <i>Taonia</i> ;
1994	215	54.1191 <sup>0</sup> N	0.075931 <sup>0</sup> W	XKScrR; Lhyp.Pk	Mixed algae on bedrock and boulders; <i>Delesseria</i> ; coralline crusts; <i>Plocamium</i> ; sand patches; <i>Laminaria hyperborea</i> park at end of tow; barnacles
1994	118	54.1561 <sup>0</sup> N	0.132485 <sup>0</sup> W		No drop

**Appendix 4.3 Summary of sites dived and data collected during 2002 monitoring survey of Flamborough Head**

Field Site No	Date	Site name	Latitude	Longitude	Phase II Survey	Quad size	No of Quadrats	Other samples <sup>1</sup>	Photos	Video	Depth (m bcd)	Biotope	Surveyors
1	19/05/02	South Landing	54° 06.05' N	00° 07.17' W	X						1.2	XKScrR	FB/EM
2	19/05/02	East of South Landing	54° 06.08' N	00° 06.36' W	X						3	XKScrR	TM/CH
3	19/05/02	Breil Nook Infralittoral	54° 07.55' N	00° 05.55' W	X						3.7	Lhyp.Ft	FB/EM
3a	21/05/02	Breil Nook Infralittoral	54.12739 <sup>0</sup> N	00.09123 <sup>0</sup> W	X	0.25 m <sup>2</sup>	10				1.5	Lhyp.Ft	FB/CMH
3b	21/05/02	Breil Nook Infralittoral	54.12725 <sup>0</sup> N	00.09040 <sup>0</sup> W		0.25 m <sup>2</sup>	10				2.4	Lhyp.Ft	TM/EH
3c	21/05/02	Breil Nook Infralittoral	54.12970 <sup>0</sup> N	00.09462 <sup>0</sup> W		0.25 m <sup>2</sup>	10				2.7	Lhyp.Ft	TM/EH
4	19/05/02	Breil Nook Circalittoral	54° 1286 <sup>0</sup> N	00° 08951 <sup>0</sup> W	X						7	Flu.HByS	TM/CH
4	21/06/02	Breil Nook Circalittoral	54.12903 <sup>0</sup> N	00.08981 <sup>0</sup> W		0.25 m <sup>2</sup>	6	4 SS	24		7	Flu.HByS	CMH/TM/DW
4a	20/05/02	Breil Nook Circalittoral	54° 1286 <sup>0</sup> N	00° 08951 <sup>0</sup> W	X	0.25 m <sup>2</sup>	7				6.8	Flu.HByS	FB/CMH
4b	21/05/02	Breil Nook Circalittoral	54.12917 <sup>0</sup> N	00.08985 <sup>0</sup> W	X	0.25 m <sup>2</sup>	5	5 scrapes	Digital		6	Flu.HByS	FB/CMH
4c	22/05/02	Breil Nook Circalittoral	54.12942 <sup>0</sup> N	00.09235 <sup>0</sup> W		0.25 m <sup>2</sup>	3				6.4	Flu.HByS	EH/CMH
4d	22/05/02	Breil Nook Circalittoral	54.12942 <sup>0</sup> N	00.09235 <sup>0</sup> W		0.25 m <sup>2</sup>	4				7.5	Flu.HByS	TM/FB
5	20/05/02	Old Fall West, South Flamborough	54° 06.25' N	00° 05.38' W	Site sheet only. Fast drift						6	StoPaur	TM/EH
6a	22/05/02	Sanwick Brig Gullies	54.13464 <sup>0</sup> N	00.11928 <sup>0</sup> W	X						4	AlcByH.Hia	EH/CMH
6b	18/06/02	Sanwick Brig Gullies	TA 22879	72699		0.1 m <sup>2</sup>	14				2.6	AlcByH.Hia	TM/CMH/ FB/EH
6c	20/06/02	Sanwick Brig Gullies	54.13436 <sup>0</sup> N	00.11703 <sup>0</sup> W		0.1 m <sup>2</sup>		4 SS			2.6	AlcByH.Hia	DW
7	22/05/02	Sanwick circalittoral	54.13469 <sup>0</sup> N	00.11706 <sup>0</sup> W	X						4.5	SabKR	TM/FB
8	18/06/02	South Landing	TA 23078	68835		0.25 m <sup>2</sup>	21				2.5	XKScrR	TM/CMH/ FB/EH
9	19/06/02	Offshore cobbles, South Flamborough Circalittoral	54.09319 <sup>0</sup> N	00.11691 <sup>0</sup> W	X	0.25 m <sup>2</sup>	14	3 SS	20	X	8.5	SNemAdia	TM/CMH/ FB/EH
10	19/06/02	Staple Neuk Gullies	54.14545 <sup>0</sup> N	00.15210 <sup>0</sup> W		0.1 m <sup>2</sup>	15		15	X	1.9 – 4.7	AlcByH.Hia	TM/CMH/ FB/EH
11	20/06/02	Old Fall, South Flamborough	54.10491 <sup>0</sup> N	00.11812 <sup>0</sup> W	Strong tide so dive aborted						8.5	StoPaur	FB/TM/DW

Field Site No	Date	Site name	Latitude	Longitude	Phase II Survey	Quad size	No of Quadrats	Other samples <sup>1</sup>	Photos	Video	Depth (m bcd)	Biotope	Surveyors
11	20/06/02	Old Fall, South Flamborough	54.10434 <sup>0</sup> N	00.08876 <sup>0</sup> W	X	0.25 m <sup>2</sup>	10		15		8.5	StoPaur	CMH/EH
11	21/06/02	Old Fall, South Flamborough	54.10405 <sup>0</sup> N	00.08956 <sup>0</sup> W		0.25 m <sup>2</sup>	6	4 SS		X	8.5	StoPaur	FB/EH/DW
12	20/06/02	Offshore Sanwick Brig	54.13565 <sup>0</sup> N	00.11801 <sup>0</sup> W	X	0.25 m <sup>2</sup>	11		10		8.6	Flu.HByS	CMH/EH
13	20/06/02 22/06/02	Sanwick Brig Kelp Park	54.13436 <sup>0</sup> N	00.11703 <sup>0</sup> W	X	0.25 m <sup>2</sup>	18			X	2.8	Lhyp.Pk	TM/CMH/ FB/EH
14	22/06/02	Offshore Breil Nook	54.13490 <sup>0</sup> N	00.07944 <sup>0</sup> W	Zero visibility; dive aborted							Flu.Flu	CMH/TM
15	22/06/02	Staple Neuk	50 m south of 54.14581 <sup>0</sup> N	00.15319 <sup>0</sup> W		0.25 m <sup>2</sup>	11				2.5	Lhyp.Pk	FB/EH
15	22/06/02	Staple Neuk	54.14526 <sup>0</sup> N	00.15381 <sup>0</sup> W	X	0.25 m <sup>2</sup>	10				1.5	Lhyp.Pk	CMH/TM
16	23/06/02	South Landing	54.10049 <sup>0</sup> N	00.12141 <sup>0</sup> W	X	0.25 m <sup>2</sup>	22				1.5	XKScrR	TM/CMH/ FB/EH

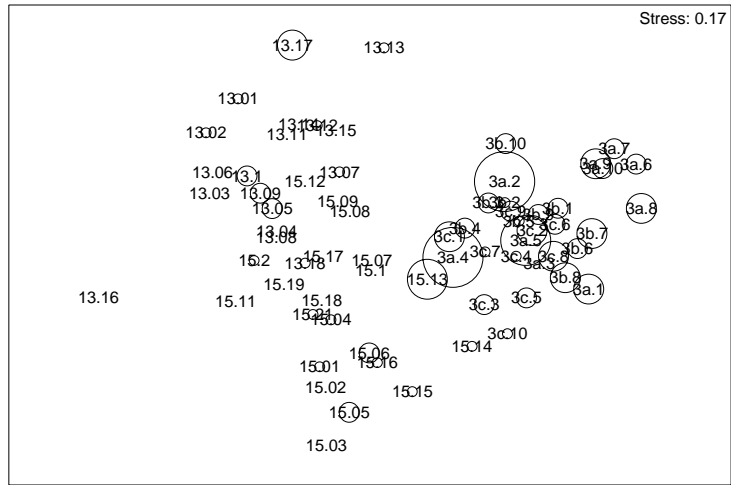
Note 1: SS = Suction sample. All scrapes and suction samples were taking using a 0.1 m<sup>2</sup> quadrat.

## **Appendix 5**

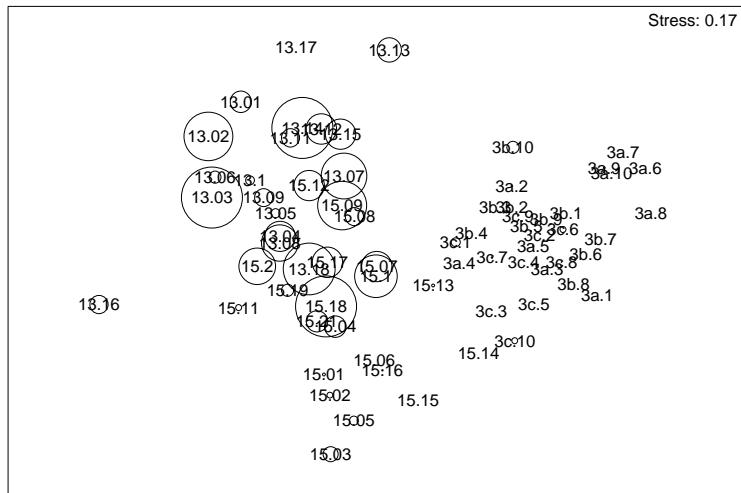
### **Results of cluster analyses and MDS ordinations for quantitative sampling**



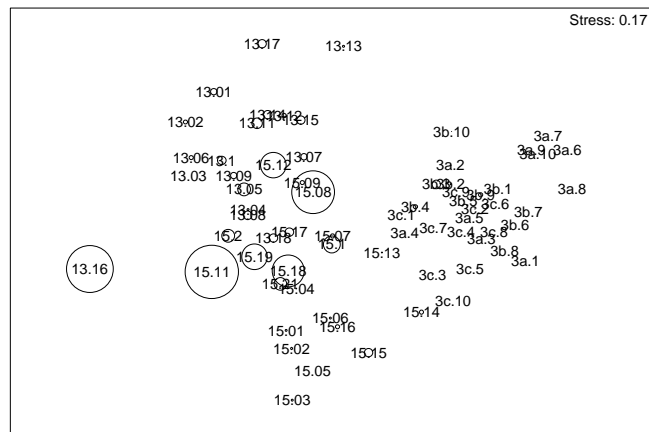
*Laminaria hyperborea* (mature plants)



*Kelp data: Delesseria sanguinea*



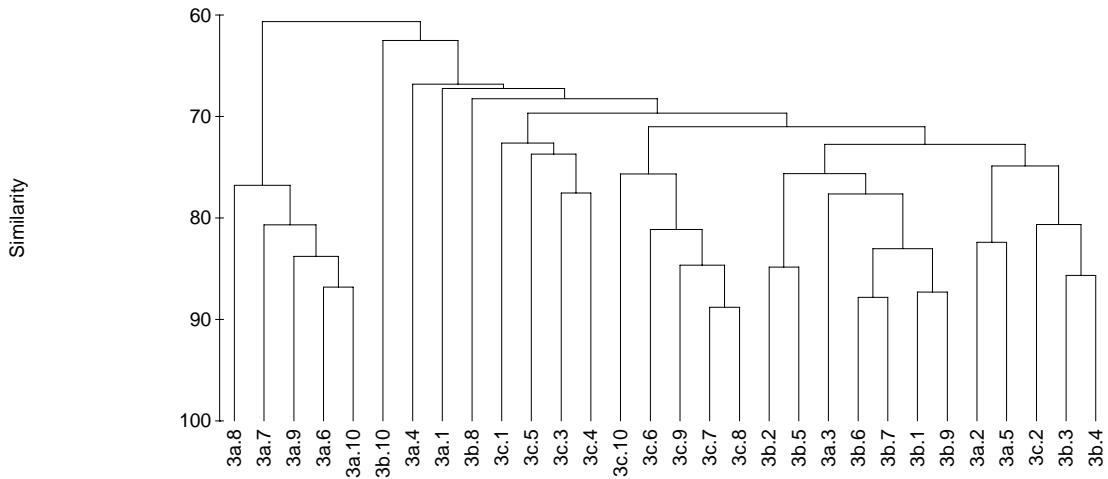
*Kelp data: Rhodomela confervoides*



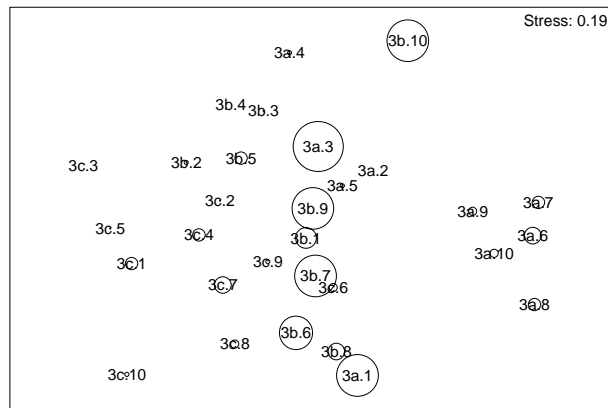
## Appendix 5.2 Infralittoral rock analyses – Lhyp.Ft

**Results of cluster analysis and MDS ordination of the kelp forest data (Site 3). The MDS plots highlight the influence of selected species.**

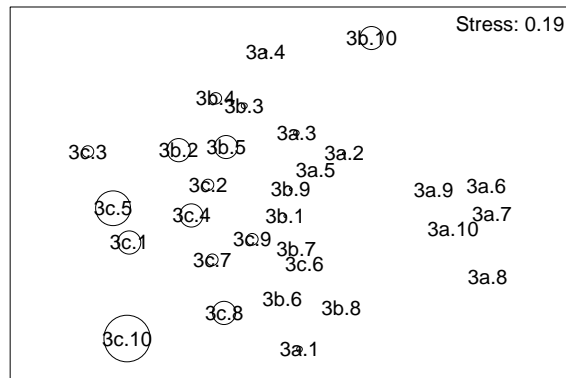
*Kelp forest Site 3*



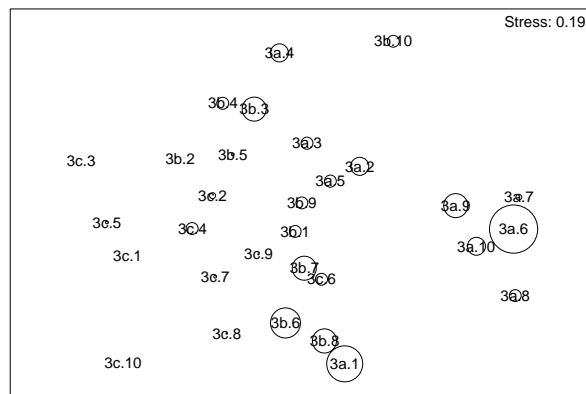
*Kelp forest Kelp sporelings*



*Kelp forest Hypoglossum hypoglossoides*



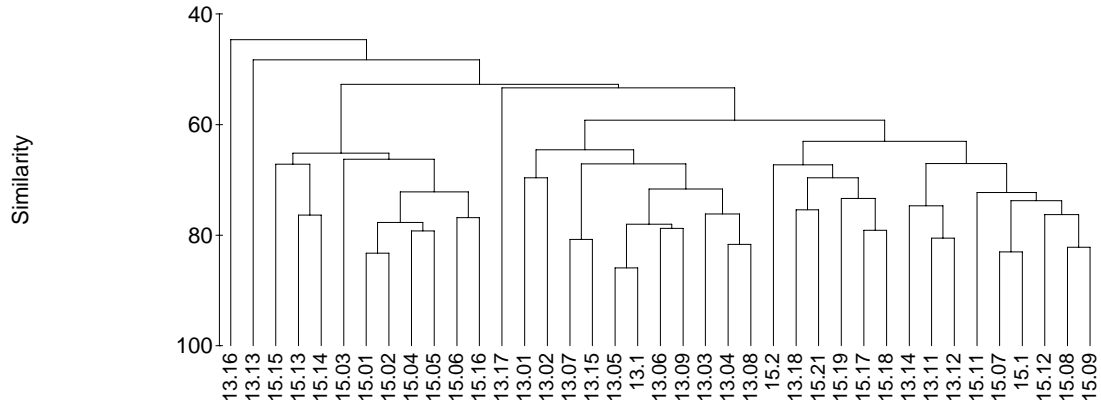
*Kelp forest Cryptopleura ramosa*



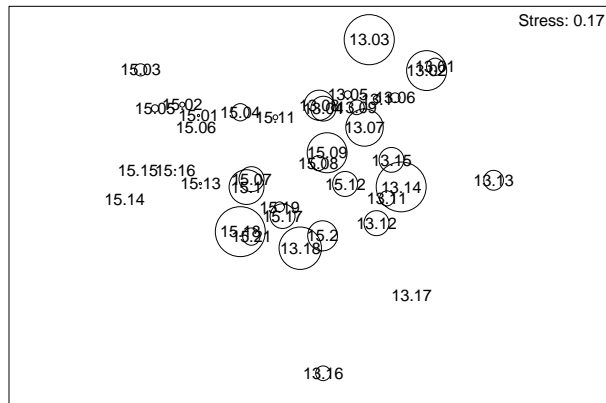
### Appendix 5.3 Infralittoral rock analyses – Lhyp.Pk

**Results of cluster analysis and MDS ordination of the kelp park data (Sites 13, 15). The MDS plots highlight the influence of selected species.**

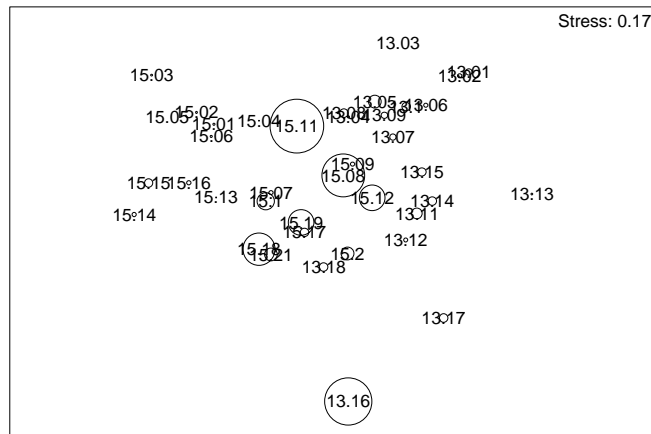
*Kelp park: Sites 13 and 15*



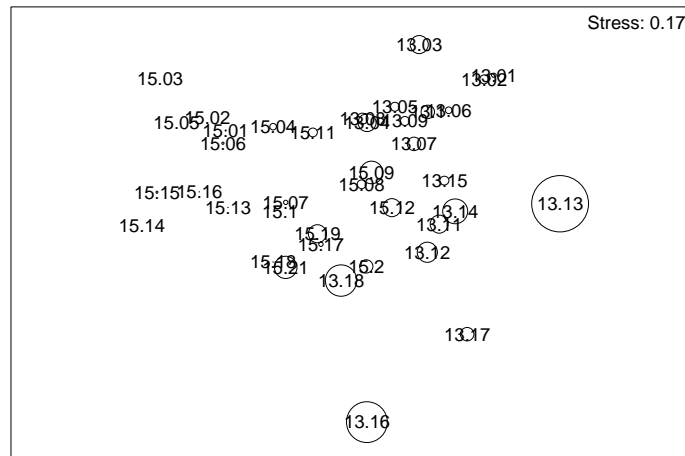
*Kelp park: Delesseria sanguinea*



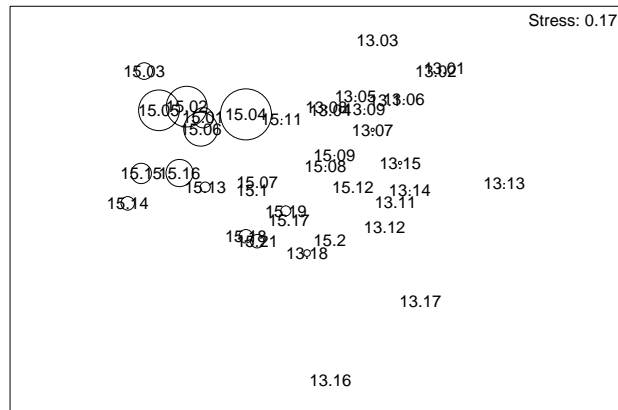
*Kelp park: Rhodomela confervoides*



*Kelp park: Hypoglossum hypoglossoides*



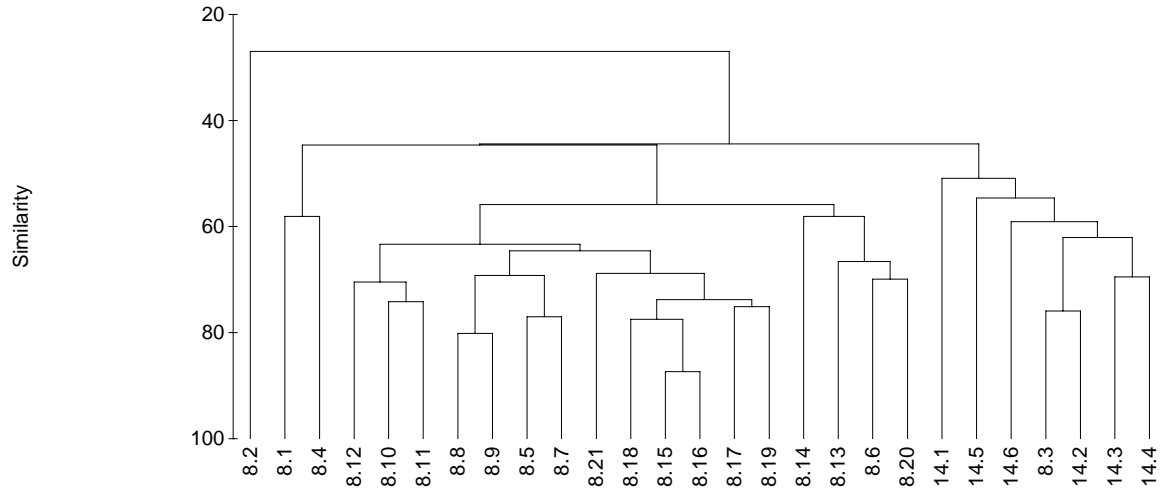
*Kelp park: Coralline crusts*



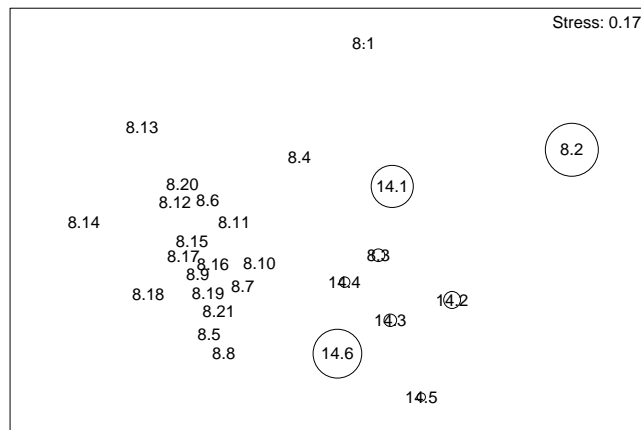
## Appendix 5.4 Infralittoral cobble analyses – XKScrR

### Results of cluster analysis and MDS ordination of south Flamborough XKScrR data (Sites 8, 14). The MDS plots highlight the influence of selected species.

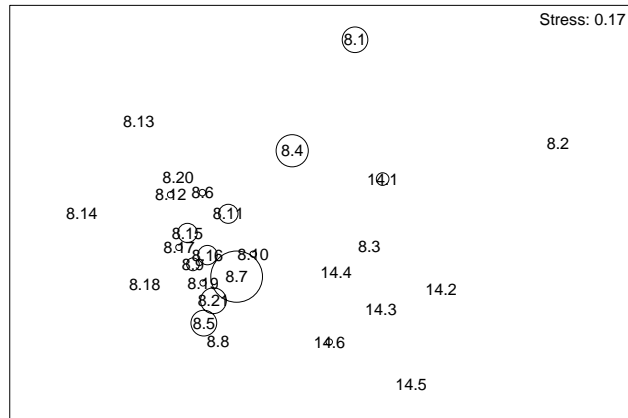
*XKScrR quadrats Flamborough Head (South Side)*



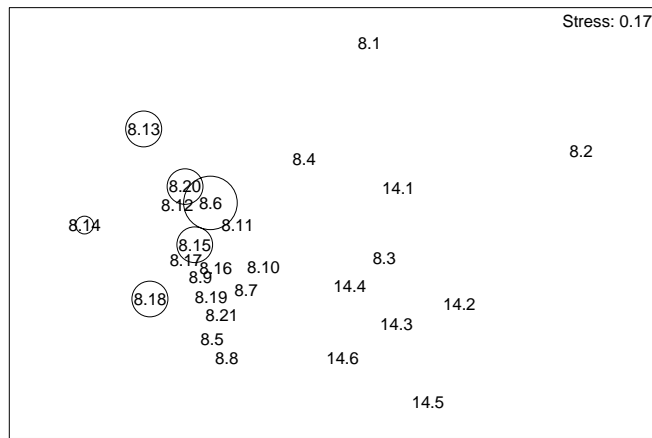
*XKScrR: Laminaria saccharina sporelings*



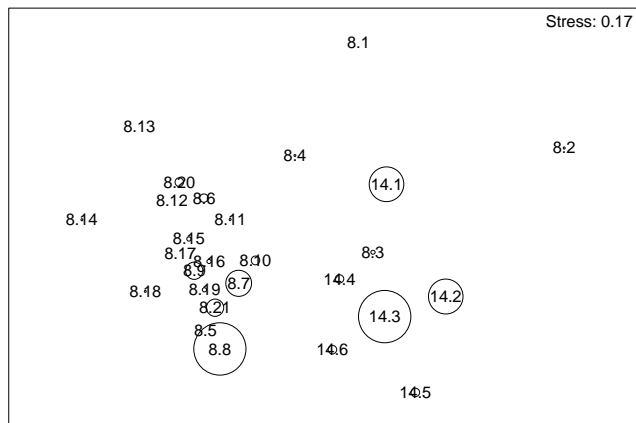
*XKScrR: Laminaria saccharina*



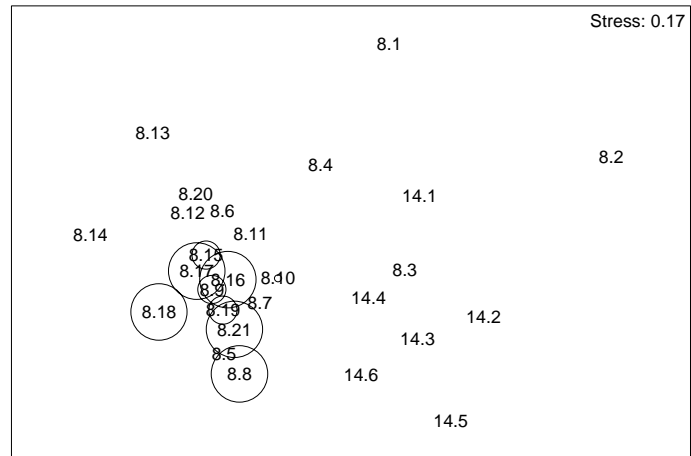
*XKScrR: Mature kelp plants*



*XKScrR: Taonia atomaria*



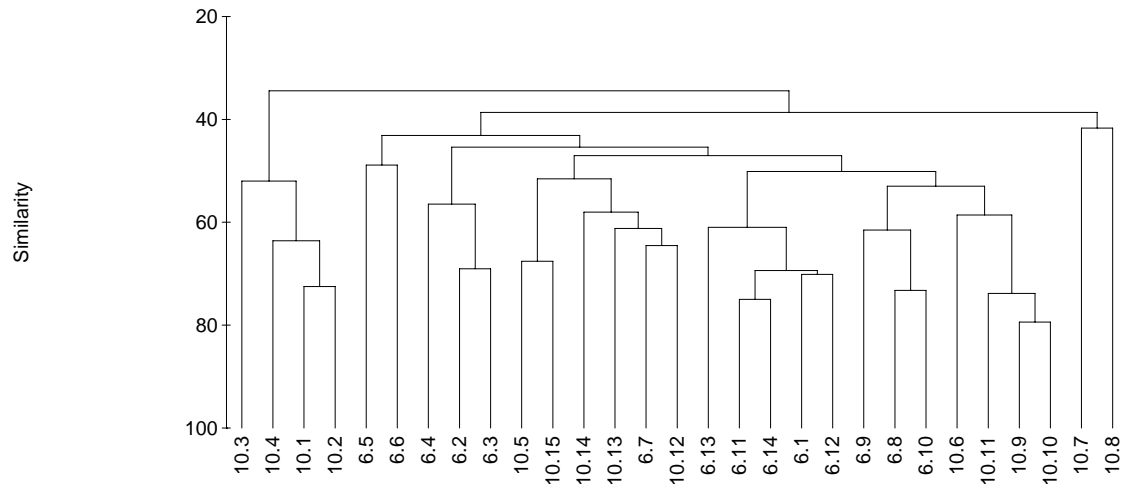
*XKScrR: enc. coralline algae*



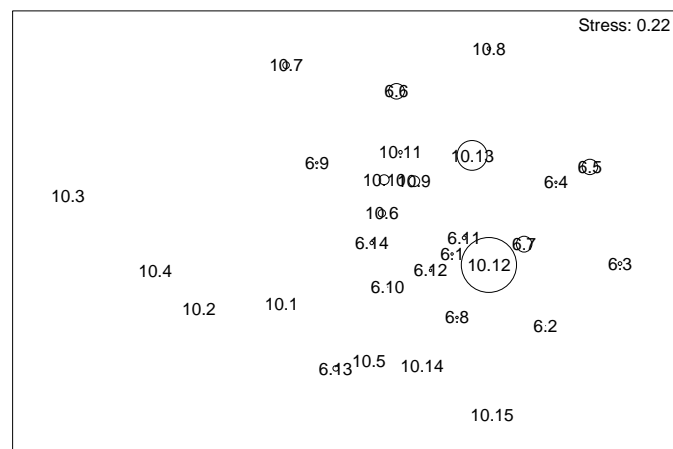
## Appendix 5.5 Vertical rock analyses – AlcByH.Hia

**Results of cluster analysis and MDS ordination of the vertical rock face data (Sites 10, 6). The MDS plots highlight the influence of selected species.**

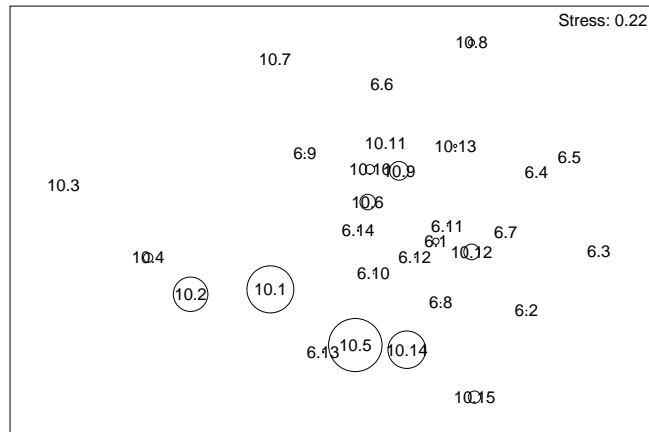
### *AlcByH.Hia*



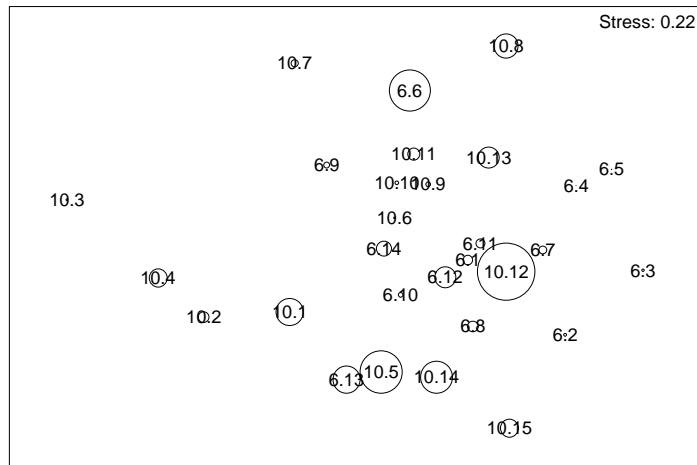
### *AlcByH.Hia: Hiatella arctica*



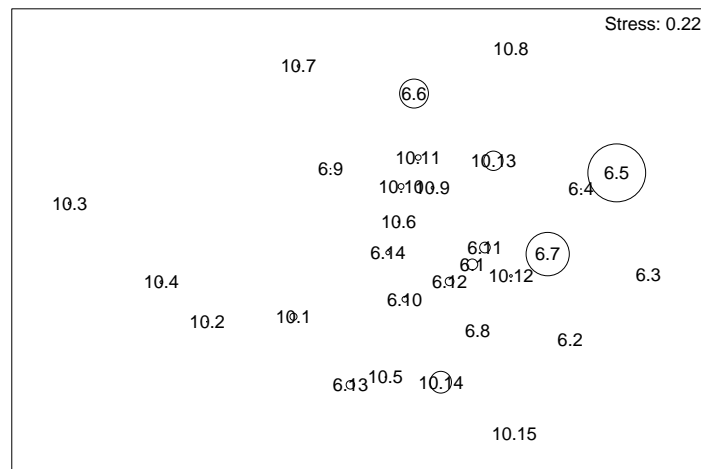
*AlcByH.Hia: Ophiactis ballii*



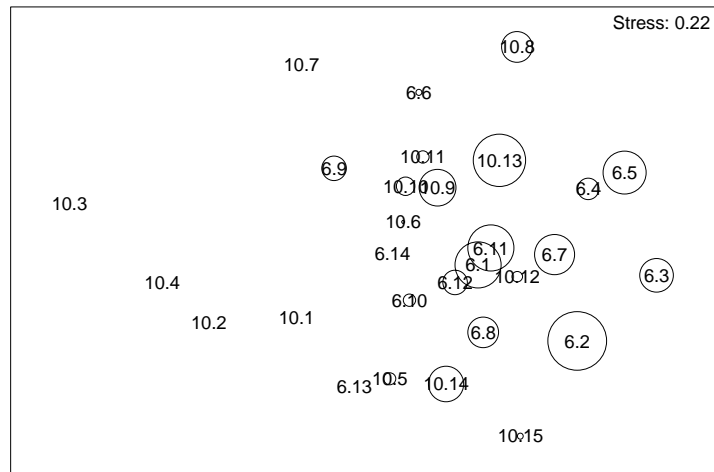
*AlcByH.Hia: Halichondria panicea*



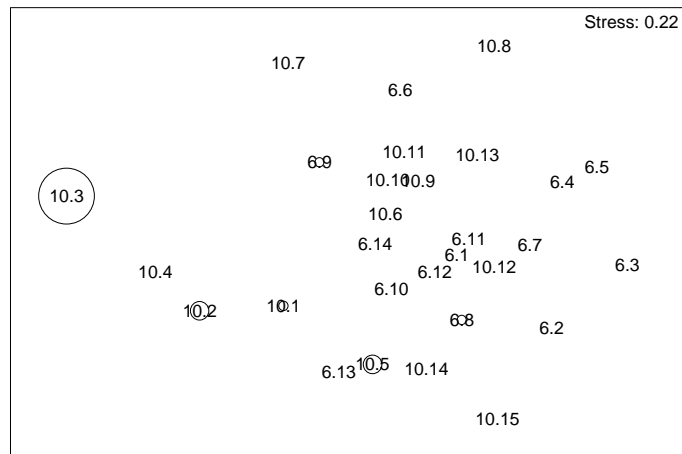
*AlcByH.Hia: Sabellaria spinulosa*



*AlcByH.Hia: Schottera niccaenisis*



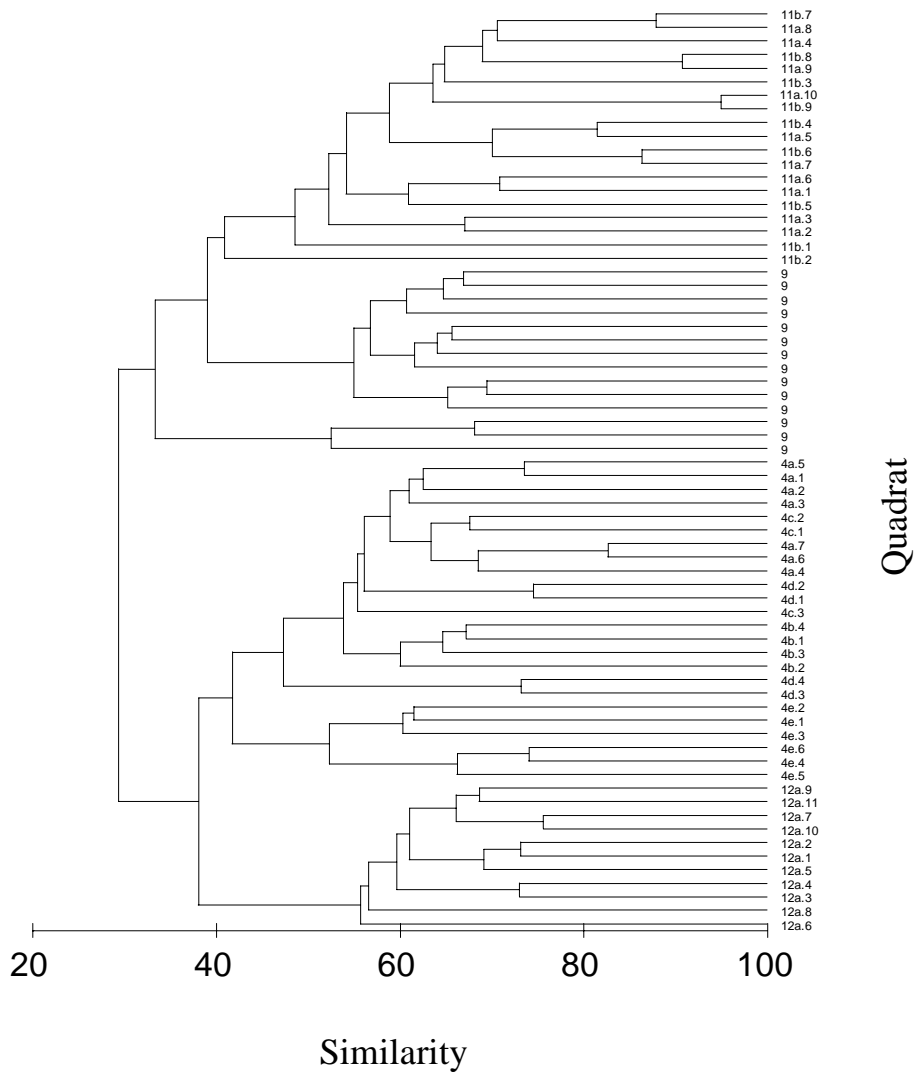
*AlcByH.Hia: Sagartia elegans*



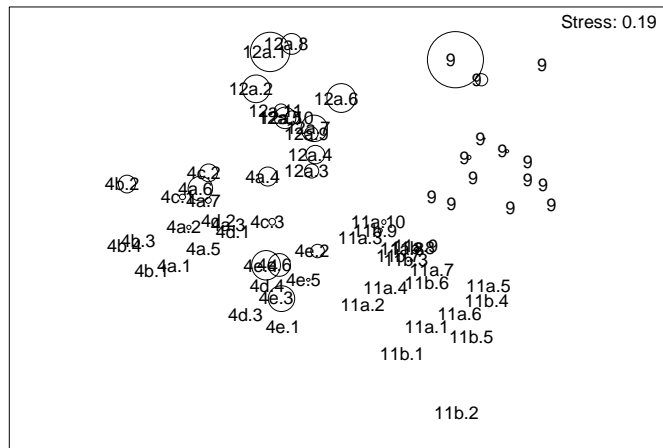
**Appendix 5.6 Circalittoral rock and cobble analyses – all data**

**Results of cluster analysis and MDS ordination of all the circalittoral data combined (Sites 4, 9, 11, 12). The MDS plots highlight the influence of selected species.**

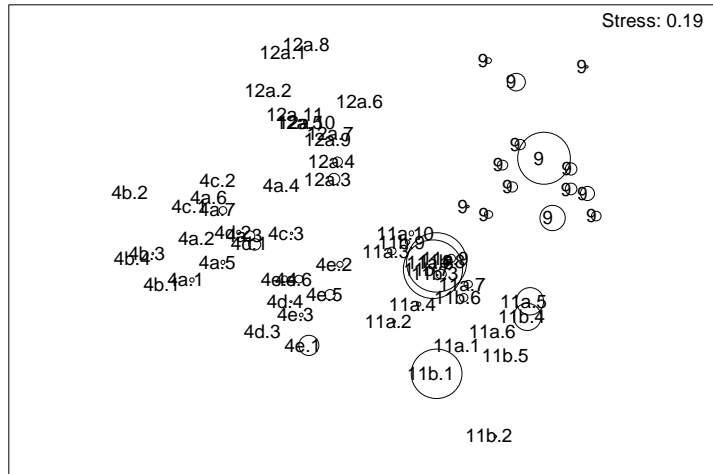
**All circalittoral quadrats**



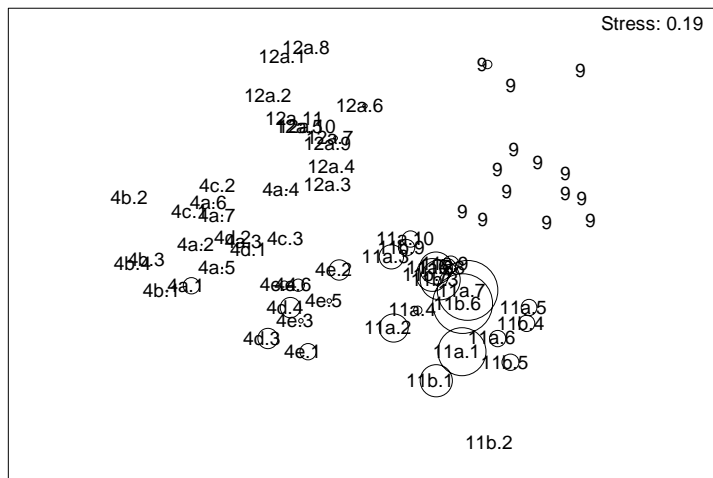
**All circalittoral: Flustra foliacea**



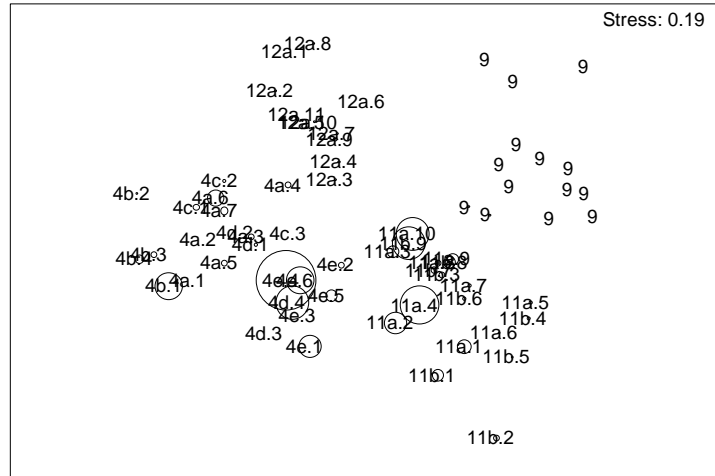
**All circalittoral: Alcyonidium diaphanum**



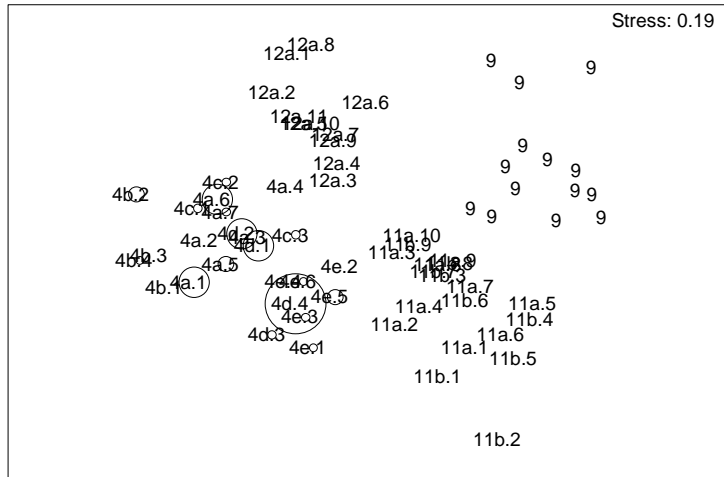
**All circalittoral: Archidistoma aggregatum**



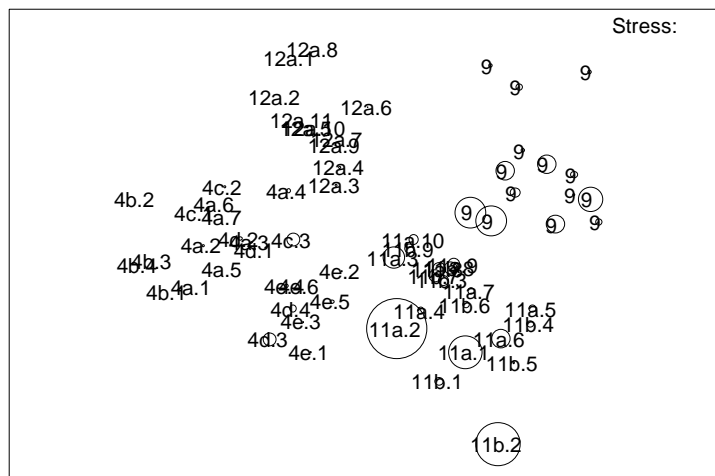
**All circalittoral: *Polyclinum aurantium***



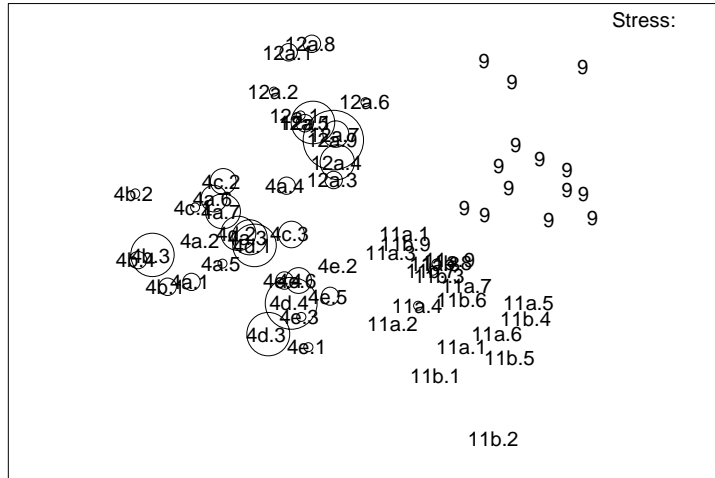
**All circalittoral: *Tubularia indivisa***



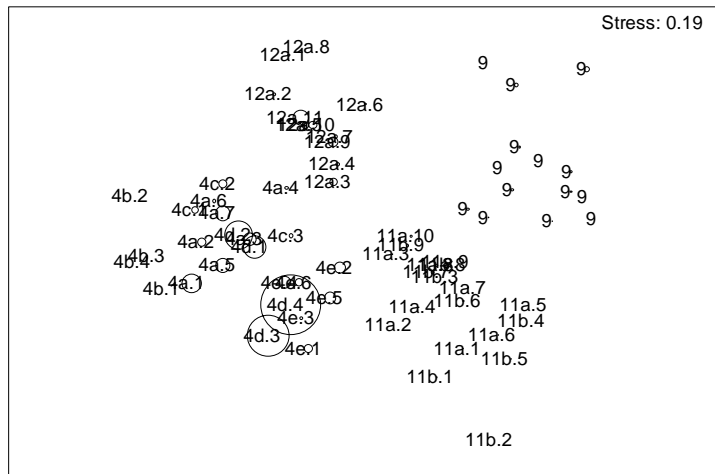
**All circalittoral: *Halecium halecinum***



### All circalittoral: *Asterias rubens*



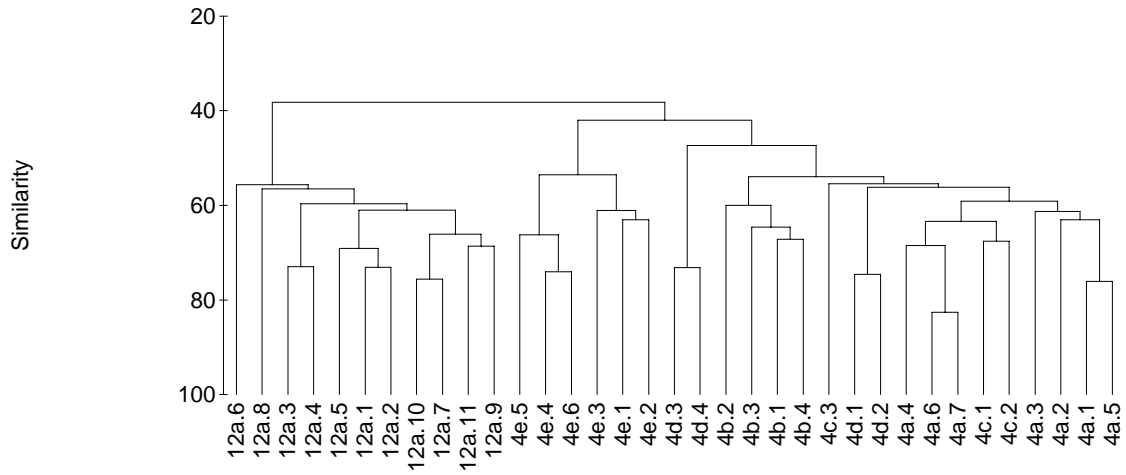
### All circalittoral: *Alcyonium*



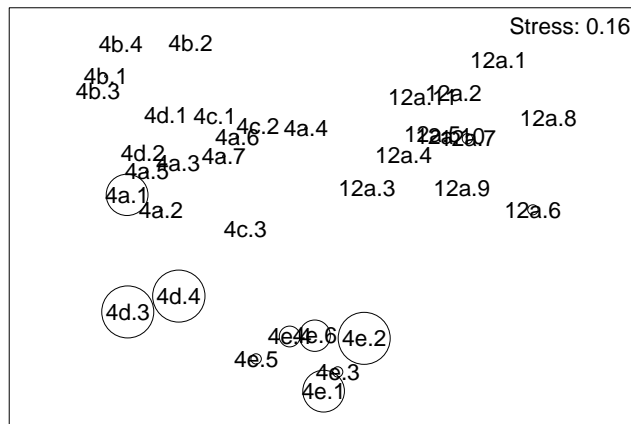
**Appendix 5.7 Circalittoral rock analyses – Flu.HByS**

**Results of cluster analysis and MDS ordination of all the north Flamborough circalittoral rock data combined (Sites 4, 12). The MDS plots highlight the influence of selected species.**

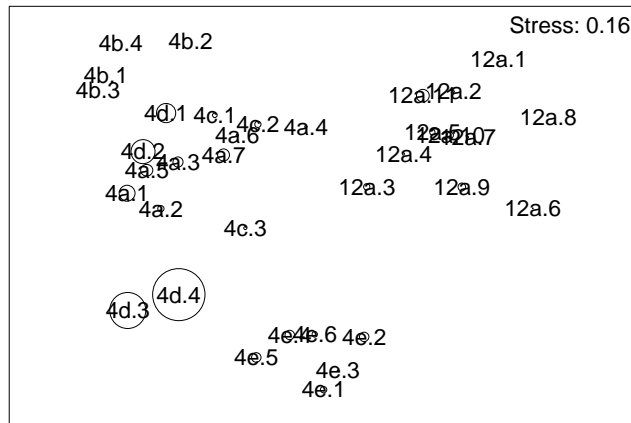
*Flu.HByS*



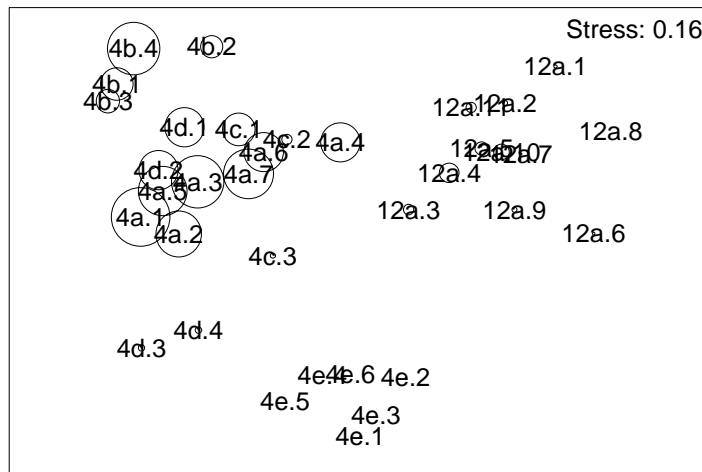
*Flu.HByS: Archidistoma aggregatum*



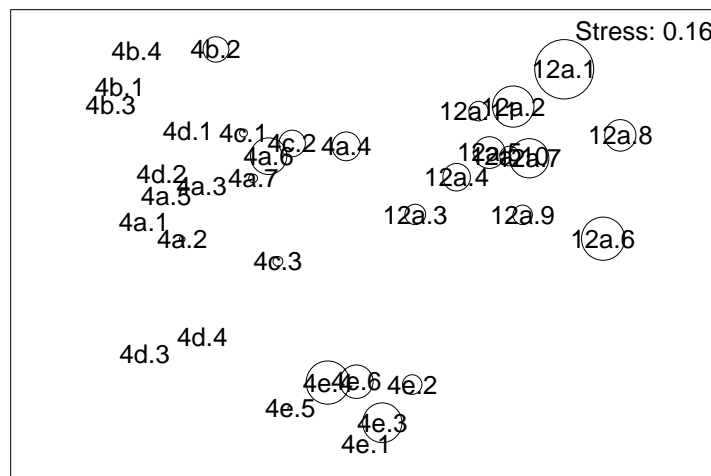
*Flu.HByS: Alcyonium digitatum*



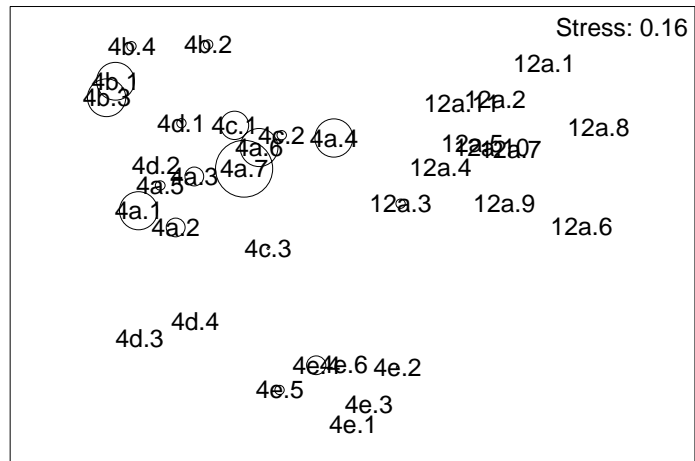
*Flu.HByS: Crisiid turf*



*Flu.HByS: Flustra foliacea*

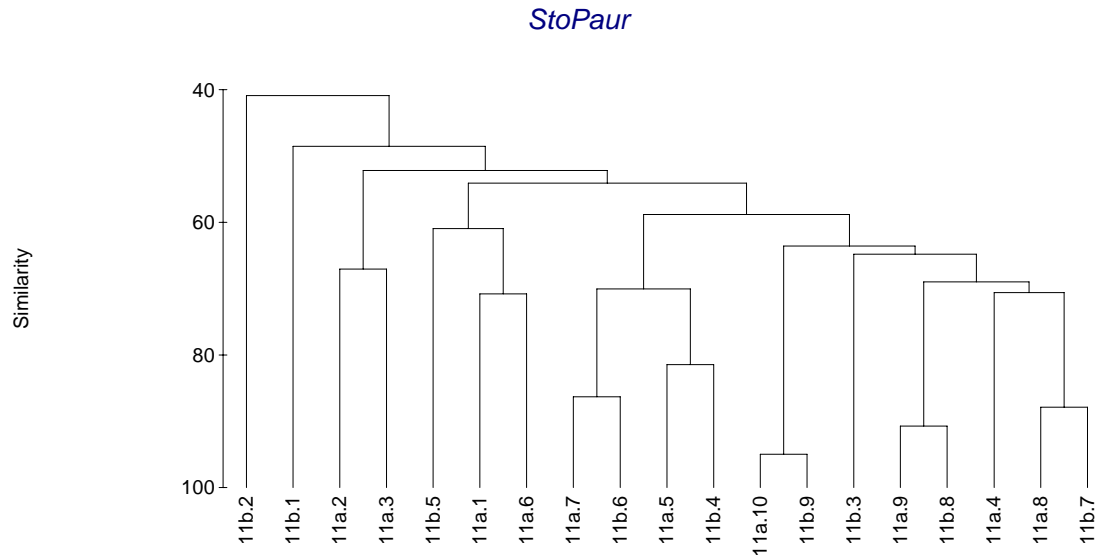


*Flu.HByS: Sertularia argentea*

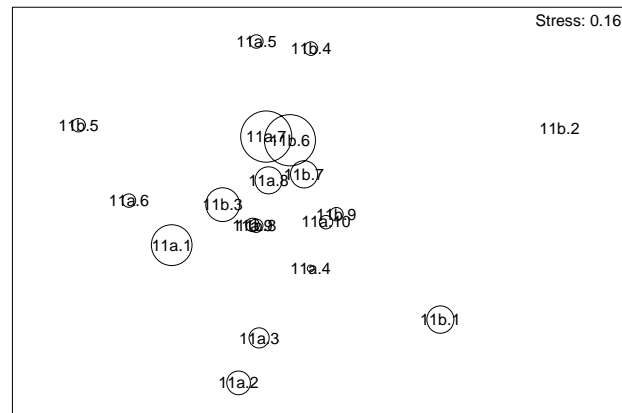


## Appendix 5.8 Circalittoral rock analyses – StoPaur

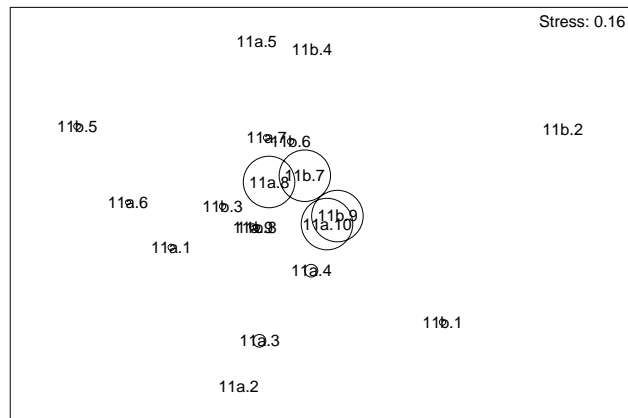
**Results of cluster analysis and MDS ordination of the south Flamborough circalittoral rock (StoPaur) data (Site 11). The MDS plots highlight the influence of selected species.**



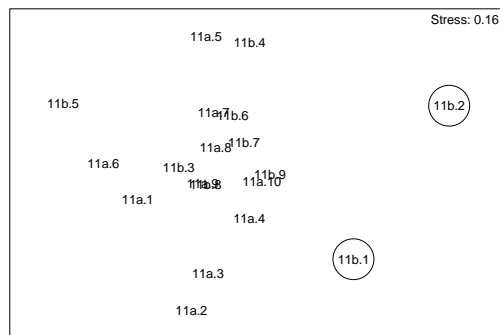
*StoPaur: Archidistoma aggregatum*



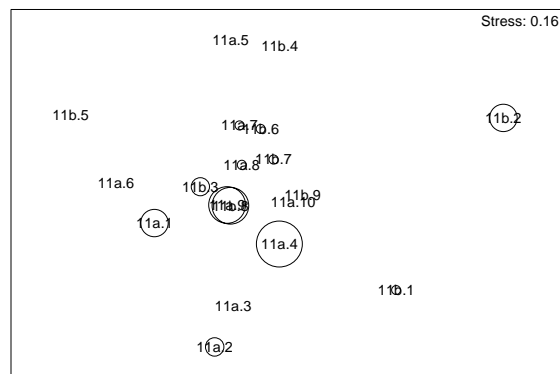
*StoPaur: Alcyonium digitatum*



*StoPaur: Sabellaria spinulosa*

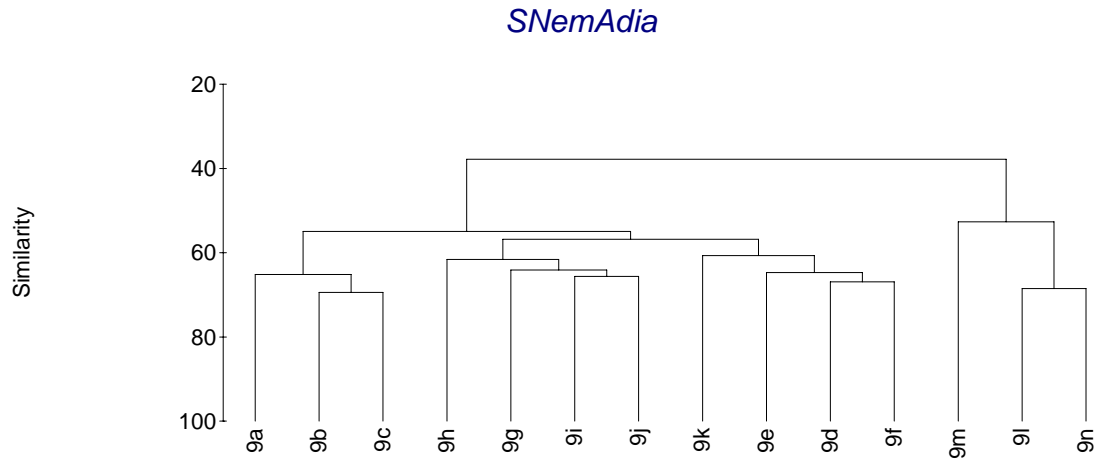


*StoPaur: Haliclona oculata*

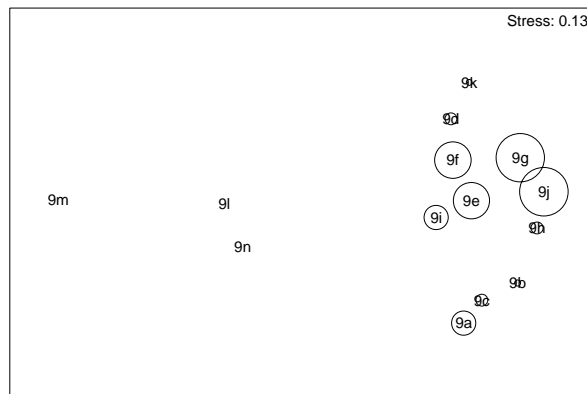


## Appendix 5.9 Circalittoral cobble analyses – SNemAdia

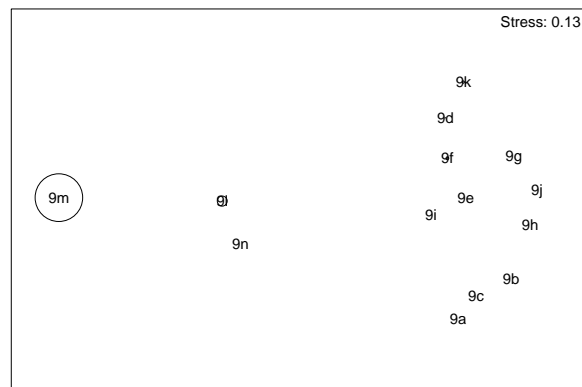
**Results of cluster analysis and MDS ordination of the south Flamborough circalittoral cobble (SNemAdia) data combined (Site 9). The MDS plots highlight the influence of selected species.**



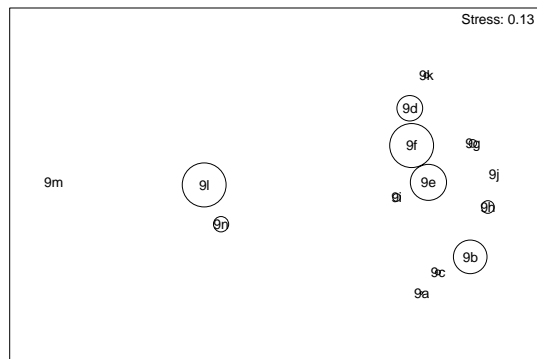
*SNemAdia: Crisiid turf*



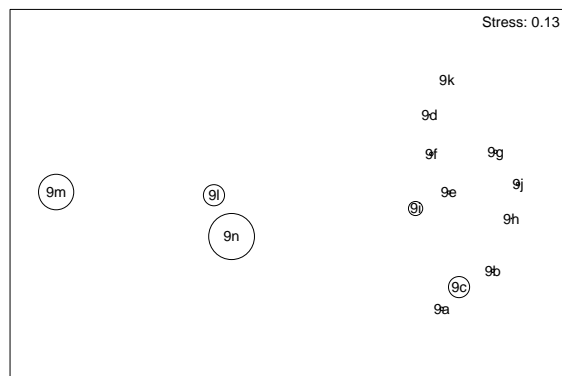
*SNemAdia: Flustra foliacea*



*SNemAdia: Lanice conchilega*



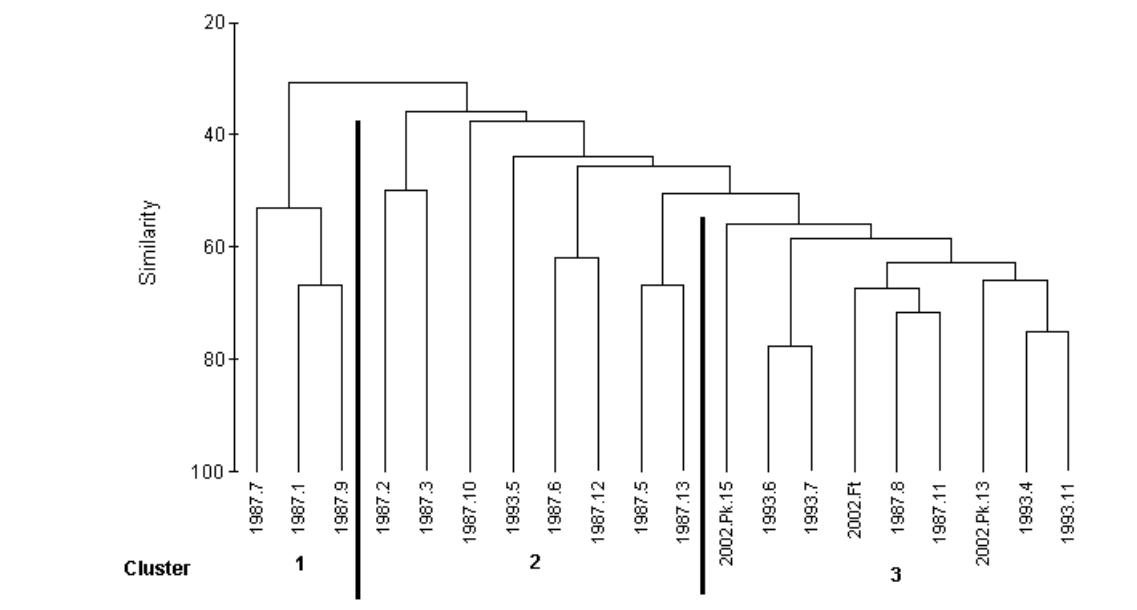
*SNemAdia: Nemertesia antennina*



### Appendix 5.10 Comparison of MNCR data and results from 2002 for Kelp forest and park – Lhyp.Ft, Lhyp.Pk

**Results of cluster analysis using presence/absence data. This analysis takes no account of the relative abundance of individual species.**

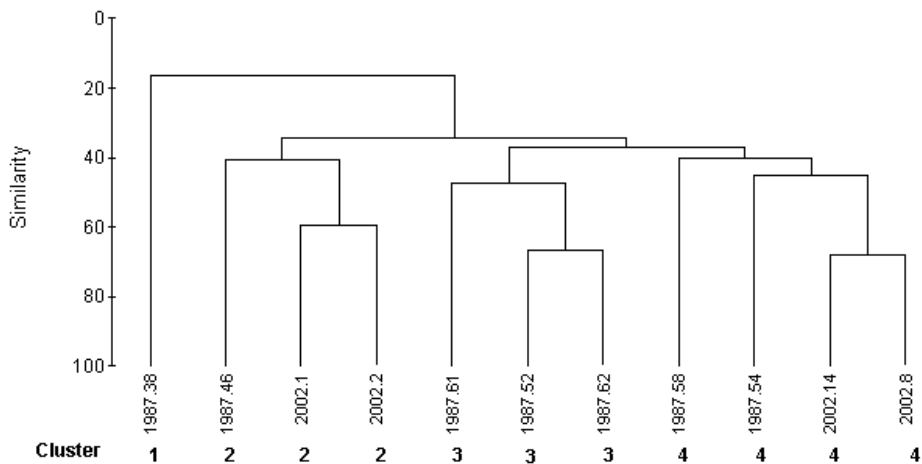
*Kelp forest and park: presence/absence data from MNCR (1987, 1993) & ASML (2002)*



### Appendix 5.11 Comparison of MNCR data and results from 2002 for scoured mixed kelp communities – XKScrR

**Results of cluster analysis using presence/absence data. This analysis takes no account of the relative abundance of individual species.**

*XKScrR: presence/absence data from MNCR (1987) & ASML (2002)*



## **Appendix 6**

### **Flamborough Head local biotope descriptions**

## ***Laminaria hyperborea* forest and foliose red seaweeds on silty, exposed chalk bedrock platforms**

### **National code:**

**MIR.Lhyp.Ft** *Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock

<b>Location</b>	Breil Nook, North coast of Flamborough Head	Site 3
<b>Wave exposure</b>	Exposed	
<b>Tidal streams</b>	Strong	
<b>Substratum</b>	Chalk bedrock	
<b>Zone</b>	Upper Infralittoral	
<b>Depth</b>	1.5 – 3 m bcd	

### **Biotope description**

Level chalk bedrock platforms extend out from the shore along the north coast of Flamborough Head; these are dissected by gullies which are 2 to 3 m deep, separating platforms of rock which support dense kelp forest and park. This habitat is subject to frequent heavy swells and the water is often very murky with suspended sediment reducing visibility to a few centimetres. As a result of the low light levels, the kelp forest is restricted to very shallow depths with no kelp recorded deeper than 4 m.

Dense *Laminaria hyperborea* dominates the level rock, with the kelp stipes covered with algal epiphytes. There are approximately 13 large kelp plants per square metre in the main kelp canopy with a dense layer of smaller plants and sporelings beneath. Much of the rock is covered by the encrusting worm *Sabellaria spinulosa* with abundant red algae and kelp sporelings growing over the worm tubes. *Plocamium cartilagineum* dominates the understory and stipe flora and is superabundant; other characteristic species include *Corallina officinalis*, *Cryptopleura ramosa*, *Callophyllis laciniata*, *Delesseria sanguinea* and *Hypoglossum hypoglossoides*. Silt-tolerant plants are frequent, although less common than in the kelp park, with *Rhodomela confervoides*, *Phyllophora pseudoceranooides*, *Phyllophora crispa* and scattered strands of the green *Chaetomorpha melagonium* recorded. The northern species *Odonthalia dentata* and *Ptilota plumosa* are both present although not common.

The diversity of both the flora and fauna of the kelp forest is relatively low. Conspicuous animals include the ascidians *Aplidium punctum* and *Dendrodoa grossularia*, the bryozoan *Bicellariella ciliata*, the sponges *Halichondria panicea* and *Dysidea fragilis* and the anemone *Urticina felina*.

## Lhyp.Ft

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Plocamium cartilagineum</i>	19
<i>Corallina officinalis</i>	12
<i>Laminaria hyperborea</i> (mature)	9
<i>Laminaria hyperborea</i> (medium)	8
<i>Laminaria hyperborea</i> (sporelings)	8
<i>Cryptopleura ramosa</i>	7
Red algal sporelings	6
<i>Phycodrys rubens</i>	6
<i>Callophyllis laciniata</i>	4
<i>Phyllophora crista</i>	3
<i>Hypoglossum hypoglossoides</i>	3

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

*Halichondria panicea*  
*Dysidea fragilis*  
*Urticina felina*  
*Sabellaria spinulosa*  
*Electra pilosa*  
*Bicellariella ciliata*  
*Aplidium punctum*  
*Dendrodoa grossularia*  
*Botryllus schlosseri*  
 Enc. Corallinaceae  
*Delesseria sanguinolenta*  
*Polysiphonia stricta*  
*Rhodomela confervoides*  
*Chaetomorpha melagonium*

### Characteristic features of the biotope

- Chalk platforms, dissected by gullies, with level surfaces heavily silted;
- Rock heavily bored and pitted;
- Dense *Laminaria hyperborea* with abundant stipe epiphytes
- *Sabellaria spinulosa* encrusting much of the rock beneath the algae;
- *Plocamium cartilagineum* superabundant, growing over *S. spinulosa*;
- Silt-tolerant algal community with *Corallina officinalis*, *Rhodomela confervoides* and *Phyllophora crista*;
- Presence of the green alga *Chaetomorpha melagonium* and the northern red algae *Odonthalia dentata* and *Ptilota gunneri*;
- Low diversity of algae and animals.

## ***Laminaria hyperborea* park and foliose red seaweeds on silty, exposed chalk bedrock platforms**

### **National code:**

**MIR.Lhyp.Pk** *Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower infralittoral rock

<b>Location</b>	Sanwick Brig, North coast of Flamborough Head	Site 13
	Staple Neuk, North coast of Flamborough Head	Site 15
<b>Wave exposure</b>	Exposed	
<b>Tidal streams</b>	Strong	
<b>Substratum</b>	Chalk bedrock	
<b>Zone</b>	Lower Infralittoral	
<b>Depth</b>	1.5 – 3.6 m bcd	

### **Biotope description**

Level chalk bedrock platforms extend out from the shore along the north coast of Flamborough Head; these are dissected by gullies which are 2 to 3 m deep, separating platforms of rock which support dense kelp forest and park, with plants in the park zone smaller than those in the forest and growing at about half the density (approximately 6 plants per square metre). This habitat is subject to frequent heavy swells and the water is often very murky with suspended sediment reducing visibility to a few centimetres. The rock surfaces are very silty and as a result of the low light levels, the kelp park is restricted to very shallow depths with no kelp recorded deeper than 4 m.

Sparse *Laminaria hyperborea* dominates the level rock, with the kelp stipes covered with algal epiphytes. There is no well-developed kelp sporeling layer beneath the main canopy, and, as in the kelp forest, much of the rock surface is covered by the encrusting worm *Sabellaria spinulosa*. *Plocamium cartilagineum* grows as a carpet over the worm crust mixed with *Delesseria sanguinea*, *Hypoglossum hypoglossoides*, *Rhodomela confervoides*, *Phyllophora pseudoceranooides*, *Phycodrys rubens* and *Phyllophora crispa* together with sparse *Bryopsis plumosa*. These silt-tolerant species are more abundant in the park than in the forest, where *Cryptopleura ramosa* and *Callophyllis laciniata* are more abundant. The northern species *Odonthalia dentata* and *Ptilota plumosa*, both of which are present in the forest, are absent from the park. Species found in this slightly deeper water, but absent from the shallower zone, include *Lomentaria orcadensis*, *Schottera nicaeensis*, *Rhodymenia delicatula* and the brown *Taonia atomaria*.

The diversity of both the flora and fauna of the kelp forest is relatively low. Patches of the sponge *Halichondria panicea* are frequent and there are scattered *Urticina felina* amongst the plants. Other conspicuous animals include the crabs *Necora puber* and *Cancer pagurus*, ascidians *Aplidium punctum* and *Dendrodoa grossularia* and the bryozoan *Bicellariella ciliata*.

## Lhyp.Pk

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Plocamium cartilagineum</i>	18
<i>Delesseria sanguinea</i>	14
<i>Hypoglossum hypoglossoides</i>	13
<i>Rhodomela confervoides</i>	12
<i>Phyllophora pseudoceranooides</i>	8
<i>Phycodrys rubens</i>	7
<i>Phyllophora crispa</i>	6
<i>Corallina officinalis</i>	4
<i>Laminaria hyperborea</i> (medium plants)	3
<i>Bryopsis plumosa</i>	2
Enc. Corallinaceae	2

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

*Halichondria panicea*  
*Urticina felina*  
*Sabellaria spinulosa*  
*Bicellariella ciliata*  
*Aplidium punctum*  
*Dendrodoa grossularia*  
*Botryllus schlosseri*  
*Schottera nicaeensis*  
*Lomentaria orcadensis*  
*Cryptopleura ramosa*  
*Polysiphonia stricta*  
*Laminaria hyperborea* (Mature plants)

### Characteristic features of the biotope

- Chalk platforms, dissected by gullies, with level surfaces heavily silted;
- Rock heavily bored and pitted;
- Sparse *Laminaria hyperborea* with abundant stipe epiphytes;
- Rock surfaces encrusted with *Sabellaria spinulosa* overgrown with algae;
- *Plocamium cartilagineum* and *Delesseria sanguinea* abundant, growing over *S. spinulosa*;
- Silt-tolerant algal community with *Rhodomela confervoides* and *Phyllophora* spp.;
- Presence of *Bryopsis plumosa*, *Lomentaria orcadensis*, *Rhodymenia delicatula*, *Schottera nicaeensis* and *Taonia atomaria*.
- Low diversity of algae and animals.

***Laminaria hyperborea* and *Laminaria saccharina* with scour-tolerant red and brown algae on scoured chalk boulders, cobbles and sand.**

**National code**

**MIR.XKScrR** Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock

**Location**

South and east of South Landing,  
south coast of Flamborough Head Sites 1, 2, 8, 16

**Wave exposure**

Exposed

**Tidal streams**

Strong

**Substratum**

Mixed boulder, cobble, pebble and coarse sand

**Zone**

Infralittoral

**Depth**

1 – 3 m bcd

**Biotope description**

There are extensive mixed chalk boulder, cobble, pebble and sand plains off the south coast of Flamborough Head. In the shallow inshore area in the vicinity of South Landing, the scoured conditions and unstable substrata allow the development of sparse kelps, foliose algae and a turf of encrusting animals on the larger boulders and cobbles. Many of the smaller cobbles and pebbles are bare although there may be seasonal growth of small algae and hydroids. The frequent heavy swells and resultant large quantities of suspended sediment often reduce underwater visibility to a few centimetres, restricting the plant growth to shallow water. No kelp was recorded deeper than 3 m.

The larger, more stable boulders support *Laminaria hyperborea* and *Laminaria saccharina* plants, with more *L. saccharina* on the smaller boulders and cobbles. Although many of the cobbles are scoured bare, there is a reasonably diverse flora of small foliose red and brown algae, characterised by scour-tolerant species. The major components of the flora are *Delesseria sanguinea*, *Plocamium cartilagineum*, *Hypoglossum hypoglossoides* and *Rhodomela confervoides* together with the larger, more leathery species *Calliblepharis ciliata*, *Dilsea carnosa* and *Phyllophora pseudoceranooides* and smaller plants of *Polysiphonia stricta* and *Cystoclonium purpureum*. The brown foliose alga *Taonia atomaria*, which has a southerly distribution in the British Isles, is common on the cobbles, growing as very small plants. Associated with these was a sparser subflora which included *Cordylecladia erecta*, *Heterosiphonia plumosa*, *Brongniartella byssoides*, *Polysiphonia fucoides*, *Cladostephus spongiosus* and *Ahnfeltia plicata*.

The animal community contained a few species of bryozoans and hydroids, in relatively small amounts, scour-tolerant animals on the cobbles such as *Balanus crenatus* and *Pomatoceros triqueter*, animals in the sediment, particularly *Lanice conchilega* and terebellid worms, the anemone *Urticina felina* and mobile species. The bryozoan/hydroid component consists of *Obelia dichotoma*, *Hydrallmania falcata*, *Alcyonidium diaphanum*, small amounts of *Flustra foliacea* and *Bicellariella ciliata*, all of which are more abundant in other sand-scoured biotopes in the area. There are several crabs present, with *Pagurus bernhardus*, *Hyas araneus*, *Necora puber* and *Carcinus maenas* all present with molluscs such as *Gibbula cineraria* and *Rissoa parva* amongst the algae.

## XKScrR

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Delesseria sanguinea</i>	56
<i>Hypoglossum hypoglossoides</i>	13
<i>Plocamium cartilagineum</i>	8
<i>Rhodomela confervoides</i>	4
<i>Laminaria saccharina</i> (mature plants)	4
<i>Taonia atomaria</i>	3
<i>Calliblepharis ciliata</i>	2
<i>Laminaria saccharina</i> (sporelings)	2

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

<i>Halichondria panicea</i>	Enc. Corallinaceae
<i>Hydrallmania falcata</i>	<i>Cystoclonium purpureum</i>
<i>Obelia dichotoma</i>	<i>Dilsea carnososa</i>
<i>Urticina felina</i>	<i>Phyllophora pseudoceranooides</i>
<i>Lanice conchilega</i>	<i>Cordylecladia erecta</i>
<i>Pomatoceros</i> sp.	<i>Polysiphonia stricta</i>
<i>Balanus crenatus</i>	Red algal sporelings indet.
<i>Necora puber</i>	<i>Laminaria hyperborea</i> (mature plants)
<i>Carcinus maenas</i>	
<i>Alcyonidium diaphanum</i>	
<i>Botryllus schlosseri</i>	

### Characteristic features of the biotope

- Mixed chalk boulders, cobbles, pebbles and sand;
- Rocks heavily bored;
- Many clean, scoured cobbles;
- *Laminaria hyperborea* and some mature *Laminaria saccharina* on stable boulders;
- *Laminaria saccharina* sporelings on cobbles;
- Scour-tolerant algal community with *Delesseria sanguinea*, *Rhodomela confervoides*, *Calliblepharis ciliata*, *Dilsea carnososa* and *Phyllophora pseudoceranooides*;
- Small plants of *Taonia atomaria*, a brown alga with a southern distribution, common on the cobbles;
- Animal community sparse and characterised by scour-tolerant opportunists such as *Alcyonidium diaphanum* and *Obelia dichotoma*.

## ***Hiatella arctica* and *Ophiactis ballii* amongst bryozoan, hydroid and ascidian turf on vertical chalk gully walls**

**National code:**

**IR.AlcByH.Hia**      *Hiatella arctica*, bryozoans and ascidians on vertical infralittoral soft rock

<b>Location</b>	Staple Neuk, North coast of Flamborough Head	Site 10
	Sanwick Brig, North coast of Flamborough Head	Sites 6, 13
<b>Wave exposure</b>	Exposed	
<b>Tidal streams</b>	Strong	
<b>Substratum</b>	Chalk bedrock	
<b>Zone</b>	Infralittoral	
<b>Depth</b>	0.9 – 4 m bcd	

### **Biotope description**

This biotope occurs on the walls of gullies and pillars cut into the chalk bedrock platforms that extend out from the shore along the north coast of Flamborough Head. These gullies are 2 to 3 m deep, separating platforms of rock which support kelp forest and park. The surfaces of the walls are pitted and irregular, and most are undercut at the base, presumably by the scouring of the boulders and cobbles that lie on the gully floors.

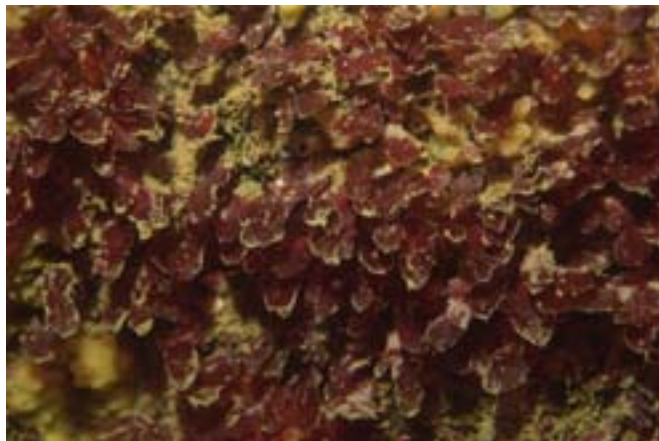
These gullies are subject to heavy swell and the flora and fauna reflect this, with a dense covering of species which thrive in such conditions. The sponges *Halichondria panicea*, *Clathrina coriacea* and *Leucosolenia complicata* are common and there is a short, patchy turf of bryozoans and small hydroids. The bryozoan turf consisted mostly of *Scrupocellaria* sp. and *Bicellariella ciliata* mixed with *Bugula flabellata*, *Bugula plumosa* and *Amathia lendigera*; hydroids present included *Abietinaria filicula*, *Diphasia rosacea* and *Sertularella tenella*. The soft rock of the vertical walls is highly pitted and bored by the bivalve *Hiatella arctica*, which is abundant. Other animals also use these holes, particularly the small brittle star *Ophiactis ballii* and ascidians such as *Ciona intestinalis* and *Dendrodoa grossularia*, with *Polyclinum aurantium* and *Aplidium punctum* colonies on the open rock. The encrusting worm *Sabellaria spinulosa* is common on the rock beneath many of the other species.

There are some red algae present on these walls, with the abundance dependent on the angle of the rock face. *Schottera nicaeensis* is particularly common, growing in sheets on the edges of overhangs. Other scour-tolerant species found include *Phyllophora crispa*, *Phyllophora pseudoceranooides* and *Corallina officinalis*. The green alga *Bryopsis plumosa* is found occasionally.

**IR.AlcByH.Hia:** *Halichondria panicea* and *Clathrina coriacea* on a chalk gully wall



**IR.AlcByH.Hia:** *Schottera nicaeensis* on a chalk gully wall



**IR.AlcByH.Hia:** *Hiatella arctica* siphons and *Ophiactis ballii* amongst *Halichondria* on a chalk gully wall



## AlcByH.Hia

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Halichondria panicea</i>	27
<i>Schottera nicaeensis</i>	25
<i>Hiatella arctica</i>	21
<i>Sabellaria spinulosa</i>	10
Crisiid turf	4
<i>Plocamium cartilagineum</i>	3

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

*Clathrina coriacea*  
*Abietinaria filicula*  
*Alcyonium digitatum*  
*Cancer pagurus*  
*Necora puber*  
*Bugula flabellata*  
*Bugula plumosa*  
*Bicellariella ciliata*  
*Scrupocellaria* sp  
*Ophiactis ballii*  
*Polyclinum aurantium*  
*Aplidium punctum*

### Characteristic features of the biotope

- Vertical chalk bedrock, often undercut at the base;
- Rock heavily bored and pitted;
- *Hiatella arctica* and *Ophiactis ballii* both abundant in the pits in the rock;
- Surge-tolerant community with *Halichondria panicea*, *Clathrina coriacea* and bryozoan turf abundant;
- Presence of shade-tolerant algae such as *Schottera nicaeensis*

**Hydroid and bryozoan turf dominated by *Alcyonidium diaphanum*, *Halecium halecinum* and crisiid bryozoans on sand-scoured chalk boulders, cobbles and sand.**

**National code:**

**MCR.SNemAdia** Sparse sponges, *Nemertesia* spp., *Alcyonidium diaphanum* and *Bowerbankia* spp. on circalittoral mixed substrata

<b>Location</b>	Offshore cobbles, S of South Landing South-east of Smithic Sand	Site 9 and video drops Video drops
<b>Wave exposure</b>	Exposed	
<b>Tidal streams</b>	Strong	
<b>Substratum</b>	Mixed boulders, cobbles, pebbles and sand	
<b>Zone</b>	Circalittoral	
<b>Depth</b>	8 – 22 m bcd	

**Biotope description**

This biotope occurs on the tide-swept mixed cobbles, boulders and sand that lie off the south coast of Flamborough Head, offshore from South Landing and to the south-east of Smithic Sand, between approximately 8 and 22 m below chart datum. In many places there are rocks beneath a thin covering of sand and many of the mobile cobbles are bare. The unstable substratum is clearly subject to considerable scour and this is reflected in the community composition.

The major community components are similar to those of the more stable bedrock and boulder biotopes (Flu.HByS and StoPaur), with a turf of bryozoans and hydroids covering many of the rocks and *Alcyonium digitatum*, *Flustra foliacea* and *Nemertesia antennina* conspicuous on the larger, more stable boulders. However, there are clear differences in the dominant species and in the relative abundances of species. The fleshy bryozoan *Alcyonidium diaphanum* is one of the most characteristic species and abundant in this biotope, often growing attached to cobbles and boulders covered by sand. It is notable that the ascidians which are abundant and characteristic in the other circalittoral biotopes are scarce in this one, with only *Clavelina lepadiformis* present in any abundance. *Halecium halecinum* and *Obelia dichotoma* are the most abundant of the larger hydroids in the turf with smaller quantities of *Hydrallmania falcata* and *Rhizocaulus verticillatus*.

The composition of the crisiid turf is similar to many of the other circalittoral sites with the small bryozoans *Crisia eburnea*, *Crisia aculeata*, *Crisidia cornuta* and *Bicellariella ciliata* dominant. The *Bugula* species *B. flabellata* and *B. plumosa* are conspicuous and tangled amongst the crisiids are the less conspicuous bryozoans *Amathia lendigera*, *Bowerbankia gracilis* and *Bowerbankia pustulosa*. There is a considerable diversity of small hydroids with *Tridentata distans*, *Diphasia attenuata* and *Diphasia alata* amongst small colonies of *Halecium beanii* and *Halecium muricatum*. The polychaete *Lanice conchilega* was common in the sand between the cobbles and *Pomatoceros* sp. encrusted many of the mobile cobbles and pebbles.

A number of larger mobile species are conspicuous although rare, notably the starfish *Henricia sanguinolenta* and *Crossaster papposus*, the crabs *Necora puber* and *Cancer pagurus* and the butterfish *Pholis gunnellus*.

## SNemAdia

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Halecium halecinum</i>	26
<i>Alcyonidium diaphanum</i>	22
<i>Lanice conchilega</i>	17
<i>Nemertesia antennina</i>	6
<i>Crisiid turf</i>	5
<i>Bicellariella ciliata</i>	3
<i>Bugula plumosa</i>	3
<i>Obelia dichotoma</i>	2
<i>Alcyonium digitatum</i>	2
<i>Hydrallmania falcata</i>	2
<i>Clavelina lepadiformis</i>	2

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

*Rhizocaulus verticillatus*  
*Pomatoceros triqueter*  
*Crisia eburnea*  
*Flustra foliacea*  
*Amathia lendigera*  
*Bowerbankia pustulosa*  
*Crisidia cornuta*  
*Scruparia chelata*

### Characteristic features of the biotope

- Mixed, unstable substrata with boulders, cobbles, pebbles and sand;
- Evidence of scour, with many bare cobbles;
- Dominance of hydroids, particularly *Nemertesia antennina* and *Halecium halecinum*, with *Flustra foliacea* and *Alcyonium digitatum* on the larger, more stable boulders;
- Abundance of *Alcyonidium diaphanum*;
- Presence of *Lanice conchilega* in the sand;
- Absence of ascidians such as *Polyclinum aurantium* and *Archidistoma aggregatum* which are common in other cirralittoral biotopes in the area;
- Well-developed but patchy bryozoan turf.

## ***Flustra foliacea* and *Alcyonium digitatum* with bryozoan, ascidian and hydroid turf on tide-swept chalk bedrock**

### **National code**

**MCR.Flu.HByS** *Flustra foliacea* with hydroids, bryozoans and sponges on slightly tide-swept circalittoral mixed substrata

**Location** Breil Nook Site 4  
Sanwick Brig Site 12

**Wave exposure** Exposed

**Tidal streams** Strong

**Substratum** Bedrock platform dissected by cracks and gullies; some boulders

**Zone** Circalittoral

**Depth** 8 – 20 m bcd

### **Biotope description**

This biotope occurs on the tide-swept circalittoral rock platforms of the north coast of Flamborough Head between approximately 8 and 20 m below chart datum. The rock platform is broken by cracks and gullies which are up to approximately 1 m deep, with small vertical faces on the sides of these, and there are scattered boulders and cobbles lying on the rock surface, particularly in the gullies. The seabed is heavily silted.

The rock is covered with a turf of bryozoans, hydroids and ascidians, with *Flustra foliacea* abundant and *Alcyonium digitatum* frequent. Whilst the rock is entirely covered with animals, the species composition is patchy within a relatively small area, such as that covered by a diver. *F. foliacea* dominates most of the rock but *A. digitatum* is dominant in places, particularly at Sanwick Brig, whilst there are also patches with the turf species and larger hydroids dominating and neither *Flustra* nor *Alcyonium* present. Other conspicuous species which protrude above the main turf layer include hydroids such as *Nemertesia antennina*, *Halecium halecinum*, *Abietinaria abietina*, *Sertularia argentea* and occasionally *Thuiaria thuja*, the fleshy bryozoan *Alcyonidium diaphanum* and the bushy *Eucratea loricata*. There are sponges present, particularly *Polymastia mamillaris* and *Haliclona oculata* and occasional large *Urticina felina* and *Urticina eques*.

A tangled turf about 2 cm high of small hydroids, bryozoans and ascidians covers all the rock surface between the *Flustra* and *Alcyonium* colonies. This is dominated by the small bryozoans *Crisia eburnea*, *Crisia aculeata*, *Crisidia cornuta* and *Bicellariella ciliata* mixed with very small colonies of the hydroids *Halecium muricatum*, *Halecium halecinum*, *Halecium beanii*, *Diphasia rosacea* and *Eudendrium album*. A number of encrusting ascidians are also abundant in the turf, particularly *Polyclinum aurantium*, *Archidistoma aggregatum*, *Sidnyum turbinatum* and *Aplidium punctum*. There are sparse, small red algae at this depth with *Phyllophora crispa*, *Plocamium cartilagineum*, *Rhodymenia ardissoni*, *Delesseria sanguinea* and *Hypoglossum hypoglossoides* all present in small amounts.

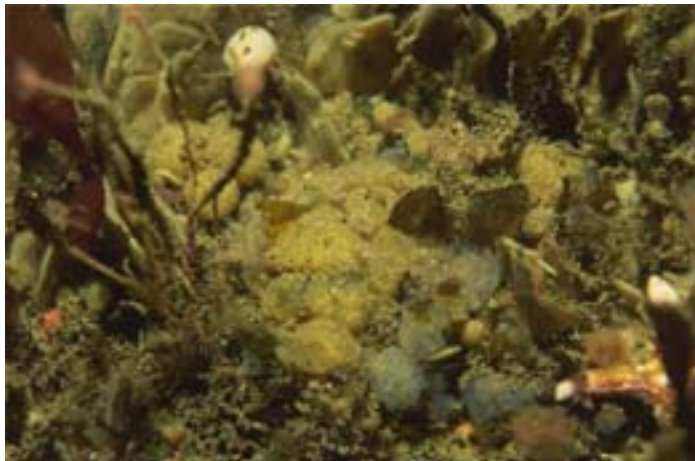
This turf is very diverse with a lot of smaller species tangled within it and around the holdfasts of the larger hydroids. The bryozoan *Amathia lendigera* is very common but inconspicuous and *Bugula* spp. and *Scrupocellaria scruposa* are frequent. Inconspicuous hydroids include *Tridentata distans*, *Diphasia attenuata*, *Clytia hemisphaerica* and *Garveia nutans* and the small sponges *Scypha ciliata* and *Clathrina lacunosa* are both present. Pycnogonids are one of the more numerous mobile groups in the turf with *Achelia echinata* and *Nymphon brevirostre* both present. The encrusting worm *Sabellaria spinulosa* was found together with several scale worms and amphipods.

A number of larger mobile species are conspicuous, notably the starfish *Henricia sanguinolenta*, *Asterias rubens* and *Crossaster papposus* and the crabs *Necora puber* and *Cancer pagurus* and butterfish are frequent.

**Flu.HByS:** *Abietinaria abietina* surrounded by *Flustra foliacea* and mixed turf



**Flu.HByS:** *Polyclinum aurantium* amongst other ascidians and bryozoan/hydroid turf



**Flu.HByS:** *Crossaster papposus* amongst *Flustra* and bryozoan/hydroid turf



## Flu.HByS

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
Crisiid turf	36
<i>Flustra foliacea</i>	31
<i>Alcyonium digitatum</i>	13
<i>Asterias rubens</i>	5
<i>Alcyonidium diaphanum</i>	2
<i>Bicellariella ciliata</i>	1
<i>Henricia sanguinolenta</i>	1

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

<i>Scypha ciliata</i>	<i>Echinus esculentus</i>
<i>Cliona celata</i>	<i>Clavelina lepadiformis</i>
<i>Tubularia indivisa</i>	<i>Polyclinum aurantium</i>
<i>Halecium halecinum</i>	<i>Archidistoma aggregatum</i>
<i>Sertularia argentea</i>	<i>Morchellium argus</i>
<i>Urticina felina</i>	<i>Sidnyum turbinatum</i>
<i>Pomatoceros lamarcki</i>	<i>Aplidium punctum</i>
<i>Cancer pagurus</i>	<i>Pholis gunnellus</i>
<i>Necora puber</i>	<i>Plocamium cartilagineum</i>
<i>Rissoa parva</i>	<i>Delesseria sanguinea</i>
Piddocks	
<i>Crisidia cornuta</i>	
<i>Crisia eburnea</i>	
<i>Crossaster papposus</i>	

### Characteristic features of the biotope:

- Stable, tide-swept bedrock platforms with small gullies;
- Dominance of *Flustra foliacea* with *Alcyonium* and hydroids, particularly *Sertularia argentea*, *Halecium halecinum* and *Abietinaria abietina* rather than *Nemertesia antennina*;
- Abundance of ascidians *Polyclinum aurantium* and *Archidistoma aggregatum*;
- High diversity of ascidians;
- Well-developed bryozoan and hydroid turf.

**Turf of hydroids, bryozoans and ascidians with *Polyclinum aurantium*, *Archidistoma aggregatum* and *Halecium halecinum*, and mats of *Polydora ciliata* tubes.**

**National code:**

**MCR.StoPaur** *Stolonica socialis* and/or *Polyclinum aurantium* with *Flustra foliacea* on slightly sand-scoured tide-swept moderately exposed circalittoral rock

<b>Location</b>	East of South Landing, South side of Flamborough Head	Site 5
	Old Fall, South side of Flamborough Head	Site 11
<b>Wave exposure</b>	Exposed	
<b>Tidal streams</b>	Strong	
<b>Substratum</b>	Broken bedrock with boulders, cobbles, pebbles, gravel and sand	
<b>Zone</b>	Circalittoral	
<b>Depth</b>	5 – 11.5 m bcd	

**Biotope description**

This biotope occurs on the inshore tide-swept broken rock of the south coast of Flamborough Head between approximately 5 and 11.5 m below chart datum. Broken and stepped plains of horizontal bedrock are mixed with extensive patches of mobile substrata, consisting of boulders, cobbles, pebbles, gravel and sand. The smoother areas of rock appear scoured but much of the seabed is heavily silted.

The rock and boulders are covered with a turf of bryozoans, hydroids and ascidians, with the boulder tops and the proud edges of the rock supporting *Alcyonium digitatum*, *Nemertesia antennina* and occasional patches of *Flustra foliacea*. The ascidians *Polyclinum aurantium* and *Archidistoma aggregatum* form a patchy crust over much of the rock amongst a mixed turf of hydroids and bryozoans, with the most abundant hydroid being *Halecium halecinum* which grows above the main turf layer. The other major conspicuous species are the bryozoans *Alcyonidium diaphanum* and *Bicellariella ciliata*, the ascidian *Clavelina lepadiformis*, the hydroid *Sertularia argentea* and small colonies of the sponges *Cliona celata* and *Haliclona oculata*. Sediment whips of the amphipod *Dyopedos porrectus* are frequent. Another important feature of this biotope is extensive mats of small muddy tubes belonging to the spionid worm *Polydora ciliata*. These cover rock between and extend into patches of the turf.

As with the Flu.HByS biotope, this turf is very diverse with a lot of smaller species tangled within it and around the holdfasts of the larger hydroids. In addition to the muddy spionid tubes, there are tubes built of coarse sand belonging to an unidentified phoronid. *Crisidia cornuta*, *Crisia eburnea*, *Bugula flabellata*, *Bugula turbinata* and *Scrupocellaria scruposa* are the major turf bryozoa. The bryozoan *Amathia lendigera* is very common but inconspicuous and, with *Bowerbankia gracilis*, is tangled around the roots of the *Nemertesia* colonies. Inconspicuous hydroids include *Sertularella tenella*, *Eudendrium album* and *Lafoea dumosa*. The prawn *Pandalus montagui* and pycnogonids are the more numerous mobile groups in the turf with *Nymphon gracile*, *Nymphon brevirostre* and *Anoplodactylus petiolatus* present. The small bivalve *Musculus discors* is common and there are numerous juvenile gastropods, cockles and other bivalves. The encrusting worm *Sabellaria spinulosa* was found together with several scale worms and amphipods.

A number of larger mobile species are conspicuous, notably the starfish *Asterias rubens* and *Crossaster papposus* and the crabs *Necora puber* and *Cancer pagurus*. Plaice *Pleuronectes platessa* were the only fish recorded.

**StoPaur:** *Nemertesia antennina*, *Halecium halecinum* and *Flustra foliacea*



**StoPaur:** *Archidistoma aggregatum* in bryozoan/hydroid turf



**StoPaur:** *Halecium halecinum* turf



## StoPaur

### Conspicuous characterising species

a) Species/groups recorded from quadrats with greatest contribution to similarity in *PRIMER* analyses

Species	% Contribution to similarity
<i>Halecium halecinum</i>	28
<i>Archidistoma aggregatum</i>	23
<i>Alcyonidium diaphanum</i>	14
<i>Polyclinum aurantium</i>	6
<i>Cliona celata</i>	6
<i>Nemertesia antennina</i>	4
<i>Clavelina lepadiformis</i>	4
<i>Haliclona oculata</i>	3
<i>Polydora ciliata</i>	2

b) Species additional to above recorded as *Frequent* or above in Phase 2 data

*Sertularia argentea*  
*Urticina felina*  
*Cancer pagurus*  
*Bicellariella ciliata*  
*Bugula plumosa*  
*Asterias rubens*  
*Alcyonium digitatum*  
*Necora puber*  
*Flustra foliacea*  
*Amathia lendigera*  
*Phoronis* sp.

### Characteristic features of the biotope

- Mixture of stable bedrock and unstable substrata;
- Evidence of scour;
- Dominance of *Alcyonium digitatum* and hydroids, particularly *Nemertesia antennina* and *Halecium halecinum*, rather than *Flustra foliacea*;
- Abundance of ascidians *Polyclinum aurantium* and *Archidistoma aggregatum*;
- Well-developed but patchy bryozoan turf;
- Mats of muddy tubes belonging to the spionid *Polydora ciliata*.

### Summary descriptions of biotopes identified from the video tapes

These descriptions are based on limited information taken from the analysis of the 2001 and 2002 video tapes. The quality of much of the video footage was poor due to the low underwater visibility and difficult sea conditions.

#### **Tide-swept bedrock, boulders and cobbles covered with foliose red and brown seaweeds and a hydroid turf.**

##### **National code**

**EIR.FoR** Foliose red seaweeds on exposed or moderately exposed lower infralittoral rock

**Location** Video blocks 6, 8, inshore south coast at South Landing and Old Fall  
**Wave exposure** Exposed  
**Tidal streams** Strong  
**Substratum** Bedrock, boulders, cobbles  
**Zone** Upper circalittoral  
**Depth** 4.5 – 6.5 m bcd

##### **Biotope description**

Mixed bedrock, boulders and cobbles with patches of coarse sand covered with a mixed hydroid turf and abundant foliose red and brown algae. There were patches of *Flustra foliacea* on bedrock outcrops and large boulders. The community looked rich with abundant *Calliblepharis ciliata*, *Nemertesia antennina* and *Sertularia argentea* identified. *Necora puber* was present.

#### **Mixed *Laminaria hyperborea* and *Laminaria saccharina* on moderately exposed boulders and cobbles**

##### **National code**

**SIR. LhypLsac** Mixed *Laminaria hyperborea* and *Laminaria saccharina* on sheltered infralittoral rock

**Location** Video block 6, inshore south coast  
**Wave exposure** Moderately exposed  
**Tidal streams** Moderately strong  
**Substratum** Boulders, cobbles,  
**Zone** Infralittoral  
**Depth** 3.5 - 4 m bcd

##### **Biotope description**

Boulder and cobble seabed with a dense kelp forest of a mixture of *Laminaria hyperborea* and *L. saccharina*. Red algae including *Delesseria sanguinea*, *Dictyota dichotoma*, *Ulva* sp. and *Laminaria* sporelings were common on cobbles.

**Clean, scoured boulders, cobbles and pebbles with *Pomatoceros triqueter*.**

**National code**

**ECR. PomByC** *Pomatoceros triqueter*, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles

**Location** Video blocks 10, 4, east coast beneath headland and extending offshore  
**Wave exposure** Exposed  
**Tidal streams** Strong  
**Substratum** Cobbles  
**Zone** Circalittoral  
**Depth** 16 – 29 m bcd

**Biotope description**

These were areas of scoured bare rock, boulders, cobbles and pebbles covered with *Pomatoceros triqueter*. The associated fauna was very sparse with small amounts of *Flustra foliacea*, *Urticina eques* and *Echinus esculentus*.

**Tide-swept bedrock with gullies covered with dense *Alcyonium digitatum* and hydroid/bryozoan turf.**

**National code**

**ECR.AlcSec** *Alcyonium digitatum* with *Securiflustra securifrons* on weakly tide-swept or scoured moderately exposed circalittoral rock

**Location** Video block 10, inshore east of Flamborough Head  
**Wave exposure** Exposed  
**Tidal streams** Strong  
**Substratum** Bedrock, boulders  
**Zone** Circalittoral  
**Depth** 6.9 – 7.5 m bcd

**Biotope description**

Bedrock and boulders with some large gullies covered with a dense, short bryozoan/hydroid turf and common *Alcyonium digitatum*. Other conspicuous species included *Delesseria sanguinea* and other unidentified red algae, *Alcyonidium diaphanum*, *Asterias rubens*, *Tubularia indivisa* and sparse *Nemertesia antennina*.

**Tide-swept silty bedrock dominated by *Flustra foliacea*.**

<b>National code</b>	
<b>MCR.Flu.Flu</b>	<i>Flustra foliacea</i> on slightly scoured silty circalittoral rock or mixed substrata.
<b>Location</b>	Video blocks 12, 13, offshore north coast
<b>Wave exposure</b>	Exposed
<b>Tidal streams</b>	Strong
<b>Substratum</b>	Silty bedrock
<b>Zone</b>	Lower circalittoral
<b>Depth</b>	18 - 22 m bcd

**Biotope description**

Silty bedrock ledges, ridges and gullies dominated by *Flustra foliacea* with clumps of *Alcyonium digitatum* and patches of hydroid turf. There were patches of muddy, shelly sediment between the bedrock ridges, and some boulders on the gully floors. *Pomatoceros triqueter* and pink crusts were visible through the silt covering the rock. Other species identified included *Thuiaria thuja*, *Abietinaria abietina*, *Alcyonidium diaphanum*, *Urticina felina*, *Haliclona oculata*, *Necora puber* and *Cancer pagurus*.

**Tide-swept mixed substrata *Sertularia argentea*, *Hydrallmania falcata* and *Lanice conchilega*.**

<b>National code</b>	
<b>MCR. Flu.SerHyd</b>	<i>Sertularia argentea</i> , <i>Sertularia cupressina</i> and <i>Hydrallmania falcata</i> on tide-swept circalittoral cobbles and pebbles.
<b>Location</b>	Video blocks 1, 2, 4, 6, 7, offshore south and east coasts
<b>Wave exposure</b>	Exposed
<b>Tidal streams</b>	Strong
<b>Substratum</b>	Boulders, cobbles, pebbles and gravel
<b>Zone</b>	Lower circalittoral
<b>Depth</b>	9 - 30 m bcd

**Biotope description**

The seabed was predominantly a muddy sand plain with cobbles, pebbles, gravel, occasional boulders and rock outcrops; in many places, the cobbles were clean with little silt. The cobbles and boulders supported a patchy turf of silty hydroids with species including *Sertularia argentea*, *Hydrallmania falcata* and *Abietinaria abietina* and rare patches of ascidian/bryozoan turf with *Polyclinum aurantium* present. There were occasional clumps of *Alcyonium digitatum* and *Flustra foliacea* on the more stable rock and boulders. Low-lying bedrock at the sediment plain level had abundant *Alcyonidium diaphanum*. The cleaner cobbles supported little apart from *Pomatoceros triqueter*. *Lanice conchilega* was common in the sediment and at a few sites there were some *Mytilus edulis* and possibly *Sabellaria spinulosa*. Other species present included the hydroids *Nemertesia antennina*, *Thuiaria thuja*, *Halecium halecinum* and *Tubularia indivisa*, the anemone *Urticina eques*, the starfish *Asterias rubens*, *Crossaster papposus* and *Henricia* sp. and *Cancer pagurus*, *Callionymus lyra* and *Haliclona oculata*.

**Mytilus edulis beds on tide-swept boulders, sand and low-lying bedrock.**

**National code**

**MCR. MytHAs**

*Mytilus edulis* beds with hydroids and ascidians on tide-swept moderately exposed circalittoral rock

**Location**

Video blocks 3, 4, 8, offshore headland, east coast extending to south coast

**Wave exposure**

Exposed

**Tidal streams**

Strong

**Substratum**

Boulders, cobbles,

**Zone**

Circalittoral

**Depth**

8.5 – 27.5 m bcd

**Biotope description**

The area off the headland had an undulating seabed of low-lying bedrock ridges, small boulders and muddy sand completely covered by dense *Mytilus edulis* with abundant *Asterias rubens*. There were scattered clumps of *Nemertesia antennina*, *Flustra foliacea* and *Alcyonium digitatum*, particularly on the bedrock, and occasional red algae at the shallower sites. Dead *Mytilus* shells were common, and the obvious fauna was relatively sparse. Other species seen included *Cancer pagurus*, *Alcyonidium diaphanum*, *Crossaster papposus*, *Pecten maximus* and *Liocarcinus depurator*.